

## NOTES & REFERENCES

### **Livestock Want Browse: Doable Methods For Use of Wild Woody Perennials**

NOFA NH Winter Conference, Saturday, February 11, 2023.

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\*\*\*Thanks to Northeast SARE (Sustainable Agriculture Research & Education) for funding Farmer Grant SARE FNE22-013. SARE is funded by NIFA (National Institute of Food & Agriculture).\*\*\*

### **Re-structure existing tree communities?**

Losses and gains:

- Immediate losses of forest climate contributions through evapotranspiration (tree breath),
- may possibly re-gain fully or reach higher levels than before in 15 to 30 years IF total climate situation allows, from new layers of understory plus increased health of leafy tree growth, and
- May possibly save the lives of trees that would otherwise become increasingly uprooted by storms.
- Immediate food for livestock
- Less dependence on open lands for food = less destruction and more restoration other places.

### **Will these trees recover and thrive if shortened to an accessible height?**

Tree size, age, species, vigor

- Young wood sprouts most reliably. Subsequent cuts are in brand-new wood.
    - For SARE FNE18-897 we cut within arm's reach from perches at all heights, or from ladders at short heights, with mostly 3" diameter cuts, unless larger growth was young and vigorous. Small branches were left.
    - Some folks have had success with large trunk cuts, providing the growth rate adds wood to attachment location fast, before fungal weakening of the old cut leads to breakage.
  - Species' responses differ:
    - Oak and beech have vast energy storage, rot resilience, and adventitiously sprout from cuts. \*Oak sprouts evenly along the trunk as well, for future climbing ease.
    - Ash sprouts vigorously, but waits for water sometimes.
    - Red maple sprouts well though rot enters cuts quickly.
    - Most birches and poplars need 1/3 of a healthy canopy left, as do conifers.
- (Yet felled or fallen poplars, browsed thoroughly on-site, re-leaf for a 2<sup>nd</sup> harvest in spring!).

### **Farmer tools, and vertical comfort zone**

- Cutting tool continuum: axes, billhooks, loppers, pole loppers, hand saws, saws-alls, chain-saws, pole chain-saws, Giraffes, feller-bunchers.
- Cutting is easily NOT safe. Be ABOVE your cut, if possible.
  - Long pieces bounce, tangle and back-fire, or split upwards and jack-knife.
  - Arborist hand-saws are VERY sharp.

Access methods

- Working up in the tree, cutting downwards, is less strenuous than from ground level.
  - Three body-points of support in a triangle make a solid plane of balance.
  - Body parts wrapped around = attachment points; have at least one.
  - A climbing harness offers 3 attachment points (make one cheaply from rope).
  - Ladder sides should extend past the trunk. Trees are better-rooted than ladders.
  - Ropes can be time-consuming to place; once well-placed, climbing is safe, and easy to learn (visit Shana for a free lesson, or stay late today for knot names and tips).
  - Cherry-picker lifts are pricey. One arborist near me has one with remote-control!
- Vertigo goes away if you stay still and wait calmly. Next time it will happen less.
- 2<sup>nd</sup> harvests are way easier and safer than initial re-structuring. (Get an arborist in winter!)

Leaf processing equipment (*added note, 2025*):

- Our Chain-Flail Leaf-Separator (highly effective 1st prototype) was built in a garage by a farmer. Parts list and photo-diagram are available, plus suggestions for improvements; search FNE22-013 Final Report on NESARE.org.
- Post-chipped sorting of leaf-matter from summer-harvested biomass is possible. (If you work on that, please tell Karl Hallen, SUNY ESF Willow Biomass and creator of above machine: (315) 416-1862. This machine is not copyrighted; please build, improve, and tell me about it!
- Leafy chipped or shredded branches (using a regular chipper) can also be ensiled (sealed anaerobically). Patient animals (Susan's sheep) will pick through leaving woodchips for bedding (my spoiled animals will not). If 1" butt or less branches are chipped, wood content is about 40% (taking up undue space in ensilement).

