Using Forage Testing for Pasture Management

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GRASSWORKS GRAZING CONFERENCE JANUARY 31, 2019

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Types of plant sampling & goals:

- Ecological Sampling
  - Looks at mapping, species, cover
  - Is done for habitat description/distribution, habitat preservation, rare/endangered species, invasive species, etc.
- Tissue Testing
  - Determines if:
    - Sufficient nutrients are available in the soil
    - Nutrients have been taken up by plants
    - Plants are healthy
  - Often looks at element levels
  - Great to combine this with soil analysis and forage analysis

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Types of plant sampling & goals:

- Forage Availability
  - Estimates forage dry matter available to cattle
  - Helps you adjust your grazing allotment
  - Measured by eyeball, pasture/grazing stick, plate meters, trac sonar, LiDAR
- Forage Analysis
  - Determines nutrients available to animals
  - Our focus today

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Why do we sample pasture?

Is this what pastures look like?

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Why do we sample pasture?

Early season

Mid season

Late season

This is what pastures and grazing look like.

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ANALYSIS #1 Corn Silage		SAMPLE #
Total DM		51.20%
CP		8.70%
ADF	RFQ:	22.54%
NDF	187.00	39.13%
NDFD48h		67.42%
ESC		2.51%
WSC		4.70%
TDN		75.00%

*All Nutritive Values at 100% DM predicted by 2018 NIRSC Models. NDFD48h is represented as % NDF.

ANALYSIS #2 Orchardgrass Hay		SAMPLE #
Total DM		84.40%
CP		9.10%
ADF	RFQ:	43.39%
NDF	68.85	75.32%
NDFD48h		45.96%
ESC		4.13%
WSC		4.95%
TDN		53.15%

*All Nutritive Values at 100% DM predicted by 2018 NIRSC Models. NDFD48h is represented as % NDF.

ANALYSIS #3 Legume Balage		SAMPLE #
Total DM		63.70%
CP		20.41%
ADF	RFQ:	43.00%
NDF	100.57	51.96%
NDFD48h		43.19%
ESC		3.81%
WSC		3.97%
TDN		53.56%

*All Nutritive Values at 100% DM predicted by 2018 NIRSC Models. NDFD48h is represented as % NDF.

ANALYSIS #4 Grass Balage		SAMPLE #
Total DM		55.80%
CP		14.88%
ADF	RFQ:	33.82%
NDF	109.29	56.40%
NDFD48h		58.26%
ESC		3.16%
WSC		4.11%
TDN		63.18%

*All Nutritive Values at 100% DM predicted by 2018 NIRSC Models. NDFD48h is represented as % NDF.

ANALYSIS #5 Sudan Balage		SAMPLE #
Total DM		48.20%
CP		9.74%
ADF	RFQ:	34.94%
NDF	100.17	60.39%
NDFD48h		62.63%
ESC		5.74%
WSC		7.22%
TDN		62.01%

*All Nutritive Values at 100% DM predicted by 2018 NIRSC Models. NDFD48h is represented as % NDF.

ANALYSIS #6 Fescue & Orchardgrass Hay		SAMPLE #
Total DM		89.30%
CP		12.94%
ADF	RFQ:	34.67%
NDF	96.23	63.15%
NDFD48h		57.02%
ESC		9.89%
WSC		10.30%
TDN		62.29%

*All Nutritive Values at 100% DM predicted by 2018 NIRSC Models. NDFD48h is represented as % NDF.

Just as stored forages vary in analysis, pastures vary also.

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UGA Extension Bulletin 1425, 2014

Can we tell forage quality by looking at lots of feed?

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UGA Extension Bulletin 1425, 2014

Lot 1:
RFQ = 178
CP = 19.5%
TDN = 65.2%

Lot 2:
RFQ = 182
CP = 18.7%
TDN = 65.7%

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How do we collect pasture samples?

