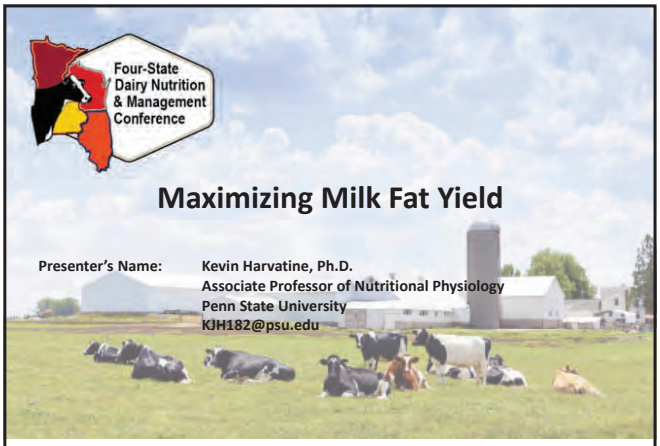
Maximizing Milk Fat Yield

Kevin Harvatine, Ph.D.
Associate Professor of Nutritional Physiology
Penn State University
KJH182@psu.edu

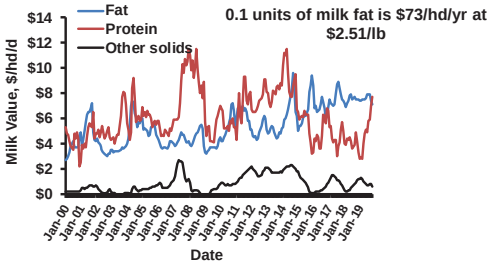


Maximizing Milk Fat Yield

Presenter's Name: Kevin Harvatine, Ph.D.
Associate Professor of Nutritional Physiology
Penn State University
KJH182@psu.edu

1

Milk fat and protein yield are the main drivers of cash flow ($/hd/d @80 lb of 3.7 fat & 3.05 protein)



Harvatine unpublished based on USDA NASS milk price

- Milk fat normally most profitable component. Better to set goals based on Fat + Protein yield!!!

2

How to adapt to "Historic" times

- Production limits/reductions
  - Most are based on milk yield, not components
- Milk fat price bottomed out
  - Profitability depends on my cost to make it
  - Think about "marginal cost"
- Distiller's grains price has increased and corn and soybean meal have decreased
  - Changes risk/value proposition
  - Is rumen available fat cheaper from soybeans or cottonseed?
- Price and some supply changes with some dry fat products

3

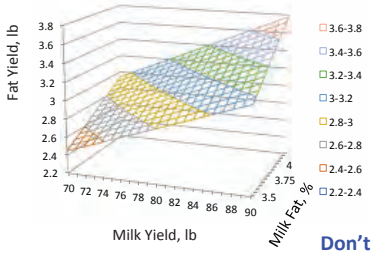
We can have both fat and protein yield!

Maximizing microbial protein yield gets you:

- Optimal amino acid supply
- Normal biohydrogenation
- Optimal acetate yield
- Optimal energy intake
  - Drives milk flow
  - Drives milk protein synthesis
    - (Don't forget insulin-IGF-I story!)

4

"Milk flow" is very important to component yield: You can't give up much yield when seeking to increase milk fat (especially when protein value is high!)



Milk, lb	Milk Fat, %	
	4.0	4.1
80	3.20	3.28
82.5	3.30	3.38

Milk lb

Don't forget protein and going to get protein with milk yield!

