

# Identifying the Major On-farm Factors Associated with Elevated **Free Fatty Acids (FFA)** in Dairy Cows' Milk



**Hannah Woodhouse, BSc, MSc Candidate**

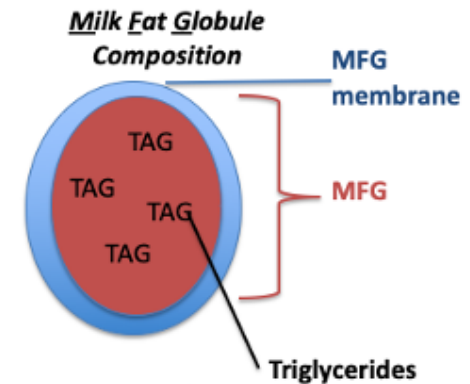
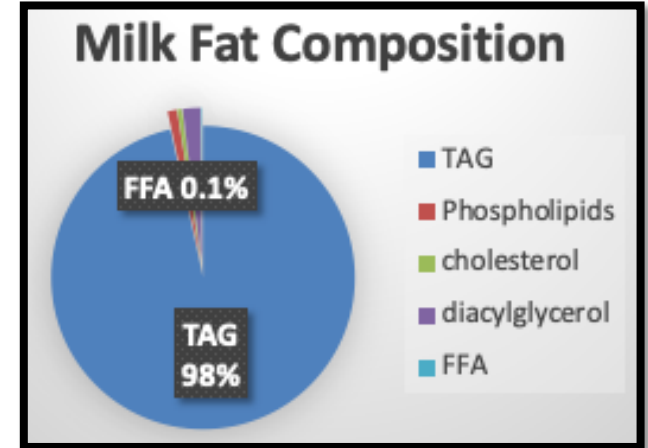
Population Medicine Department, University of Guelph,  
Ontario, Canada

National Mastitis Council (NMC) Technology Transfer Session (TTS),  
2021 NMC Virtual Annual Meeting

# Background

## *Milk Fat Composition*

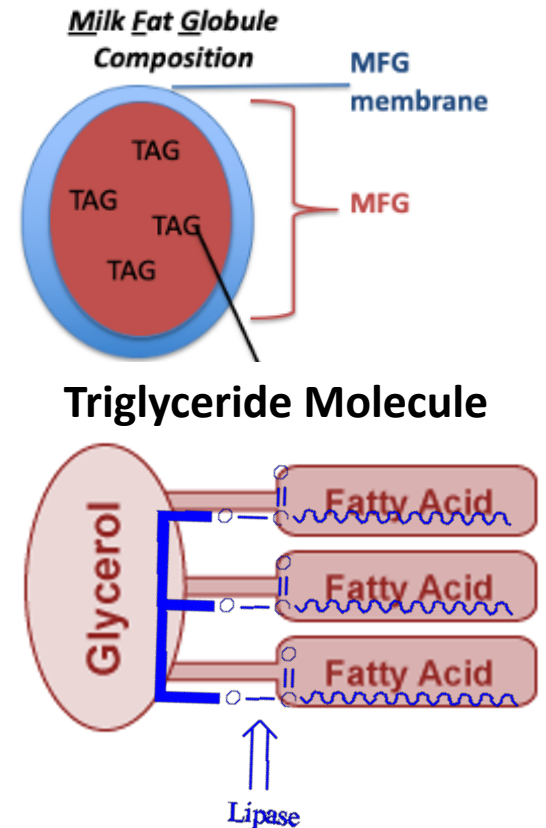
- Milk contains approximately 4% fat
- Milk fat is in globule form
- 98% of milk fat are triglycerides (TAGs) contained inside each milk fat globule (MFG)
- An outer MFG membrane acts as protection from *lipolytic enzymes*



# Background

## *Free Fatty Acids (FFAs)*

- FFAs are products of TAG *lipolysis*
  - Spontaneous and/or induced
- Levels should be minimal in milk fat
  - 0.1% of milk fat are FFAs
  - 0.5-1.2mmol/100g of fat

