Understanding the Benefits and Limitations of RUFAL

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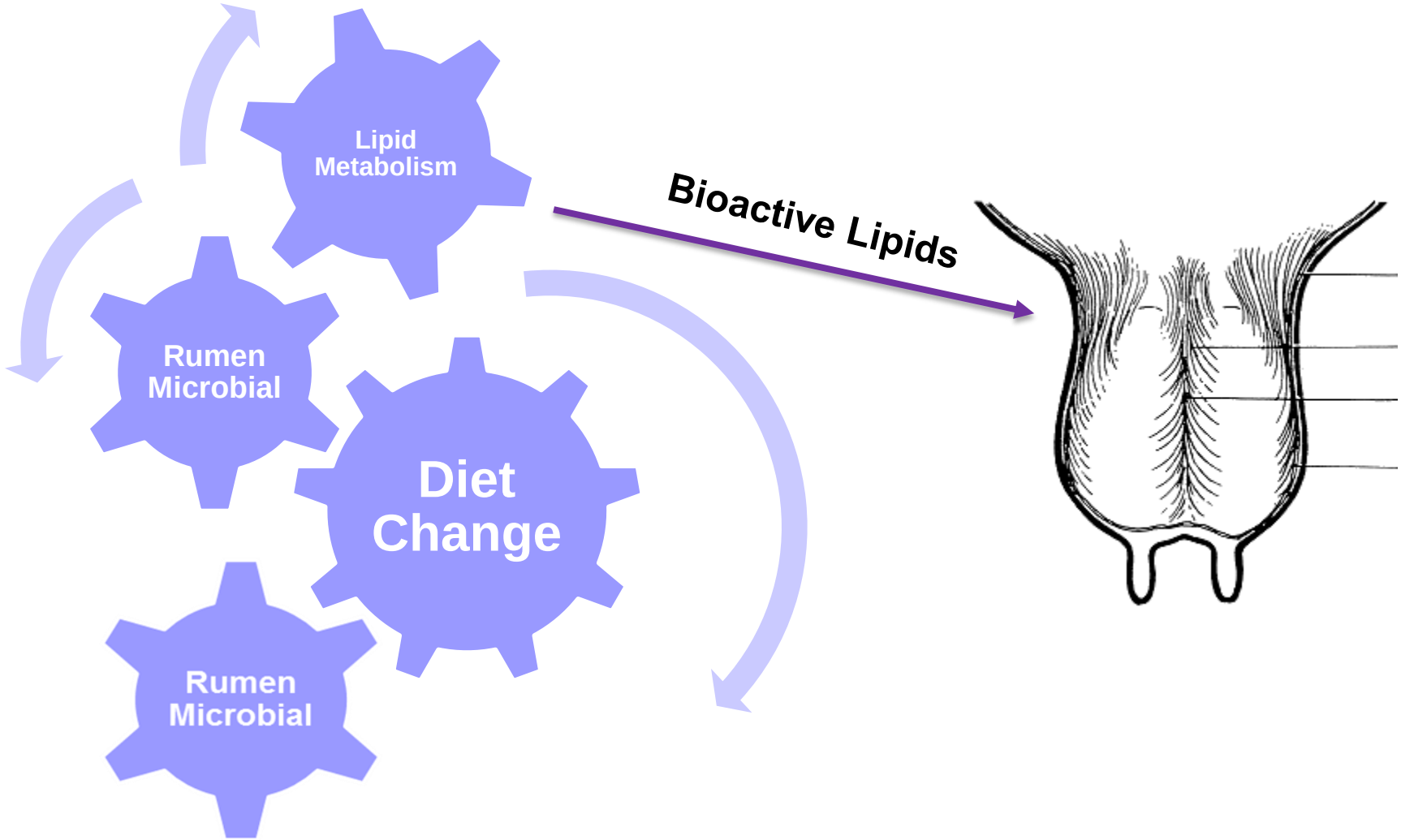
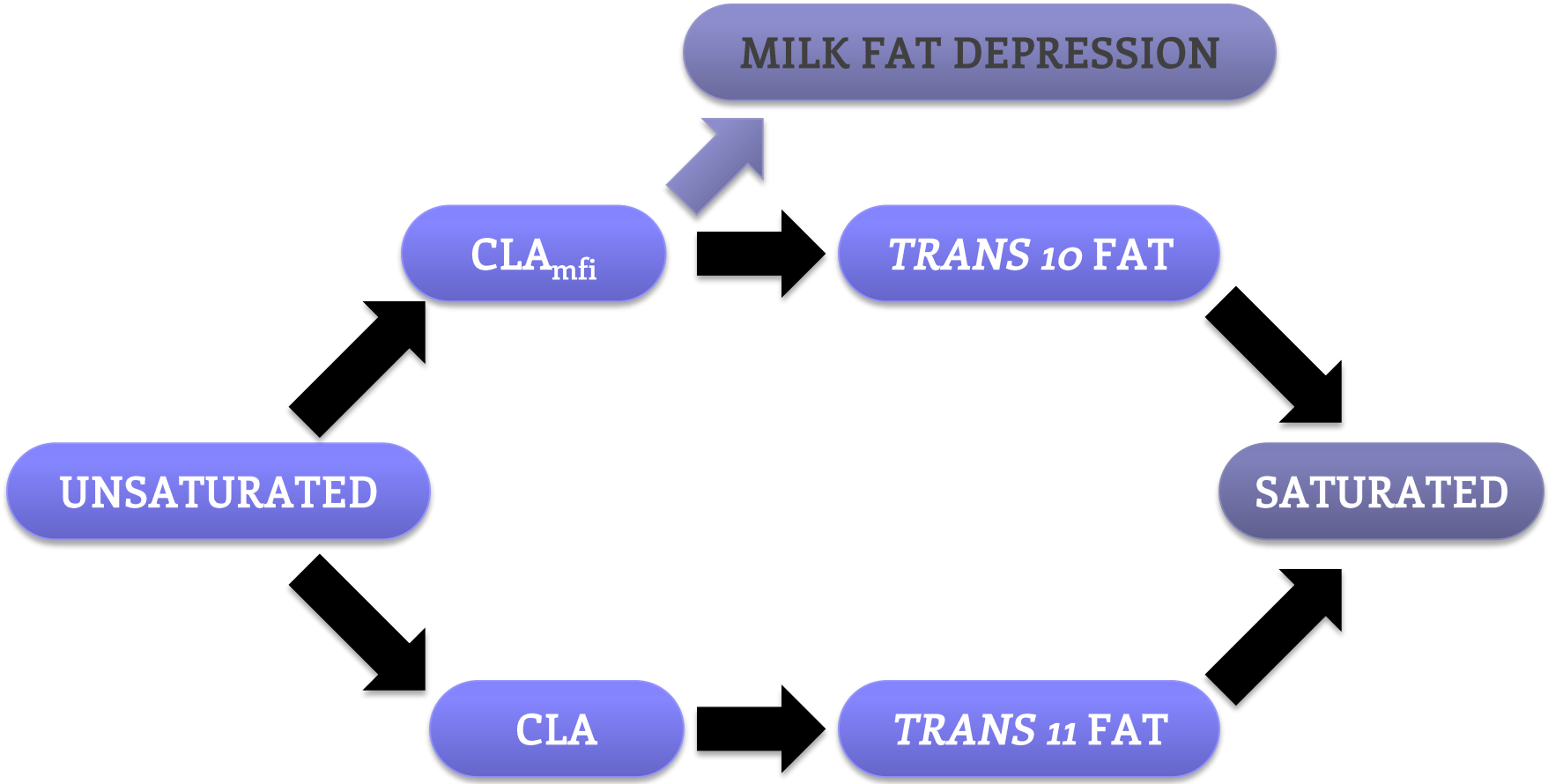
Machinery of Diet-Induced MFD



Source of Bioactive Lipids

CLA Shift



From Jenkins and Harvatine (2014) Vet. Clin. Food Anim. 30:623-642.

CLA Tested

- *trans*-8, *cis*-10 CLA
- *cis*-9, *trans*-11 CLA
- *trans*-9, *trans*-11 CLA
- *trans*-10, *trans*-12 CLA
- *cis*-11, *trans*-13 CLA

c9t11 CLA No MFD

t10c12 CLA Causes MFD

- ***trans*-9, *cis*-11 CLA (Perfield et al. 2007)**
- ***trans*-10, *cis*-12 CLA (Baumgard et al. 2000)**
- ***cis*-10, *trans*-12 CLA (Saebo et al. 2005)**

Dietary changes that affect CLA_{mfi}

- Main drivers of MFD
  - Too much of the wrong type of fat
  - Too much starch
  - Low rumen pH
- Fine tuning of MFD
  - Potassium carbonate (+)
  - Palmitate (+)
  - Yeast/Molds (-)
  - Ionophores (-)

How much fat is too much?

