

BIODIVERSITY & LIVESTOCK WELLBEING



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UVM Extension, Center for Sustainable Ag.
Pasture Program

Project Team (alphabetical):



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Center for Sustainable Agriculture, UVM Extension



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**Animal & Veterinary
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University of Vermont



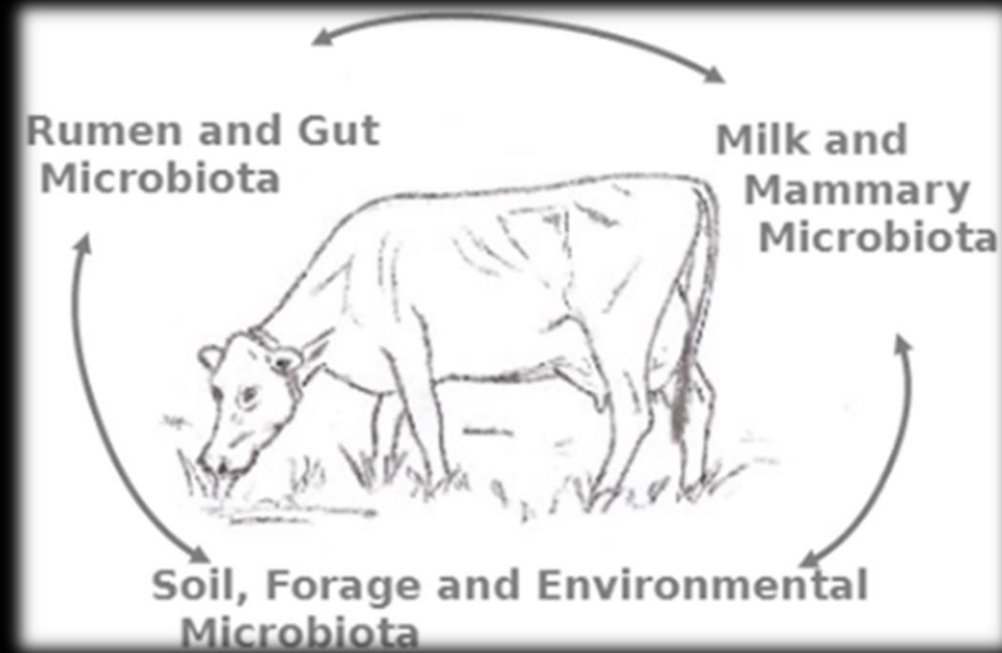
Center for Sustainable Agriculture

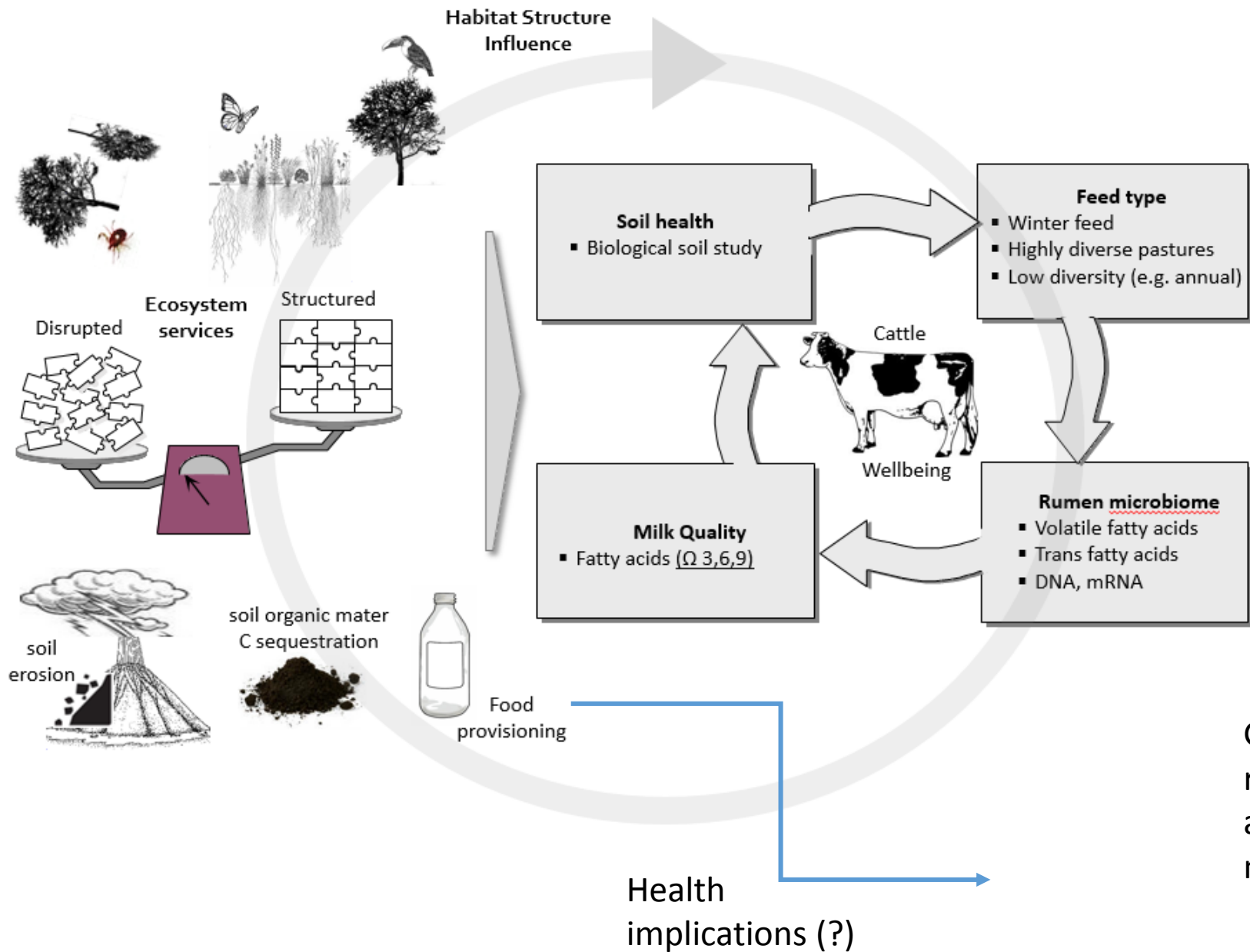


Online: <http://juanalvez.weebly.com/biodiversity--livestock-well-being.html>

Road Map

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





“organic milk healthier, because it has a more favorable balance of (ω -6 & ω -3) 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.