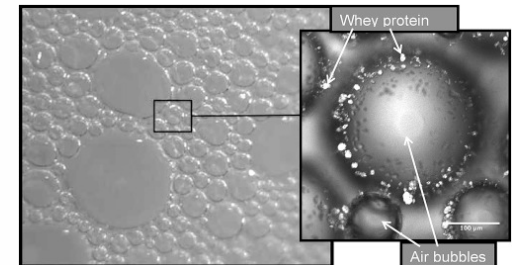
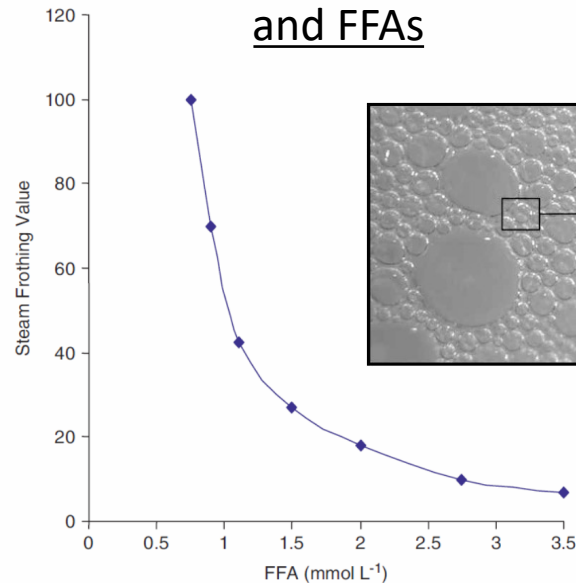


# Background

## *FFA Concerns*

- 1.2mmol/100g fat is sensory threshold for FFA
- **Consumer concerns:**
  - Milk not frothing
  - Cheese not coagulating
  - Milk tasting rancid
- **Producer concerns:**
  - Milk quality
  - Milk shipment
- **Industry concerns!**

The inverse relationship  
between steam frothing  
and FFAs

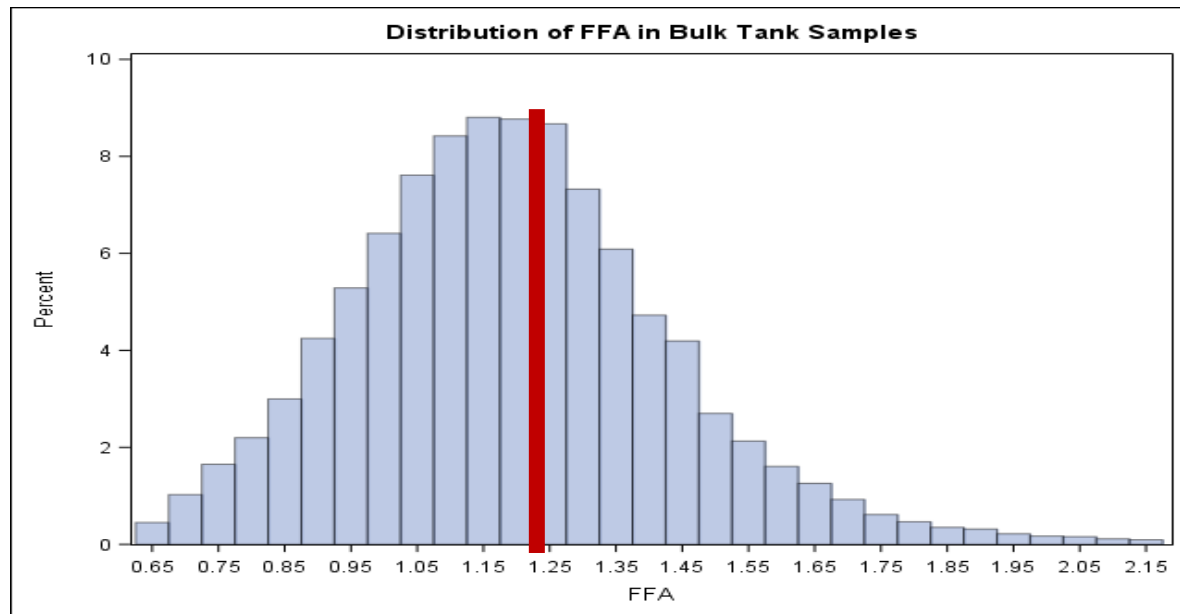


Deeth and Smith, 1983  
Buchanan, 1965  
Huppertz, 2010

# DFO FFA Testing

- Dairy Farmers of Ontario (DFO) started testing FFAs in each Ontario bulk tank milk sample in 2017