- First lets look at collecting stored feed samples
  - UW Extension Bulletin A2309, 2005
  - December 5, 2014 issue of Feedstuffs: Sampling Feedstuffs for Lab Analysis a Necessity, available at:
    - https://www.pioneer.com/home/site/us/silage-zone/library/sample-feedstuffs-lab-analysis/
- The same rules for sampling stored feed apply to pasture sampling
  1. Obtain a representative sample
  2. Sample "lots" individually
  3. Get at least the minimum number of cores or grab samples per lot
  4. Sample using rules to reduce bias

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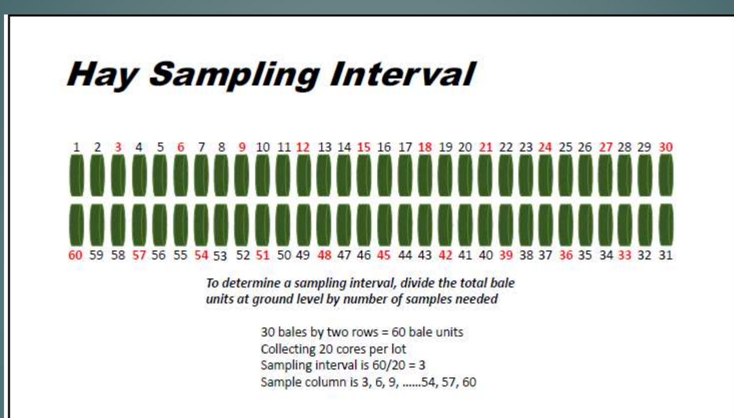

Lemus, 2018
Presented at AFGC conference January 18, 2018, Louisville, KY

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- The same rules for sampling stored feed apply to pasture sampling
  5. Combine & mix cores or grabs into one sample
  6. Label samples with as much information as possible
     - Farm name and address
     - Harvest date
     - Field number/location
     - Species, species mix, variety, type
     - Growing conditions
  7. Seal bag, refrigerate or freeze, or dry (freezing best)
  8. Send to lab

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Sample Handling Errors

- Understand sources of variation before you get started
  - The plant, the way it grows (leaf, stem, etc.)
  - Plant genetics, variety, hybrid
  - Growing conditions
- Some feeds are more heterogeneous than others
  - Think ground corn vs. alfalfa balage
- Some constituents are more variable than others
  - NDFD vs. CP

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All Analytical Results are Estimates of the True Value

- The only way to determine the CP of a 200 ton stack of hay is to analyze every pound of it
- Taking 20 cores of .5 oz give a sample of 10 oz to represent 200 ton
  - 1/640,000th of the stack
- Lab analyzes 1 gm of the sample
  - 1/181,600,000th of the stack
- Any wonder that two samples won't agree exactly – each is an estimate of the total

Mertens Innovation & Research LLC © 2010

Stacking error

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How do we collect pasture samples?

- Few grazing guides even mention collection of pasture samples
- We want to combine good non-biased technique with a little judgement (art)
  - If we sample haphazardly, we may introduce bias and "choose" samples that are not representative
  - If we sample entirely randomly, we will sample areas cows will normally avoid (manure, urine, refused weeds)
  - A sample should represent the pasture, but also the cow diet
- Two basic methods of where to collect samples:
  - Quadrat sampling
  - Point sampling or Plot-less sampling

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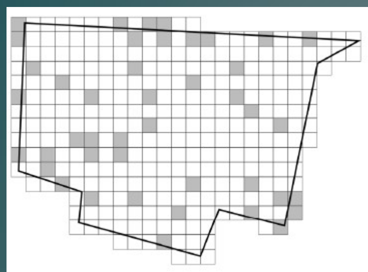
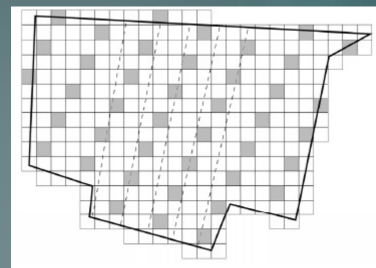


Randomly selected quadrats



Systematic quadrats

This is systematic point, but could also use random points

D. Wulfsohn, 2010

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Lemus, 2018

Using the quadrat method, clip everything inside the sampling quadrat.

