BIODIVERSITY & LIVESTOCK WELLBEING

Juan Alvez (PhD)
UVM Extension, Center for Sustainable Ag.
Pasture Program

Project Team (alphabetical):

Jimmy Aruzamen
Research Technician (DMV)

Melissa Bainbridge
Ph.D. Candidate
Dept. of Animal & Veterinary Sciences

Guy Choiniere
Choiniere Family Farm

Emily Golf
Student
Dept. of Animal & Veterinary Sciences

Robert Mugabe
Ph.D. Candidate
Dept. of Animal & Veterinary Sciences

Dr. Juan Alvez
Pasture Technical Coord.
Center for Sustainable Agriculture, UVM Extension

Dr. John Barlow
Assistant Professor
Dept. of Animal & Veterinary Sciences

Dr. Jana Kraft
Assistant Professor
Dept. of Animal & Veterinary Sciences

Dr. Joe Roman
Research Assistant Professor
Rubenstein School of Env. & Natural Resources

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Department of Animal & Veterinary Sciences, University of Vermont

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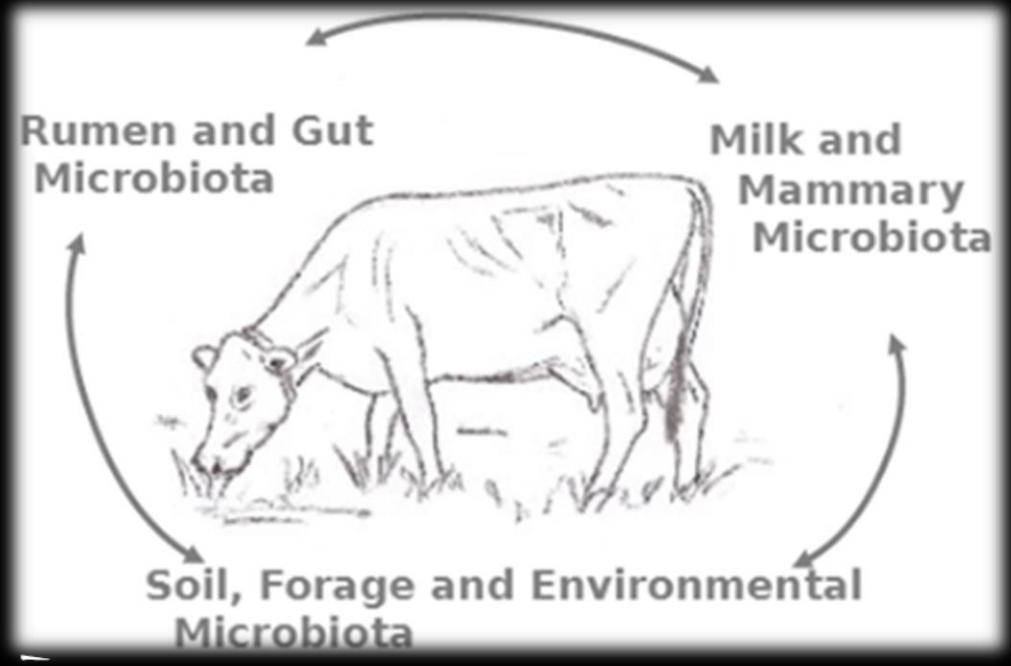
UNIVERSITY OF VERMONT EXTENSION
CULTIVATING HEALTHY COMMUNITIES

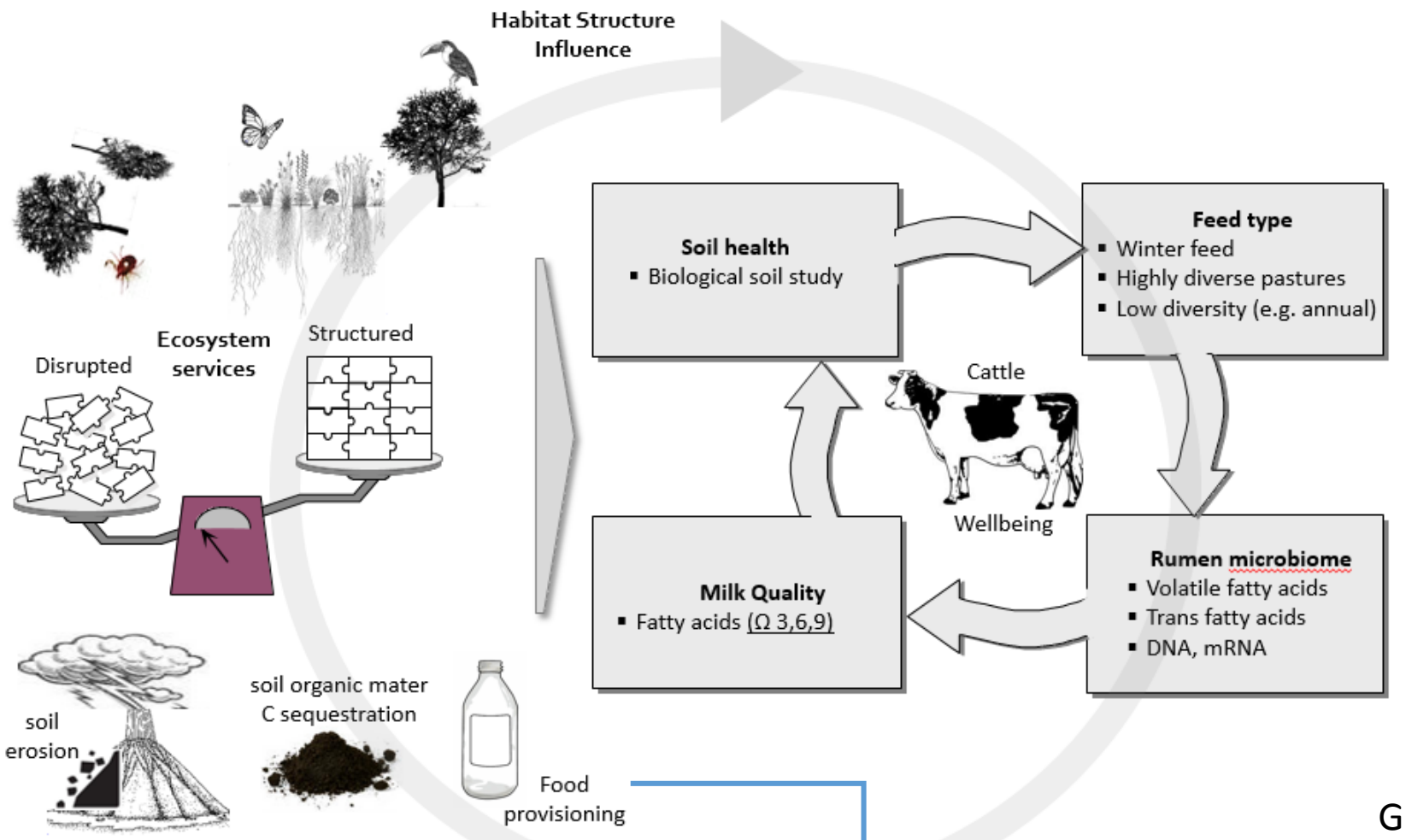
Some slides and materials, courtesy from Roman, Barlow and Villalba

Online: http://juanalvez.weebly.com/biodiversity--livestock-well-being.html

Road Map

- **Rationale**
  - **Biodiversity crisis**
  - **Soils**
  - **Forages**
  - **Animals**
- **Highgate Study**





Health implications (?)

