New milk mid-FTIR metrics for dairy cattle management

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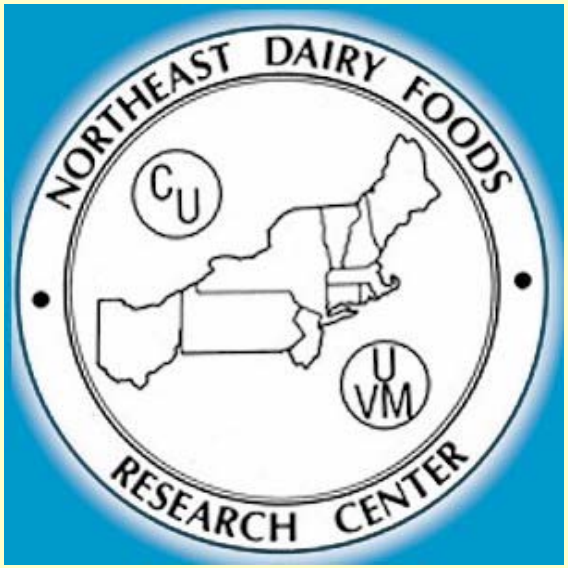
CORNELL

ICAR Meeting

Krakow, Poland

June 2015



Outline

- **Overall Vision**
- **Milk fat synthesis (*denovo*, mixed origin, preformed)**
- **Milk fatty acid analysis**
- **Objectives of our current work**
- **Survey results June 2012 – August 2013**
  - ***Milk fat and fatty acid composition***
  - ***Milk protein and fatty acid composition***
- **Next: 40 farm field study**
- **Future Directions**