### **Soil hydrology, and temperature concerns**

- Woodland hydrologies are complex, fragile, and valuable. Trees of each species grow very specifically in the right spot. Observe across years, ruminant, decide 3 times, then cut.
- Tree foliage actively regulates air temperature (and provides moisture and seeding of rain).
- 20 acres of woodland cut to 50% canopy heated almost as much as 20 acres clear-cut (Strong et al. 1997). Even a 150 ft. diameter gap-cut heated a lot, but less than the 20 acre clearcut (my comparison across their 2 studies in same article).
- The IPCC agrees with "high confidence" that latent heat transfer by trees/plants has strong local climate effects (Jia et al. 2019). Carbon sequestration effects are less strong but more famous.

Patch size, sunlight and wind

- 1/3 day of full sun is minimum requisite for sprout health (Slotte 2000). Remember that intact surrounding woodland will continue to gain height, blocking sun.
- Varied heights of pollards in a patch may have sufficient sun if harvested in cycles together.
- Regularly harvested pollards are wind-proof; full-height edge trees are not. Sculpt the canopy with intact collaborations of taller trees at edges, ideally shielded by high pollards.

### **Timing**

- Energy reserves (non-structural carbohydrates) are in branches, roots and trunks.
  - Leaf-out depletes branch energy (Furze et al. 2019).
- Moon phase, weather, and seasonal dormancies
  - Traditions recommend cutting when moon is waning.
  - Shigo advises against cutting when trees are in transitions of energy relocation, yet trees I've cut severely before leaf-fall seem fine, and beeches cut to 50% before leaves mature in spring also seem fine.
- Livestock interest in fodder - make sure they want what you are going to cut!

### **Retain, encourage or plant trees to pollard in pasture?**

#### **How many, how tall?, and what will the grass do?**

- Benefits
  - Roots and root associates of pasture trees bring soil moisture to grass when most needed (Rydgren et al. 2020).
  - Tree root die-back parallels branch harvest, providing nitrogen to grass (Austad & Losvik 1998), and bestowing drought and flood resilience to soil (Ninemets & Valledares 2006).
  - Leaf drop in non-branch-harvest years offers another fertility contribution.
  - Yield of grass went down nearest trunks, but leaf fodder yield more than compensated (Rydgren et al. 2020). In a drought year, benefits to grass may outweigh losses for grass.
  - A one-boll (head, knuckle, sprouting place) tree offers a moving lollipop of shade.

- Shadow of a high boll moves more than that of a low boll (way more than a coppice stool).  
\*Animals distribute manure as shade moves.
- Multiple bolls give animals more shade. Thinning versus complete branch harvest retains shade, and was traditional some places, to be easier on the trees (Austad & Hauge 2014).
- Field pollards: In the 1700s most trees and shrubs were retained; pastures were heavily pruned versus cleared. Trees were generally cut at about 3 meters (varying per reach of browsers).  
\*Tree and shrub species self-select to be in the right places.
- Protection of small trees
  - Eliot's 14 gauge 2"x 4" welded wire fence circles, made dangerously spiny by cutting every other 4" vertical wire in half at a steep angle, and bending outwards. (The holes now 4" square may not be goat-proof, despite spines; sheep and cattle do stay away.)
  - Shana's 1 liter soda bottles with both ends removed, stacked on two fence rods, then some stacks spiraled with electrified fence wire.
  - Shana's various triangles of electric fencing in line with rest of fence, often at corners.
  - Traditionally thorny brush was tied around young trees. In Morocco small stone wall circles are placed, to protect each tree from sheep (Colloque Trognés 2019, Sare, France).
- Plantation production
  - Steve Gabriel's SARE FNE19-930 tested nutrition and growth of black locust, willow (which?), cherry (black?), poplar (quaking), European buckthorn, honeysuckle.
  - SUNY EFS Willow Biomass is cut and chipped using a large forage harvester.