3.4% Added Soybean Oil

	CON	SBO
Milk fat, lb/d	2.27	2.02*
Milk fat, %	3.76	3.14*

*CON and FAT diets differed (P < 0.05).
Taken from AlZahal et al., 2008. J. Dairy Sci. 91:1166–1174.

3.6% Added CaFA

	CON	CaFA
Fat, lb/d	3.19	3.54*
Fat, %	3.59	3.89*

*CON and FAT diets differed (P < 0.05).

Taken from Weiss et al. 2011. J. Dairy Sci. 94 :931–939

3.5% Added Fatty Acids on 24 h Rumen In Vitro

	Control	Stearic	Oleic	Linoleic	Linolenic
Ac/Pr	5.27^{a}	4.87^{a}	4.13^{b}	2.90^{c}	2.08^{d}
F. succinogenes	2.04^{c}	2.69^{a}	2.26^{b}	1.37^{d}	1.13^{e}
Methane, mmol	1.03^{a}	0.99^{ab}	0.94^{b}	0.75^{c}	0.56^{d}
Protozoa	2.99^{a}	2.26^{b}	1.96^{c}	1.80^{c}	1.30^{c}

^{abc} Means with different superscripts within a row differ ($P < 0.05$).

Zhang et al. (2008) Anim. Feed sci. Tech. 146:256-269.

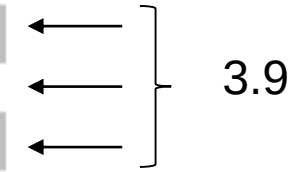
Rumen Unsaturated FA Load (RUFAL)

18:1 (oleic)
+ 18:2 (linoleic)
+ 18:3 (linolenic)

A Way to Monitor The High Risk Fatty Acids

Rumen Unsaturated FA Load (RUFAL)

		Relative Basis %	Dry Matter Sample Basis %
C12:0	Lauric Acid	0.09	0.01
C14:0	Myristic Acid	0.68	0.04
C16:0	Palmitic Acid	23.47	1.30
C16:1	Palmitoleic Acid	0.47	0.03
C18:0	Stearic Acid	2.84	0.16
C18:1	Oleic Acid	25.06	1.39
C18:2	Linoleic Acid	41.90	2.32
C18:3	Linolenic Acid	4.03	0.22
C20:0	Arachidic Acid	0.53	0.03
C20:1	11-Eicosenoic Acid	0.16	0.01
C20:2	11-14 Eicosadienoic Acid	N/D	N/D
C22:0	Behenic Acid	0.38	0.02
C22:1	Erucic Acid	N/D	N/D
C24:0	Lignoceric Acid	0.42	0.02
C24:1	Nervonic Acid	N/D	N/D
Total		100.0	5.54

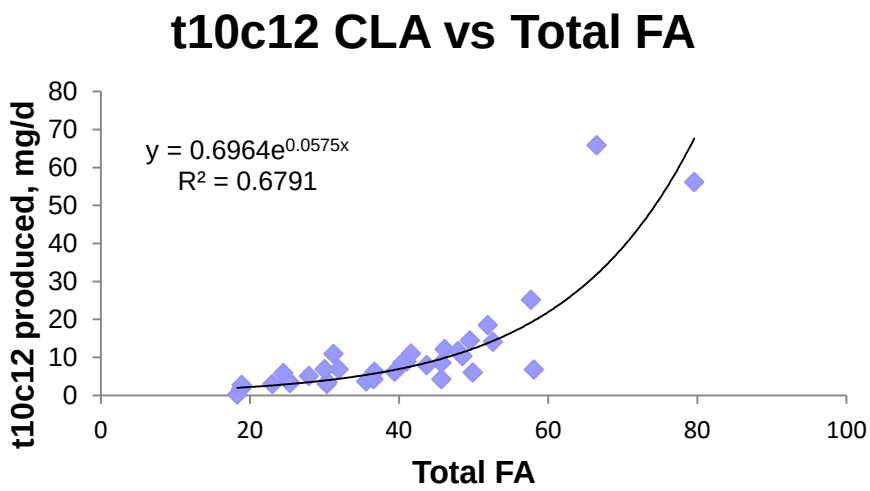


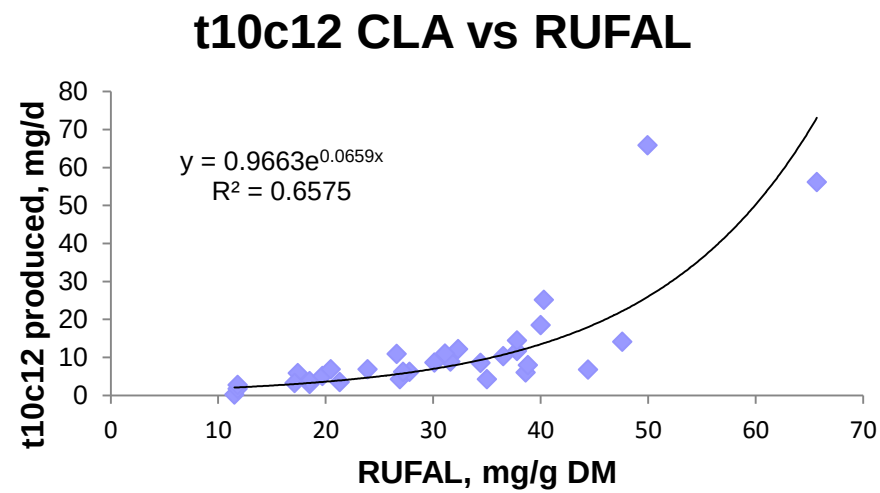
t10c12 Production in Continuous Cultures

- 6 studies (n=34 means)
- 3 fat sources
  - Canola oil (n=12)
  - Corn oil (n=4)
  - Soybean oil (n=18)
- Range
  - t10c12 0.25 to 65.8 mg/d
  - Total FA 1.83 to 7.96 % DM
  - RUFAL 1.15 to 6.57% DM

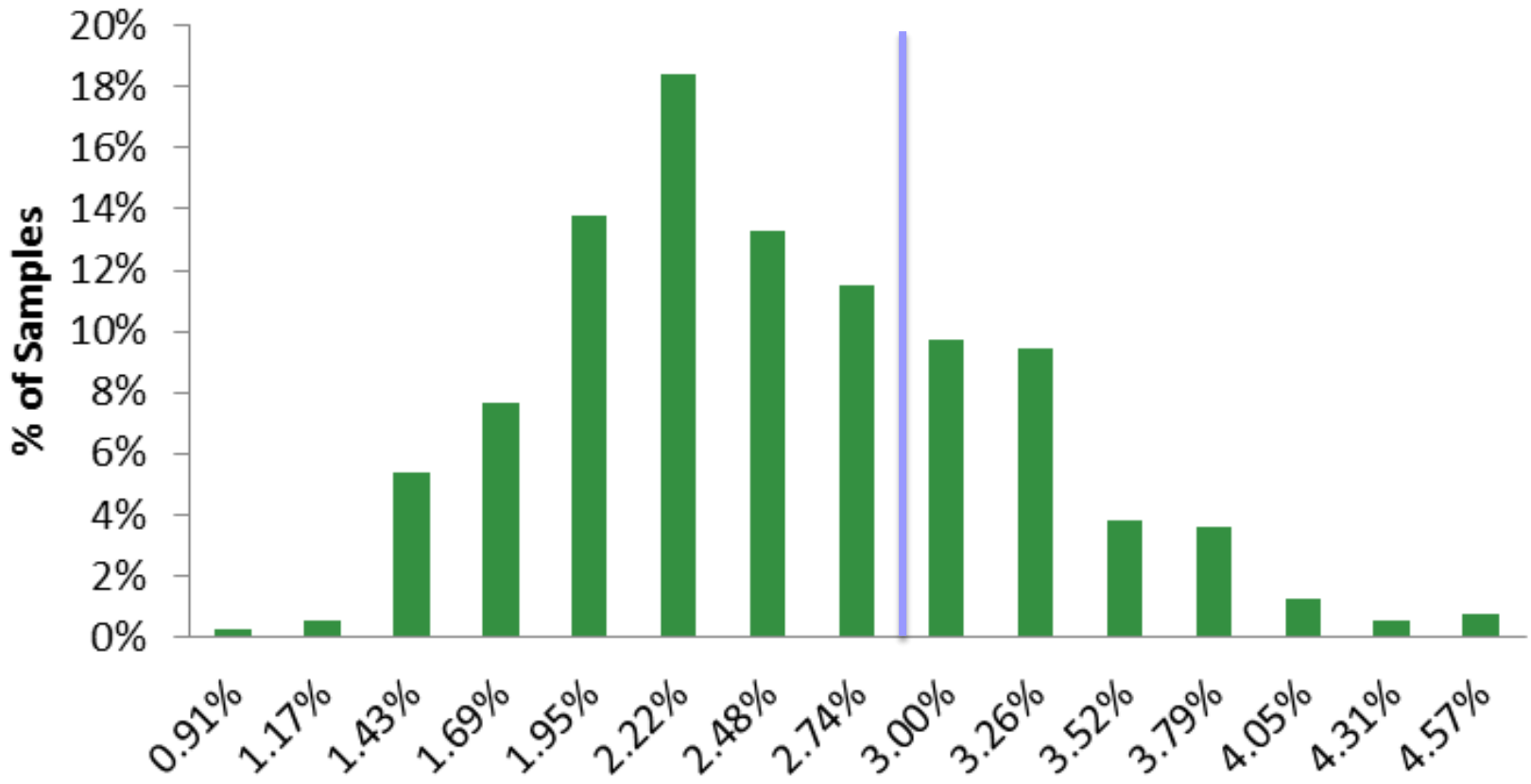
Predictors of t10c12

	R^2	
Dependent	Exp	Linear
Total FA	0.679	0.577
RUFAL	0.658	0.541
Linoleic	0.643	0.538
RUFAL2	0.604	0.568
Added FA	0.576	0.522





