

Webinars

# enhance

Resources for **DAIRYWOMEN**  
without leaving the farm



[DairyGirlNetwork.com](http://DairyGirlNetwork.com)

# Use of Milk Fatty Acids to Make Nutrition and Management Decisions



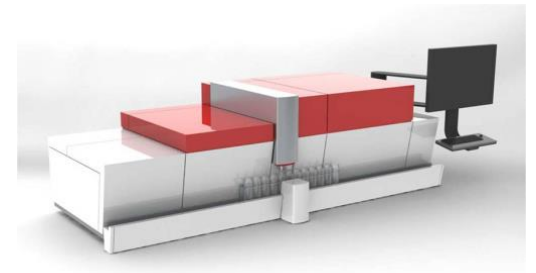
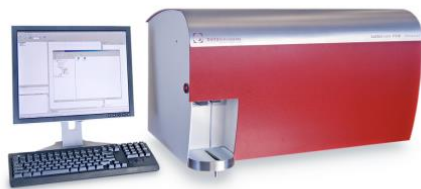
**Heather Dann, Rick Grant, & Dave Barbano**  
**Dairy Girl Network Webinar, September 21, 2018**



**Used world-wide to measure fat, protein,  
and lactose for payment and dairy herd  
improvement programs**

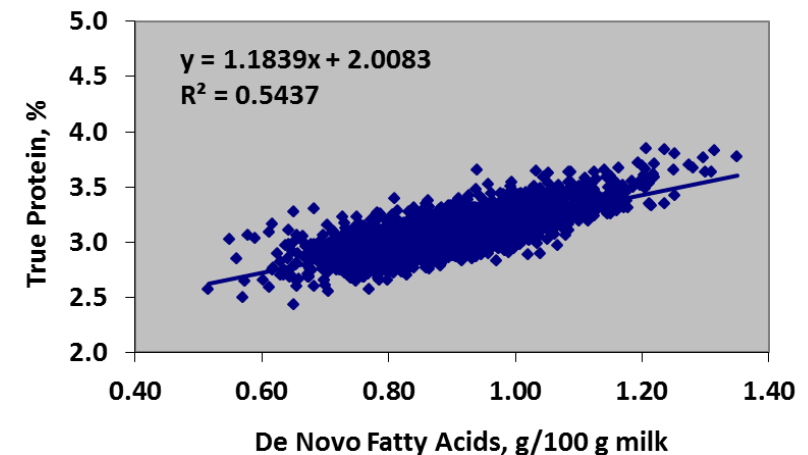
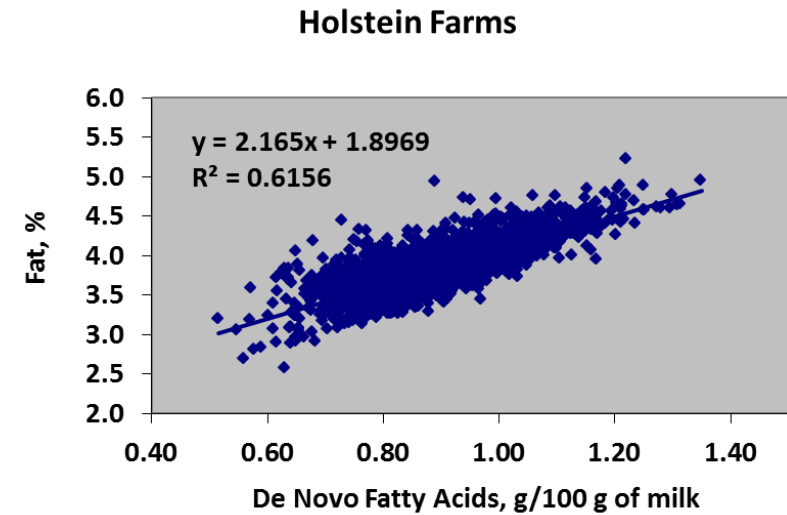


**Develop new tools in milk analysis for bulk tank using mid infrared technology to provide information to support decision making for feeding and general management of the herd**



# Key Findings from Monitoring 430 Farms over a 15-Month Period with Milk Fatty Acid Metrics

- Milk fat and protein increased when de novo fatty acids in milk increased
- Occurred for both Holstein and Jersey herds





# Bulk Tank Milk Report for Farmer & Consultant

| TRANS_DATE  | TANK | POUNDS | BFAT | PROT | LACT | TSOL  | SNF  | OSOL | CELL | MUN   | DEN  | MIX  | PREF | DBOND | RAW | PAST | PI | CRYO |
|-------------|------|--------|------|------|------|-------|------|------|------|-------|------|------|------|-------|-----|------|----|------|
| 07-MAR-2017 | 1    |        | 4.13 | 3.17 | 4.86 | 13.05 | 8.92 | 5.75 | 140  | 12.86 | 0.99 | 1.44 | 1.65 | 0.282 |     |      |    | 550  |
| 05-MAR-2017 | 1    | 15480  | 4.17 | 3.19 | 4.85 | 13.12 | 8.95 | 5.76 | 180  | 11.56 | 1.00 | 1.37 | 1.76 | 0.280 |     |      |    | 536  |
| 04-MAR-2017 | 1    | 15674  | 4.27 | 3.19 | 4.88 | 13.25 | 8.98 | 5.79 | 190  | 11.9  | 1.03 | 1.40 | 1.84 | 0.285 |     |      |    | 548  |
| 03-MAR-2017 | 1    | 15932  | 4.19 | 3.19 | 4.85 | 13.13 | 8.94 | 5.75 | 180  | 12.95 | 1.00 | 1.38 | 1.77 | 0.285 |     |      |    | 546  |
| 02-MAR-2017 | 1    | 15846  | 4.04 | 3.15 | 4.88 | 12.97 | 8.93 | 5.78 | 110  | 13.16 | 0.98 | 1.29 | 1.76 | 0.289 |     |      |    | 536  |
| 01-MAR-2017 | 1    | 15824  |      |      |      |       |      |      |      |       |      |      |      |       | 3   | 5    | 15 |      |
| 28-FEB-2017 | 1    | 16018  | 4.13 | 3.16 | 4.87 | 13.03 | 8.9  | 5.74 | 110  | 12.85 | 0.96 | 1.44 | 1.58 | 0.282 |     |      |    | 538  |
| 27-FEB-2017 | 1    | 15695  | 4.1  | 3.21 | 4.88 | 13.12 | 9.02 | 5.81 | 100  | 13.28 | 1.04 | 1.33 | 1.79 | 0.268 |     |      |    | 544  |
| 26-FEB-2017 | 1    | 15889  | 4.16 | 3.17 | 4.9  | 13.12 | 8.96 | 5.79 | 140  | 13.04 | 0.97 | 1.49 | 1.58 | 0.285 |     |      |    | 543  |
| 25-FEB-2017 | 1    | 15738  | 4.2  | 3.17 | 4.88 | 13.13 | 8.93 | 5.76 | 120  | 13.17 | 0.94 | 1.54 | 1.55 | 0.283 |     |      |    | 544  |
| 24-FEB-2017 | 1    | 15824  | 4.16 | 3.15 | 4.88 | 13.08 | 8.92 | 5.77 | 130  | 13.9  | 0.94 | 1.53 | 1.51 | 0.293 |     |      |    | 542  |
| 23-FEB-2017 | 1    | 16039  | 4.12 | 3.16 | 4.89 | 13.04 | 8.92 | 5.76 | 120  | 13.04 | 0.92 | 1.54 | 1.46 | 0.292 |     |      |    | 547  |
| 22-FEB-2017 | 1    | 16104  | 4.22 | 3.16 | 4.85 | 13.11 | 8.89 | 5.73 | 90   | 13.09 | 0.92 | 1.52 | 1.55 | 0.295 |     |      |    | 544  |
| 21-FEB-2017 | 1    | 15588  | 4.28 | 3.17 | 4.85 | 13.17 | 8.89 | 5.72 | 120  | 13.95 | 0.94 | 1.61 | 1.47 | 0.284 |     |      |    | 545  |
| 20-FEB-2017 | 1    | 16125  | 4.2  | 3.17 | 4.85 | 13.08 | 8.88 | 5.71 | 110  | 13.42 | 0.92 | 1.56 | 1.49 | 0.291 |     |      |    | 544  |
| 19-FEB-2017 | 1    | 15996  | 4.26 | 3.16 | 4.83 | 13.1  | 8.84 | 5.68 | 150  | 11.61 | 0.92 | 1.64 | 1.46 | 0.277 |     |      |    | 544  |

# Testing Facilities For Milk Fatty Acid Metrics

(MIR Spectroscopy)

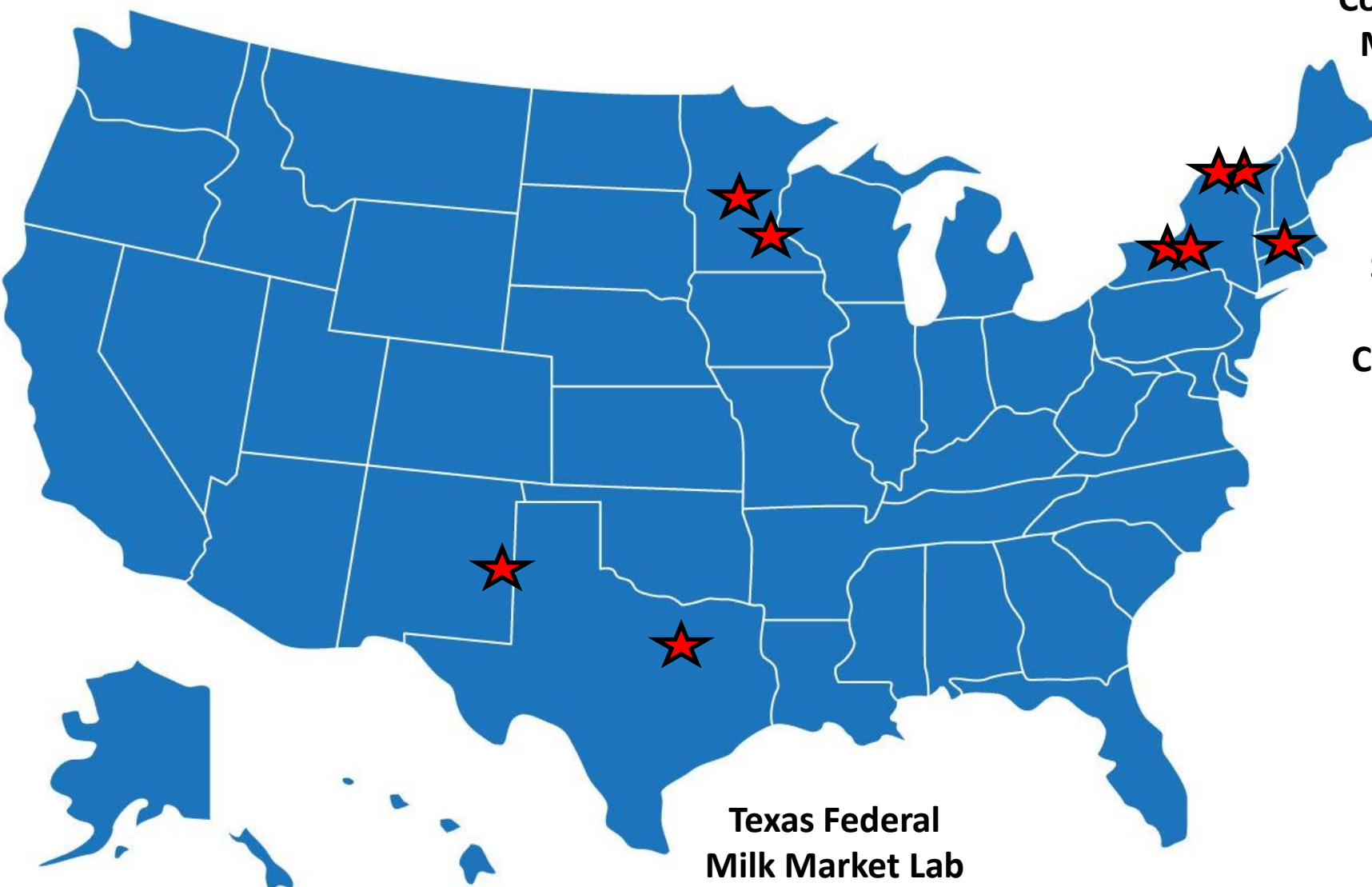
**Sterns County &  
Zumbrota MN  
DHIA Labs**

**ADM DHIA Lab**

**Texas Federal  
Milk Market Lab**

**Cornell University  
Miner Institute**

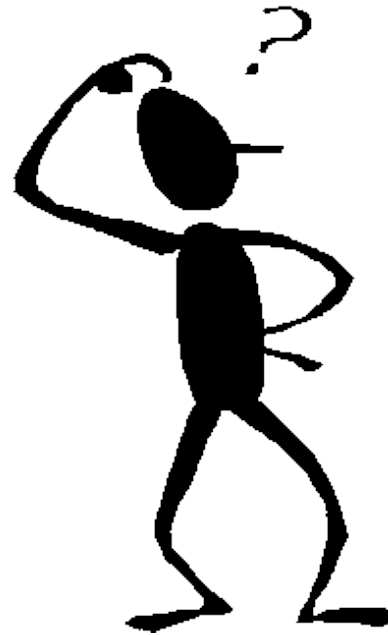
**St. Albans Coop  
AgriMark Coop  
Cayuga Marketing  
Coop**



# What are Milk Fatty Acid Metrics? Are They Useful?

*De Novo Fatty Acids*

*Mixed Fatty Acids*



*Relative %*

*g/100 g milk*

*Double Bonds per Fatty  
Acid*

*Unsaturation Index*

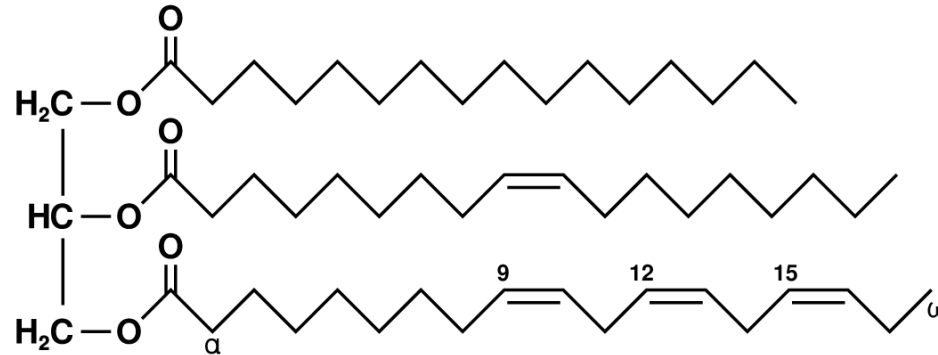
*Preformed Fatty Acids*



# Milk Fat Composition

## Most Variable Component of Milk

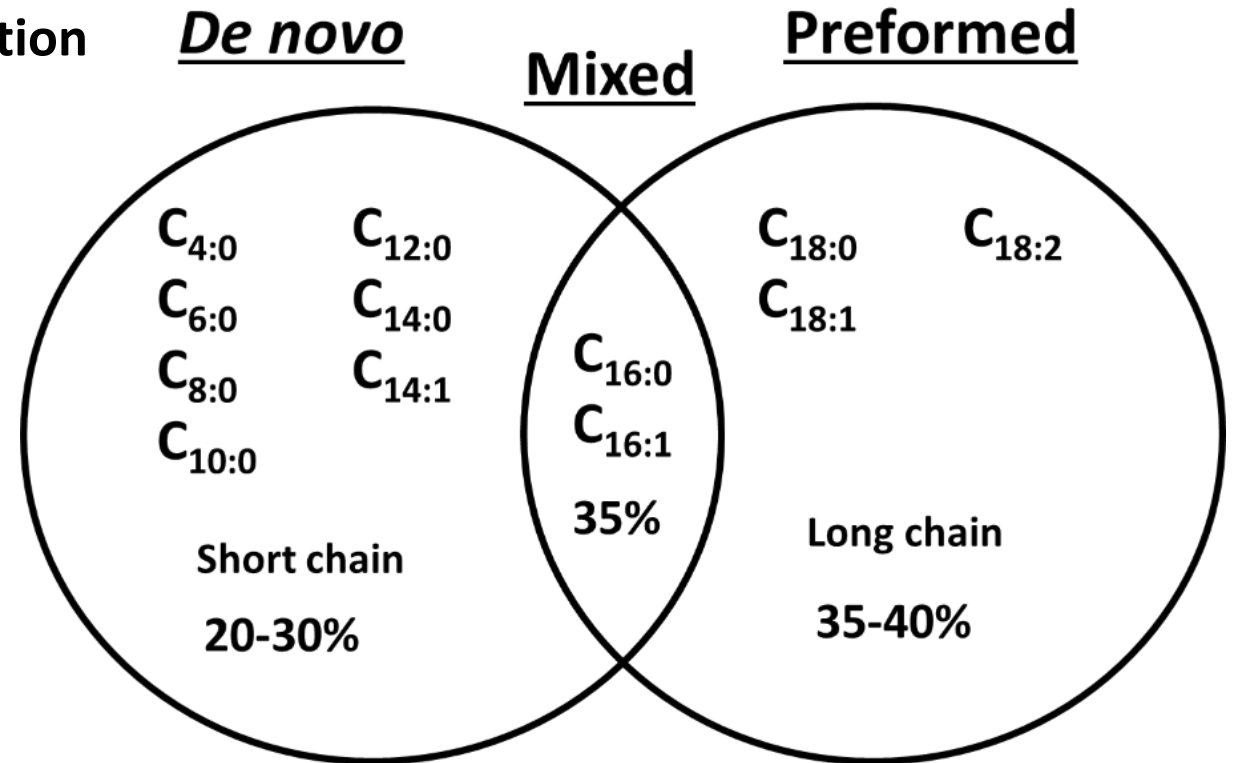
- **98% triglycerides**



- **More than 400 unique fatty acids (FA) in milk (GC analysis)**
- **About 20 FA make up the majority**
  - **Broadly grouped into 3 subcategories**

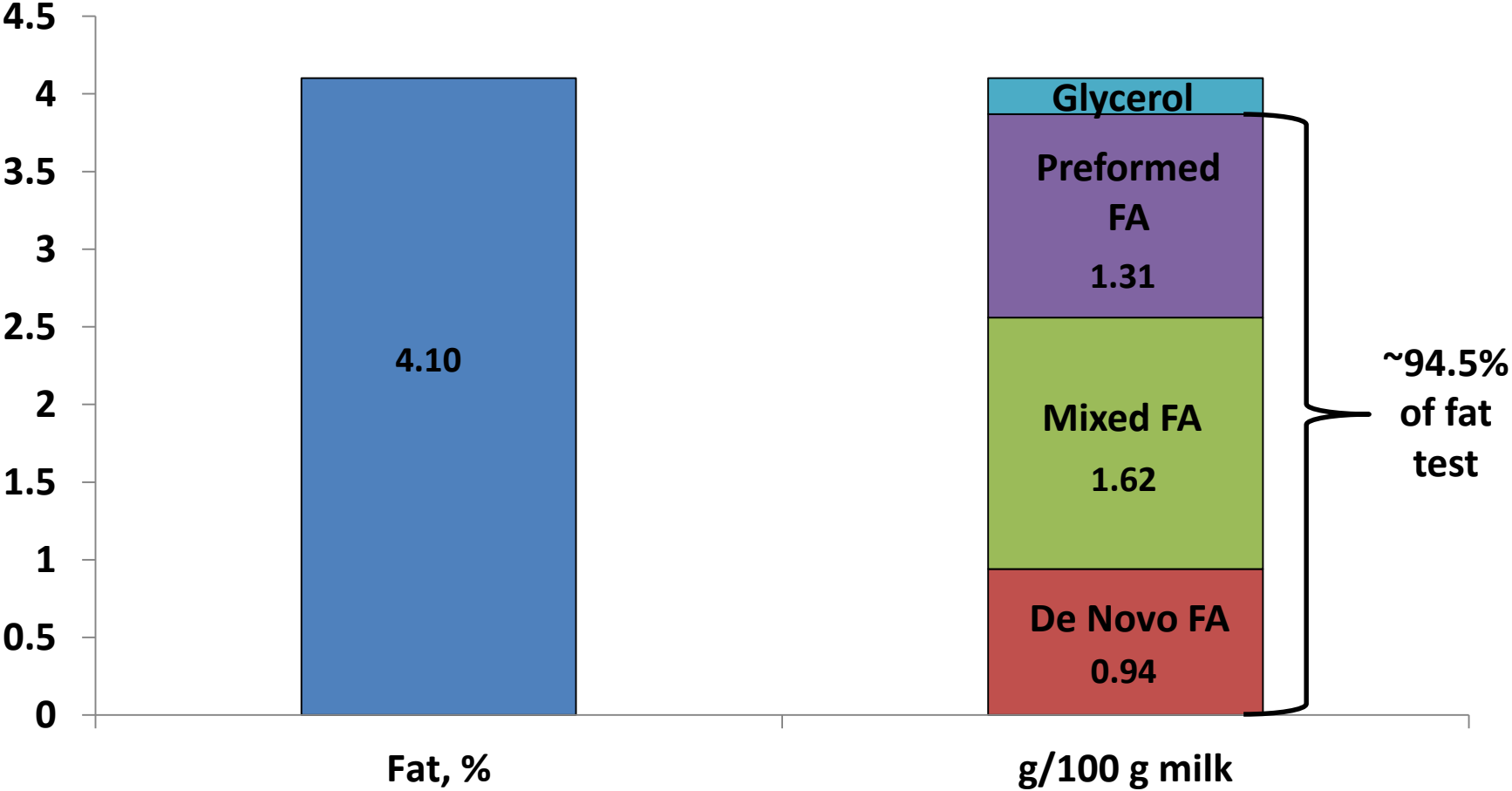
# Milk Fatty Acid (FA) Groups

- **De novo FA - < C16**
  - Made in the mammary gland
  - Influenced by rumen fermentation/function
  - 18-30 relative % (21-26)
- **Preformed FA - > C16**
  - From fat the diet
  - From body fat mobilization
  - 32-42 relative % (35-42)
- **Mixed origin FA - C16**
  - From fat the diet (preformed)
  - Made in the mammary gland (de novo)
  - 30-40 relative % (35-42)



