Milk Fatty Acid Research (Cow of Interest) Update

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NYS Cheese Manufacturers' Association Meeting

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Outline

- What do dairy farmers to need to help manage?
- Review of herd level milk fatty acid analysis and interpretation.
- New data (herd level and individual cow level)
  - milk fatty acids: relation to seasonality of fat and protein
  - data on fatty acids and stage of lactation
- Future Directions

What Do Dairy Farmers Need?

Dairy farmers need analytical results that will help them manage the efficiency of feed utilization, metabolic health during the transition period, mammary infection, animal welfare, environmental impact, and reproduction to improve economic performance and sustainability.

The success of farm management ultimately depends on correct decisions on an animal by animal basis. The challenge is to find the cow of interest, make a decision, and take action.

What Do Dairy Farmers Want?

Each cow needs to be a "Cow of Interest"

A tool that integrates diverse sources of data (e.g., milk analysis, activity monitors, cow side tests, etc.) to produce management information focused on optimization of the performance and economic return of each individual cow.

Outline

- **Where are we at on the "cow of interest"?**
  - **Bulk Tank: completed study of about 170 farms from all over the US**
  - **Instruments testing bulk tank milk for de novo, mixed performed, chain length, and unsaturation**
    - **St Albans Cooperative, AgriMark Cooperative, and Cayuga Marketing Cooperative (1 instrument each)**
    - **Sterns County and Zumbrota DHIA Labs, Minnesota (4 instruments). ADM DHIA lab in Clovis on line March 2018.**
    - **Cornell University, Miner Institute, and Texas Federal Milk Market Laboratory**

Outline

- **Where are we at on the "cow of interest"?**
  - **Individual Cows:**
  - **Instruments testing bulk tank milk for de novo, mixed performed, chain length, and unsaturation.**
    - **Sterns County and Zumbrota DHIA Labs, Minnesota (4 instruments)**
    - **Cornell University and Miner Institute (continued research for further development of more herd management metrics and to develop a hardware approach that would integrate into a milking system for analysis of milk from every cow.)**

Status Cow of Interest?

1) We are getting a much better understanding of how to use fatty acid data for whole herd or milking group diagnostics.

2) We need to develop hardware and software to integrate this approach into the milk system for analysis of milk from each cow.

Outline

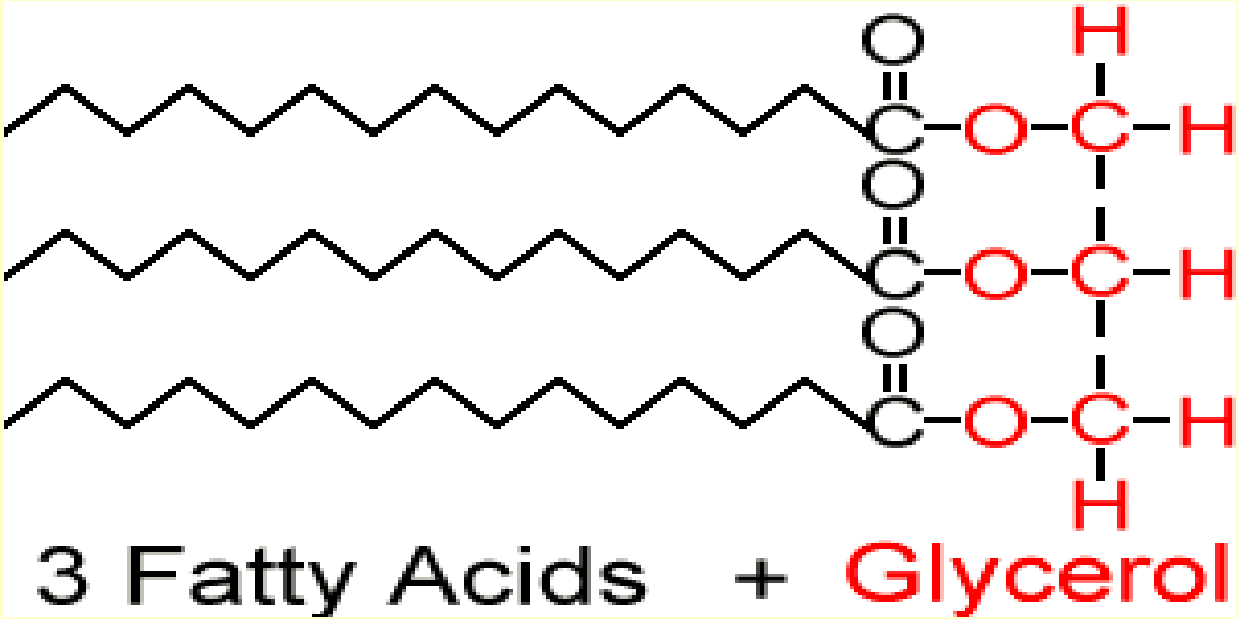
- Where are we at on the “cow of interest”?
- **Review of herd level milk fatty acid analysis and interpretation.**

Whole herd bulk tank data

Bulk Tank Milk Testing

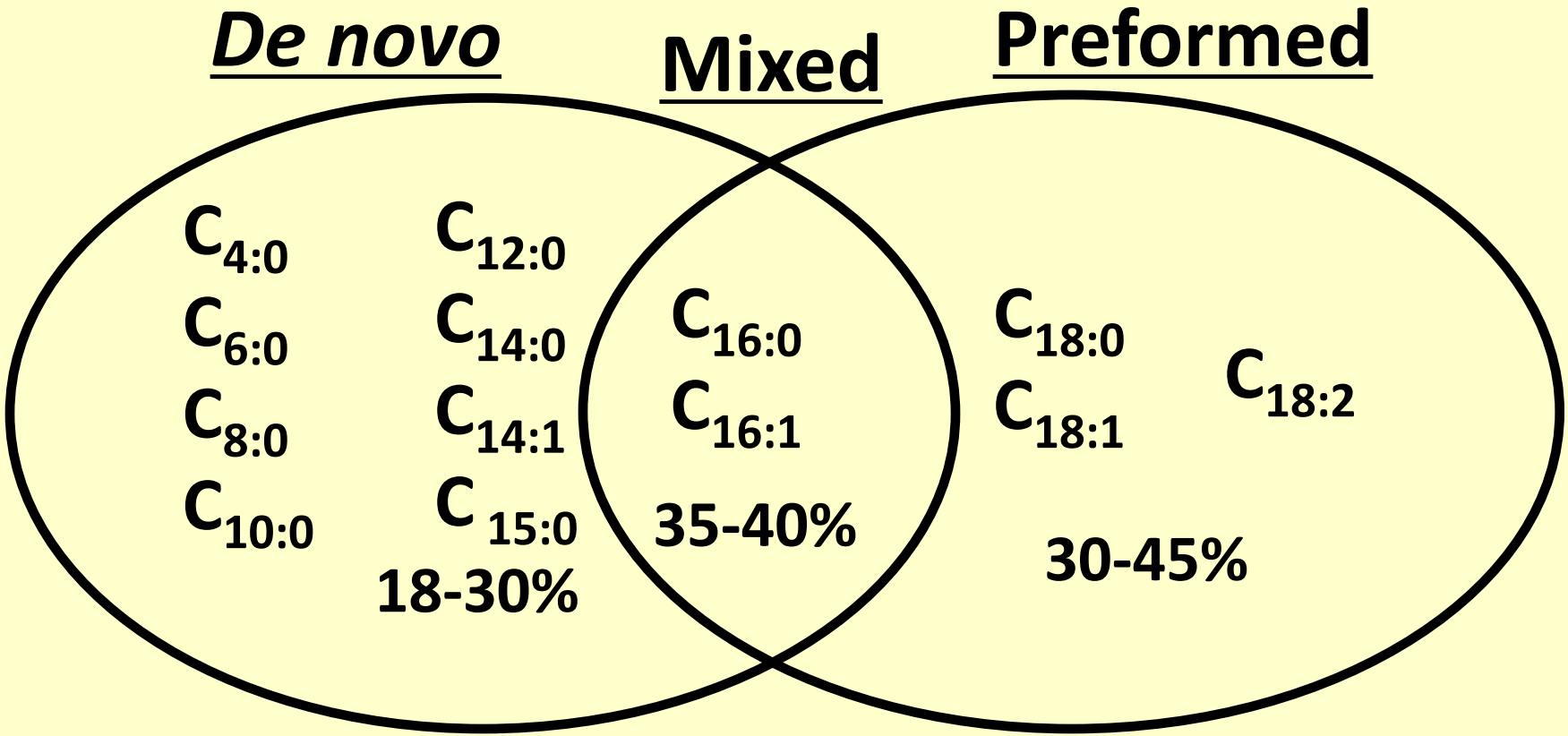
Efficiency of forage utilization (*de novo* fatty acids)