18:1 + 18:2 + 18:3 Fatty Acid % DM



Courtesy of Kyle Taysom
Business Development Manager
Dairyland Laboratories, Inc. n=397

Fatty Acid Sources

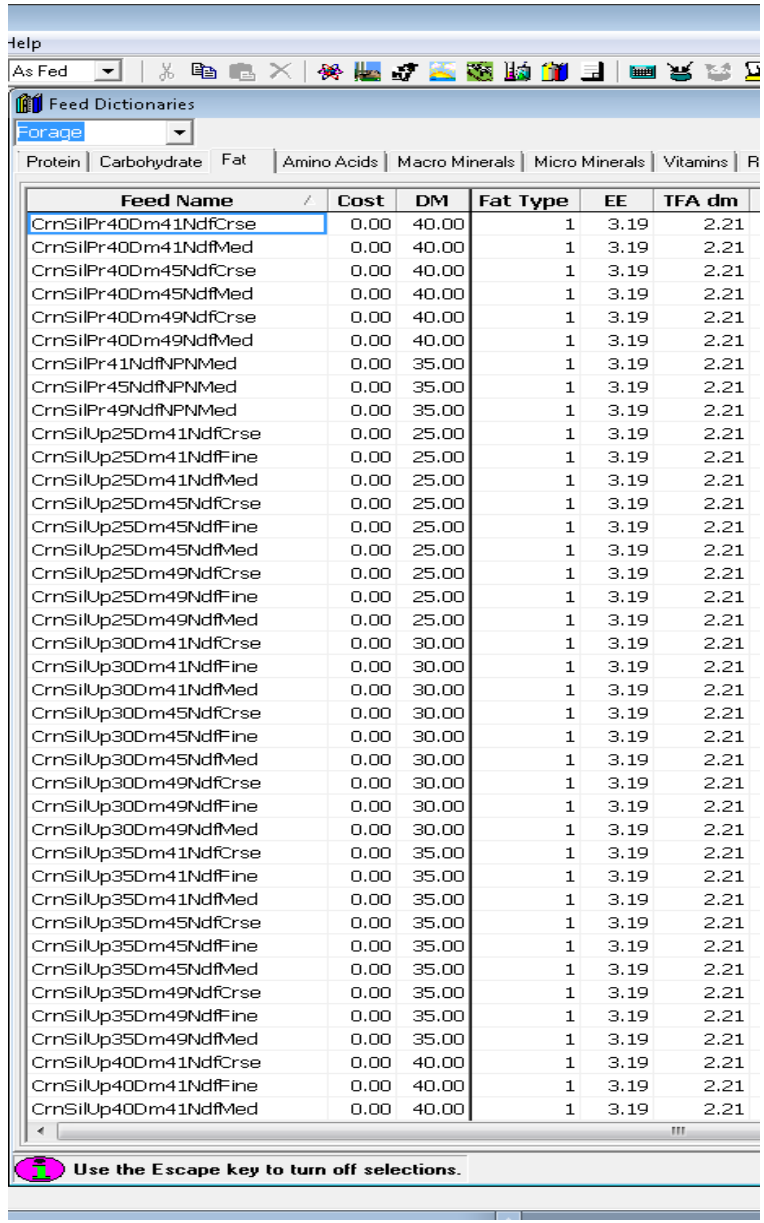
Ingredient	DMI, lb/d	RUFAL, g/d
Corn Silage, Med Chppd	21.95	
AlfHay2 20Cp40Ndf17LNDF	5.78	
CrnGrn56DryFine	9.34	
Citrus Pulp Grnd	1.03	
Cottonsd WLint	2.30	
Megalac	0.29	
Soybean ML 47.5 Solv	6.95	
Other (mineral, vitamin, trace supplements)	1.32	
Total	48.96	573
RUFAL, % DM		2.57

Fatty Acid Sources

Ingredient	DMI, lb/d	RUFAL, g/d
Corn Silage, Med Chppd	21.95	152
AlfHay2 20Cp40Ndf17LNDF	5.78	26
CrnGrn56DryFine	9.34	139
Citrus Pulp Grnd	1.03	6
Cottonsd WLint	2.30	142
Megalac	0.29	48
Soybean ML 47.5 Solv	6.95	60
Other (mineral, vitamin, trace supplements)	1.32	0
Total	48.96	573
RUFAL, % DM		2.57

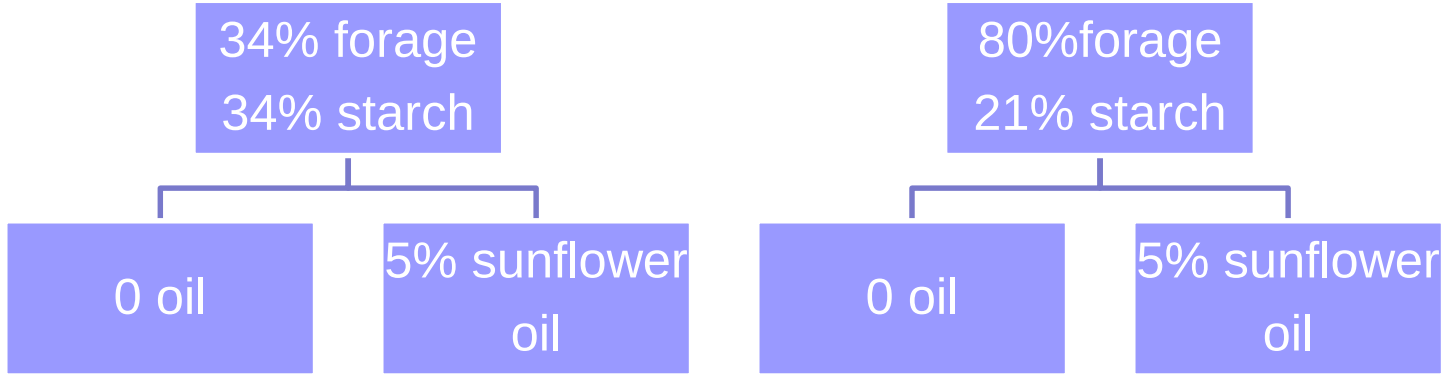
Ingredient	1.5 % CS	3.5 % CS
Corn Silage, Med Chppd	152	349
AlfHay2 20Cp40Ndf17LNDF	26	26
CrnGrn56DryFine	139	139
Citrus Pulp Grnd	6	6
Cottonsd WLint	142	142
Megalac	48	48
Soybean ML 47.5 Solv	60	60
Other (mineral, vitamin, trace supplements)	0	0
Total	573	770
RUFAL, % DM	2.57	3.47