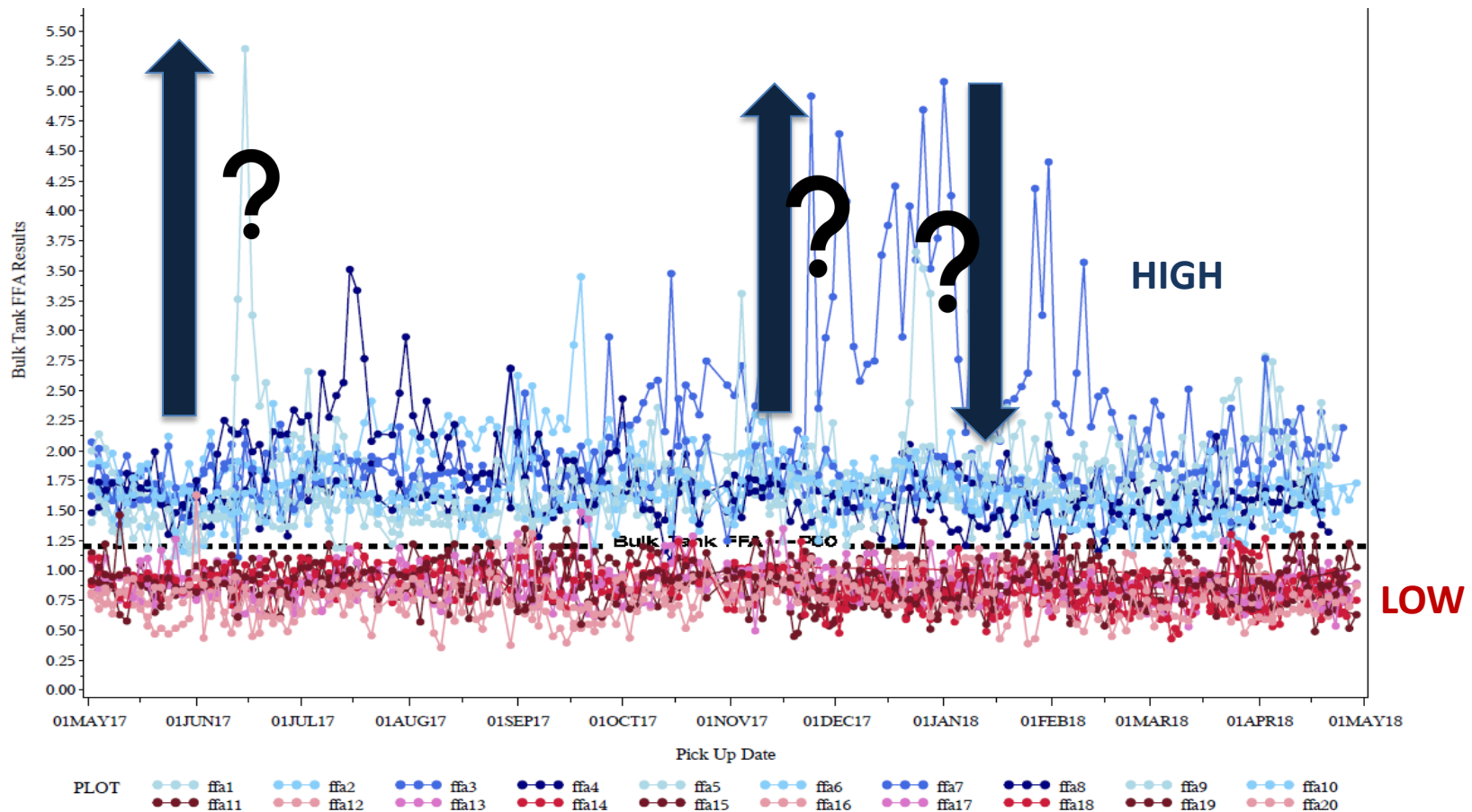
*Ontario Bulk Tank Milk FFAs (2017/18)*



# DFO FFA Testing

- High FFA herds seem to experience more fluctuations

12 Month Sampling of Ontario Bulk Tank Milk FFAs for High and Low Herds (2017/18)



# Current Literature

- Most research comes from Europe (*Wiking et al, 2017 & 2019*)
  - Milking system
  - Milking frequency
  - Milk Components
  - Health status
  - Fat supplements