### **Herd size & desired feed proportion**

- How many trees are needed, for how many animals?
  - Lineaus fed 12 sheep in winter solely from 100 large basswood pollards, cutting 33-4/yr.
  - One 20 yr. old cherry yielded 35 gallons of leaves tightly packed - about 115 lbs. of leaves; one 40 yr. old oak's 8 yrs. growth yielded 57 gals. leaves – about 175 lbs. (Hanson 2023).
  - Yield of *eaten* portion from initial restructuring of deciduous woodland was ¾ the average hay yield that yr. (Hanson 2020) (and goats waste 1/3 of hay).  
\*Traditional sources say yield of pollarded woodland was equivalent to that of good hay land (Brauner 1756), and  
\*the best leaves were more nutritious than the best hay (Machatschek 2002).
  - SARE FNE22-013 winter 2023-'24 trials aim to determine *how much separated leaf silage* various animal groups wish to eat, free choice offered for 1 hr. twice/day .  
\*Cattle are said to generally want 12% browse, sheep 20%, goats 60% (Whistance 2021) varying per group and individually, both innately *and by experience*.
  - *Added 2025 note:* My steer ate 33% of his diet as leaf-silage, by choice in our 2023-'24 SARE FNE22-013 winter trial. Susan's sheep are eager to eat as much tree forage as are my goats.

### **How much leafy matter can the farmer, animals, zip line, tractor or truck carry or transport?**

- A ton of leaf-bearing brush yields about 800 lbs. leaves (Hanson 2023).  
\*Traditional sheaves averaged 800 grams (1 ¾ lbs.) edible portion (Austad & Hauge 2008 citing Lund 1917), and a person could harvest 60 to 100 in a day, and carry 6 to 12 with leaf tips held in hands on shoulders (another person must help load, for 12).
- Stripping into a barrel with leaf-separating machine, or snapping leaf bunches into a hay bag or container by hand, makes transport easy; the ramial wood remains to benefit trees.
- Chipping (for cattle) or coarsely shredding (for goats and sheep) and packing into airtight containers means less ramial on-site fertilization, but more bedding wood for animals' yard.

- Chips steadily blown into a dump truck stayed anaerobic, fresh versus composted, all day.

### **Can animals visit the branch harvest site instead? Will they benefit or damage that place?**

- 7 goats rarely divide on a free wander, but if more they may. 300 sheep (or goats?) can be herded with help of one good dog.
- Different damages per animal group:
  - Goats are careful of wet places, but strip bark off and kill certain shrubs (witch hazel, striped maple), or browse certain tiny trees too hard (hemlock, cedar, apple...) if not watched closely.
  - Cattle can destroy stream banks and make wet places muddy, as they like stepping into water and have large feet. They browse certain small trees too hard, and may rub certain conifers too hard, but rarely strip bark to eat.
  - I haven't wandered with sheep; my impression is that Susan's sheep damage bark and Eliot's don't.
- \*Damages vary by season. (Habitual paths in deep snow used to work well for me.)
- \*If the cut fodder you are bringing them to is high priority feed and you limit their length of stay, damages are minimized.

**Will animals haul or carry branch or leaf loads backwith them?** (My cow pulled sleds loaded with barrels; my Guinea sow pulls a sled full of brush even when she would rather just eat it!)

