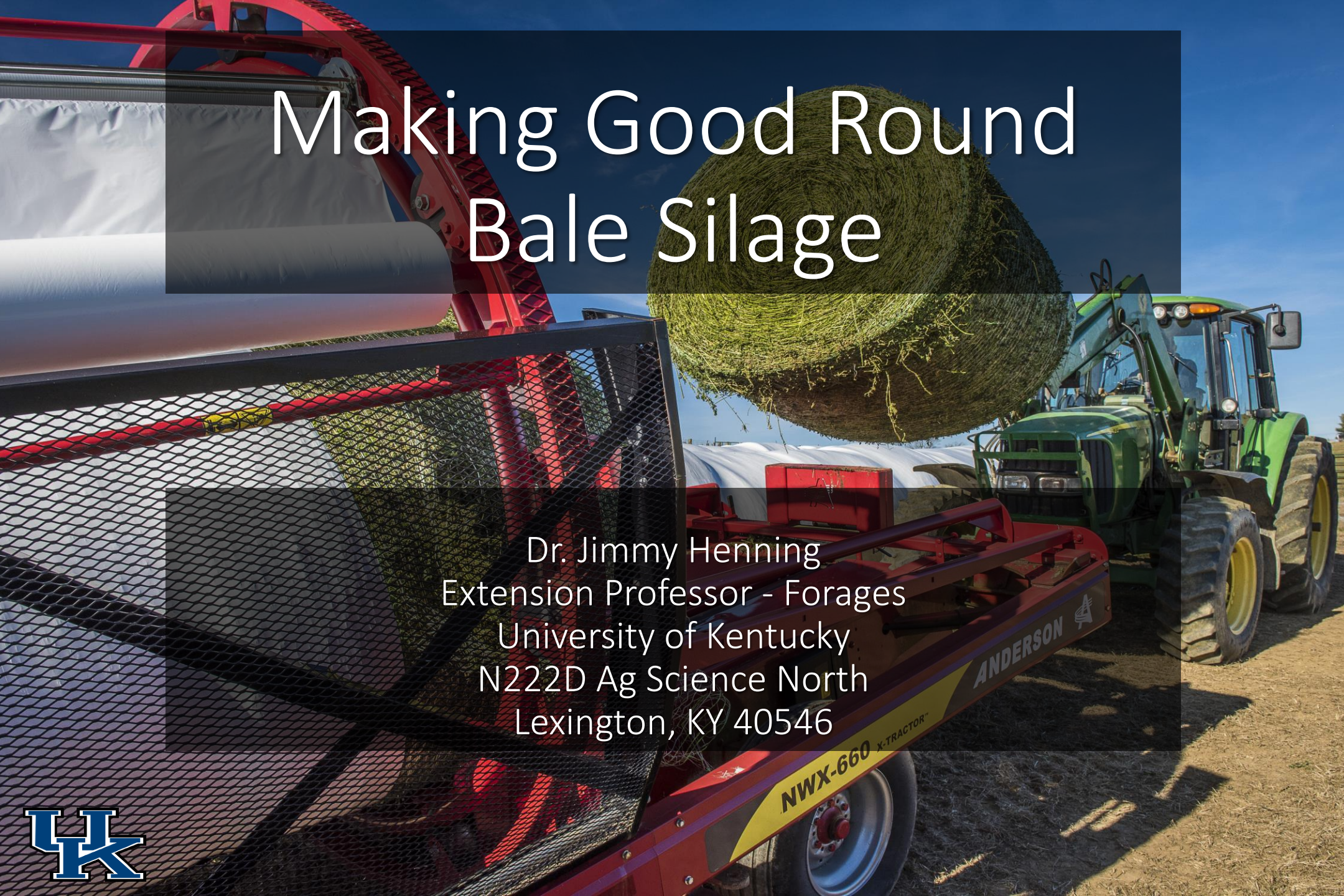

Making Good Round Bale Silage

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Situation

- Little data on the fermentation characteristics of Kentucky baleage
- Aggravating number of botulism cases, mortalities
- Little information on what farmers do to make good baleage

Project Purpose

- Define quality of Kentucky haylage, especially pH and volatile fatty acid (VFA) profile
- Identify practices leading to low pH and good VFA profile
  - Forage tests (2017-19)
  - Forage tests plus farmer interviews (2019)
- *To develop confidence in the quality and safety of haylage for livestock consumption*
  - *Identifying the risk factors for 'bad' or possibly toxic silage*

What we did

- Locate and sample a diverse set of bales and analyze for:
  - Moisture Content (MC)
  - Nutritive value (CP, TDN, RFV)
  - VFA profile (esp Lactic and Butyric Acid)

- Thanks to Brandon Sears, Corinne Belton, Levi Berg, April Wilhoit, Tommy Yankey, Don Sorrell, Dr. Jeff Lehmkuhler and Dr. Michelle Arnold, DVM

Samples Taken

- Six counties in Central and Northern Kentucky

(Madison, Campbell, Henry, Shelby, Fleming, Anderson, Bourbon Counties)

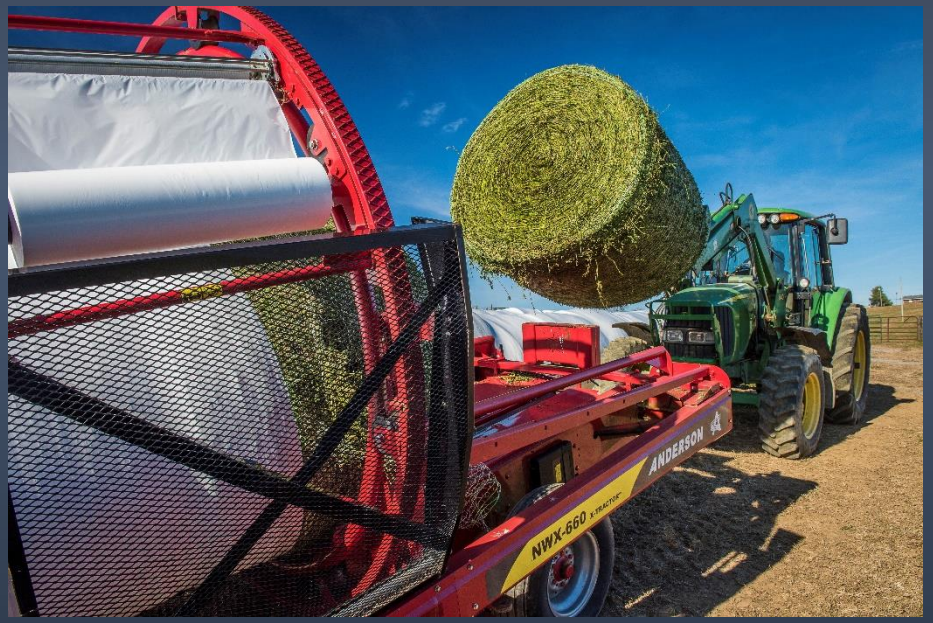
- 2017, 2018 and 2019
- Small grains, grass, summer annual and legume/legume grass
- 44 total samples from ‘17-’18, 50 from 2019.
- Analyzed at a certified commercial laboratory

Baleage

- Avoids rain damage
- Allows more timely cutting
- Disadvantages
  - Equipment
  - Hard to determine moisture content ‘in the moment’
  - Expense/labor
  - Plastic management
  - Potential for animal feeding issues, even death

