Forage use of Northeastern woody species to feed ruminants (and hogs)

Part 1, Sept 8th, 2025:
Forage use of Northeastern woody species: Opportunities within existing silvopastural systems

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Ruminants have digestive discernment abilities

Angelo and a goat eating Balsam Poplar (sometimes too aromatic), at 3 Streams Farm

Booth, 2008, p 50
Drawing from an
8th Dynasty tomb

Ruminants/humans/trees evolved together.

Figur 66. Alträd hamlas ”stäcks”. Aspkil, Kumlinge socken på Åland. Foto H. Renlund 1947. FMK 143:147.

Museum photo from Slotte, 2000, p 117

All species were used.

Leaf-silages at 3 Streams Farm, Dec. 20., 2021

The archeological sign of tree-based animal husbandry is...

No soil erosion.

Trees give multiple gifts to the soil and ground-plants:

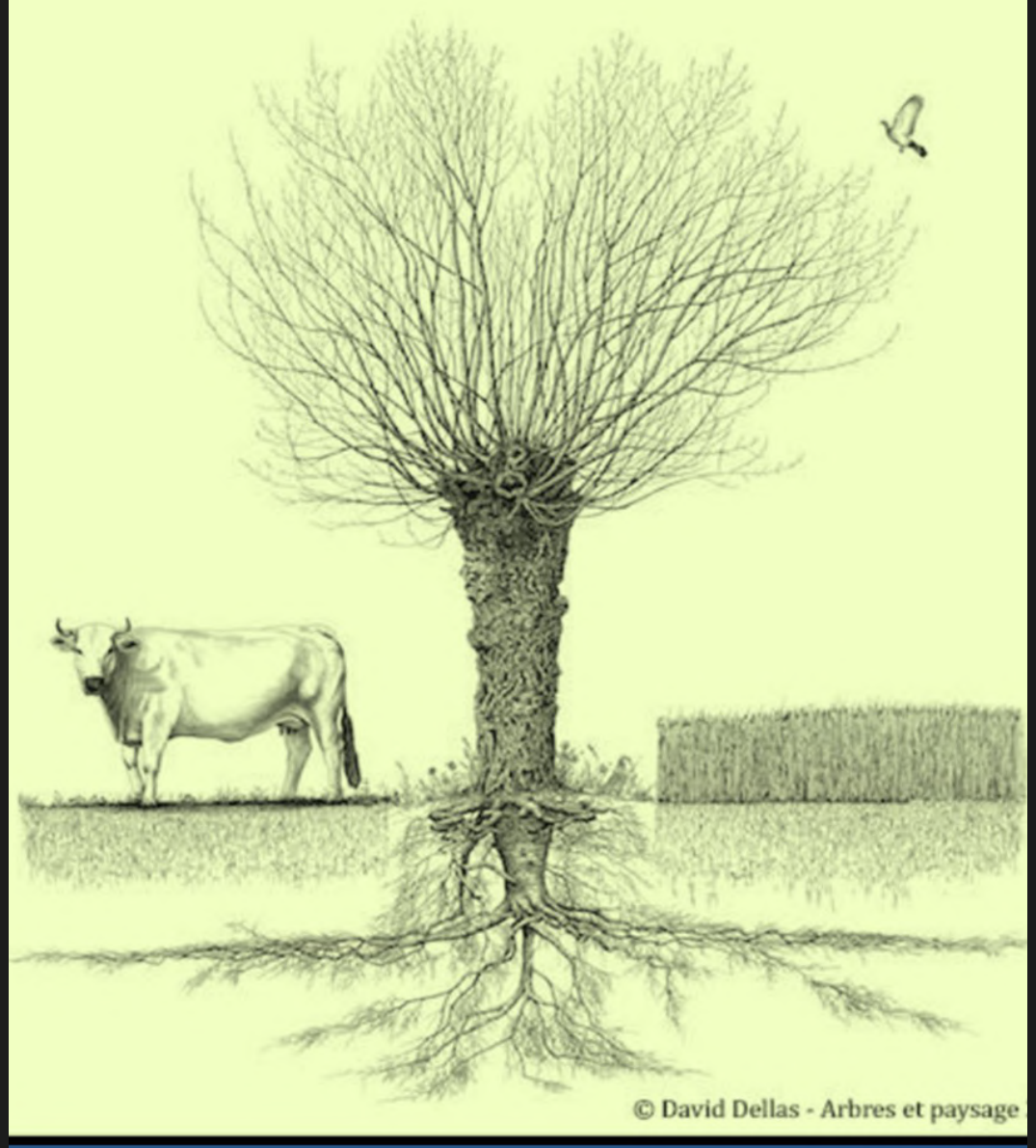
Tree root turn-over (die-back and re-growth parallel to top harvests) is the best assurance of soil resilience to both water-logging and drought, plus releases Nitrogen to crops beneath.