### **Storage**

- Traditional racking and stacking methods were state-of-the-art (takes families in villages).
  - Beneficial slight fermentation happened from tight initial placement on the drying racks (Machatschek 2002). See Slotte 2000 for great historic pictures.
- Drying leafy branches under tarps is faster, but adds microplastic and/or expense.
  - Vertical with butts downward around a post works great.
  - Wrap a rope when you add a load. Unwrap as you bring animals there to eat.
- Drying leafy matter in the barn
  - Eliot Van Peski stores a loose pile of small twigs with leaves in a huge barn.
  - Sy Schotz layered leafy twigs into tight loose-hay stacks in the barn – helps dry hay.
  - Susan Littlefield strips dried leaves off branches into 1 ton tote bags.
  - Shana stores a small number of traditional sheaves in the hay loft, put in when fresh.
- Ensiling
  - Air within container is okay if sealed.\* (\*but see last bullet!)
  - Fresh aromas collect in the container (though plastic containers or bags may impart toxins).
  - Some farmers layer tree matter in the bunker on top of grass, in England (Whistance 2021). My experience indicates that layers within should be okay too (harvest times may dictate).
  - Chipped or shredded: 1" butts = 60% edible. (Austad et al. 2003, Hanson 2020<sup>a</sup> & 2020<sup>b</sup>).
  - New leaf-separating machine: See Hanson 2023.
  - Traditional piles of partially dry raked leaves under shelter, or possibly in the open, were slightly watered just right to ferment but not compost (Machatschek 2002). *These piles were NOT sealed.* (Also see Turner 1955 or 2009 re: outdoor herbal/grass silage.) Dampening and trampling each layer is necessary (city leaf piles unfortunately compost).

### **Feeding logistics & Woody waste**

- Leaves\* (\*Can partner with arborists in summer for additional leafy branches.)
  - Hay mangers work for leaves and small branches.
  - Hay bags work for twiggy leaf bunches or stripped leaves.

- Traditional sheaves of leafy branches keep their form when eaten, for next use as fuel for the masonry heater. \*Linnaeus soaked basswood twigs to strip bast for rope, before burning.
  - Tied armloads of larger branches are quicker to gather and transport.
    - Goats can get every leaf out (even from thorny multiflora rose!) without untying.
    - Hang from a wooden tripod, tree limb, or barn beam, or just place on a brush pile.
- \*Different animal groups make different fodder choices; pass rejections to another group.
- Bark\* (\*Can partner with loggers for additional maple tree-tops in winter.)
    - Goat (AND my calf - he has learned from them) bark-stripping in winter takes more strenuous handling, to expose uneaten sides of sturdy branches.
      - Nose height is key; poopy climbing footprints cause refusal.
      - Bark stripping is *temperature* dependent. \*Norwegian farmers used draw-shaves.
  - Conifer greenery\* (\*This is another opportunity to partner with loggers.)
    - Try chipping Norway spruce (traditionally cut for bedding, but choice feed for us).
    - Try chipping hemlock, unless a terribly droughty year with high tannins (but do you still have any that are healthy? Predatory beetles for wooly adelgids...).
    - Try feeding dried hemlock needles (they drop off of dried branches).
    - White cedar is choice and easily hand-snapped (but growing less in droughts).
    - White pine: *some* fresh needles in winter, *LOTS* of fresh *bark* in spring/summer.
      - Pollarded pine shelters serve my goats well in the summer pasture.
    - Red or black spruce: Susan's sheep devour! My goats just want *young trunk bark*.
    - Fir – In winter or early spring, my animals want:
      - side buds/tips of *tiny* trees
      - all greenery from top portions of *some* larger trees
      - all bark from top portions of *some other* larger trees
      - all greenery *and* bark from top portions of rare especially tasty trees.

\*My Jersey calf desires more fir tips than do the goats.
  - Woody brush refuse
    - Leave in the winter woods yard, to become moist mulch then soil, to feed the pollards.
      - Saw through with chainsaw,\* to bring closer to soil, to speed decomposition (\*carefully – various angles of branches throw chains off easily).
      - Leave as is. After a couple years, break it downwards by walking on it.
      - Plant choice seedling trees and bushes within (or see what germinates spontaneously), and leave as protection from livestock on browse walks.
    - Weave a wattle fence around the enriched winter yard (re-use cattle panels for next yard).
    - Build mangers, cribs, hay forks, hay rakes, shovel handles, door handles, yokes, coat racks, music stands, chairs...
    - Chip for bedding.
    - Make biochar:
      - See [3streamsfarmbelfastme.blogspot.com](http://3streamsfarmbelfastme.blogspot.com) for a short video of our open-fire method.
        - Two days of piecing up the winter tangle with a chainsaw into armloads, and
        - some work filling a couple barrels of water if not next to a water source, then
        - 20 minutes of actual burning, with two people or more feeding armloads, makes
        - 1 ½ to 2 yards of biochar.
      - Paul Hand does similarly, but over a curved conical pit, the inverse of our final pile of char. He used to use a barrel method, but discarded that as less preferable.