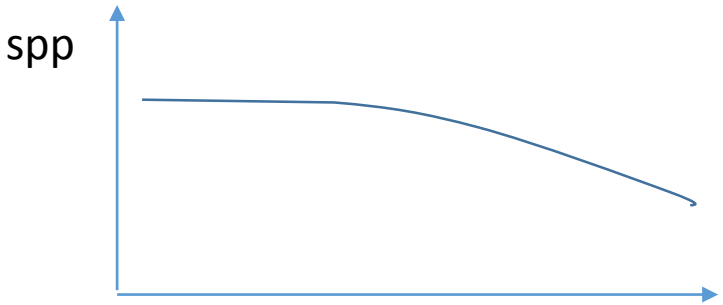
"organic milk healthier, because it has a more favorable balance of (ω-6 & ω-6) fatty acids"

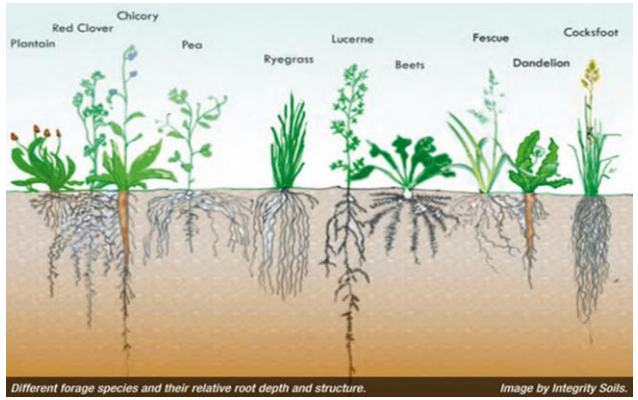
Grass-fed organic milk average has ratio of (ω-6) fatty acid to (ω-3) fatty acid of 2.3, whereas conventional milk had an average ratio of 5.8.

Benbrook, et al. (2013) PLoS1

Reasons for Studying Biodiversity Effects…

- ✓ **1. We are losing it**! What is the value of it?
  - Massive extinctions *(Primm et al. 1995)*
  - Benefits of conserving biodiversity ***100:1*** *(Balmford et al. 2002)*
  - Dilution Effect *(Bonds et all. 2012 PLOS1; Levi et. al 2012)*
- ✓ **2. Forage diversity**
  - Higher productivity & C storage *(Tillman, et al. 2001)*
  - Monotony: animals stop eating! (acidosis, amonia)
  - Tanins (BFT 13x less Ecoli) vs. alkaloids (TF, Alf. Brome)
- ✓ **3. Soil health**
  - Trophobiosis (Chaboussou)
  - Ethilene/O2 Fe3 -> Fe2 (Widdowson)
  - Biocenosis





Scope of the study: Samples and Analyses

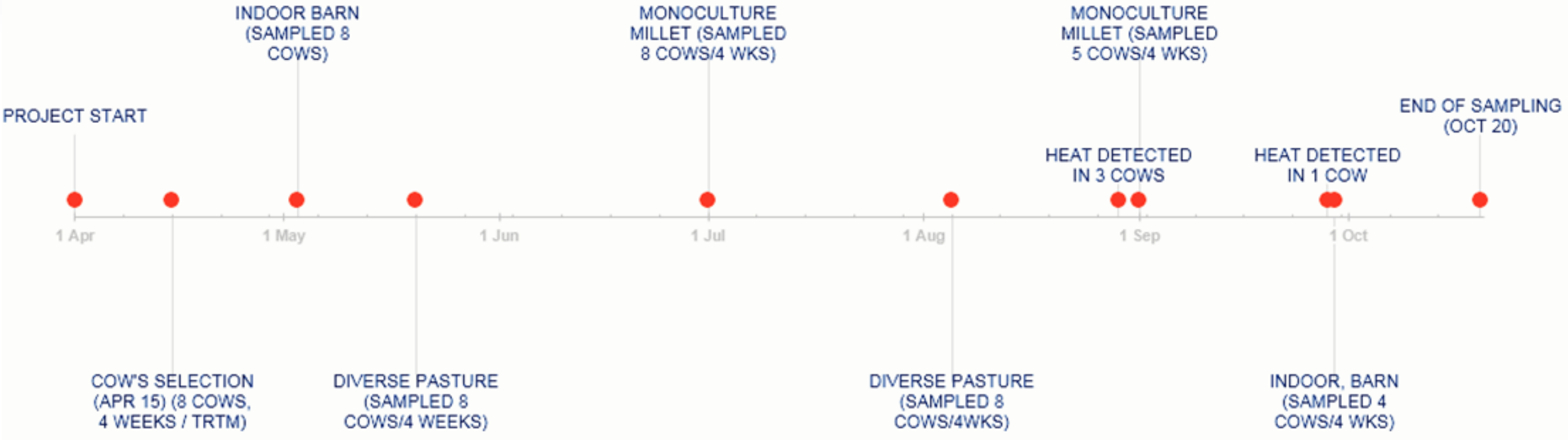
- **Hay and TMR:** for quality analysis, while cows were in barn
- **Forages**: (pre & post grazing, quality, botanical composition, pasture monitoring, 3 main spp);
- **Grazing behavior and activity**: monitoring systems with electronic data loggers
- **Bacteriological**: (nose, hock, udder skin swabs)
- **Rumen fluid**: (pH, fatty acids, dna to determine microbiome)
- **Feces**: weekly, individual samples.
- **Milk** (pH, to check fatty acids from diet, other).
- **Soil:** one sample /paddock where cows grazed. Earthfort (OR) & Woodsend lab (ME).

3 Diets


Winter feed:
hay + TMR


Diverse cool season
NE pastures*


Mono crop:
Pearl Millet


INDOOR BARN (SAMPLED 8 COWS)
MONOCULTURE MILLET (SAMPLED 8 COWS/4 WKS)
MONOCULTURE MILLET (SAMPLED 5 COWS/4 WKS)
PROJECT START
END OF SAMPLING (OCT 20)
HEAT DETECTED IN 3 COWS
HEAT DETECTED IN 1 COW
1 Apr
1 May
1 Jun
1 Jul
1 Aug
1 Sep
1 Oct
COW'S SELECTION (APR 15) (8 COWS, 4 WEEKS / TRTM)
DIVERSE PASTURE (SAMPLED 8 COWS/4 WEEKS)
DIVERSE PASTURE (SAMPLED 8 COWS/4WKS)
INDOOR, BARN (SAMPLED 4 COWS/4 WKS)

DIVERSE NE COOL SEASON PASTURES (2x, 4 wk grazings)