Courtesy of M. Woolpert

# Fat and Fatty Acid Groups – Relationship in Bulk Tank Milk



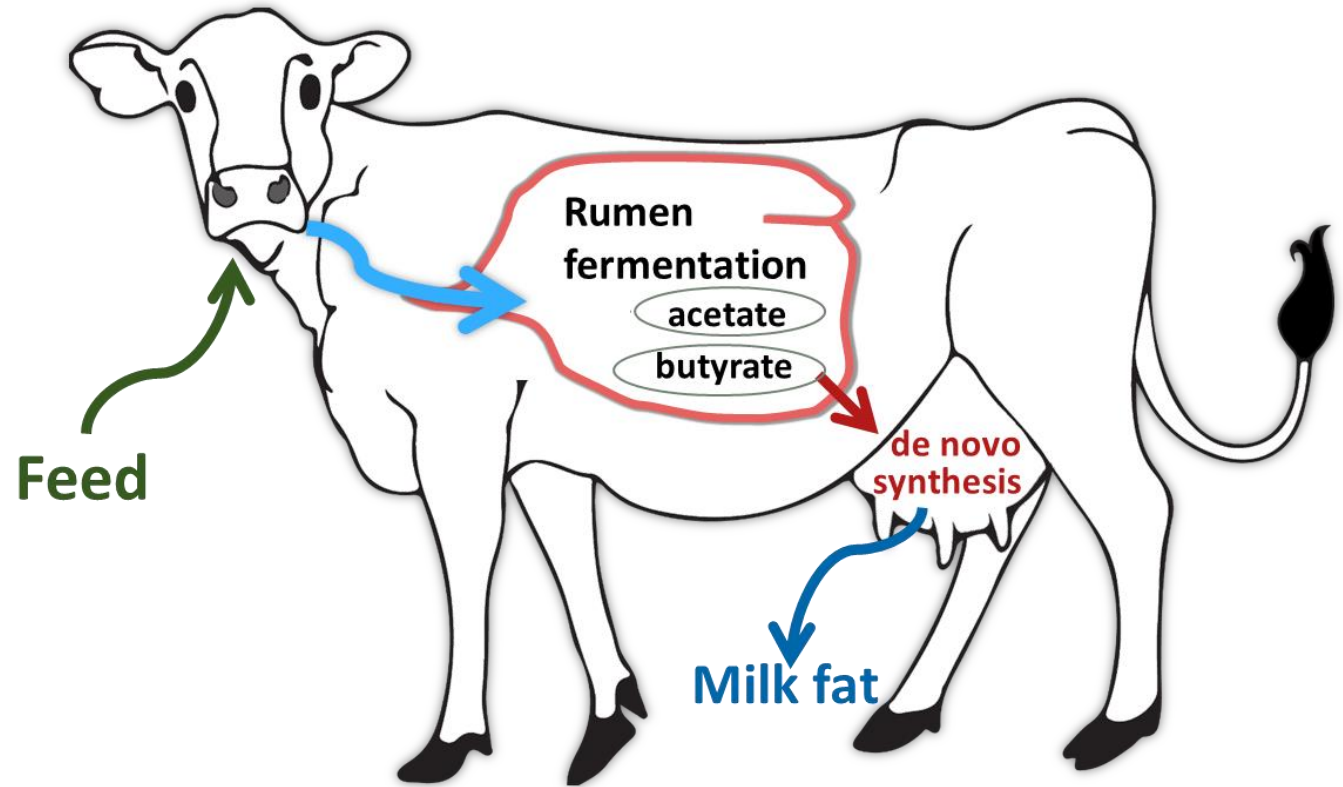
# Milk Fatty Acid Profiles Provide Insight: Performance and Health of Cow/Herd

- **Profile of de novo, mixed, and preformed fatty acids reflect:**
  - **Diet and dietary changes**
    - CHO fermentability, RUFAL, forages...
  - **Management environment**
    - Behavior, rumen pH
    - Physiological state of cow
    - Risk of milk fat depression
    - Energy balance
    - Stage of lactation



# Focus on De Novo Fatty Acids...

- De novo fatty acids reflect rumen function – especially fiber fermentation
- Acetate and butyrate are building blocks

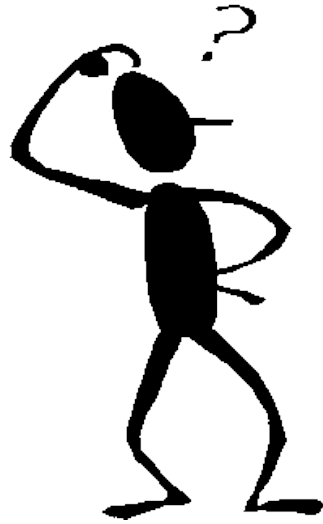


Courtesy of M. Woolpert

# Focus on De Novo Fatty Acids...

- **Rumen conditions that enhance microbial fermentation stimulate microbial protein production and increase milk protein content**
- **De novo fatty acids in milk fat tells us how well the cow is being fed and managed for optimal rumen fermentation conditions**

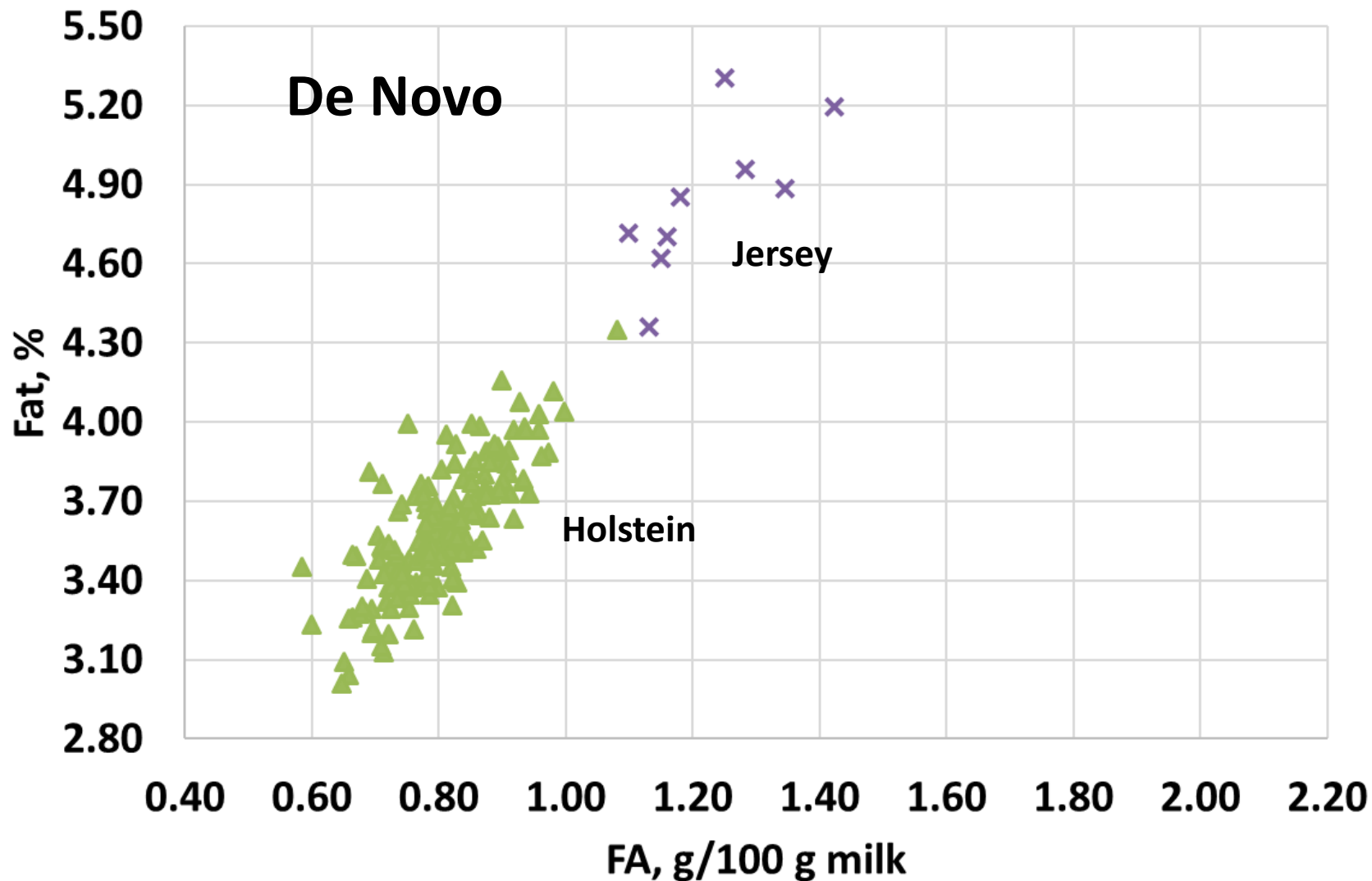
# How Should We Use Milk Fatty Acid Metrics?



- Herd “snapshot” and troubleshooting
- Evaluating changes over time

# Troubleshooting Herds

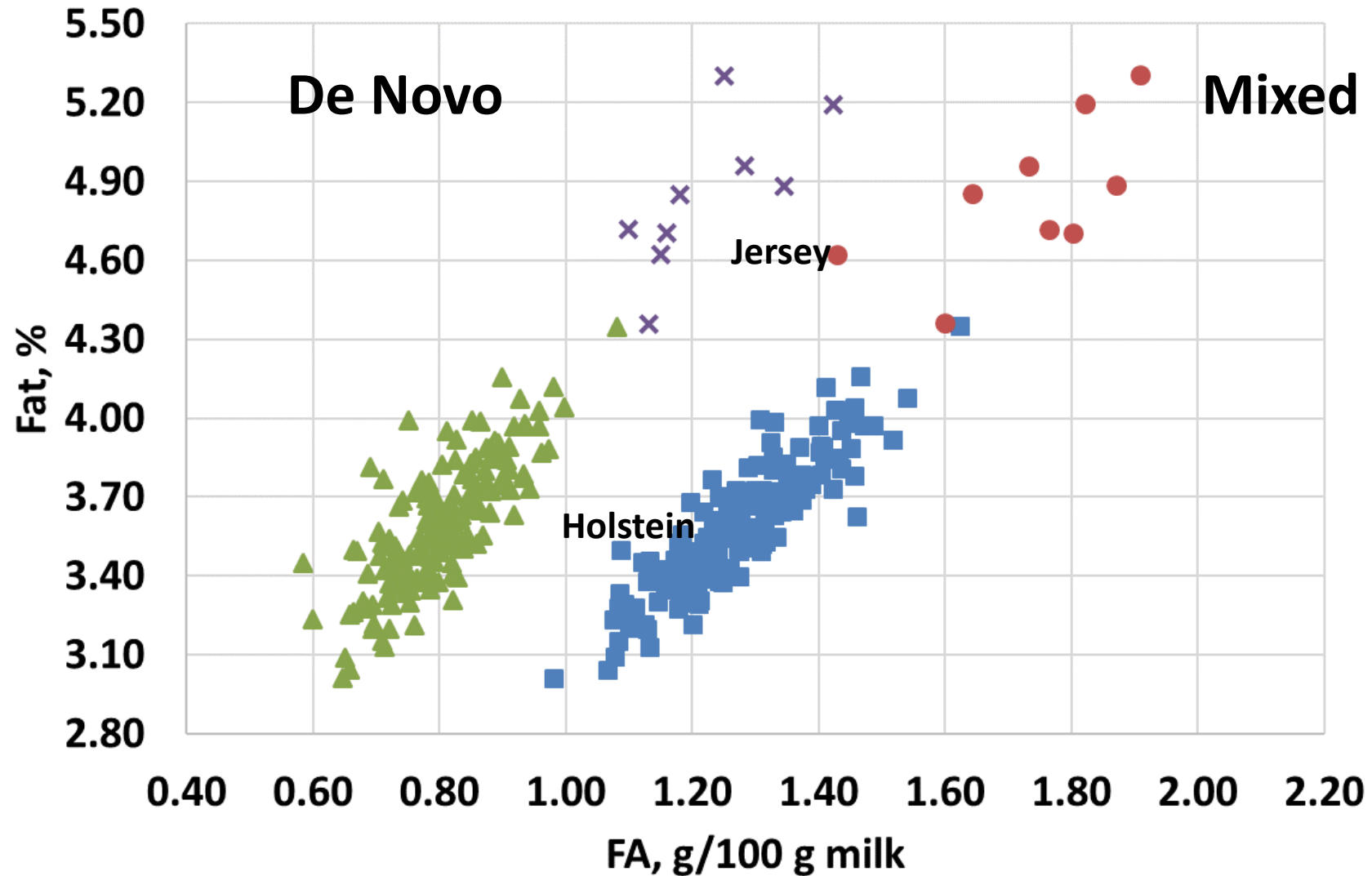
Milk Samples over Multiple Days, Herd Average Plotted





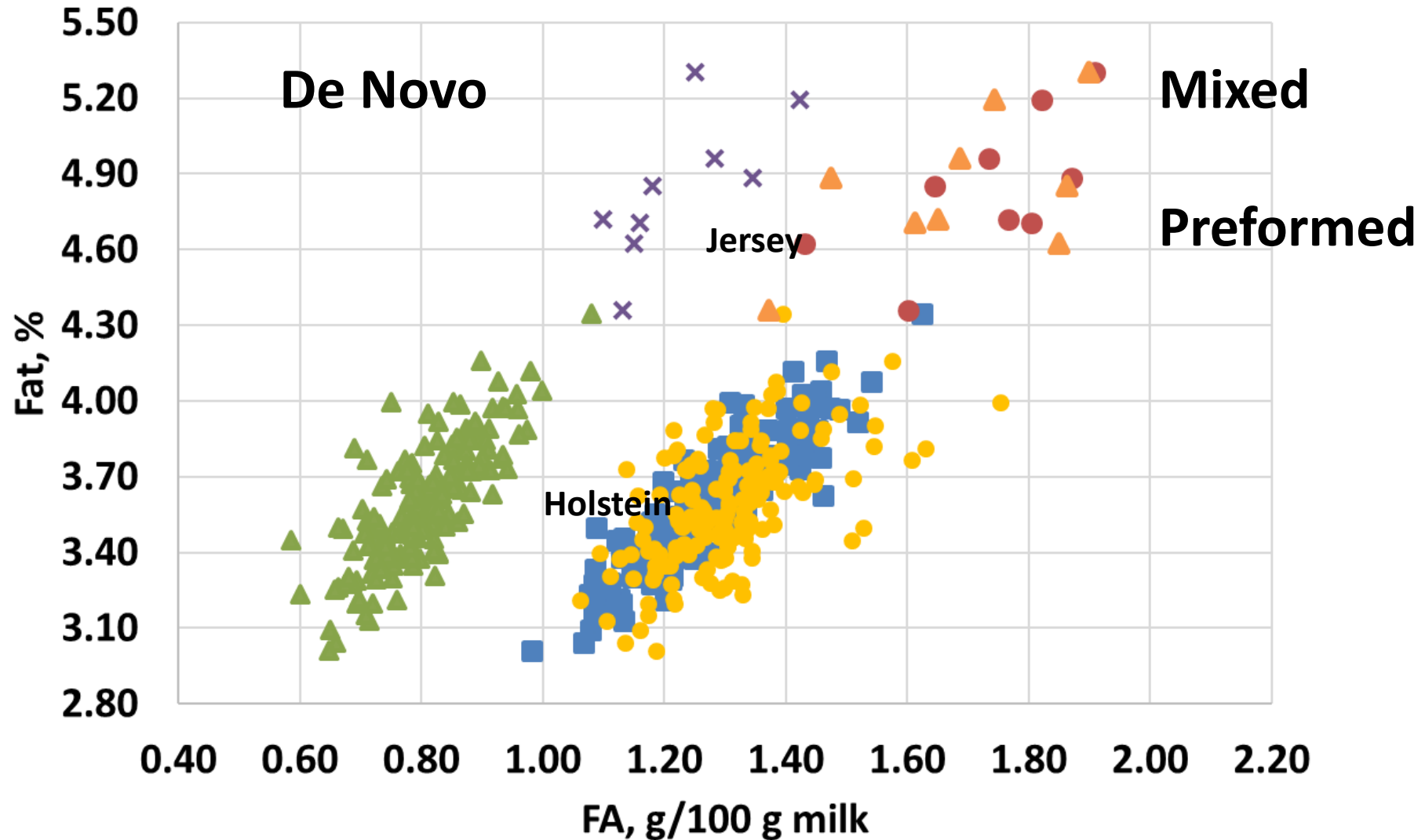
# Troubleshooting Herds

Milk Samples over Multiple Days, Herd Average Plotted



# Troubleshooting Herds

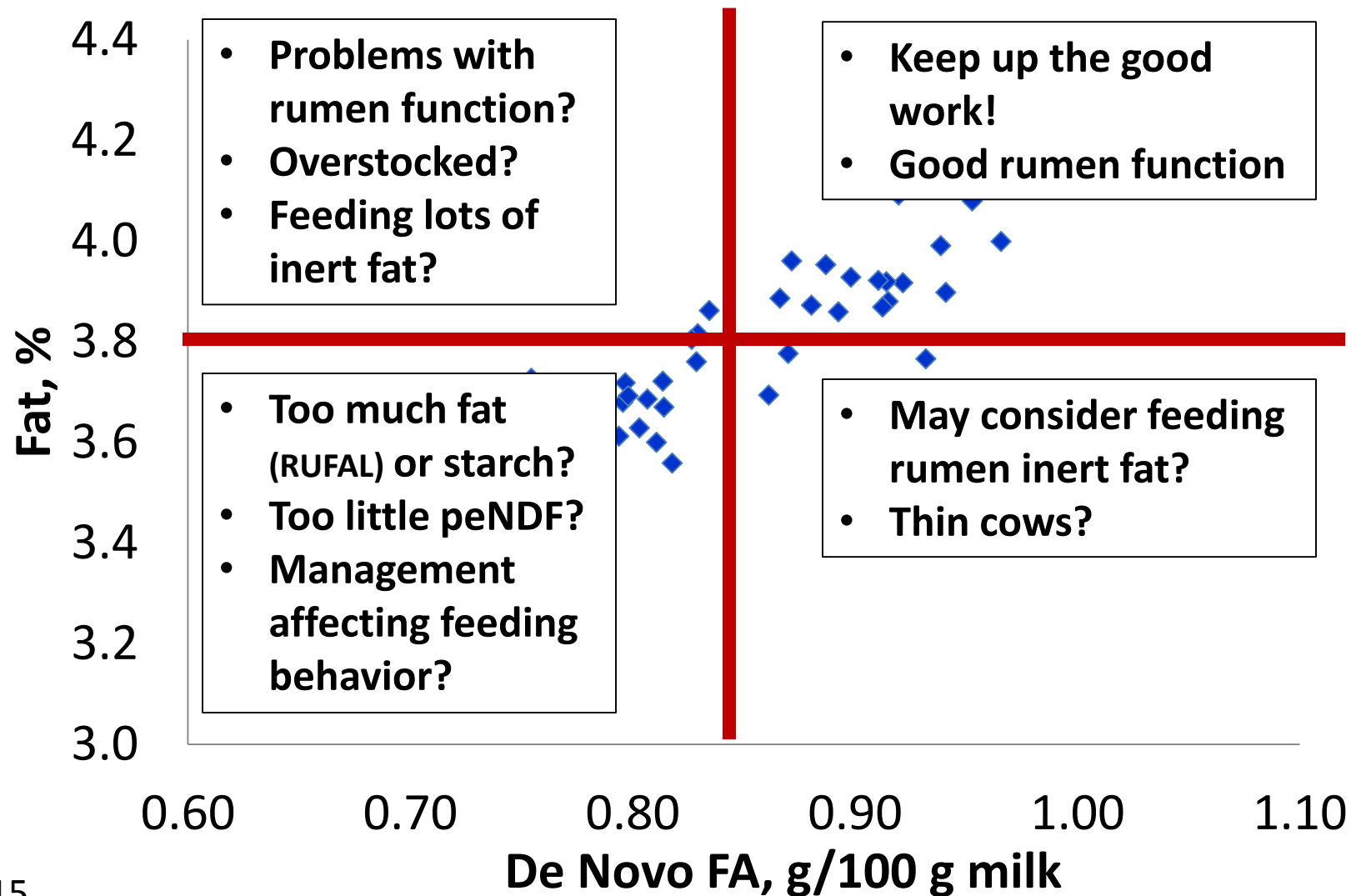
Milk Samples over Multiple Days, Herd Average Plotted