Milk Fat Structure

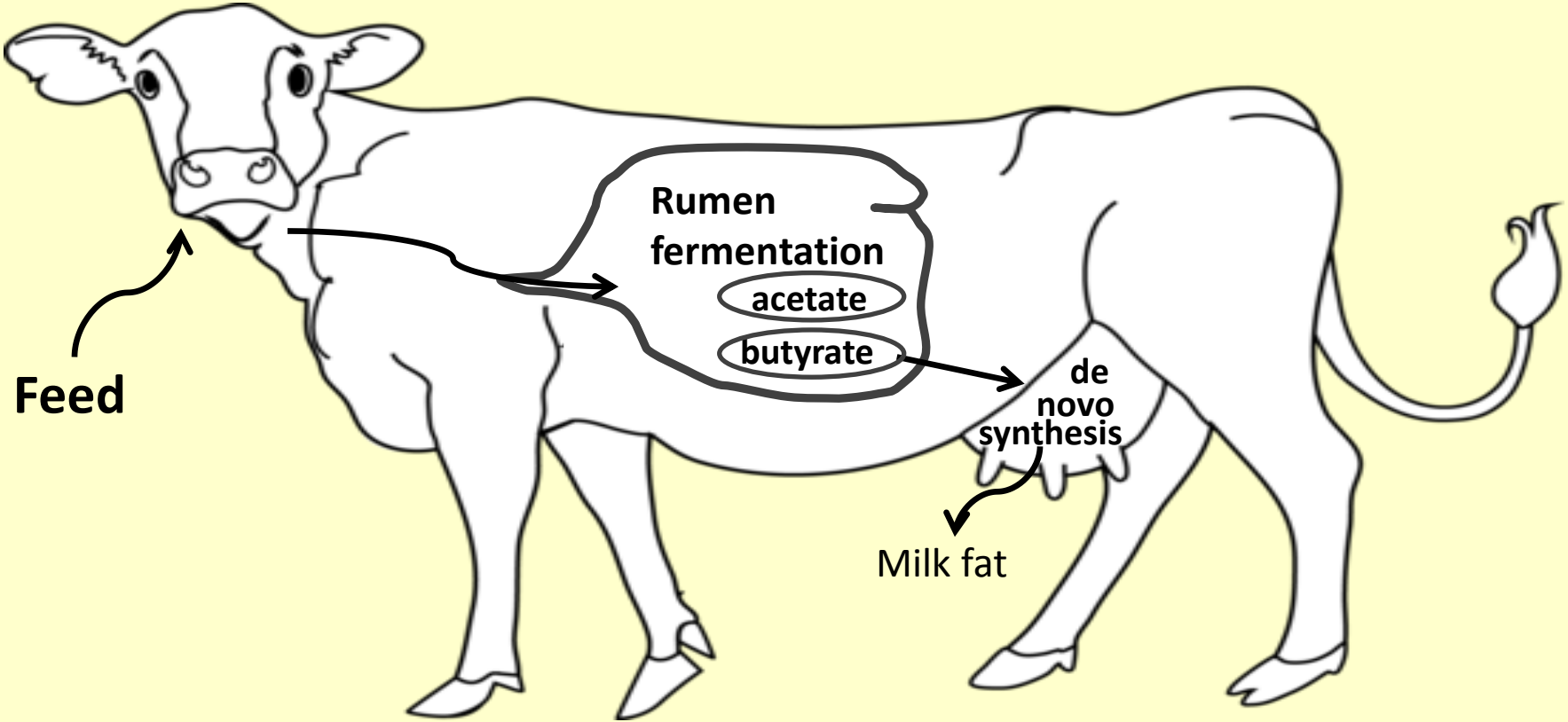


3 fatty acids per triglyceride

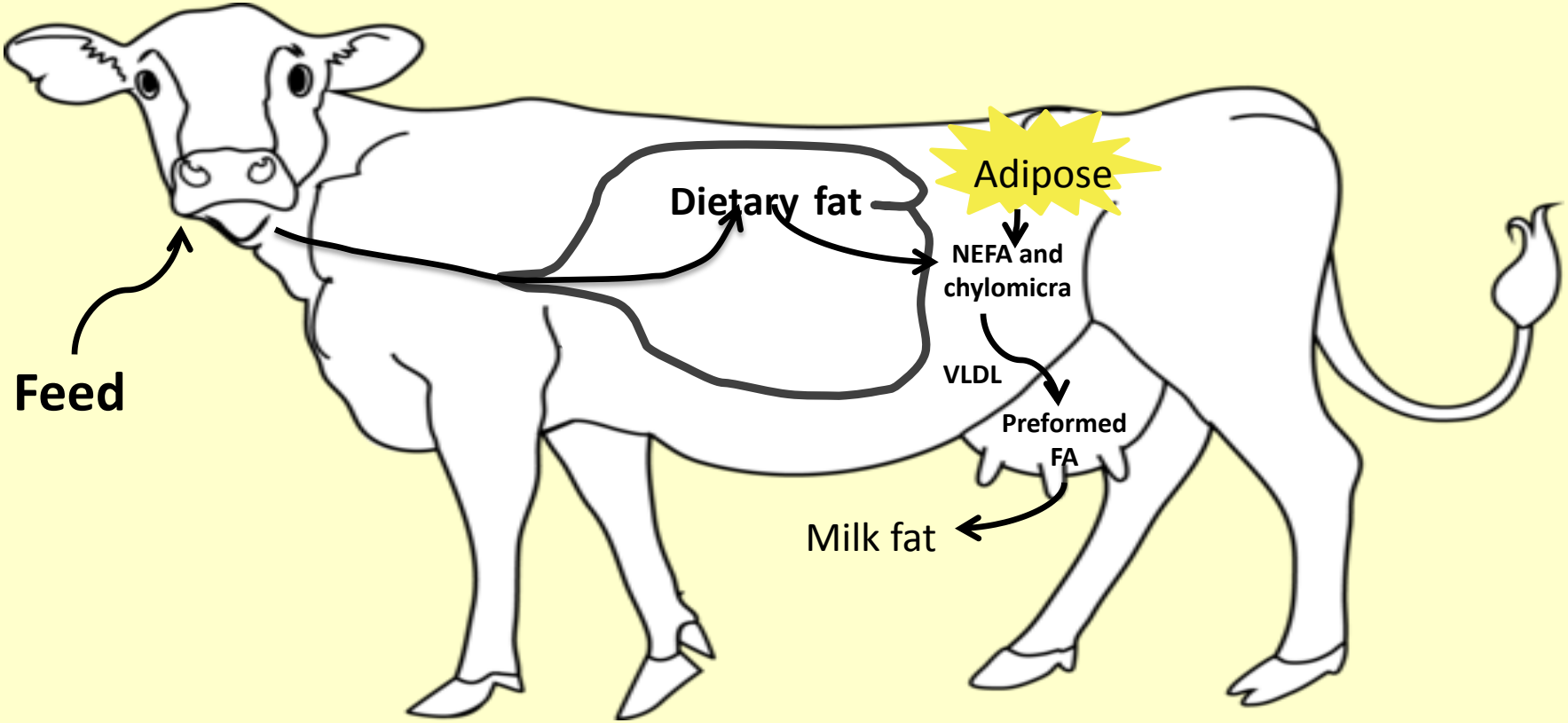
Milk Fatty Acid Origin



De novo Fatty Acid Synthesis



Preformed Fatty Acids



Infrared (mid-FTIR) Milk Analysis

Manual FTIR currently used at Cornell and Collaborator Laboratories - Delta Instruments Model FTA, The Netherlands

de novo, mixed origin, and preformed fatty acids

Fatty acid calibration was done once per month with reference milks produced at Cornell. The instrument tests about 50 to 70 samples per hour for all components, NPN/urea, and all fatty acid parameters. The automated model runs 600 samples per hour.

40 Farm Studies (2014 & 2015)

Collaboration: Cornell, Miner Institute, St. Albans Cooperative, Delta Instruments

1. **Sort all 430 farm data from low to high values for de novo fatty acids as a percentage of total fatty acids within the Jersey group of farms and within the Holstein group of farms for a field study in 2014.**

2. **Select 10 Jersey farms with low *de novo* and 10 Jersey farms that have high *de novo* fatty acids.**

3. **Select 10 Holstein farms with low *de novo* and 10 Holstein farms that have high *de novo* fatty acids.**

4. **In 2015, we repeated the study with 40 Holstein farms: 20 high de novo and 20 low de novo farms.**

Milk Composition:June 2012 – August 2013

Mean relative milk fatty acid composition for each group of 10 farms for the 15 month period: *de novo*, mixed origin, and preformed fatty acids

		St Albans	June 2012 through August 2013			
		%	%	g/100 g FA	g/100 g FA	g/100 g FA
Breed	Group	Fat	True Protein	Denovo	Mixed	Preformed
Holstein	Low *DeNovo*	3.623	2.993	24.08	33.97	41.95
Holstein	High *DeNovo*	3.975	3.148	26.08	35.08	38.84
Jersey	Low *DeNovo*	3.917	3.093	25.04	33.35	41.61
Jersey	High *DeNovo*	4.804	3.616	27.41	34.62	37.96

