New Milk Analysis Technologies to Improve Dairy Cattle Performance

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NYS Cheese Makers Meeting

March 6, 2017

Outline

- **Current Status of Precision Management Milk Testing.**
- **What Do Farmers Want?**
- **An example of connecting analytical measures to meet dairy farmer needs.**
- **Future Directions**
  - **Farm management and sustainability**

Precision Management Milk Testing

- **AfiMilk – Near IR – fat and protein combined with milk weight. Built into the milking system.**
- **Antibiotic testing (rapid milk testing).**
- **Mid-IR for milk components and milk SCC: done on some large farms with traditional laboratory testing equipment. Normally manual instruments are used.**

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.

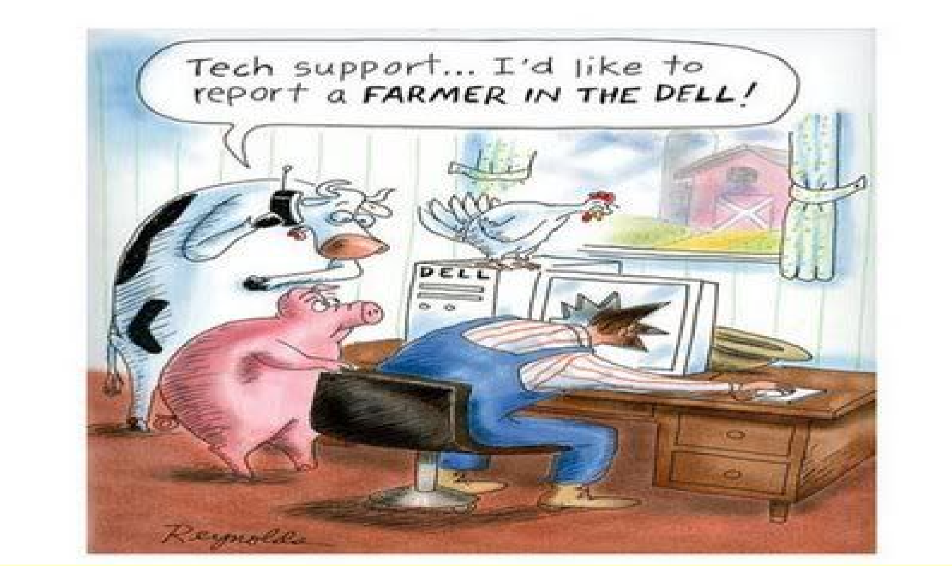
The success of farm management ultimately depends on correct decisions on an animal by animal basis. The challenge is to find the cow of interest, make a decision, and take action.

What Do Dairy Farmers Want?

Farms are getting larger, more technology (satellite technology, cloud based internet tools and information) and new tools are becoming available every day.

It is easy to be a bit overwhelmed by all of this.

In the end, milk production is all about the sum of the performance of all the individual cows.   The farmer needs information upon which to make decisions, not data.



What Do Dairy Farmers Want?

In the end, milk production is all about the sum of the performance of all the individual cows. The farmer needs information upon which to make decisions, not data.

So how can today's new technology be better harnessed to manage each individual cow?

Each cow needs to be a "Cow of Interest"

An interesting TV Program

"Person of Interest"


www.MichaelEmerson.pl

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

- Current Status of Precision Management Milk Testing.
- What Do Farmers Want?
- **An example of connecting analytical measures to dairy farmer needs.**
  - **Milk fatty acid composition**

Connecting with Dairy Farmer Needs

- **Overall Vision**

  Develop new tools in milk analysis for bulk tank and individual cow milks that will provide information to support decision making for management of feeding, health, and reproduction in dairy cows.

Objectives

1. **To develop a new rapid analysis tool to measure fatty acid composition in a format that is useful for farm management.**

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

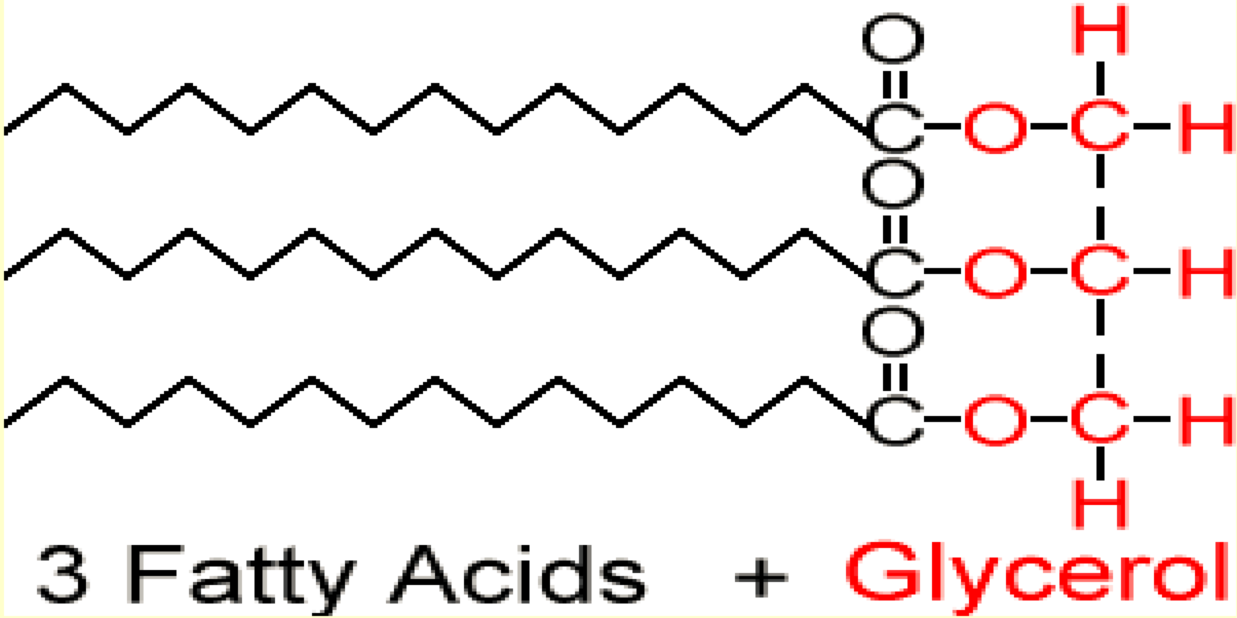
Fatty acid calibration was done once per month with reference milks produced at Cornell. The instrument tests about 50 to 70 samples per hour for all components, NPN/urea, and all fatty acid parameters. The automated model runs 600 samples per hour.