Tree leaf-drop fertilizes in years between harvests.

Trees exude nutrients underground, from their superior storage reserves.

They with their fungal associates draw up more moisture than they use, and share that moisture with the community.

David Dellas drawing >



Balanced antifeedants and minerals are medicine.

(not pregnant)

The more variety of forages, the more ruminants eat.
Access to grass or hay = MORE tree matter consumed (& vice versa?)

Nutrition of Leaf-Silage

- Slow to ferment & mold resistant: More stable over time than grass or corn;
- 2-3x as much Non-Fiber Carbs (NFC) as grass silage (DM basis);
- High varied mineral content, averaging nearly 2x the Calcium of grass silage;
- Mostly lower Soluble and Degradable Protein than grass forages,

  with exception of high-protein Autumn Olive;
- 147% of the Fat level of grass silage, due to cutin & wax leaf-coatings.

  Ensiled leaves consistently had more fat than fresh leaves (averaging 111% of fresh level).
  Perhaps the rise is in wax coatings, as the leaves suffocate?
  Can the wax coatings break down to become digestible fats for ruminants? (...or just for soil?)

Ensiled machine-separated TREE LEAVES, with varying amounts of twigs included; Dairy One forage analyses

	Dry Matter	Crude Protei	Availa P	ADIC P	Adj CP	Sol P %CP	RDP %CP	SP %DM	RDP %DM	ADF	NDF	Dig F	NFC	WSC	Fat EE
2ND CUT HAY PACKED 12/21/23	81.4	18.6			18.60	33.00	70.00	6.14	13.0	35.9	57.6	21.7	13.9	7.5	
1ST CUT HAY PACKED 12/21/23	83.00	9.40			9.40	28.00	62.00	2.63	5.8	38.50	64.30	25.8	16.3	9.70	
Dairy One Ave 2004-'24 Grass Hay		11.03				33.94	65.02	3.74	7.2				19.4	11.3	2.63
Dairy One Ave 2004-'24 Grass Silage		15.48				53.19	70.70	8.23	10.9				16.8	7.96	3.97
Ave 9 Woody Species	43.20	12.32	8.36	3.95	8.57	15.00	23.85	1.84	2.8	25.92	37.51	11.6	37.1	9.88	5.85
Red Oak Aves	47.08	14.66	11.84	2.80						28.60	45.96	17.4		5.35	6.50
Quaking Aspen Aves	39.93	14.18	10.10	4.07	11.10	11.50	18.00	1.63	2.6	23.50	33.15	9.7		11.17	
Big-Toothed Aspen Aves	39.05	13.52	8.61	4.90	9.70	11.38	18.75	1.59	2.5	25.35	36.30			10.78	
White Ash Aves	41.92	11.08	6.58	4.48	7.58	18.00	19.20	1.99	2.1	26.75	39.20	12.5		8.38	
Green Ash Aves	41.88	12.98	7.98	5.00	8.98	21.75	27.75	2.82	3.6	28.60	41.23	12.6	22.90	7.45	4.90
Black Cherry Aves	41.12	13.47	10.28	3.19	11.83	19.70	20.75	2.65	2.8	22.19	30.02	7.8	42.50	8.77	4.90
Gray Birch Aves	45.91	11.56	6.66	4.89	5.83		(54)			31.87	44.40	12.5	33.78	8.24	6.98
Red Maple Aves	44.86	9.98	7.66	2.30	7.00	13.67	32.50	1.36	3.2	23.50	33.30	9.8	39.63	14.48	7.37
Rock Maple Aves	47.10	9.45	5.55	3.90	6.55	9.00	30.00	0.85	2.8	22.90	34.05	11.2	46.70	14.30	4.45

Non-Fiber Carbohydrates are amazing.
Crude Protein is respectable. ADICP may or may not accurately describe limits on utilization.
Curiously, ensiling increased Fat Ether Extract by 10.89% of fresh level, across 16 species.