# Prediction of Fat % (Y) From Milk Fatty Acid Metrics (X)

|                                     | De Novo FA, g/100 g milk             | Mixed Origin FA, g/100 g milk        | Preformed FA, g/100 g milk           | Unsaturation, DB/FA                   |
|-------------------------------------|--------------------------------------|--------------------------------------|--------------------------------------|---------------------------------------|
| 40 Holstein Herds (St. Albans 2015) | $Y = 2.297X + 1.844$<br>$R^2 = 0.80$ | $Y = 1.540X + 1.586$<br>$R^2 = 0.88$ | $Y = 0.793X + 2.774$<br>$R^2 = 0.07$ | $Y = -8.583X + 6.421$<br>$R^2 = 0.69$ |
| 167 Holstein Herds (US 2016-2017)   | $Y = 2.233X + 1.800$<br>$R^2 = 0.61$ | $Y = 1.892X + 1.179$<br>$R^2 = 0.79$ | $Y = 1.289X + 1.911$<br>$R^2 = 0.35$ | $Y = -7.449X + 5.971$<br>$R^2 = 0.31$ |

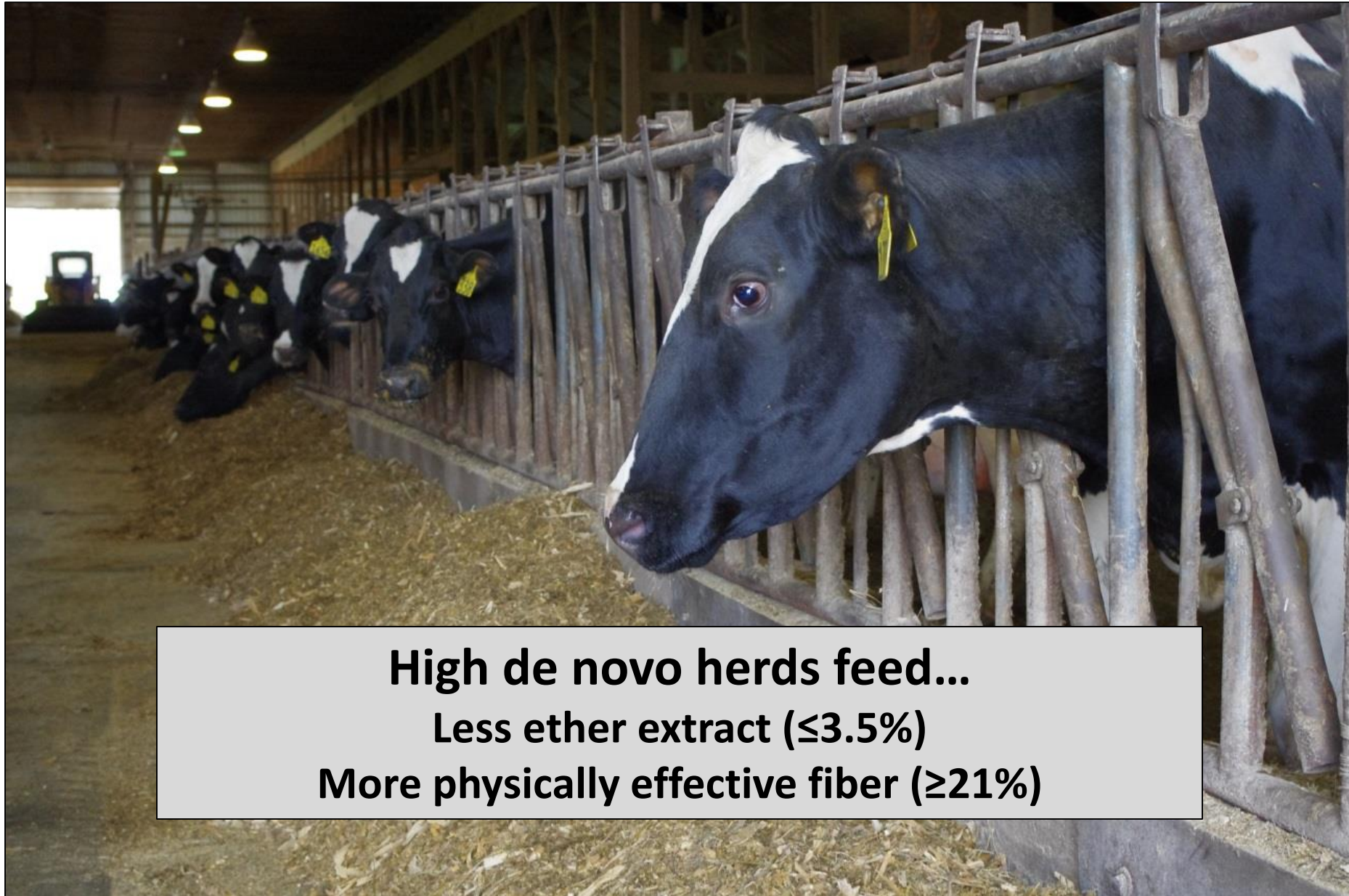
# Expected vs Actual Results – A Holstein Example with a Goal of 3.8% Fat



# Research Conducted on St. Albans Coop Herds

Better Understand Management and Nutrition Differences between Herds with High and Low De Novo Fatty Acids

|                                       | High | Low  |
|---------------------------------------|------|------|
| <b>2014 – Holstein, Jersey, mixed</b> |      |      |
| Fat, %                                | 4.55 | 3.90 |
| True protein, %                       | 3.50 | 3.16 |
| De novo FA, g/100 g milk              | 1.13 | 0.90 |
| Mixed FA, g/100 g milk                | 1.65 | 1.36 |
| Preformed FA, g/100 g milk            | 1.52 | 1.43 |
| <b>2015 – Holstein</b>                |      |      |
| Fat, %                                | 3.96 | 3.75 |
| True protein, %                       | 3.19 | 3.10 |
| De novo FA, g/100 g milk              | 0.92 | 0.81 |
| Mixed FA, g/100 g milk                | 1.53 | 1.41 |
| Preformed FA, g/100 g milk            | 1.27 | 1.30 |



**High de novo herds feed...  
Less ether extract ( $\leq 3.5\%$ )  
More physically effective fiber ( $\geq 21\%$ )**

**High de novo herds tend to be...**

**5x more likely to delivery feed 2x/d in freestall**

**11x more likely to delivery feed 5x/d in tiestalls**

Woolpert et al., 2016; Woolpert et al., 2017



**High de novo herds tend to be...**

**10x more likely to provide  $\geq 18$  in bunk space/cow**

**5x more likely to stock stalls at  $\leq 110\%$**





# Need to Get the Diet and the “Dining Experience” Right

**Must focus on**  
**diet formulation**  
**&**  
**management**  
**environment**



# Factors Associated with Increased Risk of Milk Fat Depression

## Diet Factors

- **Fermentable carbohydrates**
  - Starch
  - Forage fiber
  - peNDF
- **Fats (RUFAL)**
  - C18:1 + C18:2 + C18:3
  - < 3.5% of diet DM
- **Feed additives (+/-)**
- **Yeasts/molds**

## Cow/Environment/Management Factors

- **Genetics**
- **Parity**
- **Days in milk**
- **Season**
- **Time budget (behavior)**
  - Stocking density
- **Feeding strategy**
  - TMR vs. PMR vs. component
  - Frequency of feed delivery/push up

# Soybeans, RUFAL, and Low Milk Fat

- **Snapshot: ~3.4 to 3.5% fat**
  - 0.77 g de novo FA/100 g milk
  - 1.09 g mixed FA/100 g milk
  - 1.30 g preformed FA/100 g milk
  - 0.35 double bonds/FA
- **Problem: Diet too high in RUFAL**
  - Use of home grown roasted soybean
  - Ground extremely fine with hammer mill

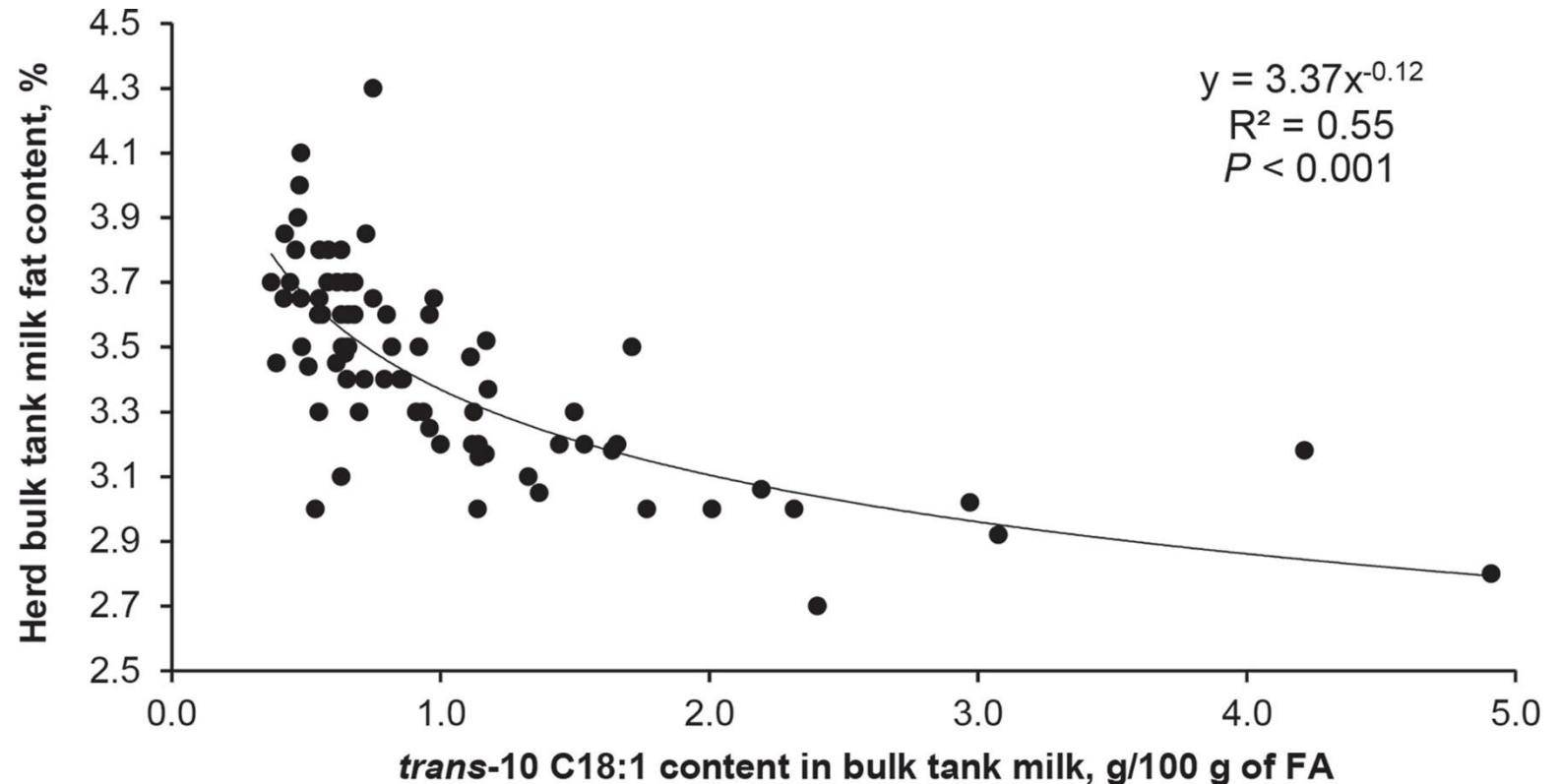
- **Solution: ↑ grind size**



- **Outcome: ≥ 3.7% fat**
  - 0.94 g de novo FA/100 g milk
  - 1.18 g mixed FA/100 g milk
  - 1.56 g preformed FA/100 g milk
  - 0.31 double bonds/FA

# Herd Level Risk Factors for Milk Fat Depression

- 79 herds feeding monensin in the NE and MW US
- Several *trans*-C18:1 fatty acids (products of alternate pathways of ruminal biohydrogenation) were negatively related to herd milk fat
- Milk fat content of fatty acids synthesized de novo in the mammary gland were positively related to bulk tank milk fat



# **Herd Level Risk Factors for Milk Fat Depression: Relationship with TMR Composition**

- **No single diet component accounted for more than 11% of the variation in herd level milk fat percentage**
- **4 factors together (starch content, monensin, PUFA, and MUFA) only accounted for 32% of the variation in herd milk fat percentage**
- **Indicates many variables contribute to low milk fat and herds experiencing low milk fat will need to examine many potential risk factors when working to troubleshoot milk fat depression**

# Milk Fat Depression Timeline When Feeding “High Risk” Diets

## Induction

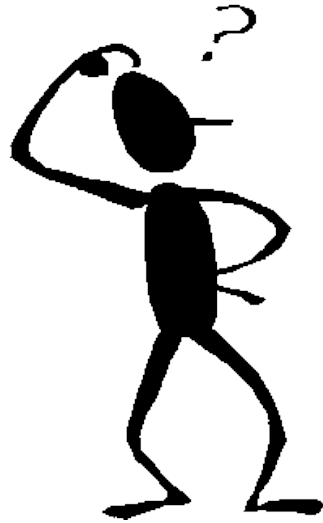
- When did the problem start?
- After a diet change – 7 to 10 day lag
- Consider diet PUFA, CHO fermentability, rumen modifiers, feeding management

## Recovery of Milk Fat

- When should it improve?
- After a diet change – 10 to 14 days



# How Should We Use Milk Fatty Acid Metrics?



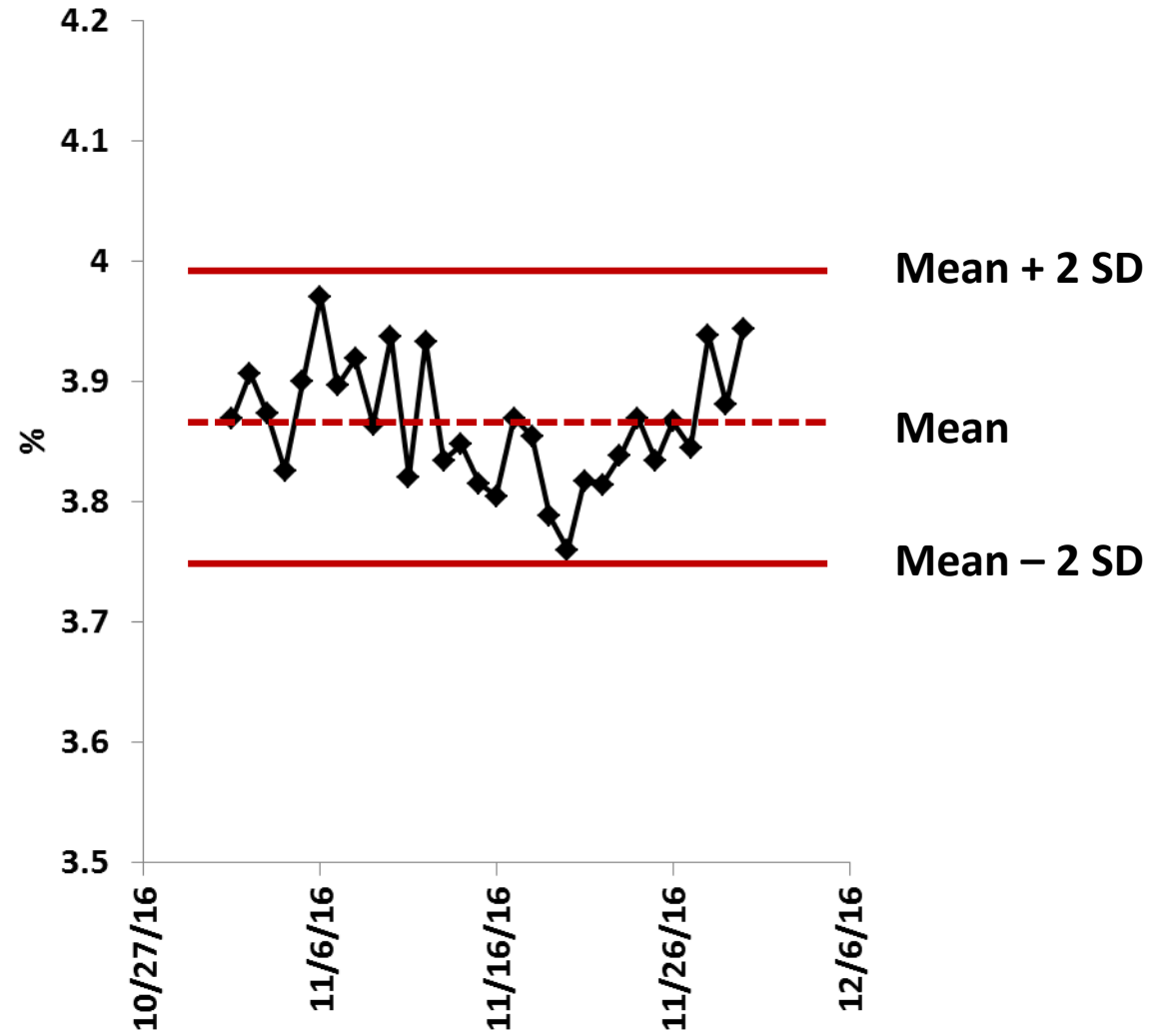
- Herd “snapshot” and troubleshooting
- Evaluating changes over time

# Monitor Fatty Acid Metrics in Bulk Tank Milk for Changes Over Time

| Fatty Acid Metric  | Increases   | Decreases  |
|--------------------|---|--|
| De novo FA         | <ul style="list-style-type: none"> <li>• Positive impact on milk fat and/or protein</li> <li>• Response to improved rumen function and/or feed quality</li> </ul> | <ul style="list-style-type: none"> <li>• Evaluate management and nutrition</li> <li>• Did an unexpected change occur?</li> </ul> |
| Mixed origin FA    | <ul style="list-style-type: none"> <li>• Response to increased dietary fat</li> <li>• Possible response to de novo synthesis</li> </ul>                           | <ul style="list-style-type: none"> <li>• Evaluate management and nutrition</li> <li>• Did an unexpected change occur?</li> </ul> |
| Preformed FA       | <ul style="list-style-type: none"> <li>• Response to more body fat mobilization or increased dietary fat</li> </ul>   | <ul style="list-style-type: none"> <li>• Milk fat may decrease</li> <li>• Energy partitioning change</li> </ul>                  |
| Unsaturation Index | <ul style="list-style-type: none"> <li>• Greater risk for milk fat depression</li> </ul>  |  |