Connecting with Dairy Farmer Needs

Bulk Tank Milk Testing

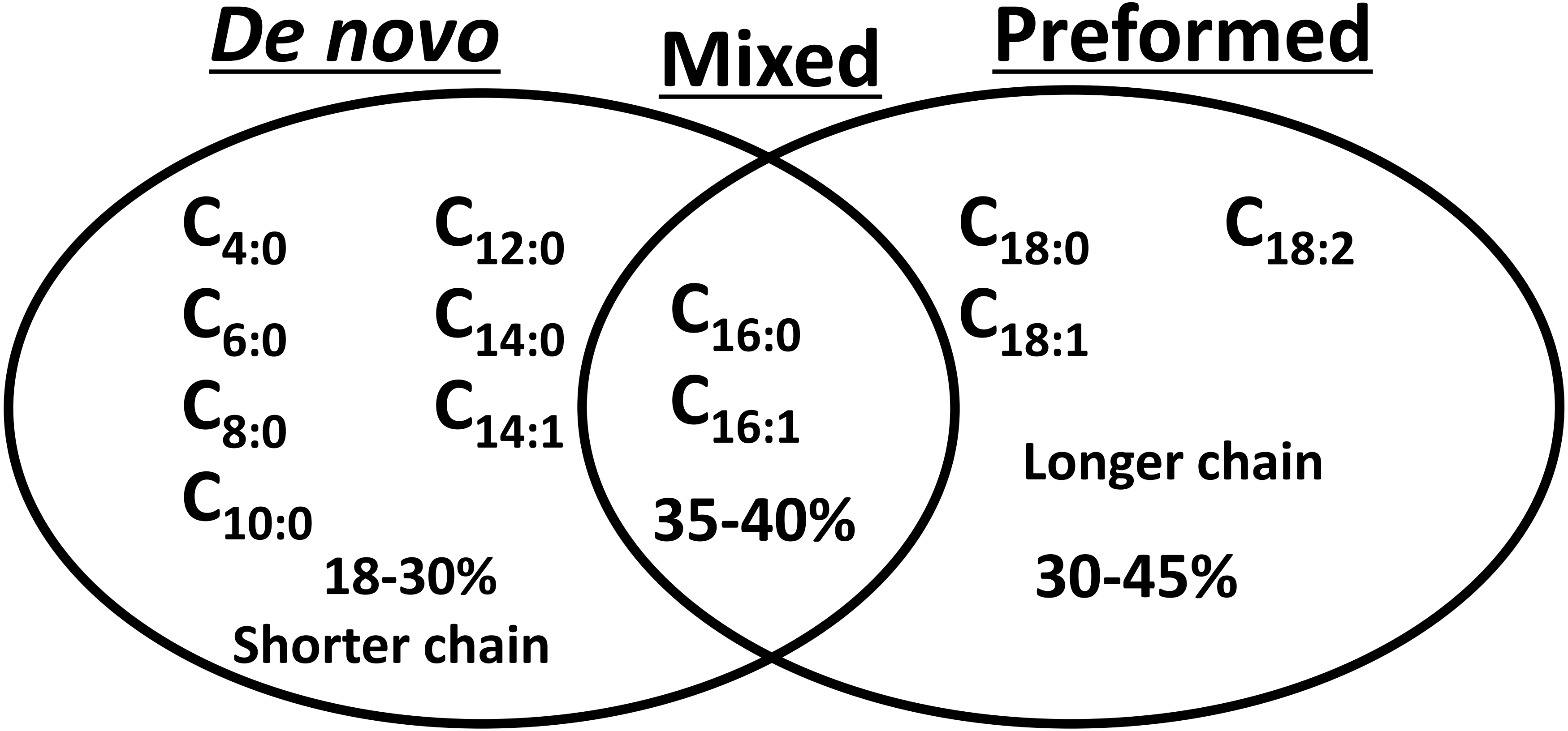
Efficiency of forage utilization (*de novo* fatty acids)