The State of Queensland, DEEDI 2010

Using the point method, grab a handful of plants at each point.

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How do we collect pasture samples?

- We want to combine good non-biased technique with a little judgement (art)
  - Instead of laying out maps and randomly selected sampling areas/points, we can use a simplified method that minimizes bias and represents the sample area well

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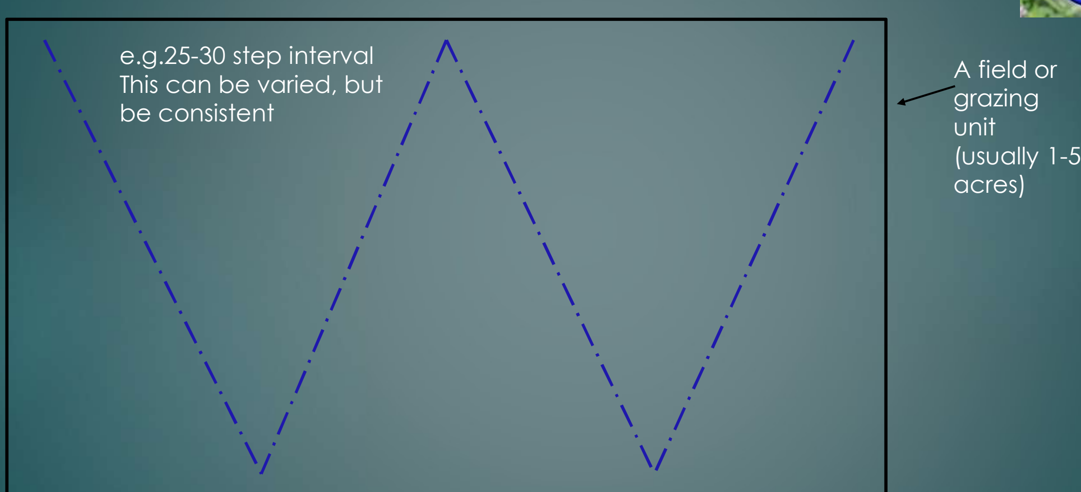
Pattern of Collection



Walking in a "W" pattern will minimize sampling bias.
PNW Extension, 2010

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Steps

1. Determine the sampling area
2. Number of samples for the area should be 20-50
3. Stop every Xth feet to take a sample
   - Quadrat
     - Clip everything in the quadrat, but avoid manure, urine or refused weeds
     - Clip to height cattle would graze
   - Point
     - Grasp a handful of forage and break off
     - Break off at height cattle would graze
     - Avoid manure, urine or refused weeds

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Steps

4. Place all sample collections into a large bag or 5-gallon bucket
5. Mix the composite sample
6. Fill a 1-gallon ziplock bag, packing in composited sample (fresh forage =75-90% water)
   - If the total sample is too large to fit into the 1-gallon ziplock, "cone and quarter" the large composite
     - Pour entire sample onto large piece of plastic
     - Form sample into a cone
     - Flatten the cone
     - Separate into quarters
     - Take 2 of the 4 quarters

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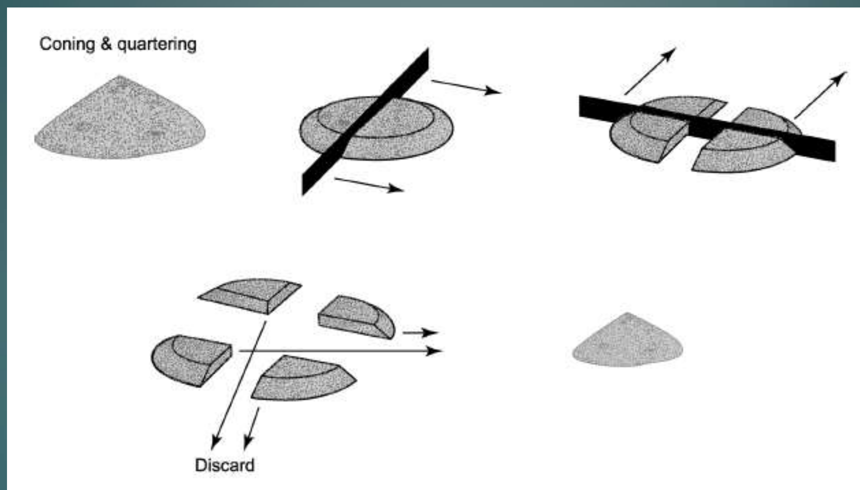