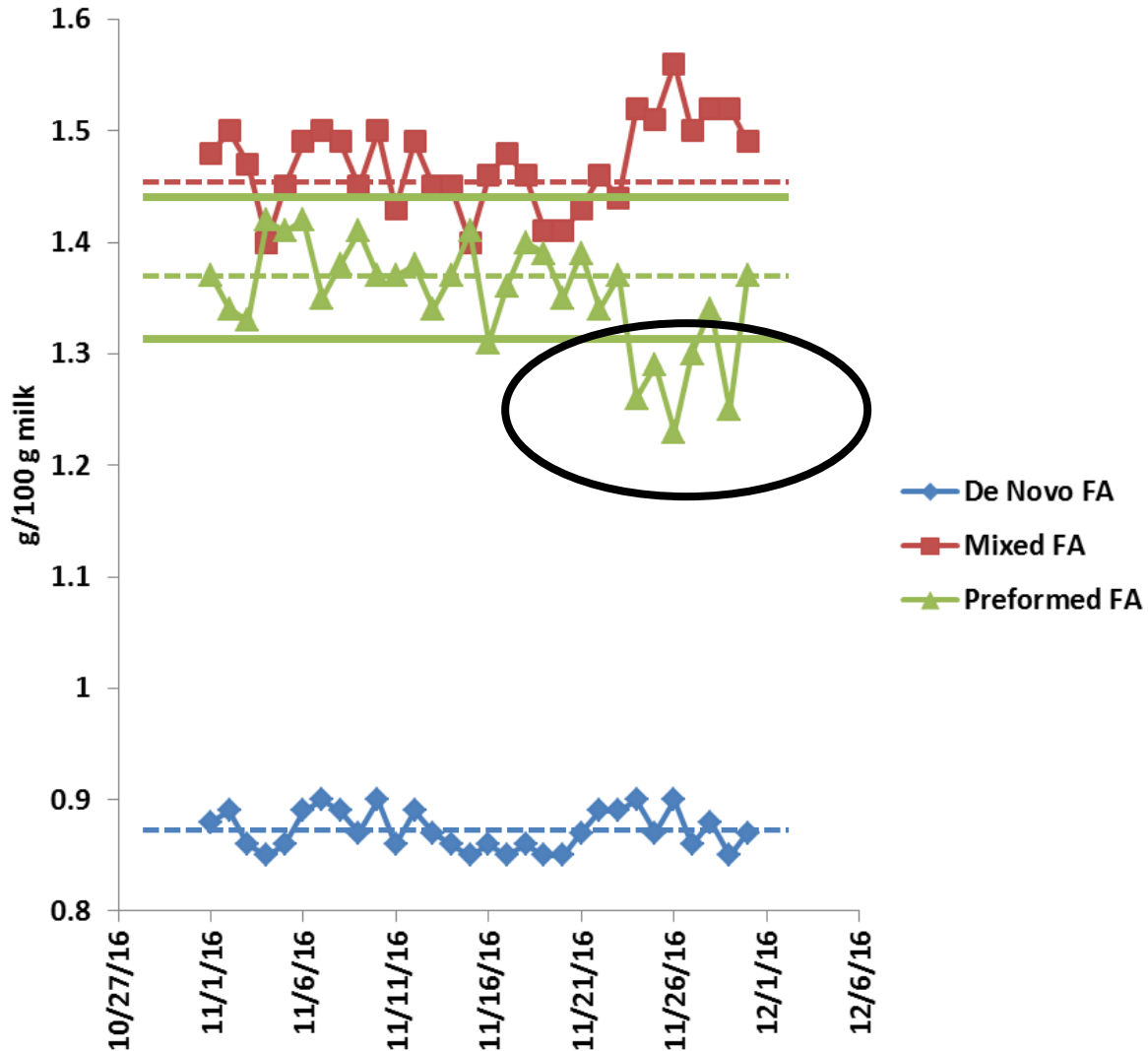


# Fat %

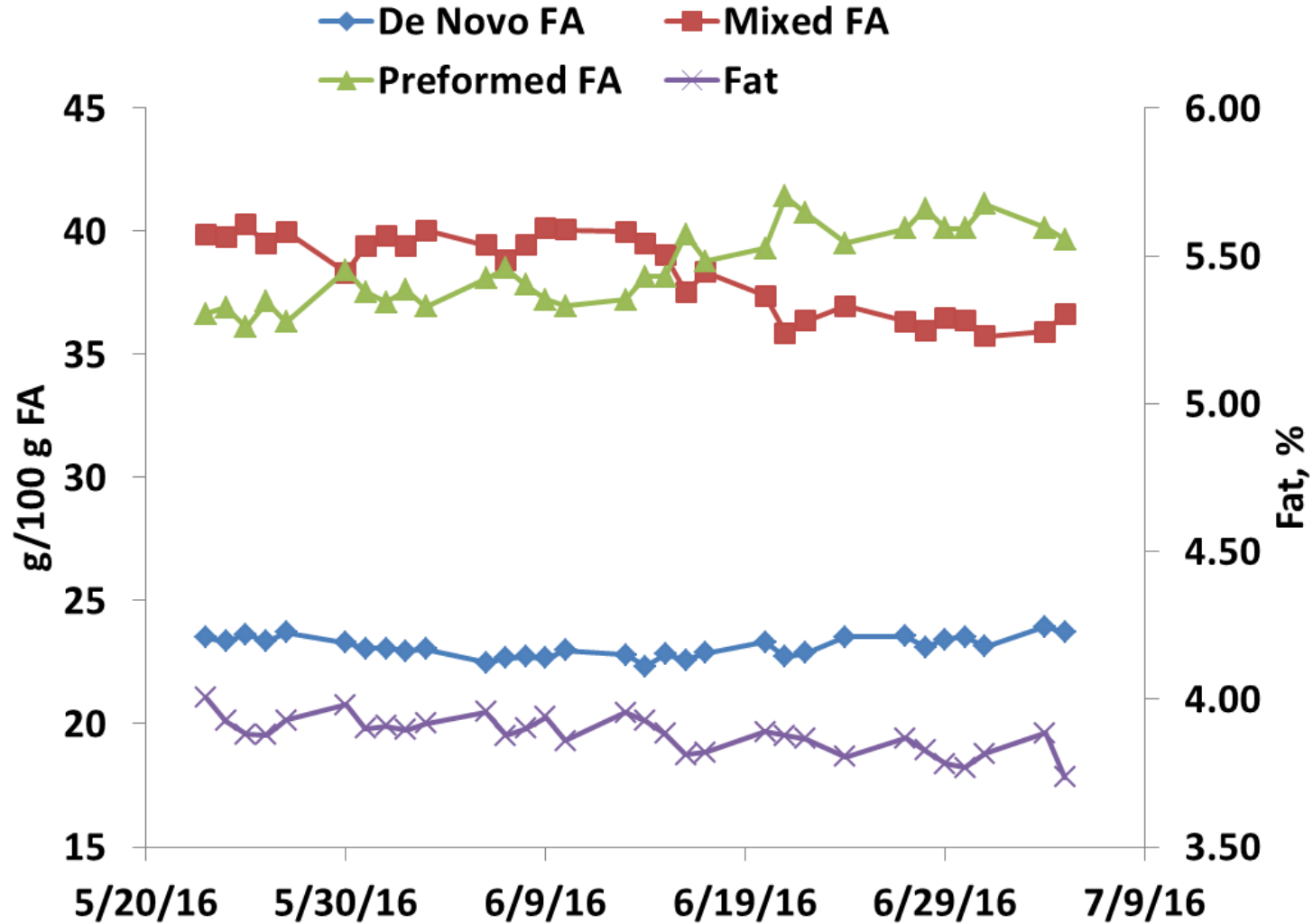


# Variation in November... Diet Changed

(More BMR CS and Different Feeder)



# Forage Quality Changed Unexpectedly



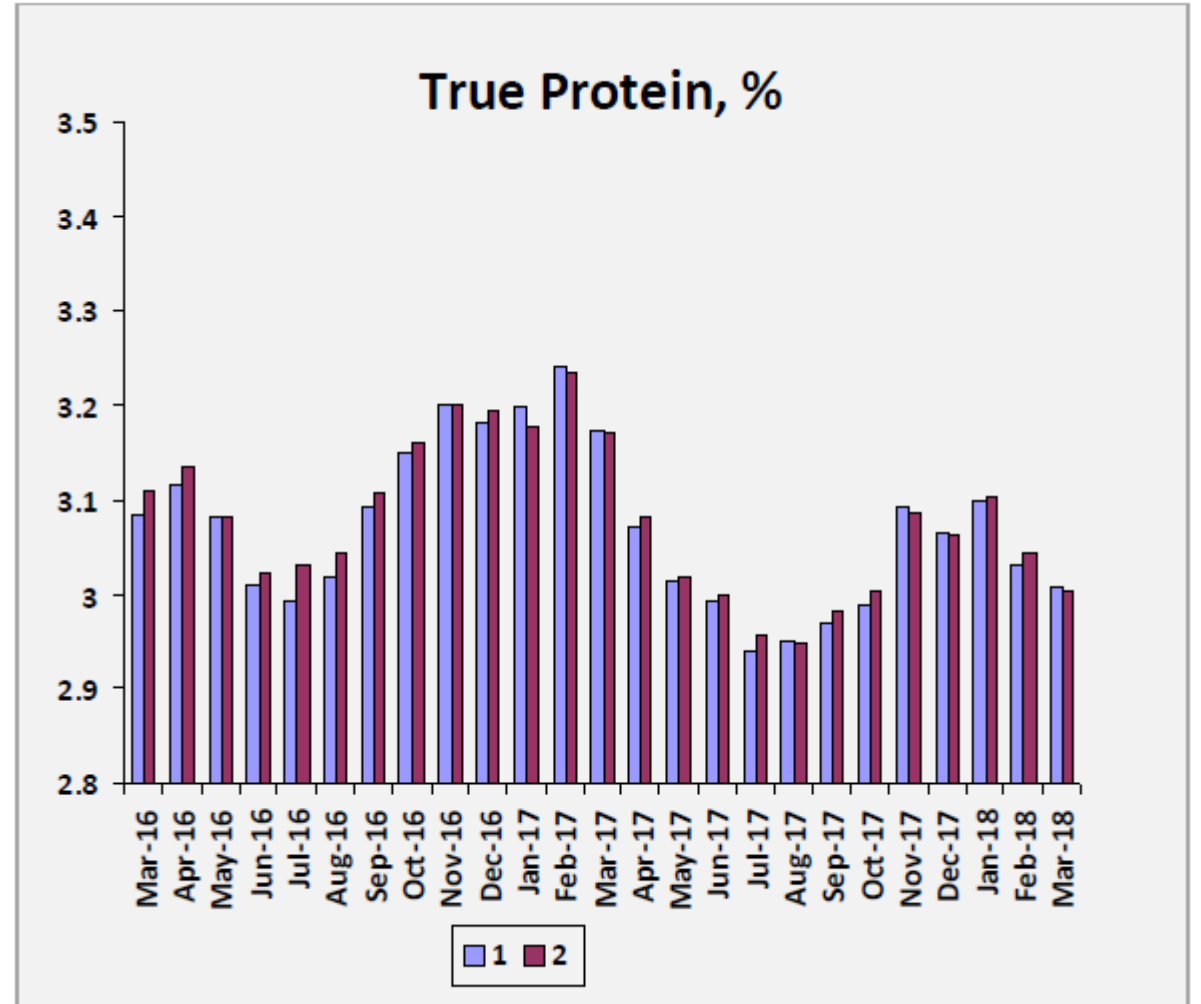
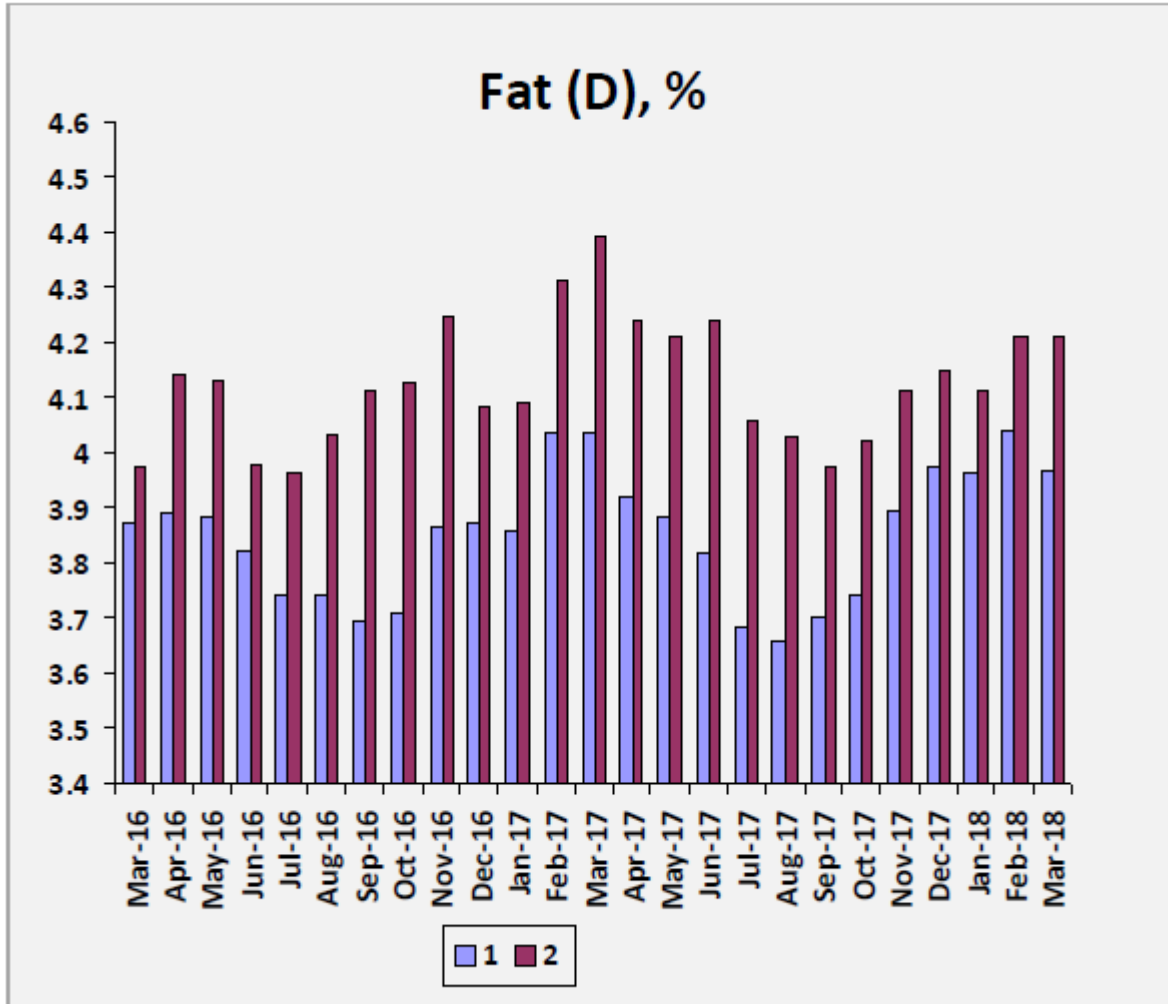
# Factors Affecting Variation Within & Between Herds

- Management related to feeding, housing, and milking of cows
- Diet and feed quality
- Consistency in day to day routine
  - Affects time budget of cow
- Days off and vacations
- Weather and season changes
- Herd demographics (parity, DIM)
- Filling sequence of multiple tanks

# Monthly Averages for Tank 1 and 2

Tank 1: 4:30 am, 8:30 pm

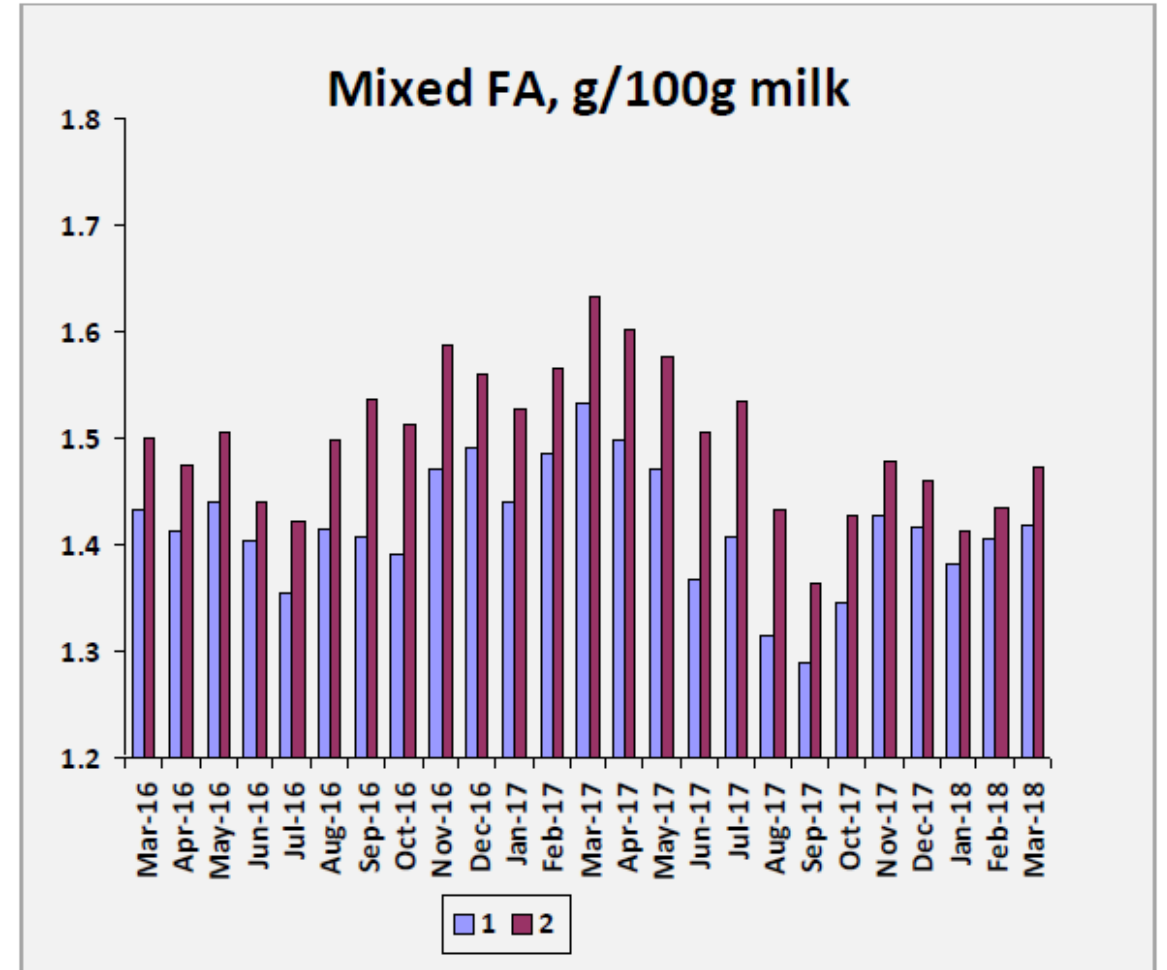
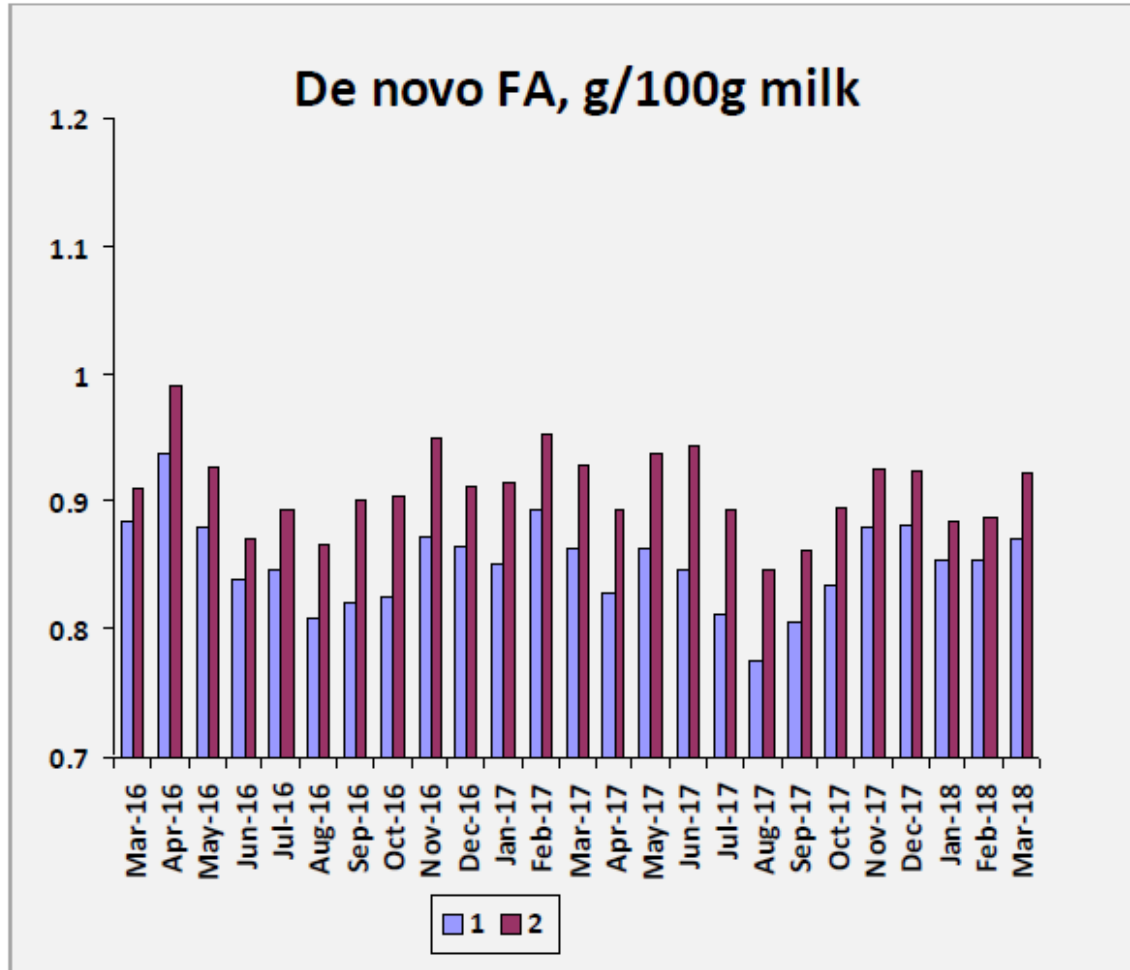
Tank 2: 12:30 pm