Reasons for Studying Biodiversity Effects...

✓ 1. We are losing it! What is the value of it?

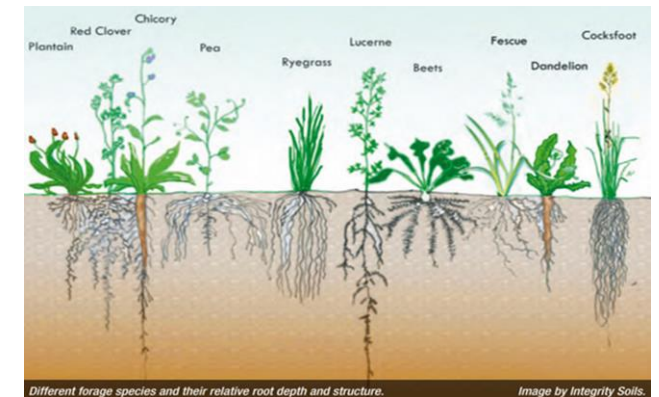
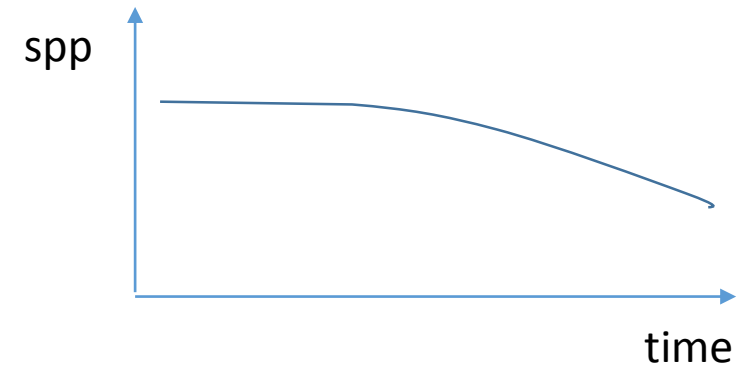
- Massive extinctions (*Primm et al. 1995*)
- Benefits of conserving biodiversity **100:1** (*Balmford et al. 2002*)
- Dilution Effect (*Bonds et al. 2012 PLOS1; Levi et. al 2012*)

✓ 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

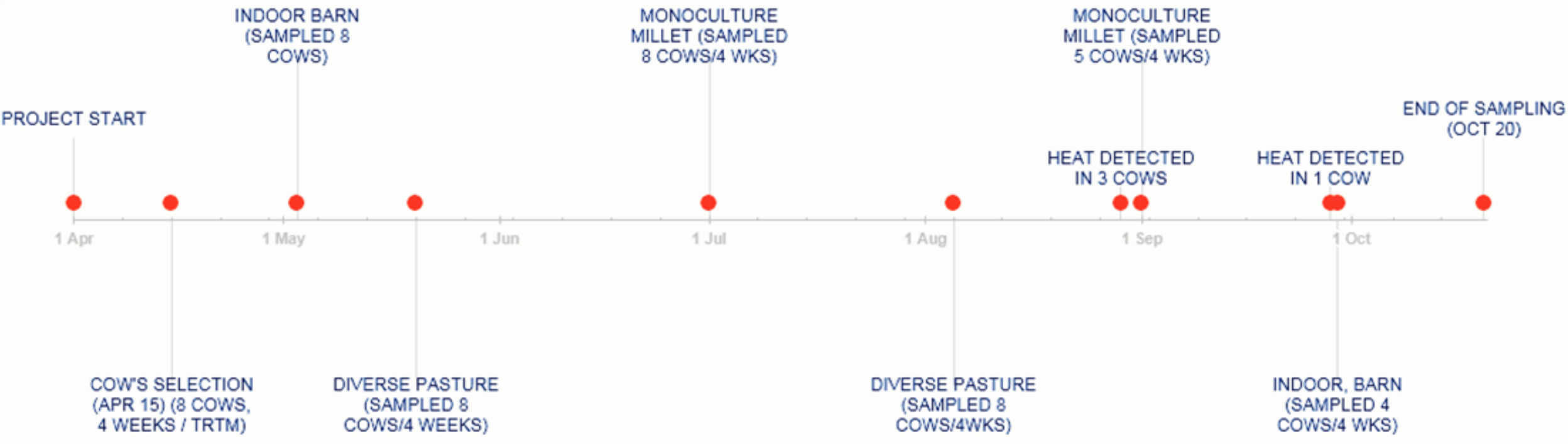
- Trophobiosis (Chaboussou)
- Ethilene/O₂ Fe³ -> Fe² (Widdowson)
- Biocenosis