Feed Libraries – use the same fat values for all corn silages



Feed Name	Cost	DM	Fat Type	EE	TFA dm
CrnSilPr40Dm41NdfCrse	0.00	40.00	1	3.19	2.21
CrnSilPr40Dm41NdfMed	0.00	40.00	1	3.19	2.21
CrnSilPr40Dm45NdfCrse	0.00	40.00	1	3.19	2.21
CrnSilPr40Dm45NdfMed	0.00	40.00	1	3.19	2.21
CrnSilPr40Dm49NdfCrse	0.00	40.00	1	3.19	2.21
CrnSilPr40Dm49NdfMed	0.00	40.00	1	3.19	2.21
CrnSilPr41NdfNPNMed	0.00	35.00	1	3.19	2.21
CrnSilPr45NdfNPNMed	0.00	35.00	1	3.19	2.21
CrnSilPr49NdfNPNMed	0.00	35.00	1	3.19	2.21
CrnSilUp25Dm41NdfCrse	0.00	25.00	1	3.19	2.21
CrnSilUp25Dm41NdfFine	0.00	25.00	1	3.19	2.21
CrnSilUp25Dm41NdfMed	0.00	25.00	1	3.19	2.21
CrnSilUp25Dm45NdfCrse	0.00	25.00	1	3.19	2.21
CrnSilUp25Dm45NdfFine	0.00	25.00	1	3.19	2.21
CrnSilUp25Dm45NdfMed	0.00	25.00	1	3.19	2.21
CrnSilUp25Dm49NdfCrse	0.00	25.00	1	3.19	2.21
CrnSilUp25Dm49NdfFine	0.00	25.00	1	3.19	2.21
CrnSilUp25Dm49NdfMed	0.00	25.00	1	3.19	2.21
CrnSilUp30Dm41NdfCrse	0.00	30.00	1	3.19	2.21
CrnSilUp30Dm41NdfFine	0.00	30.00	1	3.19	2.21
CrnSilUp30Dm41NdfMed	0.00	30.00	1	3.19	2.21
CrnSilUp30Dm45NdfCrse	0.00	30.00	1	3.19	2.21
CrnSilUp30Dm45NdfFine	0.00	30.00	1	3.19	2.21
CrnSilUp30Dm45NdfMed	0.00	30.00	1	3.19	2.21
CrnSilUp30Dm49NdfCrse	0.00	30.00	1	3.19	2.21
CrnSilUp30Dm49NdfFine	0.00	30.00	1	3.19	2.21
CrnSilUp30Dm49NdfMed	0.00	30.00	1	3.19	2.21
CrnSilUp35Dm41NdfCrse	0.00	35.00	1	3.19	2.21
CrnSilUp35Dm41NdfFine	0.00	35.00	1	3.19	2.21
CrnSilUp35Dm41NdfMed	0.00	35.00	1	3.19	2.21
CrnSilUp35Dm45NdfCrse	0.00	35.00	1	3.19	2.21
CrnSilUp35Dm45NdfFine	0.00	35.00	1	3.19	2.21
CrnSilUp35Dm45NdfMed	0.00	35.00	1	3.19	2.21
CrnSilUp35Dm49NdfCrse	0.00	35.00	1	3.19	2.21
CrnSilUp35Dm49NdfFine	0.00	35.00	1	3.19	2.21
CrnSilUp35Dm49NdfMed	0.00	35.00	1	3.19	2.21
CrnSilUp40Dm41NdfCrse	0.00	40.00	1	3.19	2.21
CrnSilUp40Dm41NdfFine	0.00	40.00	1	3.19	2.21
CrnSilUp40Dm41NdfMed	0.00	40.00	1	3.19	2.21

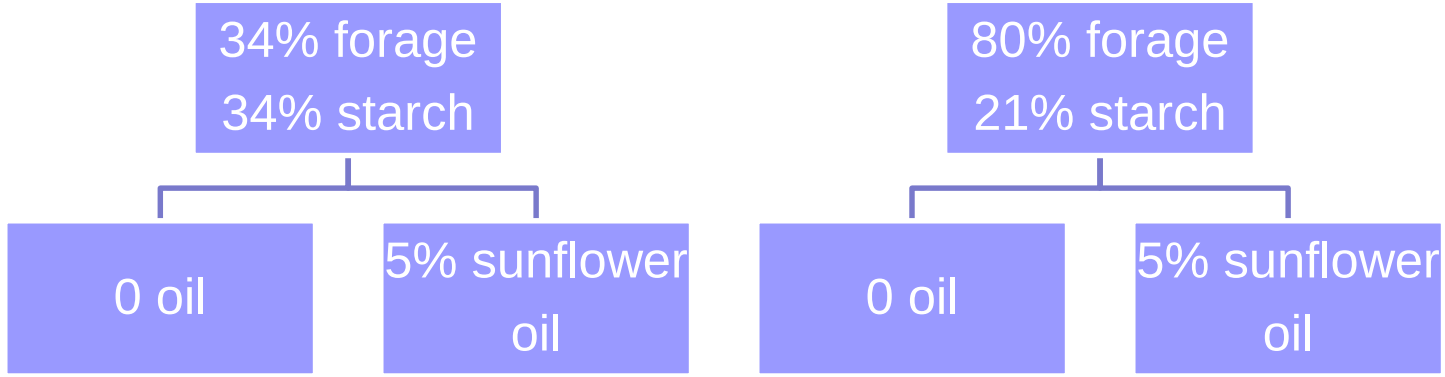
Forage/Concentrate Interactions



RUFAL, % DM	1.2	4.8
t10c12 CLA, %	17.8	53.1

From Zened et al. 2013. JDS 96:451-459.