5

What should you be thinking about to maximize milk fat yield

1. Set your goal
   - Seasonal pattern
   - Genetics
2. Balance the diet
   - Unsaturated fat
   - Fermentability
   - Fiber digestibility
   - Fat supply
   - Additives
3. Manage the feeding system
   - Feed mixing and delivery
   - Reduce slug feeding
4. Monitor and adjust
   - Milk fat concentration
   - De novo and *trans*-10 C18:1
   - Responses in 7 to 10 d

6

Milk fat is affected by many factors

Nutritional Factors

Inhibited by BH-induced milk fat depression
- Unsaturated fat
- Fermentability
- Acidosis
- Feeding strategies
- Ionophores

Increase by additional substrate
- Acetate (Forage quality)
- Palmitic acid
- High plasma NEFA

Non-nutritional Factors

These set our goals/expectations
- Genetics
- Season
- Stage of lactation
- Parity

Milk fat

7

Milk fat is the most heritable production trait and PTA Fat gives an indication of genetic potential

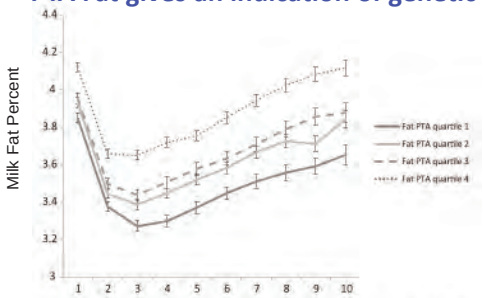
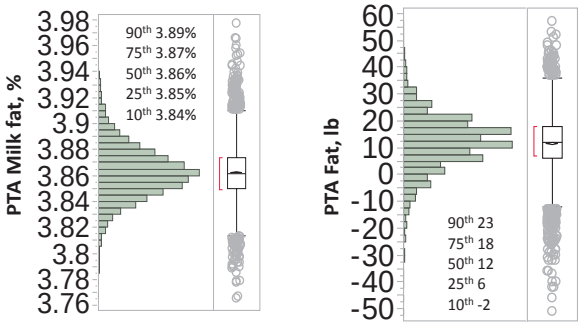


Fig. 2. The effect of sire predicted transmitting ability (PTA) for milk fat percentage quartile on milk fat percentage for the first 10 months of lactation. Data were analyzed using repeated measures ANOVA and the effect of animal nested within farm was controlled in the model as a random effect. Parity was also kept in the model as a fixed effect. Error bars represent 95% confidence interval of the mean.

Bicalho et al. 2014. Theriogenology. 81:257-265

8

There is very little difference between herds for genetic potential for milk fat (5926 DRMS Herds)

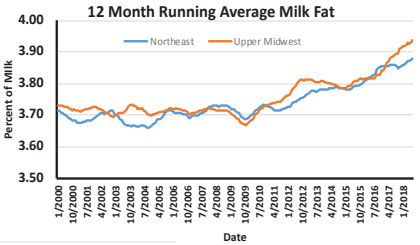


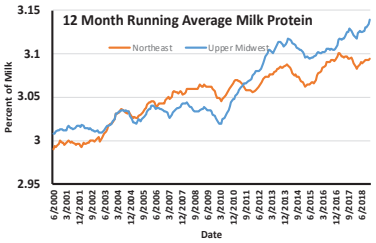
PTA Milk fat % = [(PTAF + 1006) / (PTAM + 26995)] * 100

Harvatine Unpublished

9

Milk fat and protein have been increasing

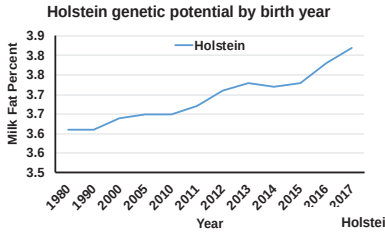




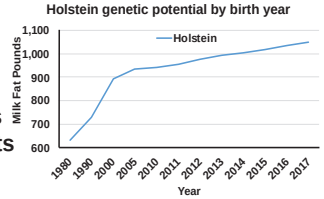
Why?
- Genetics (Yes!)
- Jerseys & Crossbreds?
- Better nutritionists?
- Better DDGS?
- BMR Corn?
- Palmitic acid?

