Tree & Shrub Leaf-Silage Production for Agroforestry Systems:

Mechanical Leaf-Separation, Harvest Yields, Ruminant Intake Rates & Milk Yields, Milk Quality and Lipid ID, Fresh-Leaf & Leaf-Silage Nutritional Analyses, & Leaf Tannin Update

Shana Hanson,
3 Streams Farm, Belfast, Maine,
for NOFA MA “Go Nuts” Discussion Series, May 2nd 2024;
updated 2/1/25

This presentation was made possible thanks to two Farmer Grants from Northeast Sustainable Agriculture Research and Education (SARE)*, SARE FNE-22-013 and SARE FNE24-083.

FMI go to https://nesare.org or https://3streamsfarmbelfastme.blogspot.com

* SARE is funded by National Institute of Food and Agriculture (NIFA).

My 3 Streams Farm home herd

Animals will eat up to one-third more when freely collaborating with a knowledgeable human herder to browse multi-course meals, than they can eat when handed the “perfect” diet in a stall. (Meuret & Provenza 2015).

Such meals support one-third more productivity.

- In France, the landscape changed when herding stopped, losing biodiversity and soil fertility. So they made 5 herding schools, and started again.

This photo was taken last summer upon return from a browse walk (I was on Angelo’s back).

Our fresh-cut winter favorites are Red Maple, Apple and other fruitwood, White Cedar and Hemlock. Winter storage of summer- and fall-cut browse matter increased our winter browse variety by three-fold or more.


Dynamic BMPA-315-112-K-P-H-20220130-215 feed systems motor
Feed Side:
John Deere gathering belt, left side driving, right freewheeling
Dynamic BMPH50H2KP, 3.15 cu.in./rev.flail rotor motors
Floating side inserts with spring action here (same below). Center rotor axle to floating edge 17”
Hydraulic pressure tank (previously propane)
22gpm 2-stage (7 gpm high/22 gpm low stage) 3000 psi max.@3600 rpm max. hydraulic pump
Honda GX390 13 horse engine
2 flow control valves (1 for feed, 1 for flails)
10”slice of 55 gal. drum (other side same))
4”½ center to side
2½”2”x3”angle iron
Shut-off
Hydraulic line guard/branch rest 2½”x 2½”x 54”
Feed roller axle centers 8¼“ apart
C beam
Trailer side cut out for leaf bin;
Our new machine prototype removes and collects leaves off of branches and trunks up to 3½“ butt diameter.
(The flail motors are actually now Dynamic BMPH32H2KP 2.20 cu.in/rev.)

The Chain-Flail Leaf-Separator didn’t just happen.

Karl Hallen at Hallen Farm and SUNY ESF Willow Biomass Project first broke 5 ribs, collapsed 1 lung & punctured his diaphram on a different machine. Once those parts were mended, he built our machine and took it apart 3 times, then put it back together a 4th time.

The 4th try works great! Karl delivered it only 3 months later than planned - amazing!! Thank you, Karl.

Here it is,
in working order.

The top gap on the Gathering Belt (JD corn head) is now tighter, after 2x new larger free-wheeling sprocket fabrications. Thanks, Jon Thomas for laser-cutting, and Pat Scribner for installing.

That belt drags small or floppy pieces through, that can't make it across moving flails, (Larger pieces are aimed through from front tire-rollers to back tire-rollers).

Red Oak at Faithful Venture Farm went well; this is 2½ barrels-worth in the bin.

Not all goes well. The strong fibers, angular branching and thorns of this over-mature Hawthorn made immediate tangles, requiring sharp hand-pruners and a screwdriver to remove.

Arrowwood also was difficult, as was Birch.

Basically, flexible floppy species with strong fibers are best suited for making baskets.

But what of the lovely leaves? (I had cut a truckload of this Hawthorn)...

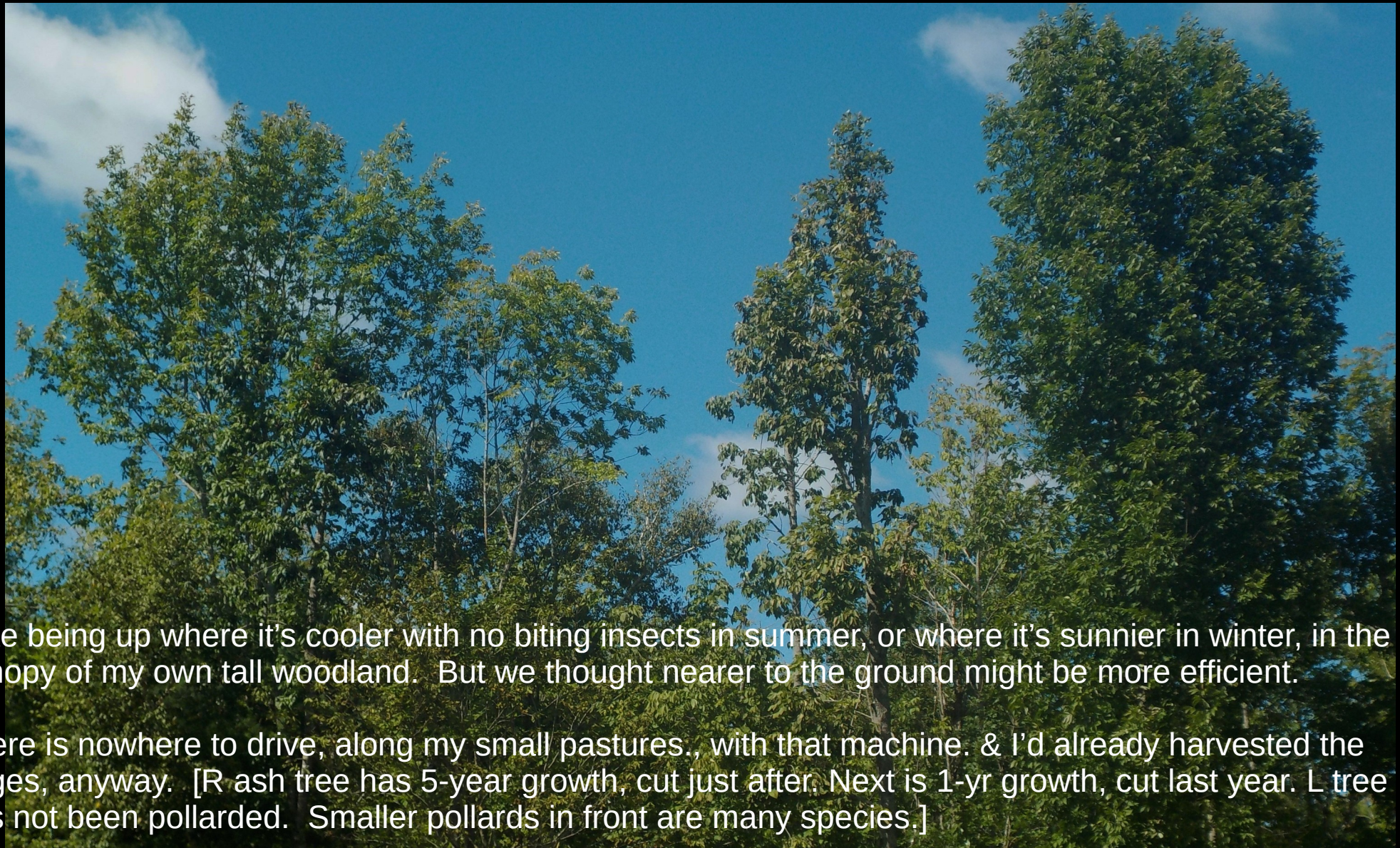
The animals are the best leaf-separators!

Here are the largest & smallest members of my herd, last year, eating Red Oak from a tall pollard.

10 finely-tuned quick mouths cannot be beat. The goats even get every leaf out of a bundle of multi-flora rose, while it's still tied.

But they fail to SAVE for WINTER.
: (

With the Leaf-Separator, we managed to save 77 (30 gal) barrels-worth of leaf-silage, from field-edge harvests using hand-held power tools (mostly).



I like being up where it's cooler with no biting insects in summer, or where it's sunnier in winter, in the canopy of my own tall woodland. But we thought nearer to the ground might be more efficient.

There is nowhere to drive, along my small pastures., with that machine. & I'd already harvested the edges, anyway. [R ash tree has 5-year growth, cut just after. Next is 1-yr growth, cut last year. L tree has not been pollarded. Smaller pollards in front are many species.]