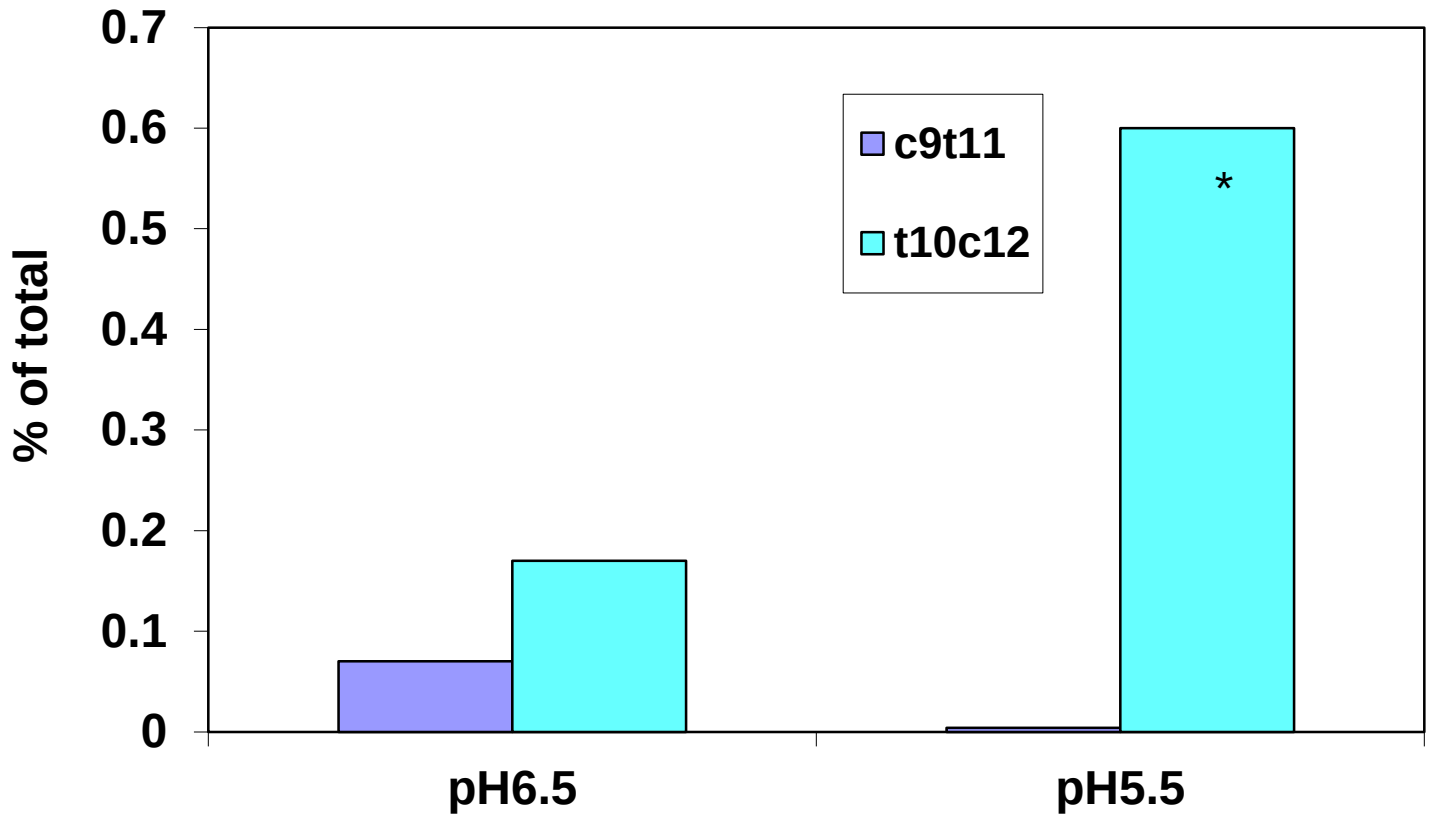
Forage/Concentrate Interactions



RUFAL, % DM	1.2	4.8	1.2	4.8
t10c12 CLA, %	17.8	53.1	5.3	2.8

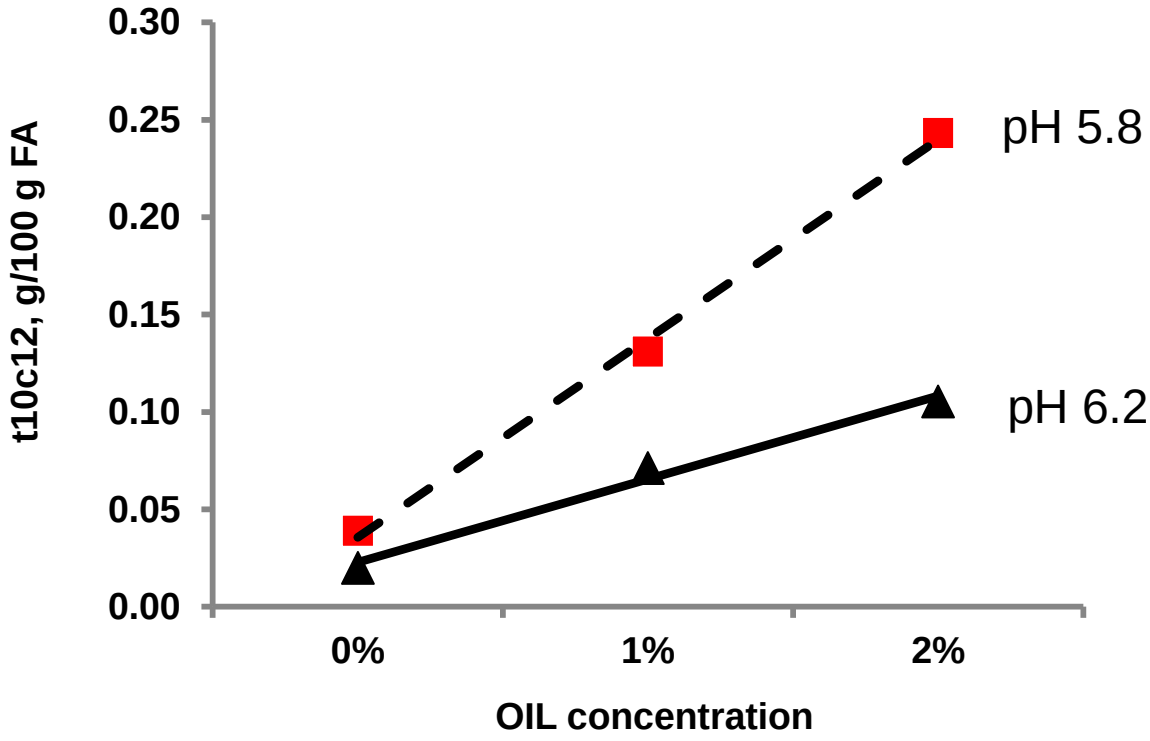
From Zened et al. 2013. JDS 96:451-459.

CLA Production vs pH



Continuous culture data taken from Fuentes et al, 2009.