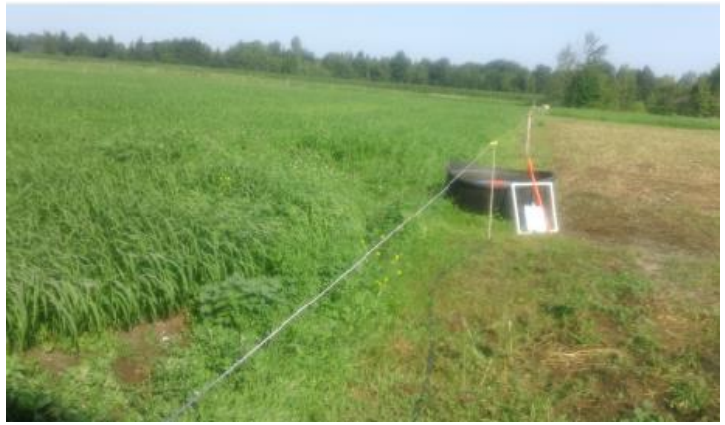


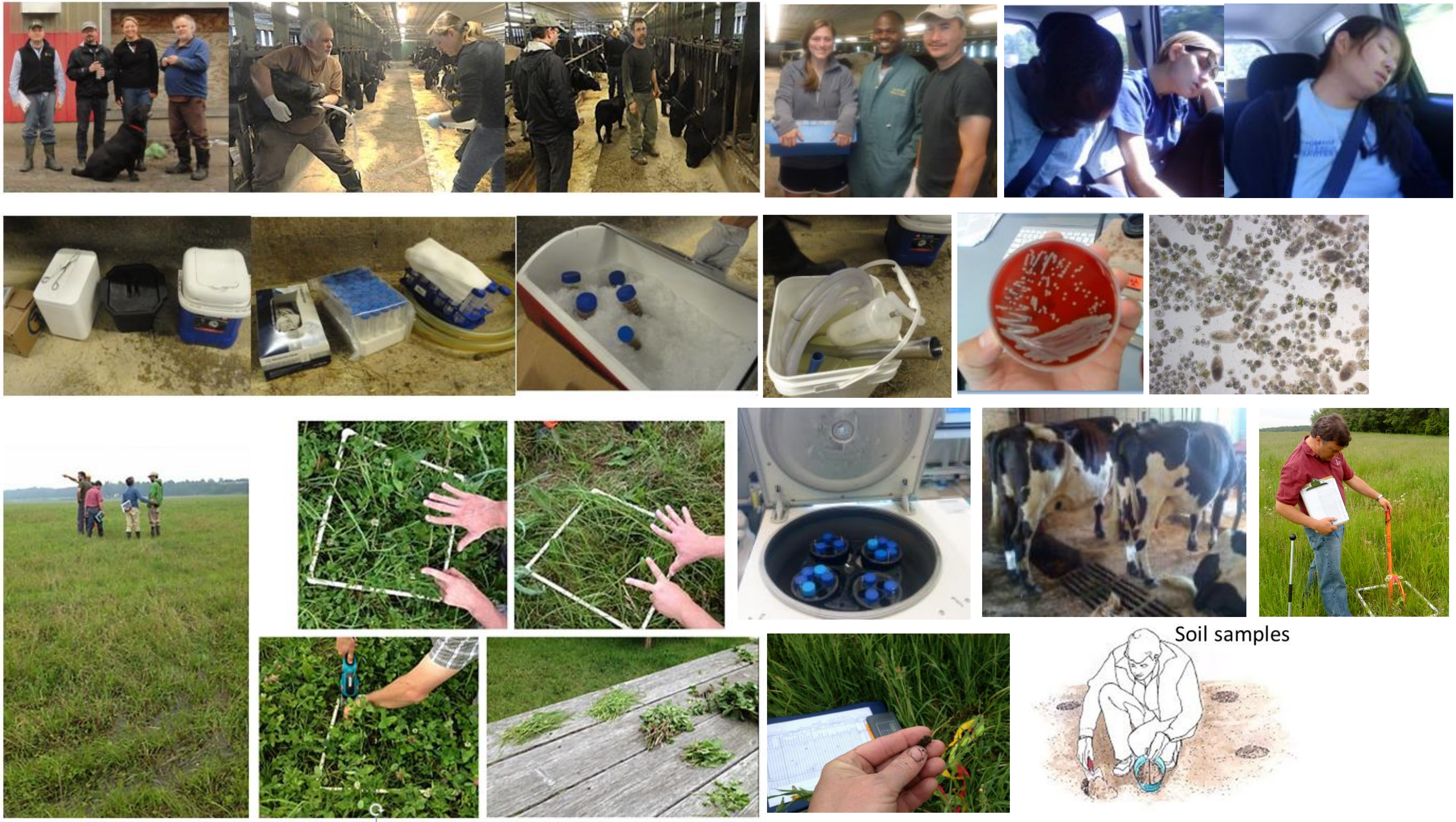



PEARL MILLET (2x, 4 wk grazings)







Soil samples

Biological Analysis
Soil

Report prepared for:

UVM Center for Sustainable Ag
Juan Alvez
23 Mansfield Ave
Burlington, VT 05401 USA

jalvez@uvm.edu

Report Sent: 6/5/2014
Sample#: 01-118763 | Submission:01-023883
Unique ID: Cool
Plant: Pasture
Invoice Number: 11197
Sample Received: 5/29/2014

For interpretation of this report please contact:
Earthfort Labs
info@earthfort.com
(541) 257-2612

Consulting fees may apply

Organism Biomass Data	Dry Weight	Active Bacteria (µg/g)	Total Bacteria (µg/g)	Active Fungi (µg/g)	Total Fungi (µg/g)	Hyphal Diameter (µm)
Results	0.740	73.8	785	7.85	427	2.85
Comments	In Good Range	Below range	Above range	Below range	In range	
Expected Range Low	0.45	75	300	75	300	
Expected Range High	0.85	150	600	150	600	

	Protozoa (Numbers/g)			Total	Mycorrhizal Colonization (%)	
	Flagellates	Amoebae	Ciliates	Nematodes #/g	ENDO	ECTO
Results	18733	62243	374	**0.96**	Not Ordered	Not Ordered
Comments	Good	Good	High	Low		
Expected Range Low	10000	10000	0	10	10%	10%
Expected Range High	100000	100000	200	20	50%	50%

Organism Biomass Ratios	Total Fungi to Tot.Bacteria	Active to Total Fungi	Active to Total Bacteria	Active Fungi to Act.Bacteria	Nitrogen Cycling Potential (lbs/ac)
Results	**0.54**	**0.02**	**0.09**	**0.11**	100-150
Comments	Low	Low	Low	Low	
Expected Range Low	1	0.25	0.25	1	
Expected Range High	2	0.95	0.95	2	

Nematode detail (# per gram or # per mL)
Classified by type and identified to genus.
(If section is blank, no nematodes identified.)

Bacterial Feeders	0.72	
Cephalobus		0.24
Eucephalobus		0.05
Prismatolaimus		0.24
Rhabditidae		0.19
Fungal/Root Feeders	0.03	
Aphelenchus		0.03
Root Feeders	0.21	
Heterodora	Cyst nematode	0.05
Longidorus	Needle nematode	0.03
Paratylenchus	Pin nematode	0.13

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Dry Weight:	Within normal moisture levels.
Active Bacteria:	Bacterial activity low, foods may be required.
Total Bacteria:	Excellent bacterial biomass.
Active Fungi:	Fungal activity low, foods may be required.
Total Fungi:	Good fungal biomass.
Hyphal Diameter:	Good balance of fungi.
Protozoa:	Nutrients are being cycled and made available to plants in good rates.
Total Nematodes:	Low numbers, low diversity, root feeders present.
Mycorrhizal Col.:	
TF/TB:	Too bacterial for some pasture grasses
AF/TF:	Low fungal activity, foods may be required.
AB/TB:	Low bacterial activity, foods may be required.
AF/AB:	Bacterial dominated, becoming more bacterial.

Interpretation Comments:

Actinobacteria Biomass = 9.29 ug/g
Fairly good fungal diversity; hyphal diameter 1.5 to 5um.