LEAF-SILAGE YIELDS FROM FIELD EDGE HARVESTS AT 3 SITES

Site	lin ft harvested	30 gal barrels*	gallons	lin ft per barrel	gal per lin ft
MOFGA	700	45	1350	15.56	1.93
YKF	190	18	540	10.56	2.84
FVF	145	14	420	10.36	2.9
Totals	1035	77	2310	30xTlf/Tgal=13.45	Tgal/Tlf=2.23
		* counting 6 buckets = 1 barrel		mean site ave 12.16	(3.87 lbs)

Site	Description
MOFGA	8 to 18 year growth with southern exposure; 18 yr stands of root-sprouted q aspen & g birch
	Black cherry approx 20 yrs old; over-mature honeysuckle; other species in buckets only
Y Knot Farm	All growth previously pollarded or coppiced for sheep fodder; 3 to 10 yr growth
	Black cherry pollards large and well-spaced
Faithful Venture Farm	First harvest of large mature plus some younger trees, on rich pasture edge
	Green and white ash, red oak; small amount of basswood

MOFGA

This tree-line runs between the two main South Parking fields.

We harvested the south-facing side.

September 22, 2024

1 year & 2 months
after our harvest

At MOFGA we used a 9 ft pole chainsaw, regular chainsaw, and a (circular) brush saw.
After the more diverse hedgerow, there was a section with tall aspen, followed by tall Gray Birch.

MOFGA Tree Stand Descriptions & Leaf-Silage Yields
(30 gal. barrels, contents ave. 52 lbs.)

18 yr growth of:	# barrels	# stools	# stools/ barrel	# trunks	# trunks/ barrel	LFT	LFT/ barrel	width	area ft^2	ft^2/ barrel
Q Aspen	12-1	n/a	n/a	26	2.3636	50	4.5454	15	750	68.1818
G Birch *	10	21	2.1	114	11.4	70	7	11	770	77

* Top pieces of trunks <3 ½” were only part of Gray Birch used, due to tangling.
Lower side-branches were fed to livestock fresh.

7 felled trunks of 18-year root-sprout growth of Quaking Aspen (shown with all lleafy portions stacked) provided leaves to fill 3 (30 gal) barrels.

We did not count our time moving large heavy wood back out of the field. Ideally someone would have taken those logs for oyster mushroom propagation.

Brittleness of branches meant no tangles; instead, we spent 5 minutes per bin removing broken sticks (not a big deal).

Gedo came to help partway through my MOFGA harvest. He is amazing! He learned more English; I learned a bit about Sudan.

We could only use the stiff 20 ft top-piece of each Gray Birch trunk, & only if we “braided” the floppy branches inward on top of each other, to keep them from wrapping around the flail rotors.

Birch branches were historically used to tie sheaves of brittler tree species – they are flexible and don’t break.

Due to need for
this “braiding” plus
limited use of branches,
Gray Birch took us
2 person-hrs
per 30 gallon barrel.

However, the animals
back home did use
all leaves off the
(inseparable) lower
branches.

Mustafa Altuma Zakria Gedo photo

Gedo liked to run our machine; we took turns.

I did all harvest with power saws.

We both limbed, (braided), stacked and carried. Those tasks took most of the time

– the machine took only 10 to 15 minutes per barrel.

I thought these 20 ft tops of Gray Birch would take less space if vertical.

Mustafa Altuma Zakria Gedo photo

I added a no smoking sign. It says “No Smoking, No Fire; Be Safe, Be Cool.”

I recently went to re-survey, and this lacey tee pee had over-wintered and was still standing.

Mustafa Altuma Zakria Gedo photo

The goats ate the leaves off the lower branches of those Gray Birch as fast as I could carry them over from the truck.

In winter, that Birch was less well-received, I think because of harvest timing (July).

I hung two bags of Birch, each about 11 lbs. The other was from Y Knot Farm, harvested October 1st, 2022 – over a year ago – so harvested after frost, and also more fermented.

Or was it a different species?

They devoured that one.

Susan’s sheep devoured the rest of that barrel.

This photo was taken after 5 or 10 minutes.

We kept 2 MOFGA July-harvested barrels of Gray Birch for another year, to see if more fermentation would override poor harvest-timing. (No.)

Y Knot Farm

1 last trunk of Red Maple is left to pollard, of a tall coppice cut about 10 years ago for the sheep.

If you look closely, the previously tall-pollarded Cherry tree has been brought in reach for future pole chainsaw harvest, leafy yield in foreground. Susan does not want to climb past reach of her 8 ft tripod ladder.

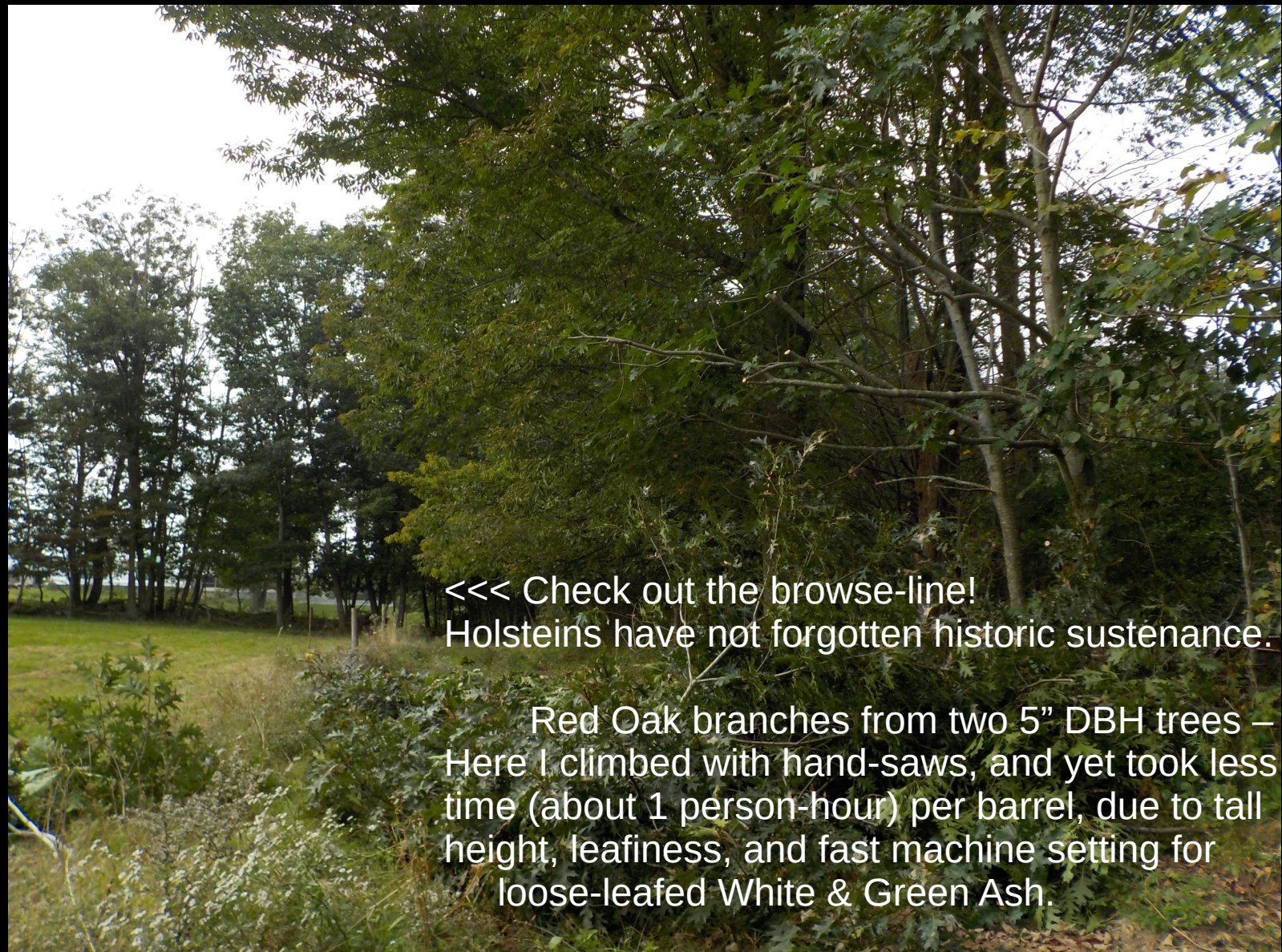
This is the opposite edge of Y Knot Farm, next to the sheep pasture. (The last photo was next to Susan's hay field, behind the pasture.) Most of what you see is choice White Ash, some re-sprouted from ground-level cutting, some already pollarded in 2021 (we are not re-harvesting those yet).