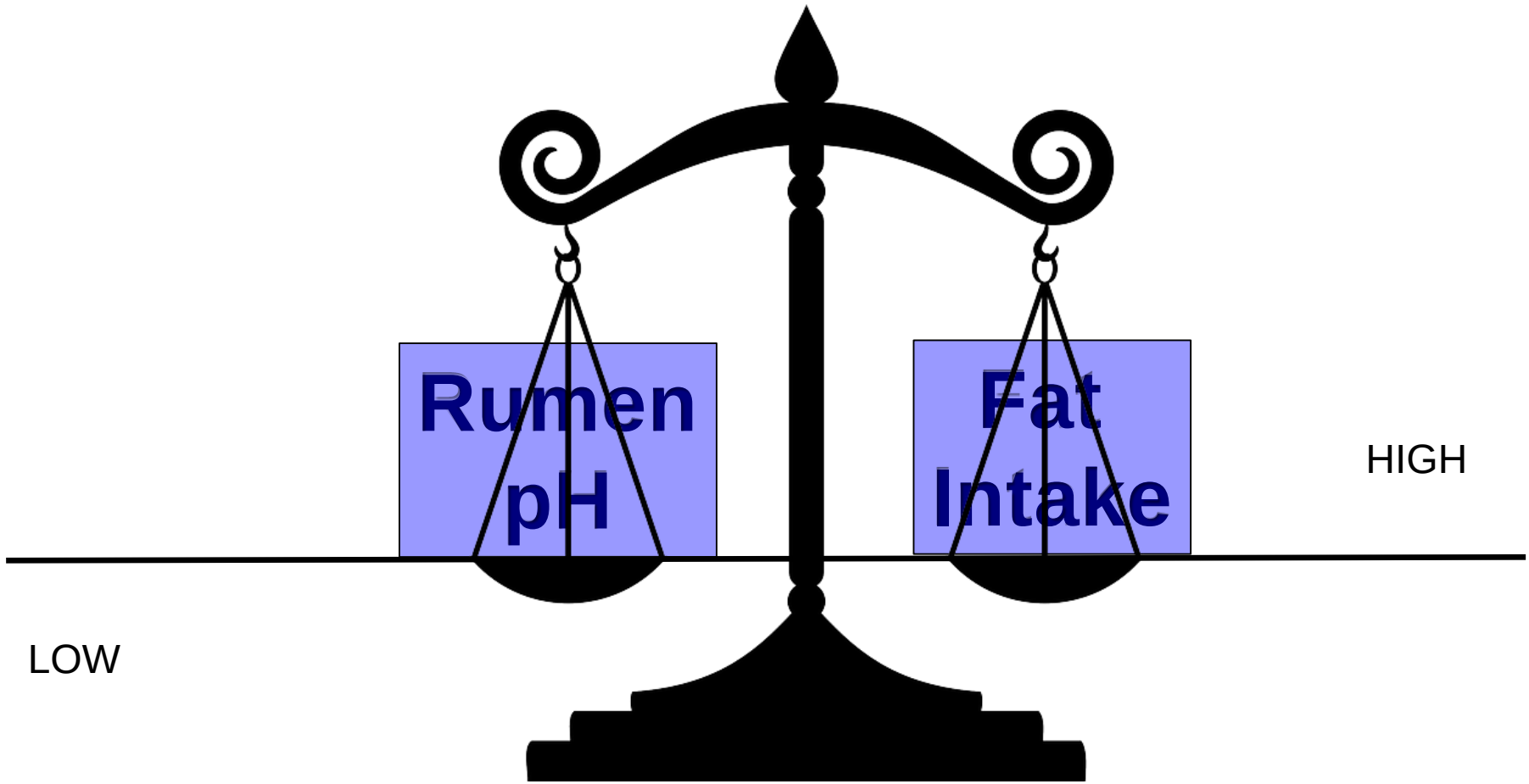
pH & Corn Oil Interactions



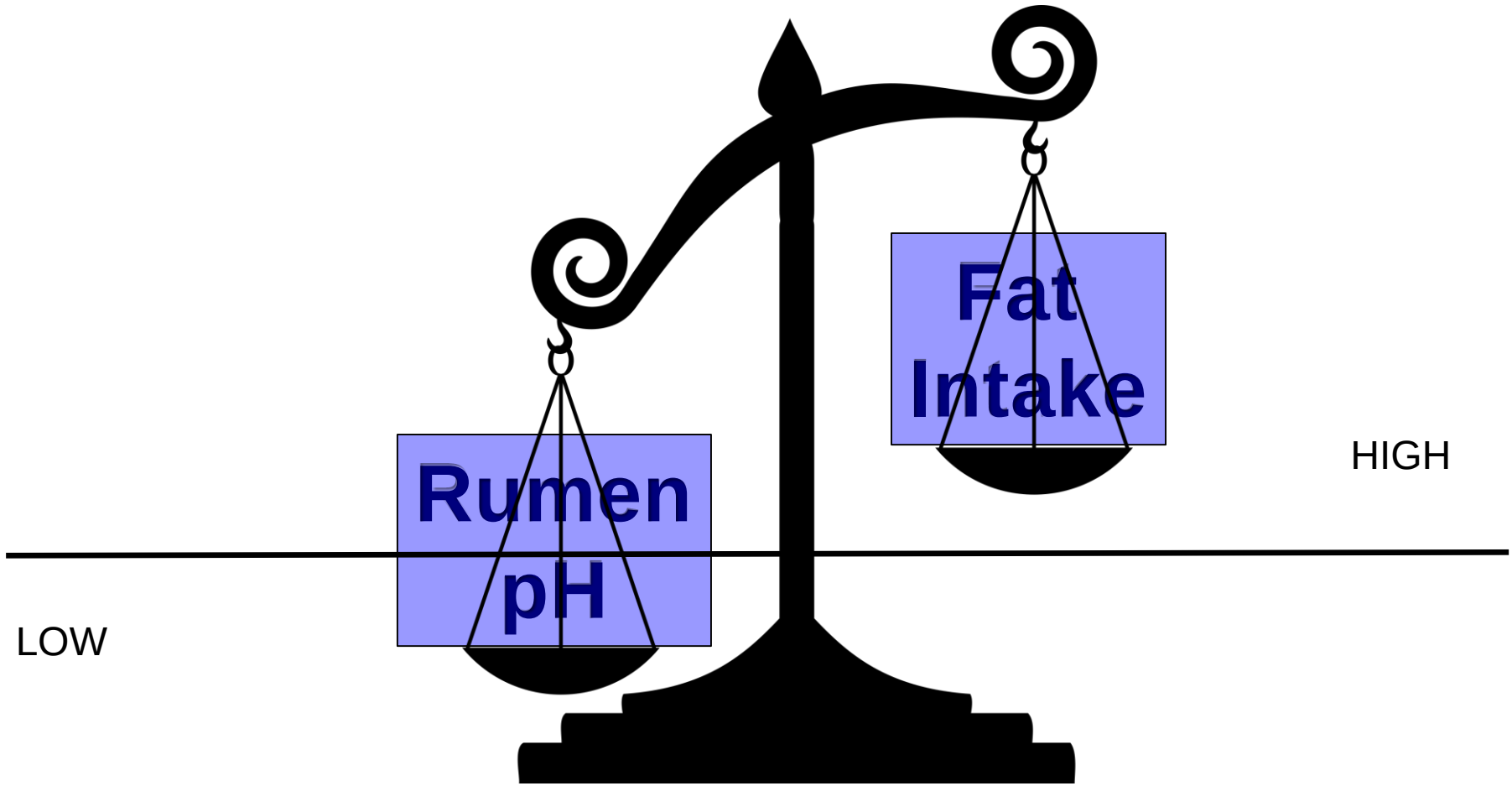
Slide courtesy of Dr. Adam Lock

Sun et al. 2014. J. Dairy Sci. 97 (E-Suppl. 1): 319.

How Do You Manage MFD?

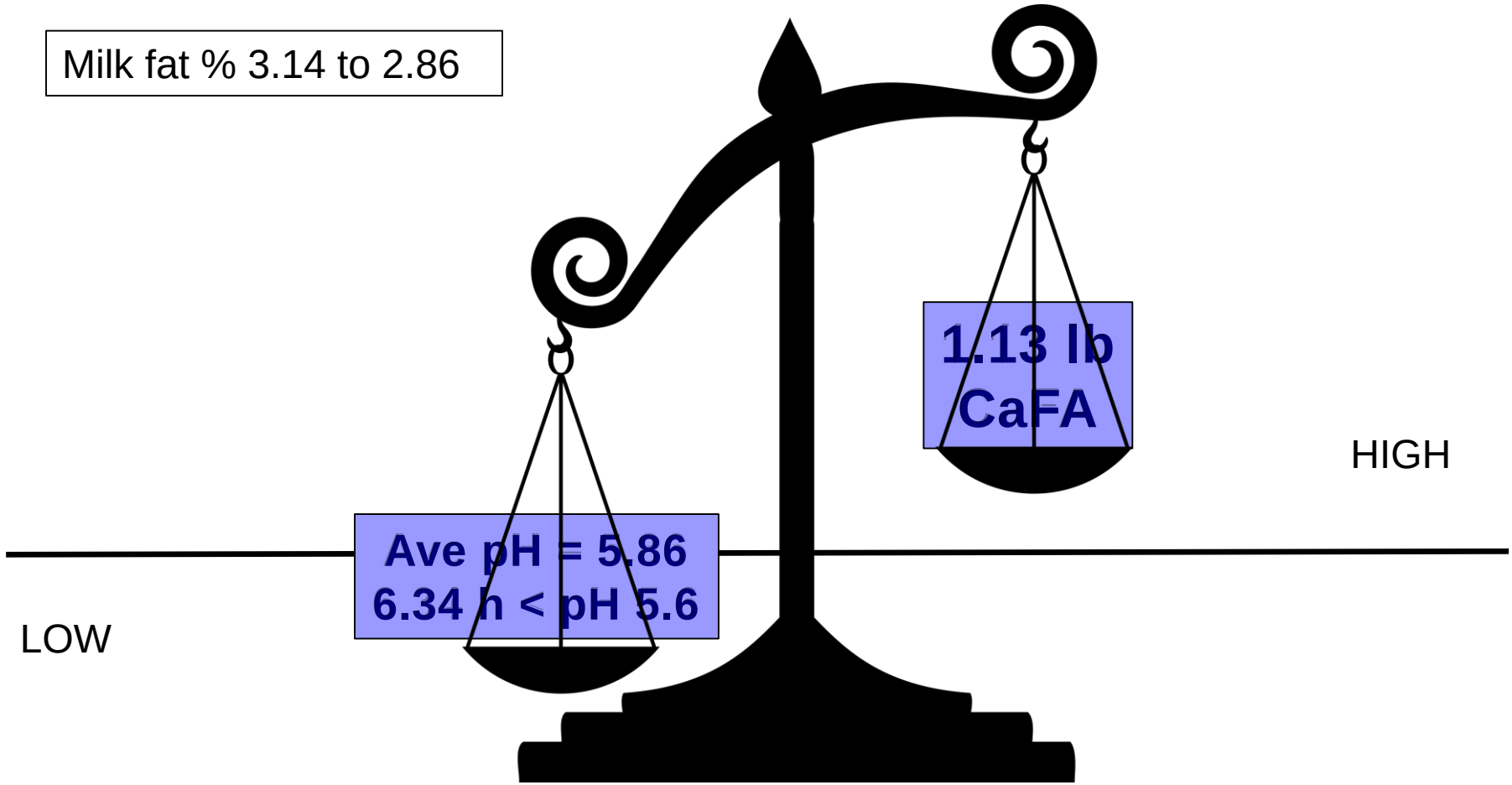


How Do You Manage MFD?



How Do You Manage MFD?

Milk fat % 3.14 to 2.86



Rico et al. (2014)

Manage Rumen pH

- Effective fiber
  - Particle Length (Cornell Epi)
    - Bottom Pan of Penn State Shaker Box <54%
    - > 49% on middle screen
    - Top screen didn't matter
- Starch (7h K_d < 85%)
- Buffers
- Management
  - TMR mixing
  - Feeding frequency
  - Crowding

K Carbonate[1] Effects on Milk Fat

	Milk Fat, %			
Δ TMR K	- K	+ K	P <	Reference
1.2 to 2.0%	4.01	4.38	0.05	Harrison et al. 2012
1.2 to 2.2 % (LF)	2.74	2.99	0.05	Kamar and Weiss, 2013
1.2 to 2.2 % (HF)	2.39	2.64	0.05	Kamar and Weiss, 2013
1.8 to 2.3%	4.06	4.28	0.05	Ma et al., 2013

[1]Added as K carbonate sesquihydrate (DCAD Plus, C&D, Inc.)

CLA production from continuous culture.

	Treatment			
mg/d	**CON**	**K_2CO_3**	**Na_2CO_3**	**SE**
Total CLA	**28.1**	**23.7**	**26.5**	**4.1**
c9t11[a]	**8.4**	**11.4**	**12.6**	**1.2**
t10c12[b]	**19.7**	**12.4**	**14.0**	**3.6**

[a] CON differed from others ($P < 0.05$)

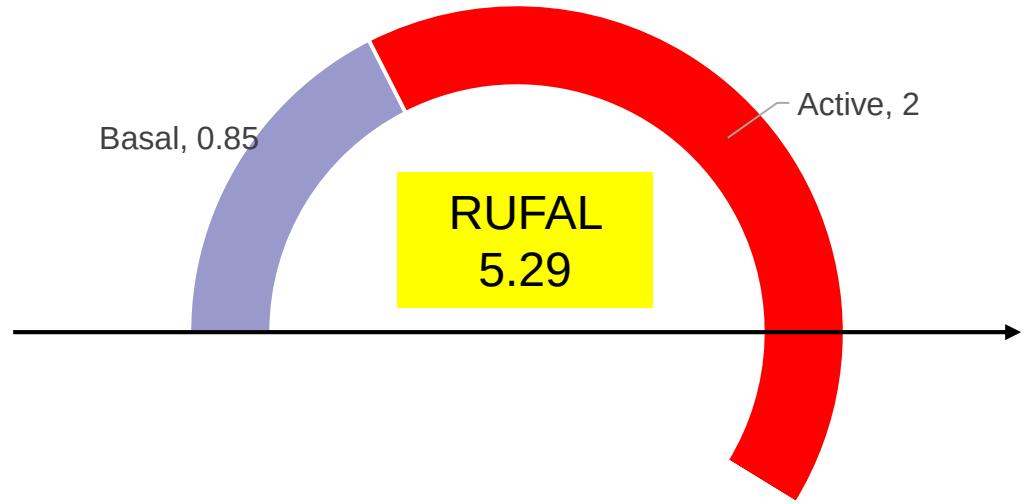
[b] CON differed from others ($P < 0.10$)

Young et al. 2015. ADSA Poster T396.