Milk Fat Structure

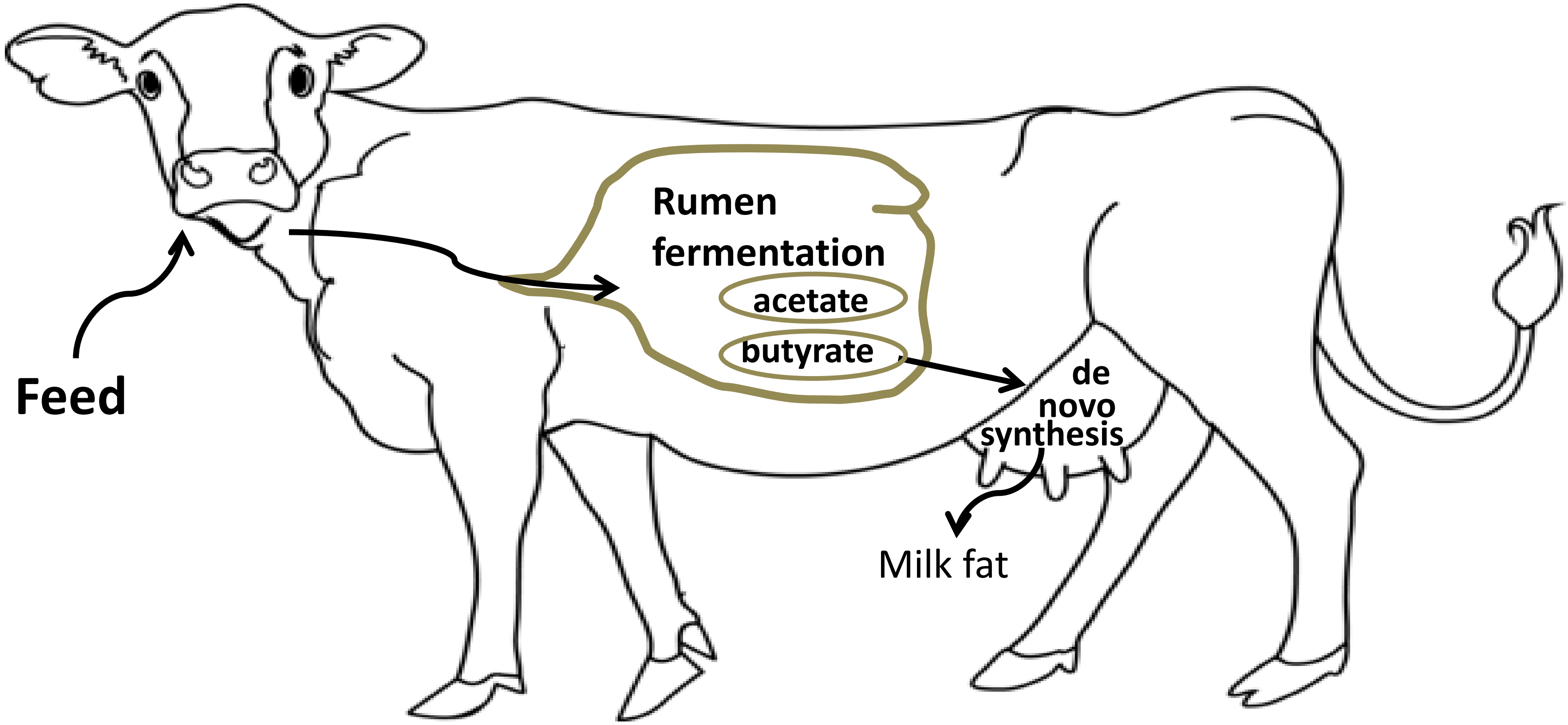


3 fatty acids per triglyceride

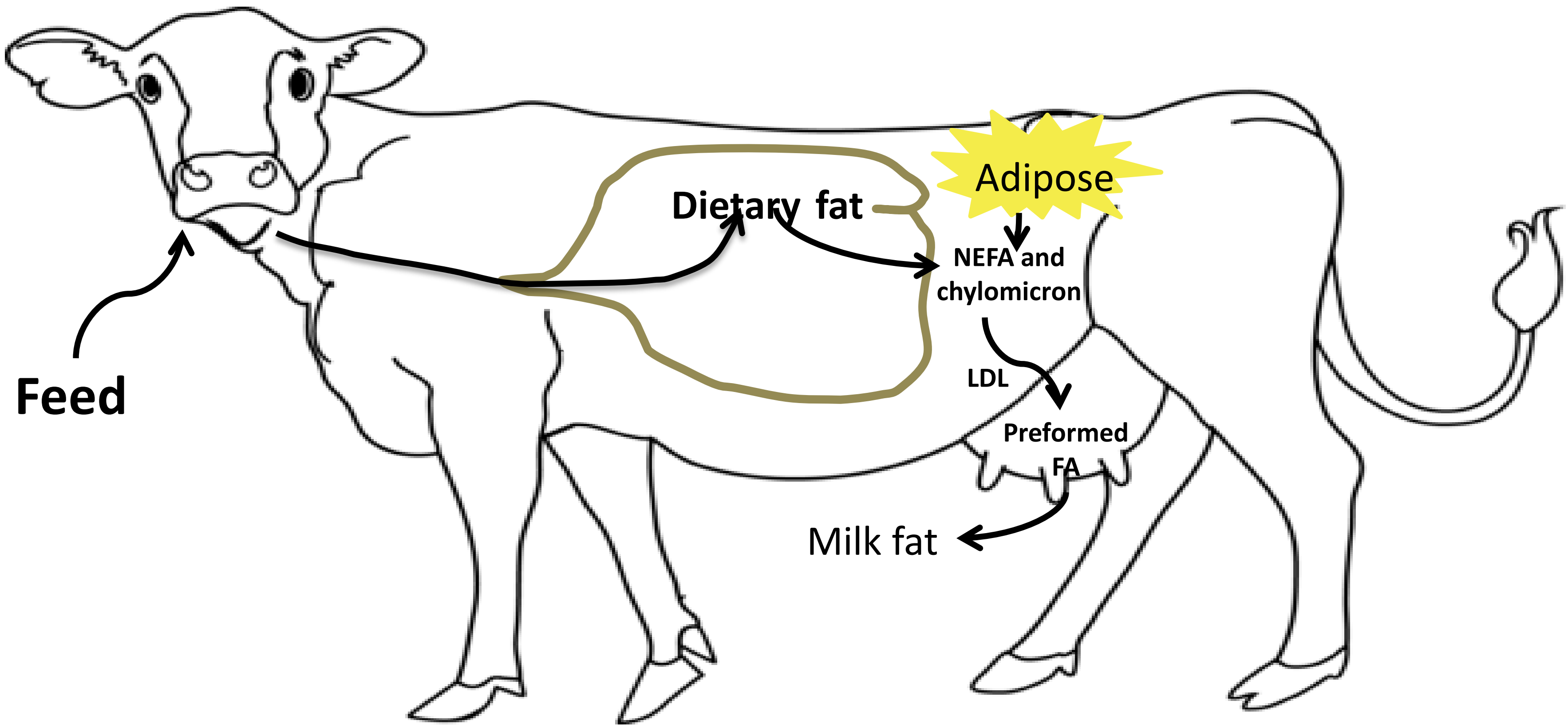
Milk Fatty Acid Origin



De novo Fatty Acid Synthesis



Preformed Fatty Acids



Objectives

1. **To develop a new rapid analysis tool to measure milk fatty acid composition in a format that is useful for farm management.**

2. **To determine how to use the milk fatty acid composition data on bulk tank and individual cow milk samples for feeding and health management of dairy cows.**

Conclusions from Preliminary Work: 430 farm survey of milk fatty acid composition for 2 years at the St Albans Cooperative in St Albans, Vermont. As de novo fatty acids in the bulk tank milk increased, the fat and protein concentration increased.

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

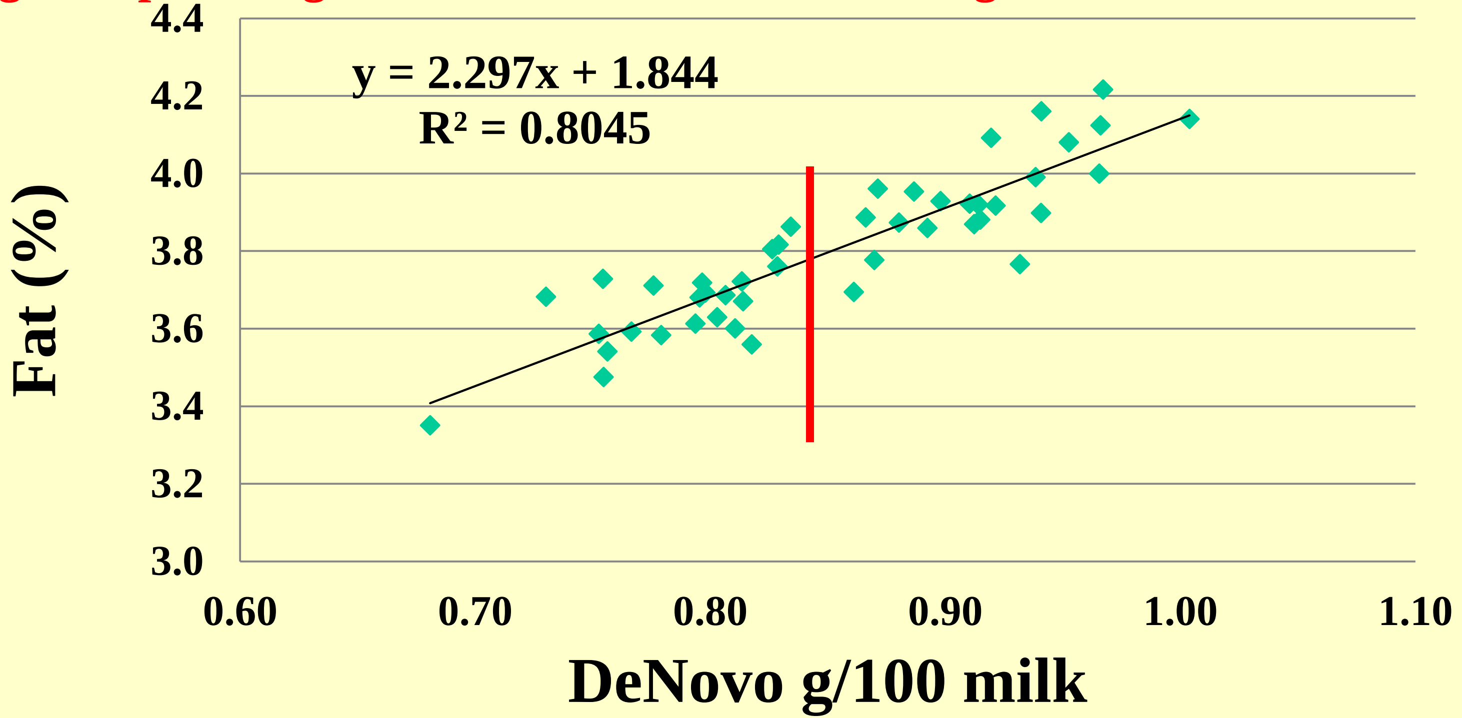
Mean relative milk fatty acid composition for each group of 10 farms for the 15 month period: *de novo*, mixed origin, and preformed fatty acids

St Albans June 2012 through August 2013

Breed	Group	% Fat	% True Protein	g/100 g FA Denovo	g/100 g FA Mixed	g/100 g FA 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