Good baleage

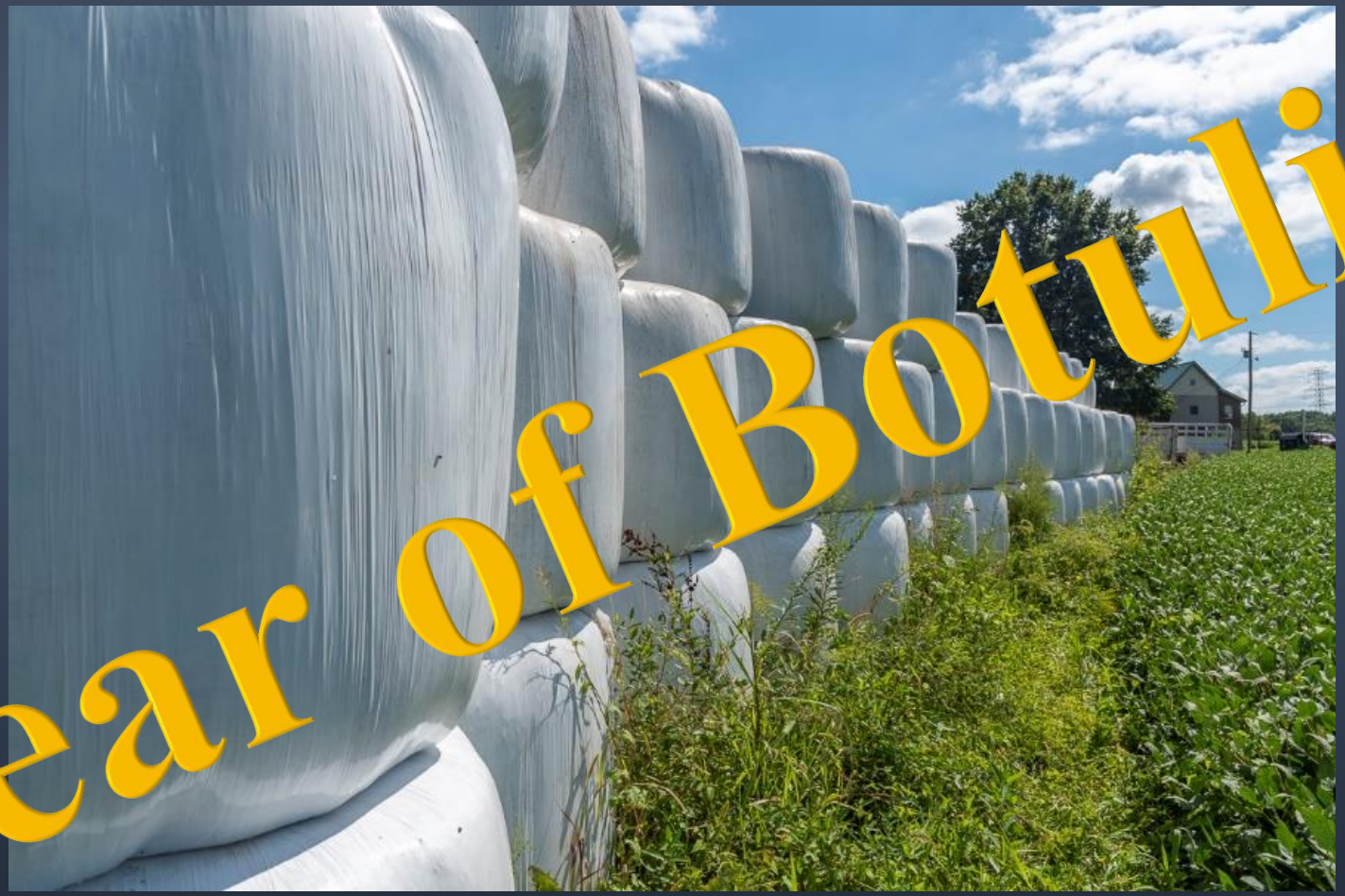
- MC between 40 and 60 to 65%*
- Tight, uniform bales
- 6 layers of plastic or more
- Cut early
  - More water soluble carbohydrates
  - Faster fermentation, pH drop
- pH 5.0 or below
- Lactic acid 3% or above
- Butyric acid 0.1% or less
- % of CP as Ammonia <15%
- Ash < 8 to 10%



What low pH and high lactic acid means…

- Forage is stable in storage
- Forage will have good bunk life when fed
- Low probability of clostridial toxin
- Low probability of listeriosis

Biggest Barrier to Making Baleage?



Fear of Botulism!

Botulism

- Toxin produced from ***Clostridium botulinum*** bacteria
- Several Clostridium spp.
  - Soil, manure most common sources
- Best indicator for Clostridial fermentation (but not proof)
  - Butyric Acid
  - % of Crude Protein as Ammonia
  - (Clostridia deaminate forage protein, metabolize lactic acid)
- Clostridial fermentation does not equal botulism

Conditions leading to Clostridial Growth

- Very high moisture content (>70%)
- Anaerobic conditions
- Poor fermentation (low CHO, mature forage)
  - Slow pH drop
- Contamination of forage
  - Soil (measured as Ash)
  - Manure
  - Dead animals

Dirt in Baleage

- Ash content is the indicator
  - Normal 6 to 8%
  - Above 11% - indicates dirt contamination
- Most common scenarios for high ash content
  - Rain damage (splashing)
  - Extremely dry conditions when raking/baling
  - Aggressive raking of a heavy crop
    - Especially drilled forages with bare soil between rows
- Most often seen with small grains, but also with summer annuals (forages planted in rows)

Example Fermentation Report, Summer Annual MC = 60

Component	DM Basis	Goal	Typical Value for DM Range 36 - 40
Dry Matter, %	39.62		
Lactic Acid, %	3.79	> 3	4.59
Acetic Acid, %	0.95	< 3	1.59
Lactic/Acetic Ratio	3.99	2.0 - 3.0	2.90
Propionic Acid, %	0.02	< 1.0	0.14
Butyric Acid, %	0.00	< 0.1	0.16
IsoButyric, %	0.00		
Total Acids, %	4.77	5.0 - 10.0	6.50
pH, As sampled	4.50	< 5	4.59
Crude Protein, %	14.68		
Ammonia, CPE %	1.05		1.37
Amm-N, % of Total N	7.18	8.0 - 15.0	9.33
VFA Score	7.41	6.0 - 10.0	