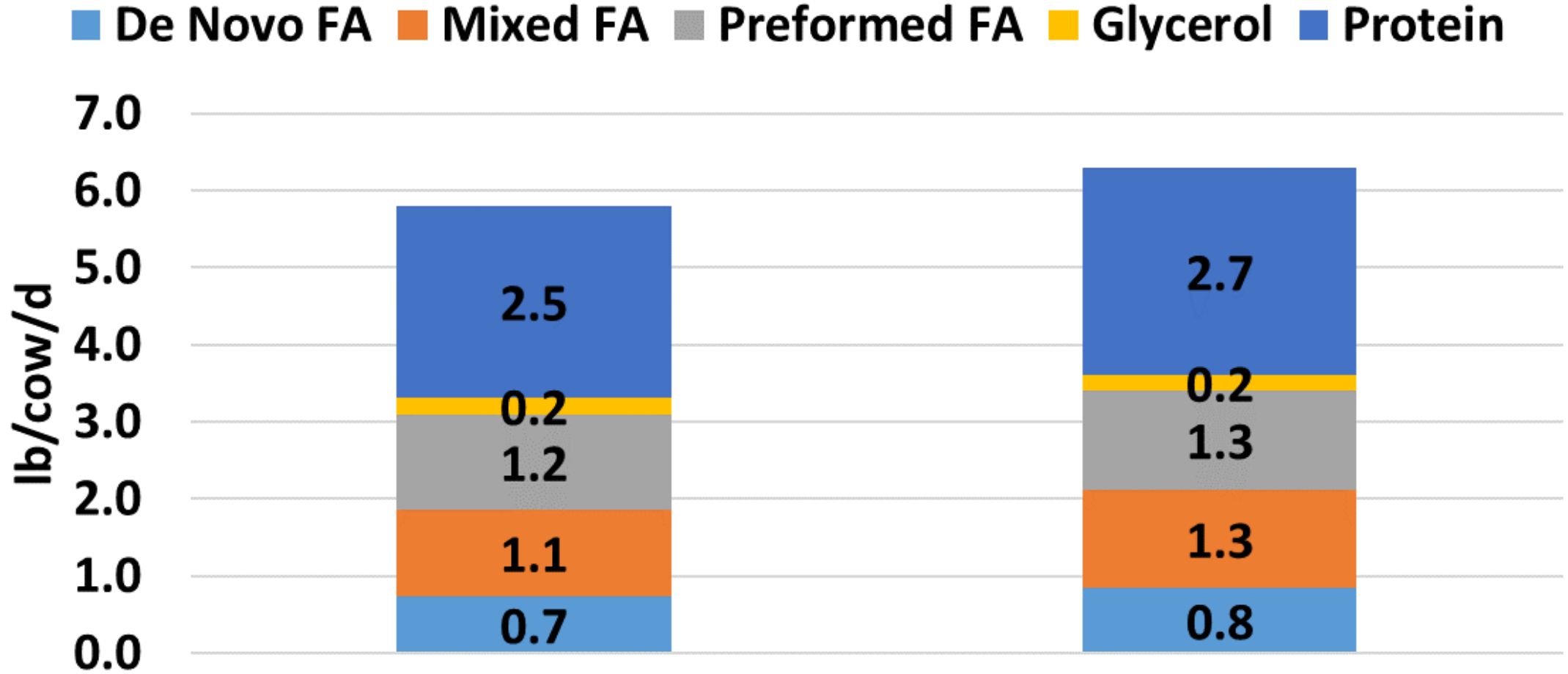
# Monthly Averages for Tank 1 and 2

Tank 1: 4:30 am, 8:30 pm

Tank 2: 12:30 pm



# Milk Solids



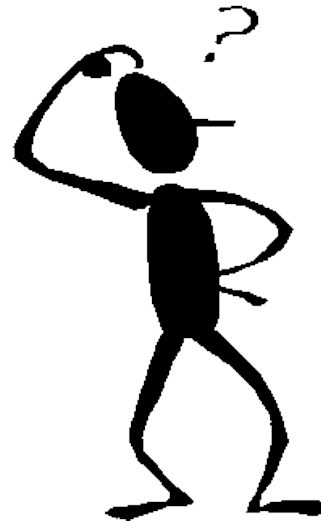
**Dec-17**  
86 lb milk, 3.85% fat,  
2.90% protein

**Jan-18**  
90 lb milk, 4.00% fat,  
3.00% protein

# What Else is Needed to Interpret Milk Fatty Acid Metrics?

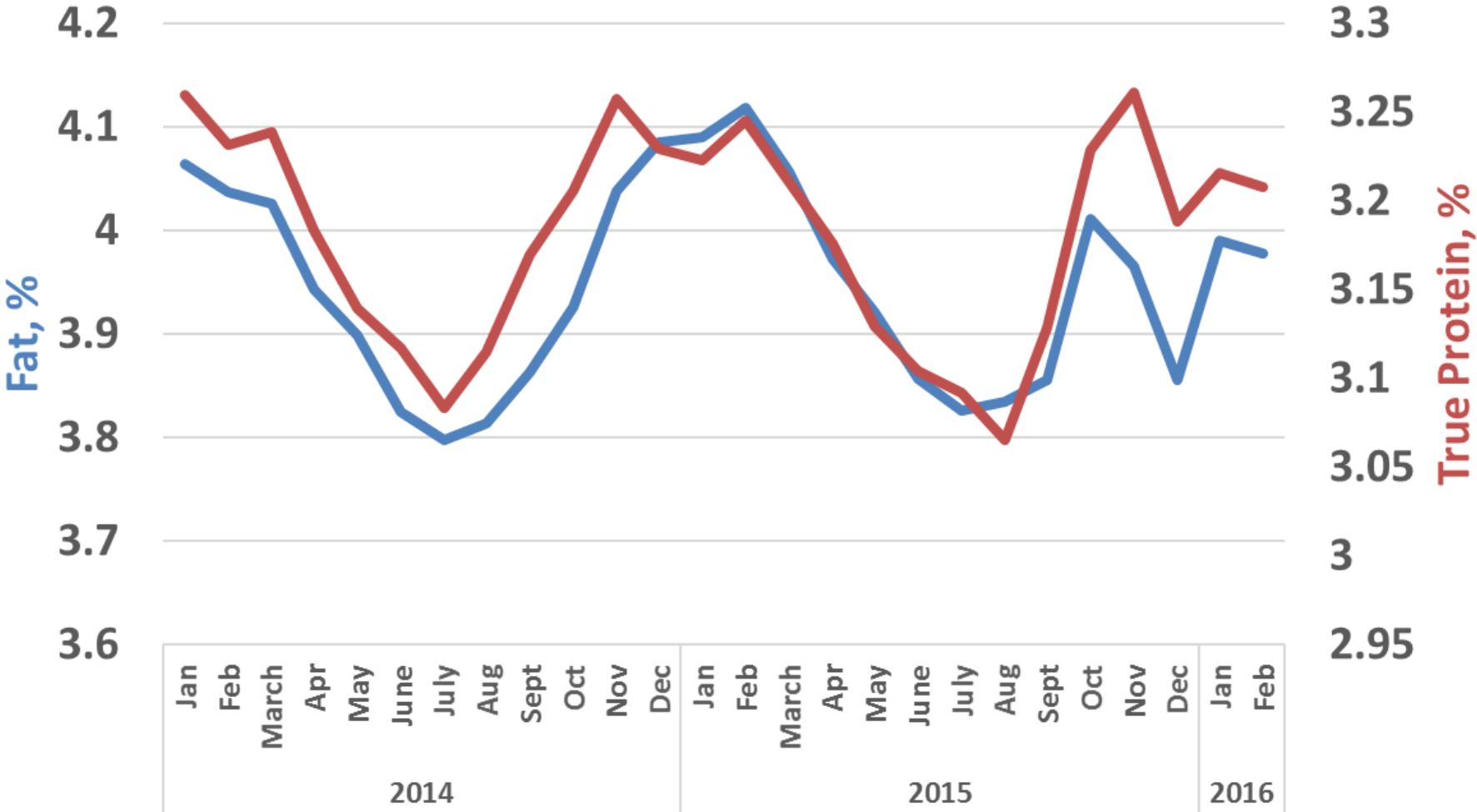
Need to understand changes in milk profiles with season and stage of lactation

Herd distribution



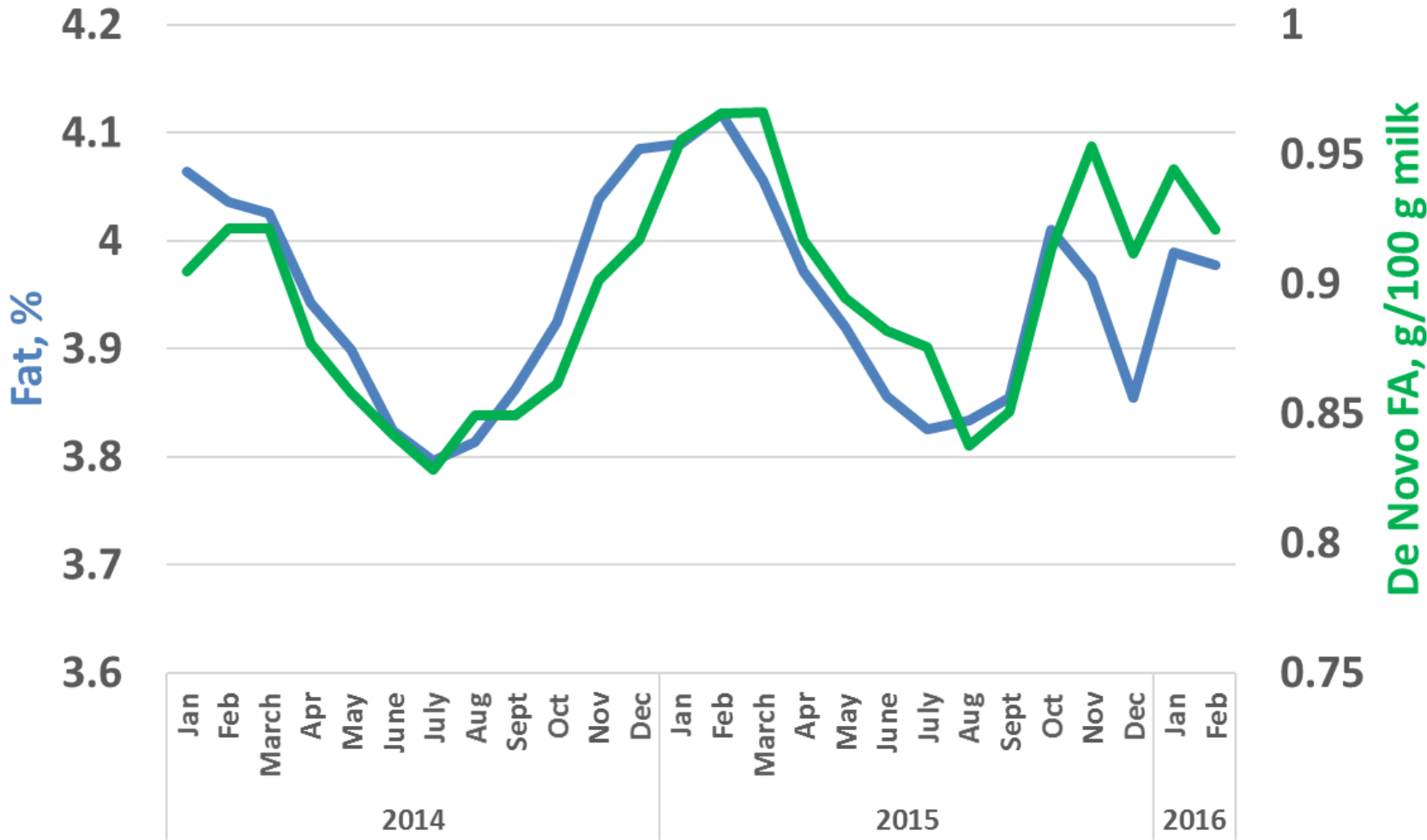


# Seasonal Changes in Milk Composition



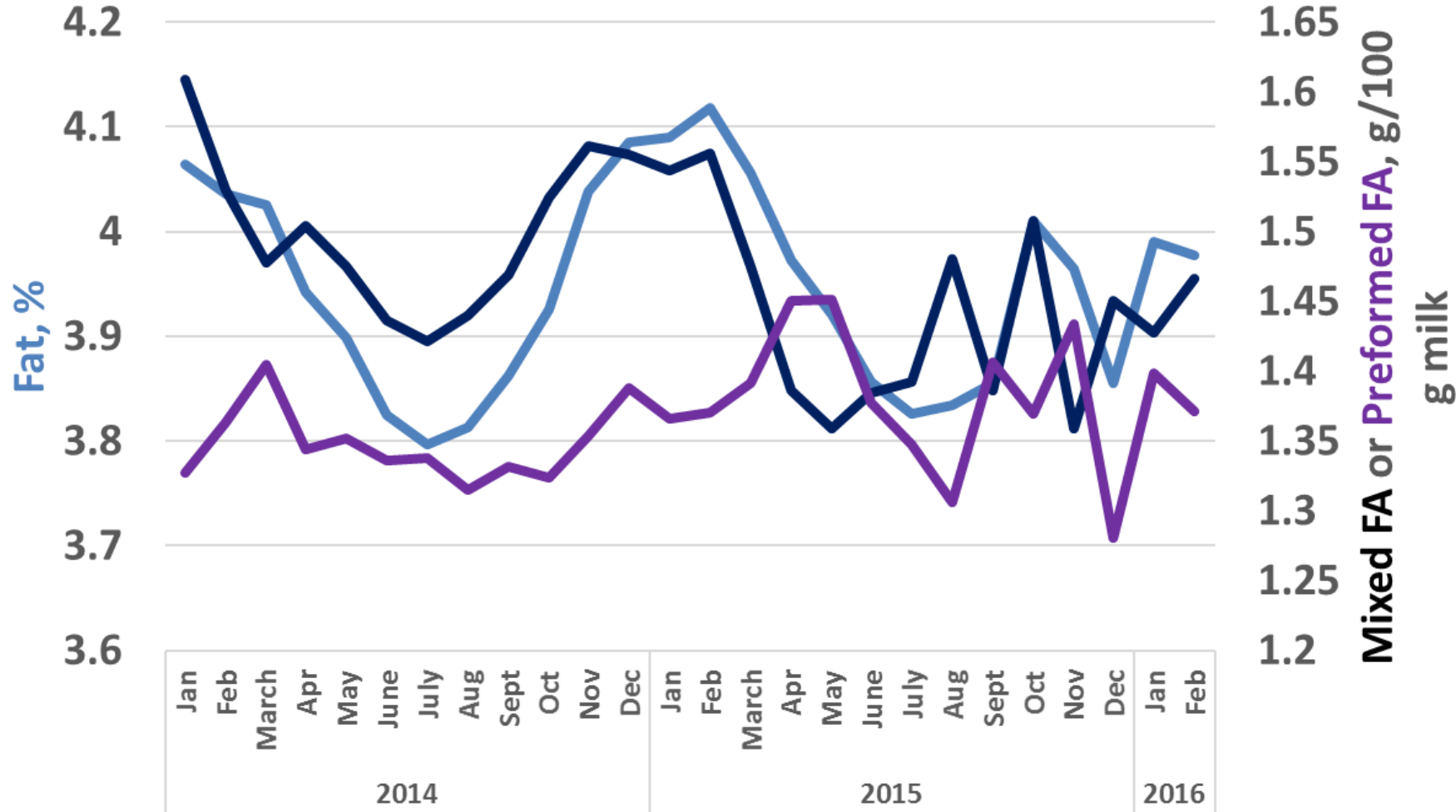
40 St. Albans Coop herds

# Seasonal Changes in Milk Composition



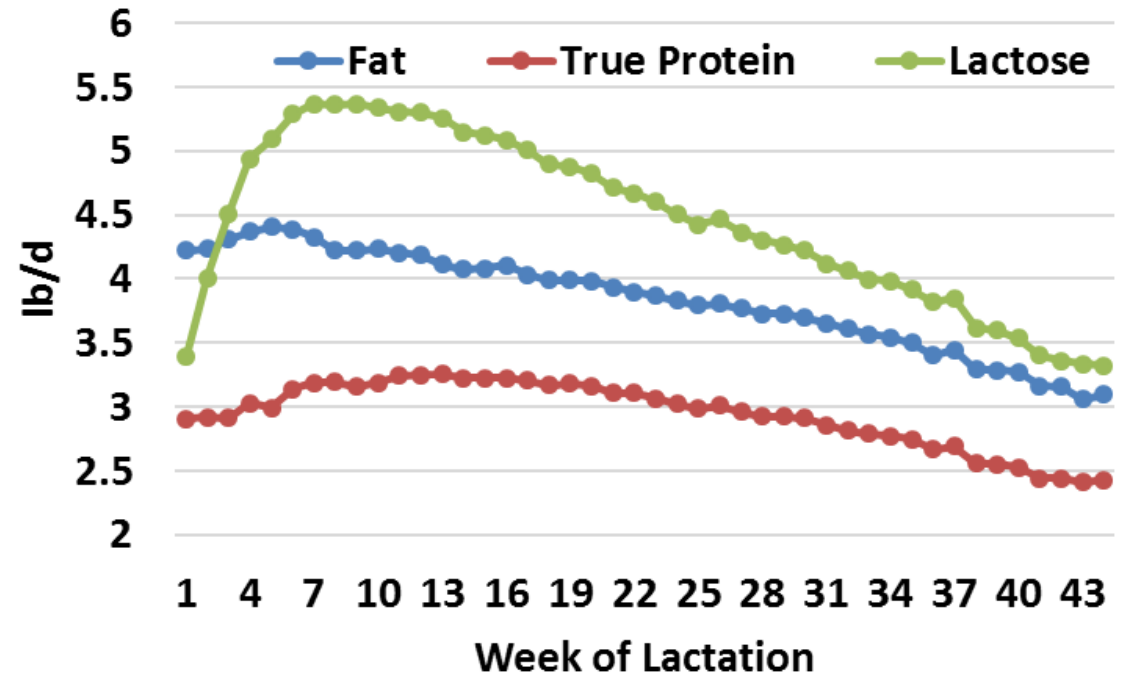
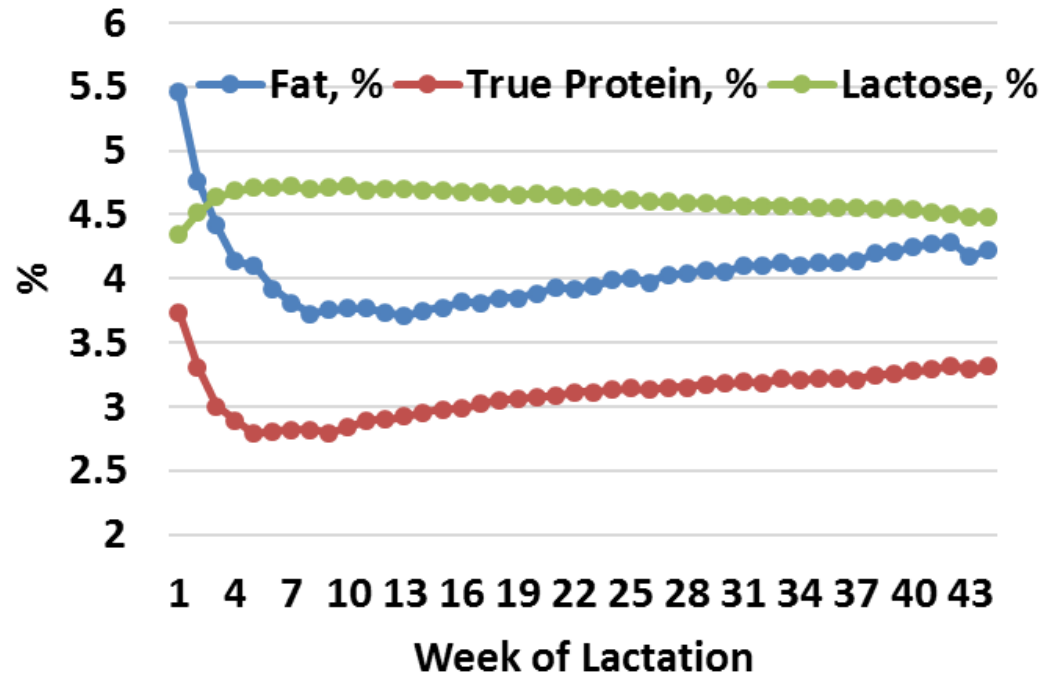
40 St. Albans Coop herds