## REFERENCES:

- Austad, Ingvild, Braanaas, Anders, and Haltvik, Marvin (2003). Lauv som ressurs; Ny bruk av gammel kunnskap. Sogndal: Hogskulen i Sogn og Fjordane (HSF rapport nr. 4/03). *This study used modern harvest methods on old pollards, fed chipped fodders to sheep, and looked at sheep health, labor time/costs, nutritional analyses etc. and found economic feasibility.*
- Austad, I. & Leif Hauge. (2008). The fjordscape of inner Sogn. In Nordic Landscapes, edited by Michael Jones & Olwig, 372-400. Minneapolis: University of Minnesota Press. *This describes seasonal farmer relocation/transhumanence with pastures and pollards over an extensive landscape, then abandoned for government incentives toward agricultural intensification. They note that Lunde (1917) measured 800 grams edible portion per sheaf, 1 meter long. Slotte (2000) describes the “neck” with thumbs touching middle fingers.*
- Austad, I. & Hauge, L. (2014). Trær og tradisjon. Bruk av lauvtrær i kulturlandskapet. (Trees and tradition: Use of leaf-trees in the cultural landscape.) Fagbokforlaget. ISBN: 978-82-11-01905-9. *A wealth of info, illustrated. Can email me for partial typed notes in English.*
- Austad, I. & Losvik, M.H. (1998). Changes in species composition following field and tree layer restoration & management in a wooded hay meadow. *Nordic Journal of Botany* 18 (6) 641-662.
- Furze, Morgan E., Brett A. Huggett, Donald M. Aubrecht, Claire D. Stolz, Mariah S. Carbone, & Andrew D. Richardson (2019). Whole-tree nonstructural carbohydrate storage and seasonal dynamics in five temperate species. *New Phytologist* (2019) 221: 1466–1477.
- Hanson, Shana (2020<sup>a</sup>). Tree Leaf Fodder for Livestock; Transitioning Farm Woodlots to “Air Meadow” for Climate Resilience. <https://projects.sare.org/project-reports/fne18-897/>
- Hanson, Shana (2020<sup>b</sup>). Lab Nutritional Analysis of Ensiled Tree Leaves and Ensiled Chipped Leafy Branches, with Dried (non-ensiled) Comparisons, plus Average Grass Fodder Comparison, and Relation to Animal Responses. Accessed 7/20/20. <https://www.google.com/url?q=https%3A>
- Hanson, Shana (2023). SARE FNE22-013 Annual Report: Efficient Leaf-dense Tree/Shrub Silage Production from Field Edges: Climate-resilient Winter Forage Supplement for Cattle, Sheep and Goats. Posted by Northeast SARE, and at [3streamsfarmbelfastme.blogspot.com](http://3streamsfarmbelfastme.blogspot.com)
- Jia, Gensuo & Elena Shevliakova, Coordinating Lead Authors (plus 10 more Lead Authors, 31 Contributing Authors, & 3 Review Editors) (2019). Chapter 2: Land-Climate Interactions. In IPCC Special Report on Climate Change and Land. *Describes “high confidence” of latent heat transfer by trees/plants providing local temperature control, with “low confidence” of global effects, mostly due to glitches in computer-modeling it seems.*
- Machatschek, Michael (2002). Laubgeschichten (foliage stories); Gebrauchswissen einer alten Baumwirtschaft, Speise – und Futterlaubkultur. Wien, Bohlau. 542pp., ill. *A wealth of info about historic practices, with lots of pictures. Available Inter-library loan thru ‘Worldcat.’*
- Meuret, Michel & Provenza, Fred D. (2015). When Art and Science Meet: Integrating Knowledge of French Herders with Science of Foraging Behavior. *Rangeland Ecology & Management*, 68/1, Jan., pp. 1-17. *This article summarizes how herders enable their animals to eat up 1/3 more, supporting growth and productivity. Also see book: The art and science of shepherding.*