40 Holstein Farms 2015
St Albans - Fat

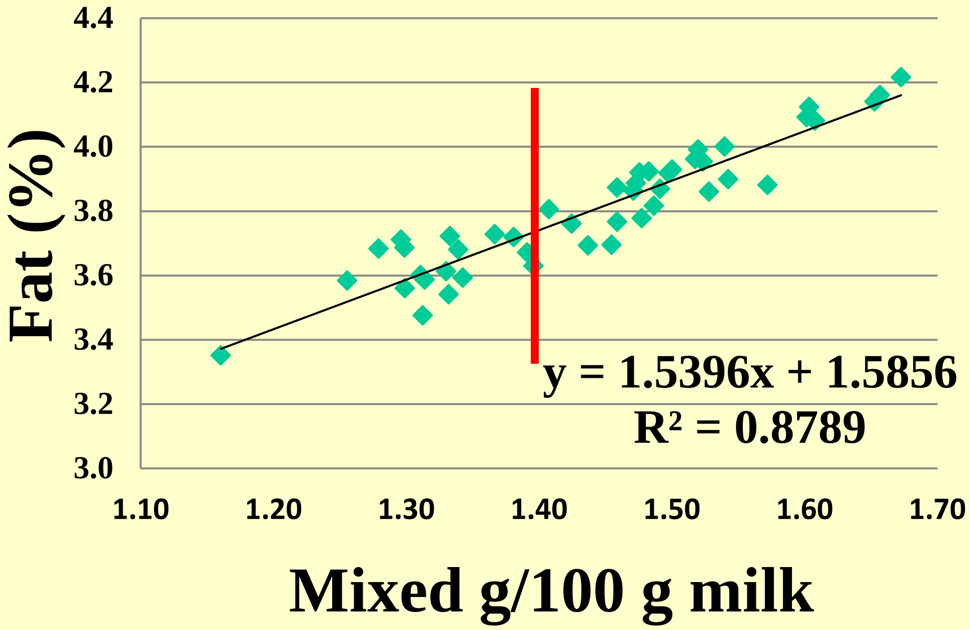
If you want a fat test > 3.75% fat in bulk tank with Holsteins, then the de novo fatty acids in grams per 100 grams of milk needs to be > 0.85 g/100 milk



40 Holstein Farms 2015

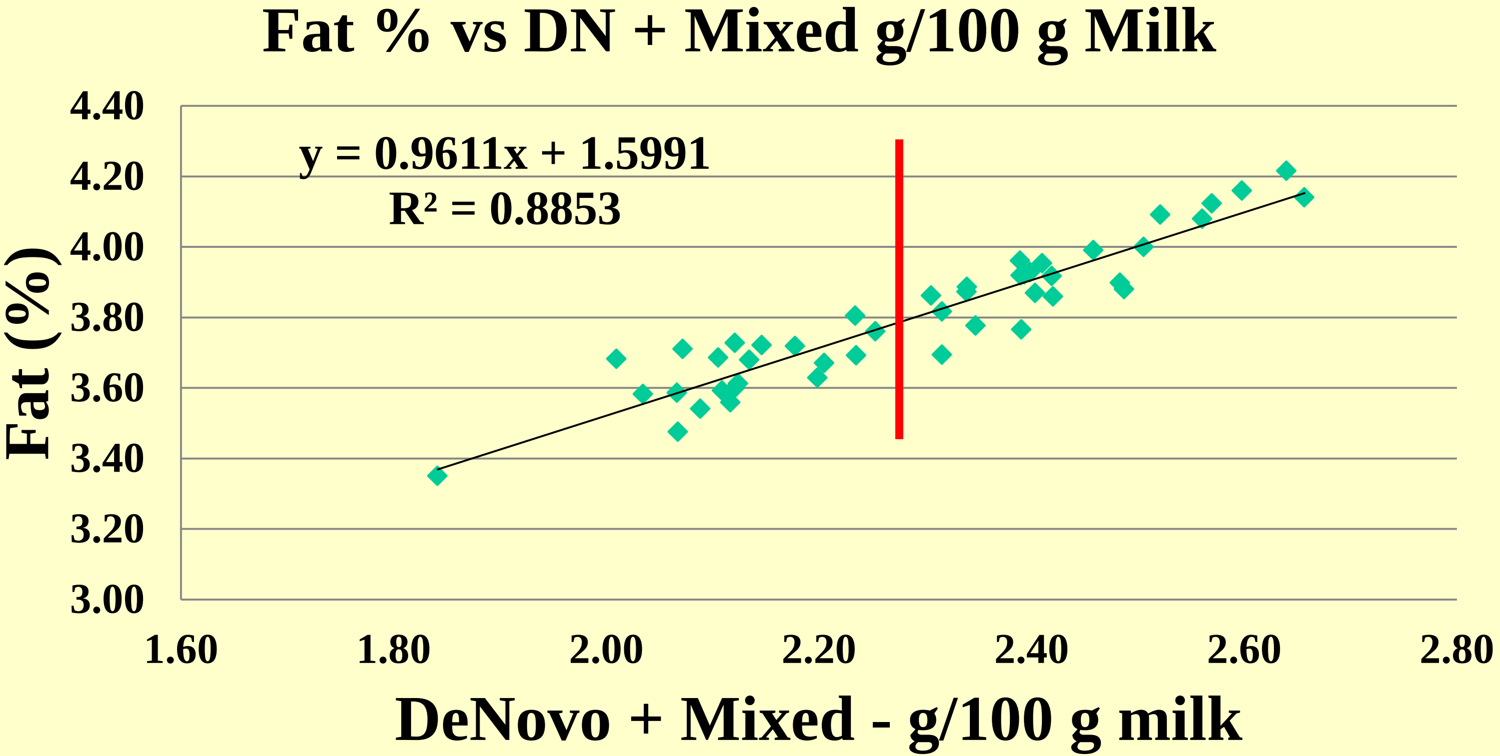
St Albans - Fat

If you want a fat test > 3.75% fat in bulk tank with Holsteins, then the mixed origin fatty acids in grams per 100 grams of milk needs to be > 1.40 g/100 milk