SHRUB LEAVES; Dairy One forage analyses

Harvest Site, Species, Harvest Date	CT 1-10	Dry Matter	Crude Prot	Avail P	ADIC P	Adj CP	Solu %CP	Degrbl %CP	Solu %DM	Degrbl %DM	ADF	NDF	NFC	% WSC	CrFat EE	pH
FVF BITTERSWEET FRESH 6/28-29/24		24	17								25.4	36.5	31.5	8.6	6.3	5.8
FVF MULTI-FLORA ROSE FRESH 6/30/24		23.3	14.1								21.7	32.7	41.1	17.8	4.4	4.9
MOFGA AUTUMN OLIVE ENSILED 7/5-6/23		39.3	21	16.6	4.3	17.6	23	50	4.83	10.5	33.7	52.3	17.9	5.6	3.1	4.8
MOFGA HONEYSUCKLE FRESH 6/25-26/23	1	31.3	11.1			11.1	13	48	1.44	5.33	29.9	45	31.8	13.6	5.2	5.3
MOFGA HONEYSUCKLE ENSILED 6/25/23		25.4	14.9	8.7	6.2	9.7	13	25	1.94	3.73	30.9	43.8		4.3	ot re	5.2
YKF SMOOTH BUCKTHORN FRESH 9 /7/23	3.5	32.6	14.3				failed	failed			20.3	32.5	39.8	15.3	6.3	5.3
YKF SMOOTH BUCKTHORN ENSI'D 9/7/23		31.8	15.4	12.4	3		failed	failed			25.9	38.9	31.4	6.5	7	5.4
YKF LEATHER WOOD FRESH 9/14/23	5	45.2	9.5			9.5	4	26	0.38	2.47	27	36.5	40.9	16.5	7.4	5.2
YKF LEATHERWOOD ENSILED 9/14/23		45.9	8.7	3.4	5.3	4.4	5	9	0.44	0.78	32.4	43.2	34.3	13.9	8	5.8
YKF WINTERBERRY FRESH 9/15/23	3.5	43.5	11.7			11.7	6	33	0.70	3.86	27.6	43.4	34.5	9.6	5.9	5.7
YKF WINTERBERRY ENSILED 9/15/23		41.8	12.6	7.1	5.5	8.1	12	24	1.51	3.02	31.4	49.2	27	4	6.1	5.4
MOFGA ARROW WOOD FRESH 6/25/23	5	39.1	12			12	12	23	1.44	2.76	31.4	43	32.5	9.4	6.4	5
MOFGA ARROW WOOD ENSILED 6/25/23		36.2	12.8	5.4	7.4	6.4	15	20	1.92	2.56	36.2	49.7	25.3	5.1	6.4	4.6
YKF STAGHORN SUMACH FRESH 6/25/24		33.3	14.9								16.9	22.9	52.2	27	5.1	4.7

Condensed Tannins

rated 1 to 10 (by darkness of liquid);
Higher rating = comparatively more.