- Ninemets, Ulo, and Valledares, Fernando (2006). Tolerance to shade, drought, and waterlogging of temperate northern hemisphere trees and shrubs. *Ecological Monographs*, 76(4), pp. 521-547.
- Read, Helen J. (2003). A study of practical pollarding techniques in northern Europe; Report of a three month study tour, August to November 2003. Sent on CD by the author, 2011. PDF accessible from <https://google.com> by title search March 1, 2021, posted by www.ancienttreeforum.org.uk. *She visited 8 countries; very thorough account. See especially "Compilation of notes on pollarding" at end of report.*
- Rupp, Mathias (2013). Creation of open woodlands through pasture: Genesis, relevance as biotopes, value in the landscape and in nature conservation in south-west Germany. *Wood-pastures are forbidden in Germany, yet these farmers struggle to restore the species-rich ecology they remember from childhood*. In Rotherham, I. (ed.) (2013) Trees, Forested Landscapes, and Grazing Animals: European Perspective on Woodlands and Grazed Treescapes. Oxon, UK and NY, NY: Routledge.
- Rydgren, Knut, Ingvild Austad, Liv Norunn Hamre, Joachim P. Töpper (2020). Wooded hay meadows as viable production systems in sustainable small-scale farming. Copyright Springer Nature, published online: 28 November 2020. Also, *Agroforest Syst* (2021) 95:165–176. *They found increased total yield when pollards are included, plus ecological benefits.*
- Slotte, Håkan (2000). Lövtäkt i Sverige och på Åland; Metoder och påverkan på landskapet. Uppsala: Acta Universitatis Agriculturae Sueciae, Swedish University of Agricultural Sciences (Agraria no. 236). *An incredible collection of museum pictures of leaf harvest, even if you can't read the Swedish. Good how-to directions about historic leaf harvest, storage and feeding in Sweden. Available Inter-library loan thru 'Worldcat' (university libraries).*
- Strong, Terry F.; Teclaw, Ron M.; Zasada, John C.(1997) Monitoring the effects of partial cutting and gap size on microclimate and vegetation responses in northern hardwood forests in Wisconsin. In: Communicating the role of silviculture in managing the national forests: Proceedings of the National Silviculture Workshop. 1997 May 19-22; Warren, PA.: Gen. Tech. Rep. NE-238. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station. 42-47. *My summary from studying graphs: Temperature effects are extreme even in small gaps, though the 20 acre clear-cut in their one study hit much higher temps than any in their gap study. Leaving 50% canopy cover in a 20 acre cut buffered cool nighttime temps but did little re: hot daytime highs. Intact forests most strongly mediate temperatures.*
- Turner, Newman (1955). Fertility pastures: Herbal leys as the basis of soil fertility and animal health. London: Faber and Faber. *Talks about small outdoor piles of silage. 2009 edition, Acres USA.*
- Walder, Michael (2017). Tree hay for meat goats. *Acres USA*, May, pp 24-26. *Michael has pollarded areas of woodland, trims and carries edible portions very quickly with arborist skill and hand tools, bales with a contraption I think, dries, shreds refused twigs to grass texture and re-feeds.*
- Whistance, Lindsay (2021). Farming, animals, and trees. In Tree fodder webinar hosted by Steve Gabriel, Wellspring Forest Farm, December 10, 2021. Accessed 2/16/22. <https://www.youtube.com/watch?v=hCJYKhOZt58&list=PL3dng73x0WAQKUQKFWM12Ky2DkHgub7rt&index=4> *Lindsay gives in-depth description of benefits of silvopasture for livestock.*