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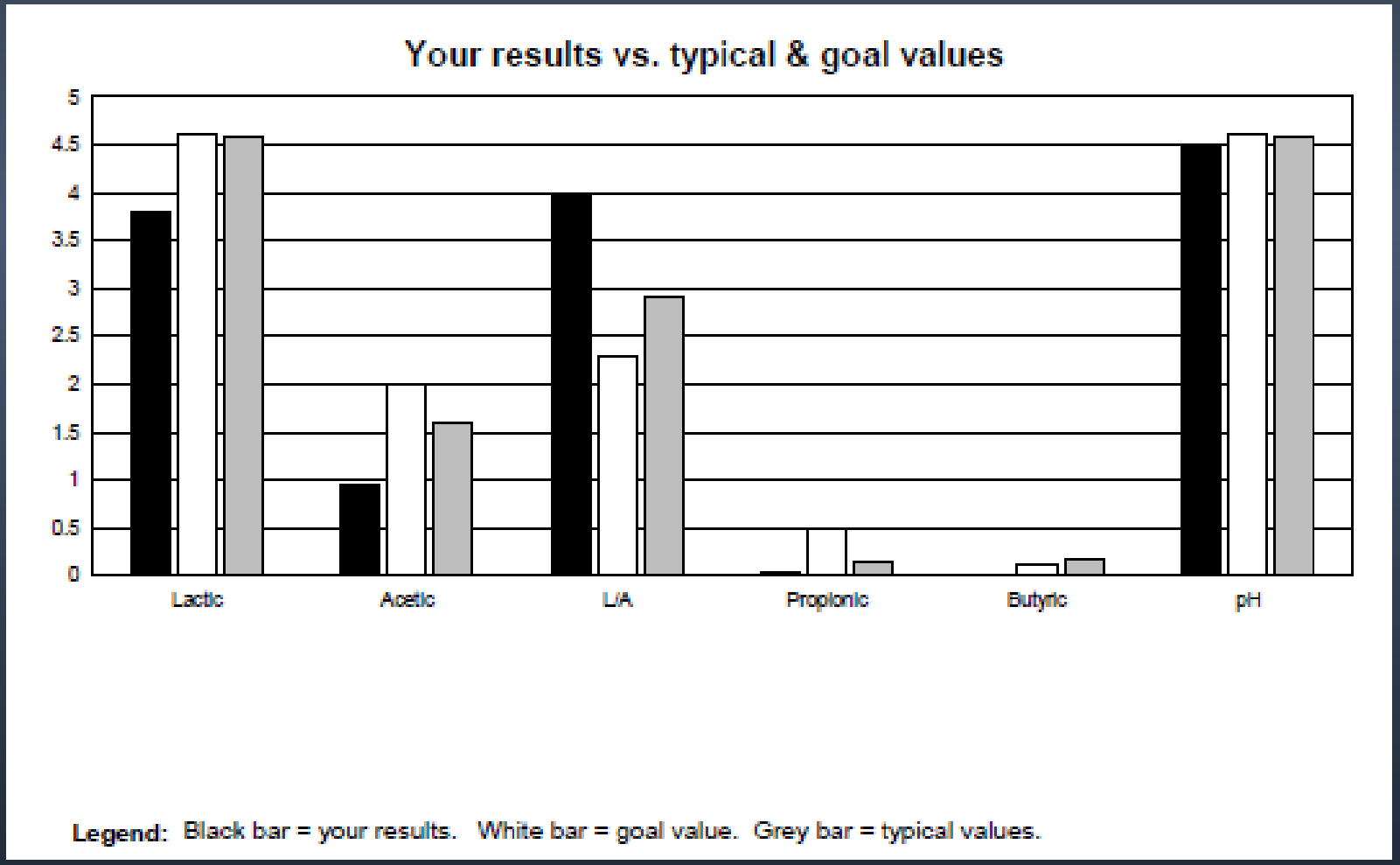
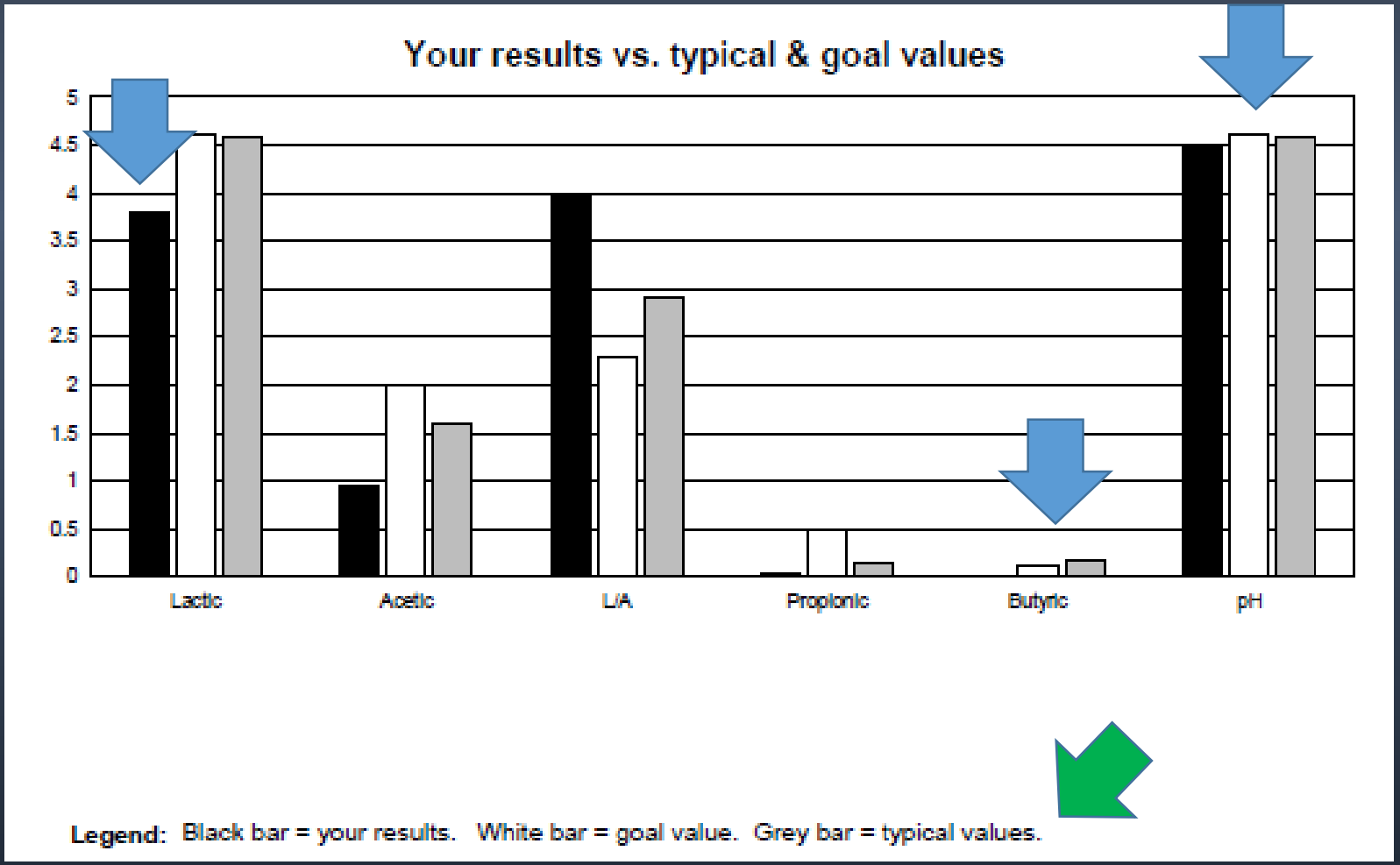
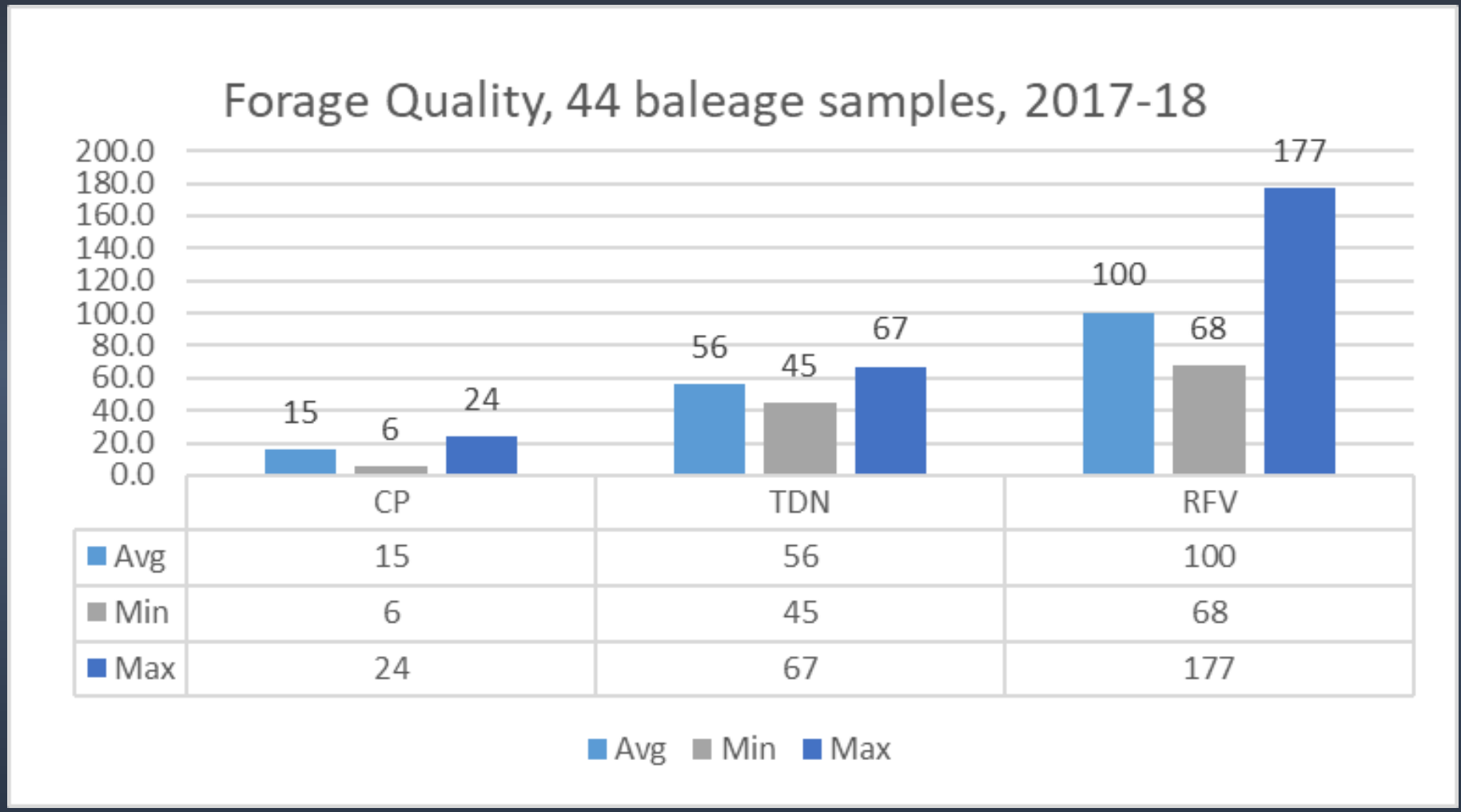


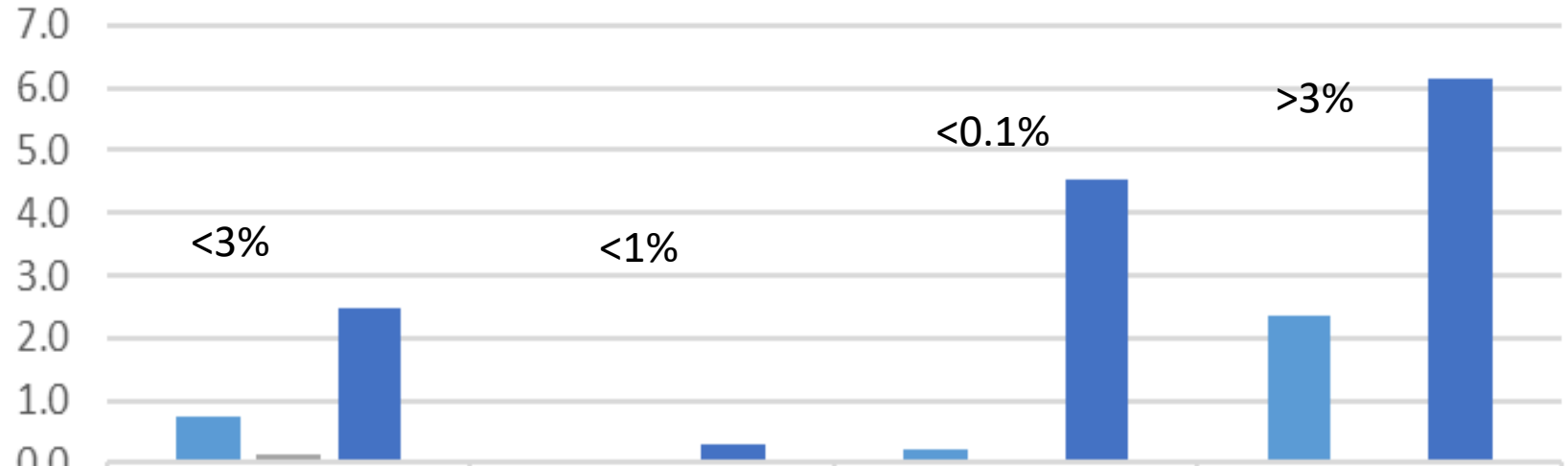
Summer Annual MC=60



What did we find?