0 White Ash

1 Green Ash, Honeysuckle, Pagoda Dogwood

1.5 Creeping Blackberry

3 American Basswood

3.5 Winterberry, Smooth Buckthorn, Norway Maple

5 Red Maple, Rock Maple, Black Cherry, Pin Cherry, American Elm, American Beech, Arrowwood, Leatherwood,

5.5 Red Oak

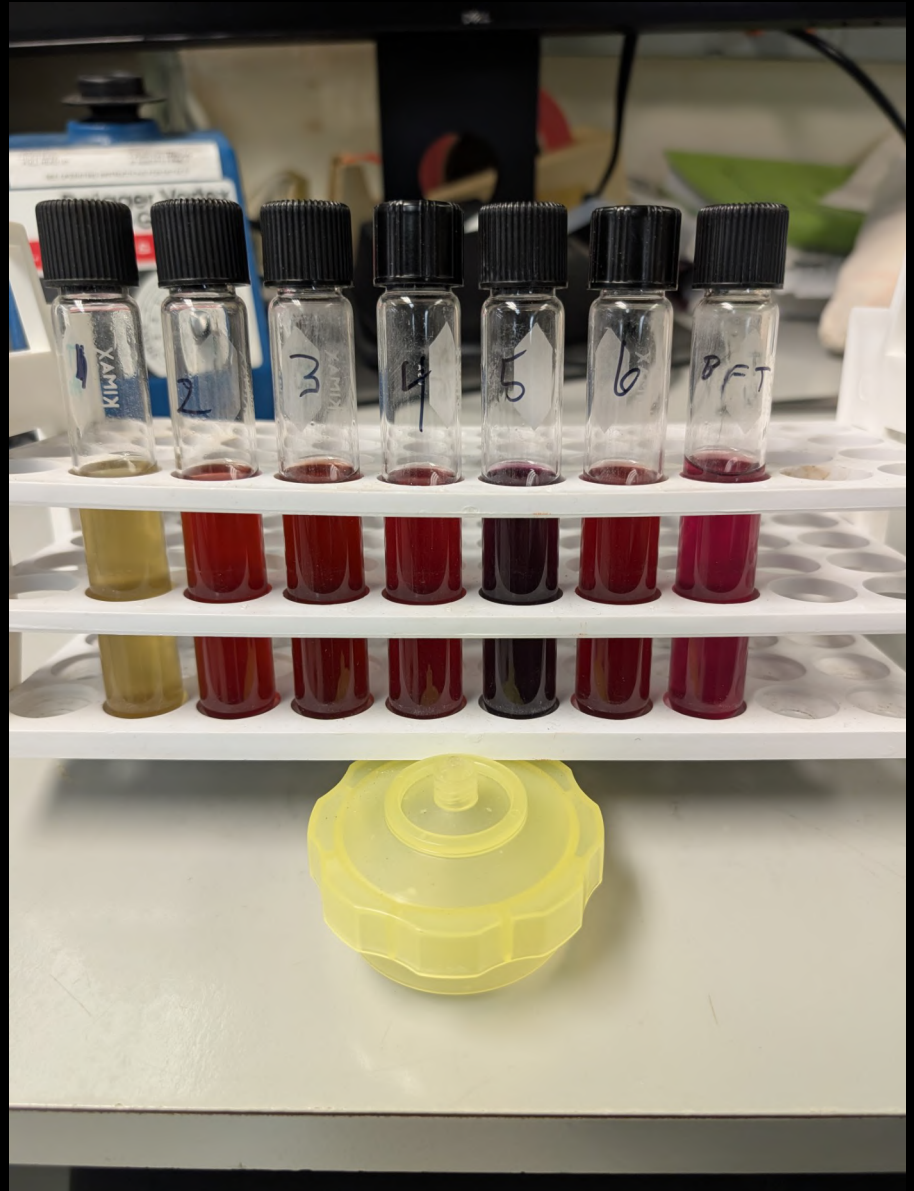
6 Box Elder, Birdsfoot Trefoil

7 Gray Birch (catkins were same), Quaking Aspen, Big-Toothed Aspen,

8 White Birch

10 Black Locust

from Wayne Zeller's 4/03/24 data chart



Wayne Zeller's 2nd screen of Waldo County, Maine tree/shrub leaves for relative levels of Condensed Tannins

USDA ARS
US Dairy Forage Researh Center,
Madison, WI

All >5 except Sumac.

From left to right:
Staghorn Sumac fresh
Multi-floral Rose ensiled
Bittersweet fresh
Apple ensiled
Striped maple fresh (this is rated a 10)
Hybrid Willow ensiled
Birdsfoot trefoil reference

Wayne Zeller photo, 1/23/25, 11:07AM

Our 2025 Condensed Tannin findings will include:

Digestibility & methane in a continuous-feed rumen simulator

CT date comparisons on Am. Beech,
Gray & White Birches,
Quaking & Big Toothed Aspen, &
Striped Maple;

Screening of comparative levels of CT in
many more tree & shrub species, plus choice ferns;

Structure & identity of CTs in
all tree & shrub species which I've laid hands on.

(Prior research has focussed on bioengineering forage legumes to produce CT.)

Forage species are diverse.

Bendable shrubs
vary in bark palatability*

Beaked & Am. Hazels
Winterberry
Buckthorns*
Witchhazel**
Pagoda Dogwood***
Alder(*)
Autumn Olive*

Side-sprouting trees
can become saw logs

Oaks

Adventitious sprouts
may repair trunk cuts

Oaks, Beech
Ashes, Maples (small D)
Cherry, Apple, Mulberry

Birches, Aspens & Conifers
sprout less & need lots of foliage left.

In Morocco, multiple stalks of certain bendable shrubs are twisted together
..to form sheep-proof pollards, which offer staple fodder in their dry season.