Biological Analysis
Soil

Report prepared for:

UVM Center for Sustainable Ag
Juan Alvez
23 Mansfield Ave
Burlington, VT 05401 USA

jalvez@uvm.edu

Report Sent: 6/5/2014
Sample#: 01-118764 | Submission:01-023883
Unique ID: Mill
Plant: Pasture
Invoice Number: 11197
Sample Received: 5/29/2014

For interpretation of this report please contact:
Earthfort Labs
info@earthfort.com
(541) 257-2612

Consulting fees may apply

Organism Biomass Data	Dry Weight	Active Bacteria (µg/g)	Total Bacteria (µg/g)	Active Fungi (µg/g)	Total Fungi (µg/g)	Hyphal Diameter (µm)
Results	0.770	68.7	597	10.4	465	2.9
Comments	In Good Range	Below range	In range	Below range	In range	
Expected Range Low	0.45	75	300	75	300	
Expected Range High	0.85	150	600	150	600	

	Protozoa (Numbers/g)			Total	Mycorrhizal Colonization (%)	
	Flagellates	Amoebae	Ciliates	Nematodes #/g	ENDO	ECTO
Results	5981	36007	359	4.22	Not Ordered	Not Ordered
Comments	Low	Good	High	Low		
Expected Range Low	10000	10000	0	10	10%	10%
Expected Range High	100000	100000	200	20	50%	50%

Organism Biomass Ratios	Total Fungi to Tot.Bacteria	Active to Total Fungi	Active to Total Bacteria	Active Fungi to Act.Bacteria	Nitrogen Cycling Potential (lbs/ac)
Results	0.78	0.02	0.12	0.15	100-150
Comments	Low	Low	Low	Low	
Expected Range Low	1	0.25	0.25	1	
Expected Range High	2	0.95	0.95	2	

Nematode detail (# per gram or # per mL)
Classified by type and identified to genus.
(If section is blank, no nematodes identified.)

Bacterial Feeders	3.62	
Cephalobus		1.14
Diploscapter		0.40
Eucephalobus		0.20
Monhystrella		0.07
Panagrolaimus		0.13
Rhabditidae		1.61
Zeldia		0.07
Fungal Feeders	0.07	
Discolaimus		0.07
Fungal/Root Feeders	0.20	
Aphelenchus		0.07
Ditylenchus	Stem & Bulb nematode	0.07
Filenchus		0.07
Root Feeders	0.33	
Paratylenchus	Pin nematode	0.20
Pratylenchus	Lesion nematode	0.07
Xiphinema	Dagger nematode	0.07

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Report Sent: 6/5/2014
Sample#: 01-118764
Unique ID: Mill
Plant: Pasture
Invoice Number: 11197
Sample Received: 5/29/2014

Dry Weight:	Within normal moisture levels.
Active Bacteria:	Bacterial activity low, foods may be required.
Total Bacteria:	Good bacterial biomass.
Active Fungi:	Fungal activity low, foods may be required.
Total Fungi:	Good fungal biomass.
Hyphal Diameter:	Good balance of fungi.
Protozoa:	Lacking species diversity.
Total Nematodes:	Low numbers, good diversity, root feeders present.
Mycorrhizal Col.:	
TF/TB:	Too bacterial for some pasture grasses
AF/TF:	Low fungal activity, foods may be required.
AB/TB:	Low bacterial activity, foods may be required.
AF/AB:	Bacterial dominated, becoming more bacterial.

Interpretation Comments:

Actinobacteria Biomass = 8.93 ug/g
Farily good fungal diversity; hyphal diameter 1.5 to 5.5um.

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Mount Vernon, ME 04352
207 293 2457
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lab@woodsend.org

SOIL HEALTH TOOL PREMIUM TEST

Performed with USDA-ARS ***H3A Extraction Method***

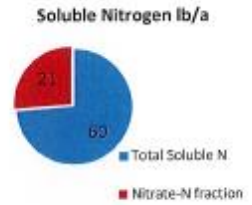
For:

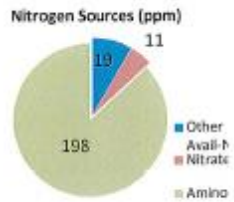
Juan Alvez
UVM - Extension
23 Mansfield Ave
Burlington, VT 05452

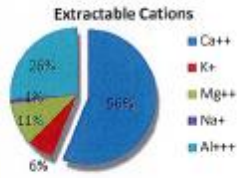
Lab ID: 9136.0 **Acct No:** 2849
Sample: **Soil: M 1-2**
Sample Received: 11/3/2014
Report Date: 11/24/2014
Crop Intended: Hay-Unimproved
QAQC: CB

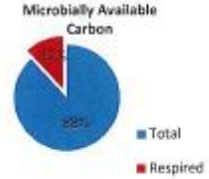
Tested Factors	Symbol	UNITS	Level Found	Rating
* Total Soluble N	Org N + NO3-N + NH4-N	ppm §	29.8	ML
* Nitrate-N fraction	NO_3-N	ppm	10.6	M
* Water Extract Org. C	C_{org}	C-ppm	252	M
* SLAN *Amino-N*	NH_2-N	N-ppm	198	M
* Phosphate (P^-)	P	lb/a	107	VH
* Potassium	K+	lb/a	384	H
* Calcium	Ca++	lb/a	1724	MH
* Iron	Fe++	ppm	80	ML
* Aluminum	Al 3+	ppm	180	L
Availability Factors				
Nitrogen (N-min+Avail)		lb/a	67	M
Phosphorus P_2O_5		lb/a	247	VH
Potassium K_2O		lb/a	461	H
Indicator Factors				
P-Saturation		P/(Al + Fe)	20.7	H
* Fe+Al (acidity indicator)		ppm	260	L
* Calcium Saturation		Ca/(Fe+Al)	3.32	VH

Test Interpretations		Rating
* Soil Health Score (updated 10-15-2014)	26.2	H
* Soluble C:N Ratio	8.5	ML
* Solvita CO_2-Burst ppm	30.3	L
* Microbially Active Carbon- "MAC"	12%	L
Micro Aggregate Stability	9%	VL









Nutrient Calculations, Value as $/acre available				
$N + P_2O_5 + K_2O$ / acre	$ 317			
Nutrient Requirements		Nitrogen	Phosphate	Potash
Hay-Unimproved	lbs/acre	none	none	none
(assumed total nutrient requirement)		50	25	25
Limestone Requirement	lbs/acre	None		
USDA Cover Crop Recommendations				
>Based on Soil Health Score of: **26.2**				
Mix Recommended:	100% Grass			
* Fall Cover Crop Recommended				

Optional Tests (included with Premium Soil Test)							
Soil Organic Matter	LOI %	5.1	MH	pH in Water	6.98	M
Basal CO_2-C	ppm	30.38	H	Magnesium (lb/a)	192	OK
Effective CEC**	cmol/kg	7.7	-	Sodium lb/a	33	OK

USDA Climate Zone Used for this report: 4b **Ratings: VL=Very Low, L=Low, M=Moderate, MH=Medium High, H=High, VH=Very High**

* **Soil Health Test Traits** *All nutrients in Soil Health Tool Extract (H3A), **Effective CEC = H3A extr. Al+Ca+Mg+K+Na; optional SOM by LOI @360°C*

Methods: Soil Health Tool, USDA-ARS Temple TX; *Soil Test Procedures for the NE USA Bulletin #493, Univ of DE; VT Aluminum Index*

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Mount Vernon, ME 04352
207 293 2457
for more information:
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SOIL HEALTH TOOL PREMIUM TEST

Performed with USDA-ARS ***H3A Extraction Method***

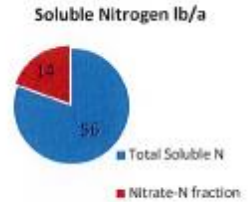
For:

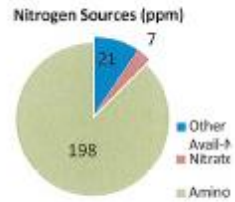
Juan Alvez
UVM - Extension
23 Mansfield Ave
Burlington, VT 05452

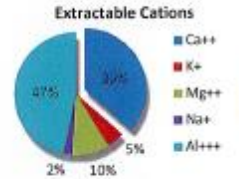
Lab ID: 9136.1 **Acct No:** 2849
Sample: **Soil: Bn Side R**
Sample Received: 11/3/2014
Report Date: 11/24/2014
Crop Intended: Hay-Unimproved
QAQC:

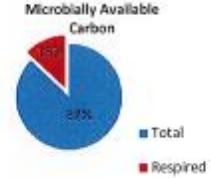
Tested Factors	Symbol	UNITS	Level Found	Rating
* Total Soluble N	Org N + NO3-N + NH4-N	ppm §	28.2	ML
* Nitrate-N fraction	NO_3-N	ppm	6.8	L
* Water Extract Org. C	C_{org}	C-ppm	268	M
* SLAN *Amino-N*	NH_2-N	N-ppm	198	M
* Phosphate (P^-)	P	lb/a	74	H
* Potassium	K+	lb/a	215	MH
* Calcium	Ca++	lb/a	841	L
* Iron	Fe++	ppm	90	ML
* Aluminum	Al 3+	ppm	244	M
Availability Factors				
Nitrogen (N-min+Avail)		lb/a	64	M
Phosphorus P_2O_5		lb/a	169	H
Potassium K_2O		lb/a	259	MH
Indicator Factors				
P-Saturation		P/(Al + Fe)	11.0	H
* Fe+Al (acidity indicator)		ppm	334	L
* Calcium Saturation		Ca/(Fe+Al)	1.26	MH

Test Interpretations		Rating
* Soil Health Score (updated 10-15-2014)	29.0	H
* Soluble C:N Ratio	9.5	ML
* Solvita CO_2-Burst ppm	34.7	L
* Microbially Active Carbon- "MAC"	13%	L
Micro Aggregate Stability	31%	MH









Nutrient Calculations, Value as $/acre available				
$N + P_2O_5 + K_2O$ / acre	$ 204			
Nutrient Requirements		Nitrogen	Phosphate	Potash
Hay-Unimproved	lbs/acre	none	none	none
(assumed total nutrient requirement)		50	25	25
Limestone Requirement	lbs/acre	None		
USDA Cover Crop Recommendations				
>Based on Soil Health Score of: **29.0**				
Mix Recommended:	100% Grass			
* Fall Cover Crop Recommended				

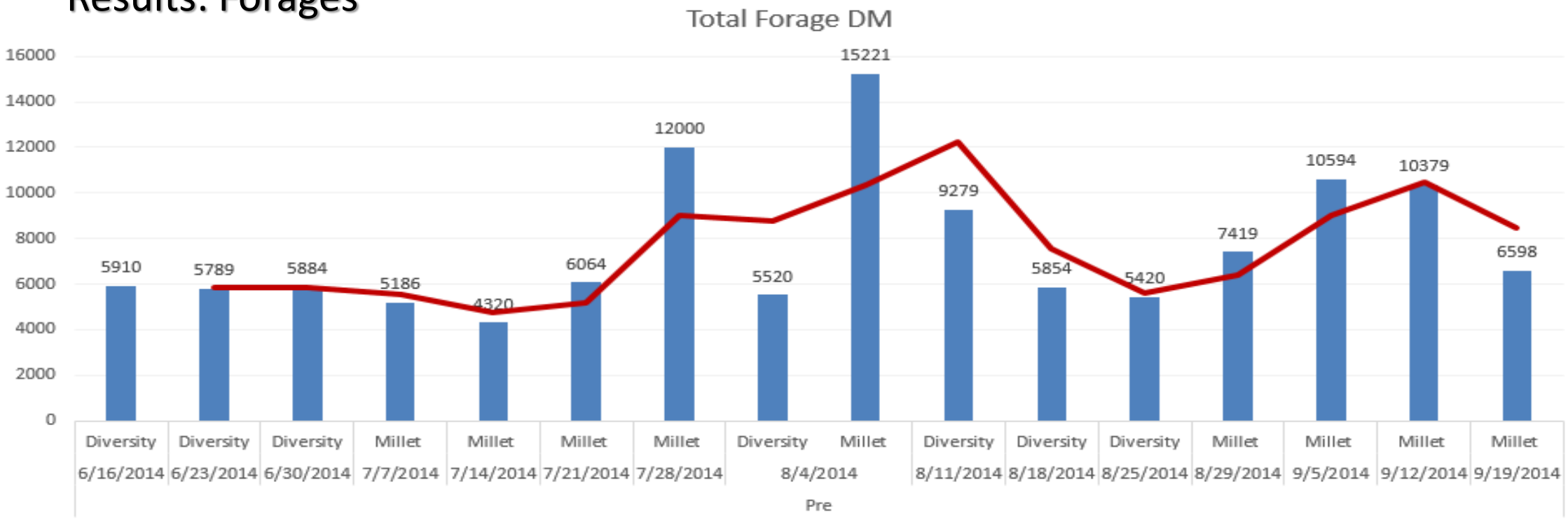
Optional Tests (included with Premium Soil Test)							
Soil Organic Matter	LOI %	5.1	MH	pH in Water	6.75	ML
Basal CO_2-C	ppm	29.11	MH	Magnesium (lb/a)	134	OK
Effective CEC**	cmol/kg	5.8	-	Sodium lb/a	62	H

USDA Climate Zone Used for this report: 4b **Ratings: VL=Very Low, L=Low, M=Moderate, MH=Medium High, H=High, VH=Very High**

* **Soil Health Test Traits** *All nutrients in Soil Health Tool Extract (H3A), **Effective CEC = H3A extr. Al+Ca+Mg+K+Na; optional SOM by LOI @360°C*

Methods: Soil Health Tool, USDA-ARS Temple TX; *Soil Test Procedures for the NE USA Bulletin #493, Univ of DE; VT Aluminum Index*

Results: Forages



Millet DM (ave): 8,531 Kg/ha (7,618 lbs/A)

Diverse DM (ave): 6,227 Kg/ha (5,561 lbs/A)

Botanical Composition		
Grasses (67.3%)	**Forbs (10.8%)**	**Legumes (14.8%)**
Orchard grass, Timothy, Ryegrass, June grass, Meadow fescue, Brome grass, Bent grass, Quackgrass, Kentucky Blue grass and Millet (treatment monoculture)	Platain, Dandelion, Burdock, Milkweed, Bull Thistle	White clover, Red clover, Common Vetch.

Pasture and soil biology between Diverse and Millet

- Excellent overall pasture forage production and management
- Soils were covered (D, $p<0.01$)
- Adequate manure and trampling (D, $p<0.01$)
- Adequate moisture distribution (D, $p<0.01$)
- Grazed at mature stage (D, $p=0.05$)
- More earthworms and insects (D, but n/s)

Diverse NE cool season forage soils **were not different** than Millet soils

Monoculture vs. a Diverse Pasture on Milk Fatty Acids

M. Bainbridge, J. Barlow, J. Roman, J. Alvez, and J. Kraft

The UNIVERSITY of VERMONT

Media report health benefits of milk fatty acids

The Washington Post

Scientists have found another reason we should be drinking more whole milk

By Peter Whoriskey October 29

The New York Times

December 9, 2013

More Helpful Fatty Acids Found in Organic Milk

By KENNETH CHANG

Whole milk from organic dairies contains far more of some of the fatty acids that contribute to a healthy heart than conventional milk, scientists are reporting.