10

Milk fat genetic potential of Holsteins has increased ~0.17 units and 107 lb in 10 years



From Center for Dairy Cattle Breeding



Genetic potential of Jerseys has also increased ~0.15 units and 132 lb in <10 years

11

Let's talk about nutrition: Milk fat can be decreased by BH-Induced Milk Fat Depression (MFD)

- **Diet and management risk factors result in a change in the rumen microbes that produces bioactive "*trans*-10" FA intermediates**
  - **Up to a 50% reduction in milk fat**
  - **Greater decrease in fatty acids made by the mammary gland (de novo)**

This is a very common cause of reduced milk fat yield, but is not meant to explain every change in milk fat!!!

Reviewed by Harvatine et al. 2009

12

We must manage the risk factors that cause "Diet-Induced MFD"

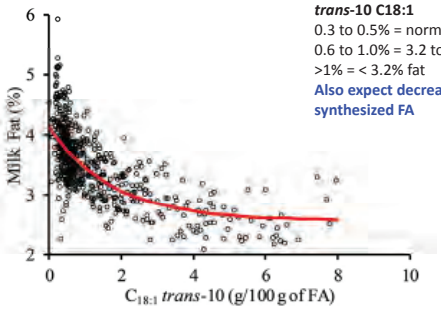
- Dietary fatty acids
  - Level and profile
  - Rate of availability
- Diet fermentability
  - Carbohydrate profile
  - Rate and extent of fermentation
  - Effective fiber
- Adequate RDP/ Ruminal N balance
- Feeding strategies/management
- Ruminal acidosis
- Rumen modifiers- ionophore
- Silage fermentation/quality
- Forage types
- Individual cow effect (level of intake etc)

RUFAL: Rumen Unsaturated Fatty Acid Load (but C18:2 most important)

High producing cows normally most susceptible

13

Can milk fatty acids be used to troubleshoot milk fat problems? Milk *trans*-10 18:1 & Milk Fat %



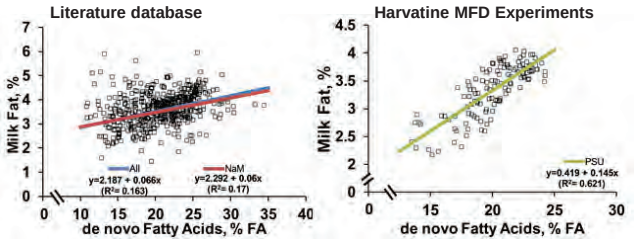
***trans*-10 C18:1**
0.3 to 0.5% = normal fat
0.6 to 1.0% = 3.2 to 3.5% fat
>1% = < 3.2% fat
Also expect decrease in de novo synthesized FA

N = 497

Matamoros Unpublished

14

There is also a relationship between milk fat and de novo FA, but is not specific for MFD

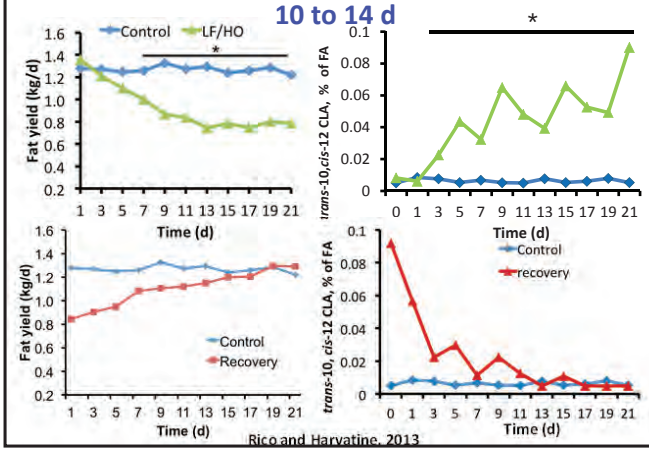


De novo (< 16 C) FA can be predicted by some DHIA labs.