The Leaf-Separator was just around the corner; I tried moving this one load with the truck; carrying directly to the machine was just as fast.

We caught these leaves rather late. In this rainy year, fungal leaf damage made it already look like autumn in early September.

Yet the animals loved this Ash.

Faithful Venture Farm



The Apple tree in front is partly dead, due to encroachment by the tall White Ash.

I talked Glendon into letting me fully harvest canopies of both tall trees (I care about these large firm late apples, and also my mouth watered on behalf of the Holsteins, for those lush White & Green Ash leaves).

The Green Ash (at right) was holding its color in this September 28th, 2023 picture; the White Ash had become a bit yellow.

Here are those 2 trees again, after harvests on Oct. 5th & 6th.

Each tree yielded about 2 barrels = 100 lbs of leaves.

I ended up stealing the Faithful Venture Farm White Ash for my home trial, but the Holsteins got to show their apprecition for the Green Ash.

My animals did not mind that the White Ash leaves had started to turn.

Dec 2022, Nosenia my retired American Guinea sow was hauling hemlock and hay (plus the bucket of apples, which she knew she was allowed to have upon arrival) to the winter yard.

Dec 2023, she started hauling hay and barrels of leaves to the other animals at my “Research Station” winter yard, for our 66-day home trial.

We alternated periods with leaf-silage versus with 2nd-cut hay offerings, x3 rotations.

4-day transitions between these 7-day measurement periods	Estimated DM 5 Milkers ate, 45% of T, 4.5% BW		Estimated DM 5 Non-milkers ate, 25% of T, 3% BW		Estimated DM Steer ate, 30% T, 2% BW		Actual DM used	10% 1st-cut hay est waste	Est DM eaten (Used – 10% 1st-cut hay)	
DM Intake based on refs	22.5		12.5		15				50	
AL	22.842		12.69		15.228		53.59	2.83	50.76	
AH		23.0535		12.8075		15.369	54.08	2.85		51.23
BL	21.5055		11.9475		14.337		50.93	3.14	47.79	
BH		23.607		13.115		15.738	55.07	2.61		52.46
CL	23.994		13.33		15.996		56.58	3.26	53.32	
CH		23.643		13.135		15.762	55.29	2.75		52.54
Ave:	22.78	23.44	12.66	13.02	15.19	15.62	54.26	2.91	50.62	52.08





They ate a bit less DM (actually less of the unlimited 1st-cut hay), on average in leaf-silage periods versus this 2nd-cut hay.

Angelo ate leaf-silage as almost 1/3 his diet.
He kicked up hs heals, to get to it.
This is White Ash on the last day, very tasty.

Leaf-silage DM Steer		1st-cut hay DM Steer = T – leaf-silage	
5.556		9.672	
4.984		9.353	
4.244		11.752	
4.93		10.26	

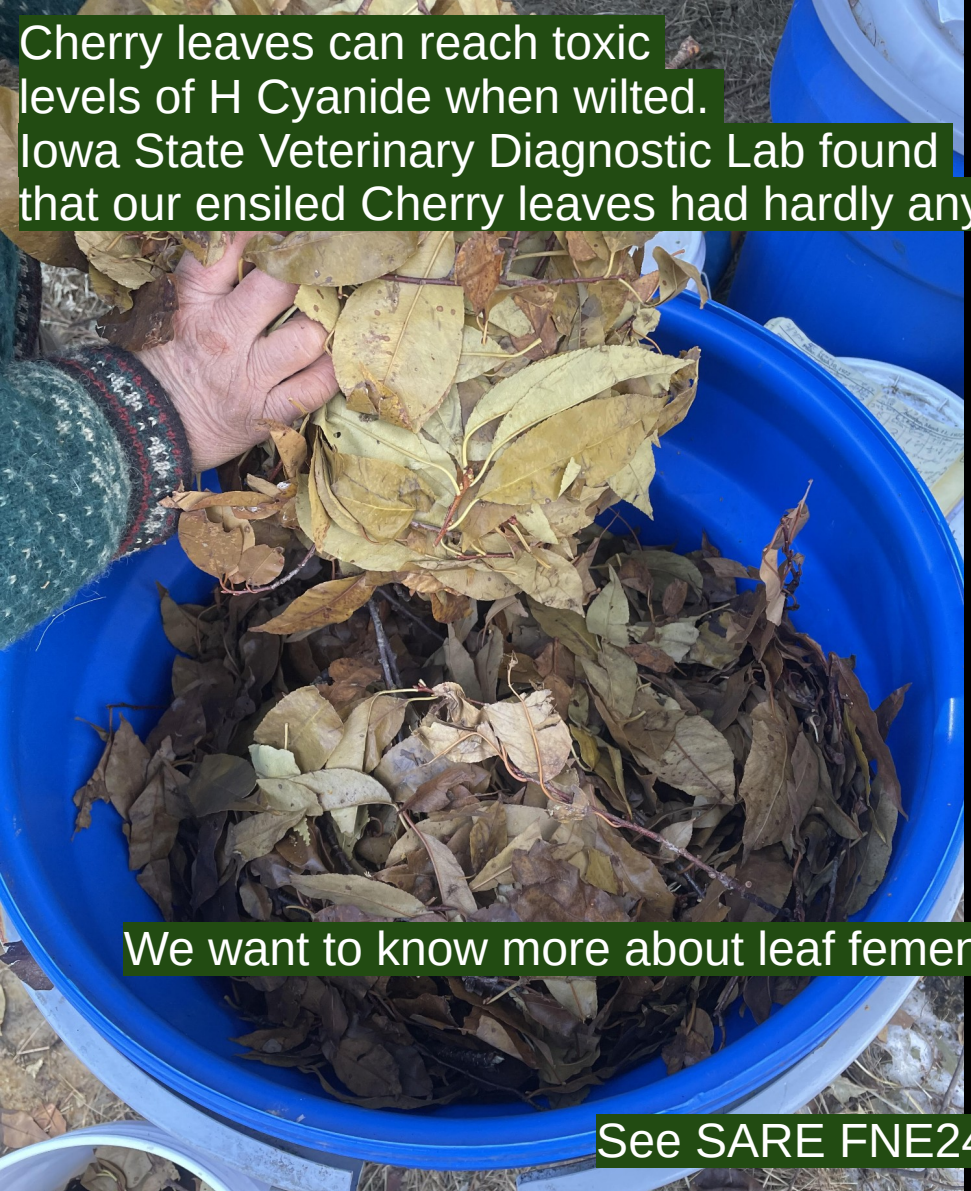
The 1st-cut hay was shared with goats, so I am estimating T DM based upon his 1½yr-old measurement-estimated body-weight.

Folks at West Coast Metabolomics Center,
at UC Davis Genome Center, Davis, CA, were helpful & willing to work with me.

They offer Primary Metabolism by GC-TOF-MS:
carbohydrates and sugar phosphates, amino acids, hydroxyl acids, free fatty acids, purines, pyrimidines, aromatics, exposome-derived chemicals

But the people at MU Metabolomics Center convinced me that they were more familiar with tree leaves, and often collaborated with the Center for Agroforestry there.

They analyzed 6 potentially toxic compounds in leaves of various Maples, Box Elder and Staghorn Sumac.



Cherry leaves can reach toxic levels of H Cyanide when wilted. Iowa State Veterinary Diagnostic Lab found that our ensiled Cherry leaves had hardly any.

We want to know more about leaf fementation.

Norway Maple (above) is an unlimited choice leaf-silage. Red Maple (below) has anti-feedant issues. They eat some eagerly, then stop and look for a different forage, to balance it.

(This is one photo; the color of ensiled Norway and Red Maple are really this different!)

The bark and twigs of Red Maple are preferred to the leaves, in unlimited quantity all winter.

Box Elder leaves killed a goat near me; she bloated. My animals often reject Box Elder, which has 4 non-proteinogenic Amino Acid toxins..

See SARE FNE24-083 Project update for Maple & Box Elder findings..