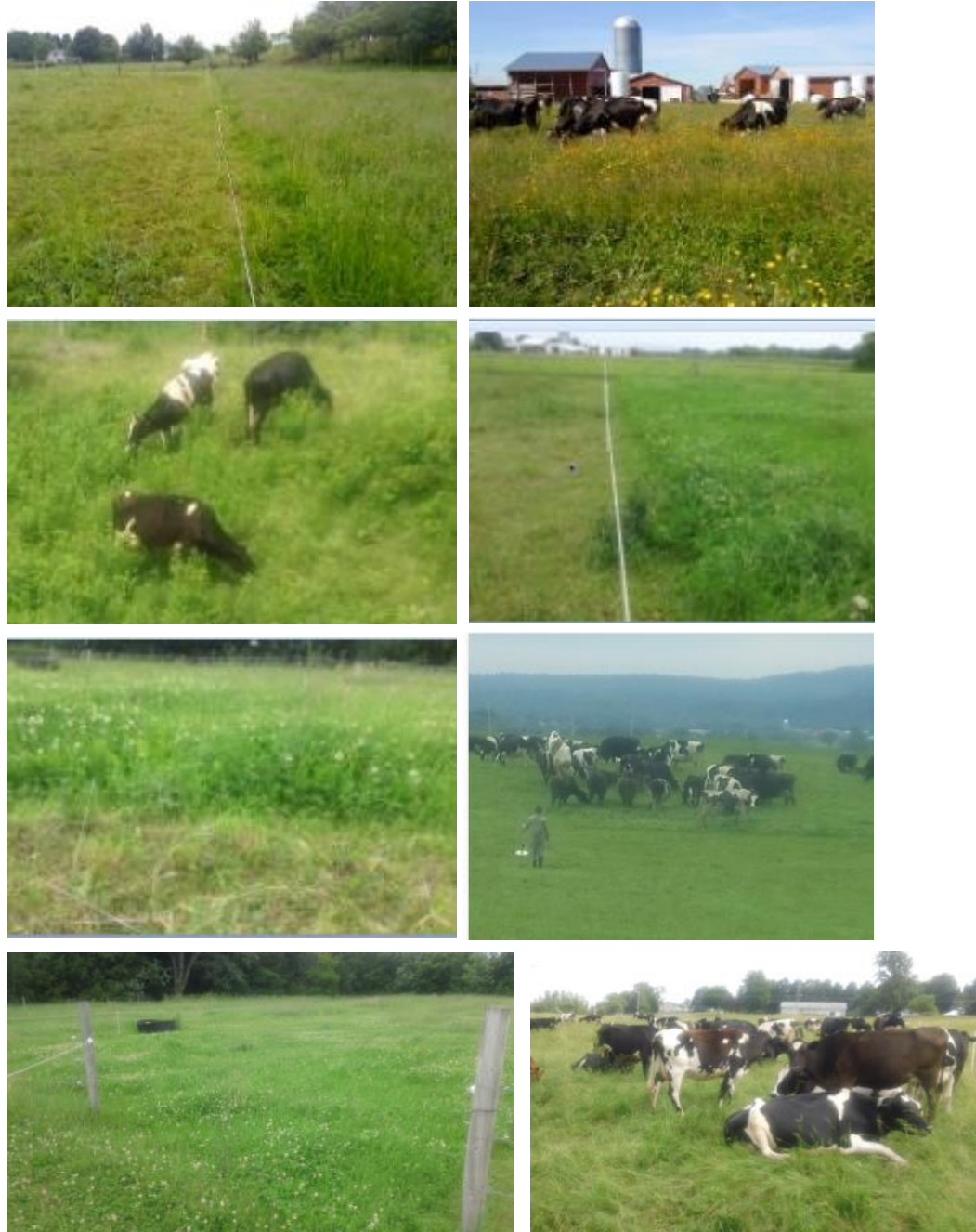
Scope of the study: Samples and Analyses

- **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

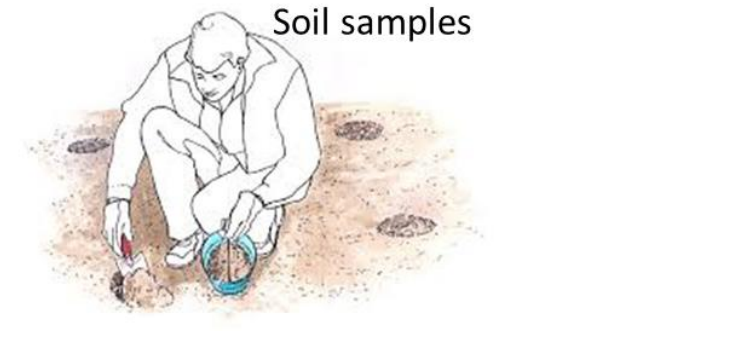


DIVERSE NE COOL SEASON PASTURES (2x, 4 wk grazings)



PEARL MILLET (2x, 4 wk grazings)







Biological Analysis Soil

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

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

Invoice Number: 11197
Sample Received: 5/29/2014

jalvez@uvm.edu

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)	Nematode detail (# per gram or # per mL) Classified by type and identified to genus. (If section is blank, no nematodes identified.)	
Results	0.740	73.8	785	7.85	427	2.85	Bacterial Feeders	0.72
Comments	In Good Range	Below range	Above range	Below range	In range		Cephalobus	0.24
Expected Range	Low: 0.45 High: 0.85	75 150	300 600	75 150	300 600		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
		Protozoa (Numbers/g)			Total Nematodes #/g	Mycorrhizal Colonization (%)		
		Flagellates	Amoebae	Ciliates		ENDO	ECTO	
Results		18733	62243	374	0.96	Not Ordered	Not Ordered	
Comments		Good	Good	High	Low			
Expected Range	Low: 10000 High: 100000	10000	100000	0	10	10%	10%	
				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 High: 2	0.25	0.25	1				
		0.95	0.95	2				

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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

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

Invoice Number: 11197
Sample Received: 5/29/2014

jalvez@uvm.edu

For interpretation of this report please contact:
Earthfort Labs
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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)	Nematode detail (# per gram or # per mL) Classified by type and identified to genus. (If section is blank, no nematodes identified.)	
Results	0.770	68.7	597	10.4	465	2.9	Bacterial Feeders	3.62
Comments	In Good Range	Below range	In range	Below range	In range		Cephalobus	1.14
Expected Range	Low: 0.45 High: 0.85	75 150	300 600	75 150	300 600		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	0.07
							Filenchus	0.07
							Root Feeders	0.33
							Paratylenchus	0.20
							Pratylenchus	0.07
							Xiphinema	0.07
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 High: 2	0.25 0.95	0.25 0.95	1 2				

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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
Fairly good fungal diversity; hyphal diameter 1.5 to 5.5µm.

