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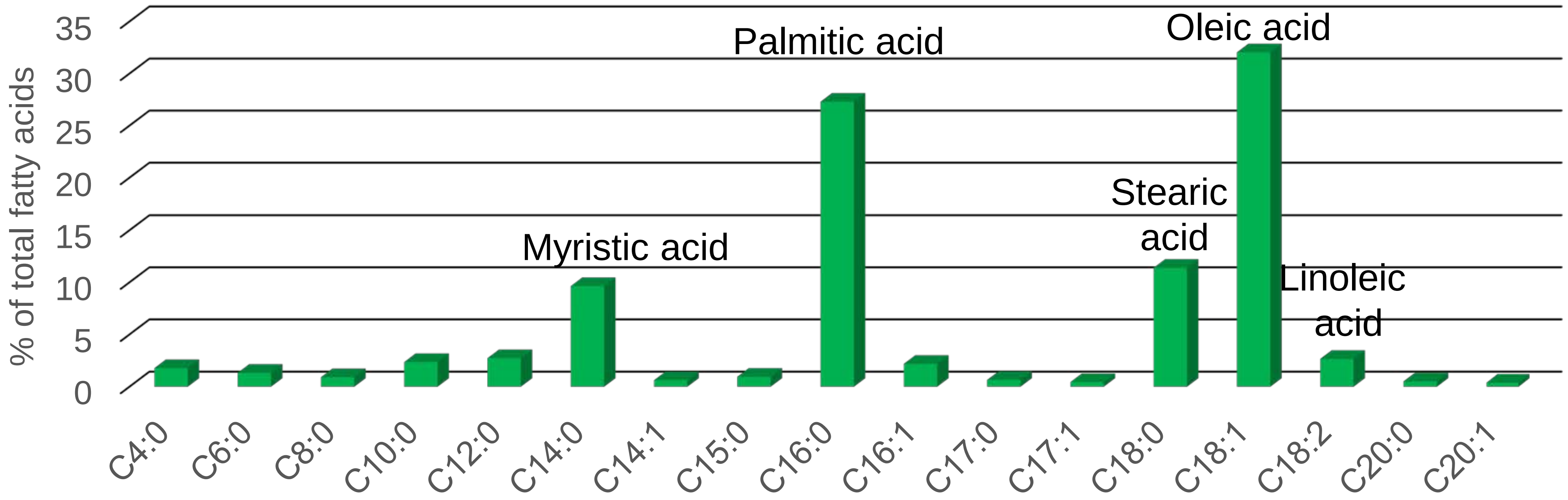
Maximizing milk fat yield: A review

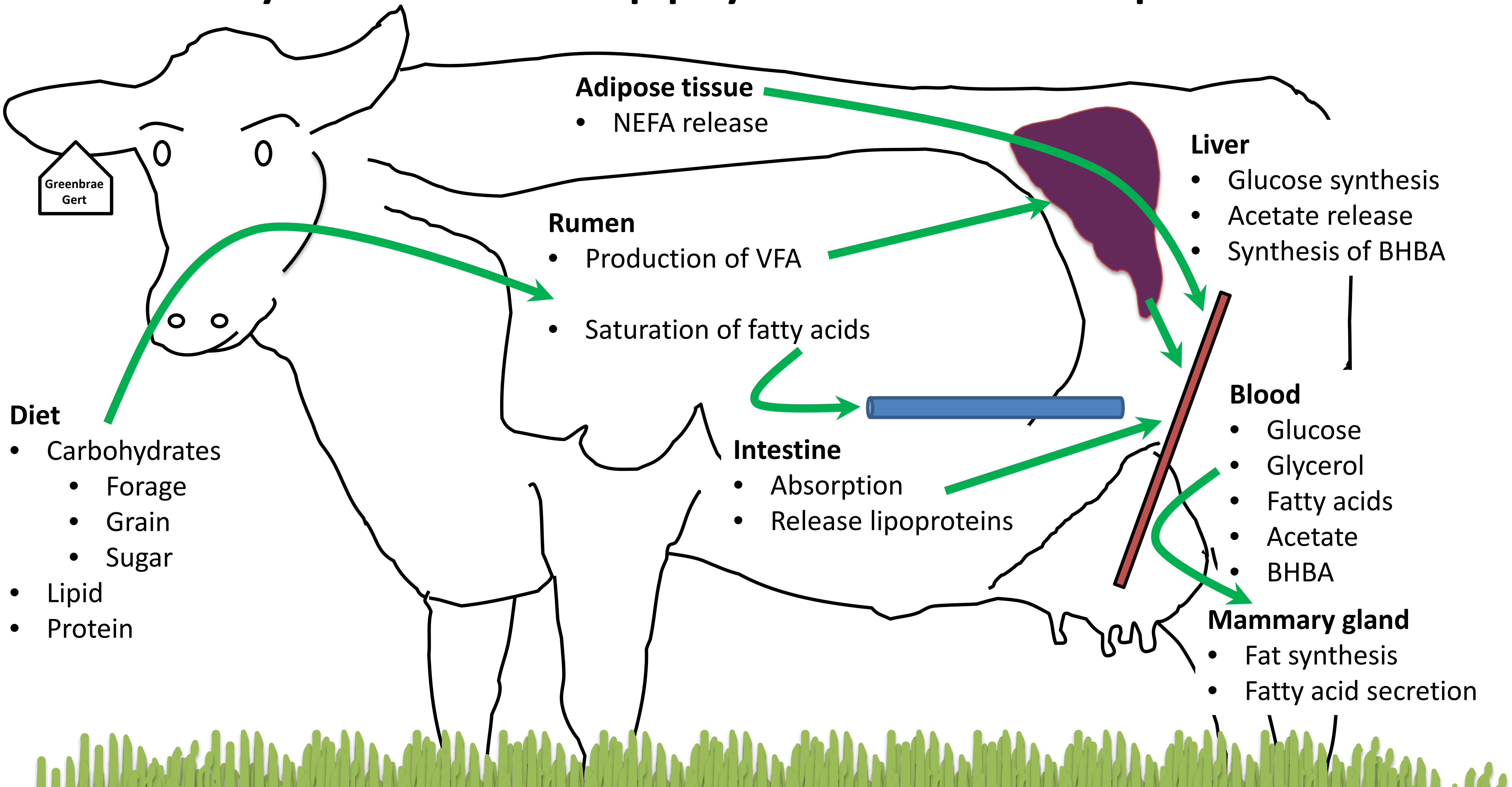
Greg Penner, PhD
Associate Professor and Centennial Enhancement Chair in Ruminant Nutritional Physiology
Room: AGRIC 6D18
Phone: 966-4219
Email: greg.penner@usask.ca