Results of 40 Farm Study Year 1

- ***Half Holstein Herds and Half (Jersey – mixed breed)***
- ***De novo* FA as a % of total fatty acids (25.6 vs 23.7% relative %, *P*<0.01)**
- **Milk (26.3 vs 22.7 kg/d, *P*=0.06),**
- **Fat (4.33 vs 4.14%, *P*=0.10),**
- **True protein (3.41 vs 3.22%, *P*<0.01)**
- **MUN (11.4 vs 11.3 mg/dL, no significant difference)**
- **These differences for fat and protein between HDN and LDN herds at 25 kg of milk per 100 cows per year would result in a gross income difference of $8,544 for fat and $15,695 for protein.**

Results of 40 Farm Study Year 2

- **All herds were Holstein**
- ***De novo* FA as a % of total fatty acids (26.0 vs 23.8% relative, significant $P < 0.01$)**
- **Milk (31.9 vs 32.1 kg/d, no significant difference),**
- **Fat (3.98 vs 3.78%, $P<0.01$),**
- **True protein (3.19 vs 3.08 %, $P<0.01$)**
- **MUN (12.1 vs 12.9 mg/dL, no significant difference)**
- **These differences for fat and protein between HDN and LDN herds at 30 kg of milk would result in a gross income difference of $9,125 for fat and $6,935 for protein per 100 milking cows per year.**

Factors Related to De novo Fatty Acid Synthesis

Less feed bunk space per cow (i.e., < 46 cm, or < 18 inches) was related to lower de novo fatty acids and lower fat and protein test.

Higher stall stocking density in pens (i.e., > 1.1 cows per stall) was related to lower de novo fatty acids and lower fat and protein test.

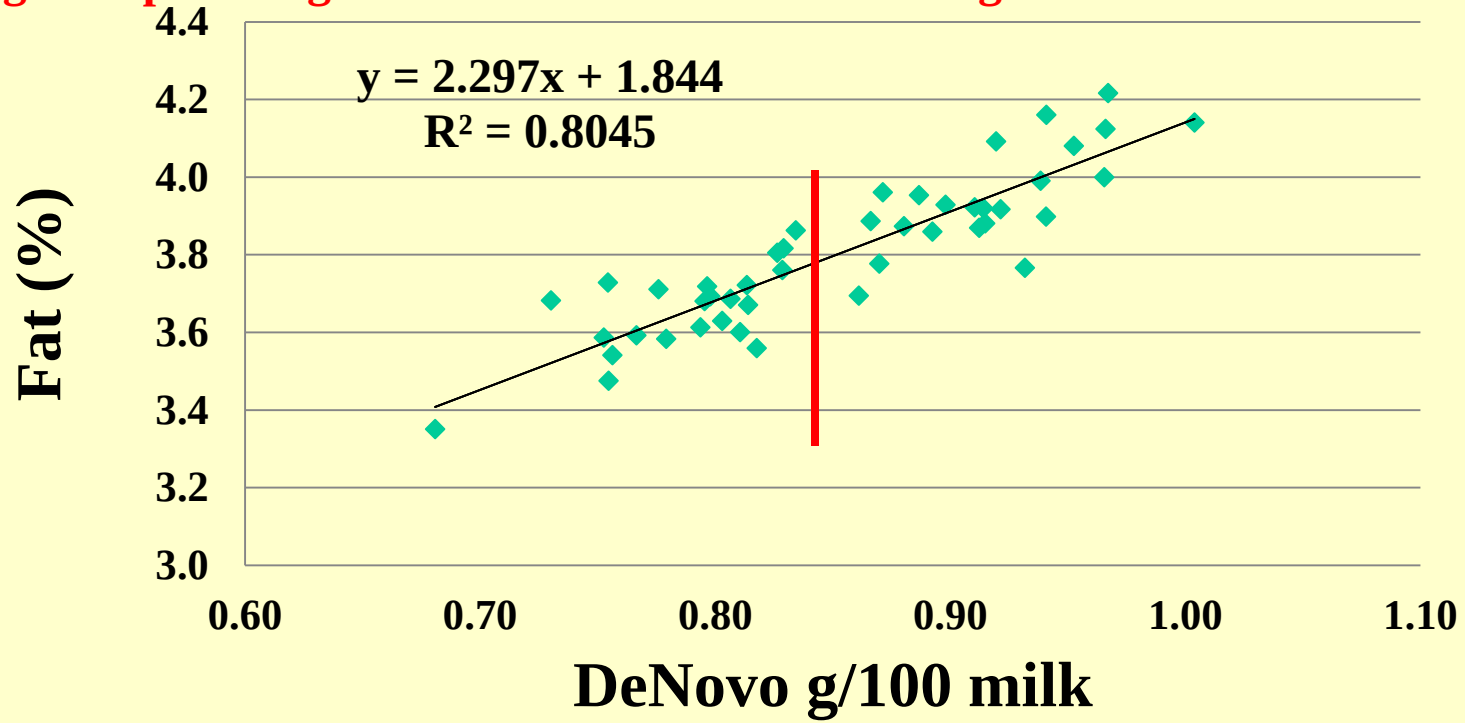
Higher average ether extract in the ration for lower de novo fatty acid farms.

Higher peNDF as a % of DM for the high de novo fatty acid farms (26.8 vs 21.4%) ($P < 0.01$)

40 Holstein Farms 2015

St Albans - Fat

If you want a fat test > 3.75% fat in bulk tank with Holsteins, then the de novo fatty acids in grams per 100 grams of milk needs to be > 0.85 g/100 milk