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	$\frac{Org\ N + NO_3-N}{NH_4-N}$	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 ₂ O ₅	lb/a	247	VH
Potassium K ₂ O	lb/a	461	H

Indicator Factors

P-Saturation	P/(Al + Fe)	ppm	20.7	H
* Fe+Al (acidity indicator)	ppm	260	L	
* Calcium Saturation	Ca/(Fe+Al)	ppm	3.32	VH

Nutrient Calculations, Value as \$/acre available

N + P₂O₅ + K₂O / acre \$ 317

Nutrient Requirements	Nitrogen	Phosphate	Potash
Hay-Unimproved (assumed total nutrient requirement)	none	none	none
Limestone Requirement lbs/acre	50	25	25

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

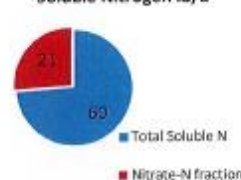
USDA Climate Zone Used for this report: 4b Ratings: VL=Very Low, L=Low, M=Moderate, MH=Medium High, H=High, VH=Very High

* 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

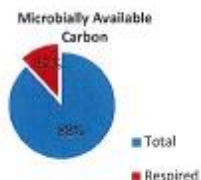
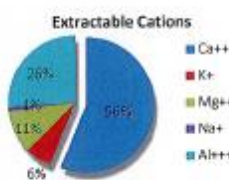
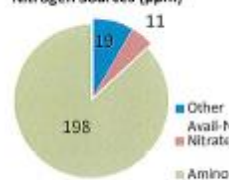
Methods: Soil Health Tool, USDA-ARS Temple TX; Soil Test Procedures for the NE USA Bulletin #493, Univ of DE; VT Aluminum Index

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

Soluble Nitrogen lb/a



Nitrogen Sources (ppm)



SOIL HEALTH TOOL PREMIUM TEST

Performed with USDA-ARS H3A Extraction Method

For:

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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	$\frac{Org\ N + NO_3-N}{NH_4-N}$	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 ₂ O ₅	lb/a	169	H
Potassium K ₂ O	lb/a	259	MH

Indicator Factors

P-Saturation	P/(Al + Fe)	ppm	11.0	H
* Fe+Al (acidity indicator)	ppm	334	L	
* Calcium Saturation	Ca/(Fe+Al)	ppm	1.26	MH

Nutrient Calculations, Value as \$/acre available

N + P₂O₅ + K₂O / acre \$ 204

Nutrient Requirements	Nitrogen	Phosphate	Potash
Hay-Unimproved (assumed total nutrient requirement)	none	none	none
Limestone Requirement lbs/acre	50	25	25

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

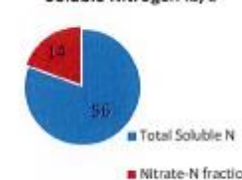
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* Soil Health Test Traits All nutrients in Soil Health Tool Extract (H3A). **Effective CEC = H3A extr. Al+Ca+Mg+K+Na; optional SOM by LOI @360°C

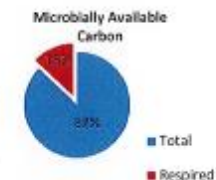
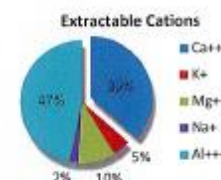
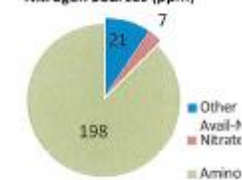
Methods: Soil Health Tool, USDA-ARS Temple TX; Soil Test Procedures for the NE USA Bulletin #493, Univ of DE; VT Aluminum Index

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

Soluble Nitrogen lb/a

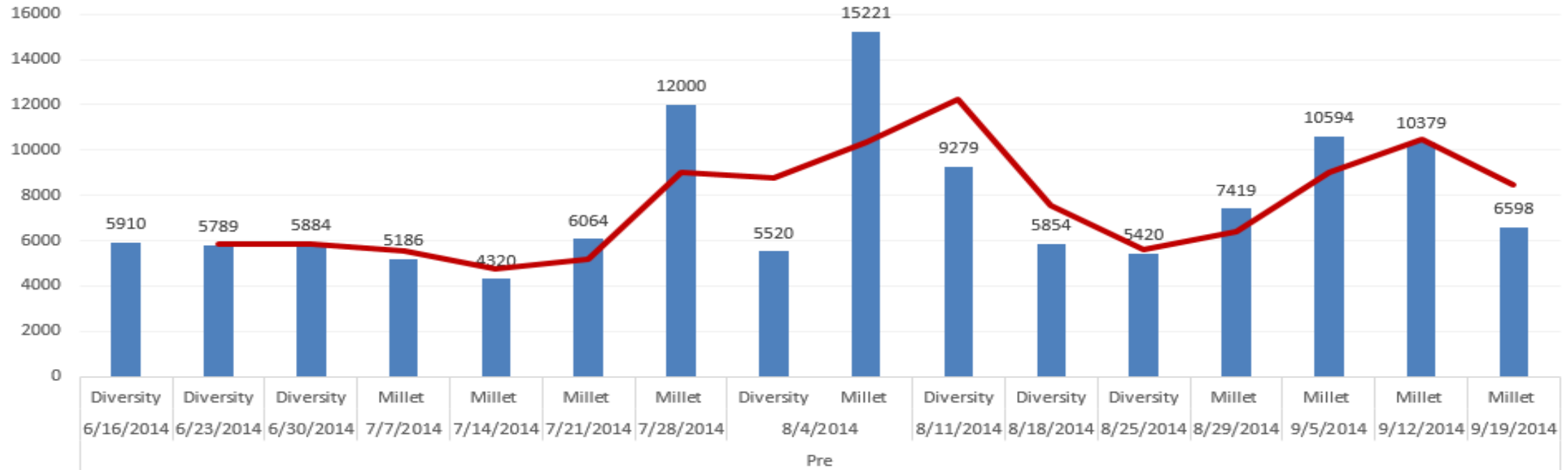


Nitrogen Sources (ppm)