Matamoros Unpublished

15

Diet-induced MFD occurs and can be fixed in 10 to 14 d



Rico and Harvatine, 2013

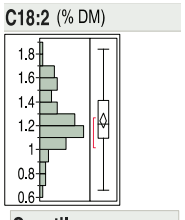
16

Unsaturated fatty acids are a big risk factor

1. Amount of unsaturated fatty acids
   - Fatty acid concentration and profile
   - 18:2 more important than 18:1 and 18:3
2. Rate of availability of the fatty acids
   - Cottonseed vs DDGS

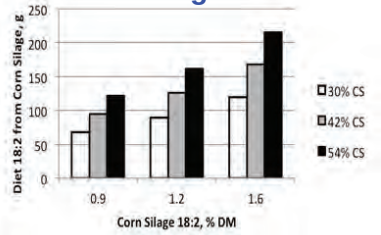
17

Corn silages differ in C18:2 and should be considered in ration balancing



Quantiles		
90.0%		1.60384
75.0%	quartile	1.4094
50.0%	median	1.2167
25.0%	quartile	1.0954
10.0%		0.93576

67 Corn Silages from Test Plots



~60 to 90 g/d difference in C18:2 intake just in the corn silage

Baldin et al. JDS 2018

18

High oleic soybeans decrease risk of milk fat depression

Feedstuff (% FA)	16:0	18:0	18:1	18:2	18:3	20:1	22:1
Soybean	11	4	23	54	8	-	-
High Oleic Soy	6.5	4	75	7	2.5	-	-

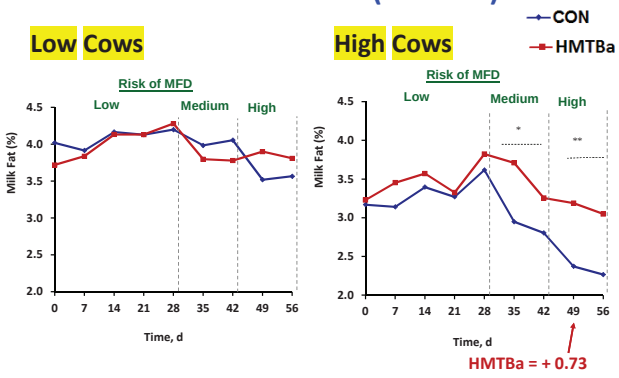
https://www.plenish.com/food/oil-profile/

High oleic soybeans were lower risk for milk fat in previous experiments by Weld and Armentano (2018)

We observed that high oleic soybean increased milk fat ~0.2 units and 0.2 lb/d compared to conventional soybeans

19

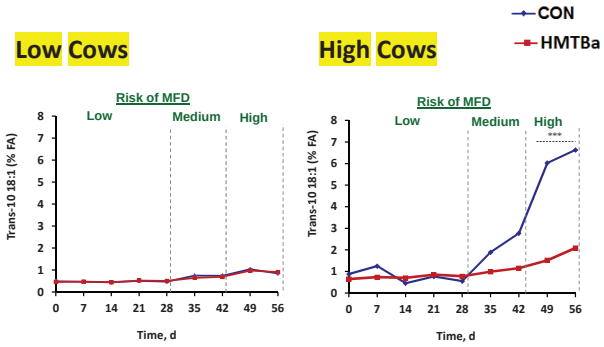
Example of feed additive that reduces risk of MFD: HMTBa (Alimet®)



Baldin et al., JDS 2018

20

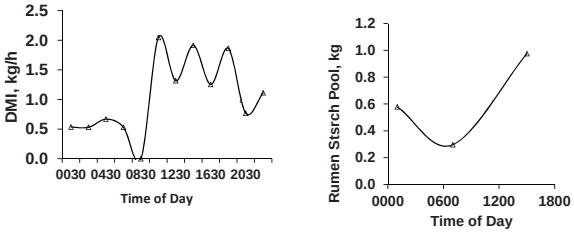
HMTBa prevented increase of *trans*-10 C18:1 in milk



Baldin et al., JDS 2018

21

We need to think about when cows are eating over the day as this can disrupt rumen fermentation!