THE HUFFINGTON POST

Got (Organic Whole) Milk? New Study Says It's Healthier

Posted: 12/18/2013 12:55 pm EST | Updated: 02/17/2014 5:59 am EST

But a new study, led by Washington State University researcher Dr. Charles Benbrook, examined nearly 400 samples of organic and conventional milk over an 18-month period, and found that organic milk contained significantly more healthy omega-3 fatty acids than conventional milk. The researchers also found that whole milk was even higher in omega-3 fatty acids than low fat or fat free versions.

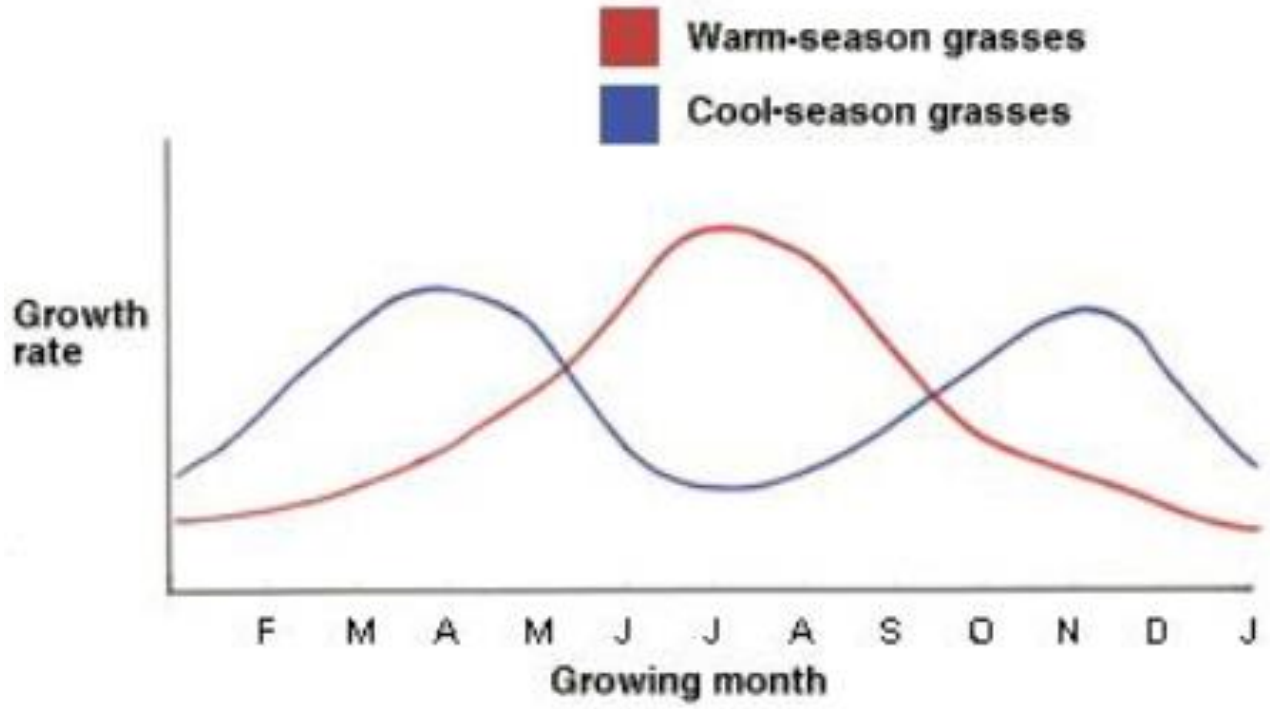
High omega-3 and CLA contents are advertised on products from grass-fed cows

Desired milk fat composition changes

- Increase Polyunsaturated Fatty Acids (**PUFA**)
  - Particularly the omega-3 fatty acid α-linolenic acid (**ALA**)
- Increase Conjugated linoleic acids (**CLA**)
- Decrease Saturated fatty acids (**SFA**)

Ruminants must ingest PUFA for CLA and omega-3 fatty acids to be secreted in milk (CLA are derived from 18:2 and 18:3)

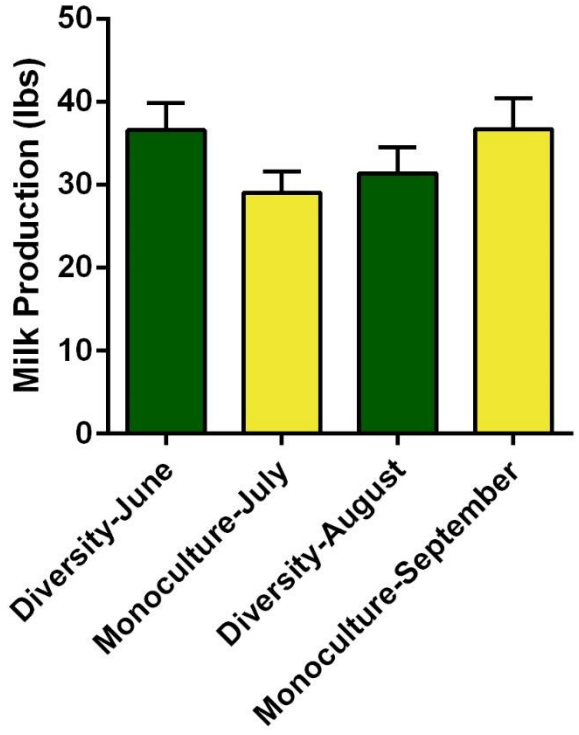
Grazing warm season annuals could produce more forage during hot months