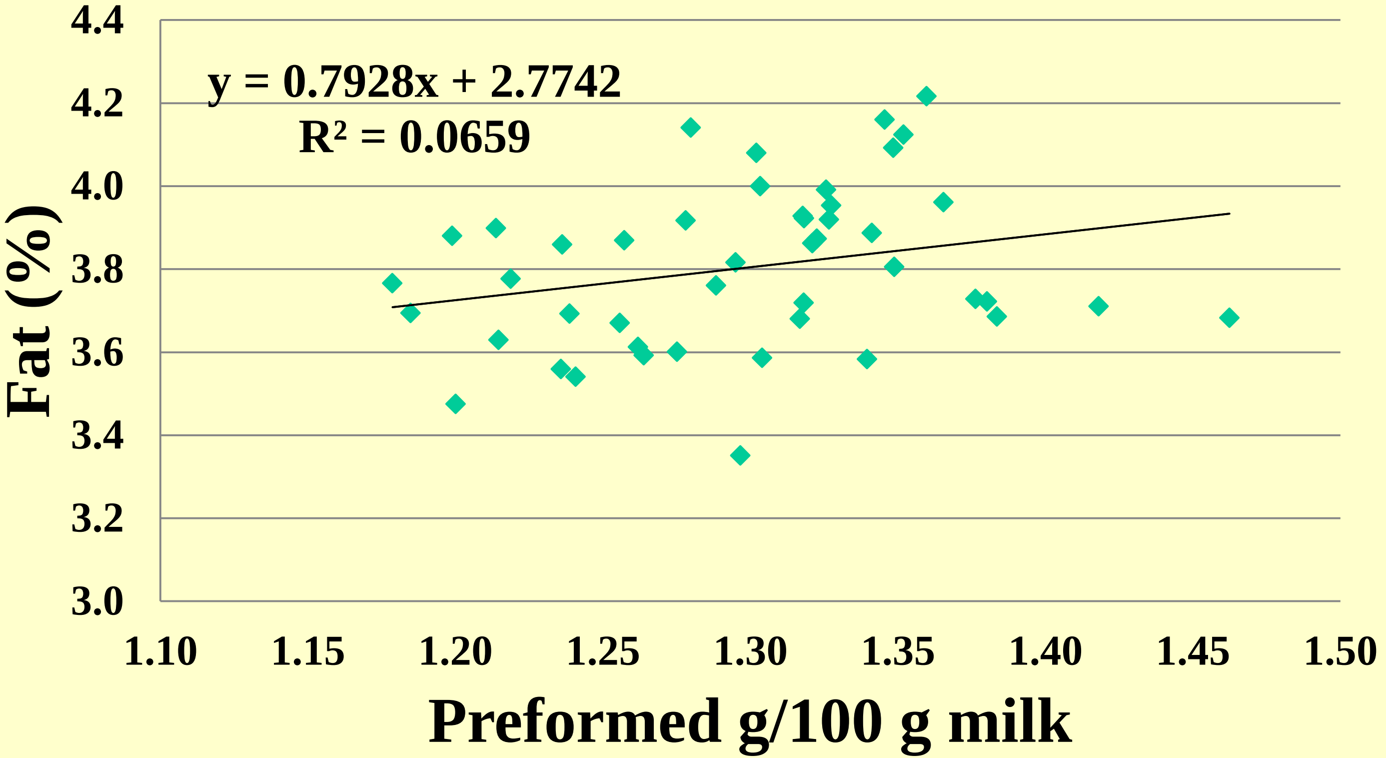


40 Farms Holstein Farms 2015
St Albans - Fat

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



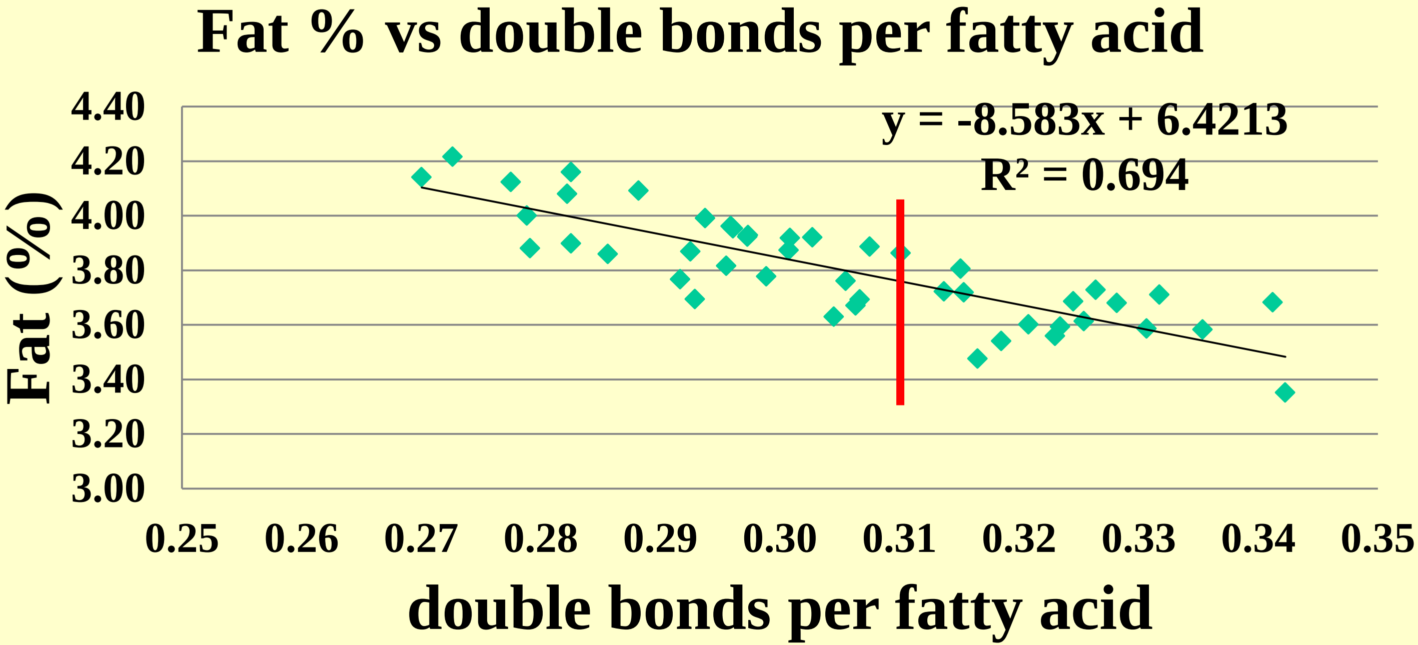
40 Holstein Farms 2015
St Albans - Fat



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.