Results: Forages

Total Forage DM



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



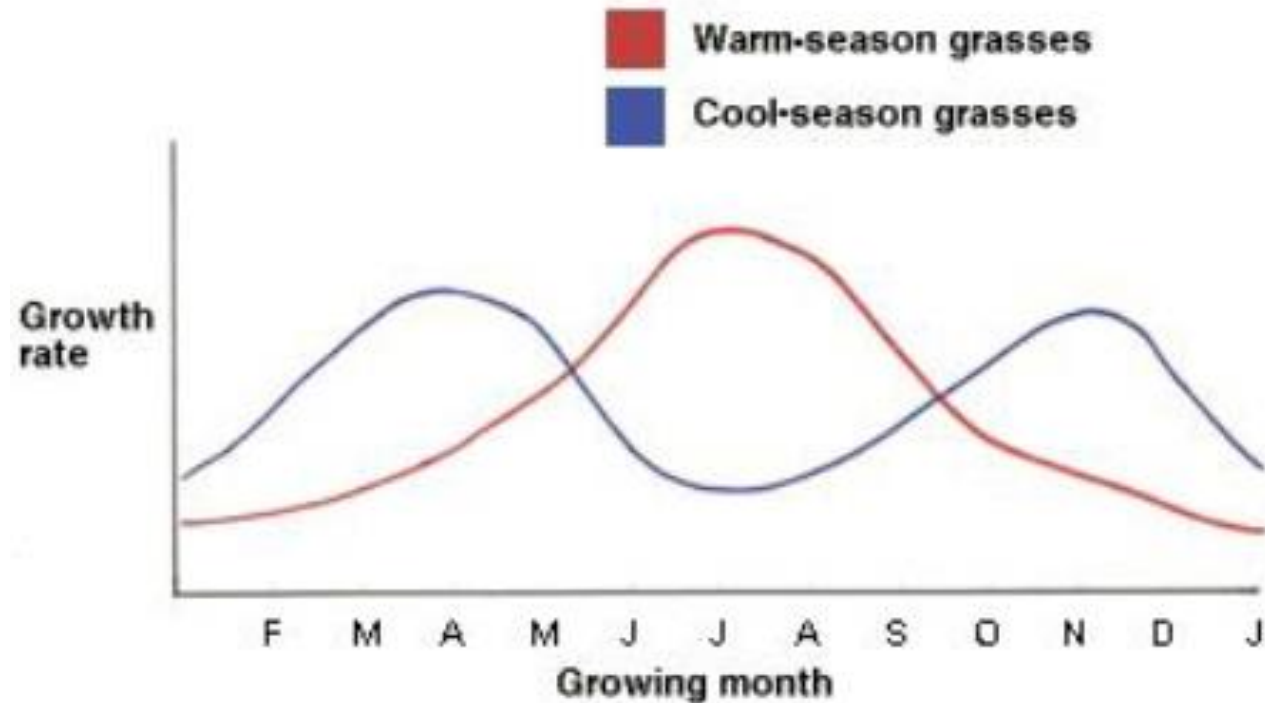
Desired milk fat composition changes

- 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**)

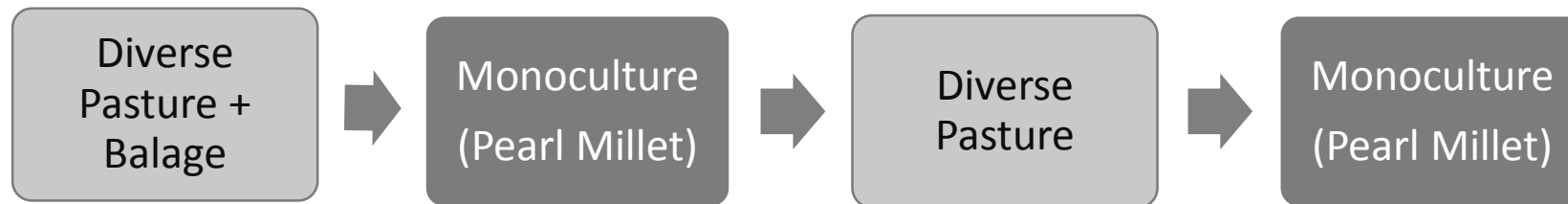
Ruminants must ingest PUFA for CLA and omega-3 fatty acids to be secreted in milk
(CLA are derived from 18:2 and 18:3)