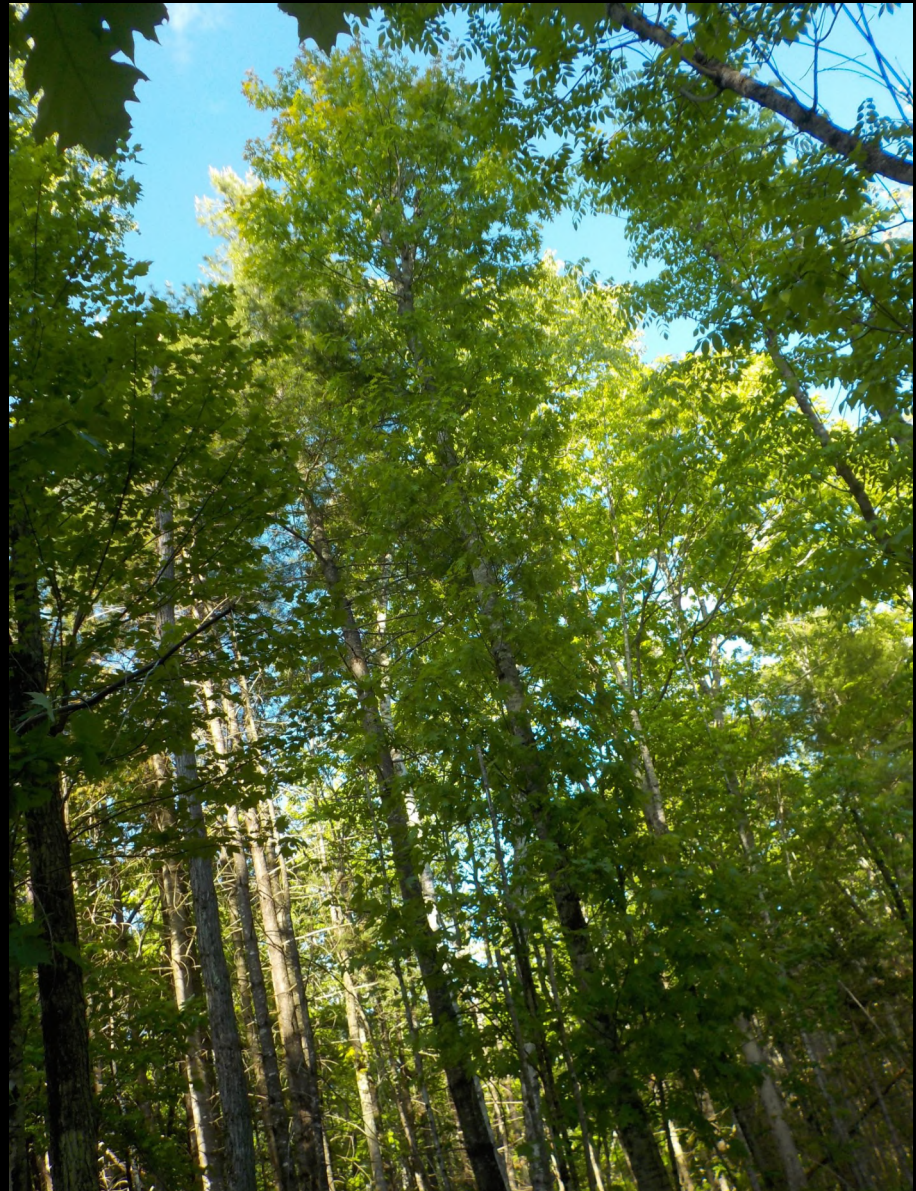
Witch Hazel

Autumn Olive >

Smooth AKA Glossy Buckthorn

Forage species are diverse.

Side-sprouts on previously bare trunks of Red Oak



Adventitious sprouts

This is an old photo of an American Beech which I cut at shoulder height, simply to not hit a fence.

My Beeches grow slowly, but persist.

Root sprouts vs
basal (stump) sprouts

MOFGA 18-year pasture-edge spread of quaking aspen

MOFGA 18 yr field-edge growth of Q Aspen			
	15 ft deep		39.933%DM
lbs DM per trunk	ft^2 per trunk		lbs DM per lin ft
8.595	28.85 = 5.37 x	5.37	4.47

Animal (response to trees/plants)-driven harvest timing details

Seasons of palatability
& toxins

Digestibility
& need for rumen adjustment

Austin, P.J., Suchar, L.A., Robbins, C.T., & Hagerman, A.E. (1988).
Tannin-binding proteins in saliva of deer and their absence in saliva of sheep and cattle.
Journal of Chemical Ecology, Vol.17, No.4.


Felled white birch in late spring

Tree/plant-driven harvest timing & cutting details

Kays, Jonathan S., and Canham, Charles D. (1991).
Effects of Time and Frequency of Cutting on Hardwood Root Reserves and Sprout Growth.
In *Forest Science* vol. 37, No. 2, pp. 524-539

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.