47.5 lb basal @ 1.8% FA = 0.85 lb
+ 2.2 lb soybean oil (2 lb FA)

Max lbs = $\frac{4*NDF*DMI}{(UFA*FA)_{fat}}$

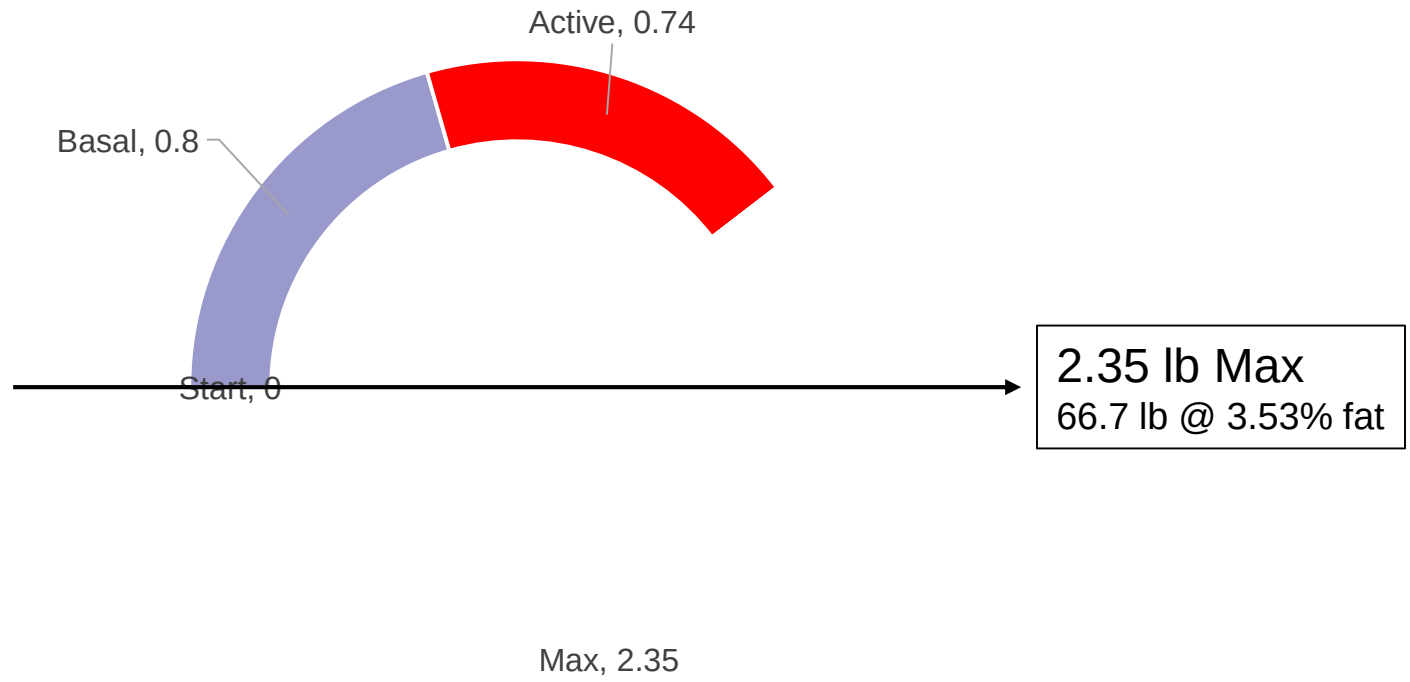
0.8 lb Soybean oil
0.74 lb FA



2.35 lb Max
66.7 lb @ 3.53% fat

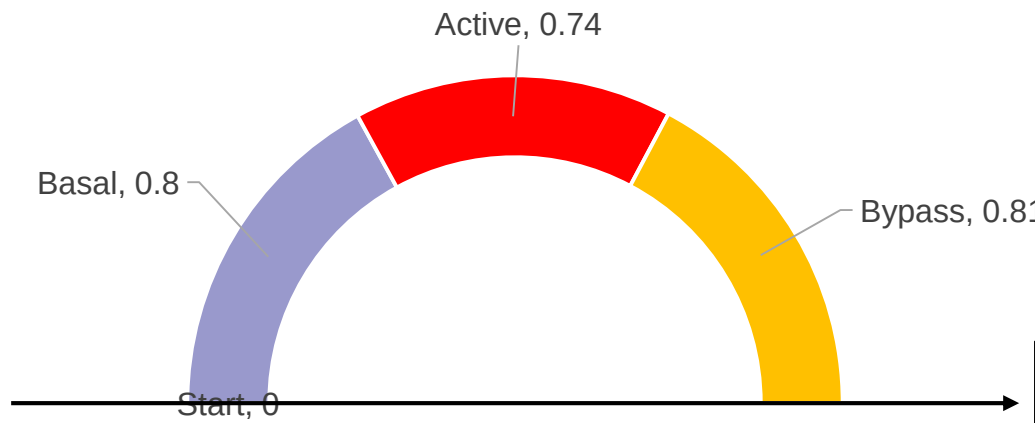
Milk fat % 3.59 to 2.62

Huang et al. (2008)



Huang et al. (2008)

0.81 lb bypass
0.81 lb (100 % FA)
0.95 lb (85% FA)



2.35 lb Max
66.7 lb @ 3.53% fat

Milk fat % 3.59?

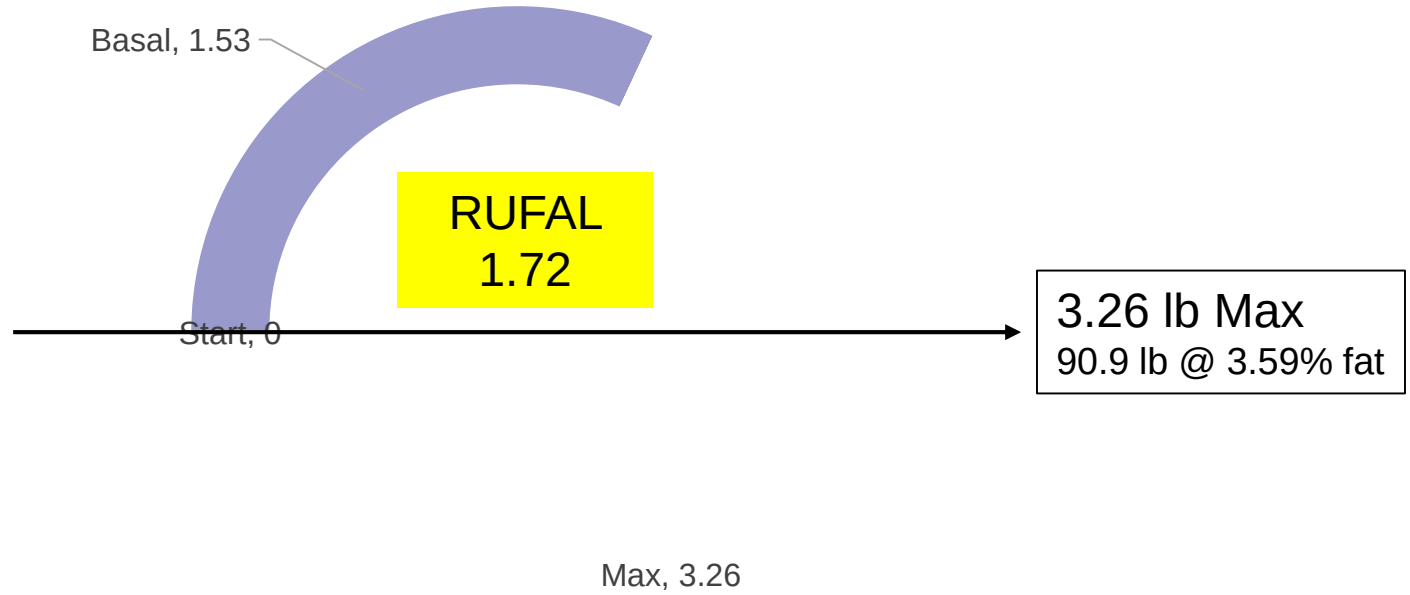
Huang et al. (2008)