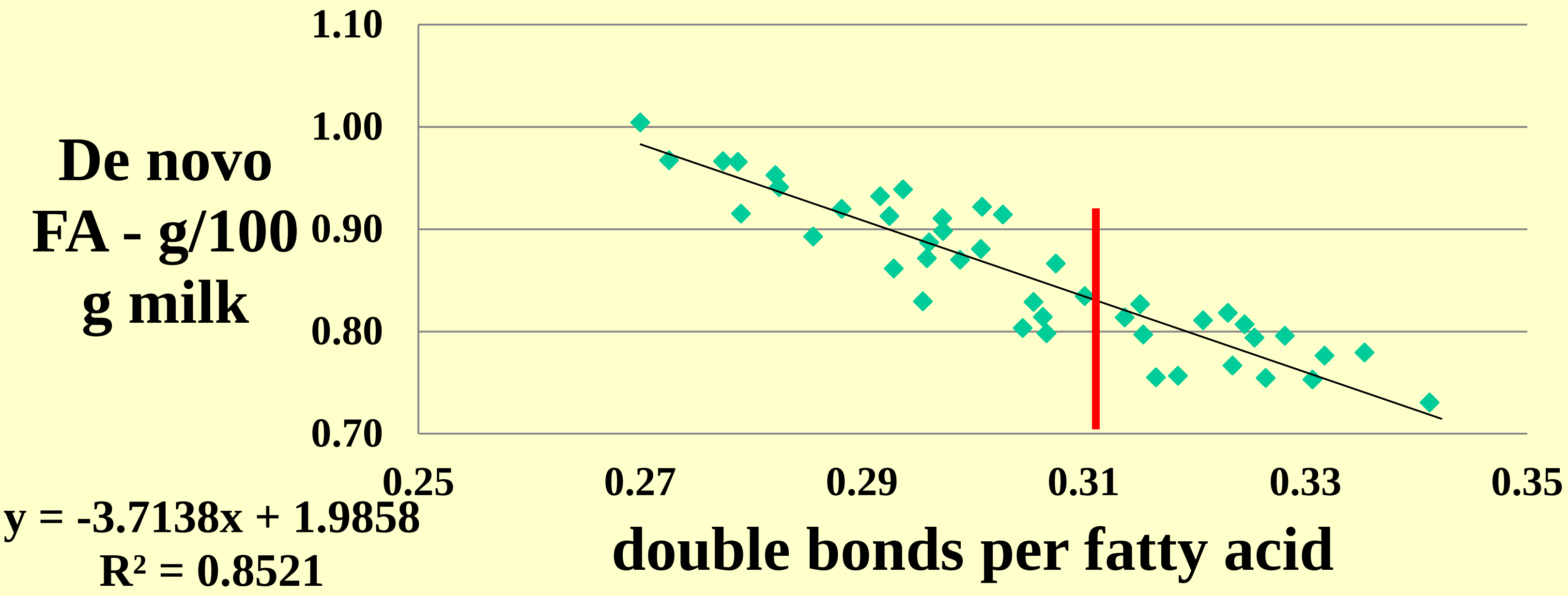


40 Holstein Farms 2015

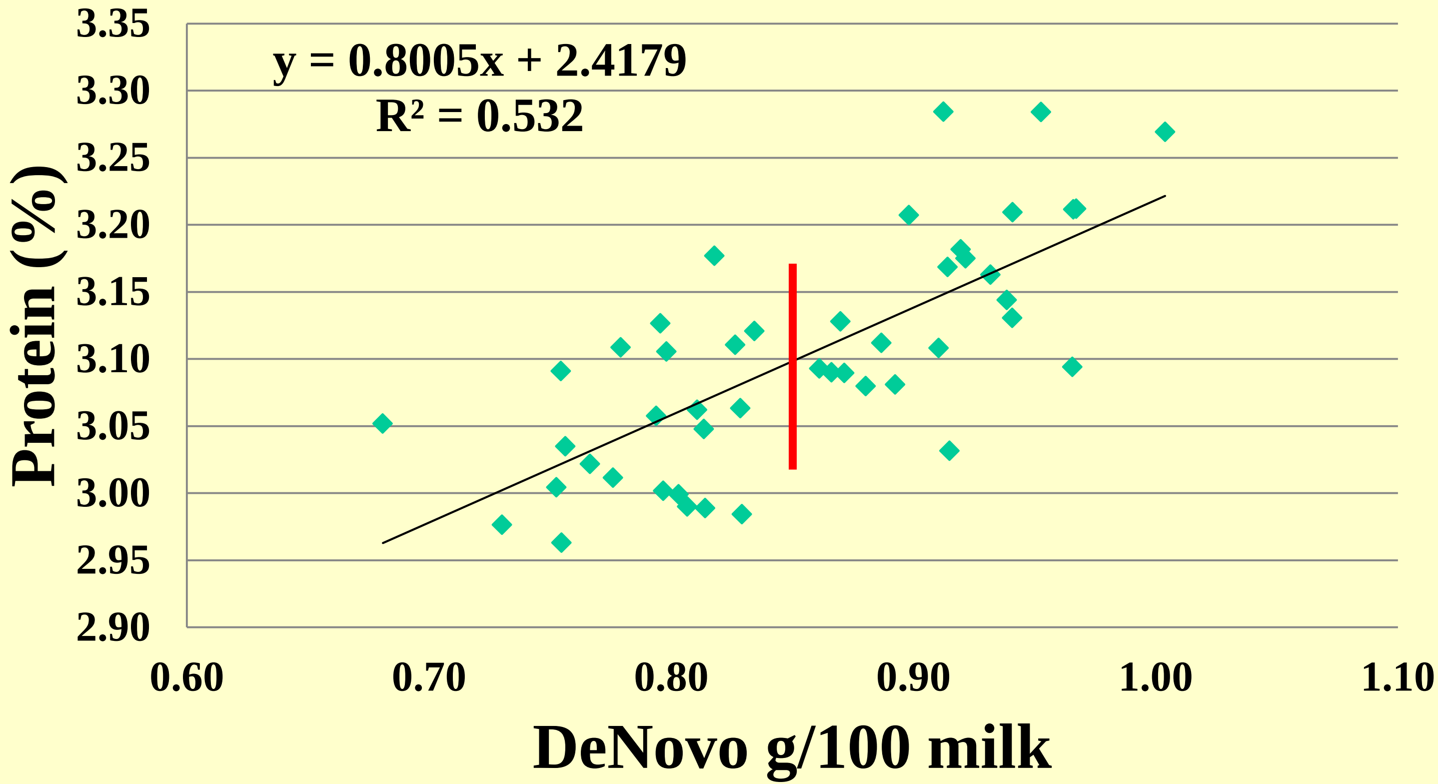
St Albans – Milk Fat Depression

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

de novo fatty acids vs double bonds per fatty acid



40 Holstein Farms 2015
St Albans - Protein



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%) ($P < 0.01$)

Main Conclusions from Bulk Tank Milks

The strongest correlation between milk fatty acid composition and the concentration of fat and protein in milk was with *de novo* fatty acid production.

De novo fatty acid level seems to be barometer of rumen health and proper rumen function.

Thus, feeding and farm management strategies that produce an increase in synthesis of *de novo* fatty acids may produce an increase milk fat and milk protein percentage and possibly output of fat and protein per cow per day.

Even more information may be gained by measuring the fatty acid composition of milk from individual cows.

Current Field Work with Nutritionists

Progress on one 1800 cow Holstein farm in Northern NY

Holstein Farm #1	lbs	X1000 SCC	%(m/m) Fat D	Anhyd %(m/m) Lactose	True P %(m/m) Protein	MUN	fatty acids per 100 g milk: Denovo g/100 g	Mixed g/100 g	Preformed g/100 g
May-16	92	182	3.52	4.65	3.15	10.8	0.84	1.18	1.27
Sep-16	91.3	207	3.46	4.61	3.10	11.2	0.72	1.20	1.31
Nov-16	92	147	3.89	4.61	3.25	9.7	0.91	1.40	1.34

	carbon # FA CL	DB/FA FA Unsat	Milk lbs per day	fatty acids Denovo g/day	Mixed g/day	Preformed g/day	Lactose g/day	Fat g/day	Protein g/day
May-16	14.59	0.324	92	350	493	531	1940	1472	1316
Sep-16	14.90	0.342	91.3	300	497	544	1911	1433	1284
Nov-16	14.54	0.302	92	380	587	560	1927	1626	1358