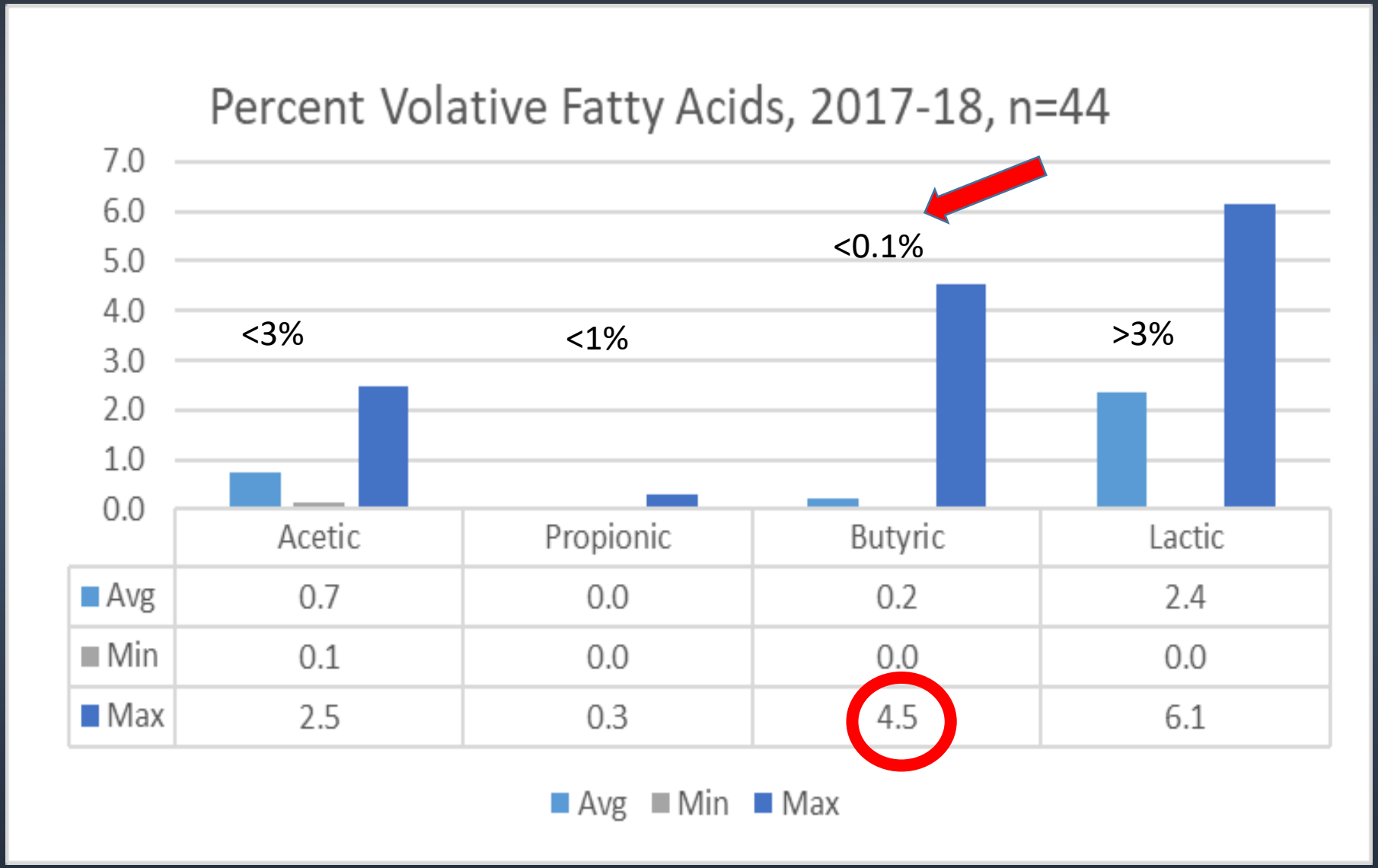

Forage Quality, 44 baleage samples, 2017-18
200.0
180.0
160.0
140.0
120.0
100.0
80.0
60.0
40.0
20.0
0.0
15
6
24
56
45
67
100
68
177
CP
TDN
RFV
Avg 15 56 100
Min 6 45 68
Max 24 67 177
Avg
Min
Max

Percent Volative Fatty Acids, 2017-18, n=44



	Acetic	Propionic	Butyric	Lactic
Avg	0.7	0.0	0.2	2.4
Min	0.1	0.0	0.0	0.0
Max	2.5	0.3	4.5	6.1

Avg Min Max



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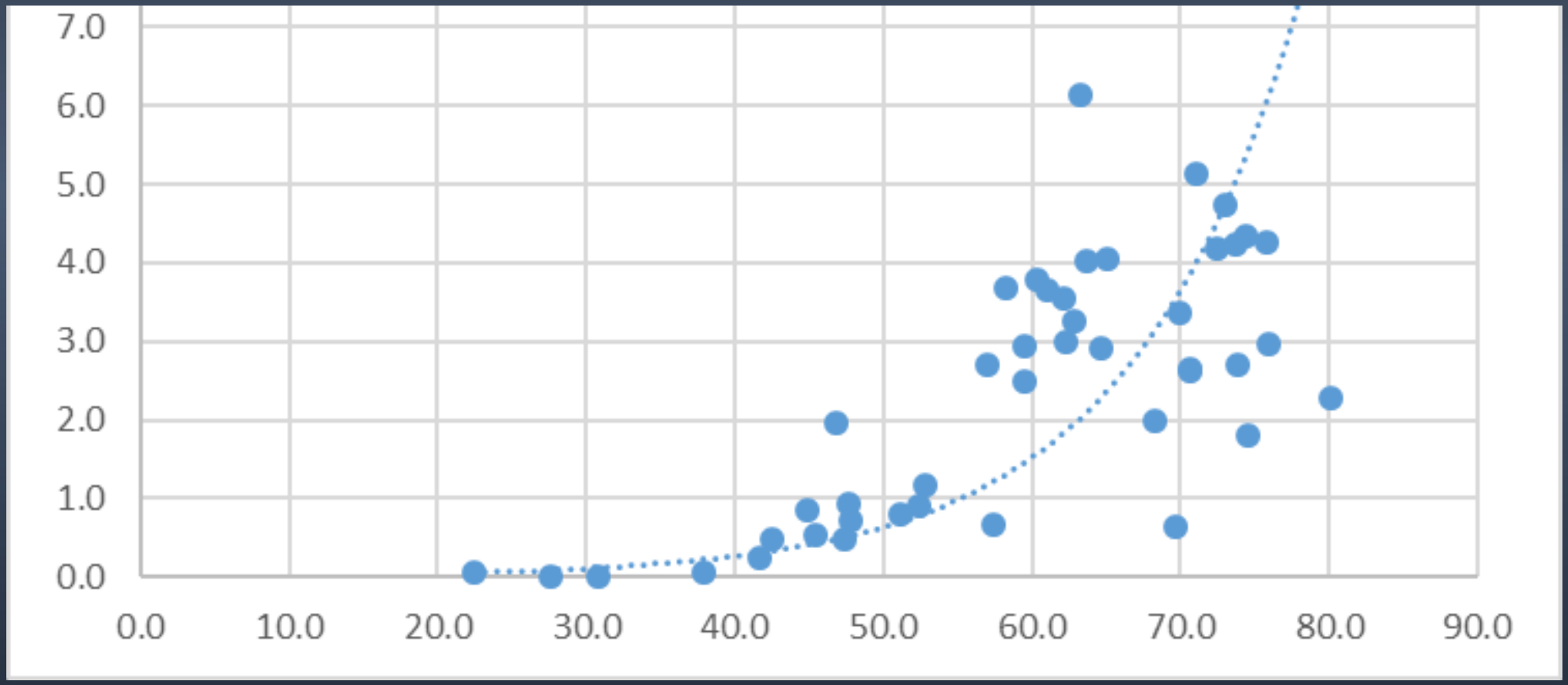
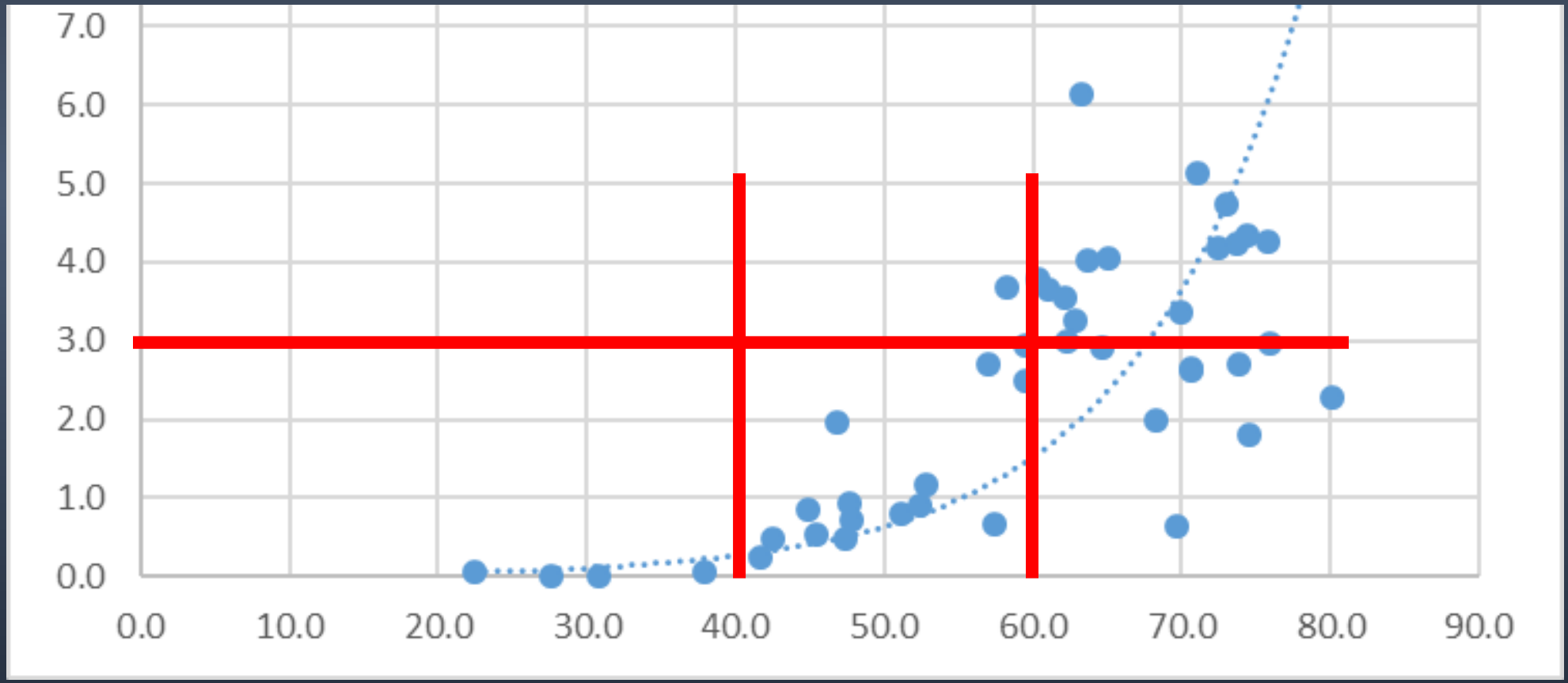
Baleage quality by forage type