Milk fat composition

- One of the most diverse naturally occurring source of fat
    - Over 400 individual fatty acids have been identified



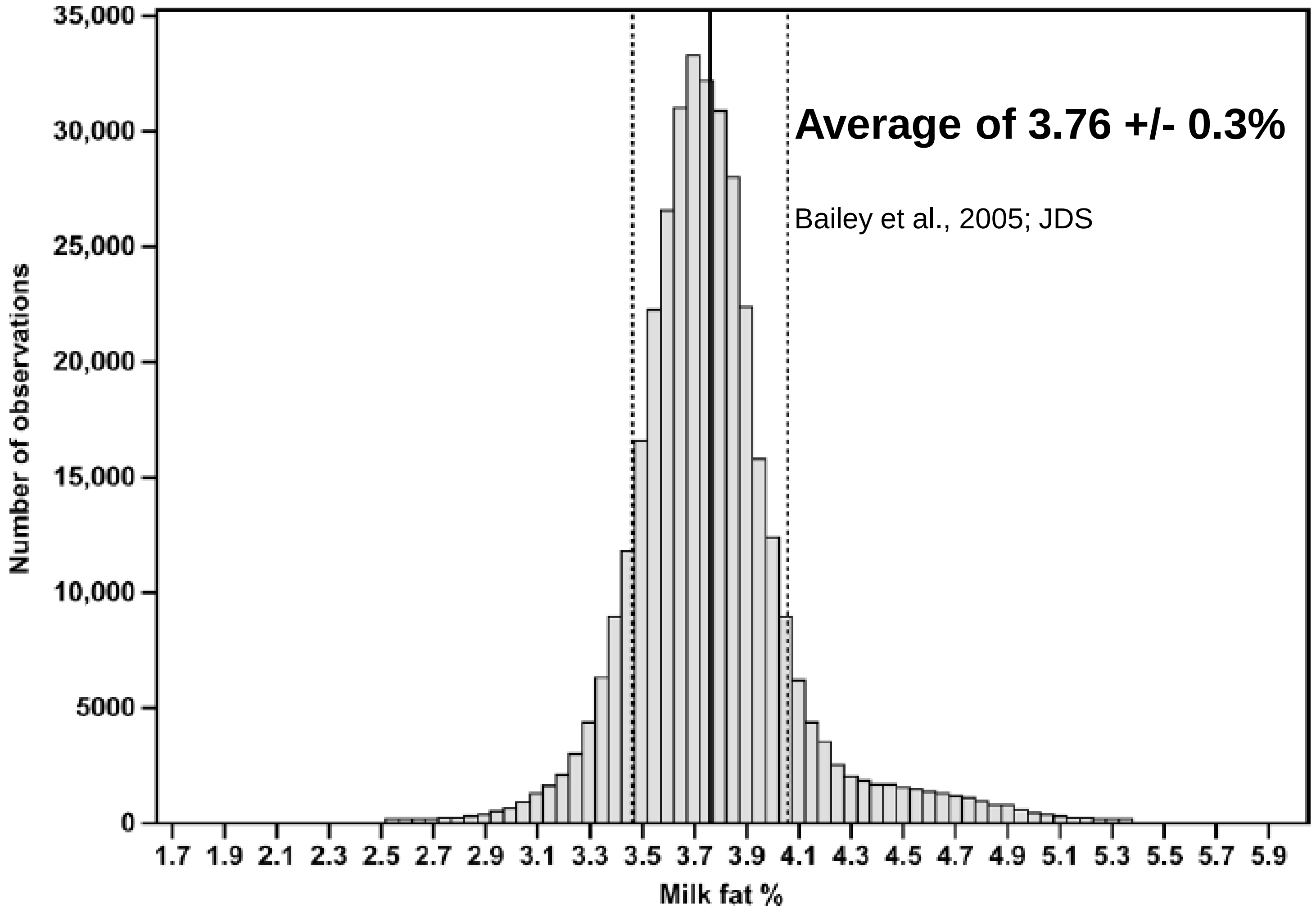
Dietary nutrient supply and milk fat production