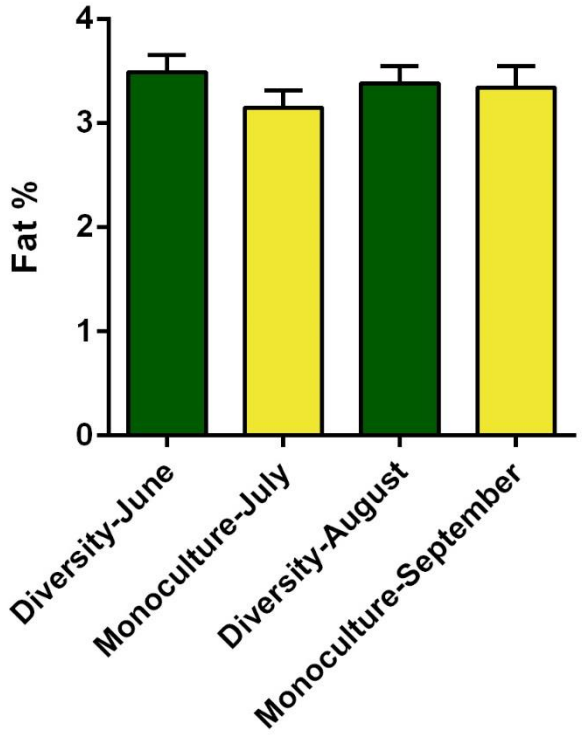


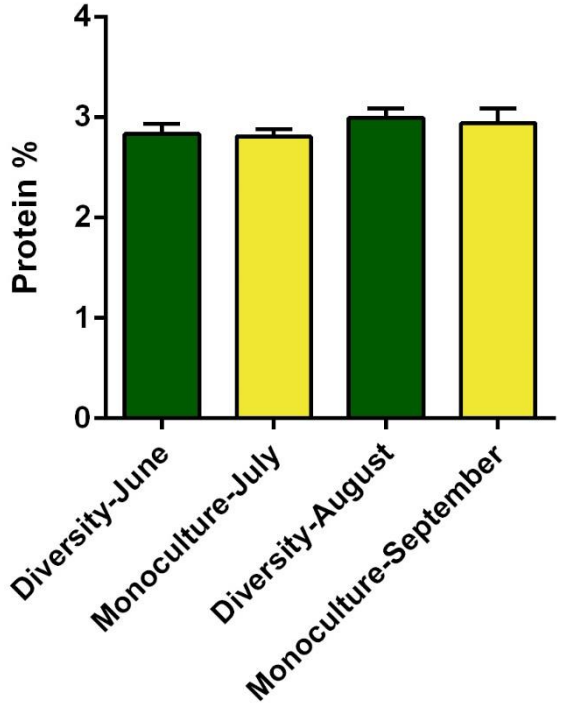
Study Design

Diverse Pasture + Balage → Monoculture (Pearl Millet) → Diverse Pasture → Monoculture (Pearl Millet)

There is no difference in milk production, fat %, or protein % between the two pasture types

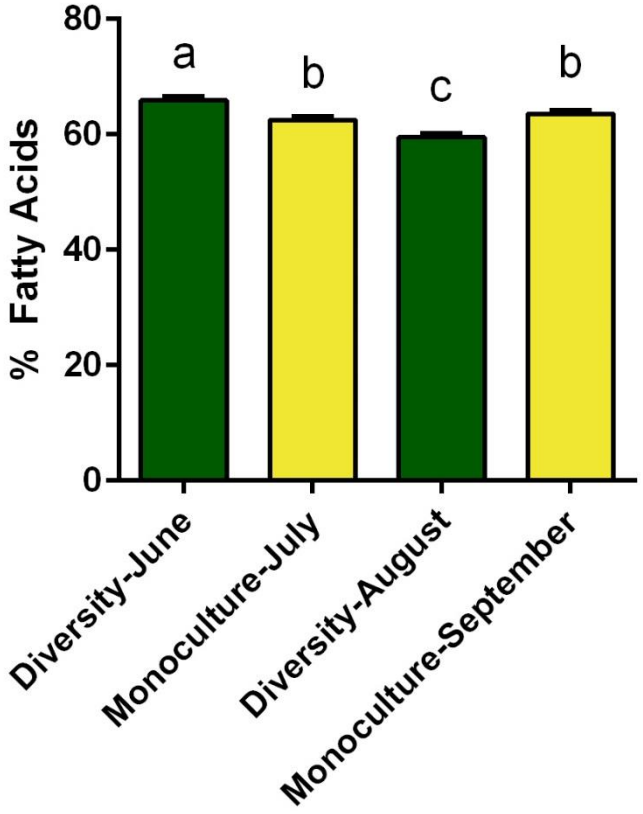




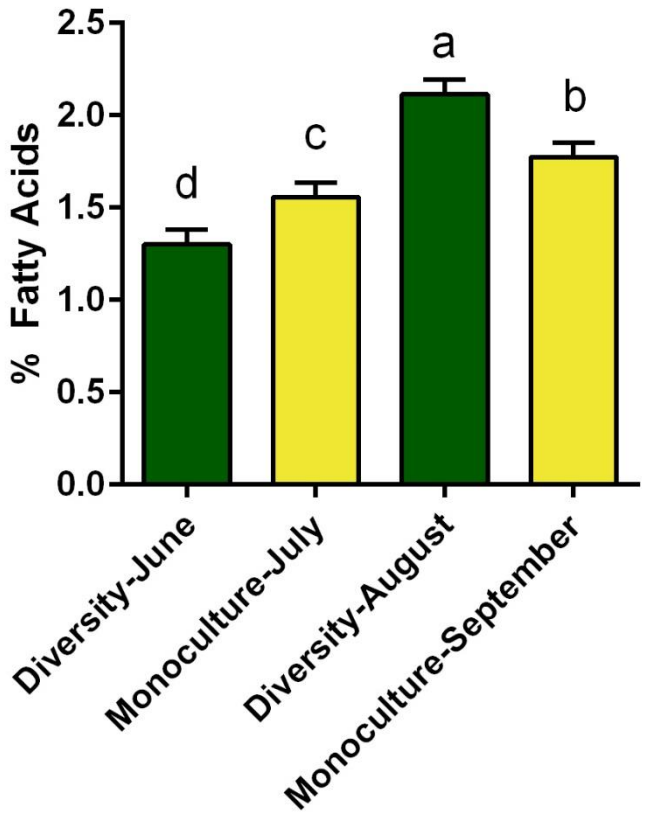


CLA are highest in milk when cows graze exclusively on a diverse pasture

SFA



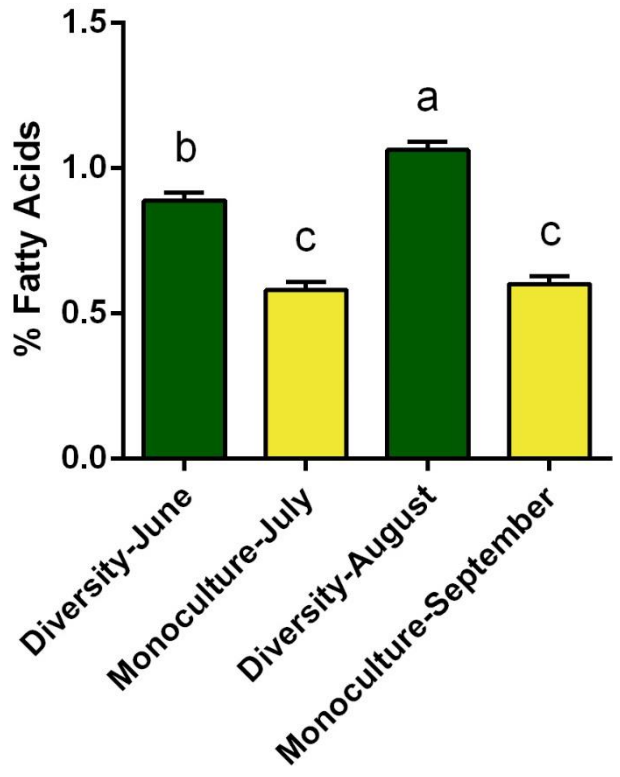
CLA



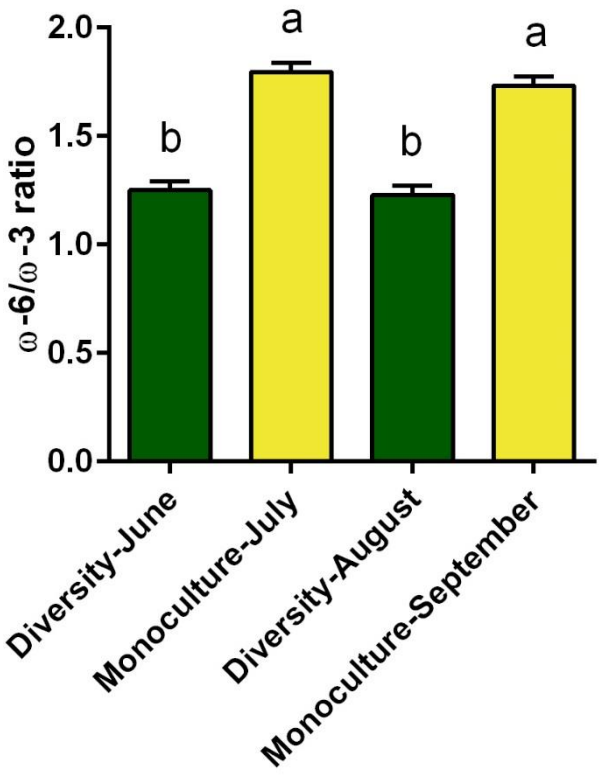
Means without a common letter differ significantly.