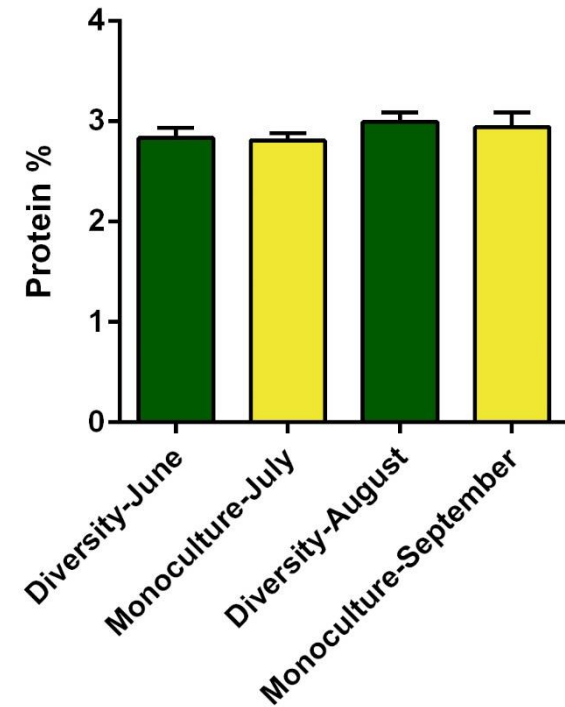
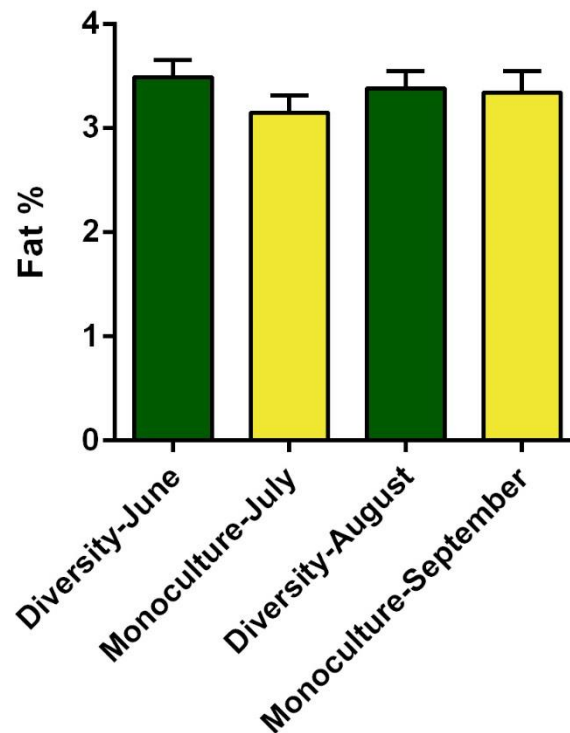
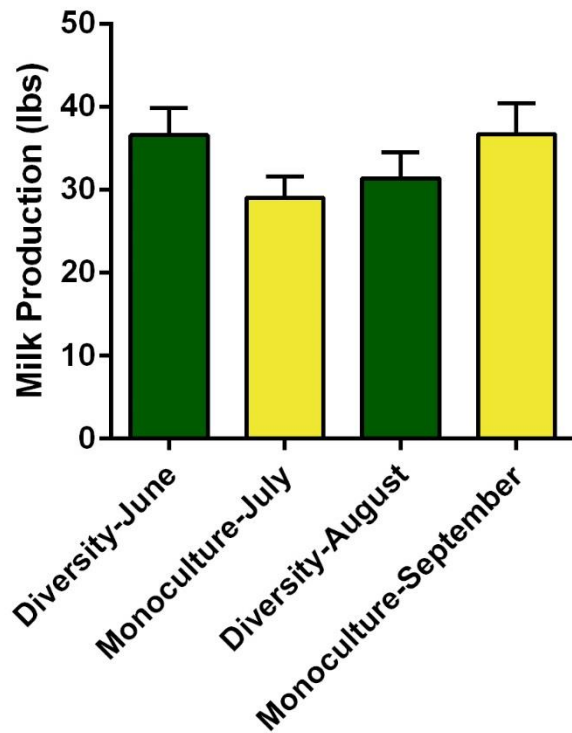
Grazing warm season annuals could produce more forage during hot months



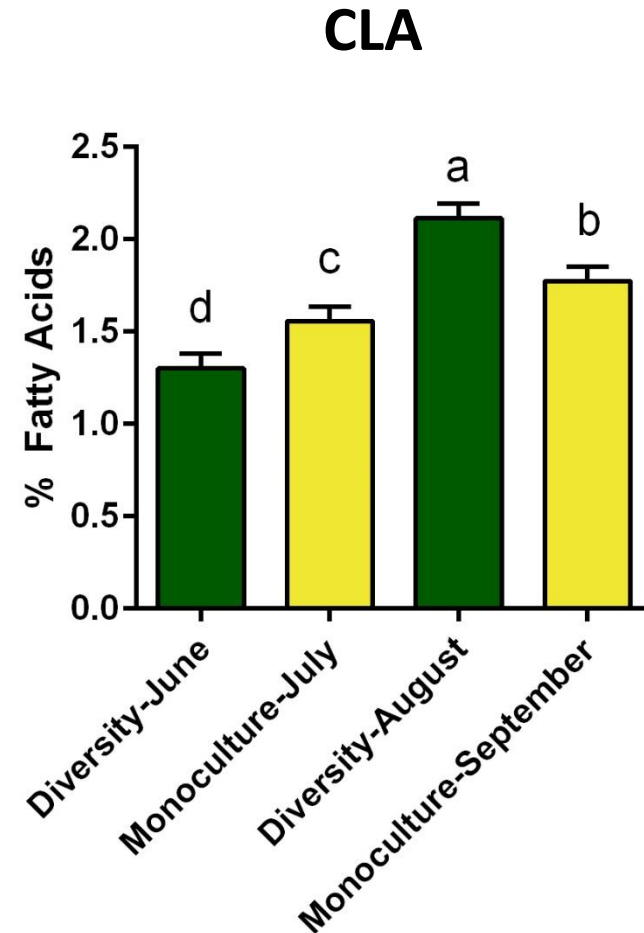
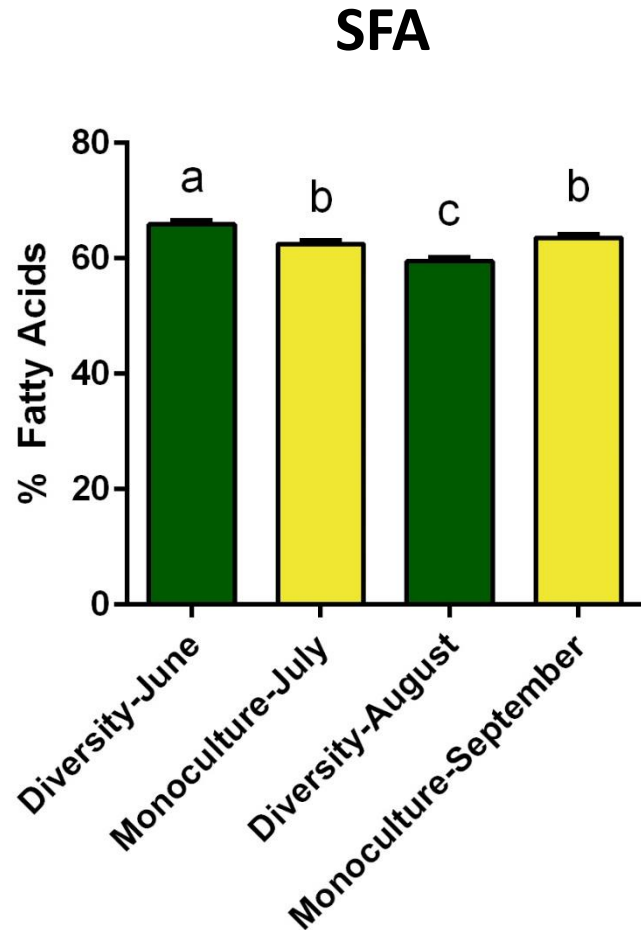
Study Design