Outline

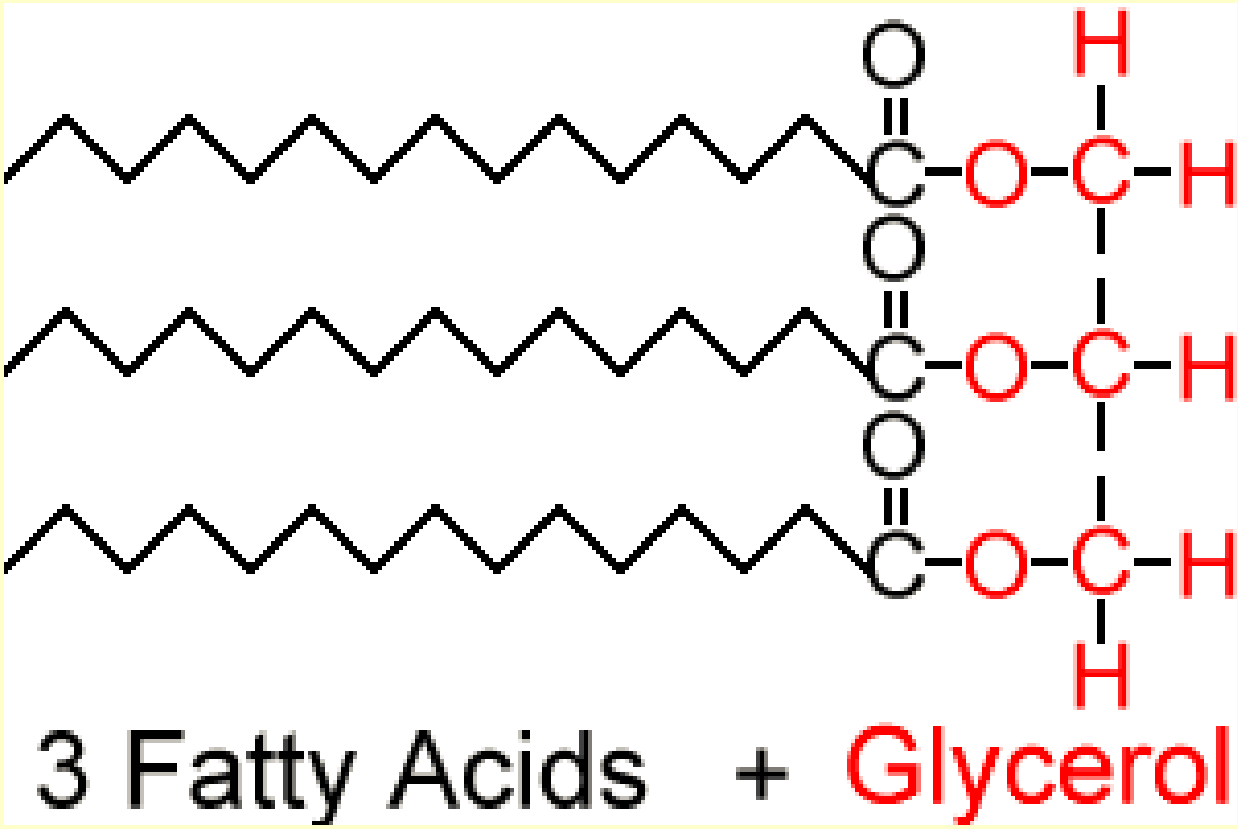
- **Overall Vision**

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

Outline

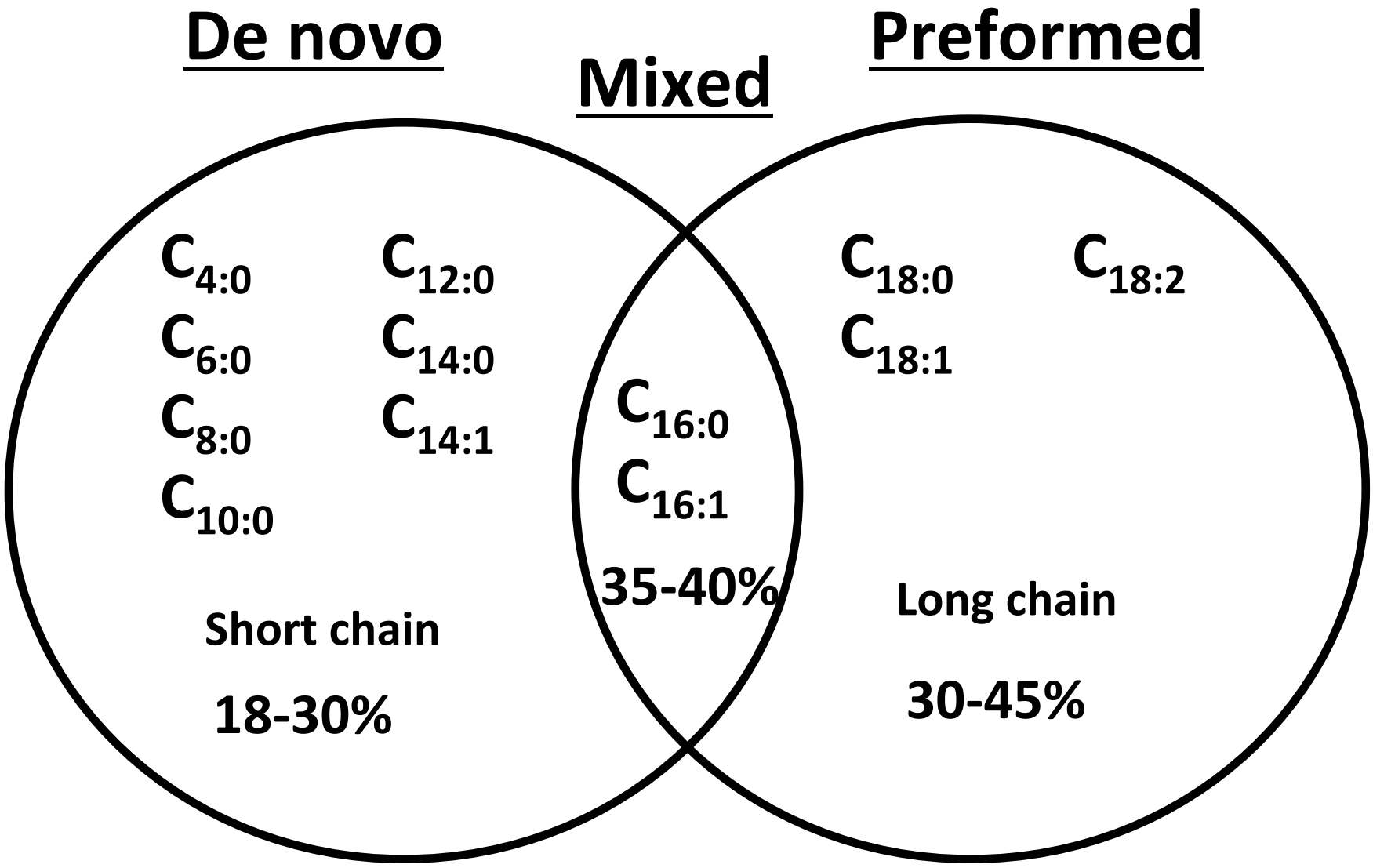
- **Overall Vision**
- **Milk fat synthesis (*denovo*, mixed origin, preformed)**