Milk fat

- Derived from 2 major sources
  1. Synthesized by the mammary gland (~50%)
     - Primarily short-to-medium chain fatty acids
       - Highly regulated
  2. Transfer from the diet/adipose tissue (~ 50%)

- Secreted into the milk as globules
  - Lipid rich with protein-rich membrane


35,000
30,000
25,000
20,000
15,000
10,000
5000
0
Number of observations
1.7 1.9 2.1 2.3 2.5 2.7 2.9 3.1 3.3 3.5 3.7 3.9 4.1 4.3 4.5 4.7 4.9 5.1 5.3 5.5 5.7 5.9
Milk fat %
Average of 3.76 +/- 0.3%
Bailey et al., 2005; JDS

Maximizing milk fat production

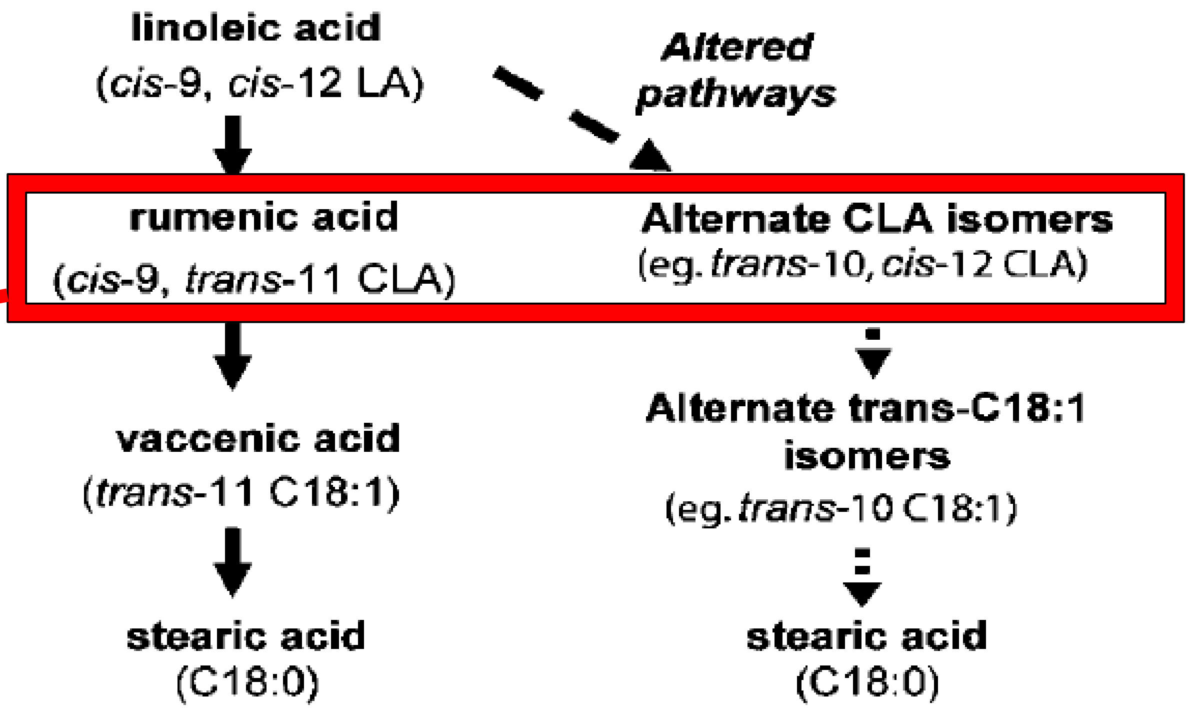
- Strategic approach
  1. Limit risk for milk fat depression (MFD)
     - Optimize DMI and rumen fermentation
  2. Provision of protected fatty acid supplements

1. Optimizing ruminal fermentation: key points

- What we want
  - High intake
  - High digestibility
    - VFA, microbial protein
- What we need to avoid
  - Low pH
  - High load of RUFAL