## Herd factors influencing free fatty acid concentrations in bulk tank milk

Lars Wiking<sup>1</sup>, Martin Bjerring<sup>2</sup>, Mette Marie Løkke<sup>1</sup>, P. Løvendahl<sup>3</sup> and T. Kristensen<sup>4</sup>

## Impact of Milking Frequencies on the Level of Free Fatty Acids in Milk, Fat Globule Size, and Fatty Acid Composition

L. Wiking<sup>1</sup>, J.H. Nielsen, A.-K. Båvius, A. Edvardsson, K. Svennersten-Sjaunja

<sup>1</sup> Department of Food Science, Danish Institute of Agricultural Sciences, Research Centre Foulum, DK-8830 Tjele, Denmark

<sup>†</sup> Department of Animal Nutrition and Management, Kungsängens Research Centre, Swedish University of Agricultural Sciences, 753 23 Uppsala, Sweden

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L. STÁDNÍK et al.: Milk components and free fatty acid content, *Mlékarstvo* 65 (1), 18-25 (2015)

Original scientific paper - Izvorni znanstveni rad

UDK: 637.046

### Relations between basic milk components and free fatty acid content in Holstein cow milk as lipolysis parameter

doi: 10.15567/mljekarstvo.2015.0103

Luděk Stádník<sup>1\*</sup>, Jaromír Ducháček<sup>1</sup>, Renáta Toušová<sup>1</sup>, Jan Beran<sup>1</sup>, Martin Ptáček<sup>1</sup>, Lenka Kourímská<sup>2</sup>

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*Bulgarian Journal of Agricultural Science*, 22 (No 5) 2016, 796–803  
*Agricultural Academy*

### MILK FAT FREE FATTY ACIDS IN DEPENDENCE ON HEALTH OF DAIRY COWS

O. HANUŠ<sup>1</sup>, M. KLIMEŠOVÁ<sup>1</sup>, P. ROUBAL<sup>1</sup>, E. SAMKOVÁ<sup>2</sup>, D. FALTA<sup>3</sup>, M. ŠLACHTA<sup>2</sup>, L. HASOŇOVÁ<sup>2</sup> and I. NĚMEČKOVÁ<sup>1</sup>

<sup>1</sup> Dairy Research Institute Ltd., 160 00 Prague 6 – Vokovice, Czech Republic

<sup>2</sup> University of South Bohemia České Budějovice, Faculty of Agriculture, 370 05 České Budějovice, Czech Republic

<sup>3</sup> Mendel's University in Brno, 613 00 Brno, Department of Animal Rearing and Breeding, Agronomical Faculty, Czech Republic

# Current Literature

- FFAs are *multifactorial*
- FFAs stem from:

## COW FACTORS



## MILK HARVEST



## POST-HARVEST



## TRANSPORTATION



- |   |  |  |   |
|---|--|--|---|
| <ul style="list-style-type: none"> <li>• Breed</li> <li>• Lactation stage</li> <li>• Components</li> <li>• Nutrition</li> </ul> | <ul style="list-style-type: none"> <li>• Milking system</li> <li>• Milking frequency</li> <li>• Pump type</li> <li>• Air admission</li> <li>• Pipelines (layout, diameter, turns)</li> </ul> | <ul style="list-style-type: none"> <li>• Plate coolers</li> <li>• Bulk tank cooling and agitation</li> <li>• Buffer tanks</li> </ul> | <ul style="list-style-type: none"> <li>• ???</li> </ul> |
|---|--|--|---|