Milk Fat Structure

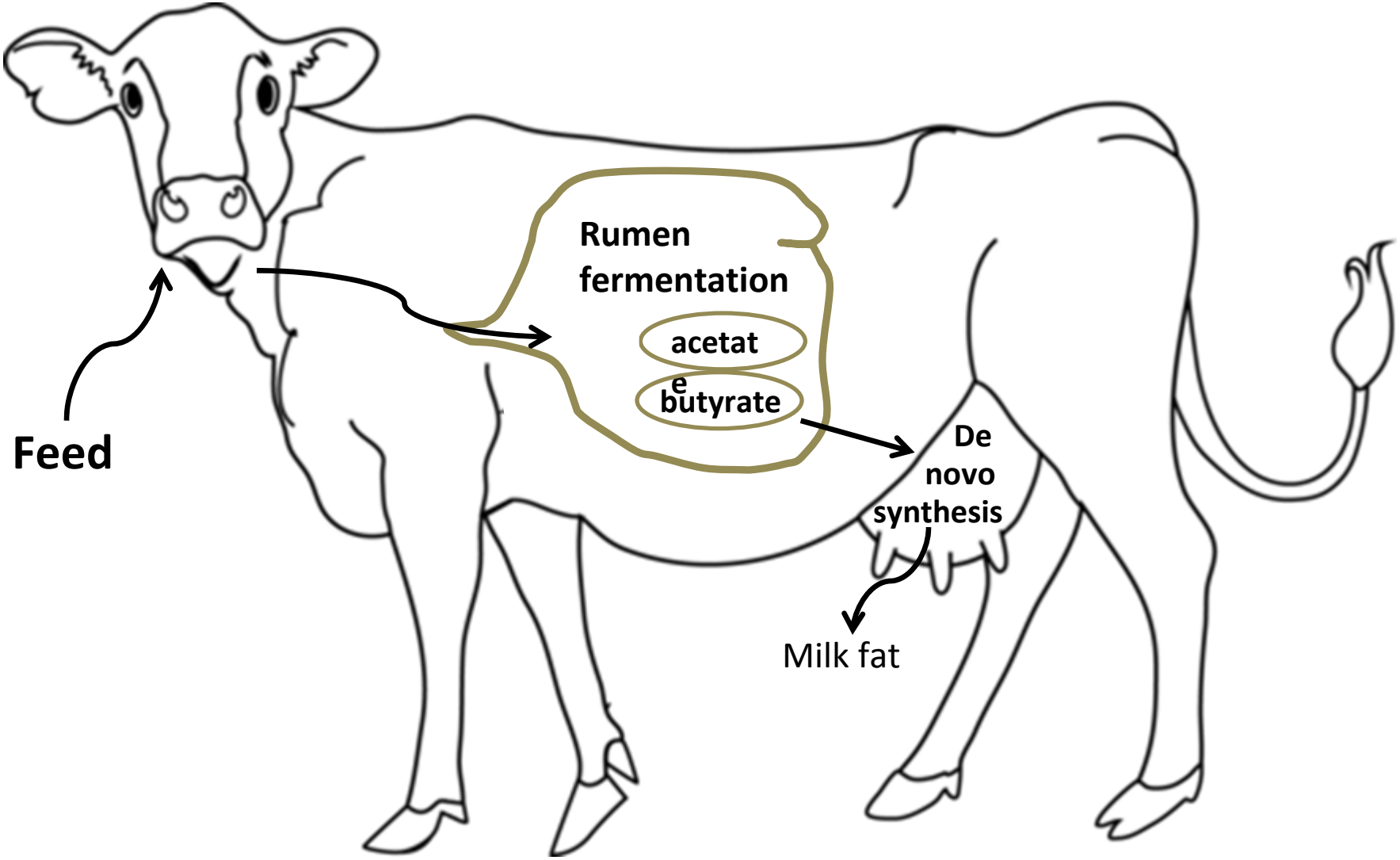


3 fatty acids per triglyceride

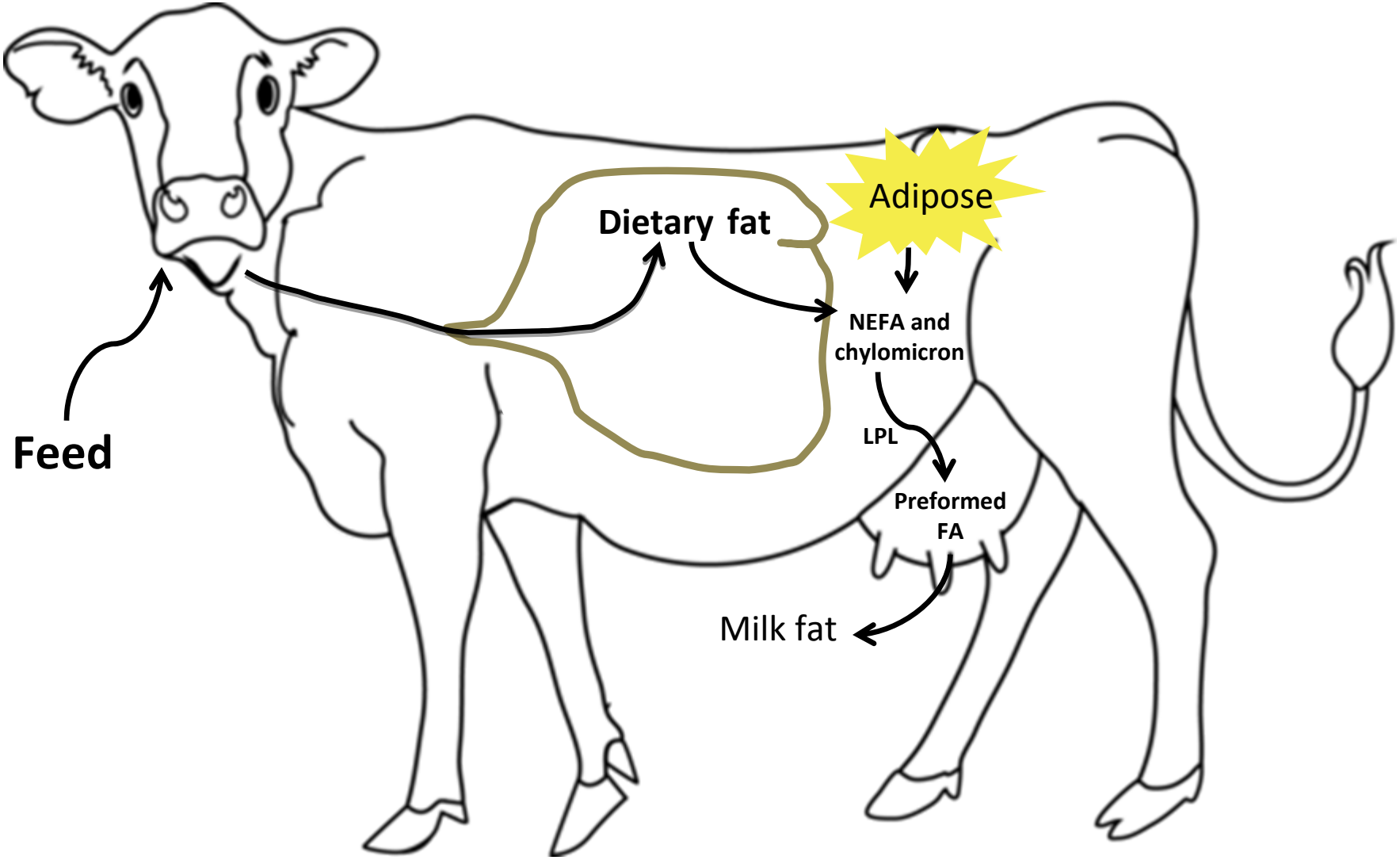
Fatty Acid Categories



De Novo Fatty Acid Synthesis



Preformed Fatty Acids



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- **Milk fatty acid analysis**

  Groups of fatty acids

  ***Denovo*, mixed origin, and preformed**

Outline

- **Milk fat synthesis (*denovo*, mixed origin, preformed)**
- **Milk fatty acid analysis**
- **Objectives of our work**

Objectives

1. **To measure fatty acid composition of milk fat for 430 individual herds in the St. Albans Cooperative using new advanced calibration methods for infrared milk analysis over a 15 month period.**
2. **To determine if there is a correlation between milk fatty acid composition and bulk tank milk fat and protein concentration.**

St. Albans Survey Structure

Data from 430 farms

Bulk tank milk samples tested 3 up to 20 times per month per farm

Infrared milk analysis for components and fatty acid composition. GLC analysis of selected samples for periodic validation of the IR calibration.