Forage type	#	MC %	CP %	Lactic Acid %	TDN %	RFV	pH
Small grain	7	70	13.3	3.2	58	93	4.9
Grass	6	50	12.6	1.1	59	95	5.3
Summer annual	12	68	13.7	3.2	50	80	5.2
Legume or legume grass	18	50	18.3	1.8	59	115	5.5
Goal		40 to 65		>3			<5

MC was biggest factor in Lactic Acid %

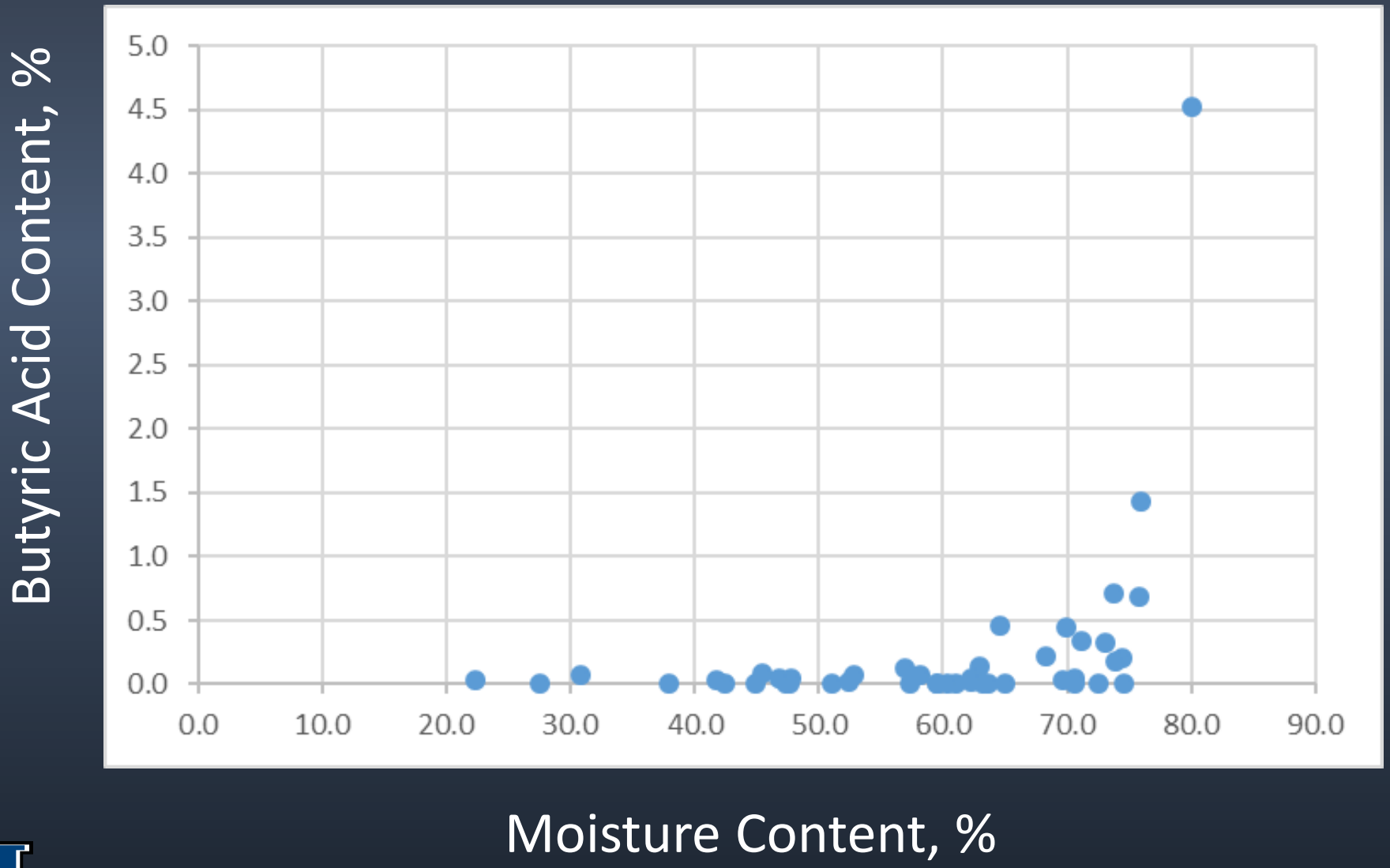