On-farm factors

# Undergraduate Research 2019

## *Objective and Hypothesis*

**Objective:** To identify the major on-farm risk factors associated with elevated FFAs in milk

### **Hypothesis:**

1. Milking system
  - Automated milking systems
2. Fat additives in ration
  - Palm fat
3. Pipeline diameter
  - Narrow



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## *Methods*



Obtain purposive sample of dairy farms



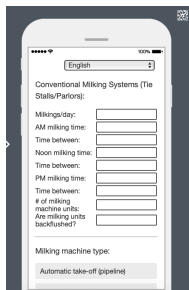
Visit farms to conduct producer  
questionnaire and pipeline recording



Request farm-specific milk records from DFO

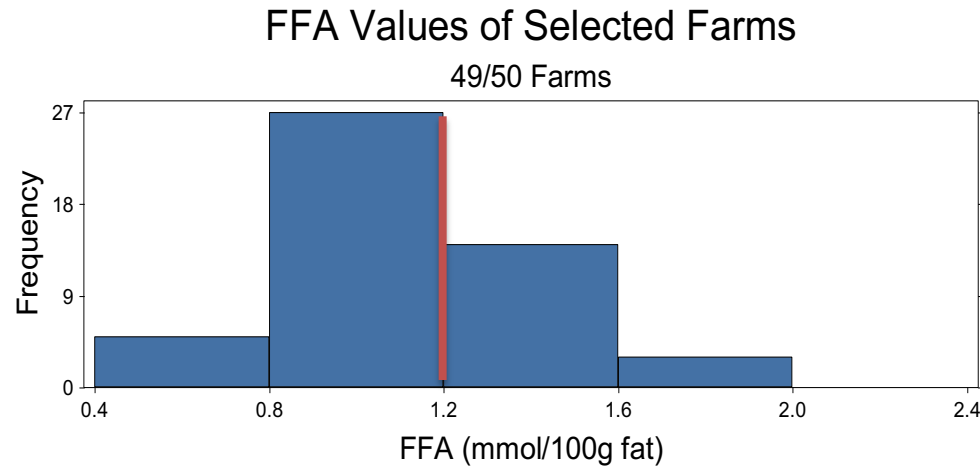


Analyze data to determine major factors



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## *Results*

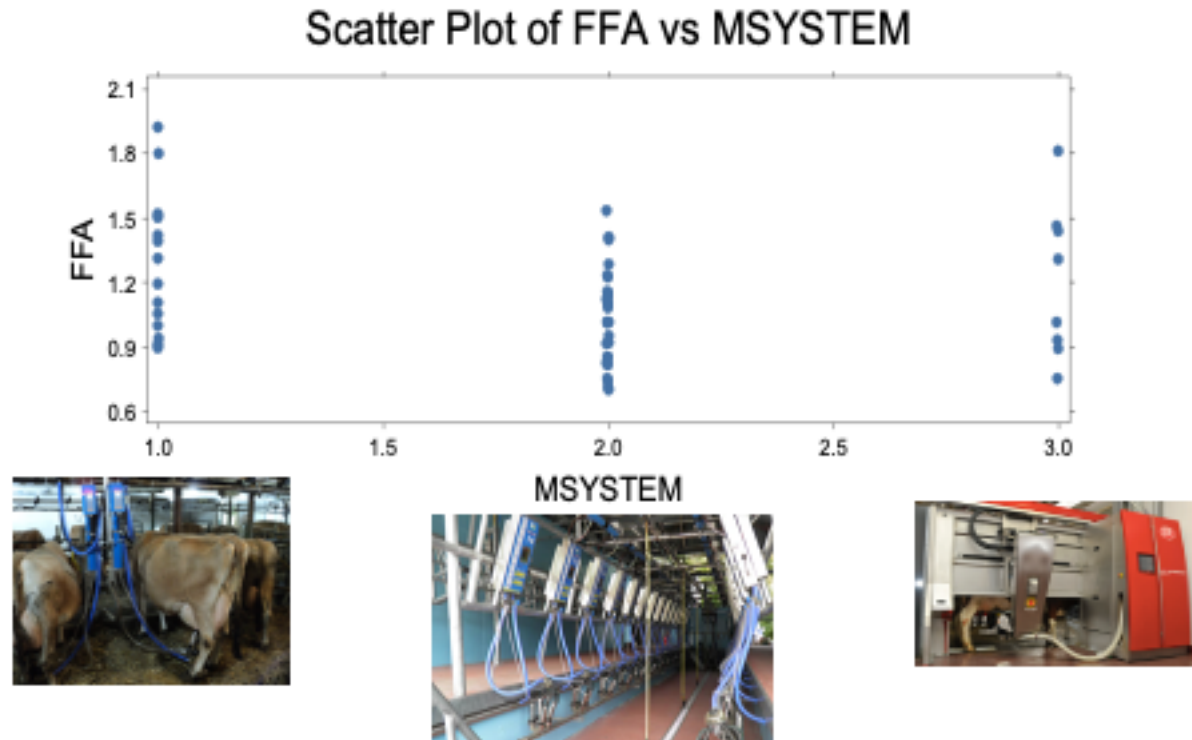


- **49 farms** analyzed between July 10-Oct. 8/19
- **34.7%** of farms are above suggested sensory threshold

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## *Results*

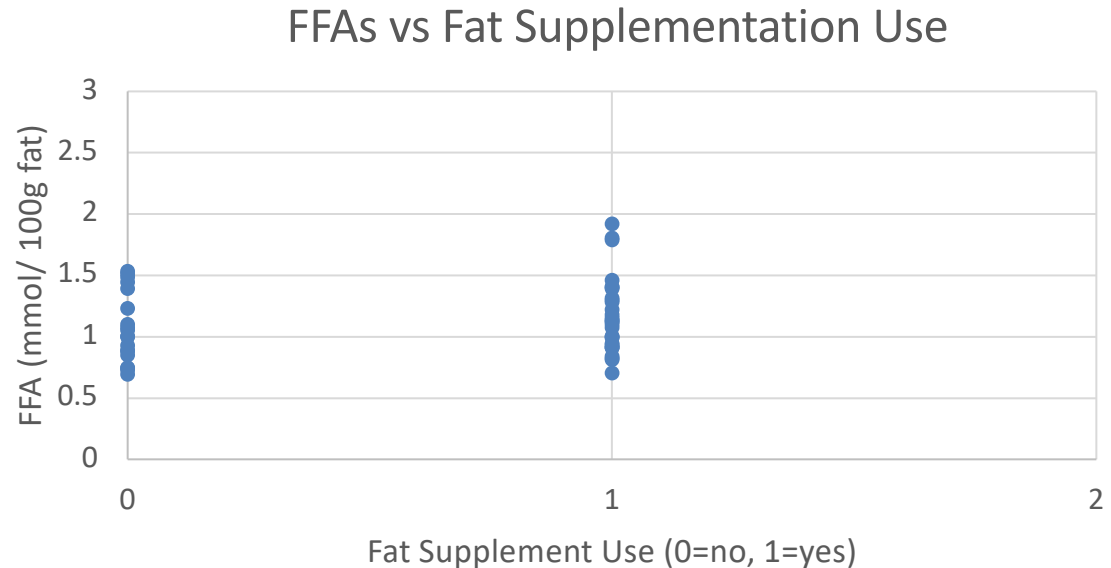
- **14** tie stall
- **27** parlor
- **8** robotic



- No significant differences in FFA between milking systems ( $p=0.2617$ )