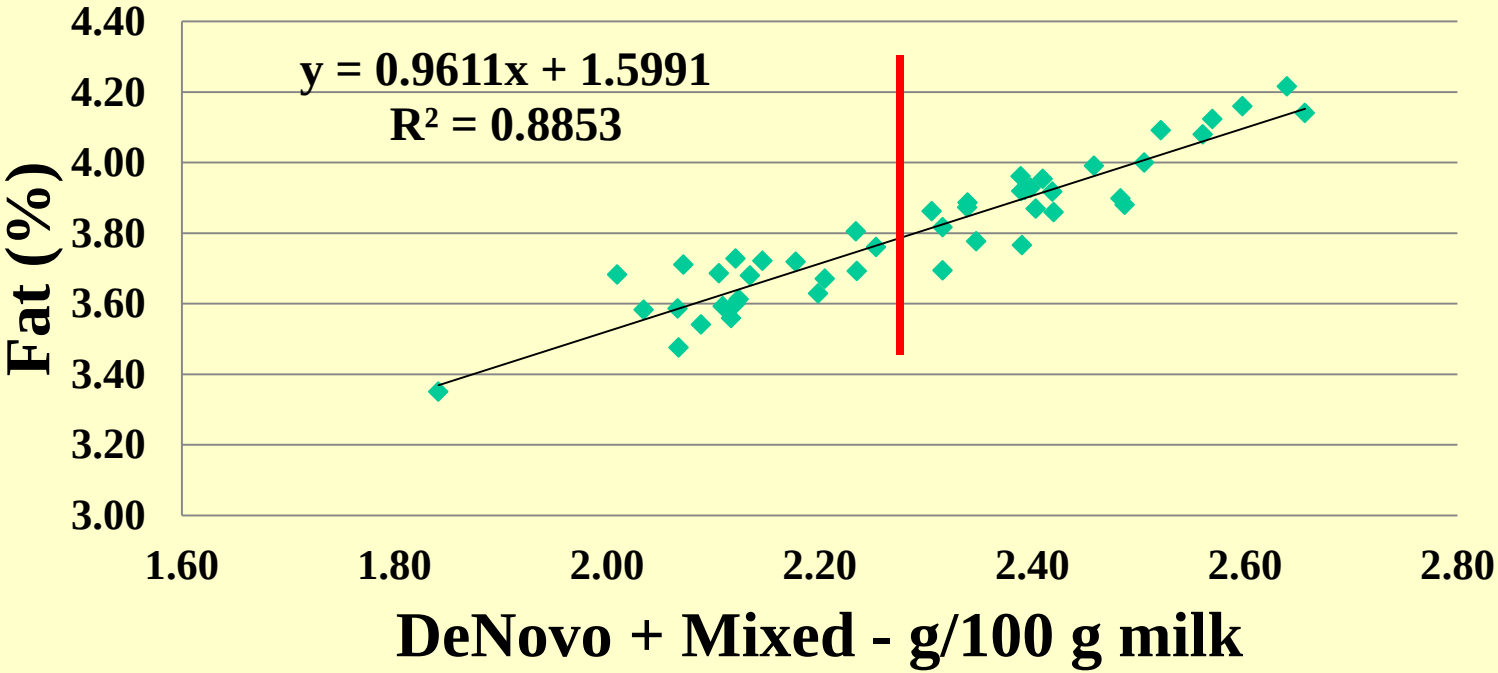


40 Farms Holstein Farms 2015

St Albans - Fat

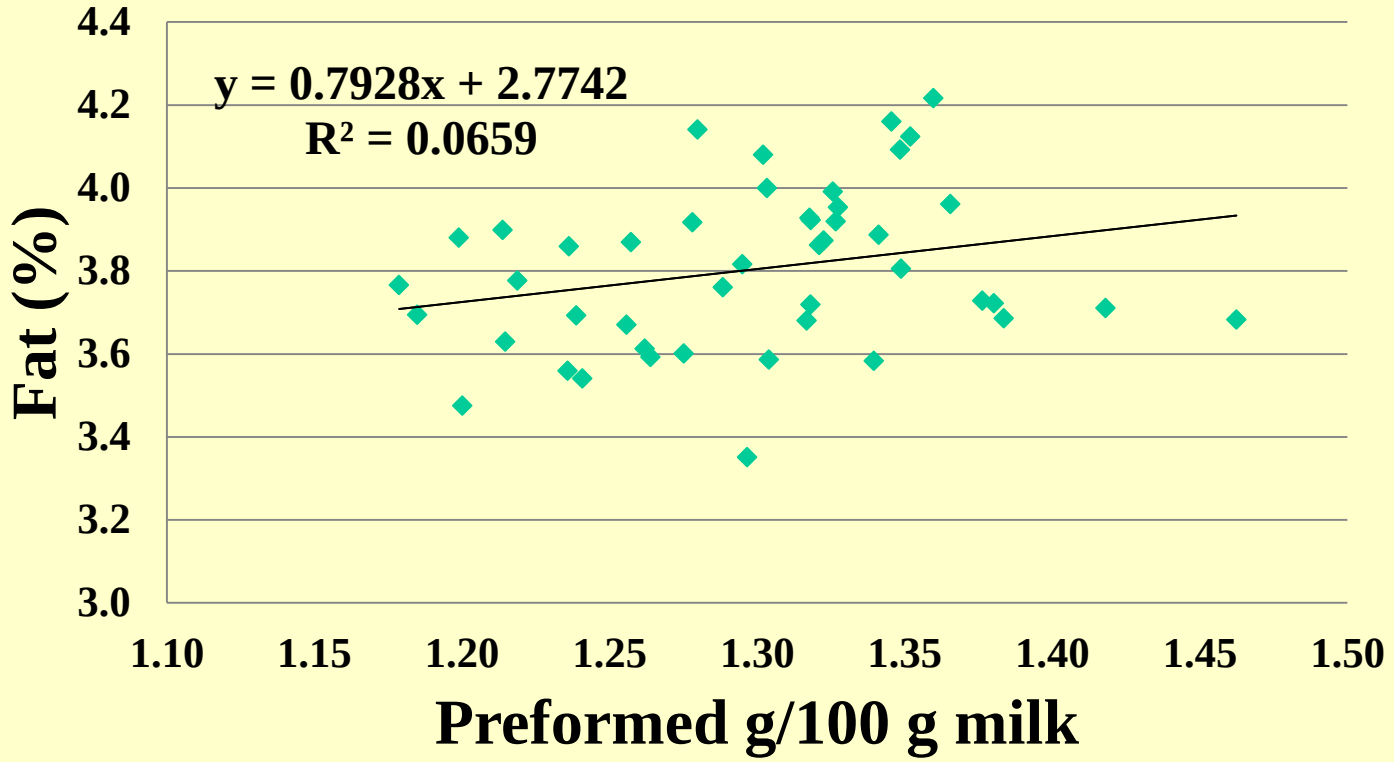
If you want a fat test > 3.75% fat in bulk tank with Holsteins, then the denovo + mixed fatty acids in grams per 100 grams of milk needs to be > 2.25 g/100 milk

Fat % vs DN + Mixed g/100 g Milk



40 Holstein Farms 2015

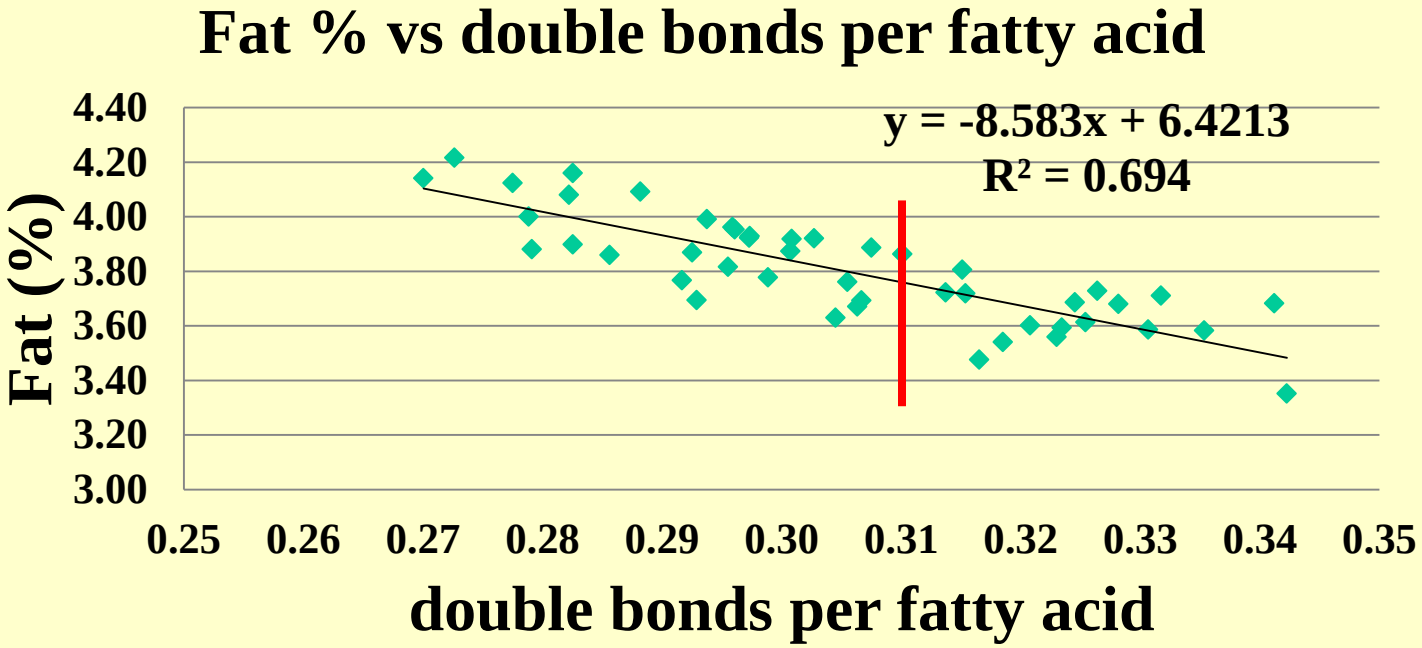
St Albans - Fat



40 Holstein Farms 2015

St Albans - Fat

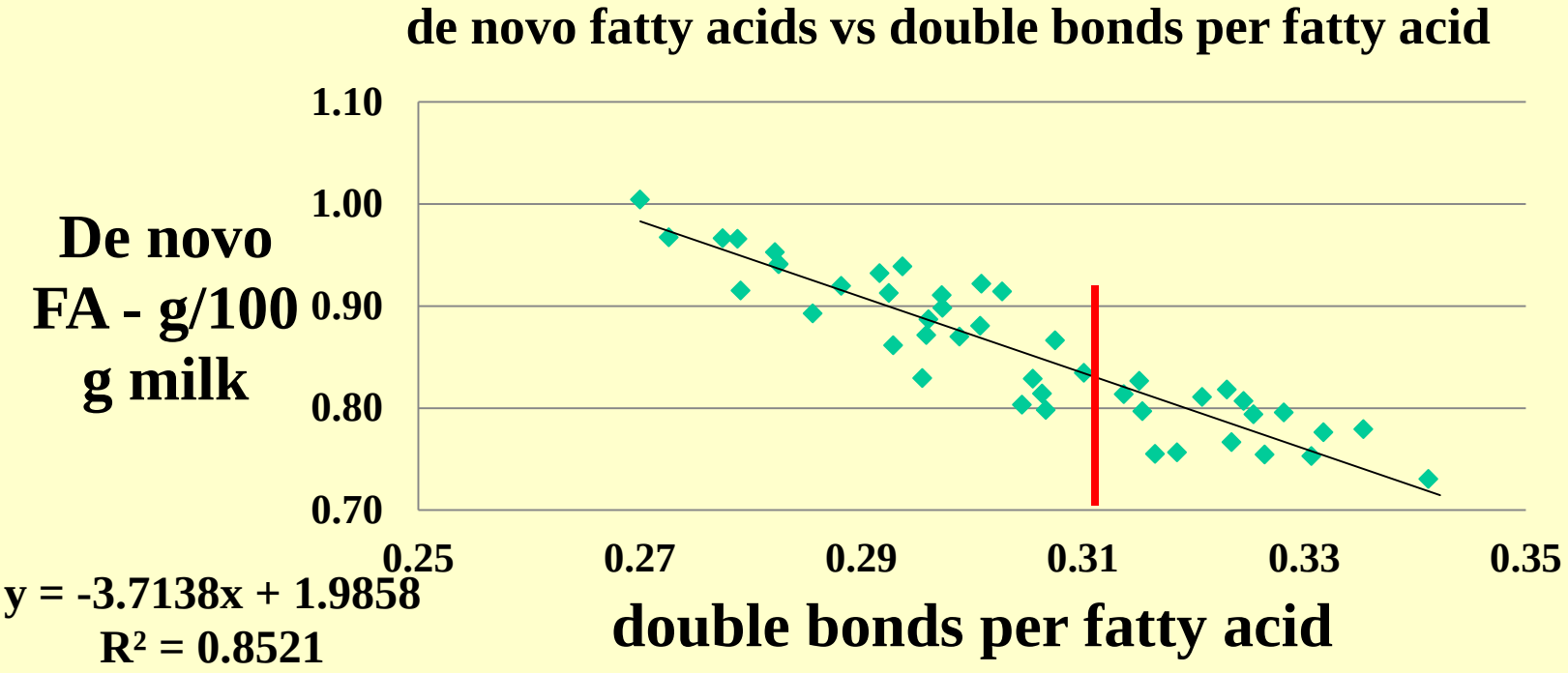
If you want a fat test > 3.75% fat in bulk tank with Holsteins, then the double bonds per fatty acid in milk fat needs to < 0.31.