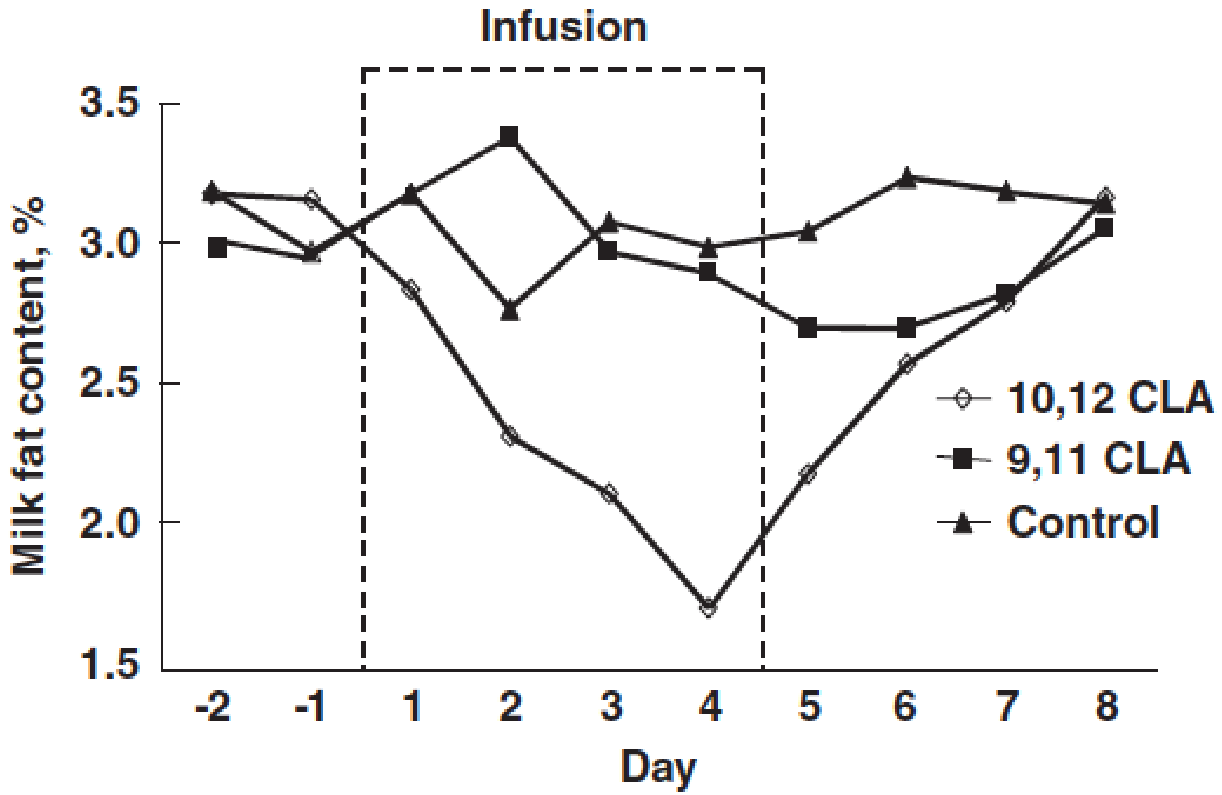
Milk fat depression (MFD) / low milk fat production

- Extent reduction in milk fat varies
- Bacteria saturate fatty acids
- Incomplete saturation
  - Cis 9 trans 11
  - Trans 10 cis 12

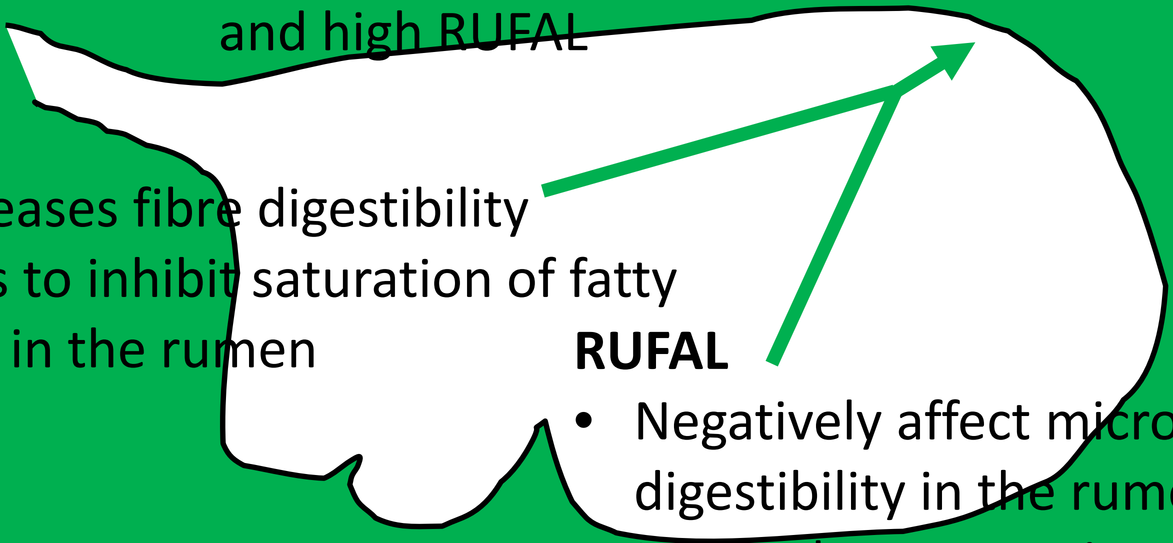


Harvatine et al., 2009

Trans 10 cis 12 is most potent at reducing milk fat



Harvatine et al., 2009



Ionophores

- Increase risk
    - when diets contain high starch and high RUFAL

Greater supply of trans 10 cis 12 and Cis 9 trans 11

Low pH

- Decreases fibre digestibility
- Helps to inhibit saturation of fatty acids in the rumen

RUFAL

- Negatively affect microbes (reduced digestibility in the rumen)
- Incomplete saturation produces potent inhibitors of milk fat uptake and synthesis

Preventing low pH

- Many dietary combinations and permeations
  - Forage
  - Type of starch and degree of processing
  - Starch vs. sugar
- Feeding management
  - TMR, PMR, component feeding
  - Bunk space
  - Continuous access to feed

What is RUFAL?