# Seasonal Changes in Milk Composition



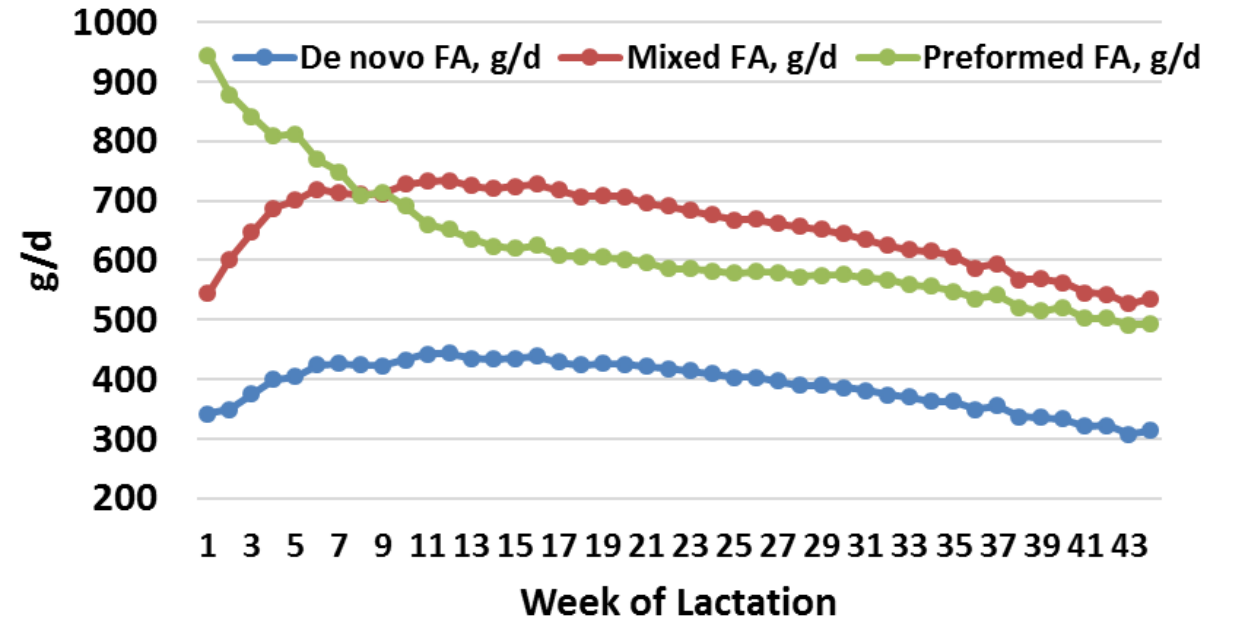
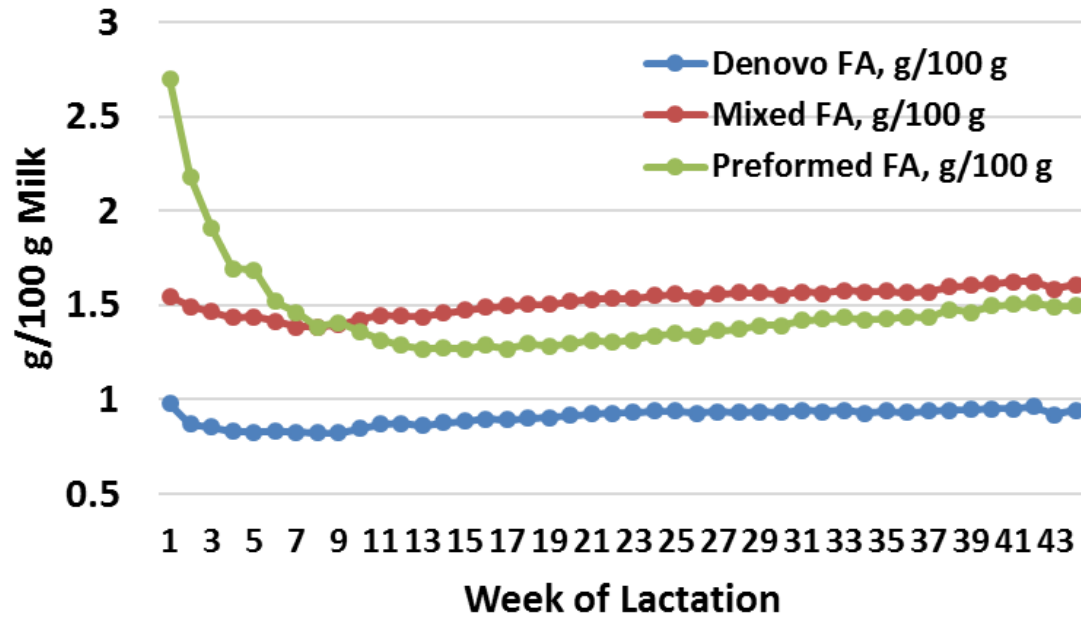
40 St. Albans Coop herds