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



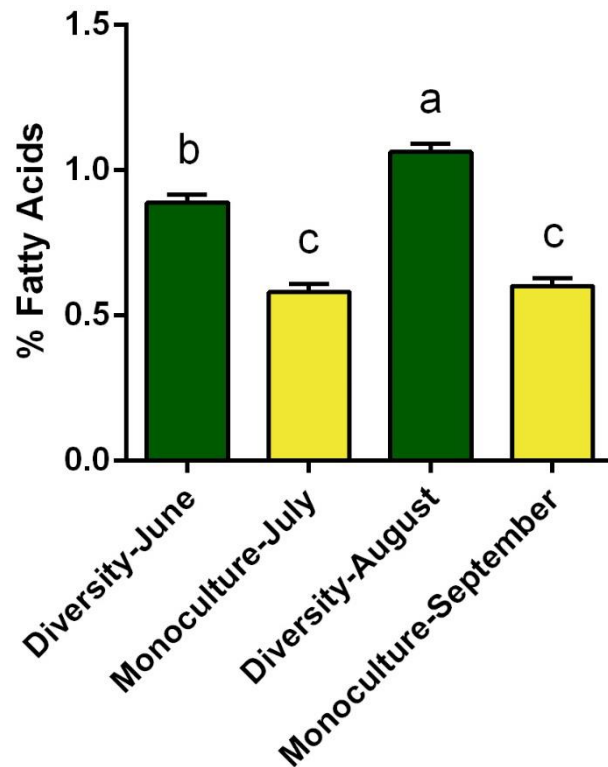
CLA are highest in milk when cows graze exclusively on a diverse pasture



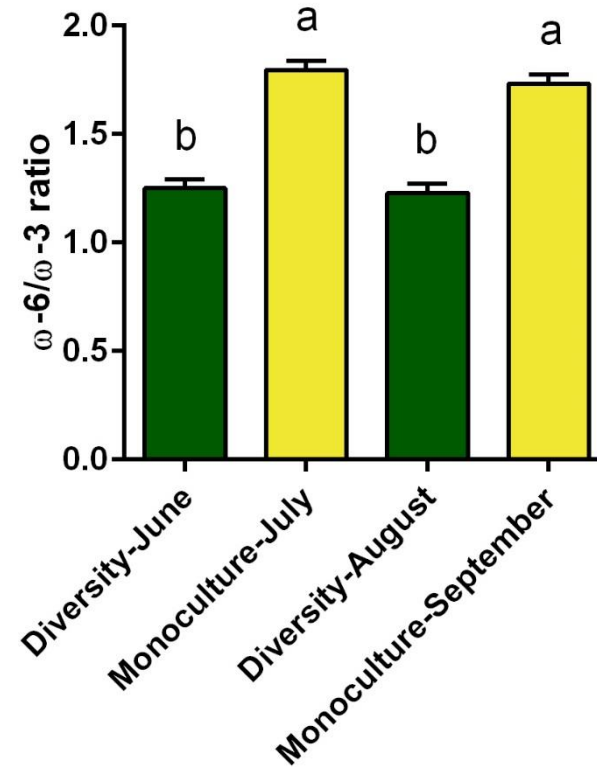
Means without a common letter differ significantly.