Timing of feed delivery is our best chance to impact this!

Goal is to spread intake more across the day. Feeding 2x and earlier in the day is best way to do this.

Ying et al. 2015

22

Other dietary effects with smaller impacts

- **Absorbed fat**
  - **Palmitic acid**
- **Acetate supply**
  - **Forage digestibility and rumen function**

23

How much fat does a cow need to provide preformed fatty acids at 4% milk fat and 55% preformed FA at 55% transfer?

Milk, lb	Fat, lb	Milk Preformed, lb	DMI, lb	Diet Fat % Needed
60	2.4	1.3	45	5.3%
90	3.6	2.0	55	6.5%
120	4.8	2.6	65	7.4%
150	6	3.3	75	8.0%

Obviously, cows are making it work, but in some cases we might be limiting milk fat because of limited fat supply

24

Effect of high oleic soybeans on milk fat when increasing risk of MFD

	Treatment Means[1]							
	Conv. Soybean		High 18:1 Soybean			*P*-Values[2]		
Item	5%	10%	5%	10%	SEM	Type	Level	Type* Level
Milk, lb/d	96.4	96.3	95.5	98.6	2.8	0.69	0.28	0.18
Milk Fat								
%	3.28	3.46	3.42	3.66	0.12	<0.05	0.01	0.69
lb/d	3.06	3.22	3.22	3.46	0.24	0.08	0.01	0.55
Milk Fatty acids, % FA								
>16C[5]	37.4	41.5	37.8	41.5	0.70	0.42	<0.001	0.57
*t*10 C18:1	0.79	0.89	0.62	0.63	0.13	0.01	0.96	0.67

25

Palmitic acid is the most consistent to increase milk fat, but others can also increase in some cases

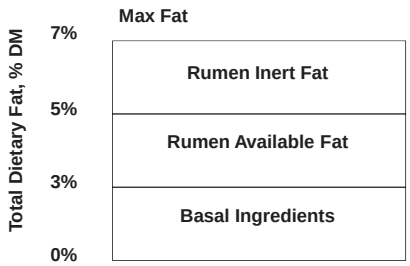
- May depend on concentration of FA in the basal diet, diet type, cow physiology, etc.

Biology of palmitic acid

- **Apparent transfer to milk ~15 to 20%**
- Old isotope data reported 40 to 70% of ^{14}C palmitic acid entered milk (Palmquist and Conrad, 1971)
- I think palmitic decreases the de novo portion of C16:0 in milk fat, but does not decrease de novo as much as C18 FA

26

Make sure you are managing all the fat sources in the diet!



27

Increasing acetate increases milk fat under normal conditions

	Acetate (g/d)					*P*-value	
	0	300	600	900	SE	Linear	Quad.
DMI, lb	59.9	62.2	60.0	59.5	2.2	-	-
Milk, lb	84.9	86.3	88.9	85.6	6.2	-	-
Milk Fat							
g	1382	1468	1582	1577	59	<0.001	-
%	3.64	3.87	4.03	4.10	0.20	<0.001	-

- 600 g/d of acetate increased milk fat by 200 g/d
- Mostly increase in de novo synthesized FA

How do we get more acetate?

Forage quality and good rumen fermentation!

Urrutia et al. J. Nutr. 2017

28

Nutrition is best practiced as an "Experiment in Progress"!!

- When milk fat is Acceptable

- Inclusion of risk factors is advantageous to feed cost, production, and efficiency

- When milk fat is Low: Look For a Reason

- When did it start and what happened ~7-10 d prior?
- Is it a certain string or group of cows?
  - High producing cows are normally more susceptible
- What season is it?
- Is the sample a daily average?