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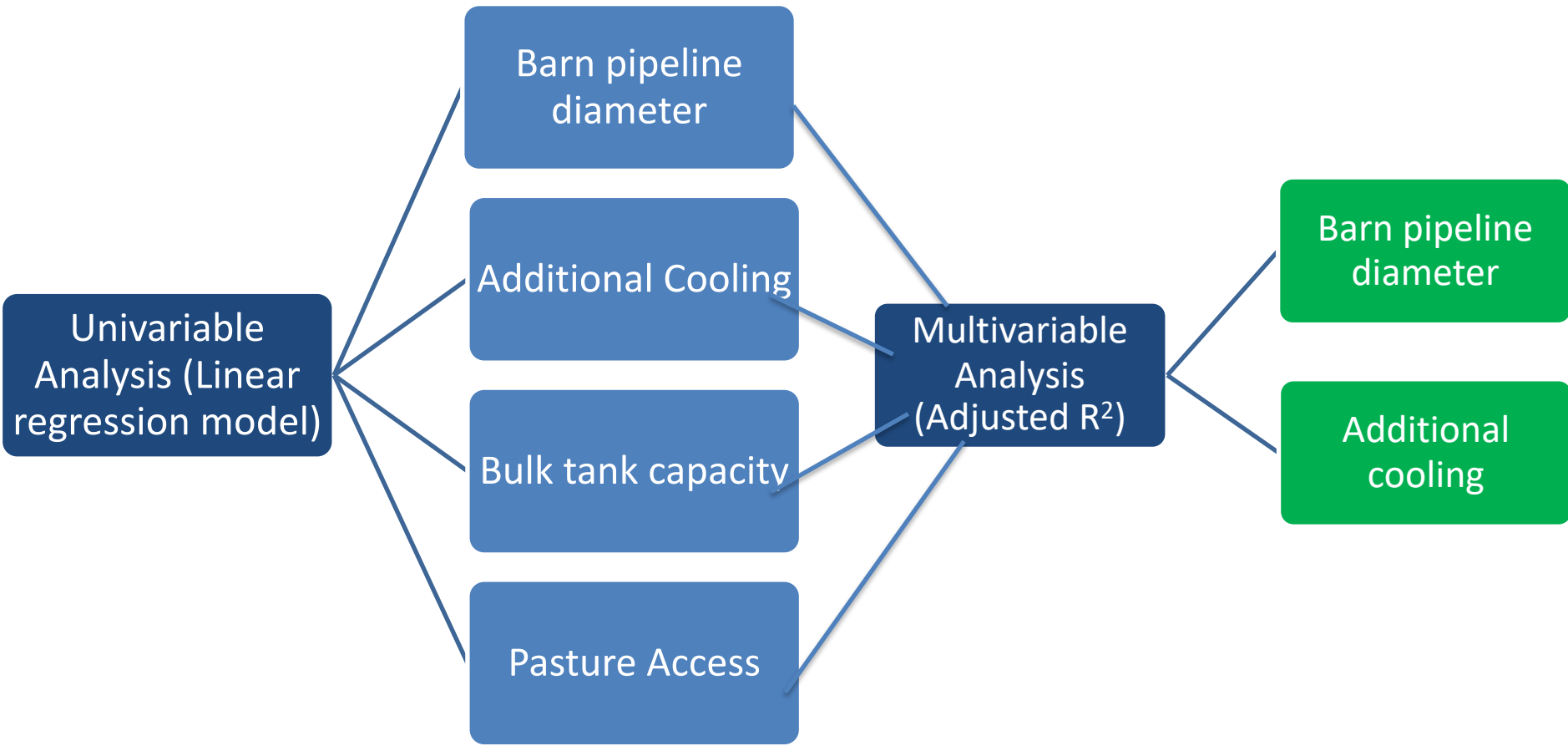
## *Results*



- The use of fat supplementation was not significantly associated with FFAs ( $p=0.2696$ )