New Format Fatty Acid Data at St. Albans

TRANS_DATE	TANK	POUNDS	BFAT	PROT	LACT	TSOL	SNF	OSOL	CELL	MUN	DEN	MIX	PREF	RAW	PAST	PI	CRYO
20-FEB-2017	1		4.2	3.17	4.85	13.08	8.88	5.71	110	13.42	0.92	1.56	1.49				544
19-FEB-2017	1		4.26	3.16	4.83	13.1	8.84	5.68	150	11.61	0.92	1.64	1.46				544
18-FEB-2017	1	15975	4.2	3.15	4.82	13.03	8.83	5.68	140	10.57	23.71	40.48	35.80				545
17-FEB-2017	1	15717	4.29	3.17	4.84	13.17	8.88	5.71	110	10.62	22.91	40.06	37.04				547
16-FEB-2017	1	15846												2	5	11	
15-FEB-2017	1	15717	4.24	3.19	4.83	13.14	8.9	5.71	110	12.15	22.67	38.13	39.20				543
14-FEB-2017	1	15932	4.25	3.2	4.83	13.17	8.92	5.72	110	13.39	23.60	38.43	37.96				542
13-FEB-2017	1	15867	4.21	3.2	4.84	13.13	8.92	5.72	130	12.63	23.34	38.06	38.61				543
12-FEB-2017	1	15416	4.23	3.21	4.85	13.17	8.94	5.73	120	13.07	23.37	39.17	37.46				545
11-FEB-2017	1	15846	4.19	3.21	4.87	13.17	8.98	5.77	130	10.86	24.41	40.99	34.60				547
10-FEB-2017	1	15523	4.24	3.22	4.83	13.19	8.95	5.73	150	12.8	24.65	41.49	33.86				546
09-FEB-2017	1	15652	4.16	3.19	4.83	13.07	8.91	5.72	140	12.36	23.89	40.75	35.36				545
08-FEB-2017	1	15867	4.22	3.21	4.84	13.15	8.93	5.72	140	12.19	24.35	41.54	34.11				547
07-FEB-2017	1	16082	4.19	3.21	4.83	13.11	8.92	5.71	150	14.45	24.21	41.51	34.28				546

Outline

- What Do Farmers Want?
- What Do Processors Want?
- An example of connecting analytical measures to dairy farmer needs.
  - Milk fatty acid composition
  - Blood NEFA estimated from milk analysis

Objective

To develop and validate a Fourier transform mid-IR-based milk analysis method to estimate blood NEFA concentrations for lactating dairy cows.

Connecting with Dairy Farmer Needs

- **Transition Cow**

Calving: going from negative energy balance to positive energy balance (weeks 1 to 10 of lactation)

Measures: feed composition, activity monitor data, milk fatty acid composition, blood NEFA, blood BHB, milk BHB, acetone, milk weight, body weight, automated video observation. New data available every day.

Challenge and Opportunity: Integrate all of this into actionable information in real-time.

Comparison of blood and milk NEFA results

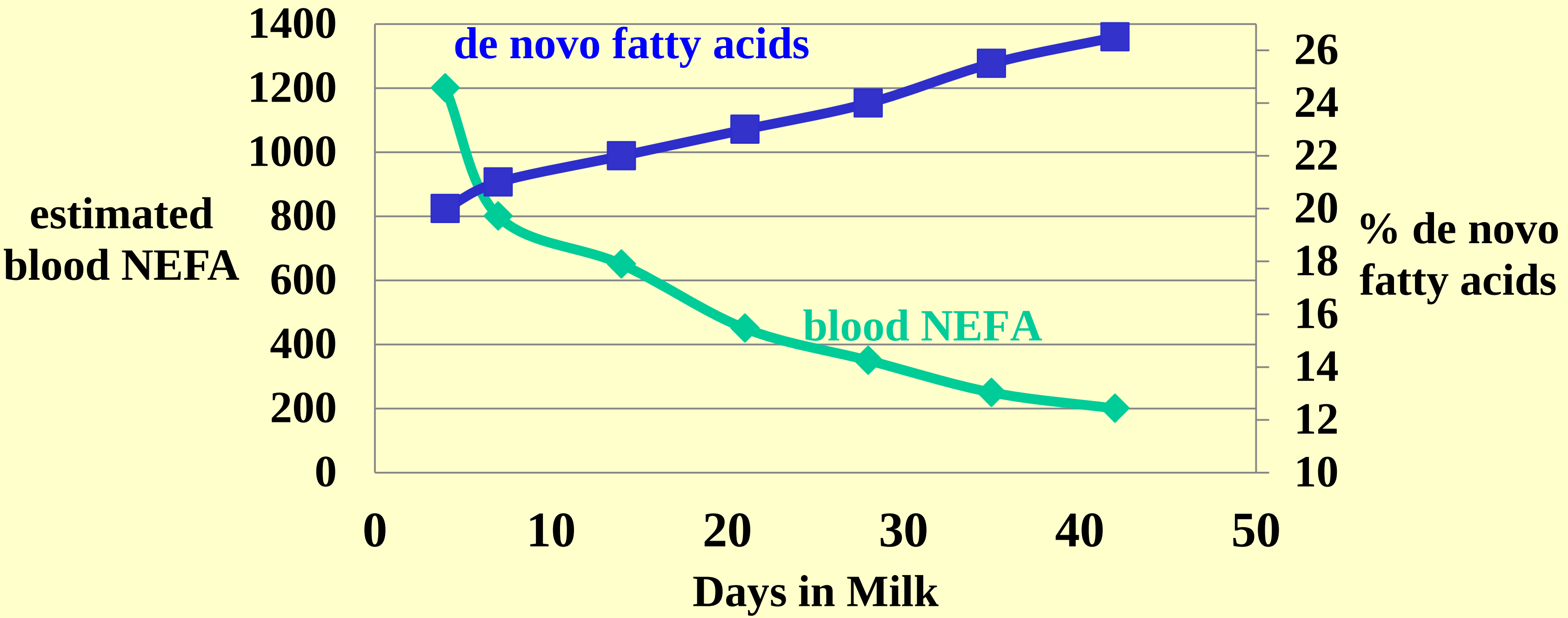
The NEFA concentration measured in blood represents the concentration at an instant in time. The level can vary with time and with the level of stress of the individual cow at the time of blood sampling.

It is hypothesized that the blood NEFA concentration estimated from milk represents the time average status of blood NEFA for full period of time between milkings.

Therefore, the estimate for blood NEFA based on milk analysis may be a more stable and integrated estimate of the status of a cow's blood NEFA level for a period of time than the estimate obtained from a blood sample.