Means for each farm calculated by month

Farm Data Organized in 2 groups:

- **Jersey and Other (almost totally Holstein)**

Infrared milk analysis

Manual FTIR currently used at St. Albans - Delta Instruments Model FTA, Drachten, The Netherlands

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

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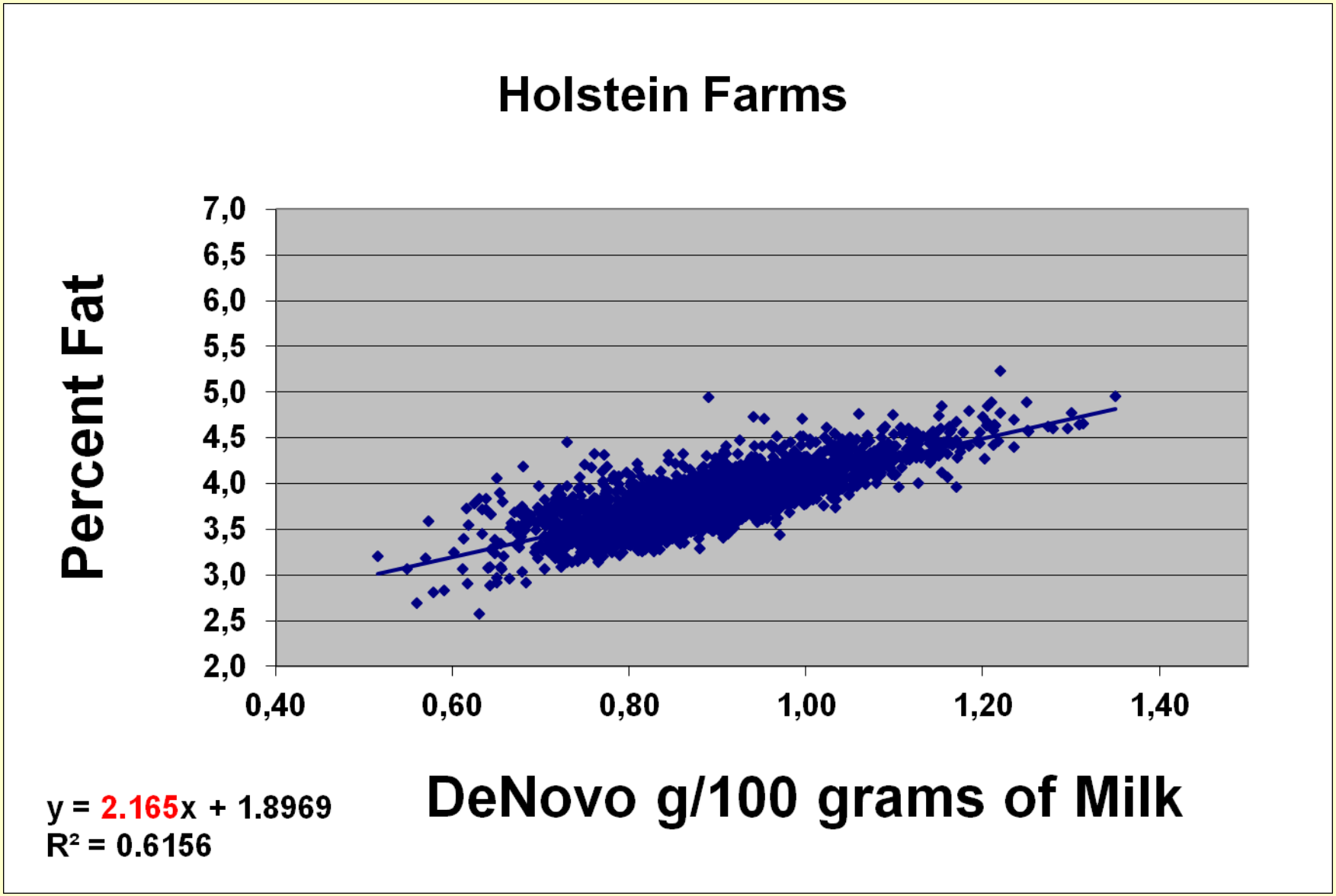
Survey Results June 2012 – August 2013