- Calculated as the sum of dietary C18:1, C18:2, C18:3
  - Should target <3.5% of the total dietary fatty acids
  - **DOES NOT CONSIDER** whether fatty acids are protected
  - Tool not guideline

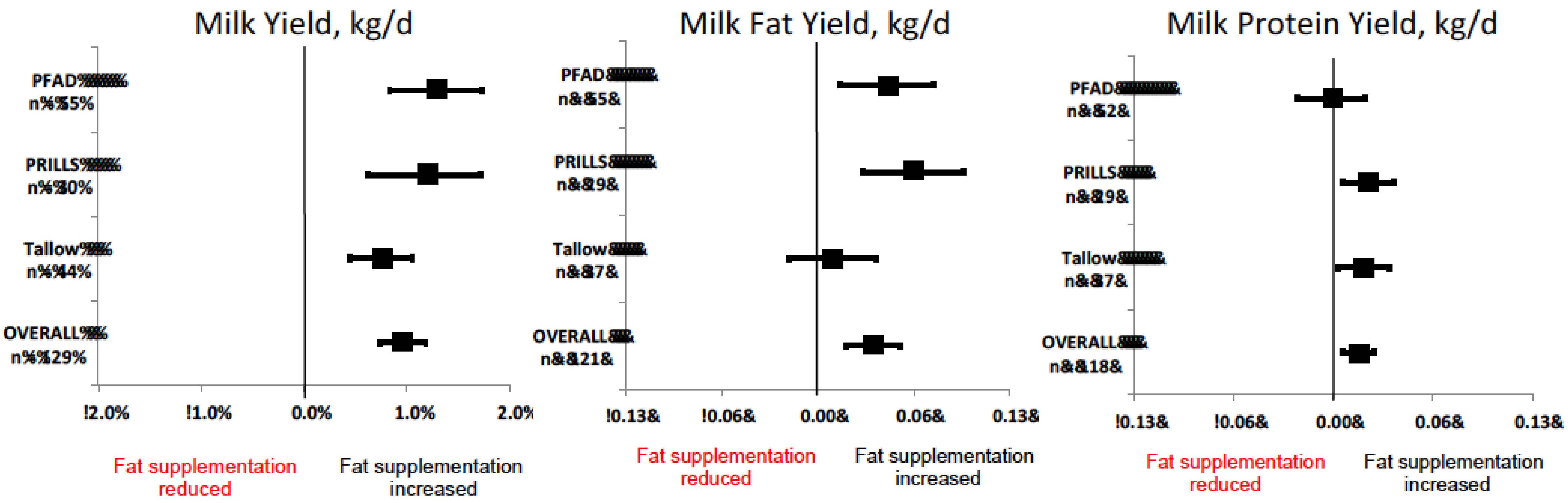
Common fatty acid supplements

Fatty Acid, g/100 g	Tallow	Ca-salt PFAD	Saturated free FA	C16:0-enriched
C14:0	3.0	2.0	2.7	1.6
C16:0	24.4	51.0	36.9	89.7
C18:0	17.9	4.0	45.8	1.0
C18:1	41.6	36.0	4.2	5.9
C18:2	1.1	7.0	0.4	1.3

Lock and de Souza, 2015

2. Dietary fatty acid supplements

Lock and de Souza, 2015



Dietary palmitic acid as a supplement

Rico et al., 2013; JDS

	C16:0 supplementation, % diet DM					
Variable	0%	0.75%	1.50%	2.25%	SEM	*P*-value
DMI, kg/d	28.8	28.8	28.6	27.4	0.83	0.05
Milk yield, kg/d	43.7	43.5	44.5	42.5	1.73	0.06
Fat yield, kg/d	1.63	1.69	1.78	1.70	0.09	0.01
Milk Fat, %	3.78	3.88	4.01	4.03	0.17	0.01
Protein yield, kg/d	1.36	1.36	1.40	1.32	0.06	0.08
Milk Protein, %	3.17	3.15	3.18	3.16	0.07	0.32
3.5% FCM, kg/d	45.3	46.1	48.0	45.9	1.91	0.02
3.5% FCM/DMI	1.57	1.60	1.68	1.68	0.07	0.21
Body weight, kg	703	705	701	701	25.7	0.76
BCS	2.66	2.48	2.71	2.84	0.05	0.94