51.9 lb basal @ 2.94% FA = 1.53 lb

Max lbs = $\frac{4*NDF*DMI}{(UFA*FA)_{fat}}$

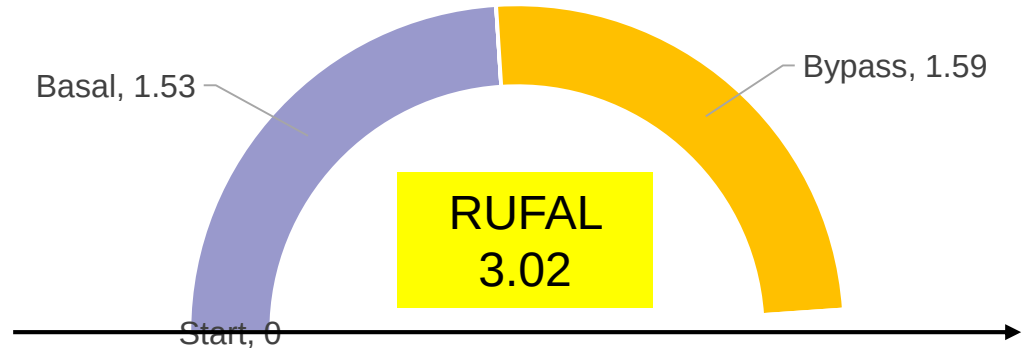
7.8 lb DDG

0.78 lb FA



Weiss et al. (2011)

51.9 lb basal @ 2.94% FA = 1.53 lb
+ 1.87 lb CaFA (1.59 lb FA)

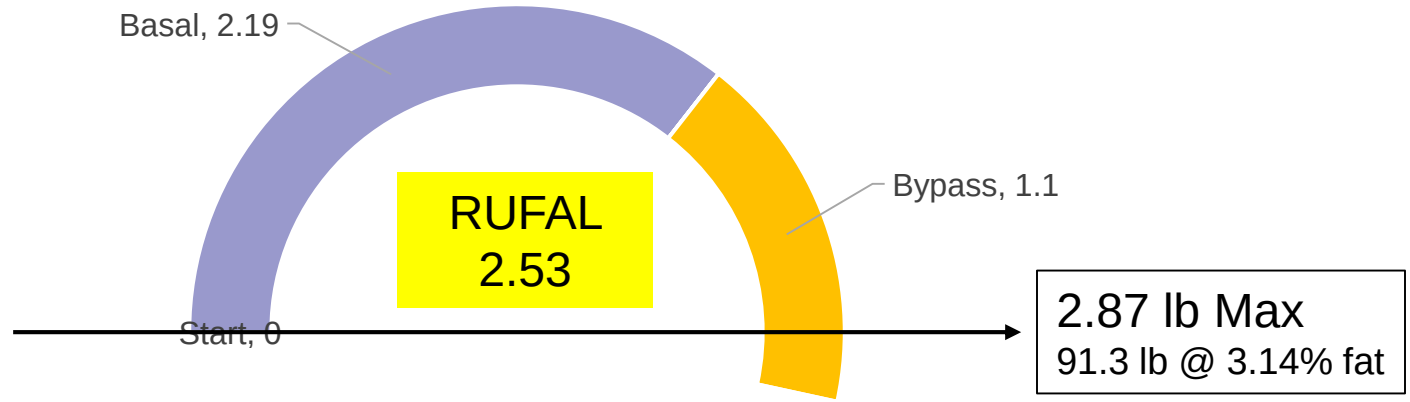


3.26 lb Max
90.9 lb @ 3.59% fat

Milk fat % 3.59 to 3.89

Weiss et al. (2011)

57.6 lb basal @ 3.8% FA = 2.19 lb
+ 1.1 lb PA (1.1 lb FA)



Milk fat % 3.14 to 3.22

Rico et al. (2014)

Bakery Waste Example

I can get a GREAT deal on bakery waste from a local cookie plant that makes chocolate chip cookies and I want to use as much as I can.

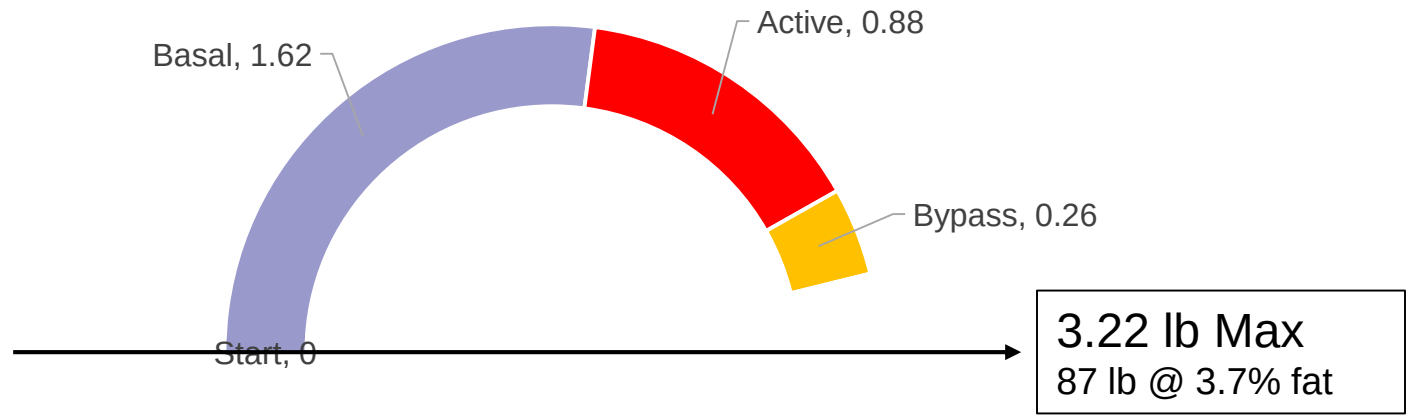
I presently feed about 1/3 lb commercial calcium salt product and 5 lbs whole cottonseed. I need to leave these in the ration because of previous commitments but we can adjust their amounts to use up inventory.

The supplier states that the waste product contains 24.7% total fat of which 12.5% is saturated.

How Much ?

56 lb basal @ 2.9% FA = 1.62 lb

CURRENT
5 lb WCS * 17.5% FA = 0.88 lb
.3 lb Bypass * 85% FA = 0.26 lb



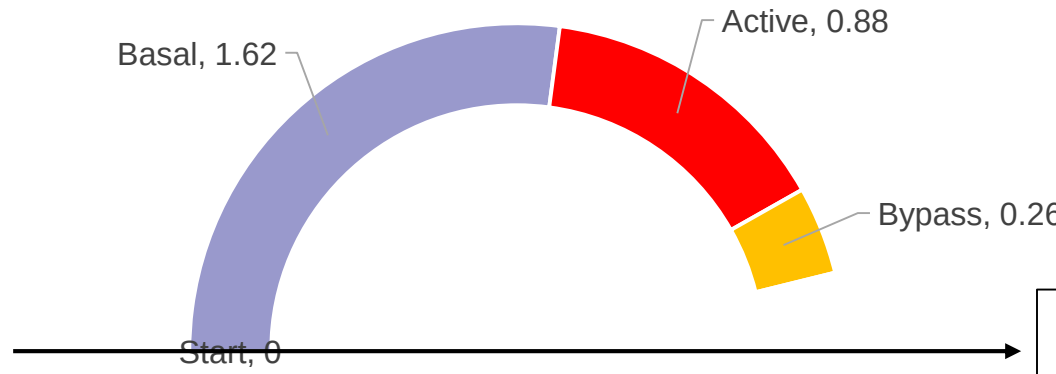
3.22 lb Max
87 lb @ 3.7% fat

56 lb basal @ 2.9% FA = 1.62 lb

Max lbs = $\frac{4*NDF*DMI}{(UFA*FA)_{fat}}$

5.9 lb WCS = 1.03 lb WCS FA

3.42 lb Bakery = 0.84 lb Bakery FA



3.22 lb Max
87 lb @ 3.7% fat

5 lb WCS = 0.88 lb FA

Max FA = 1 lb

0.12 lb FA = 0.5 lb Bakery

RUFAL > 3 % Always Shows TMR High in Fat ……..But Might Not Predict MFD Well!

Reasons	Why CLA_{mfi} not increased?
Reduced release from glycerol	Only FFA are antimicrobial
Reduced release from intact plant	Fatty acid not in contact with microorganism
Lipid is rumen-inert	Ca salts have little to no antimicrobial effects
TMR is high in fiber	RUFAL binds to fiber instead of microbial cell
Rumen pH high low	Intensifies CLA shift

Points to Remember

- Lipid is unique among feed nutrients because of its potential insult on the rumen microbial population.
- RUFAL is useful for a quick look at the FA fraction that potentially disrupts rumen function.
- RUFAL > 3% of TMR DM is higher risk because of **potential** to increase CLA that causes milk fat depression.
- RUFAL is in balance with rumen pH to determine effects on rumen function.
- Learn how to limit fats and oils that can negatively affect animal performance.

Thank You!!!