DeNovo Fatty Acids

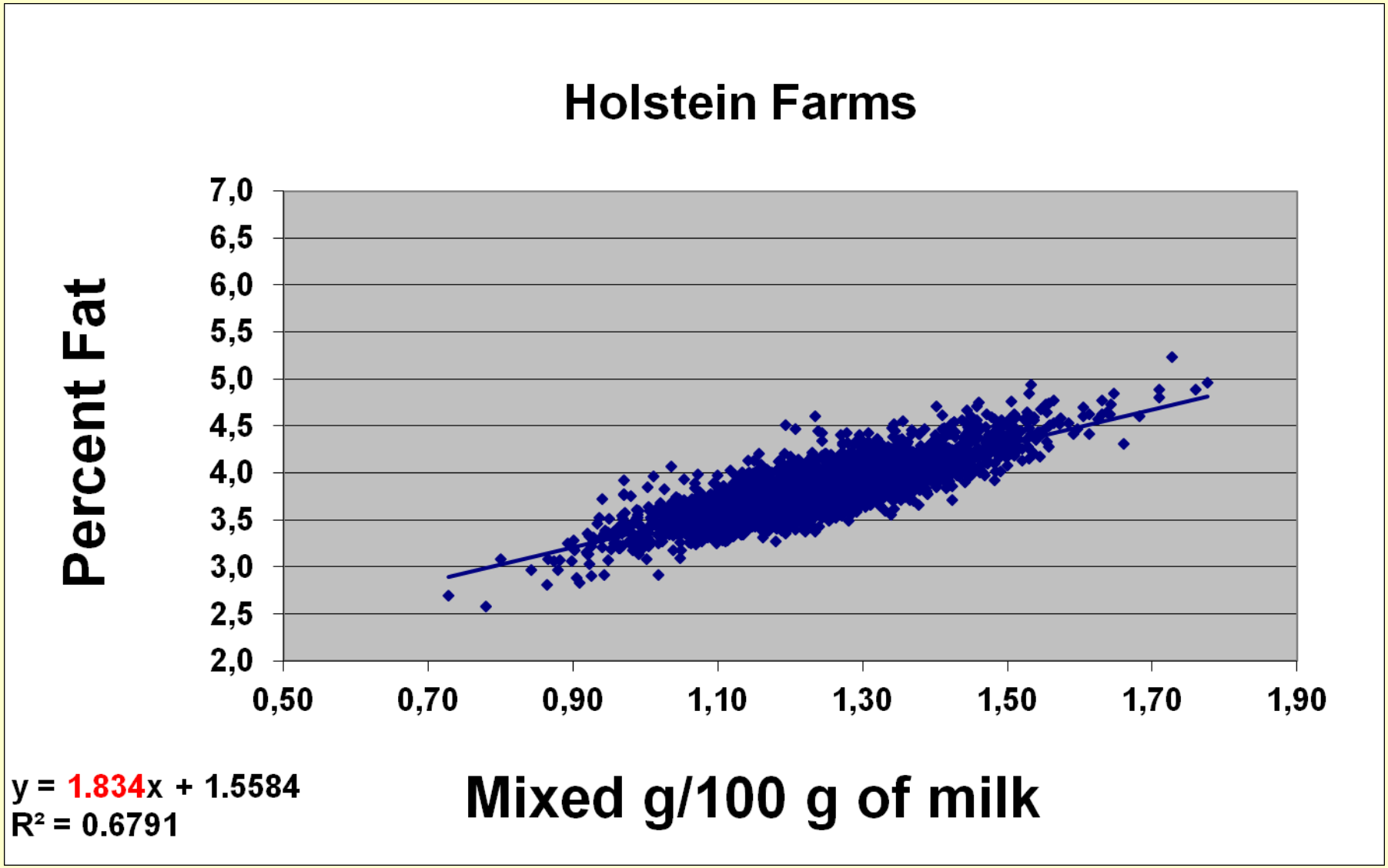
Survey Results June 2012 – August 2013



Survey Results July 2012 – August 2013

Mixed Origin Fatty Acids

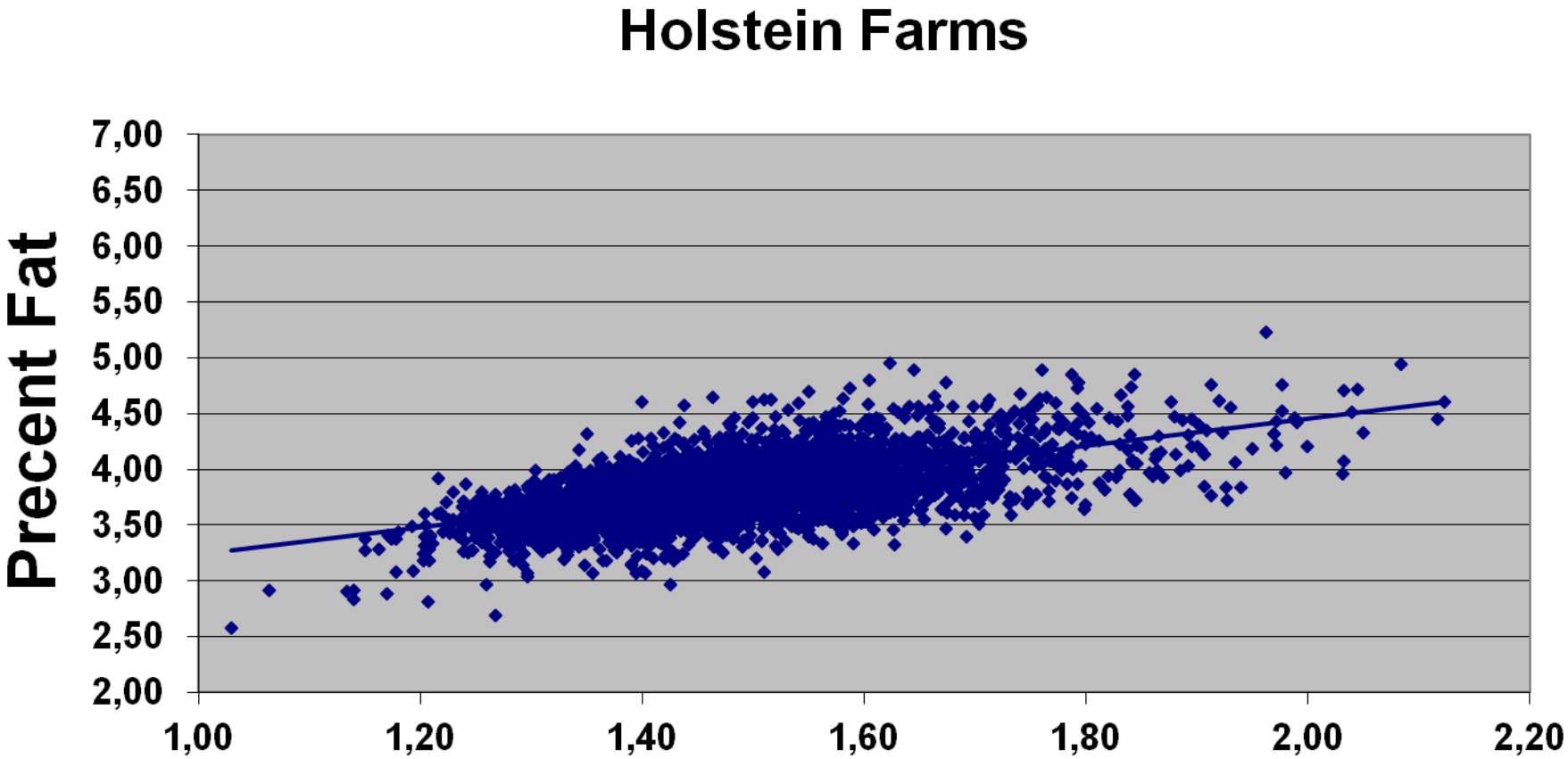
Survey Results June 2012 – August 2013



Survey Results July 2012 – August 2013

Preformed Fatty Acids

Survey Results June 2012 – August 2013



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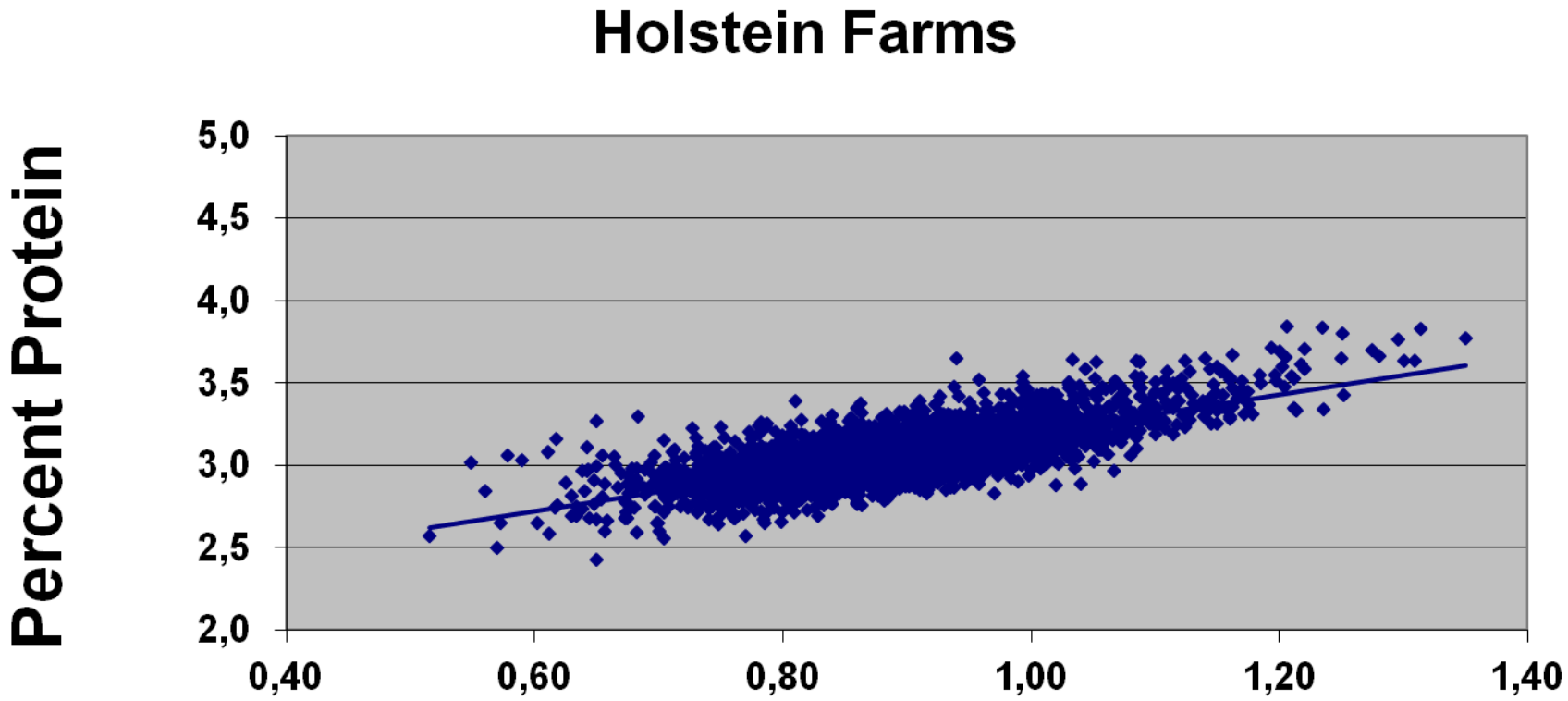

Main Conclusions from Survey

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

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

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40 Farm Study 2014

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

1. **Sort all 430 farm data from low to high values for DeNovo as a percentage of total fatty within the Jersey group of farms and within the Holstein group of farms.**
2. **Select 10 Jersey farms with low *DeNovo* and 10 Jersey farms that have high *DeNovo* fatty acids.**
3. **Select 10 Holstein farms with low *DeNovo* and 10 Holstein farms that have high *DeNovo* fatty acids.**