Baleage MC and Lactic Acid %

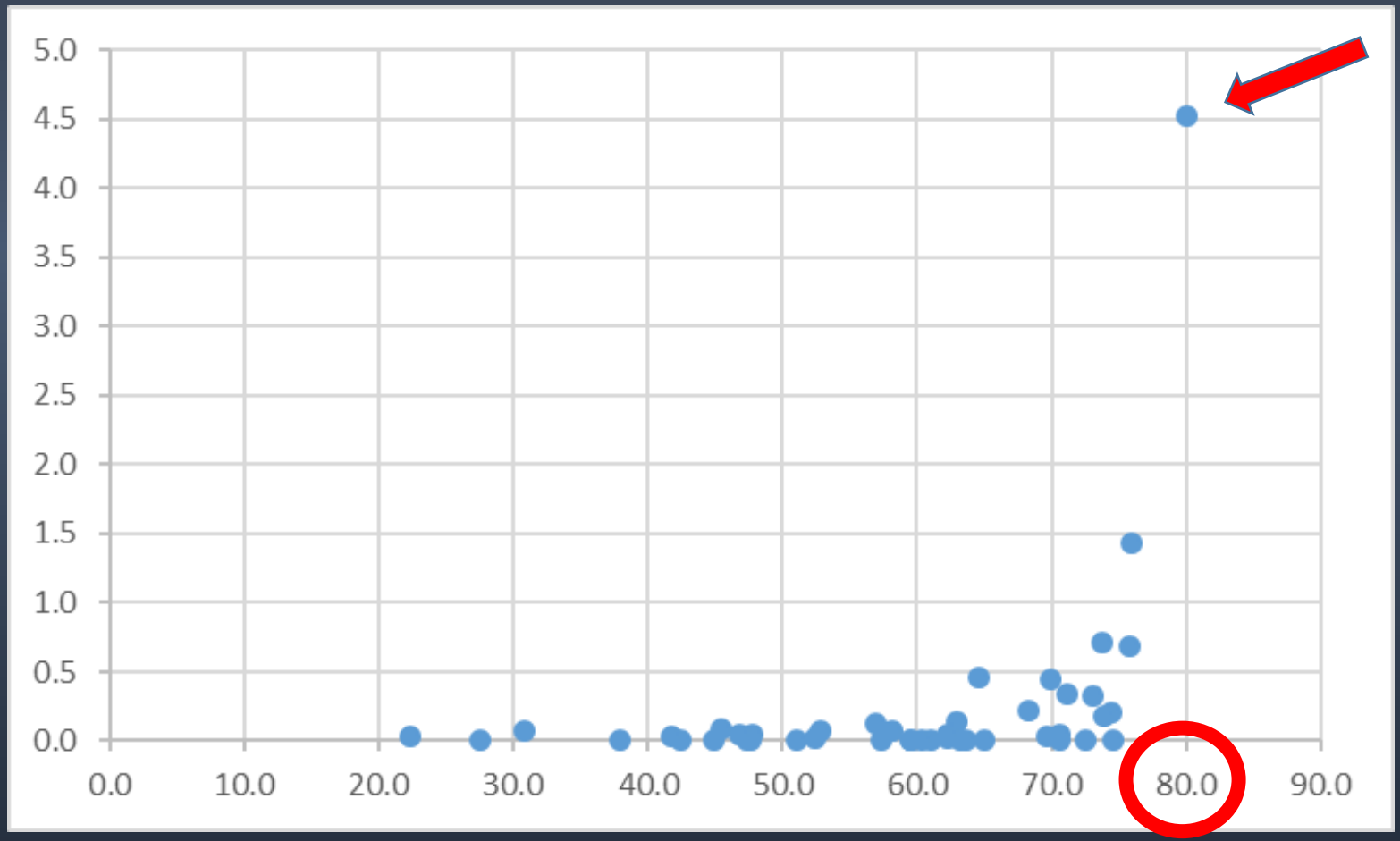


Moisture Content, %

2018 Baleage MC and Butyric Acid %

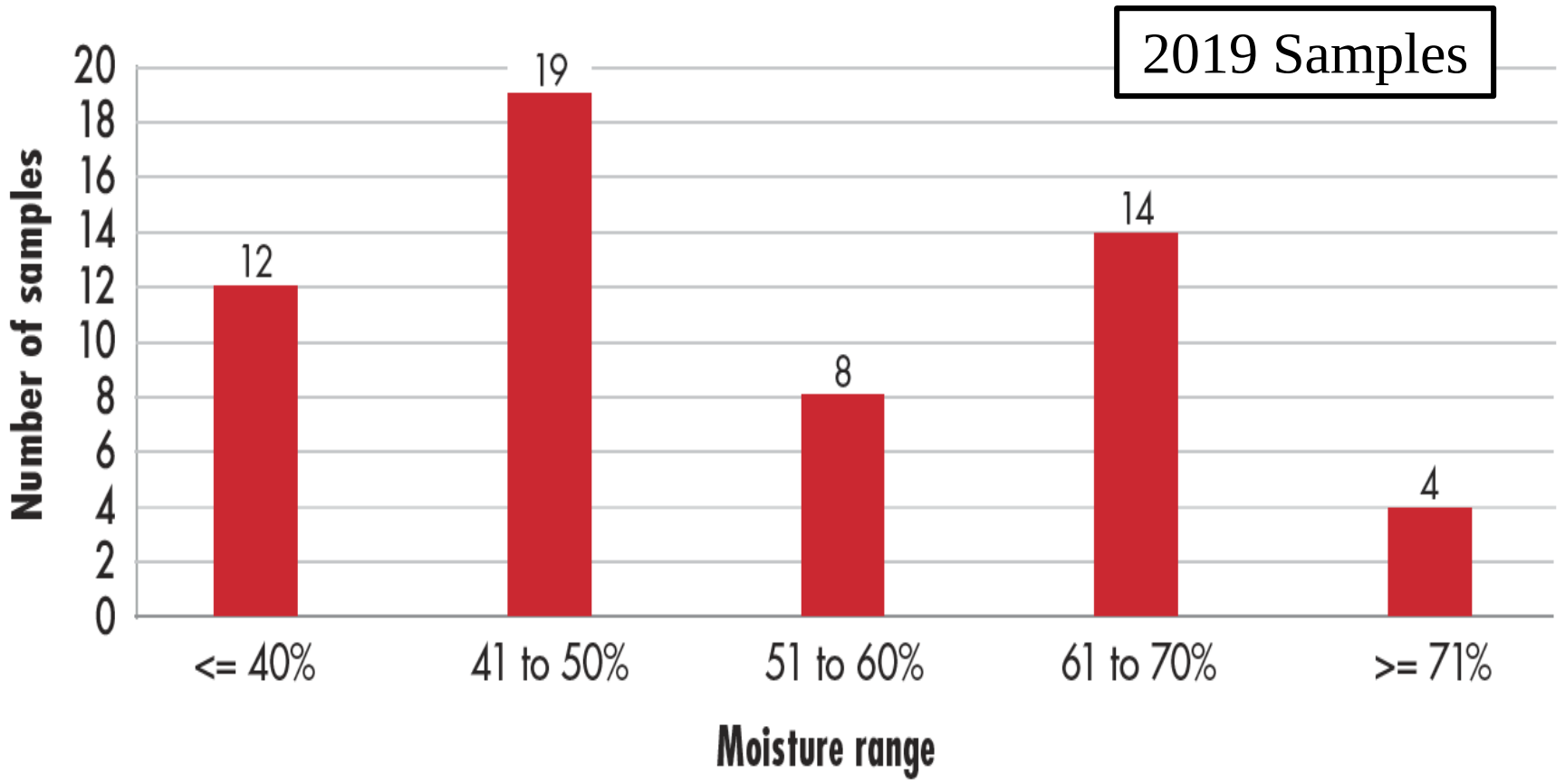


2018 Baleage MC and Butyric Acid %



2019 Results

Figure 1. Frequency (n=57) of moisture content, Kentucky baleage, 2019