# Stage of Lactation Affects Milk Components



Holstein herd, ~90-95 lb milk/d, TMR feeding system

# Stage of Lactation Affects Milk Fatty Acid Metrics

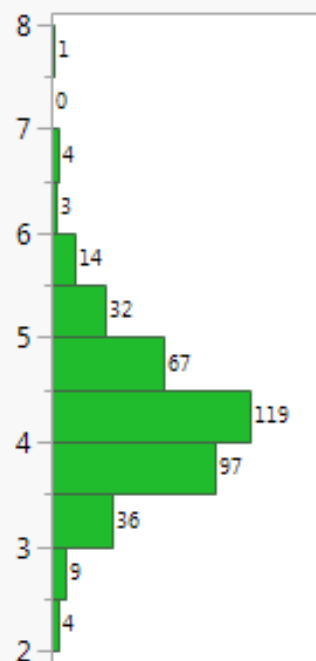


Holstein herd, ~90-95 lb milk/d, TMR feeding system

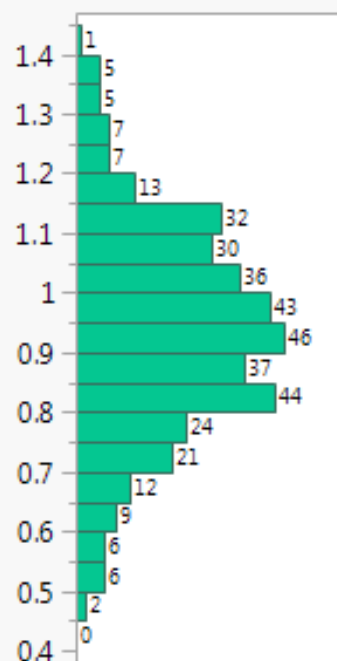
# Holstein Herd Distribution

## Distributions

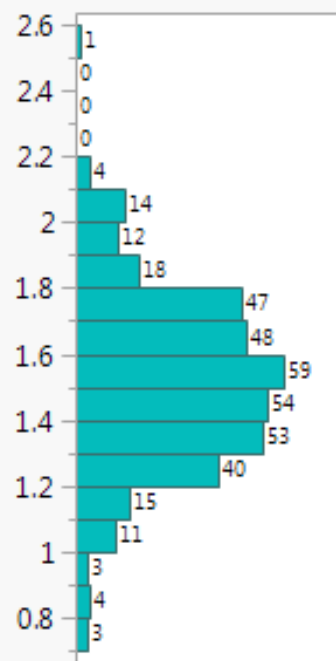
### Fat, %



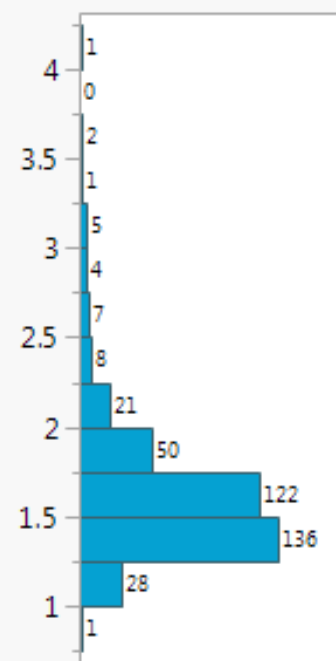
### De novo, g/100 g milk



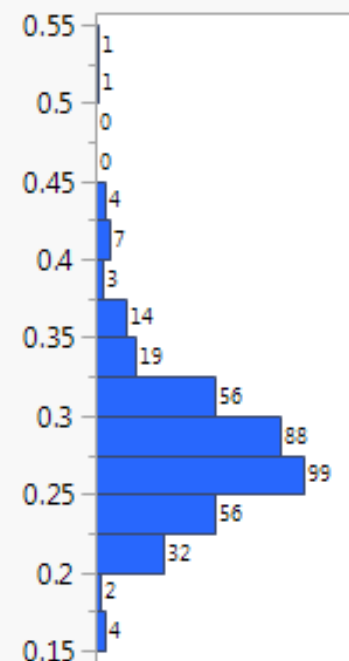
### Mixed, g/100 g milk



### Preformed, g/100 g milk



### Unsaturation, DB/FA



# Going Beyond Bulk Tank Sampling...

**Bulk Tank/Tanker**



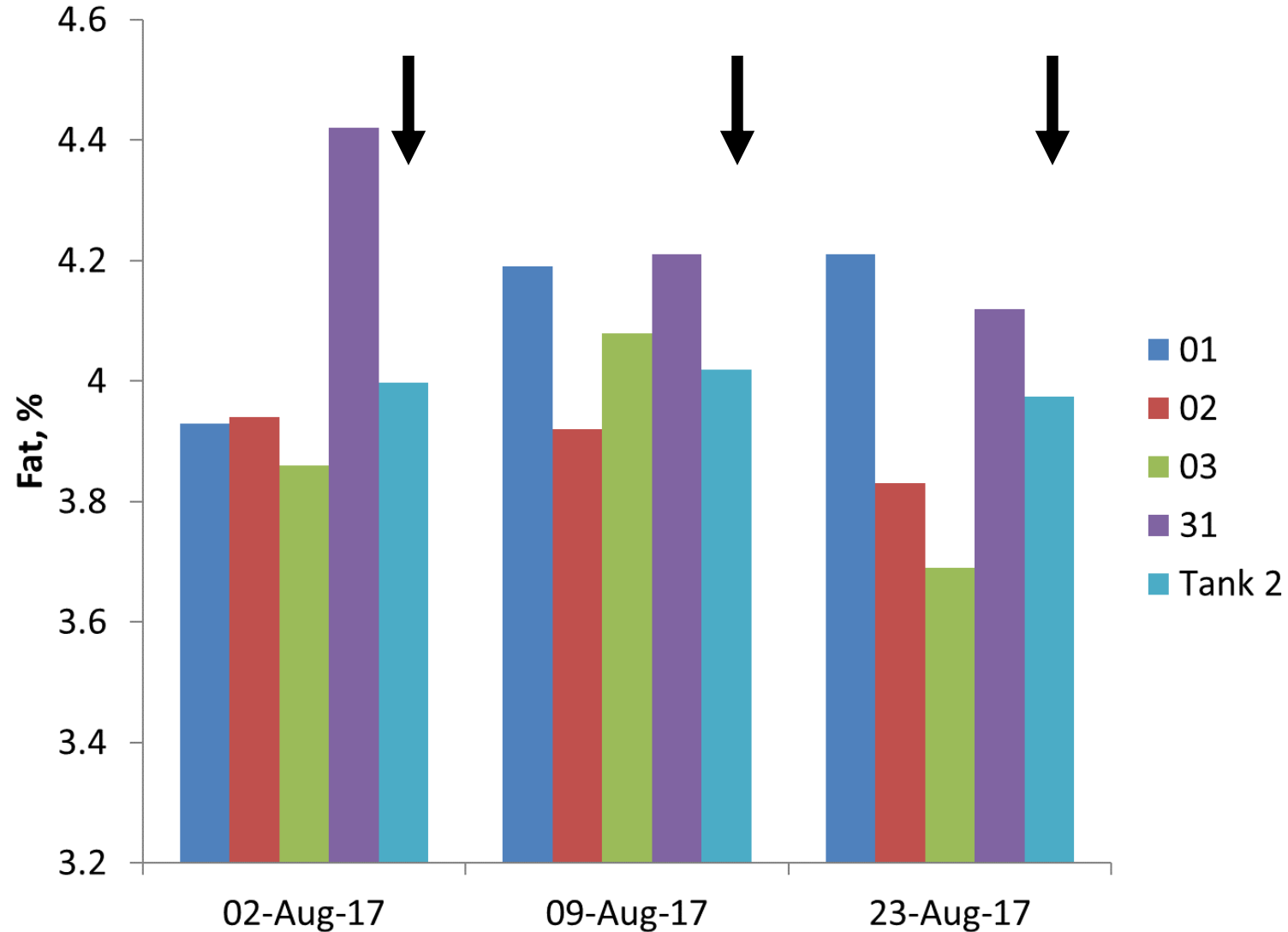
**Group/Pen/String**



**Cow**

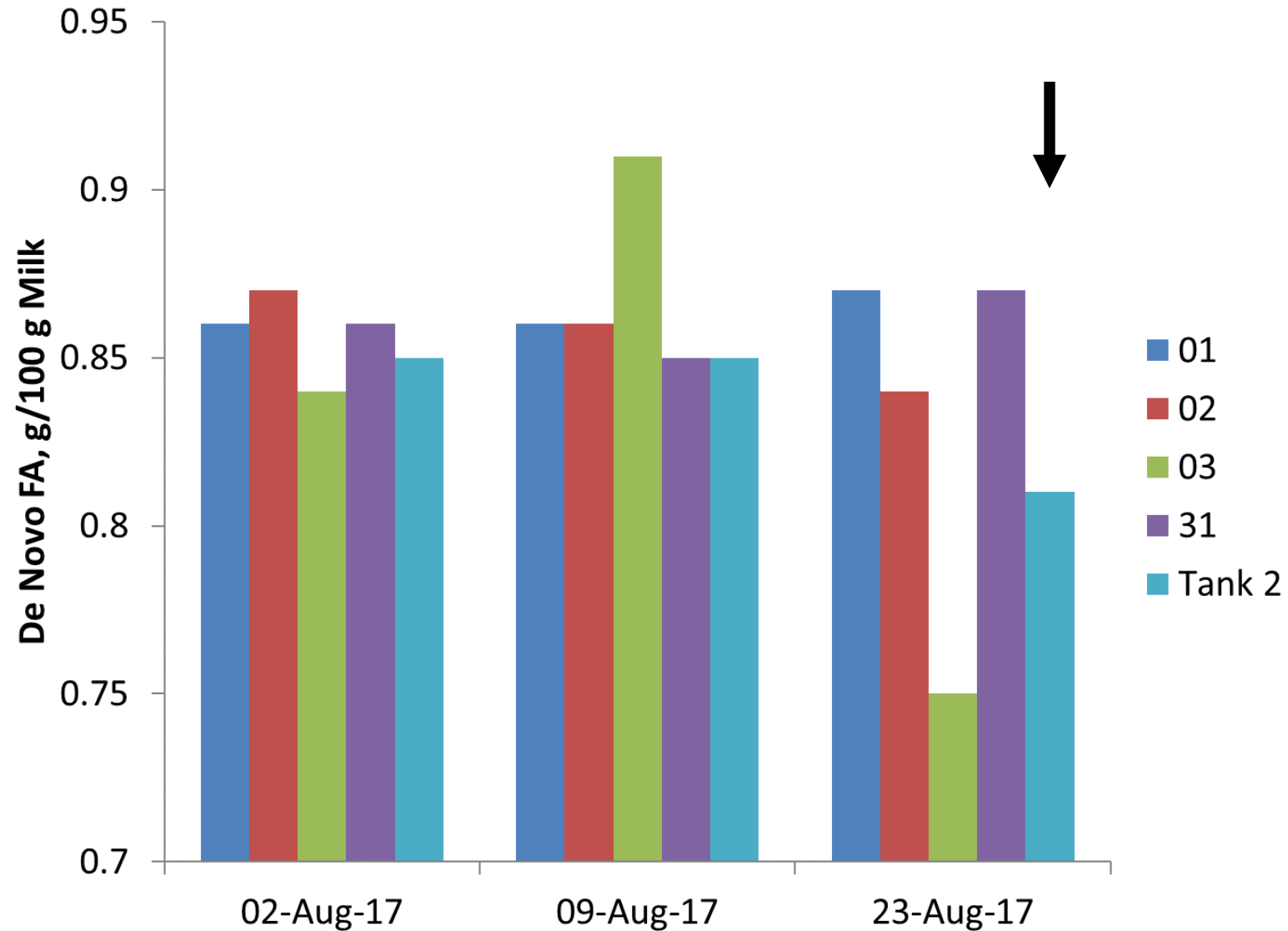


# Bulk Tank vs. In-line Group Sampling (More Sensitivity)

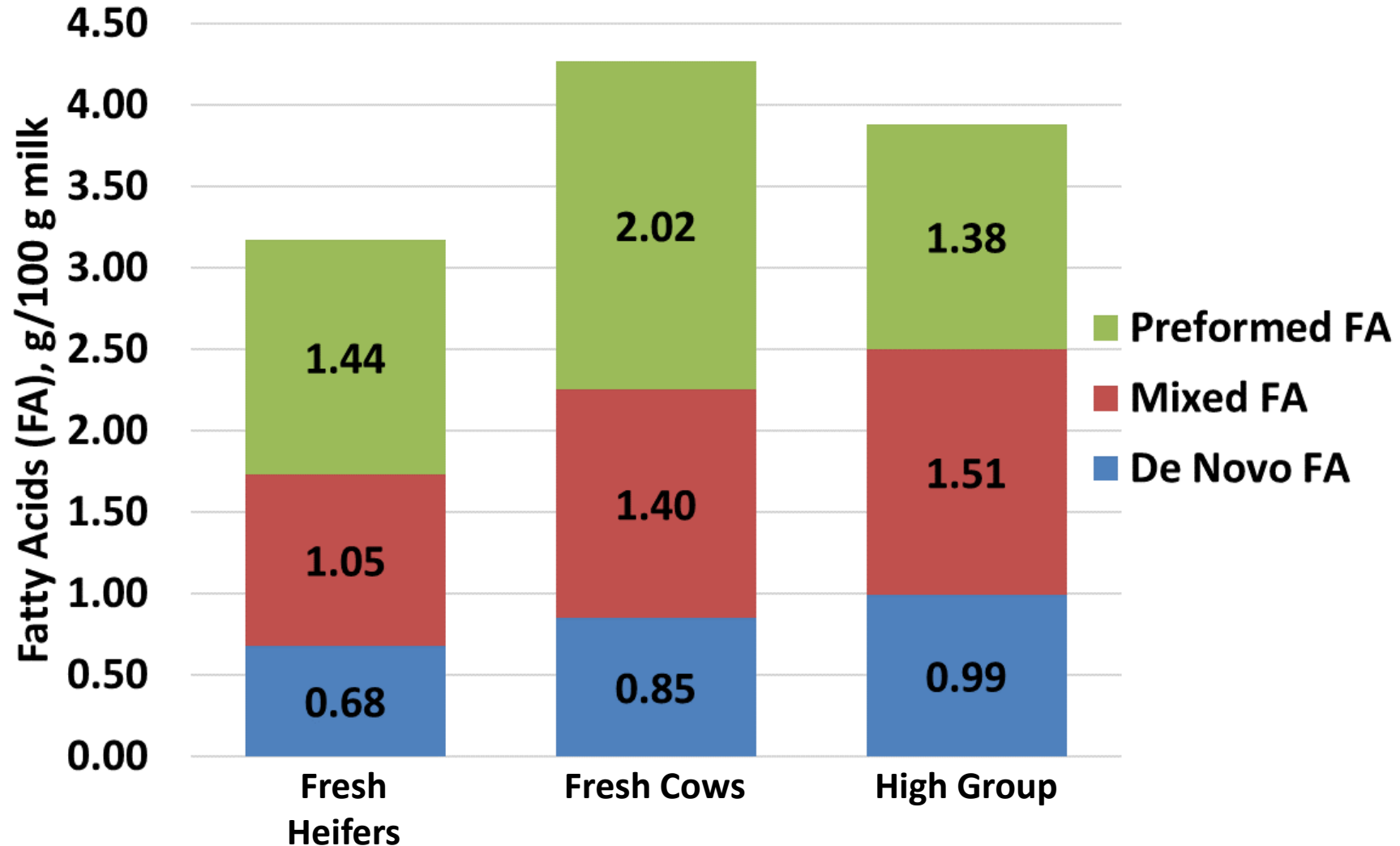




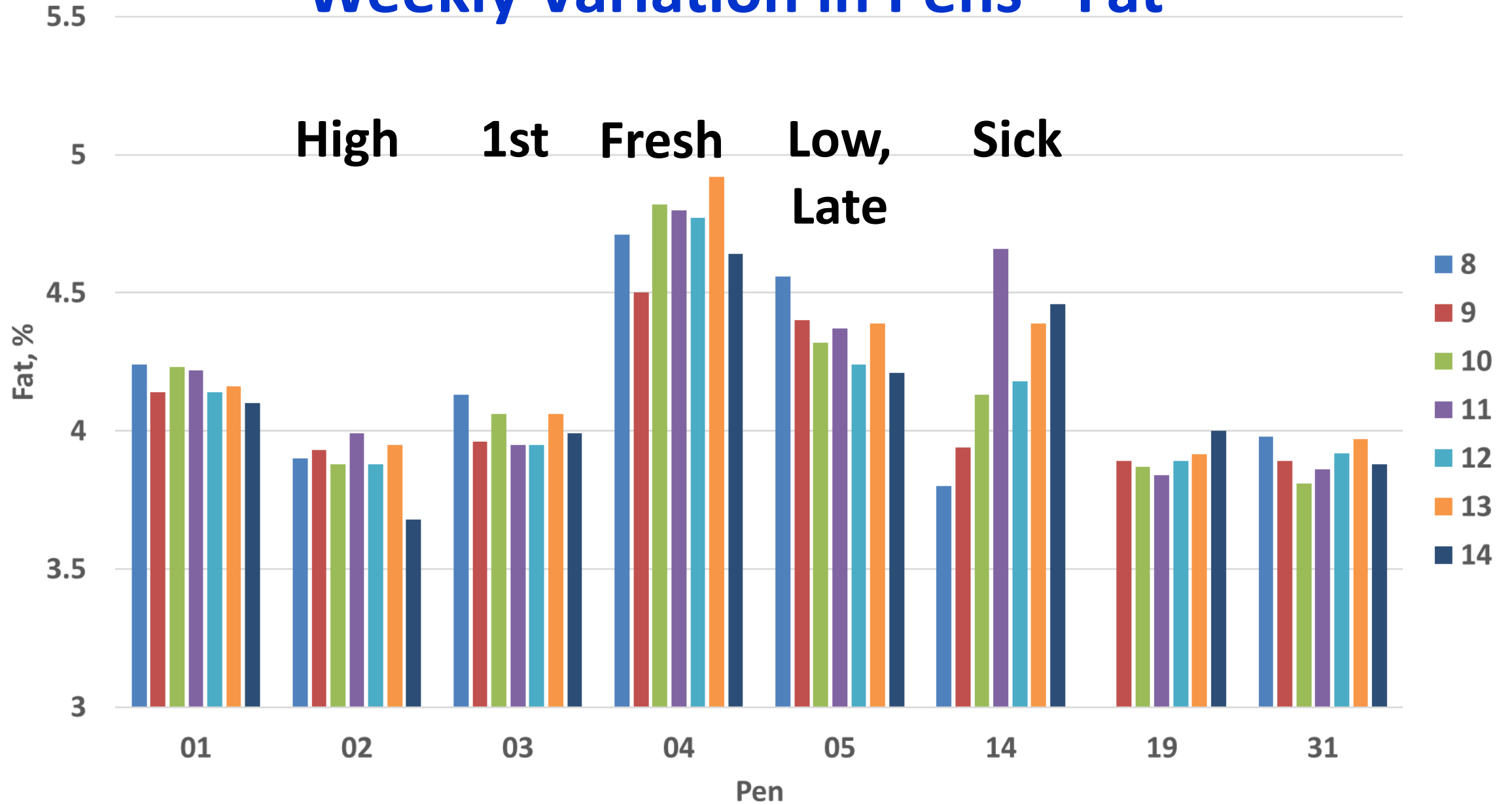
# Bulk Tank De Novo FA Changed when Fat % Did Not



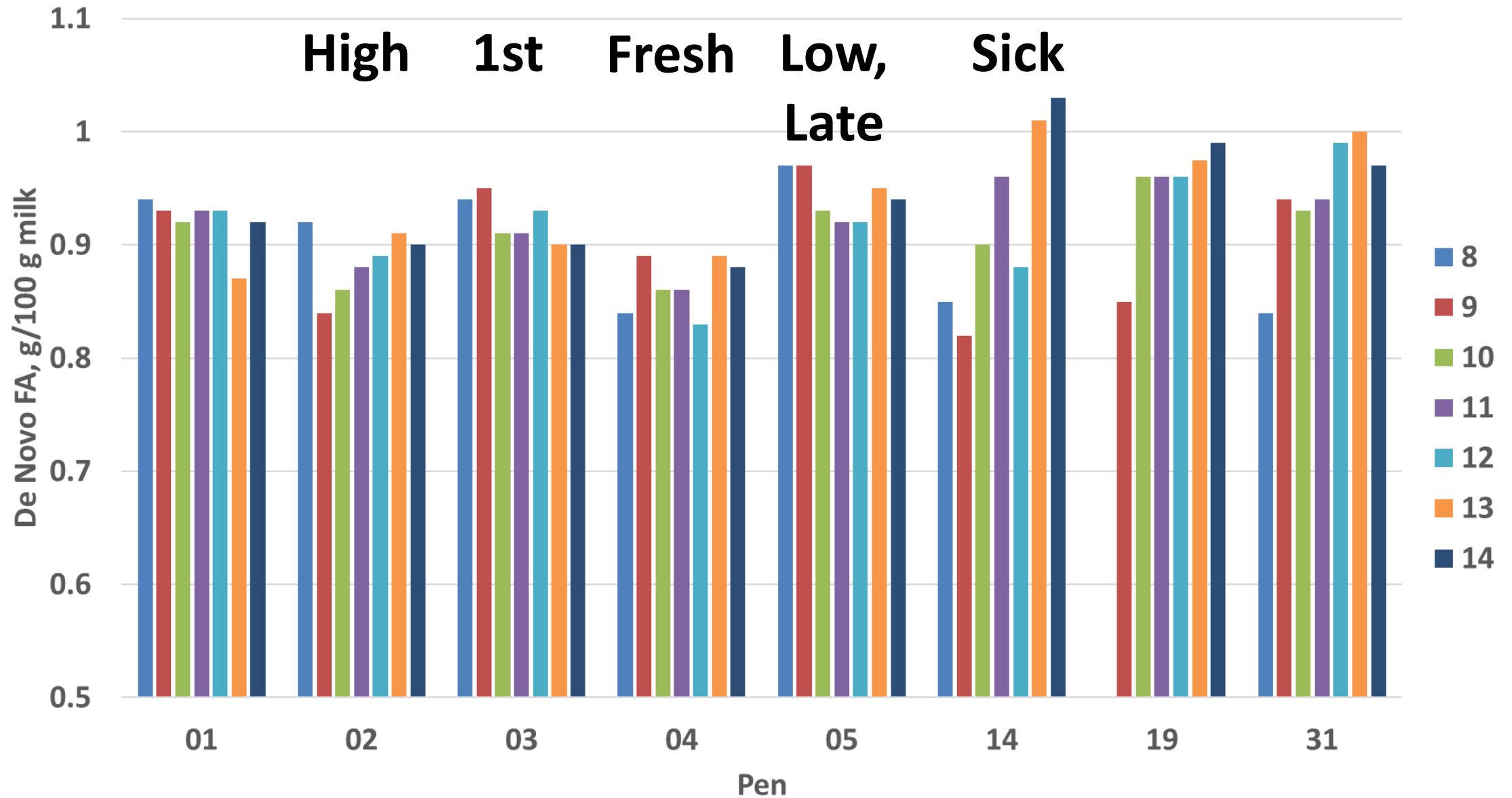
# Holstein Herd – Group Example



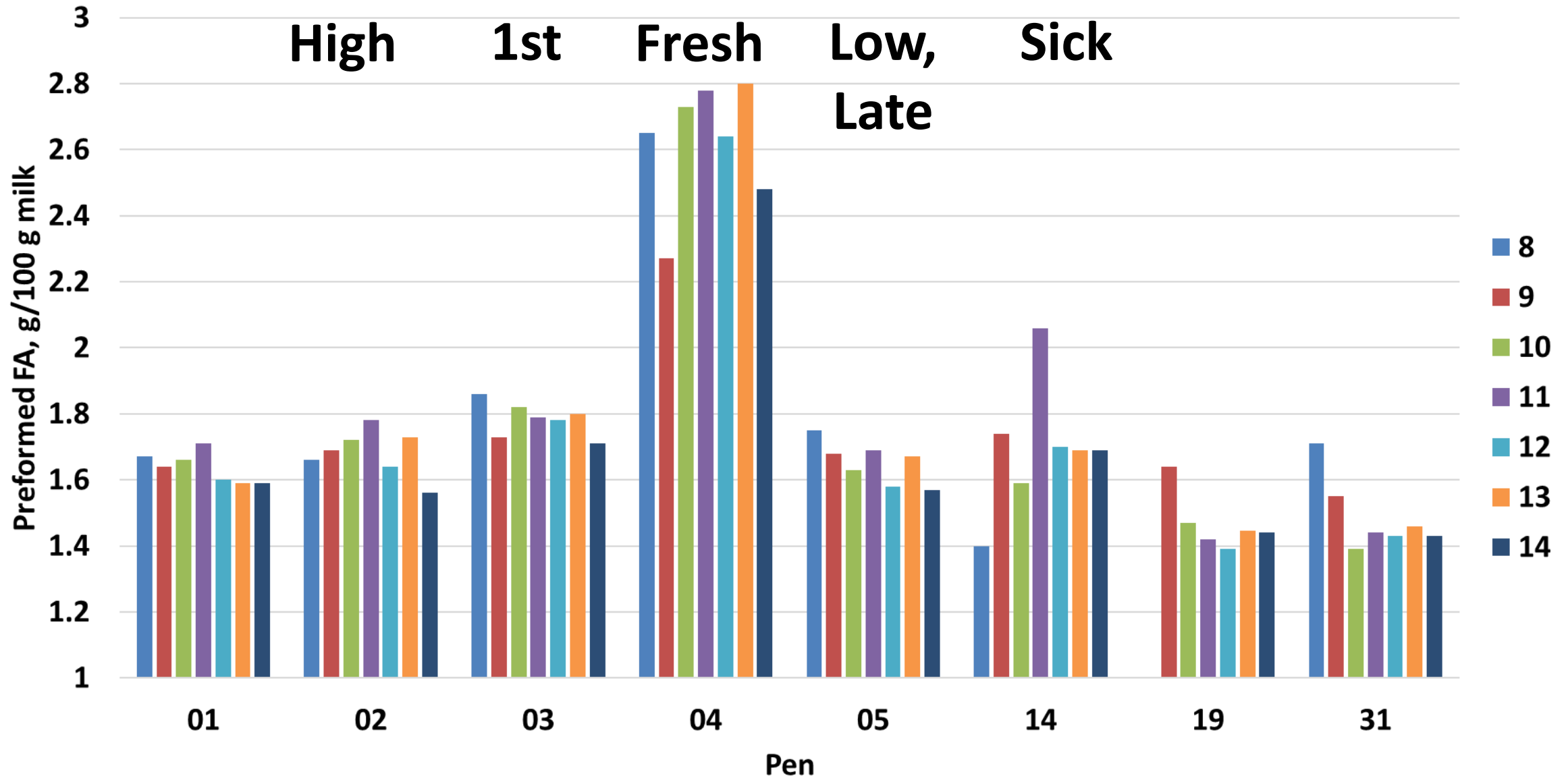
# Weekly Variation in Pens - Fat



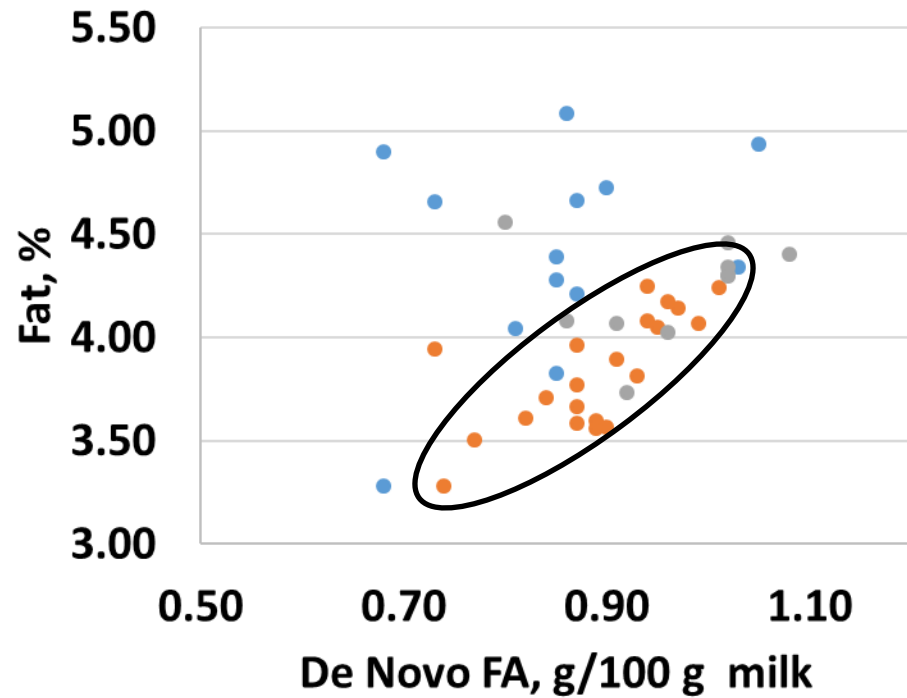
# Weekly Variation in Pens – De Novo FA



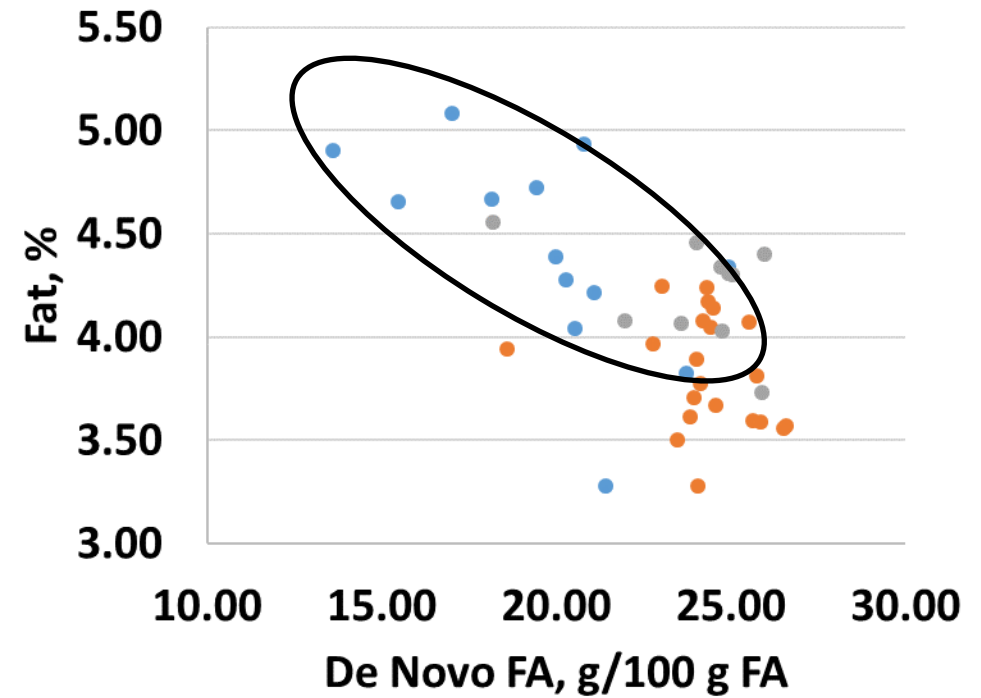
# Weekly Variation in Pens – Preformed FA



# Commercial Herds – Group Samples

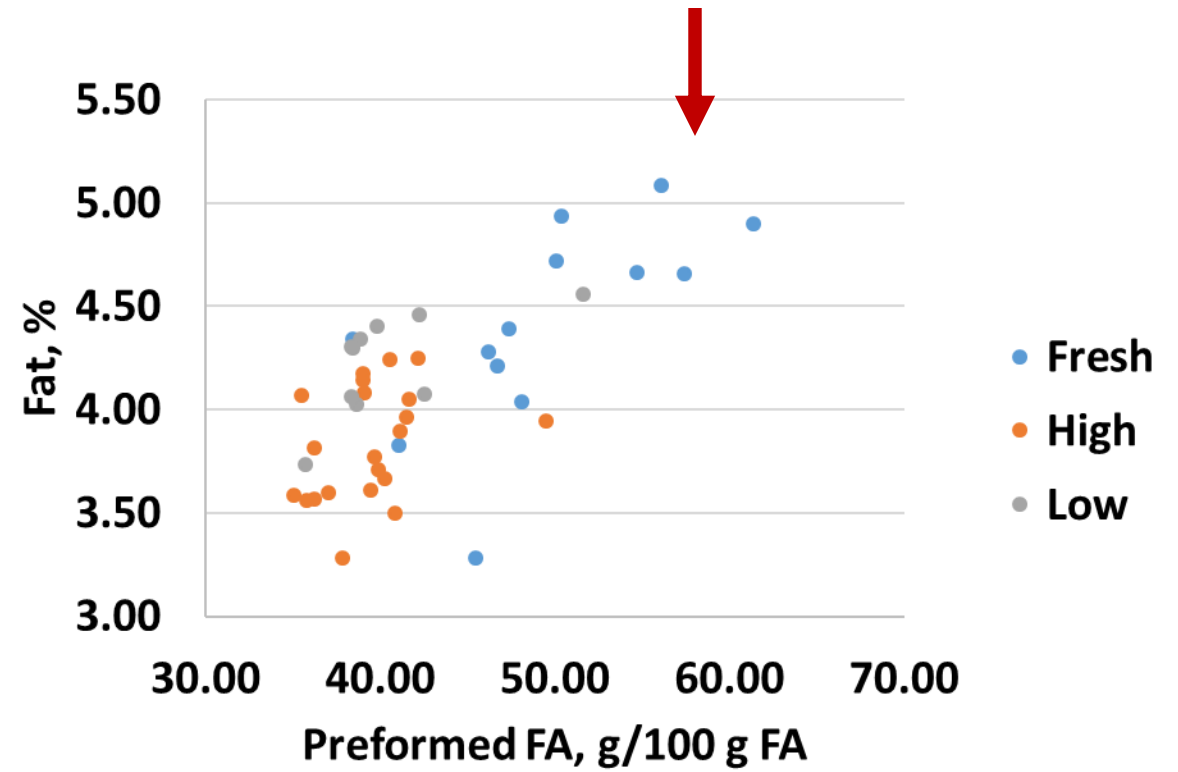
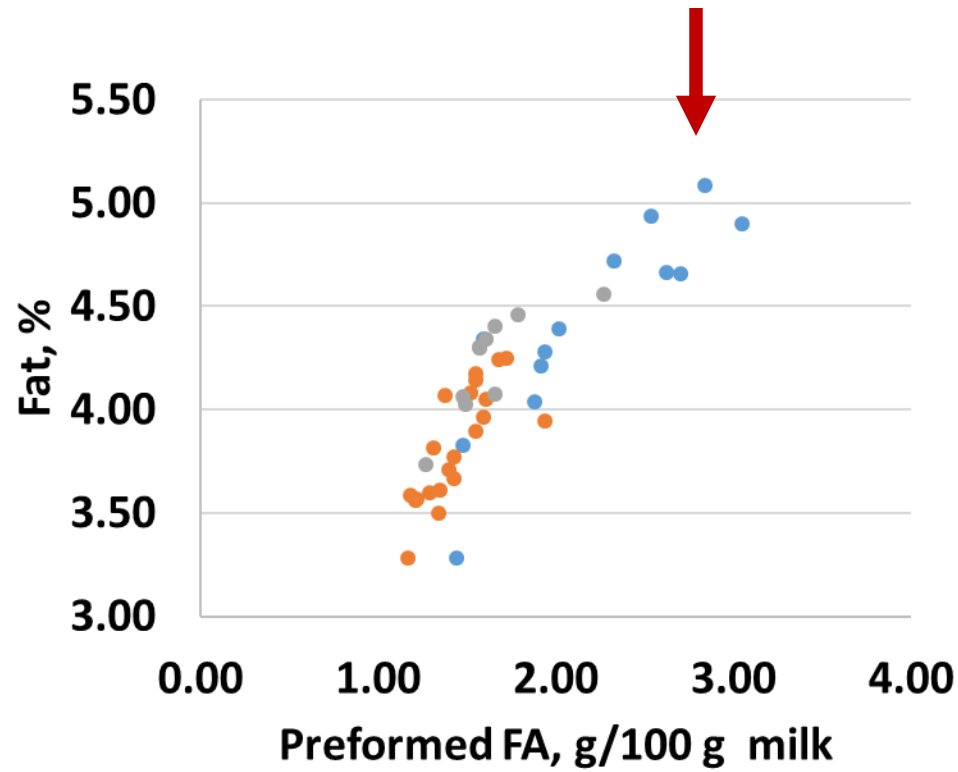