40 Holstein Farms 2015

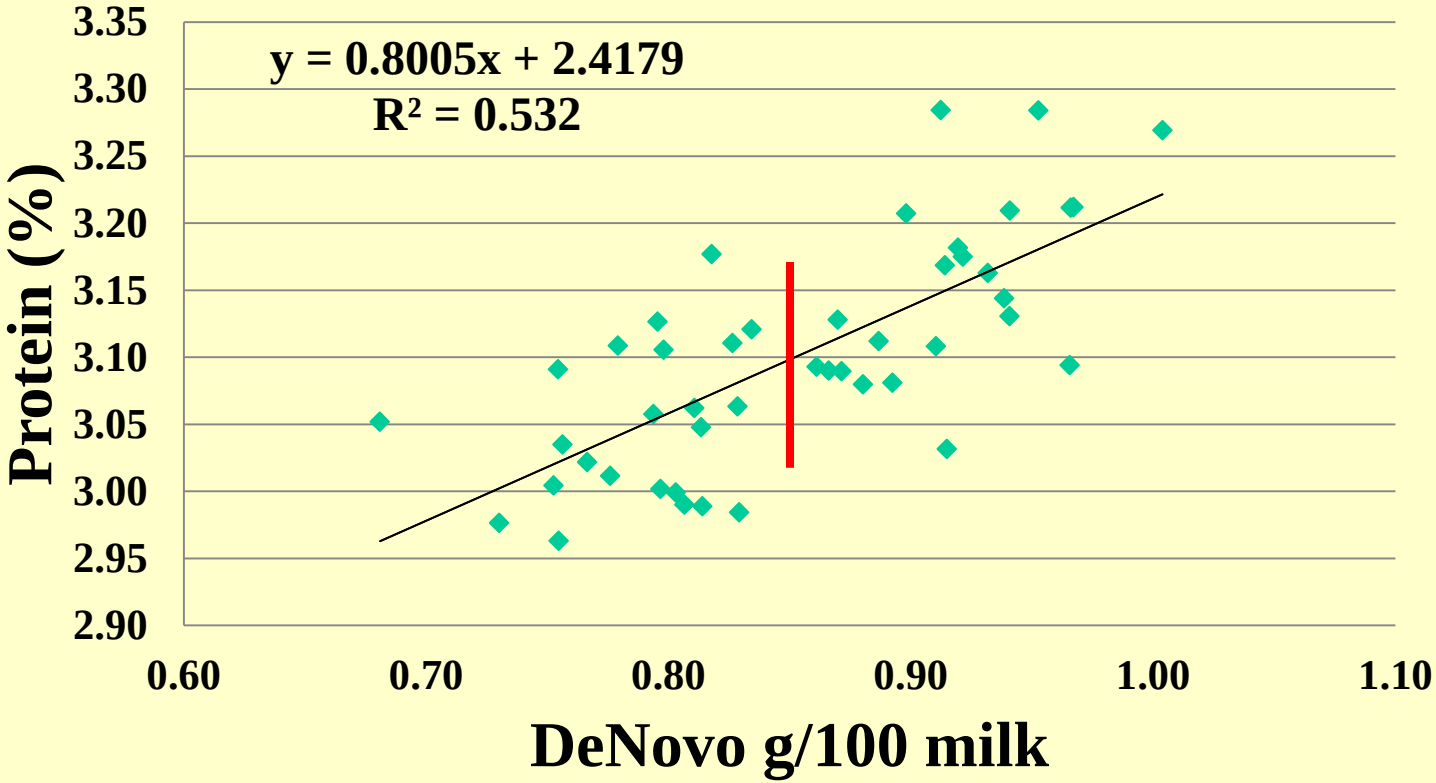
St Albans – Milk Fat Depression

As double bonds per fatty acid increases in milk fat, the output of de novo fatty acids decreases. This metric seems to indicate the overall level of milk fat depression



40 Holstein Farms 2015

St Albans - Protein



Outline

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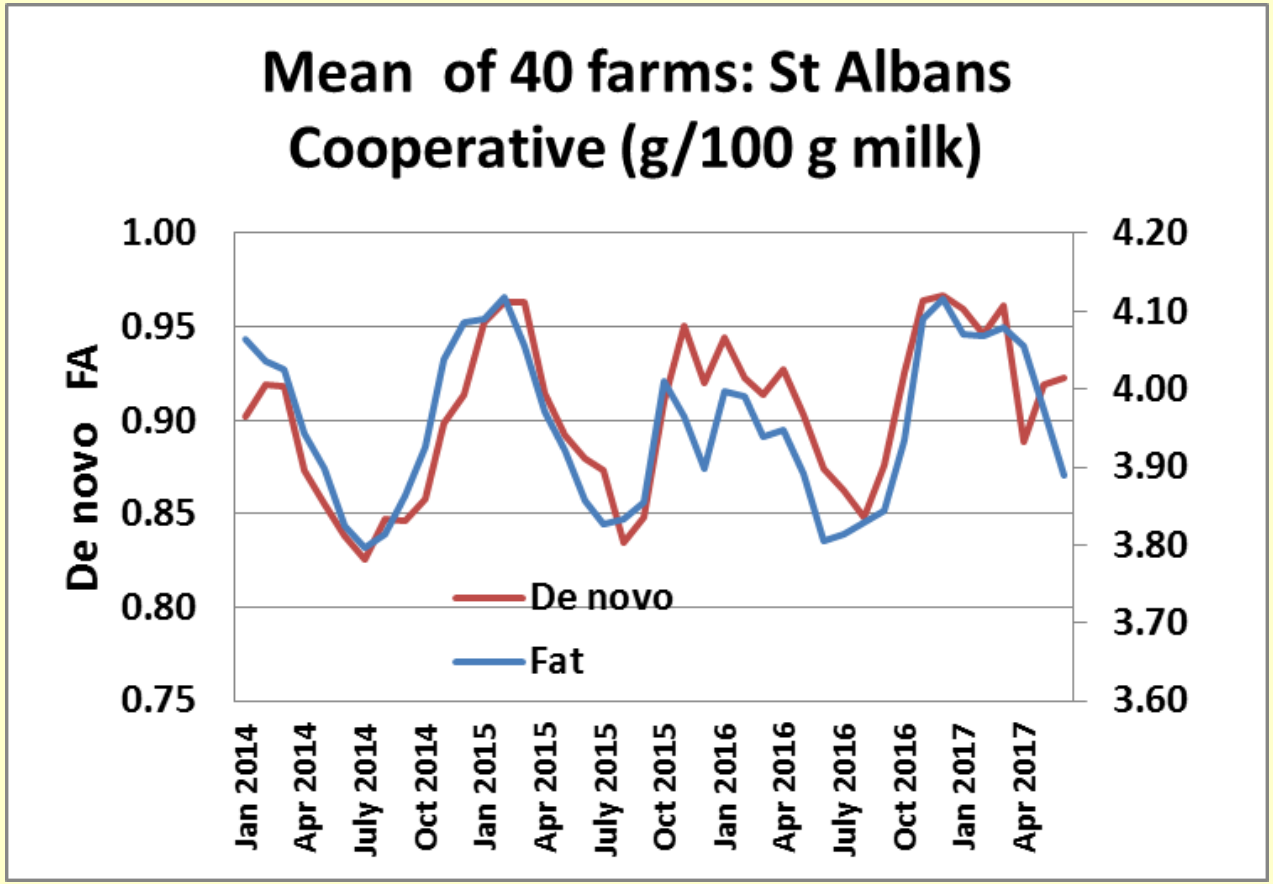
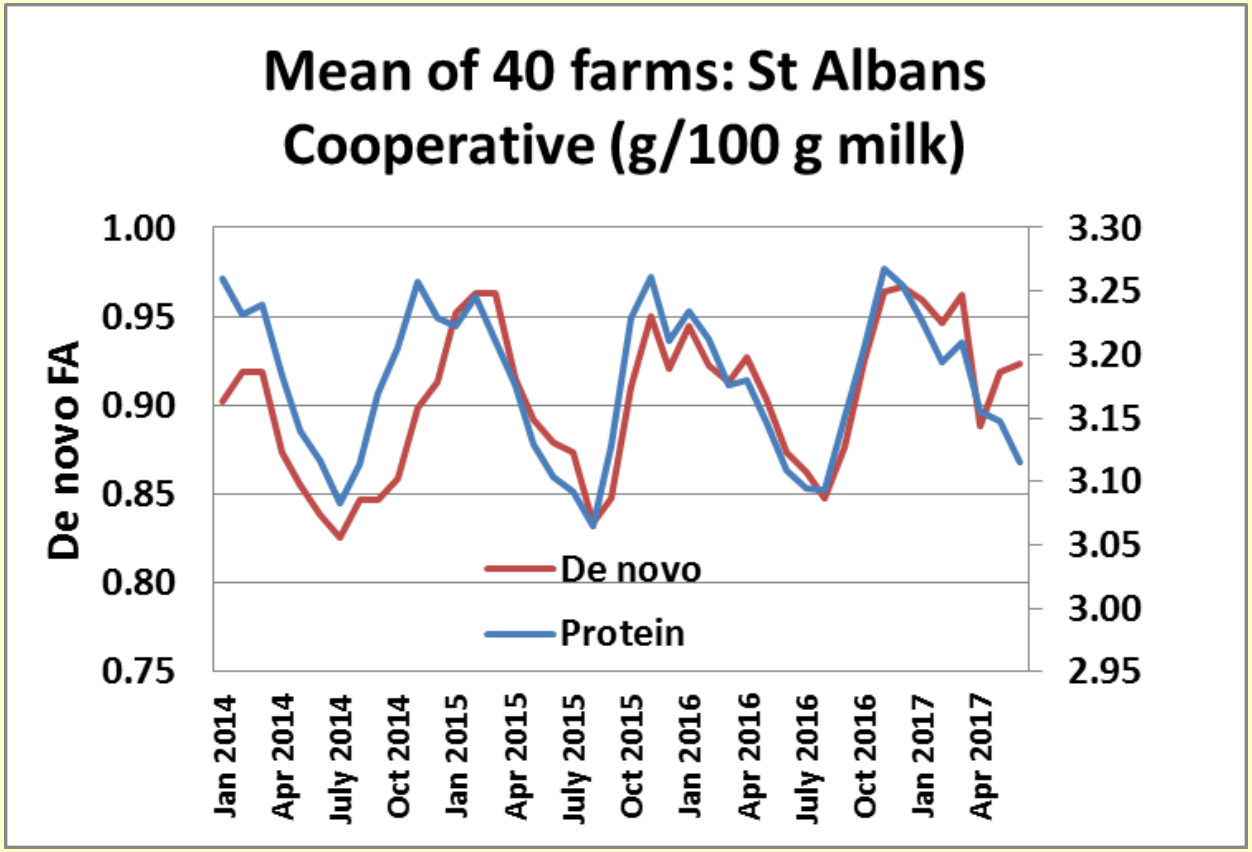
- Review of herd level milk fatty acid analysis and interpretation.
- **New data (herd level and individual cow level)**
  - **milk fatty acids: relation to seasonality of fat and protein**