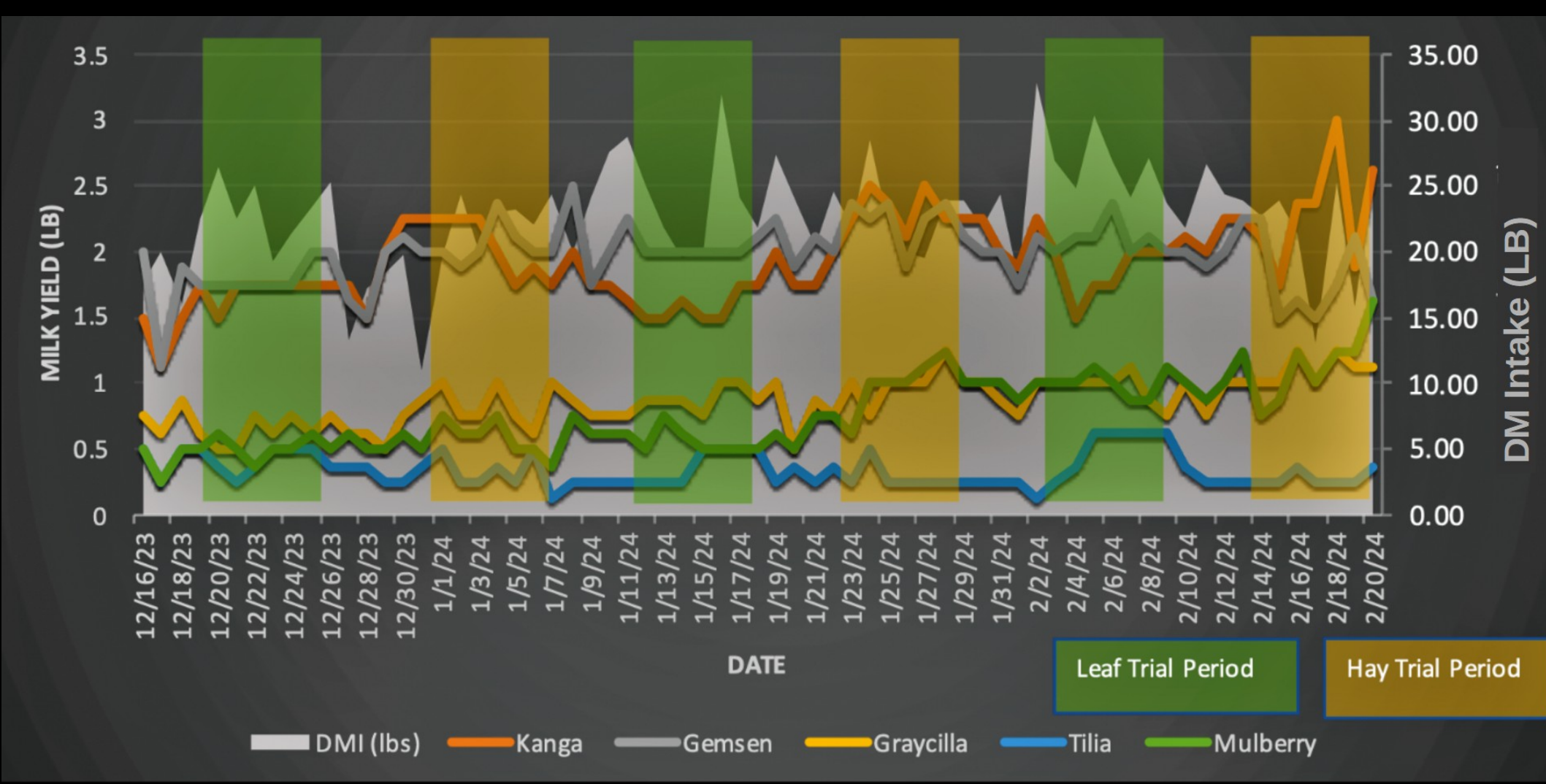
No concentrates are fed, hence modest milk amounts in winter. 2nd-cut hay supported a bit more milk on ave. than did leaf-silage, yet butterfat lbs/day yield with leaf-silage was equivalent between treatments (with or without 1st Leaf-period removed to control for day-length).

This is Tilia,
3 yrs old, & “virgin” milking.

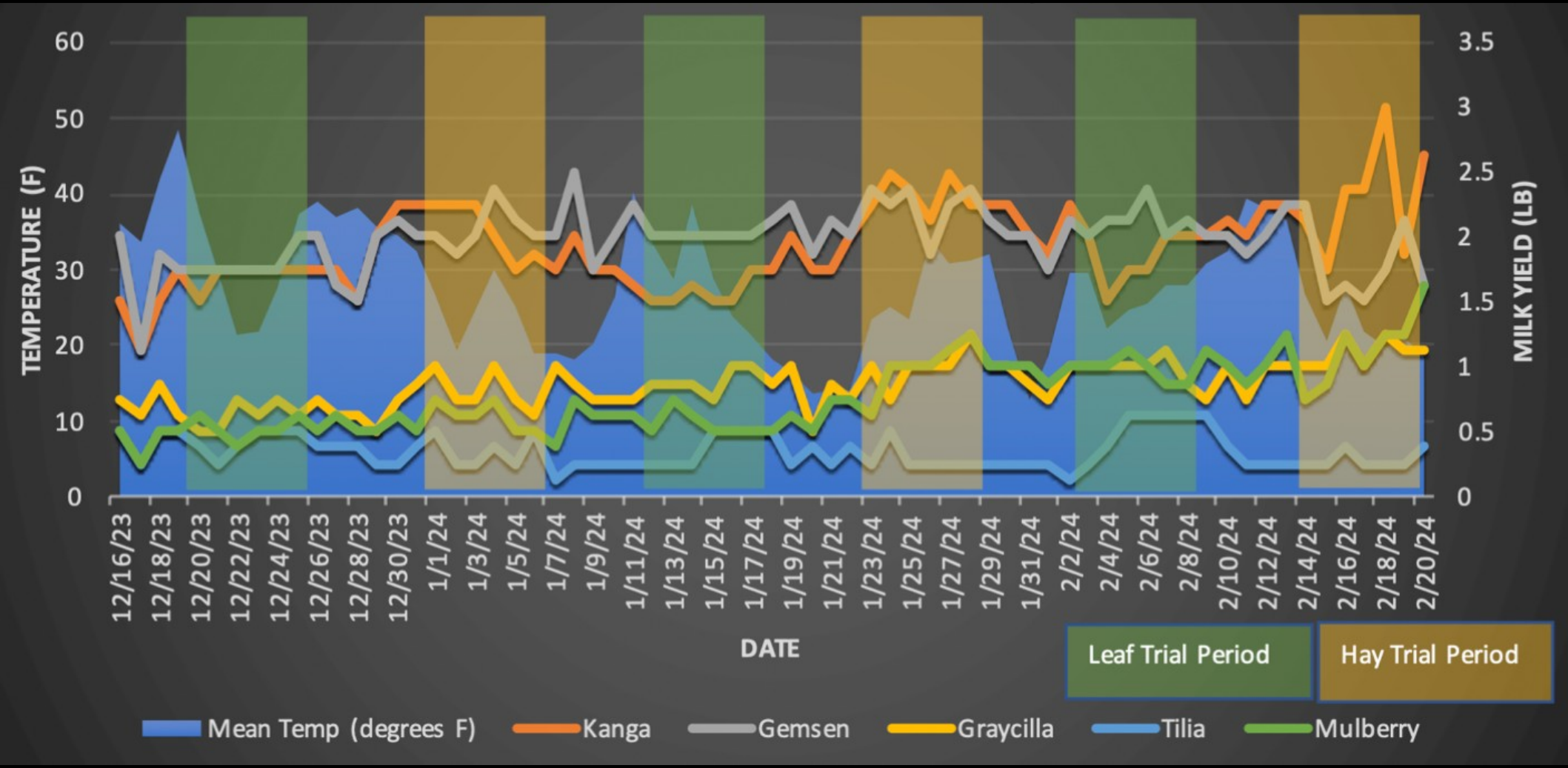
Milking Goats estimated DMI related to milk yields:

Period	Leaf-s & hay, DM 5 Milking Goats	Leaf-silag DM 5 Milking Goats	1st-cut hay DM 5 Milking Goats	Ave. T lbs. milk, adj to 24 hrs.	lbs milk/ lb DM
AL	22.84	12.72	10.12	5.08	0.23
BL	21.51	11.29	10.22	5.55	0.26
CL	23.99	13.29	10.7	6.59	0.28
ave.	22.78	12.44	10.35	5.74	0.26
1 av Goat:	4.56	2.49	2.07	1.15	

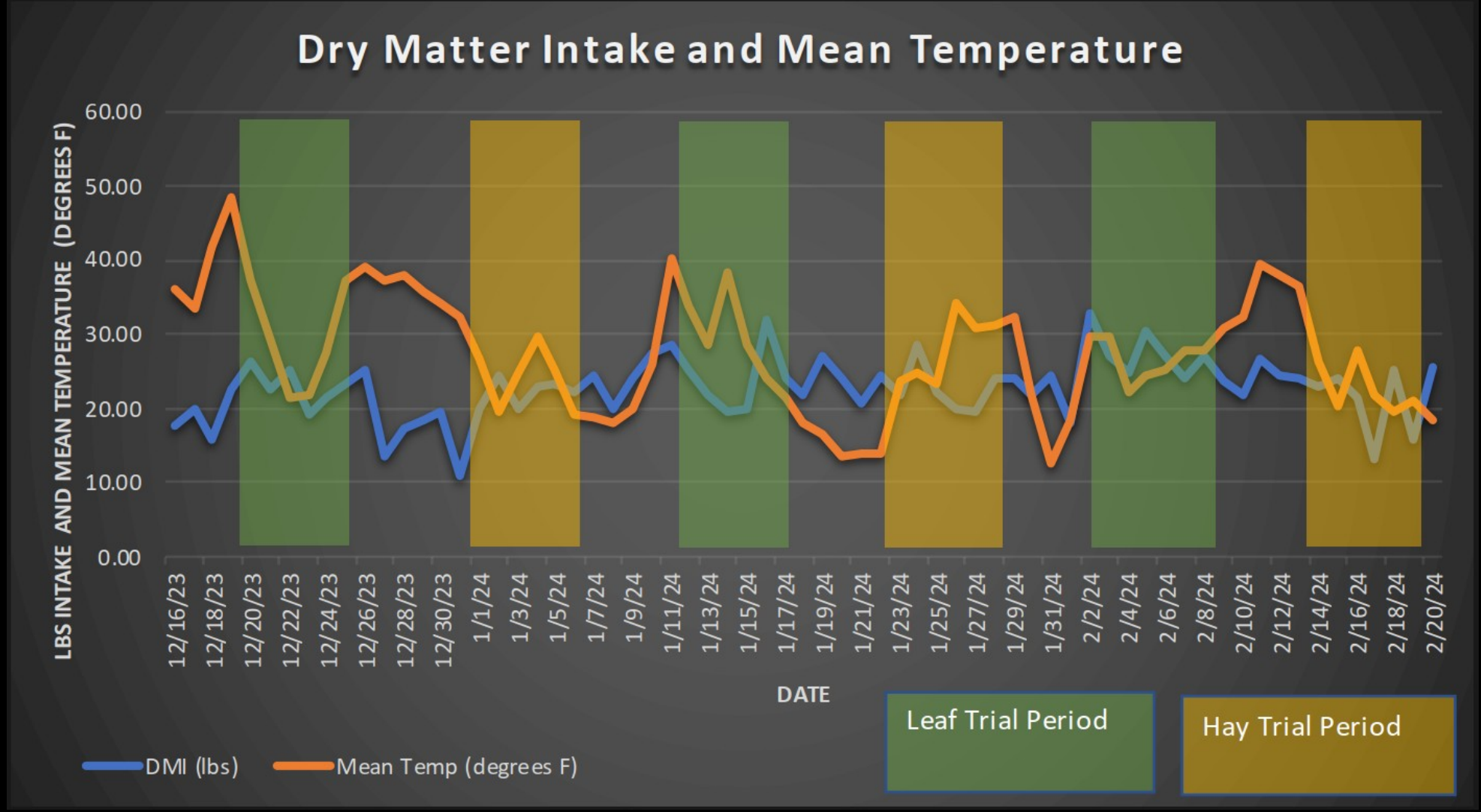
Period	T hay DM 5 Milking Goats	2nd-cut H-only, DM 5 Milking Goats	1st-cut H-only, DM 5 Milking Goats	ave T lbs. milk adj to 24 hrs.	lbs milk/ lb DM
AH	23.0535	10.58	12.4735	5.86	0.25
BH	23.607	12.12	11.487	6.83	0.29
CH	23.643	14.63	9.013	6.69	0.28
ave.	23.44	12.44	11	6.46	0.27
1 av Goat:	4.69	2.49	2.2	1.29	



Graph by Megan Smith, UME Sustainable Agriculture 2024 (Shana corrected R label)



Graph by Megan Smith, UME Sustainable Agriculture 2024 Graduating Class



Graph by Megan Smith, UME Sustainable Agriculture 2024 Graduating Class

All higher in Bfat during Leaf-Silage Periods, except Gemsen.
Tilia gave higher Protein in Leaf-Silage Periods; others varied in both directions insignificantly.
Kanga, Tilia, and Graycilla gave higher Solids in Leaf-Silage Periods; Gemsen higher in Hay-Only.
SSC averages were higher in Leaf-Silage Periods, excepting Graycilla's – and ranged broadly.
Lactose was slightly lower in Leaf-Silage Periods.

		Bfats	1 Protien	Total Solids	SCC x 1000	Lactose	FPD	Denov FA	Mixed FA	Perform FA
L	Mulberry	3.19	3.83	12.34	1030	4.14	-0.57	1	1.22	0.7
L	Kanga	3.85	4.09	13.32	2114	4.21	-0.57	1.2	1.56	0.79
L	Tilia	3.56	5.09	12.9	486.67	2.74	-0.56	1.28	1.47	0.54
L	Graycilla	3.52	3.96	12.83	1572	4.175	-0.57	1.1	1.39	0.745
L	Gemsen	2.59	3.7	11.49	680	4.11	-859.71	0.74	1.06	0.59
	L ave	3.34	4.13	12.58	1176.5	3.875	-172	1.06	1.34	0.67
H	Mulberry	2.85	4.19	12.49	820	4.31	-0.57	0.92	1.27	0.47
H	Kanga	2.99	3.99	12.42	1166	4.33	-0.58	0.89	1.28	0.54
H	Tilia	1.85	3.84	9.93	330	3.08	-0.56	0.64	0.82	0.56
H	Graycilla	4.67	4.33	14.56	993	4.5	-0.575	0.905	1.275	0.505
H	Gemsen	3.61	4.15	13.38	207.3	4.49	-0.58	1	1.45	0.95
	H ave	3.19	4.1	12.56	703.26	4.14	-0.57	0.87	1.22	0.605

Yulica Santos Ortega was at
MaineHealth Institute for Research
Lipidomics & Proteiomics Core – *and*
our Belfast Blueberry Cooperative!
(Now she is at U VA, helping to start a new
Lipidomics & Proteiomics program.)

Yulica’s family, including Noah, came for milk sampling.