Milk Composition:June 2012 – August 2013

Mean Relative Milk Fatty Acid Composition for each Group of 10 farms for the 15 month period: *DeNovo*, Mixed Origin, and Preformed Fatty Acids

St Albans June 2012 through August 2013

Breed	Group	%m/m Fat	%m/m True Protein	Rel % Denovo	Rel % Mixed	Rel % Preformed
Holstein	Low *DeNovo*	3.623	2.993	24.080	33.971	41.949
Holstein	High *DeNovo*	3.975	3.148	26.076	35.082	38.842
Jersey	Low *DeNovo*	3.917	3.093	25.037	33.352	41.611
Jersey	High *DeNovo*	4.804	3.616	27.414	34.623	37.963

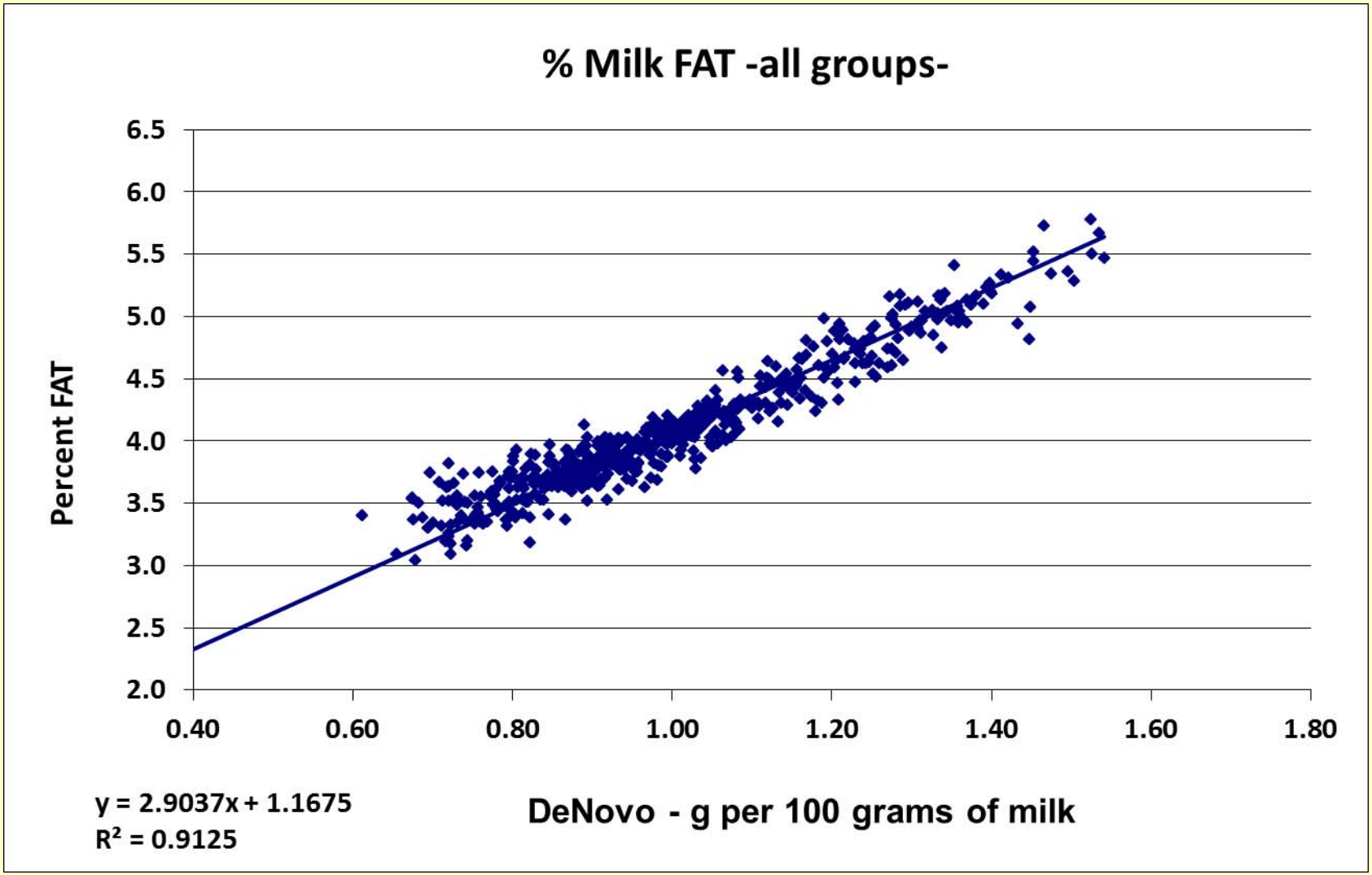
Milk Composition:June 2012 – August 2013

Mean Relative % *Denovo* Fatty Acids within each Group of 10 Farms average for the 15 month period

DeNovo Fatty Acids as Percent of Total Fatty Acids

Farm	LDN - H	HDN - H	LDN - J	HDN - J
1	24.13	27.00	26.11	27.11
2	21.89	25.67	24.70	27.97
3	24.43	25.83	23.75	26.86
4	24.27	25.28	23.80	27.43
5	24.81	26.22	26.50	28.50
6	23.48	26.83	25.42	27.51
7	24.74	25.68	25.46	26.89
8	23.62	25.46	26.44	26.85
9	24.67	25.60	22.73	27.12
10	24.82	27.21	25.47	27.89
Mean	24.08	26.08	25.04	27.41