Gerlach & Nocerino, 2003

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Steps

7. Seal the 1-gallon sample bag well
8. Label the 1-gallon sample bag with collection information
   - Farm, location/field #, species, variety, growing conditions, etc.
9. Record sampling information
   - List samples taken, labels, fields sampled, # of samples for composite
10. Sample may be dried but analysis of total Dry Matter can not be done
11. Freezing sample will stop plants from continued respiration or spoilage
12. Send or deliver to the lab

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Developing a baseline of pasture quality

- When do we want to routinely collect pasture samples?
- Sample each pasture unit at beginning, middle, and end of season
- Sample units with stockpiled forage over time to see how quality is retained over time
- Take photos with sampling to enhance eyeball skill
- Take samples for 3 years minimum for the baseline
- Record sample and field data well

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Coordinating pasture quality

- Compare season to season
- Compare varieties and species
- Look at growth rates of different fields
- Help in making harvesting decisions
- Compare mixes
- Extending the grazing season
- Use pasture data to balance ration with some supplemental feed and minerals
- Sample pastures under unusual growing conditions
  - Flooding anyone? Fungus?
  - Drought

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How are forages tested?

- Wet Chemical Techniques
  - A specific method is used to determine a particular constituent
    - Crude Protein, Fat, Lignin, ADF, NDF, NDFD$_{48}$ etc.
    - Methods are overseen by groups such as AOAC, AAFCO, and NFTA
- NIRS
  - Is a secondary method used to predict a nutrient value
  - Is not an estimate

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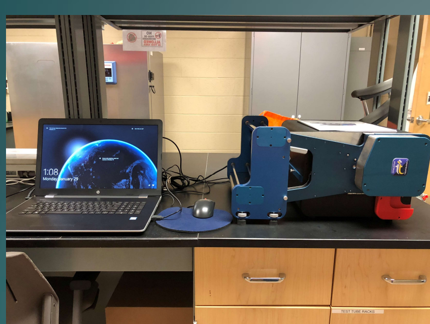
The role of NIRS in pasture testing



Advanced spectroscopy systems

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NIRS for rapid analysis

- Concern with pasture testing: “I will not get my results in time before I feed my pasture, or it will not represent the sample that I took.”
  - NIRS offers rapid analysis, so the analysis will be very close to what you are feeding
  - You are building a database of information so that you can make better decisions on your farm
  - If you know your stored feed, you can adjust your pasture

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Using Multiple Sampling

Single	Mean (2)	Mean (5)	Single	Mean (2)	Mean (5)
41.2			38.2		
39.7	40.5		38.9	38.5	
38.3		40.5	38.1		38.9
42.0	40.1		41.2	39.7	
41.5			38.1		
40.1	40.8		39.6	38.9	
41.3			41.8		
40.3	40.8	40.2	40.5	41.2	40.4
38.5			38.5		
40.7	39.6		41.3	39.9	
Grand Mean			40.0	40.0	40.0
SD or SE of Mean (n)			1.34	1.19	0.77
Estimated SE based on ±sd/√n				0.95	0.84

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Forage Analysis

For a complete listing of forage analysis please see our website uwlab.soils.wisc.edu/forage
Energy estimates and forage quality indexes included

Hay/ Haylage
- UW Recommended: Standard NIR with wet chemistry NDFD, NDF, Ash — $32
- Standard NIR: DM, CP, ADF, ADF-CP, NDF-CP, NDF, lignin, NDFD, Fat, P, Ca, K, Mg, Ash — $16