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

Omega-3 fatty acids



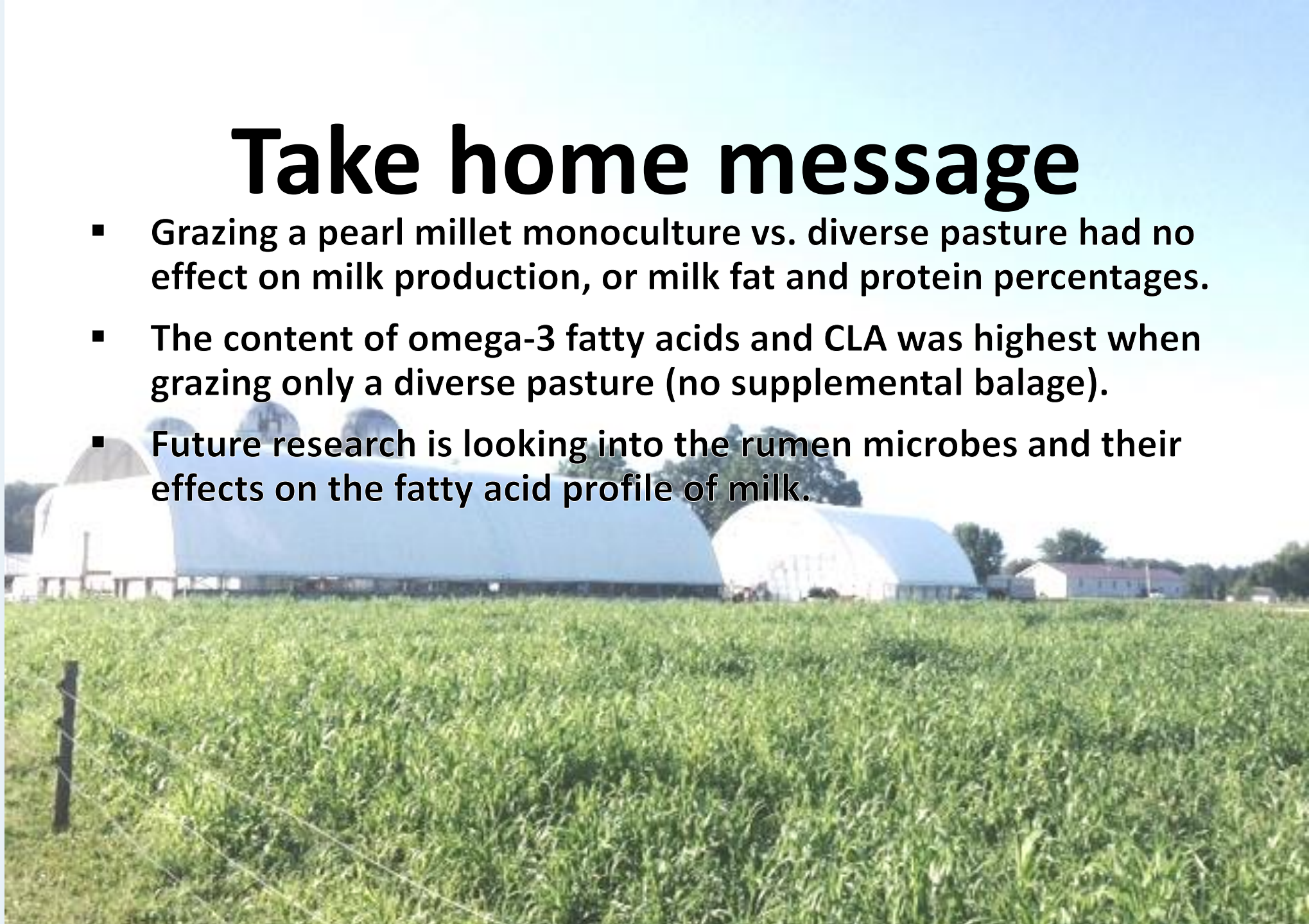
Omega-6/Omega-3 ratio



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



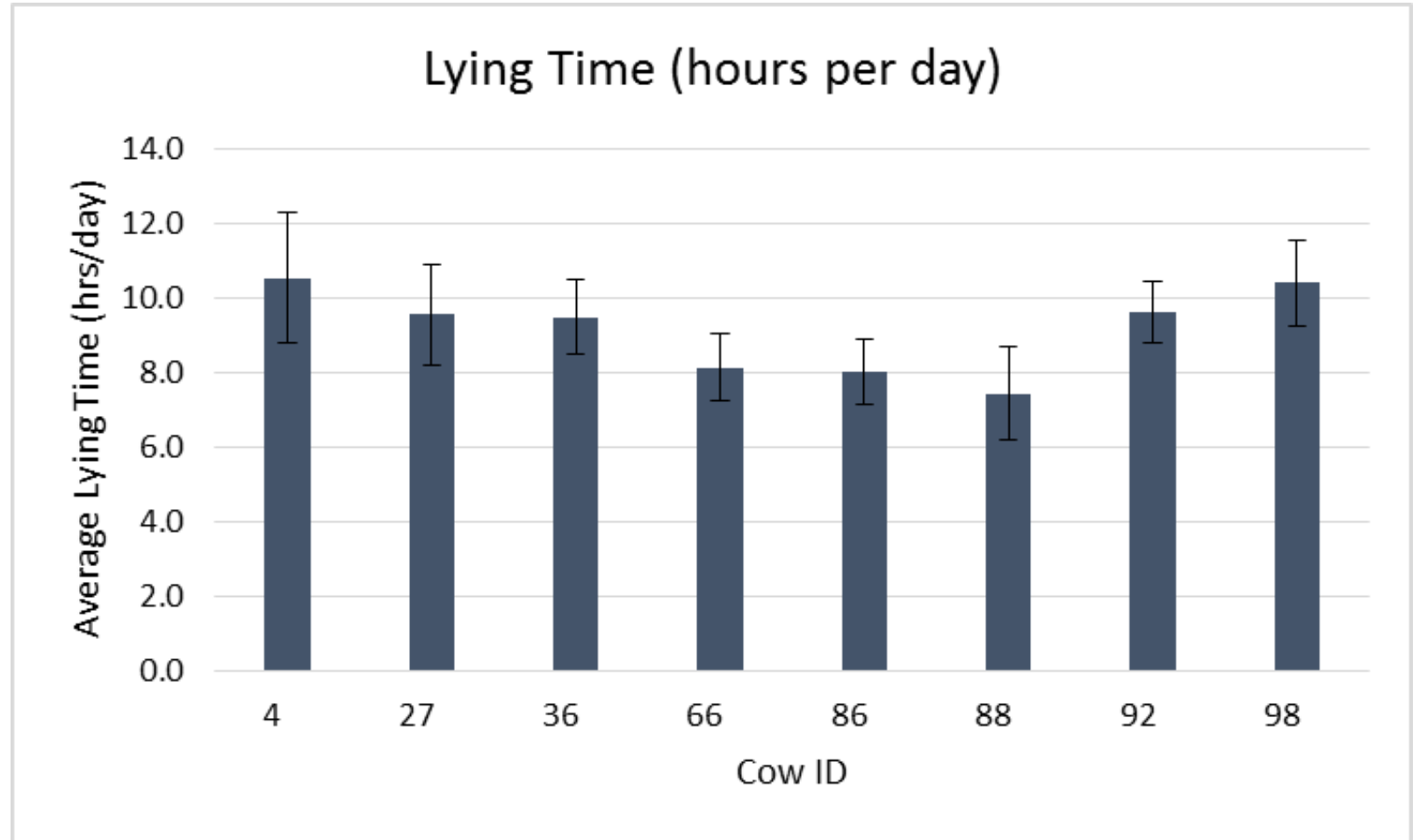
Results:

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



Acknowledgements:

NESARE Grant

UVM REACH Grant