Omega-3 fatty acids in milk are higher when cows graze a diverse pasture vs. a monoculture of pearl millet

Omega-3 fatty acids



Omega-6/Omega-3 ratio



Means without a common letter differ significantly.

Take home message

- Grazing a pearl millet monoculture vs. diverse pasture had no effect on milk production, or milk fat and protein percentages.
- The content of omega-3 fatty acids and CLA was highest when grazing only a diverse pasture (no supplemental balage).
- Future research is looking into the rumen microbes and their effects on the fatty acid profile of milk.

Questions?

Activity monitoring for pasture-based dairy cattle

- Optimizing lying time is important to ensure
  - Good welfare and cow comfort
  - Good production
- Optimizing rumination time is important to ensure
  - Rumen health
  - Good production

Visual observation is the “gold standard”

Time consuming

Labor intensive

Continuous electronic monitoring systems offer alternatives

Grazing activity *(via Hobo accelerometers)*

1. Assess lying time and frequency using accelerometers as a potential proxy for grazing activity to estimate forage intakes, grazing behavior and rumen health.

2. demonstrate how real-time monitoring of grazing behavior and forage intakes allow farmers' to optimize forage utilization, rumen activity, and milk composition.

Activity and rumination monitoring

Wireless sensor and radiofrequency devices on identification tags

- Activity monitors for animal movement/behavior

    Accelerometers

  - Cow comfort assessments – influence of housing
  - Estrus / heat detection
  - Health status – metritis detection; mastitis detection – before clinical signs

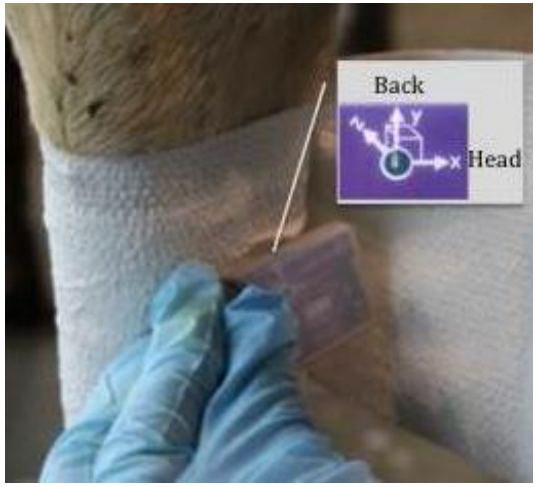
- Rumination monitors

    Microphone and vibration recording

Some commercially available systems

- Hobo Pendant G Accelerometers

(research applications)



- Heatime (SCR) Accelerometers and sound recorders

(commercially available)

Check with any major AI stud service or milking systems company

Source - http://extension.psu.edu/animals/dairy/news/2015/choosing-an-activity-system-for-your-dairy

Methods:

- 8 cows fitted with Hobo data loggers for 5 x 14 day periods from June to September while grazing 2 different pasture types

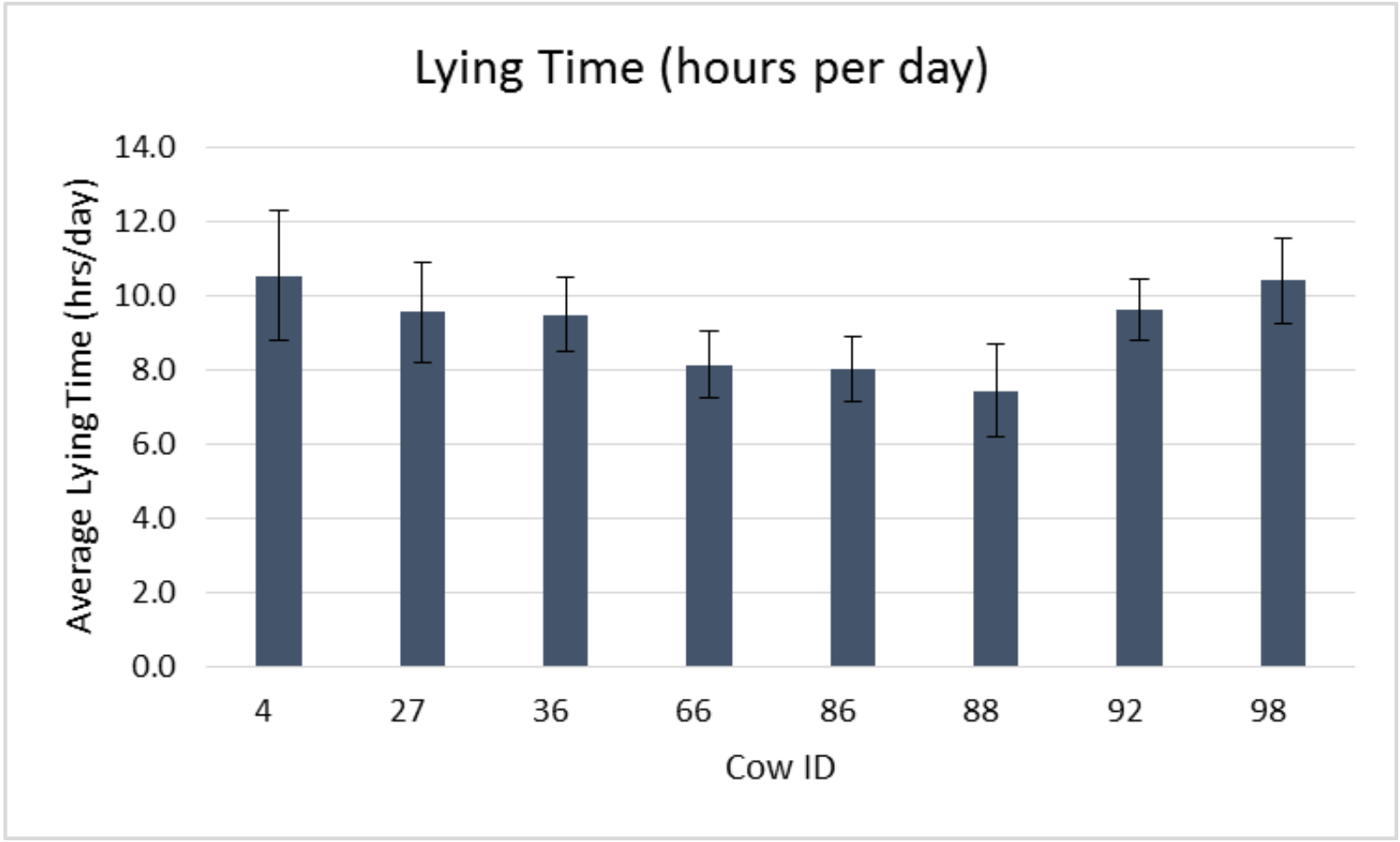
Results:

Average lying time 9.2 hrs per day

No effect of pasture type on lying time

Differences among cows in lying time

Higher producing cows had longer average lying times



Discussion or Questions

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