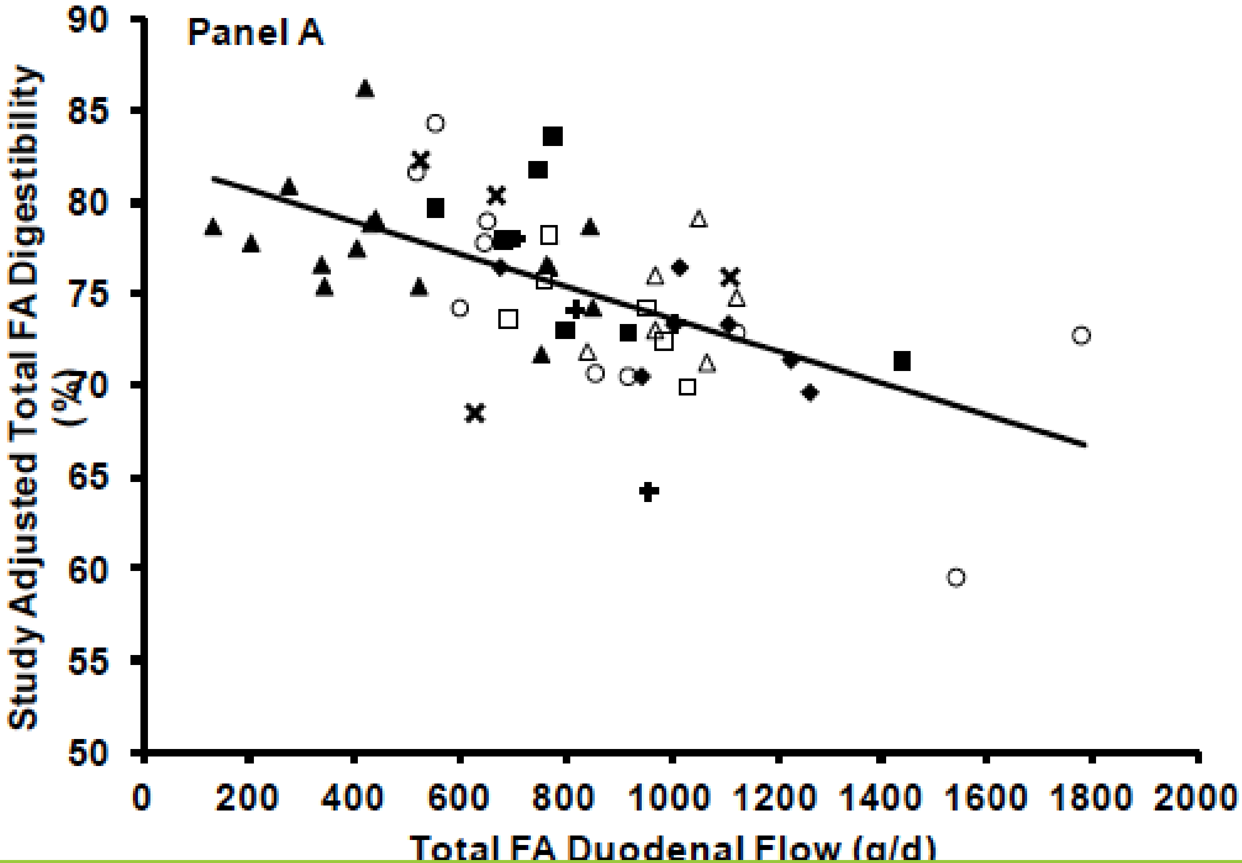
Does it pay?

Values based on Rico et al., 2013; JDS

- $2100/Mt for palmitic acid (~90% palmitic acid)
- $18/kg milk fat

	Dietary inclusion rate, %			
	0	0.75	1.5	2.25
Palmitic amount, kg/d	0	0.21	0.42	0.63
Palmitic cost, $/cow/d	0	0.44	0.88	1.32
Milk fat yield, kg/d	1.63	1.69	1.78	1.70
Milk fat revenue, $/cow/d	29.34	30.42	32.04	30.60
Difference relative to control, $	0	1.08	2.7	1.26
Net benefit/cost	0	0.64	1.82	-0.06