Corn Silage
- UW Recommended: Standard NIR with wet chemistry; NDFD, NDF, Ash — $33
- Standard NIR: DM, CP, ADF, ADF-CP, NDF-CP, NDF, lignin, NDFD, Fat, with P, Ca, K, Mg, Ash and starch — $17
- UW Recommended + wet chemistry starch & starch digestibility (DSA) — $55

TMR
- Wet chemistry DM, CP, Ash, NDFD, NDF, Ca, P, Mg, K, Fat — $46
- TMR wet chemistry + starch & starch digestibility (DSA) — $68

Grain/Feed/Byproducts
- UW Corn Grain Evaluation - wet chemistry DM, prolamin protein, mean particle size with NIRS starch, CP, NDF, Fat, Ash — $33
- Grain Mixes/Byproducts: wet chemistry DM, CP, Ash, NDF, Ca, P, Mg, K, Fat — $26
- Soybeans (% Bypass): NIR (DM, CP, %Bypass) — $12

Scissor Cuts by NIR (whole plant fresh forage only)
- CP, ADF, NDF (predicted TDN, RFV, NEL) — $10

MILK 2006 by NIR (Fermented Highly Recommended)
- Legume: DM, CP, ADF, NDF, NDFD, Ash, Fat, Milk/ton — $16
- Corn Silage: DM, CP, ADF, NDF, NDFD, Ash, Fat, Starch, milk/ton — $16
- Corn Silage: NIR + Starch Digestibility (DSA) — $38

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Importance of good NIRS techniques

NIRS can be more repeatable than wet chemistry

Table 1. NIRS reduces variation

Nutrient (% DM)	Average	SD*, wet chemistry	SD*, NIRS
CP	15.8	0.33	0.05
ADF	31.4	0.78	0.32
NDF	41.9	0.70	0.28
Ash	11.3	0.20	0.07
Fat	3.44	0.12	0.02

*Standard deviation

Ondarza and Ward, Feb 25, 2013, Hoard's Dairyman

Good calibrations are important

Legume Hay					
Constituent	N	Mean	SEC	RSQ	SECV
DM	515	94.32	0.35	0.94	0.38
CP	799	20.37	0.74	0.94	0.79
ADF	876	32.48	1.54	0.93	1.63
aNDF	1176	41.56	1.87	0.95	1.97
ASH	529	8.43	0.80	0.93	0.87
FAT	188	1.99	0.19	0.94	0.22
Lignin	107	7.08	0.63	0.82	0.73
dNDF30	107	17.87	2.88	0.70	3.22
IVTDMD30	107	68.00	3.28	0.89	4.37
dNDF48	388	20.99	2.02	0.90	2.26
IVTDMD48	387	76.89	2.56	0.86	2.75
Ca	539	1.42	0.17	0.77	0.19
P	538	0.27	0.04	0.62	0.04
K	493	2.41	0.25	0.85	0.27
Mg	451	0.32	0.05	0.77	0.05

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Hay & Forage Grower

Big-profit practices? And the survey says . . .

Jan 15, 2019, By Mike Rankin

We'd like to move #9 up by soil testing!

Scale:

2 = Improvement in net farm income of over 10 percent
1 = Slight positive impact on net farm income
0 = Neutral return
-1 = Slight negative impact on net farm income
-2 = Reduction in net farm income of over 10 percent

The top 10 practices that all combined respondents (producer, public, and private sectors) ranked as having the most positive net return and their average scores were:

1. Soil testing — 1.58
2. Extending the grazing season / feeding less hay — 1.57
3. Correcting soil pH — 1.42
4. Rotational stocking (1 to 2 moves per week) — 1.37
5. Better establishment techniques and tools — 1.30
6. Aligning parturition with forage quantity/quality — 1.26
7. Better hay storage methods (barn, baleage, tarp) — 1.26
8. Stockpiling forage for later grazing — 1.25
9. Testing hay/baleage for forage quality — 1.20
10. Adding improved clovers — 1.18

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Where is the money in milk production?