Seasonality of Bulk Tank Milk - Fat



Seasonality of Bulk Tank Milk – Protein



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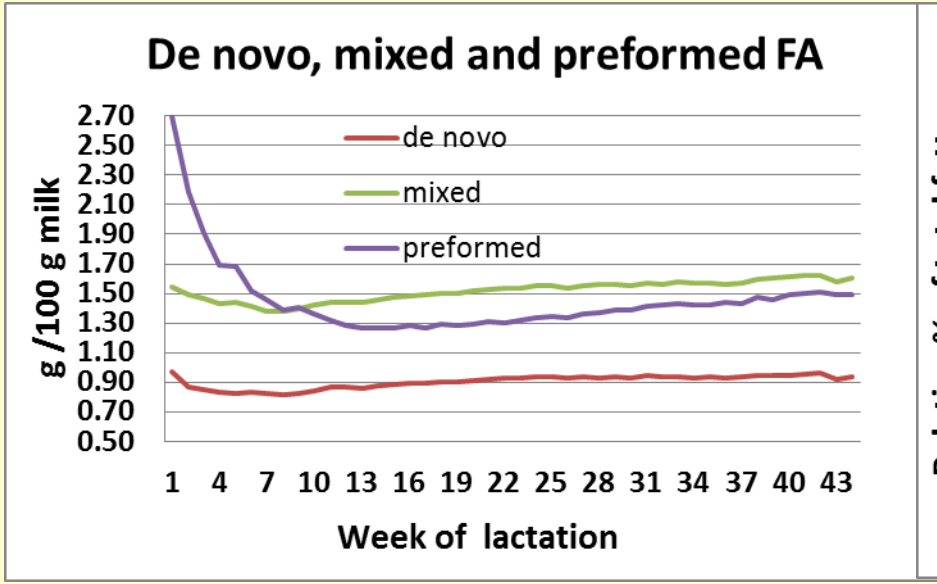
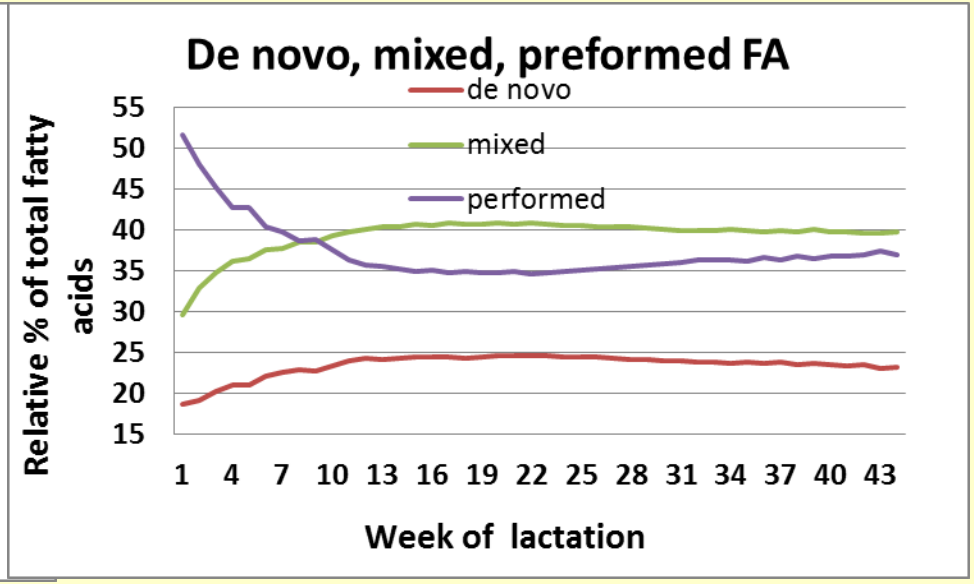
Stage of Lactation – Holstein





Herd producing an average of about 92 lb (41.77 kg) per cow per day on TMR feeding system.

Conclusions

1) Seasonality in fat and protein content of bulk tank milk is related to seasonality in de novo fatty acid levels in milk.

2) Stage of lactation has a large impact on milk fatty acid composition and when evaluating milk fatty acid data from feeding groups within a herd, mean days in milk needs to considered when interpreting data.

3) The relationship between variation in milk fatty acid composition and bulk tank milk fat and protein content for Holstein herds in the Northeast US is consistent with data collected from a wide diversity of 167 Holstein farms from across north America. (data not shown)

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  - data from 167 farms from all over the US – bulk tank
- **Future Directions**

Future Directions – New Metrics

Management Indices on Individual Cows

Blood Chemistry Measures (done on MILK!!! Every milking???)