Our 2024-“25 findings on Maple species with notable intake limits

Species	Site	Gallic acid (ug/mg)	Hydrolyzed Gallic acid (ug/mg)	Free ellagic acid (ug/mg)	Hydrolyzed Ellagic acid (ug/mg)	Hypoglycin A (HGA) peak area	Hypoglycin B (HGB) peak area	Methylenecyclpropylglycine (MCPrG) peak area	γ-glutamyl-MCPrG peak area
Staghorn Sumac	Belfast Rail Trail, Belfast	20.34	5.45	n.d.	n.d.	11904	n.d.	6413	1621
Staghorn Sumac	Old Belmont Rd., Lincolnville	20.28	52.13	n.d.	n.d.	6043	n.d.	8600	1664
Staghorn Sumac	Y Knot Farm, Belmont	24.01	24.98	n.d.	n.d.	7562	n.d.	7955	1332
Box Elder	Belfast Rail Trail, Belfast	12.61	5.46	n.d.	n.d.	14908	29957	3117	5015
Box Elder	Hunt Rd., Unity	12.89	5.01	n.d.	n.d.	11351	25632	7507	10652
Box Elder	MOFG Kitchen, Unity	12.59	33.76	n.d.	n.d.	17159	161409	7623	52148
Red Maple	Belfast Rail Trail, Belfast	52.48	26.21	n.d.	0.17	2655	n.d.	42351	629
Red Maple	3 Streams Farm, Belfast	35.18	21.4	0.16	n.d.	1429	n.d.	36843	n.d.
Red Maple	Y Knot Farm, Belmont	73.04	6.07	1.20	0.70	1712	561	28661	n.d.
Sugar maple	Belfast Rail Trail, Belfast	15.25	0.32		21.18	5153	n.d.	8692	1020
Sugar maple	3 Streams Farm, Belfast	16.16	4.26	6.05	21.25	74983	934	11062	609
Sugar maple	Y Knot Farm, Belmont	13.91	7.1	0.17	14.65	70984	n.d.	10416	1286
							n.d.		
Norway Maple	Belfast Rail Trail, Belfast	17.83	26.88	n.d.	0.18	755	n.d.	2598	1733
Norway Maple	3 Streams Farm, Belfast	13.48	0.52	n.d.	n.d.	4174	n.d.	8921	1353
Norway Maple	Y Knot Farm, Belmont	13.36	0.56	n.d.	n.d.	5426	n.d.	14890	1899

Thanks to MU Metabolomics Center, & MU Center for Agroforestry

Hydrogen Cyanide in Cherry leaves

Cherry species are sometimes toxic.

Animals at many farms seem to sense & honor safe intake limits.

There seems to be reduced safety threat in 60 day ensiled Cherry leaves, bur toxic exceptions are possible, especially when fresh levels are high, as in spring growth.

Drying does not always ensure safety, either. More data is needed!

Iowa State Veterinary Diagnostic Labortory Cyanide Analyses on Cherry Leaves

*Ensiled samples were drawn and frozen in winter or early spring.
June-harvested samples had more warm weather for fermentation than did October-harvested.

Harvest Date	Site, Sample Description	HC ppm as fed	Moisture %	HC ppm DM
09/29/22	YKF Black Cherry, Fresh	123.8	60	309.50
09/29/22	YKF Black Cherry, Ensiled	22.3		
06/27/23	MOFGA Black Cherry, Fresh	201.9	62	531.32
06/27/23	MOFGA Black Cherry, Ensiled	<50	66	<147.06
06/29/23	MOFGA Pin Cherry, Fresh	115.3	58	274.52
06/29/23	MOFGA Pin Cherry, Ensiled	<50	67	<151.52
10/11-12/23	YK WW Black Cherry, Fresh	113.4	58	270
10/11-12/23	YK WW Black Cherry, Ensiled	<50	64	<138.89
	(left out 24 hrs on a gray day)			

Level of prussic acid in forage (dry matter basis) and potential effect on animals

ppm HCN	Effect on animals
0-500	Generally safe; should not cause toxicity.
600-1,000	Potentially toxic; should not be the only source of feed.
1,000 and above	Dangerous to cattle and usually will cause death.

An afterword: My subsequent Cyanide findings in Cherry were confusing, irregular & scary (even in a dried sample), when I sampled earlier growth & new growth only. (My animals do seem to know when it's okay.)

Species-specific toxins do not prohibit forage use.

Be aware of known cautionary tree/shrub/plant species,
& offer those when offering multiple species.

Ideally these species complement vs replace grass-based forages.

Animals select bites knowingly. Be careful when feeding in a stall.

All-season favorites

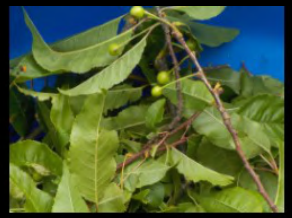
Red & White Oak, White Green & Brown Ash, Black, Pin & Choke Cherry, Elm, Black Locust, Basswood (but not for hogs?), Smooth & European Buckthorn (not for hogs?), Multi-flora Rose, Bittersweet….

American elm separated October 1st at Faithful Venture Farm

Apple, separated July 1st, small tree cut low by Andres before species ID

Austree Willow, MOFGA South Orchard pollard, cut Sept 24th, separated Sept 26th, 2024, ensiled - Copy

Basswood separated September 29th at Faithful Venture Farm



Black cherry, cut June 26th, separated June 27th, yet another nice pic

Black locust separated October 4 th at Faithful Venture Farm

Green ash separated July 26th

Hawthorn, tattered small % leaves separated, then must lop tangled branches

Multflora Rose, FVF, separated Sept 18, 2024 at John & Nancy's

Norway maple separated September 14th at Y Knot Farm

Red oak separated September 14th at Y Knot Farm

White ash separated September18th,at Y Knot Farm, turning early with fungal

Favorite Connifers

White Cedar

Favorite Connifers

Hemlock

Favorite Connifers

Norway Spruce

(Are trees named “Norway” evolutionarily disposed to offer tasty forages?)