Of hundreds of lipids present, these are the ones with greatest difference between means of 5 goats' milk at one milkimg, in 3 Streams Farm C Rotation Leaf-Silage versus Hay-Only periods:

Higher Spikes in Hay-Only Periods:

Category: SPHINGOLIPIDS; Group: CERAMIDE LIPID; Class: CERAMIDE; "Cer"

Category: SPHINGOLIPIDS; Group: PHOSPHOSPHINGOLIIDS; Class: SPHINGOLIPIDS; "SM"

Category: GLYCEROLIPIDS; Group: GLYCEROL ESTERS; Class: DIACYLGLYCEROL PHYROPHOSPHATE; "DGPP"

Category: GLYCEROLIPIDS; Group: GLYCEROL ESTERS; Class: MONOALKYL-DIACYLGLYCEROL ; "MADAG"

Category: PHOSPHOLIPIDS; Group: ESTER PHOSPHOLIPIDS; Class: PHOSPHATIDYLCHOLINE ; "PC"

Category: PHOSPHOLIPIDS; Group: ESTER PHOSPHOLIPIDS; Class: PHOSPHATIDYLCHOLINE ; "PE"

Higher Spikes in Leaf-Silage Periods:

Category: GLYCEROLIPIDS; Group: GLYCEROL ESTERS; Class: DIGALACTOSYLDIACYLGLYCEROL; "DGDG"

Spikes Varying across 5 Goats, in whether Leaf-Silage or Hay Periods were higher:

Category: STEROL LIPIDS; Group: CHOLESTEROL LIPID; Class: CHOLESTERYL ESTER; "Ce";

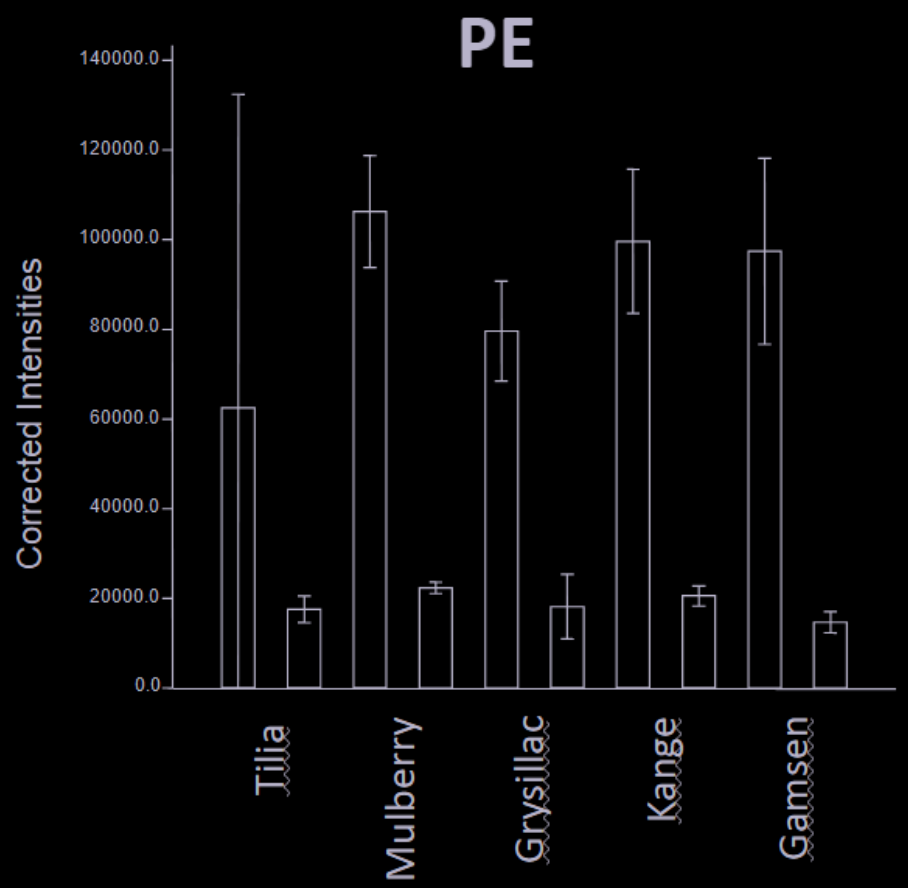
Category: GLYCEROLIPIDS; Group: GLYCEROL ESTERS; Class: DIACYLGLYCERYL-TRIMETHYLHOMOSERINE ; "DGST";

Category: GLYCEROLIPIDS; Group: GLYCEROL ESTERS; Class: TRIACYLGLYCEROL ; "TAG"

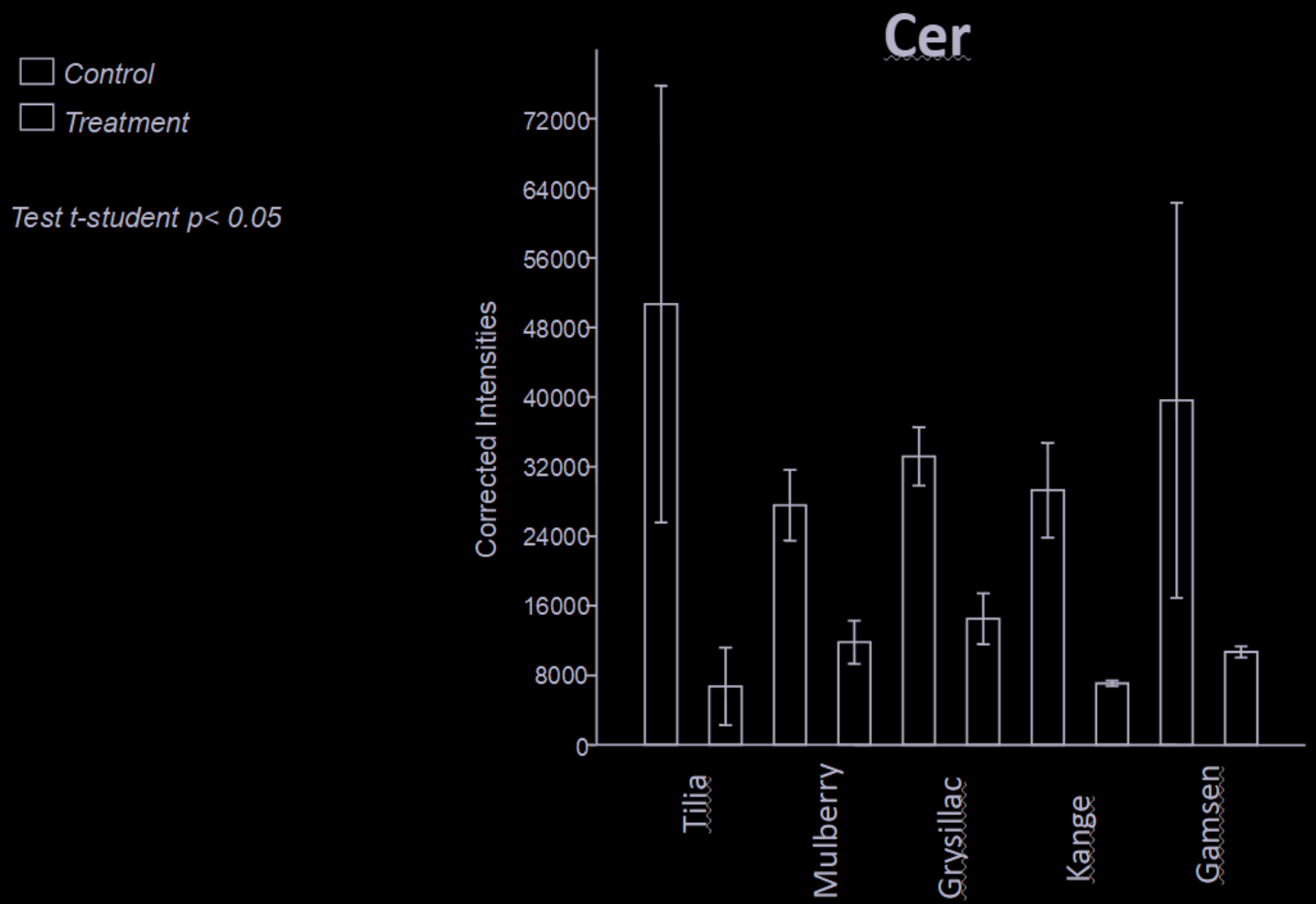
Lipid Category: PHOSPHOLIPIDS; Group: ESTER PHOSPHOLIPIDS; Class: PHOSPHATIDYLCHOLINE ; "PE"

☐ *Control*
☐ *Treatment*

Test t-student p< 0.05



Lipid Category: SPHINGOLIPIDS; Group: CERAMIDE LIPID; Class: CERAMIDE; "Cer"



Tilden Pond Farm

Betsy convinced John Morse to remove every twig from her leaf-silage. He dilligently weighed both sticks and leaves, keeping neat hand-written records.

Her milk went up by nearly a quart/day, with about 7 lbs honeysuckle or poplar leaf-silage in addition to her usual feed of 1st-cut hay and 8 lbs raw grain.

We did not weigh the hay, which was shared with her dry-cow friend.