Sample Individual Cow Data

Cow with high body condition at calving with good liver function



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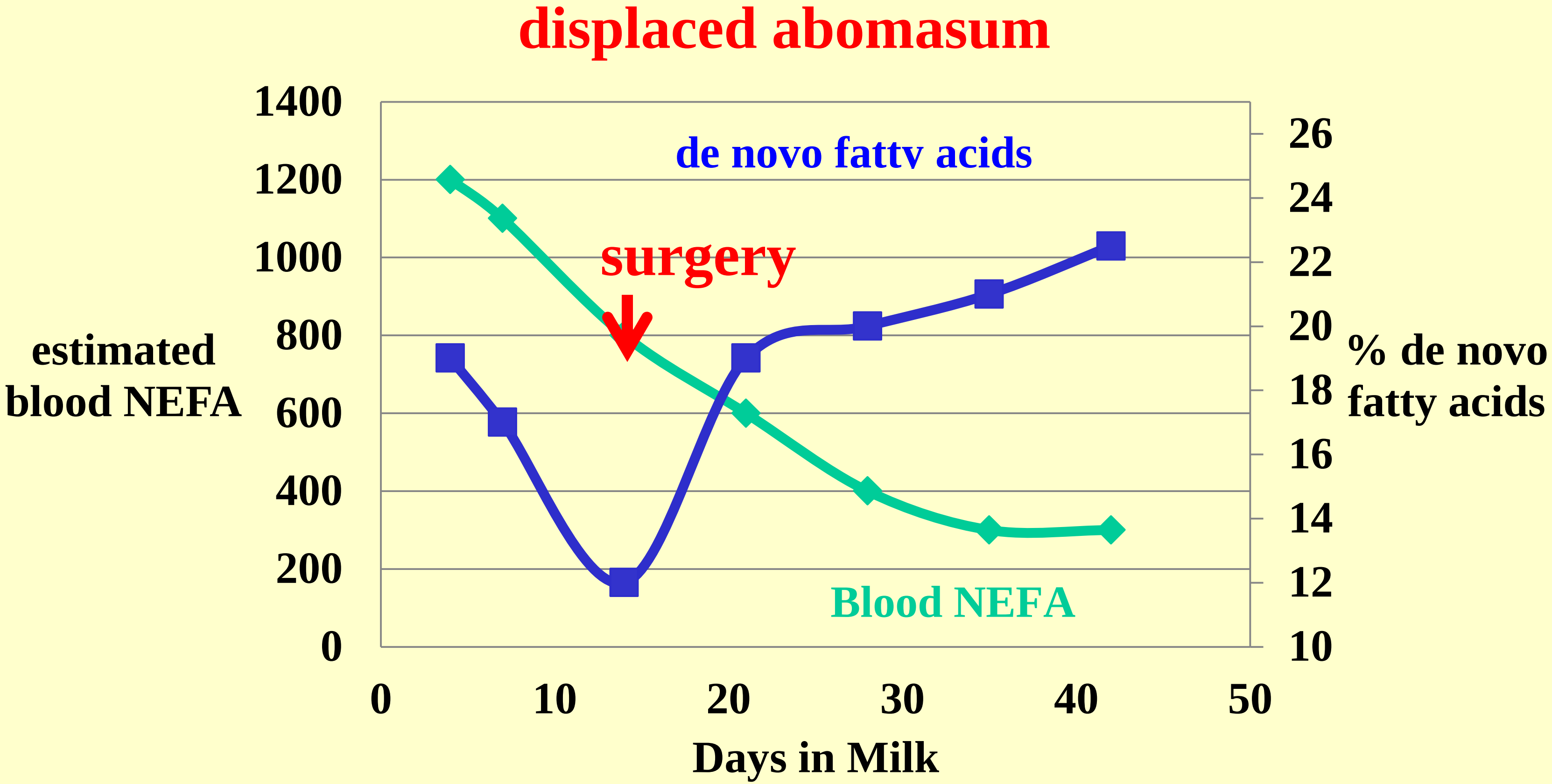

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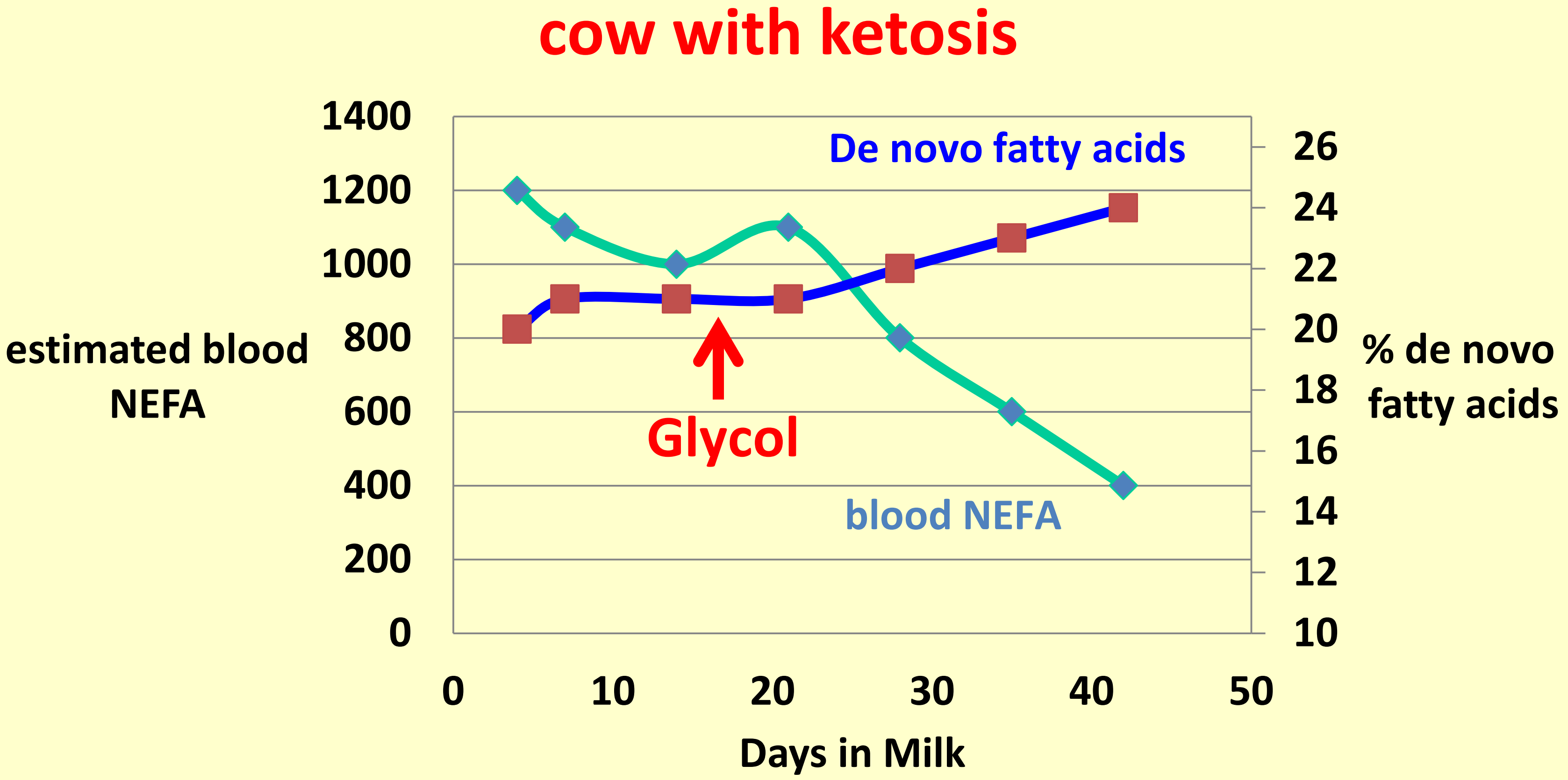

Conclusion

- **The milk estimated blood NEFA and milk fatty acid data correlated well with documented ketosis and displaced abomasum (DA), but more data is needed.**

Outline

- Current Status of Precision Management Milk Testing.
- What Do Farmers Want?
- An example of connecting analytical measures to meet dairy farmer needs.
- Future Directions

Future Directions – Dairy Processing

Improved Dairy Product Calibration and Standards for:

- **WPC 80**
- **Vat Whey**
- **Concentrated Whey**
- **Condensed Milk**
- **Light Cream**
- **Heavy Cream**

Completely New

- **Testing Cheddar cheese for:**
  - **fat, protein, salt, and solids with a mid-IR milk analyzer**
  - **? Cheese aging indices?**

Future Directions – Milk Production

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

What is next? Cow of Interest Season #2 the “Man in the Boots”?

Coming to a Dairy Nutrition Conference Near You!

October 2018

Caladriel

Riddle Number 1

What has roots as nobody sees,
Is taller than trees,
Up, up, up it goes,
And yet never grows?

Dandolf the White

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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www.landersz.com

Questions??