- **Blood NEFA**
- **Blood BHB**
- **Milk urea nitrogen (MUN)**
- **Stress/inflammation compounds?**
- **others – related to reproduction??**

Used: Milk Fat Depression, Predict Ketosis, DA, acidosis, and reproductive performance

Rumen Function

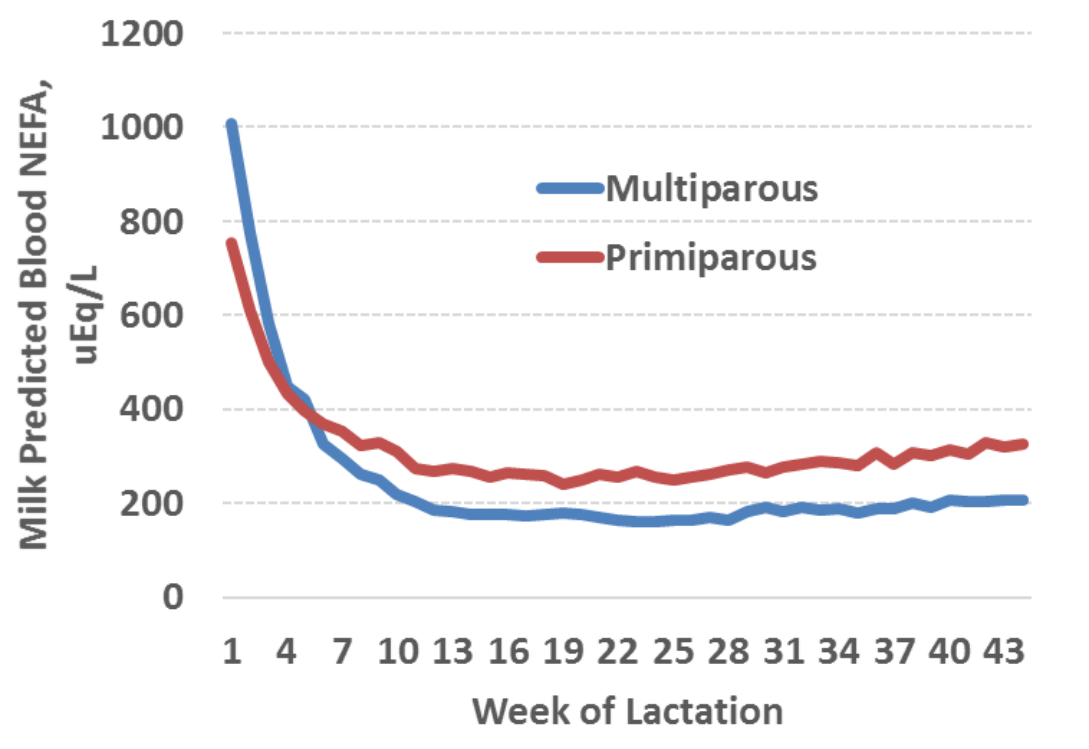
- **prediction of rumen pH?**

Future Directions – Transition Cow Health Diagnostics

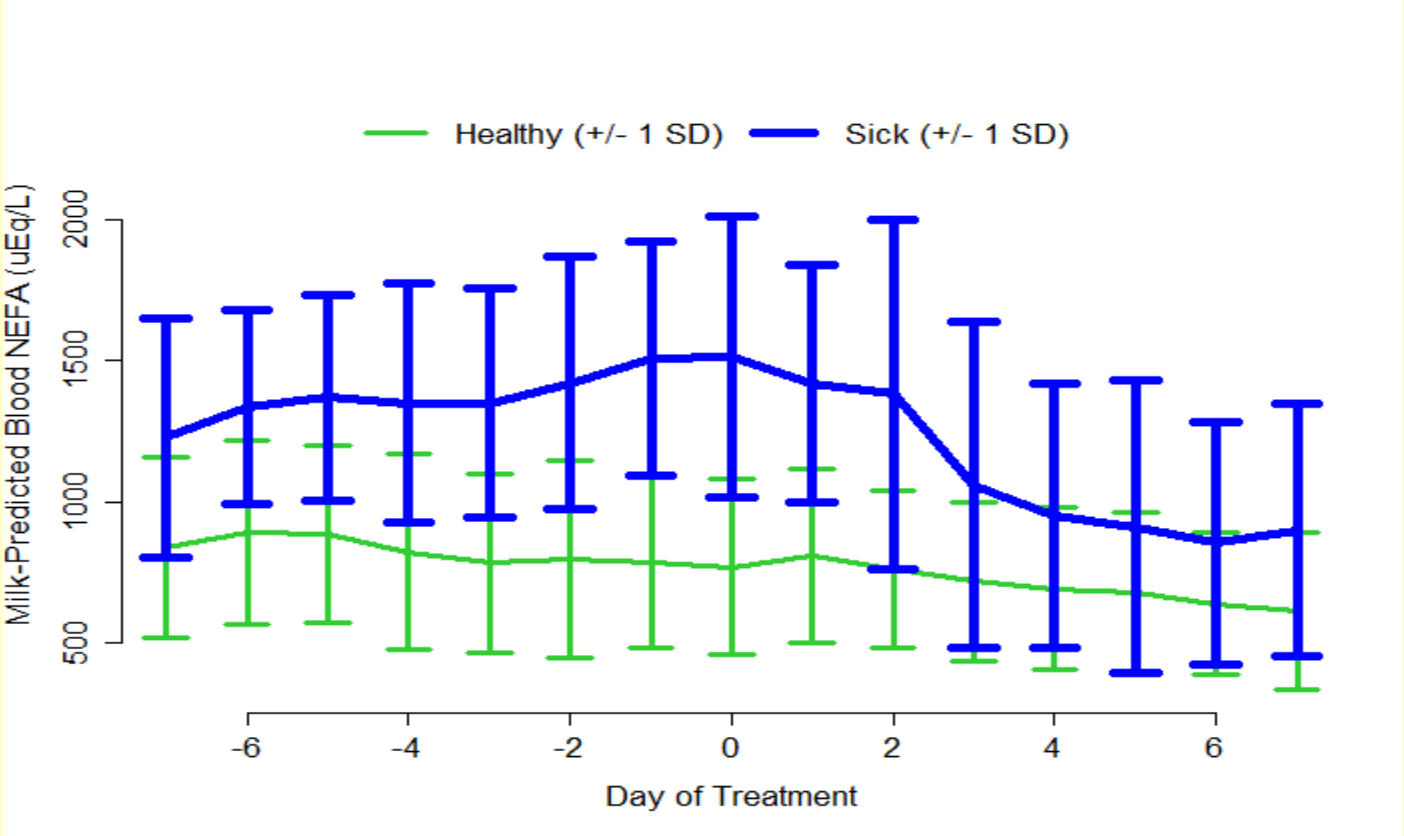
1) **Measurement of milk estimated blood NEFA and de novo fatty acid expressed on a relative basis (i.e., % of total fatty acids) allows rapid identification (day 4 to 7 in lactation) of transition cows that are going to diagnosed with clinical ketosis or with a displaced abomasum.**
2) **These milk-based transition cow analytical tools provide an opportunity to intervene earlier thereby improving recovery while reducing the negative impact of these adverse metabolic health events on animal welfare and lactation performance.**

Future Directions:(estimated blood NEFA)

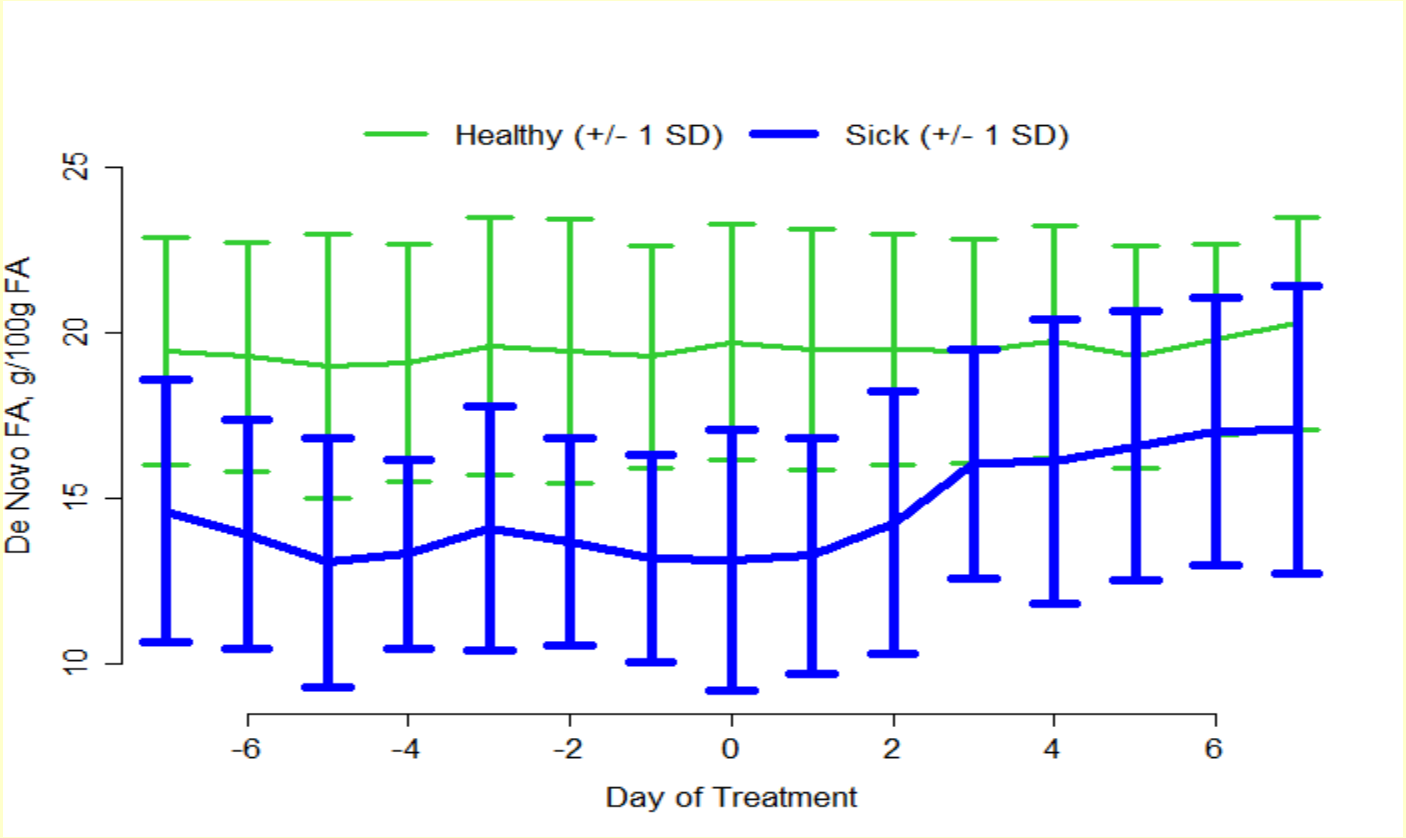
Change in estimated blood NEFA with days in milk