TILDEN POND FARM COW TRIAL

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

Mini-Jersey Betsy's milk amounts with/without leaf-silage

With leaf-silage	lbs.AM	oz. AM	lbs. PM	oz. PM
12/12/23	9	13	12	5
12/13/23	9	0	11	6
12/14/23	10	14	11	8
12/15/23	10	3	12	3
12/16/23	10	15	11	0
12/17/23	10	15	10	13
12/18/23	10	2	11	8
12/19/23	10	9	11	5
12/20/23	10	5	10	9
12/21/23	11	6	11	0
Averages	9.9	8.2	11	5.7
Ave. daily total	21.775 lbs.			
1.625 lbs. = 1 lb. 10 oz more/ day with leaf-silage (approx 3 ½ cups)				

Without leaf-silage	lbs.AM	oz. AM	lbs. PM	oz. PM
12/27/23	10	2	11	7
12/28/23	10	0	11	8
12/29/23	11	9	10	6
12/30/23	10	0	10	4
12/31/23	10	3	8	9
01/01/24	9	9	9	10
01/02/24	10	5	9	12
01/03/24	9	1	10	0
01/05/24	9	8	9	4
01/06/24	11	12	8	13
Averages	9.9	4.9	9.5	7.3
	Ave. daily total 20.15 lbs (excluding 1/4/24)			
01/04/24	10	13? smudged	9	13
That day's total 20.825 lbs if 0 or 13 oz are both correct				

	A	B	C	D	E	F
		(without sticks)		lbs sticks	oz sticks	
	Leaf-silage intake	lbs.	oz.	removed	removed	Barrel #, site, species, harvest date
	12/12/23 AM	3	5		9	#2 MOFGA Honeysuckle 6/26/23
	PM	3	0		8	#2 MOFGA Honeysuckle 6/26/23
	12/13/23 AM	2	3		12	#2 MOFGA Honeysuckle 6/26/23
	PM	2	4		5	#9 MOFGA Black Cherry 6/30-7/1/23
	12/14/23 AM	2	8		6	#2 MOFGA Honeysuckle 6/26/23
	PM	2	7	2	3	#2 MOFGA Honeysuckle 6/26/23
	12/15/23 AM	5	4	1	4	#2 MOFGA Honeysuckle 6/26/23
	PM	3	0		12	#41 MOFGA Quaking Aspen 7/26/23
	12/16/23 AM	3	0		10	#41 MOFGA Quaking Aspen 7/26/23
	PM	3	0	2		#41 MOFGA Quaking Aspen 7/26/23
	12/17/23 AM	3	0	1	4	#41 MOFGA Quaking Aspen 7/26/23
	PM	4	3		6	#41 MOFGA Quaking Aspen 7/26/23
	12/18/23 AM	4	0	1		#41 MOFGA Quaking Aspen 7/26/23
	PM		rainstorm;	not offered		
	12/19/23 AM		rainstorm;	not offered		
	PM	4	0	1	8	#41 MOFGA Quaking Aspen 7/26/23
	12/20/23 AM	4	0	1		#41 MOFGA Quaking Aspen 7/26/23
	PM	4	0	3		#41 MOFGA Quaking Aspen 7/26/23
	12/21/23 AM	4	0		8	#41 MOFGA Quaking Aspen 7/26/23
	PM	5	3		6	#41 MOFGA Quaking Aspen 7/26/23

That day's total 20.625 lbs if 2 x 13 oz are both correct.

3.46 lbs ave leaf-silage intake /feeding x 2 feedings/day = 6.92 lbs./day

NOTE: Betsy had very loose stool throughout the leaf-silage period, yet maintained higher milk production than without leaf-silage. 3 Streams steer Angelo has very firm stool, eating 2 x as much leaf-silage as Betsy.

NOTE: Betsy ate 8 lbs grain/day in addition to these forages.

NOTE: This cow milks on only 2 teats.

Faithful Venture Farm

I fed a barrel/day, each a different species, for 4 days, to about 14* mostly Holstein heifers.

Elm and Ash disappeared fastest.

This was Elm.
In 23 min, 37 lbs (of 39) was eaten. I gave the 2 lbs of elm sticks back, & they eagerly sorted through some more.

*We started with 16 heifers, but small ones could climb over this feed-wall, so a couple got relocated to a younger group during my trial-period. Glendon and Jody Mehuren confused each other about this, and re-counted the group for me multiple times :)

Red Oak:
A bit more work to chew, and more twigs attached. They ate steadily.


After 50 minutes,
8¼ lbs were left of 35.

Green Ash: In 30 Minutes, 99% of leaves from 44 lbs of leaf-silage were eaten; 7¼ lbs twigs were left.

Black Locust:
In 30 Minutes, 24 lbs (of 33¾) were eaten; 9¾ lbs twigs were left.

Heifer 296 liked to eat the thorny twigs!

(That was the coldest week in January; very sorry that my camera fogged up.)

Y Knot Farm

Susan Littlefield has fed leaves to her sheep ever since some goats taught them to browse.

This White Ash came from initial pollarding of a couple small trees next to her rich pasture, during our Tree Fodder Seminar 2021.

Susan prefers to dry leafy branches in her large hay barn, and/or hand-strip leafy twigs into 1-ton totes, versus using our new machine and barrels for leaf-silage.

I do not have photos of Susan's leaf-silage trial. Her sheep run away when I visit.

In late winter. Susan rationed out 15 barrels to the sheep, as their evening feed in place of hay.

They left nothing – ate ALL the twigs.

Susan's Freisan-Dorset dairy sheep have various long mangers; the one on opposite wall from this has a long wooden tray beneath, ideal for our leaf-silage offerings. Susan had over 100 head when she produced for the "Ewegurt" company – now, 15 ewes produce for the farm store.

Meadowsweet Farm

On April 7th, Eliot Van Peski's sheep and cattle got the least favorite summer-harvested Gray Birch leaf-silage, the only leaf-silage that Susan's and my animals did not want.

Certain beef cattle valued it, and ate significantly. Their 30 gallon barrel was 2/3 gone in 2 hrs, but left-overs took two more days to completely disappear.

For our previous SARE FNE18-897, Eliot's animals tested palatability of many species, both dried and ensiled, both chipped and hand-stripped. This photo shows 5 Icelandic sheep crouding hand-stripped White Ash leaf-silage.

In that study, Eliot's Angus cattle ate EVERYTHING, even chipped silages with 40% wood.

I am so grateful to Karl for our Leaf-Separator, which mimics hand-stripping, with much less time spent.

Eliot’s sheep were no more excited about hay-bags full of 2023 summer-harvested gray birch leaf-silage than were Susan’s or my animals.

So I unfortunately neglected to take their pictures.

Hence another 2019 photo, with Yellow Birch leaf-silage from my SARE FNE18-897 “Air-Meadow” Demo Plot (much taller trees than in this current study, & Y Birch is palatable all season).

As aforementioned, Eliot's Icelandic sheep were not very interested that day, when I hung Gray Birch leaf-silage in a mesh bag.

But Eliot had tried it a different way, and he wanted to continue to feed out the 2 barrels we'd allocated to the sheep.

Eliot said they seemed to value it when sprinkled in low volume on their hay each day. He fed out all in about 1½ weeks.

This year in Jan. 2025, almost 1 yr later, I am feeding some other barrels of that 2023 Gray Birch to my goats & steer, again.

With less leaf-choices, my animals eat it quite a bit faster than last year.
It remains nicely aromatic, though faded.


Freshly separated GrayBirch, July 2023


Gray Birch leaf-silage, 1½ yrs old, a bit fungal from air
(this barrel was left ½ full) & frosty cold in this photo

This poster summarized findings from testing of stored leaf-fodders, funded by a VT Grass-Farmers Mini-Grant, and also has a bit of palatability results per livestock group, from SARE FNE18-897.

Our SARE FNE24-083 laboratory testing added comparison of fresh leaves versus ensiled, and added additional species, with triplicate (or more) testing on most tree species.

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Samples were produced as part of SARE FNE18-897 2 year Leaf Fodder project.

Nutritional Analysis of Ensiled Tree Leaves & Ensiled Chipped Leafy Branches..., and relation to Animal Responses

> Historically, ruminants were wintered on only tree leaf fodders, & seasonally milked.

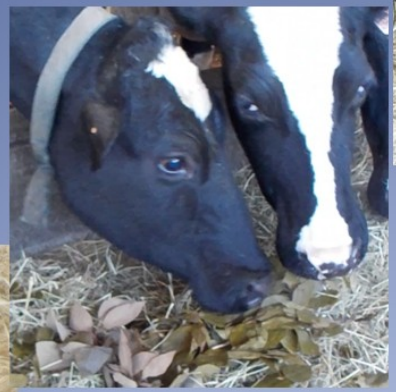
LABORATORY FINDINGS

Higher than Grass Silage
Non-fiber Carbs
ave. 36 (20 chipped);
Digestible Energy
ave. 3 (2.25 chipped);
Relative Feed Value (RFV)
ave. 156 (82 chipped).