Cutting Spruce bedding in Austria
Machatschek 2002, p 366

TRADITIONAL WOODED HAY MEADOW

Rydgren, Knut, Ingvild Austad, Liv Norunn Hamre, Joachim P. Töpper (2020).
Wooded hay meadows as viable production systems in sustainable small-scale farming.

Also in Agroforest Syst (2021) 95:165–176. *Above are Leif Haug's photos from p 168.*

They found increased total yield when pollards are included, plus ecological benefits.
An unfertilized wooded hay meadow yielded as well as average fertilized hay meadows w/out trees.

Pollarding Trees

- Sunlight & spacing (& rising unpruned canopy horizons)
- Age and vigor
- Harvest date (weather, moon phase) & nutrient storage
- Collars and fungal entry
- Climbability & ergonomics
- Apical dominance and energy flow
- Economy of form

Pests and threats

Know your tree species.

Oaks support a lot of insects.

New leaves on my White Oaks are consistently shredded.

Nurturing of “volunteers” is more ancient (& more reliable?) than planting.

The ground layer of our Demo Plot very quickly became greener and more diverse.

I use 2-liter soda bottles, with tops & bottoms cut off, as tree tubes. They're protecting native seedlings that appeared, plus White Willow (tree) cuttings that Karl Hallen of SUNY ESF Willow Biomass project generously sent.

When protecting small trees within our pasture paddocks, I wrap electrified fence-wire around them.

I wish I had 7 foot poles, for the steer.

Eliot Van Peski photo, Meadowsweet Farm

Eliot's Spiny Cages have every 2nd vertical wire (of 6 ft tall light-weight 14 gauge welded wire fencing) cut at a literally sharp angle with tin snips, then bent outward. (Goats might need smaller than these 4"x4" holes.)

The cattle and sheep are allowing these tasty apple trees to grow. Wood-chips, from branches Eliot fed out, keep down the vigorous pasture grasses.

NESARE results summary: FNE22-013 & FNE24-083

(You can also look up FNE18-897.)

Harvest and storage were weather-flexible.

Ground-based harvest with power tools was not faster per yield than climbing taller edge-trees.

Animals ate a lot, fast.

Faithful Venture Farm, Searsmont, ME

14 Holstein heifers ate a barrel of elm in 20 minutes, but had to chew this oak longer (finished in 1 hour).

*My animals are grass/browse-fed (no grain is fed).

My steer ate leaf-silage as 33% DM of his diet;

My goats ate leaf-silage as 55% DM of their diet,

all in only one 2-hour offering period per day.

They all had unlimited 1st-cut hay 24 hours per day.

Winter milk and butterfat yields held reasonably steady ...

I confounded my 3 Streams Farm home trial, by replacing leaf-silage with higher-protein 2nd-cut treat-hay in the 2-hr offering-periods (with no treat, they might have jumped the fence).

Also, they ate a bit less DM in 1st-cut hay, due to more concentrated energy in leaf-silage.
Yet butterfat yield was identical, & milk-yield difference was small.

	Crude Protein	Adj Crud Protein	Sol P %CP	R Degr P %CP	SP %DM	RDP %DM
2ND CUT HAY	18.6	18.6	33	70	6.138	13.02
LEAF-SILAGE	12.37	8.54	14.53	23.31	1.84	2.77

6% less milk in leaf-silage period than in 2nd-cut hay period

4.9% less 1st-cut hay eaten in leaf-silage than 2nd-cut hay per.

2.9% less T DM eaten in leaf-silage period than in 2nd-cut hay per

..or increased.