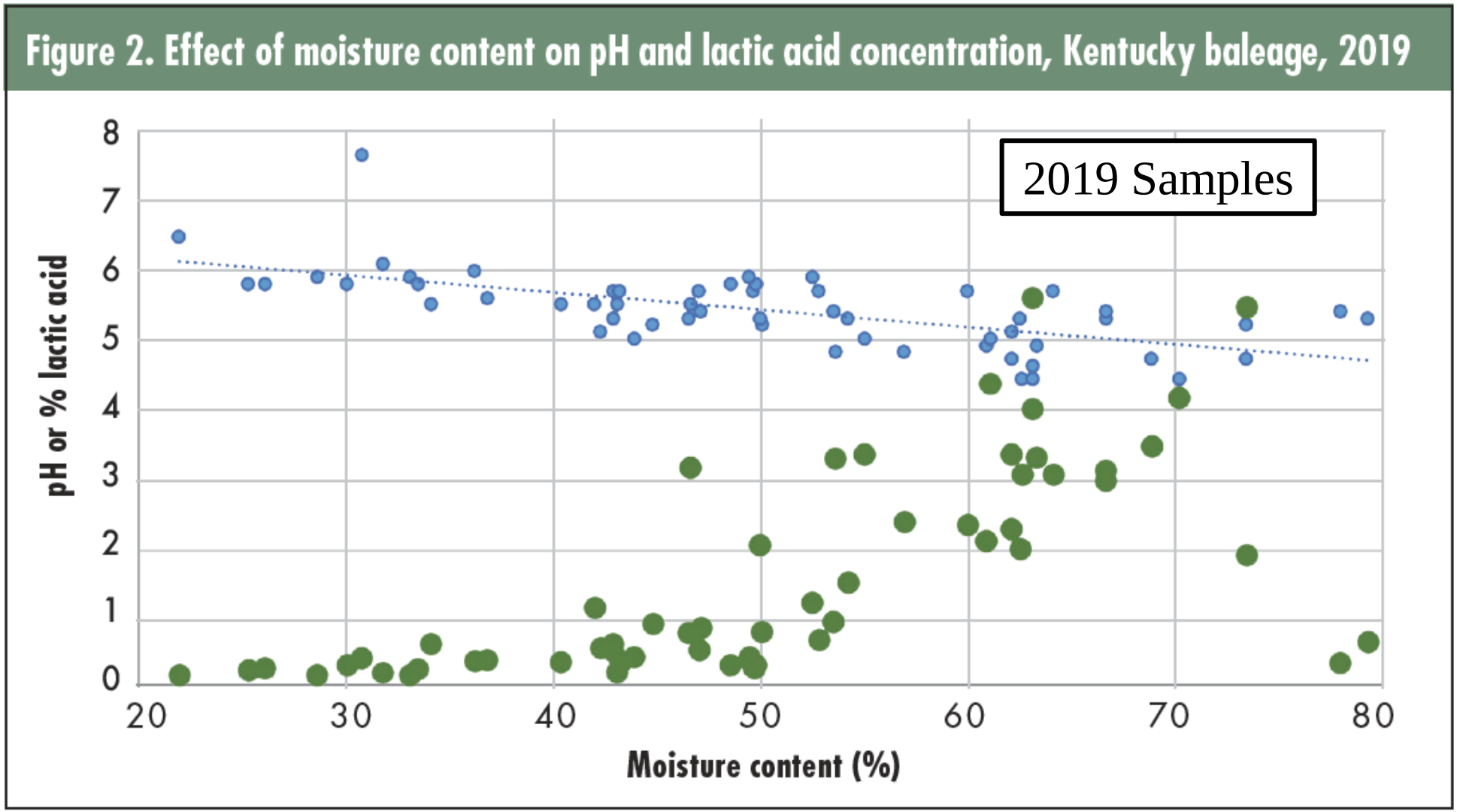
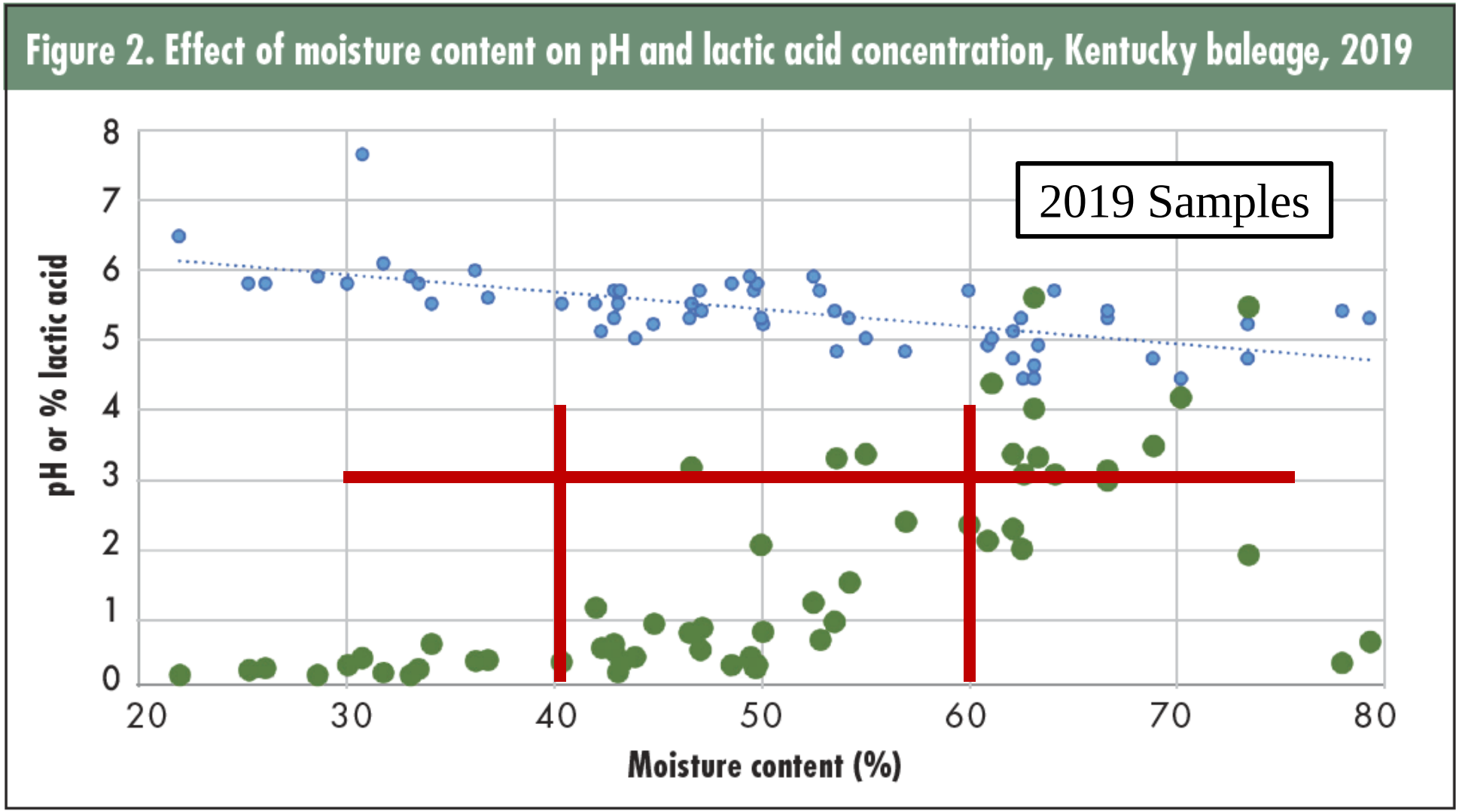
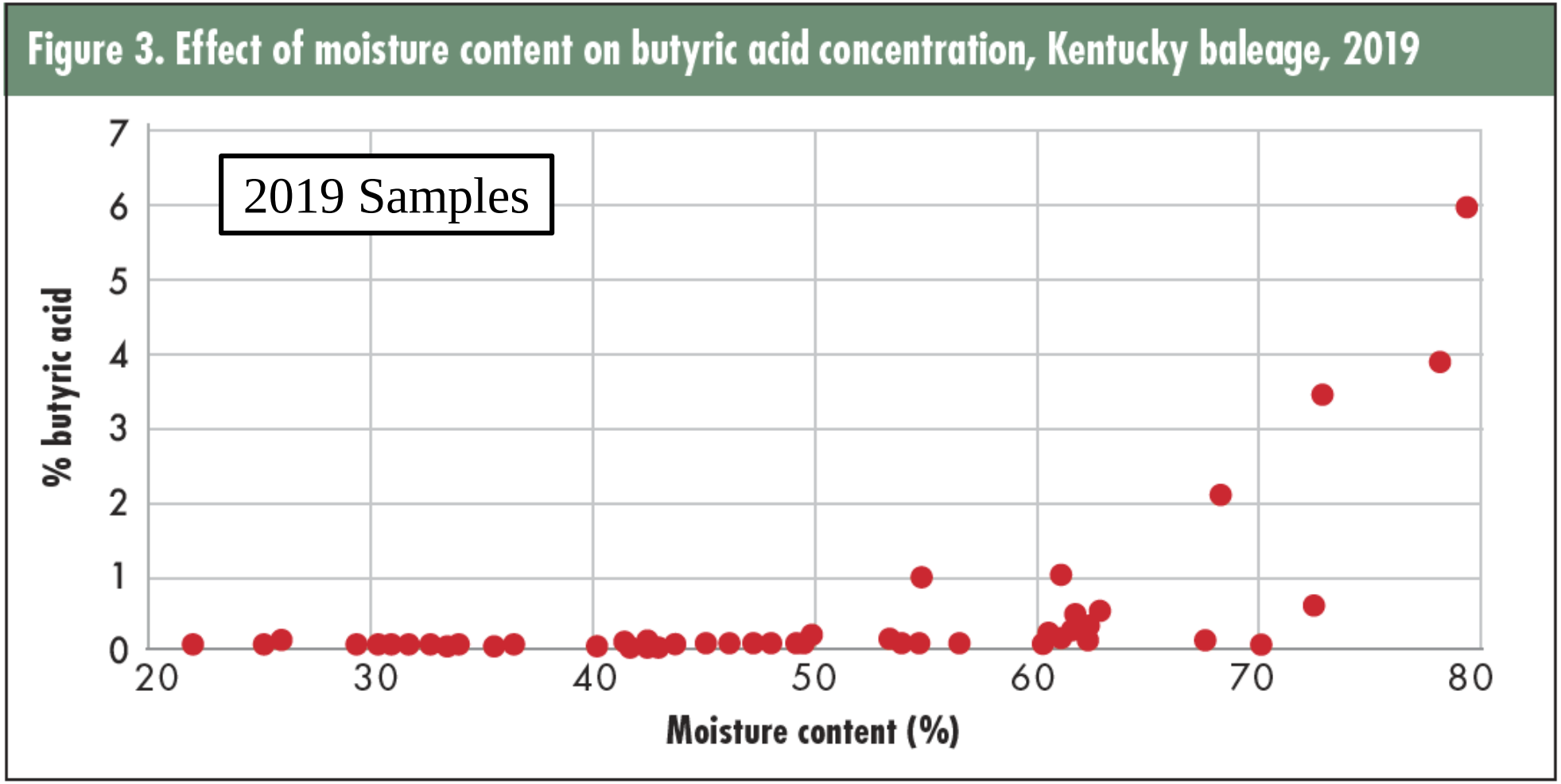


Figure 2. Effect of moisture content on pH and lactic acid concentration, Kentucky baleage, 2019
2019 Samples
pH or % lactic acid
Moisture content (%)
0
1
2
3
4
5
6
7
8
20
30
40
50
60
70
80