High Mineral Contents
Calcium: W. Ash, Q. Aspen, Hyb. Willow
Manganese: W. Birch, Y. Birch, R. Maple
Zinc: Y. Birch, Q. Aspen

Top Tree Species
By RFV? Q. Aspen, R. Maple, Beech*- No! ... All good differently!

Protein: Lower than Grass Silage. Beech* and R. Oak highest.**



•Beech cut in early spring (only hogs like later).

** Both were 3rd vs. initial cuttings of pollards.

ANIMAL OPINIONS

Rating Totals across Animal Groups,
Highest to Lowest: (3 = immediately consumed)
Hyb. Willow$^{2.88}$> Beech$^{2.84*}$> Y. Birch$^{2.81}$> W. Ash$^{2.75}$> R. Maple$^{2.47}$> W. Birch$^{2.41}$> Q. Aspen$^{2.38}$> R. Oak$^{2.27}$> B. T. Aspen$^{2.25}$. (0 = refused).

Yet W. Birch was Sheep Top Favorite!, and B.T. Aspen was Cattle Top Favorite (tied w. Willow).

Each group ate differently.

Individuals ate differently, too.

Nutrition of Leaf-Silage

- More stable over time than grass or corn silages
- 2-3x as much Non-Fiber Carbs (NFC) as grass silage (DM basis)
- High varied mineral contents, averaging almost 2x the Calcium of grass silage
- Mostly lower Soluble and Degradable Protein than grass forages, with exception of high-Protein Autumn Olive and possibly Buckthorns
- 150% of the Fat level of grass silage; part of this is cutin & wax leaf-coatings

The following is my (Shana Hanson's) summary
from Wayne Zeller's data on our tree and shrub leaf forage samples.

HCI-Butanol-Acetone-Iron Assay
(modified HCI-Butanol Assay)

Screening tool for assessing presence and relative levels of Condensed Tannins

Thanks to: Wayne E. Zeller
USDA-ARS, U.S. Dairy Forage Research Center, Madison, WI 53706

Thanks to Andrea Clemensen
for introducing Wayne to me,
for this collaboration.

Samples 1-5 along with controls

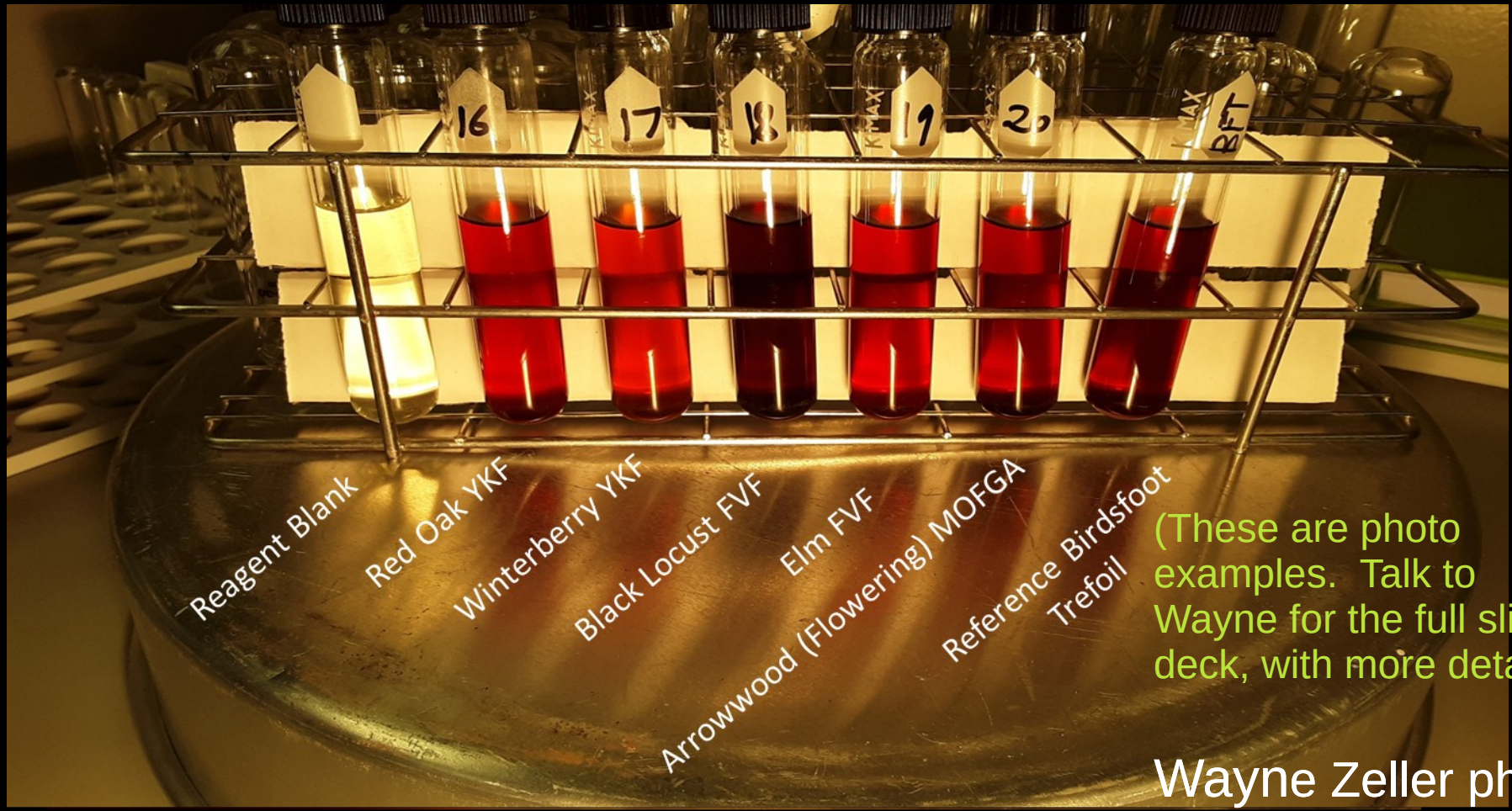
(The darker the solution becomes, the more Condensed Tannins.)

Wayne Zeller photo

Samples 6-10 along with controls

Wayne Zeller photo

Samples 16-20 along with controls



(These are photo examples. Talk to Wayne for the full slide deck, with more details.)

Wayne Zeller photo

(The higher the rating, the more Condensed Tannins, comparatively.)

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

Pollarded trees to feed livestock are or were in fields everywhere. I grew up with the Swiss cloth hanging (right). The Japanese painting (left) was generously passed to my house, because of the trees.

Woodlands, especially rich portions of woodlands, were also traditionally pollarded for livestock forage. This is the aforementioned SARE FNE18-897 Demo Plot.. Every Oak trunk sprouted full-length to near the ground, making our next climb very easy.

We let a lot of light in.

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.

More of the Tree Protection Fashion Show:

The White Oak in front has a triangle of electric fencing, at corner where three hexagonal paddocks meet (hexagons save wire; triangles save posts).

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.

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

Tree root turn-over (die-back & 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 draw up more moisture than they use, to share with their underground life-support community.

They also exude nutrients underground, from their superior storage reserves.

David Dellas drawing >

The best fertilizer is the footprint of the farmer.

Thanks to NOFA Massachusetts,

and especially Hannah McDonald, for hosting us all.

Thanks to Karl Hallen for everything - the machine, willows,

travel & hands-on help, never-ending phone consultations and listening.

Thanks to Brett Chedzoy for advising and encouraging SARE FNE22-013,

and for telling me to do a webinar.

Also, Thanks to the Farmers:
Glendon and Jody Mehuren for counting the heifers 3 times,
Susan Littlefield for wrapping up all the Leaf-Separator oil leaks, and assisting with harvest,
John Morse for patiently removing many lbs. of sticks and tollerating loose cow manure,
Eliot Van Peski for raising the least camera-shy sheep and cattle
(who are also the least fussy eaters).

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(I love to hear what farmers are doing with trees. I live with my herd; your call brings me human contact!)

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