Pre-study data: June 2012 – August 2013



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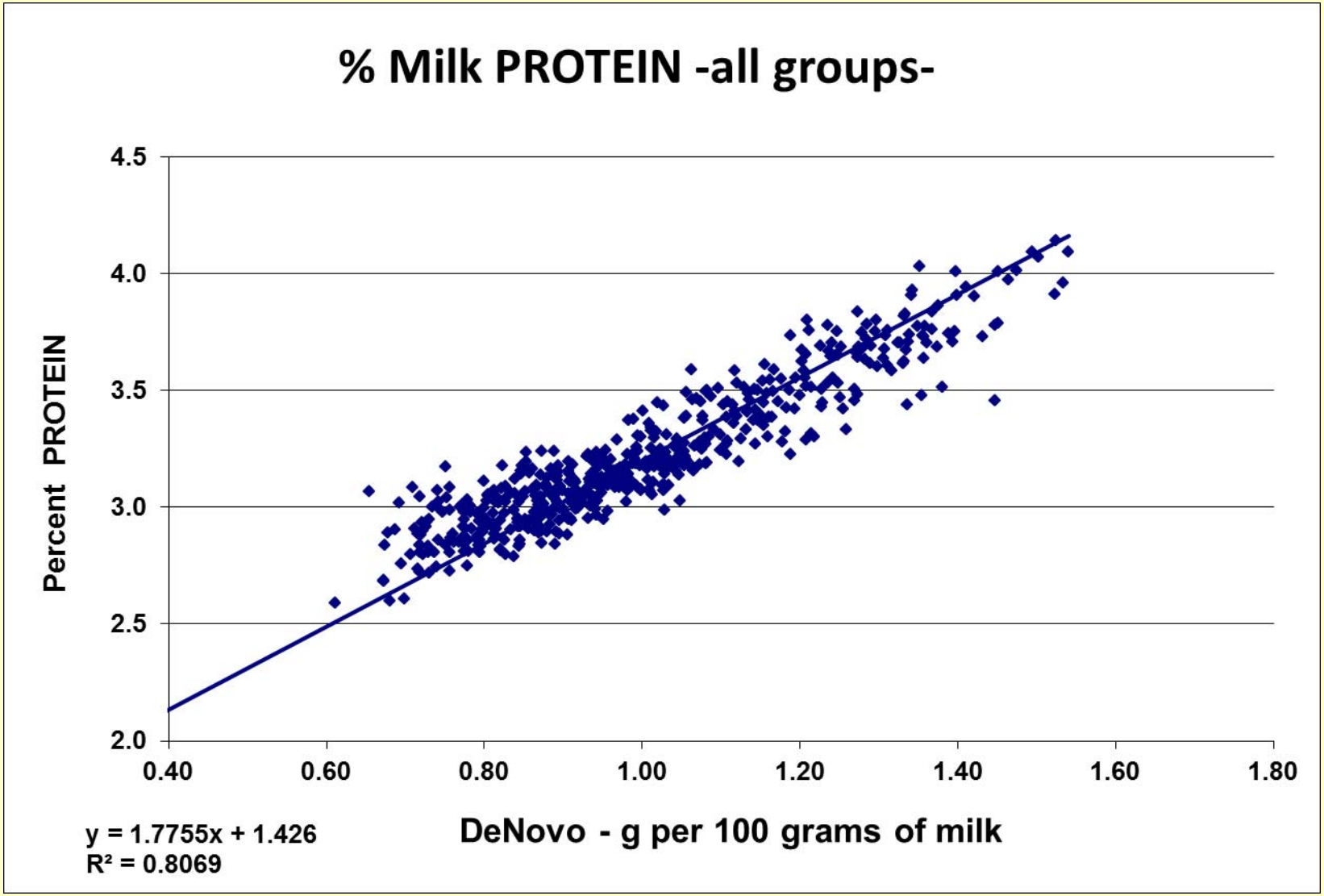

Results of First 40 Farm Study

- **Milk (26.3 vs 22.7 kg/d, SE=1.3, *P*=0.06), fat (1.1 vs 0.9 kg/d, SE=0.1, *P*<0.01), true protein (0.9 vs 0.7 kg/d, SE<0.1, *P*<0.01), and de novo FA (25.6 vs 23.7 relative %, SE=0.2, *P*<0.01) were higher for high versus low *DeNovo* farms, respectively.**
- **The gross difference in farm income from milk between the low and high *DeNovo* fatty acid farms was approximately $30,000 per year per 100 cows with higher income for the high *DeNovo* fatty acid farms.**

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- **Future Directions**

Future Directions

Bulk Tank Milk Testing

- **feed utilization (fatty acids)**
- **milk fat depression index**

Future Directions

Individual cow "real-time" milk testing for precision farm management of feeding, health, and reproduction.

Future Directions

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

- **Blood NEFA**
- **Blood BHB**
- **Milk NPN/MUN**

Use: Predict Ketosis, DA, acidosis, and reproductive performance

Management Indices on Individual Cows

Future Directions

Efficiency of Feed Utilization and Rumen Function

- ***DeNovo* fatty acid synthesis**
- **Proportion of C16:0 from *DeNovo* vs Preformed C16:0**
- **Total trans fatty acid level**
- **Ratio of C18:1 *trans* 10 to C18:1 *trans* 11 fatty acid**

?? Targeted, automated, feeding of concentrates to individual cows based on need to support each cow's unique nutritional requirements based on production output.

Acknowledgments

The lab staff at St. Albans Cooperative for running the infrared testing of fatty acid composition of the milk fat for the milks from 430 farms.

Delta Instruments for technical support in development of fatty acid calibration models and equipment trouble shooting.

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