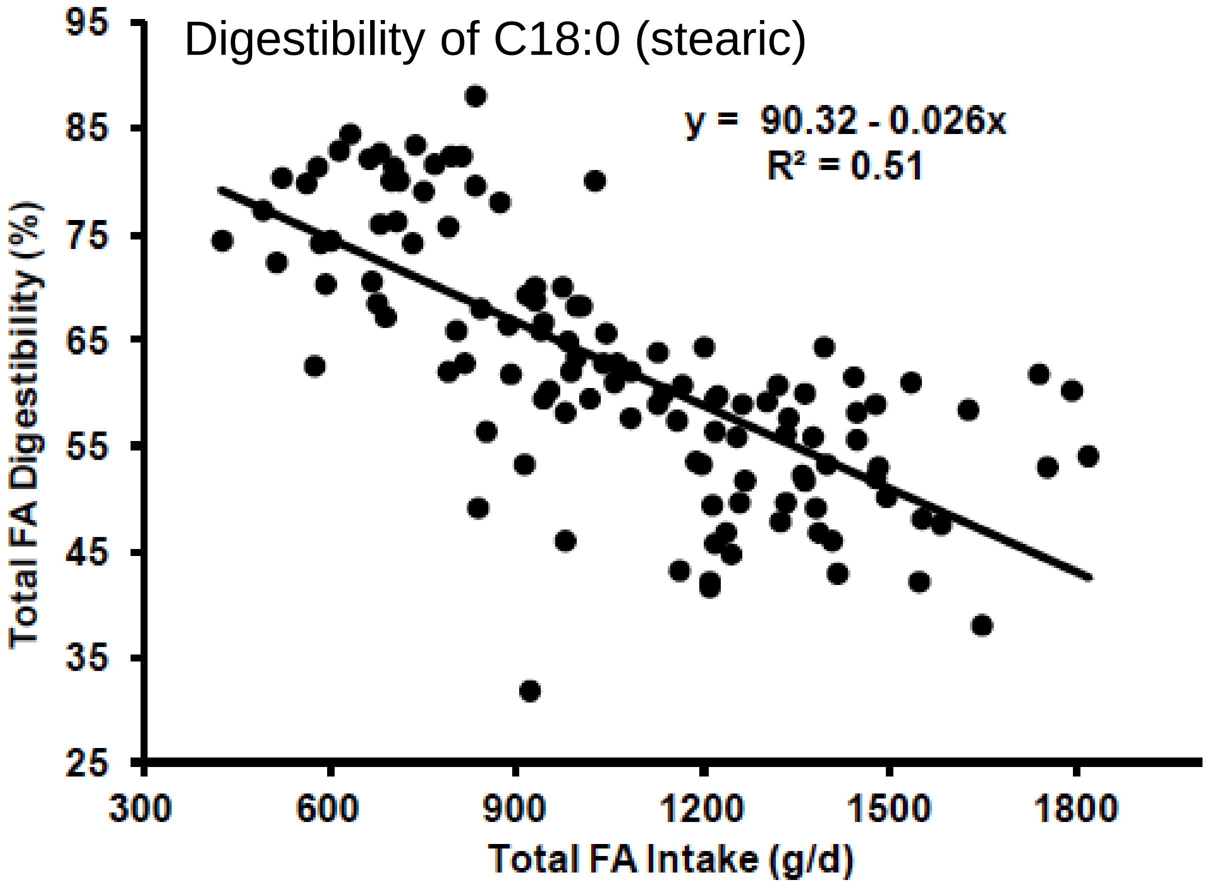
Why doesn’t more = better

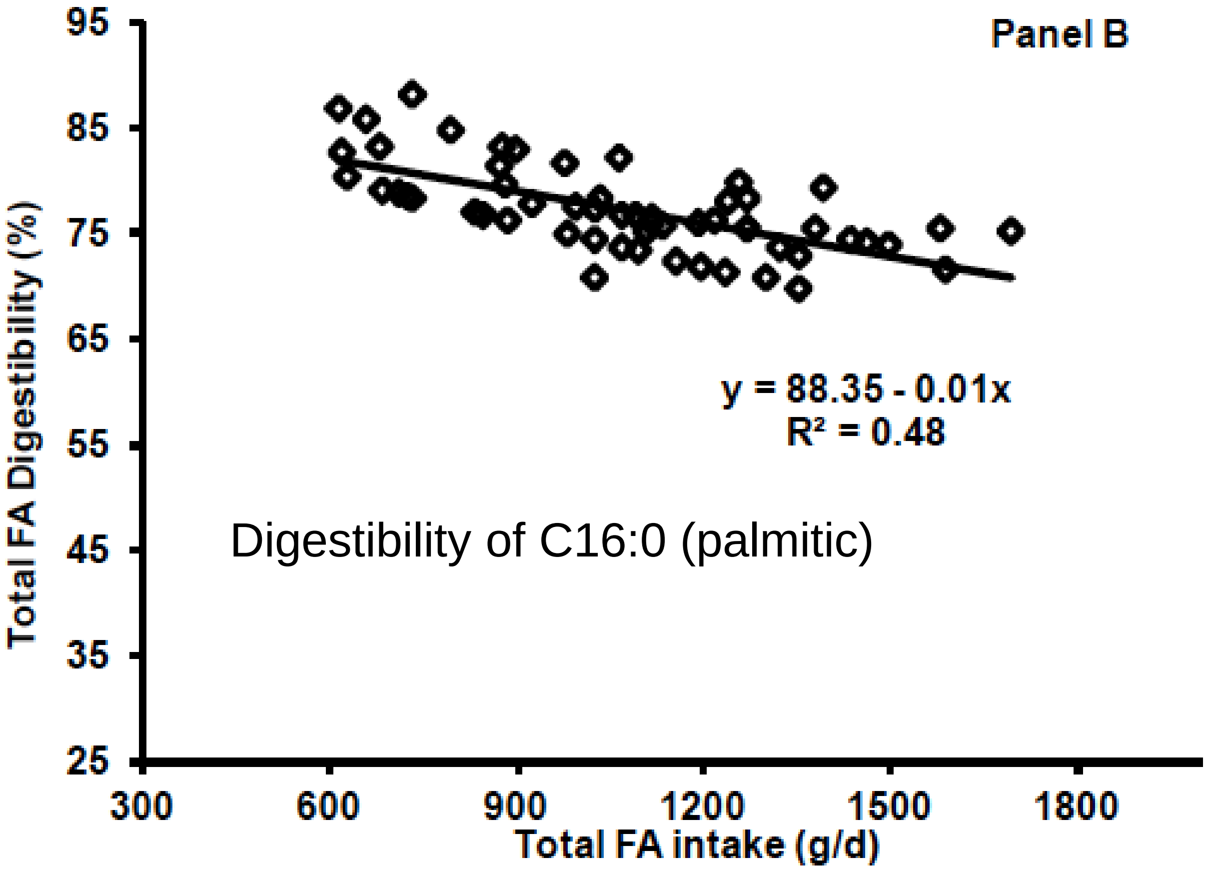


Lock and de Souza, 2015

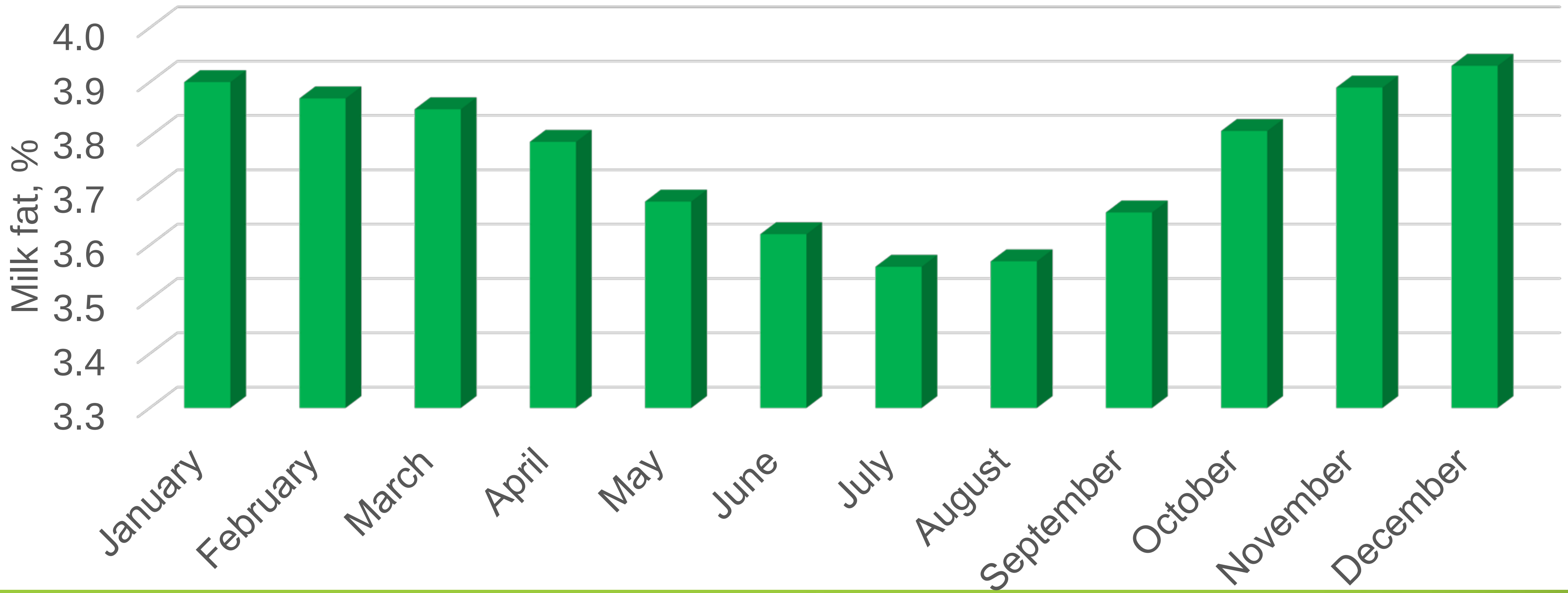
But, digestibility of fatty acids differ

Lock and de Souza, 2015





It is more than just the diet!



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It is more than just the diet!

Bailey et al., 2005; JDS

		Milk shipped, lb/mo		Fat, %	
Category[1]	n	Mean	SD	Mean	SD
<50,000	112,534	31,172	11,609	3.83	0.38
50,001 to 100,000	110,766	72,006	14,115	3.75	0.31
100,001 to 500,000	121,001	190,090	87,858	3.72	0.27
>500,000	12,021	1,090,598	1,220,788	3.61	0.23

[1]Categorized by pounds of milk shipped per month.

Where to go from here?

- There may be the potential to identify individual fatty acids with a high digestibility and transfer efficiency
  - Lower rate of decline in digestibility with increasing dietary supply
  - Adequate transfer from diet to milk
- Locally abundant sources of C14:0, C16:0, and C18:0?
- Evaluation of methods of rumen protection

Take-home messages

- Many factors contribute to milk fat production
- Nutritional strategies must take a 2-pronged approach
  - Optimize ruminal fermentation to limit MFD
  - Supplement with rumen inert fatty acids

- Cost/benefit must be evaluated!