- Fresh
- High
- Low



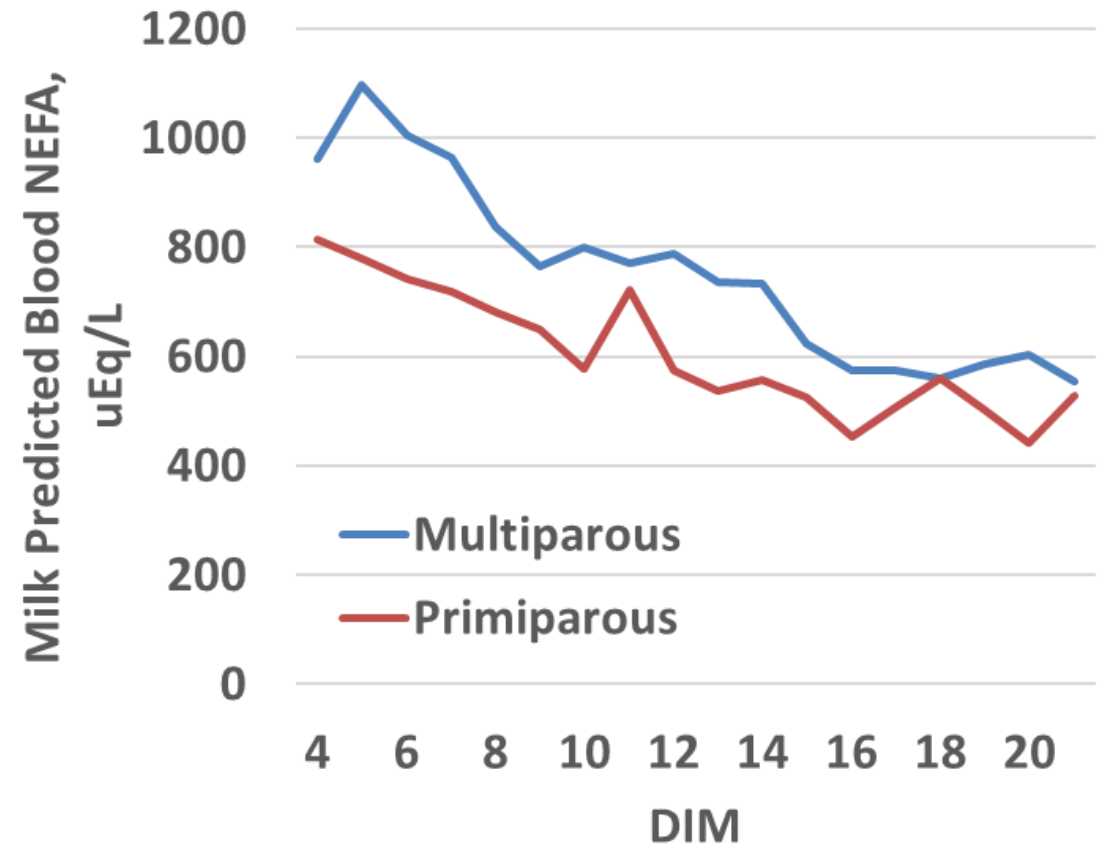
- Fresh
- High
- Low

# Commercial Herds – Group Samples



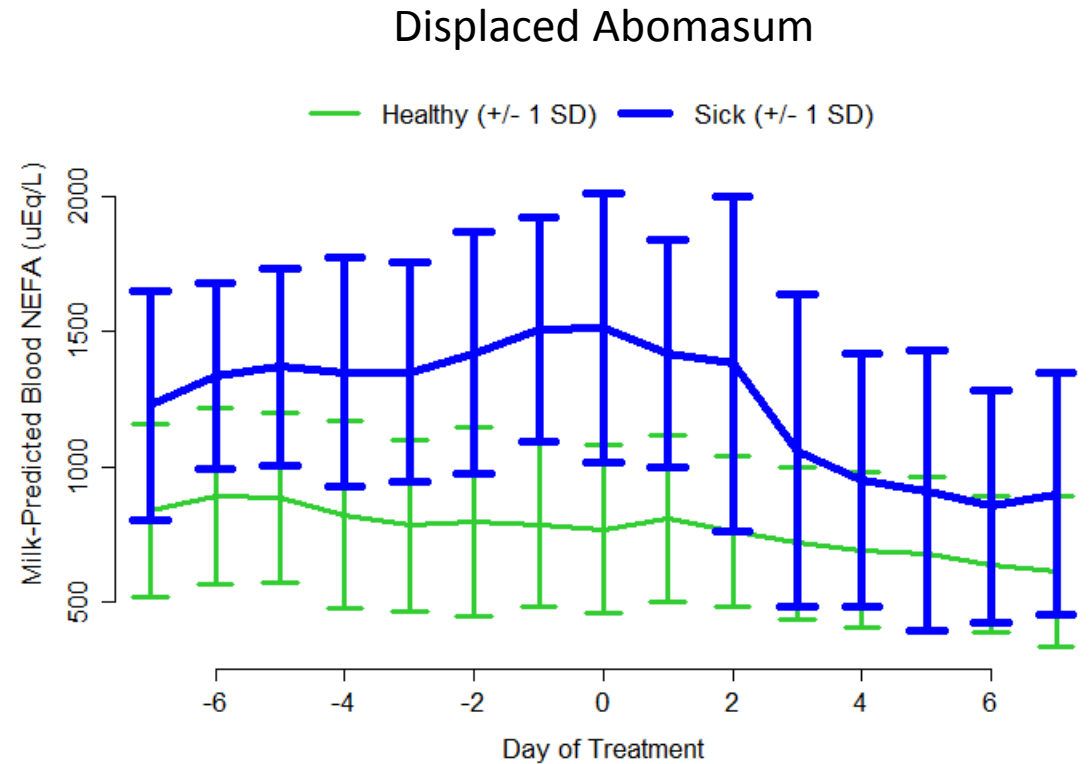
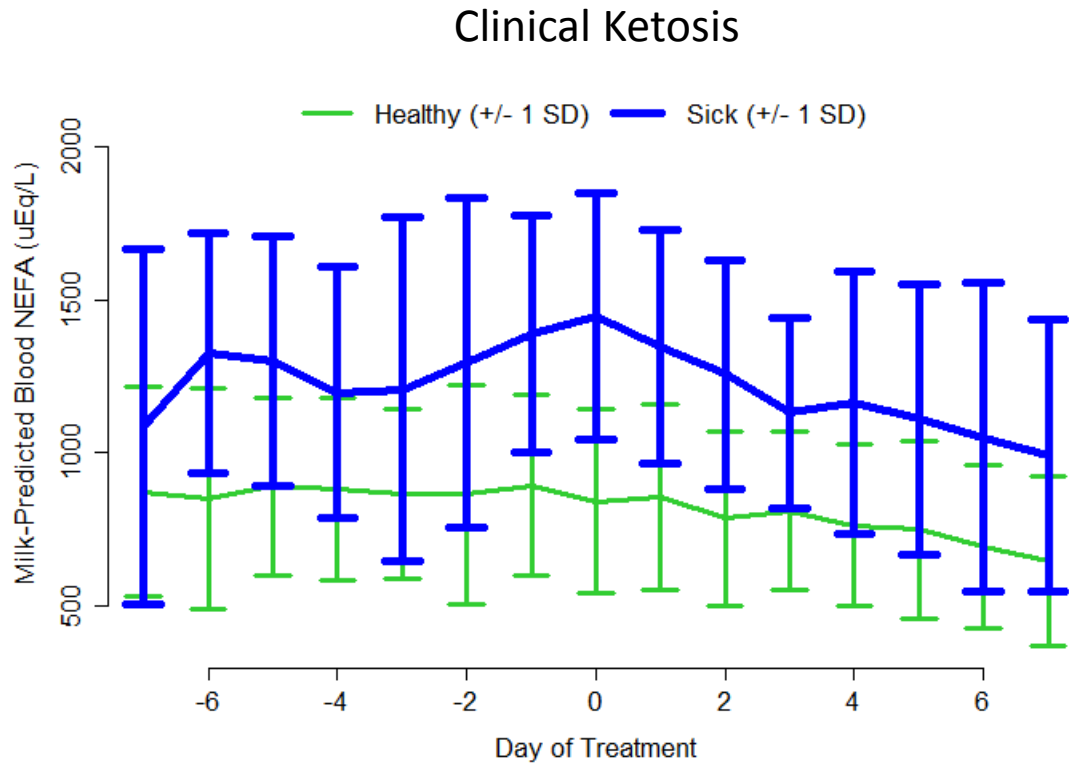
# Blood NEFA can be Predicted from Milk During the Fresh Period

- Provides information about the severity and duration of the negative energy balance (fat mobilization)
- Early warning of problems ahead

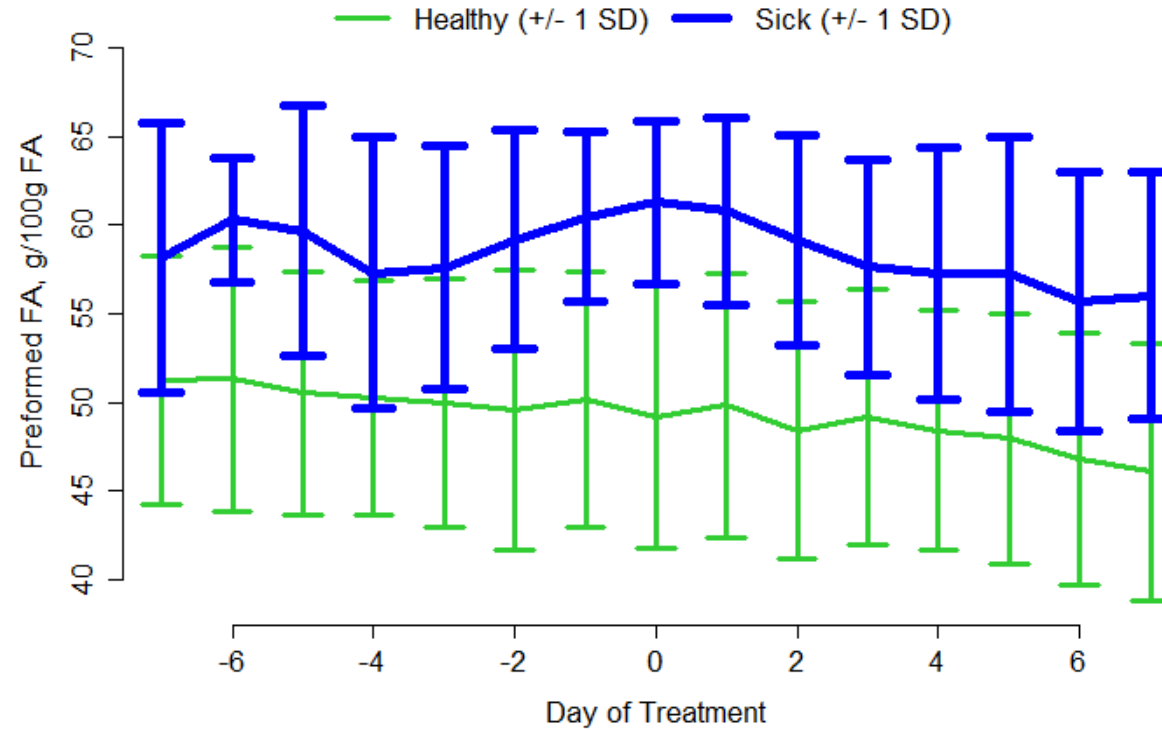
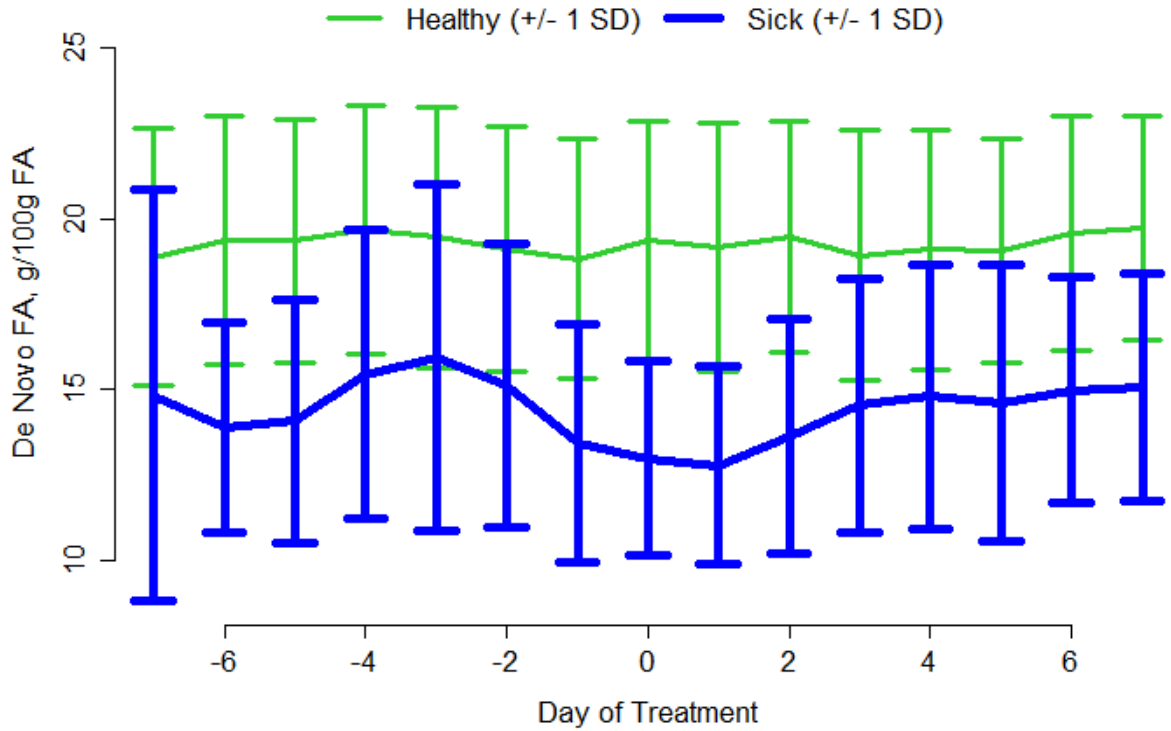




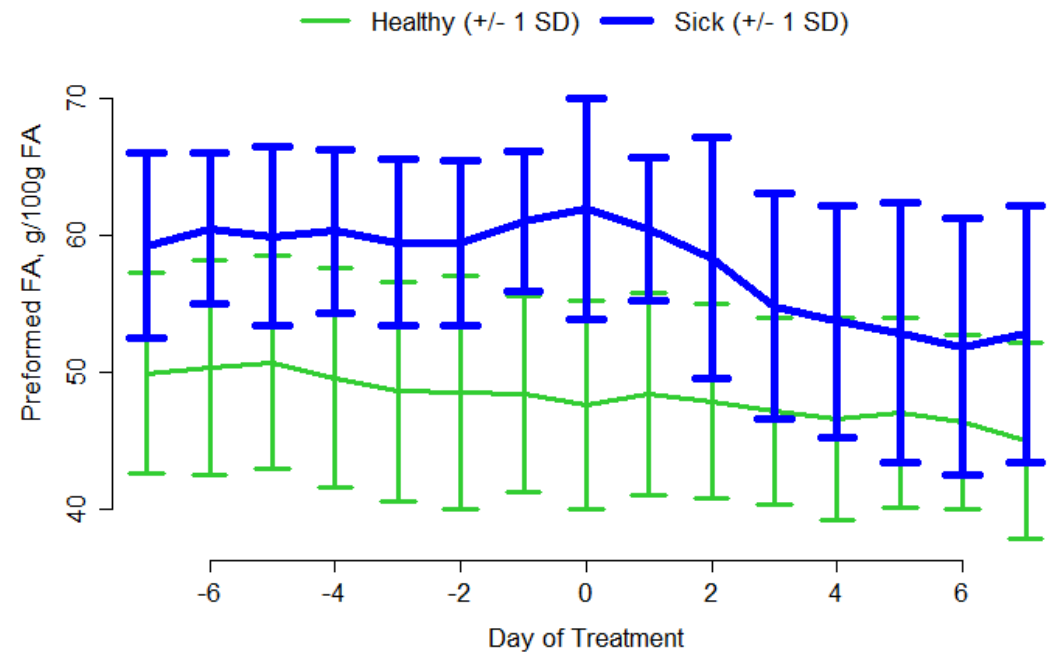
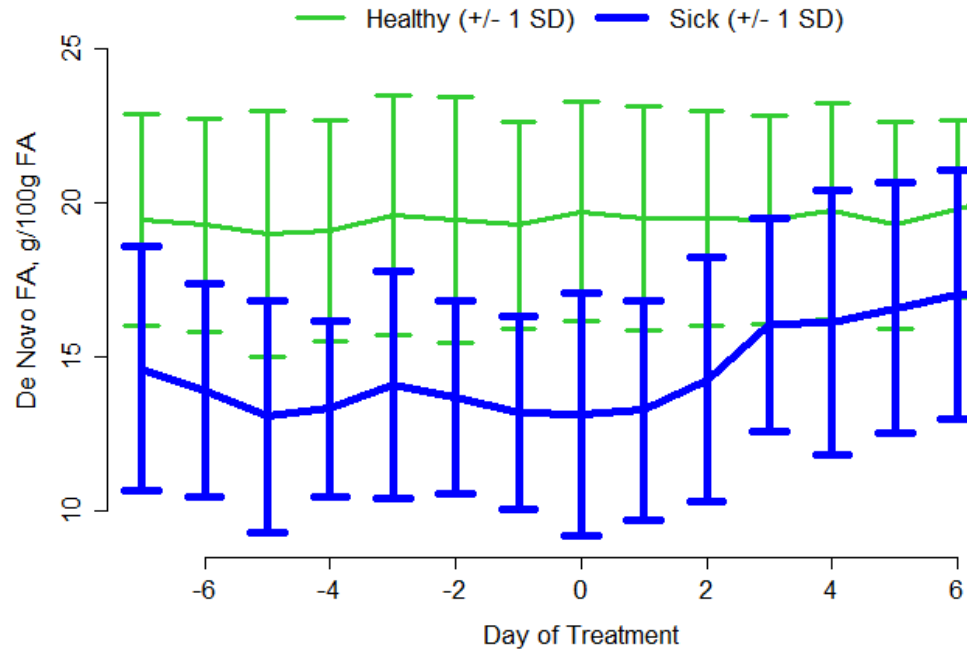
# Milk Predicted Blood NEFA is Higher for Cows with Ketosis or Displaced Abomasum

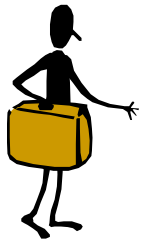


# Fatty Acid Metrics for Cows with Ketosis



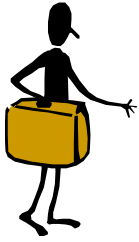
# Fatty Acid Metrics for Cows with Displaced Abomasum





# Milk Fatty Acid Metrics – Another Tool for Your Toolbox





# How Best to Use the Milk Fatty Acid Metrics Information

- **In conjunction with**
  - Diet information
  - Management information, other systems
  - On-farm assessment
  - *Don't use the FA information "in a vacuum"*
- **Can give you clues as to what is happening**
  - More specific than milk fat or protein %
  - Low milk fat can be caused by different factors – MIR FA information may allow you to identify what is wrong
  - May allow more rapid decision making



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# enhance



## Questions

Thank you for attending Dairy Girl Network's Enhance Webinar



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