- Components, Components, Components, and Fat is worth more than Protein
- Specialty: e.g. grassmilk, on-farm products?
- How can forage testing help with making good feeding decisions?
- Pasture is not limitless, even in the grazing season.
  - Coordinating with stored feed can help the bottom line.
  - Adjusting harvest of pasture can improve $ efficiency

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Table 1. Factors affecting milk composition with pasture based systems.			
Nutrition Factor	Milk Yield	Protein Percent	Fat Percent
Energy Intake			
Increased dry matter intake	++	+	+
More concentrate, Less forage (fiber)	+	+	-
More fermentable carbohydrates	+	+	-
Grain processing	+	+	-?
Fat Supplementation			
Fish oil	+	+	-
Vegetable oil	+	-	-
Hydrogenated fat	+	0	+
Cow Status			
Increased frequency of concentrate feeding	+	+	+
Over conditioned dry cows	-	-	+
Negative energy balance (thin cows)	-	-	-
Forage Supplementation			
Partial TMR	+	+	+
Corn silage	+?	+?	0
Hay	0	0	+?
Other			
Feeding buffers	+	0	+
Pre-fresh dry cow program	+	+	+
More rumen undegradable protein	+	+	0

Muller and Delahoy, 2016 available at:
https://extension.psu.edu/enhancing-milk-components-with-pasture-based-systems

However:
We know that breed has a great impact on butterfat production.

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Table 2. Milk yield and milk component yield of Holstein cows fed pasture or pasture plus 19.1 lb concentrate.a		
[a]Study at Penn State with high genetic Holsteins (Bargo et al., 2002a. J. Dairy Sci. 85:1777-1792). [b]Total protein.		
Item	Pasture with no concentrate	Pasture plus 19.1 lb concentrate
Milk yield, lb/day	45.5	65.6
Milk fat		
%	3.81	3.31
lb/day	1.74	2.13
Milk true protein		
%	2.95 (3.15)[b]	3.10 (3.30)[b]
lb/day	1.32	1.98

Muller and Delahoy, 2016 available at:
https://extension.psu.edu/enhancing-milk-components-with-pasture-based-systems

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Increasing sugar in the diet can increase butterfat yield.

TABLE 1: Changes in milk yield and composition with changes in sucrose and starch supplementation

Sucrose %	Startch %	DM Intake, lb	Milk, lb	Milk fat, lb	Milk protein, lb	FCM, lb
0	7.5	54.0	85.8	3.24	2.73	89.3
2.5	5.0	56.4	89.1	3.37	2.82	93.0
5.0	2.5	57.3	88.2	3.64	2.84	96.8
7.5	0	57.3	86.9	3.57	2.82	95.2

FCM= fat-corrected milk (Broderick et al., 2000)

Table 1. Concentrations (% of DM) of carbohydrates in feeds.1

Feed	NDF	Starch	Sugar
Alfalfa (fresh, pasture)	32.0	1.0	8.5
Alfalfa hay	40.0	2.0	6.0
Alfalfa silage	38.0	1.0	2.0
Bakery waste	23.0	18.0	11.0
Citrus pulp	24.0	1.0	26.5
Corn grain	13.0	70.0	0.0
Corn silage	45.0	30.0	1.0
Molasses, cane	0.0	0.0	55.0
Sugar beet pulp	45.0	2.0	14.0
Whey	0.0	0.0	75.0

Eastridge, 2014 available at:
https://articles.extension.org/pages/68420/sugar-in-diets-for-lactating-dairy-cows

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Other factors that may affect milk components

- Cation/Anion balance:
  - Minerals in alfalfa. Increasing the dietary cation-anion difference [DCAD calculated as: (dietary sodium + potassium) – (dietary chloride + sulfur), where minerals are expressed as milliequivalents per kilogram of diet] linearly increases milk fat concentration and yield. On average, the DCAD concentration in alfalfa is about 3 times greater than that of corn silage.
- pH of rumen: sodium bicarbonate, potassium bicarbonate; increases in DCAD often increase milk fat yield

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