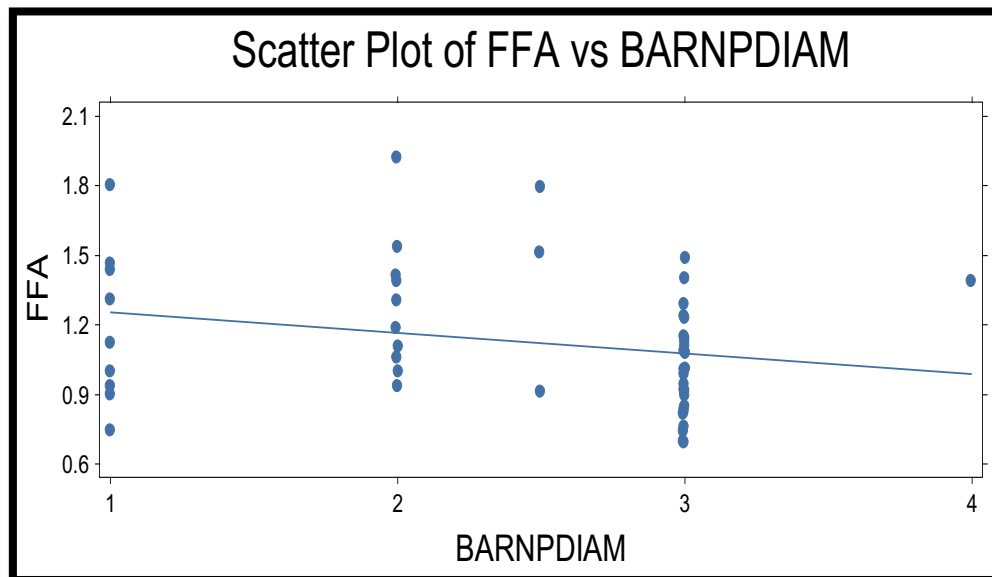
# Undergraduate Research 2019

## *Results*



## Results

- **Narrow barn pipeline diameter (1")** was significantly associated with elevated FFAs ( $p=0.0941$ )



Multivariable  
Analysis  
(Adjusted  $R^2$ )

Barn pipeline  
diameter

Additional  
cooling

# Undergraduate Research 2019

## *Results*

- **Additional Cooling**  
(plate coolers, tube coolers, chillers) was significantly associated with lower FFAs ( $p=0.014$ )



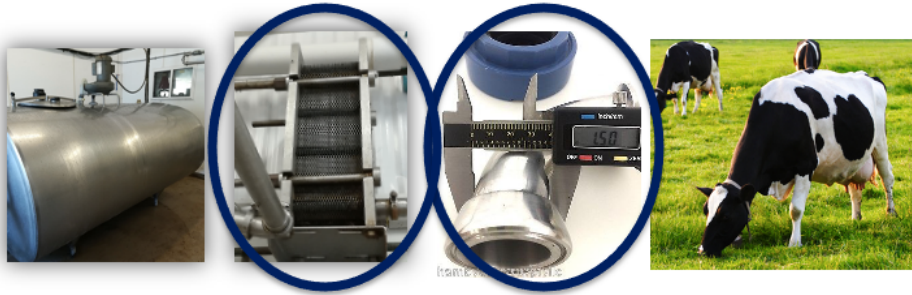
Multivariable  
Analysis  
(Adjusted  $R^2$ )

Barn pipeline  
diameter

Additional  
cooling

# Undergraduate Research 2019

## *Results*



- Adjusted  $R^2$  value= **22%**

Multivariable  
Analysis  
(Adjusted  $R^2$ )

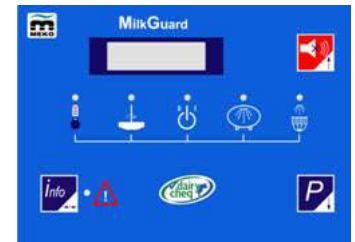
Barn pipeline  
diameter

Additional  
cooling

- Interpretation: A **narrow barn pipeline diameter** and **absence of additional cooling** can explain elevated amounts of FFAs in 22% of sampled Ontario Dairy Farms

# FFA Research 2020

- Inclusion criteria expanded
  - 200+ Ontario dairy farms
  - Not specific to feed company
- Time Temperature Recorder (TTR) data collection
  - Cooling, agitation, cleaning, alarms



# Conclusion

- Elevated FFAs impair milk quality
- Current provincial research aims to identify the major on-farm factors associated with elevated FFAs
- Research results will be communicated with the industry and producers
  - Implemented changes to CQM program?
- Future research:
  - Milk processing effect on FFAs
  - Human health implications?



# Acknowledgements

- Dr. David Kelton
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– Guy Seguin



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- Art Hill
- U of G President's Scholar committee



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# Questions?

Hannah Woodhouse

BSc. BIOM, MSc. POPM Candidate

[woodhouh@uoguelph.ca](mailto:woodhouh@uoguelph.ca)