29

The experiment in progress

1. Diet Polyunsaturated Fatty Acids

- Concentration of C18:2
- Source of C18:2
  - Very different rates of rumen release
  - Ca Salts are more slowly released, but are not inert
- Fish oil is very potent (EPA and DHA)
- **Decreasing unsaturated fat has the lowest risk to losing milk yield!**

30

2. Diet Fermentability

- Analyze carbohydrate profiles and effective fiber
- Experience with similar diets in the region is important

- Sugars may be beneficial
- Start to titrate down starch and increase fiber
- Switch rapidly fermentable sources for less rapidly fermentable sources
- Increase forage NDF and effective fiber

**Careful….. May Lose Milk!!

31

3. Rumen Modifiers

- Rumensin®
  - Risk factor, but does not cause MFD by itself
  - Can be synergistic with other risk factors for induction
- DCAD
  - Increasing DCAD decreases MFD (both Na and K)
- HMTBa
  - Reduces the risk of MFD
- Yeast & Direct Fed Microbials
  - May reduce incidence of MFD in some cases
  - Have not tested their effect on recovery

**Remember we are dealing with many interactions!

32

4. Feeding Strategies

- Number of feeding times per day
- Slick bunks before feeding?
- Feeding times

* You can slug feed TMR!

5. Saturated Fat Supplements

- No risk for induction of milk fat depression
- High palmitic acid (C16:0) supplements may increase milk fat in some cases
- Milk fat depression will reduce the effectiveness of high palm supplements

Monitor milk yield and milk fat over time!!!

****Set Expectations for the Time Required**

33

Lets review

Rumen environment is critical to milk fat yield and involves interactions of numerous dietary, cow, and environmental factors

1. Set your goal
2. Balance your diet
3. Manage feeding

Constant "Experiment in Progress" to maximize energy intake, milk yield, and milk fat yield

34

Lab Members:

Cesar Matamoros, Beckie Bomberger, Alanna Staffin, Reilly Pierce, Ahmed Elzennary, and Rachel Walker.

Previous Lab Members:

Chengmin Li, Elle Andreen, Dr. Isaac Salfer, Dr. Daniel Rico, Dr. Michel Baldin, L. Whitney Rottman, Mutian Niu, Dr. Natalie Urrutia, Richie Shepardson, Andrew Clark, Dr. Liying Ma, Elaine Brown, and Jackie Ying

Disclosures

K.J. Harvatine's research in the past 10 years were partially supported by the Agriculture and Food Research Initiative Competitive Grant No. 2010-65206-20723, 2015-67015-23358, 2016-68008-25025 from the USDA National Institute of Food and Agriculture [PI Harvatine], USDA Special Grant 2009-34281-20116 [PI Harvatine], Berg-Schmidt, Elanco Animal Health, BASF, Novus International, PA Soybean Board, Phode Laboratories, Kemin International, Milk Specialties Global, Adisseo, Micronutrients Inc., Organix Recylcing, Insta-Pro Intl., and Penn State University. Harvatine has consulted for Milk Specialties Global, a manufacturer of prilled saturated fat supplements and Micronutrients Inc. as a member of their science advisory boards. Harvatine has also received speaking honorariums from Elanco Animal Health, Novus International, Cargill, Virtus Nutrition, Chr Hansen, NDS, Nutreco, Mycogen, and Milk Specialties Global in the past three years.

Thank You

35

WANT MORE MILK?

Consider increasing the percentage of **canola meal** in your dairy diet. Visit Canolamazing.com to download a free copy of the 2019 Canola Meal Dairy Feed Guide and learn why canola meal is the preferred protein source for dairy.

The guide provides up-to-date nutrient profiles, including optimized values for accuracy in the latest feed formulation platforms.

CANOLAMAZING.com


BON SILAGE
Premium Silage Inoculants for all Crop Types and Dry Matter Ranges.
www.provita-supplements.com | (888) 580-7797