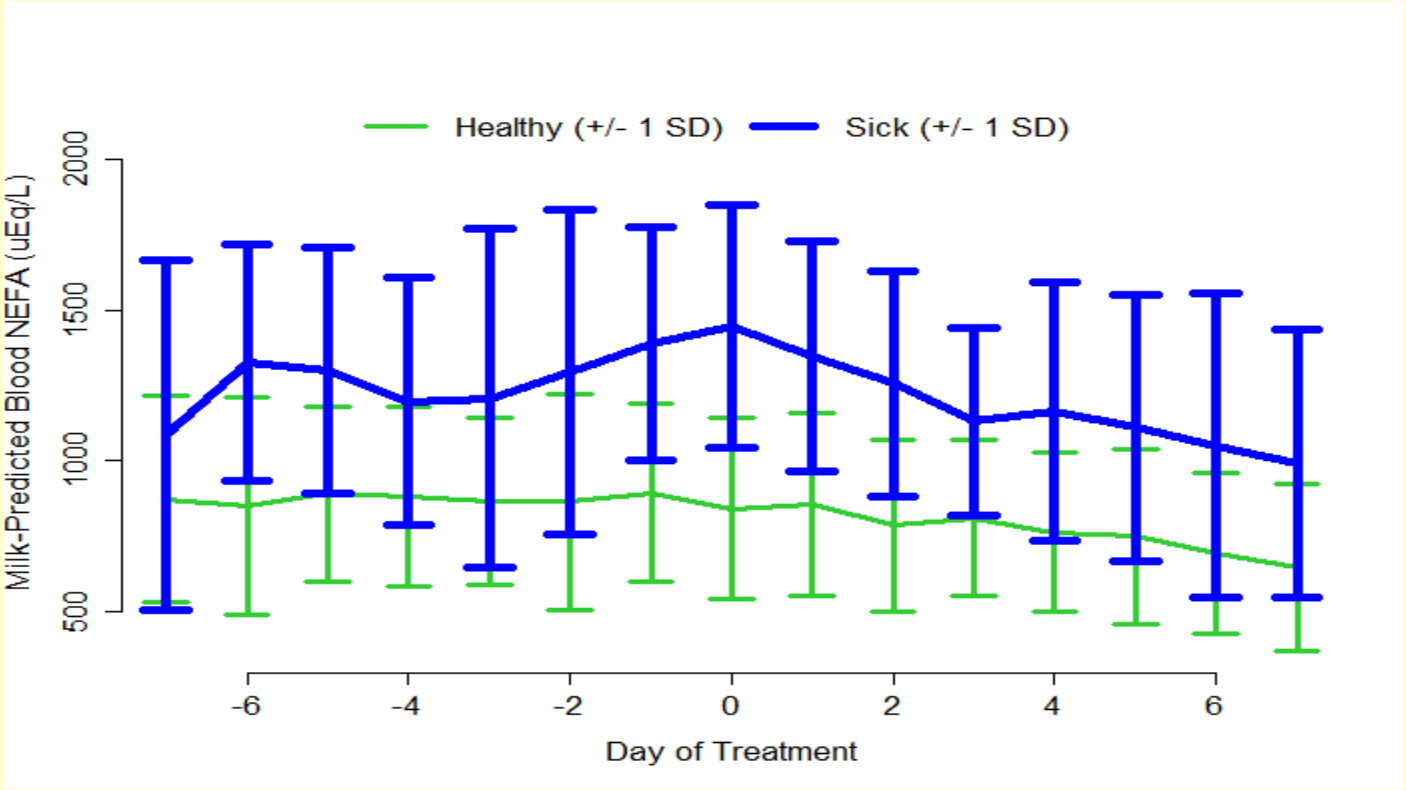
Future Directions –Displaced Abomasum (blood NEFA)



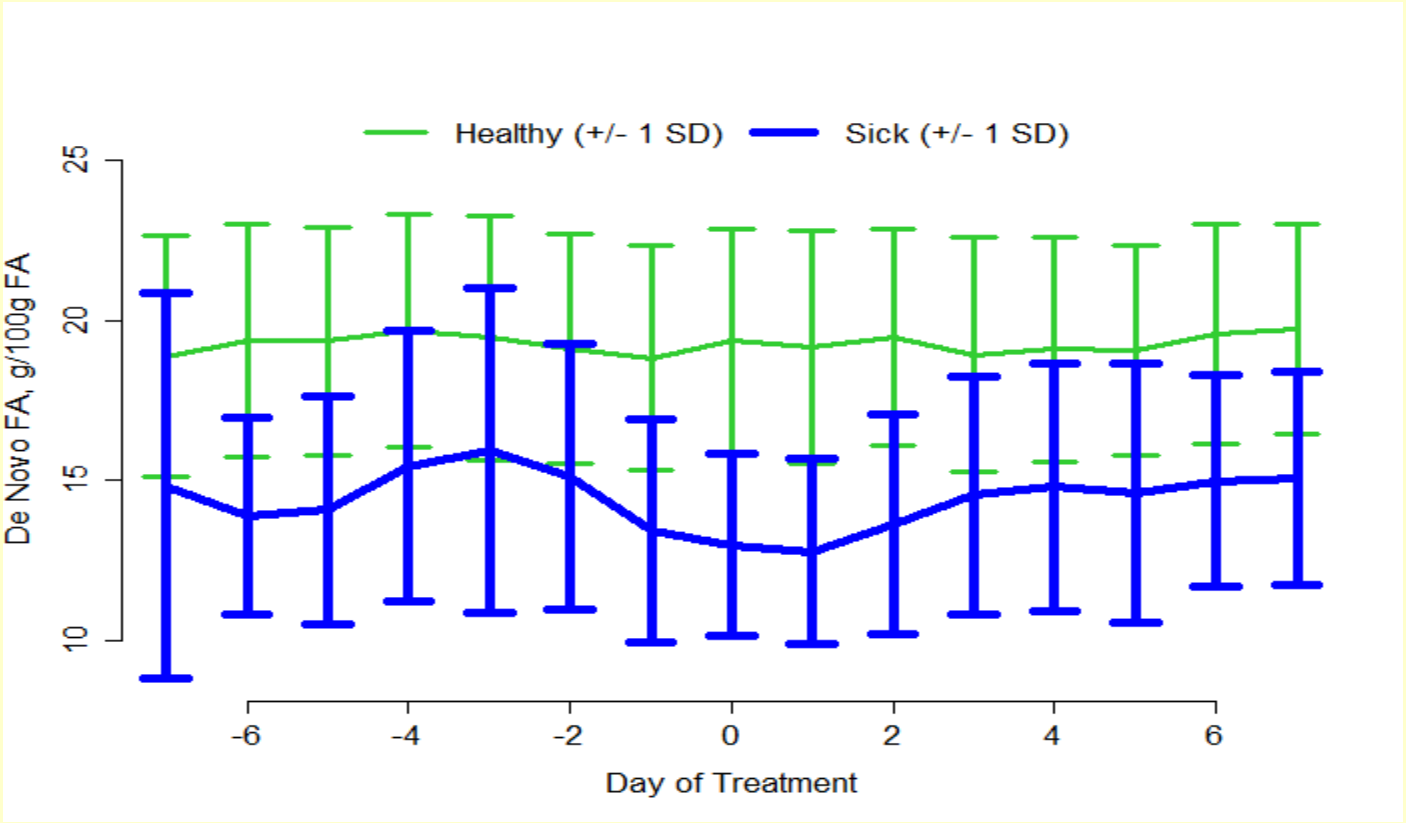
Future Directions –Displaced Abomasum (de novo FA)



Future Directions – Clinical Ketosis (blood NEFA)



Future Directions – Clinical Ketosis (de novo FA)



Acknowledgments

The lab staff at St. Albans Cooperative for infrared milk testing of fatty acid composition of bulk tank milk of 430 farms over 4 years and Miner Institute (R. Grant, H. Dann, M. Woolpert and many others) for individual cow milk and blood samples.

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The USDA Federal Milk Markets for support of the development of improved milk testing methods.

Shawn Landersz for "Cow of Interest" video production.
www.landersz.com

Questions??