TILDEN POND FARM COW TRIAL

Mini-Jersey Betsy's Milk Yields With & Without Leaf-Silage

With leaf-silage	lbs.AM	oz. AM	lbs. PM	oz. PM		Without leaf-silage	lbs.AM	oz. AM	lbs. PM	oz. PM
12/12/23	9	13	12	5		12/27/23	10	2	11	7
12/13/23	9	0	11	6		12/28/23	10	0	11	8
12/14/23	10	14	11	8		12/29/23	11	9	10	6
12/15/23	10	3	12	3		12/30/23	10	0	10	4
T Honeysuckle	38	30	46	22	21.81 lbs/day ave. with Honeysuckle					
12/16/23	10	15	11	0		12/31/23	10	3	8	9
12/17/23	10	15	10	13		01/01/24	9	9	9	10
12/18/23	10	2	11	8		01/02/24	10	5	9	12
12/19/23	10	9	11	5		01/03/24	9	1	10	0
12/20/23	10	5	10	9		01/05/24	9	8	9	4
12/21/23	11	6	11	0		01/06/24	11	12	8	13
T Quaking Aspen	61	52	64	35	21.74 lbs/day ave. with Q. Aspen					
Ave Honeys+Asp	12.45455	10.18182	14.18182	7.181818		Averages	9.9	4.9	9.5	7.3
Ave. daily total	21.775 lbs.						Ave. daily	total 20.15 lbs (excluding 1/4/24)		
1.625 lbs. = 1 lb. 10 oz more/ day with leaf-silage (approx 3 ½ cups)						01/04/24	10	13? smudged	9	13

HOW DO WE INCREASE & USE TREE/SHRUB FORAGES WITHIN AN EXISTING SYSTEM?

Farm consultation idea results for Wolfe's Neck Center:

* Harvest bushes, shrubs, trees in 7 (1 per yr) lineal divisions along fences, & fresh-feed to animals (reduce fence trespasses);
* Cut & feed Multiflora Rose within paddocks, to help cattle develop them into direct-graze mini-bramble bushes;
* Utilize new apprentice Tom's arborist skills to re-structure some large Ash (& possibly an Oak or two) to produce forage;
* Plant & protect Austree Willows etc within flood-zone paddocks, for cyclical forage harvests, soil stabilization/enrichment, & shade.

Farm-based research needed on QUALITATIVE differences between farm products with & without browse and woody forages

(Notice reflection of Gemsen the goat, on the milk stand)

May you stay in the cool breath of
Foliage Height Diversity (FHD).

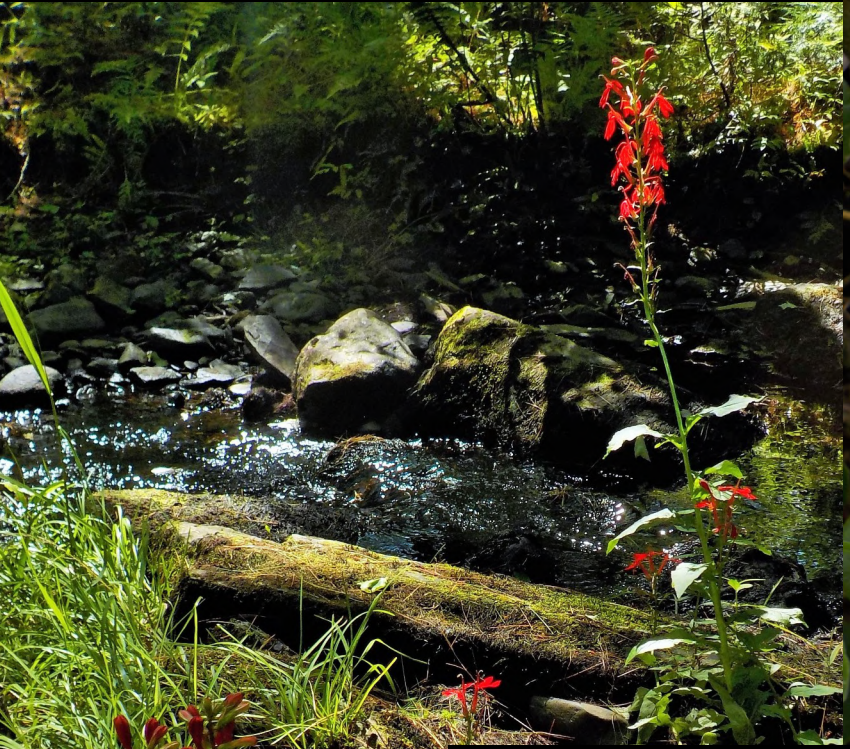
Direct local (& global) environmental benefits:

* Tree sensory-driven transfer of Latent Heat
(carried in water vapor bonds);

* Tree-driven Air Movement;

* Tree (stomata) bacterial seeding of Rain;

* Aromatic VOCs & improved air quality.



It’s more work; why do we do it?
German farmers remember more flowering plants.

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. In Rotherham, I. (ed.) (2013) Trees, Forested Landscapes, and Grazing Animals: European Perspective on Woodlands and Grazed Treescapes. Oxon, UK and NY, NY: Routledge

The best fertilizer
is the footprint
of the farmer.

Thanks to Erica Frenay for her organizing
of this educational agroforestry event,
thanks to all of you for your work toward
supporting farmers' foliar developments,
& thanks to the trees & animals,
for their patient efforts to teach us what they know.

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