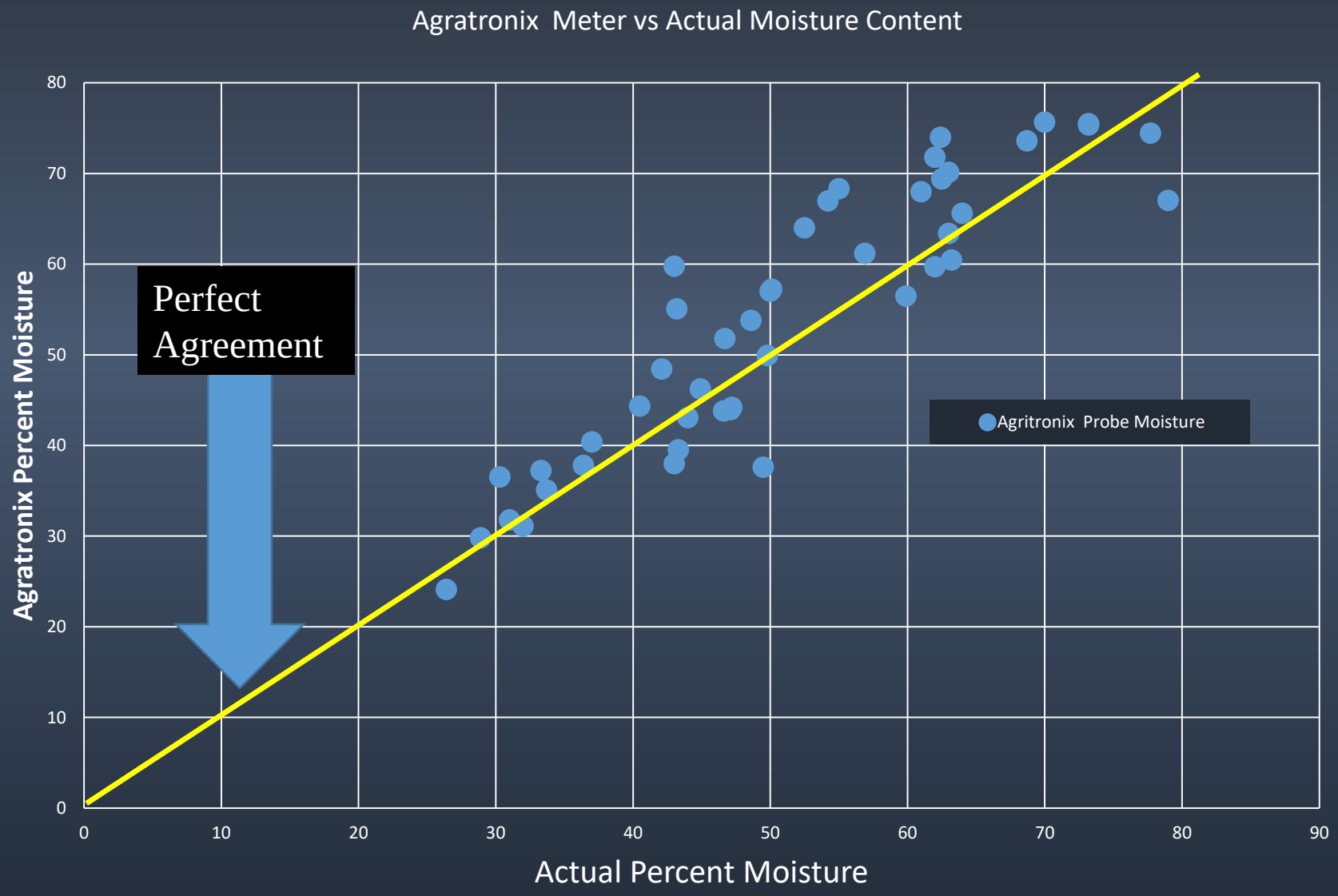


Is Low Lactic Acid in Baleage a Problem?

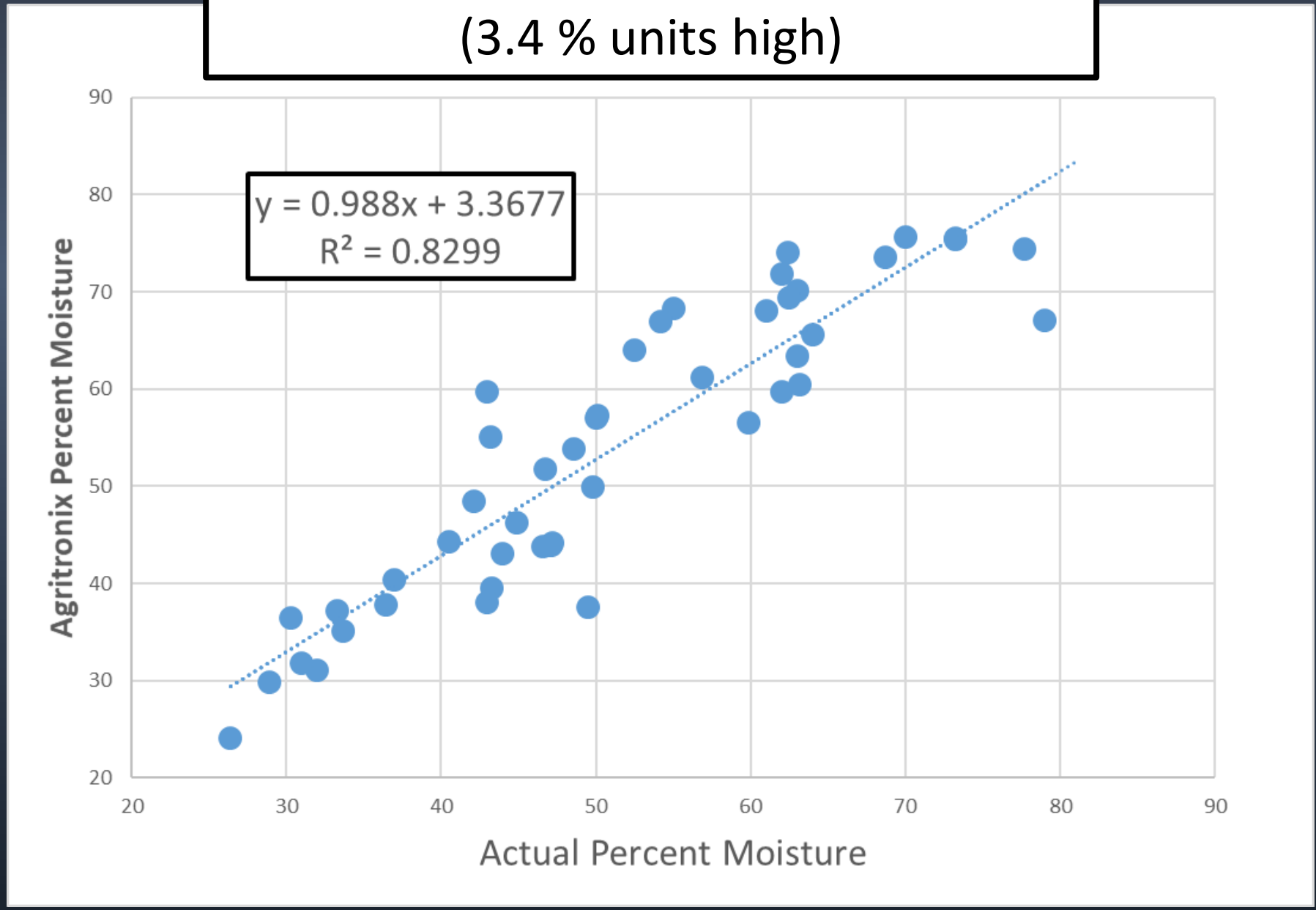


Does High Butyric Acid Mean Toxic Baleage?

Agratronix Moisture Tester Results


Agratronix Meter vs Actual Moisture Content
Agratronix Percent Moisture
Actual Percent Moisture
Perfect Agreement
Agritronix Probe Moisture
0
10
20
30
40
50
60
70
80
90

Agratronix consistently estimated MC (3.4 % units high)



Correlation of Practices to Good Baleage

Yes:

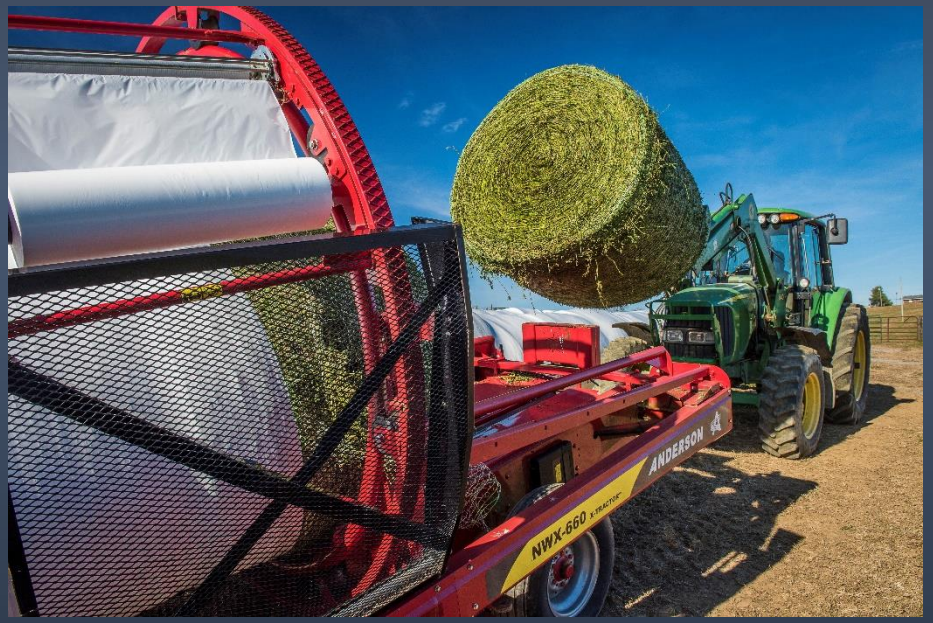
- Cutting early
- Tight uniform bales
- Mowing what can be wrapped in a day
- Baling at wet end of MC range
- 6 plus layers of plastic
- Plastic integrity

Still unclear:

- Mower type
- Baler type
  - Silage type or not
  - Knives or not
- Rake type
- Silage inoculant

High Risk Baleage Factors

- MC above 70%
- Loose uneven bales
- < 4 layers of plastic
- Holes in plastic
- Bad odor
- pH > 5.0
- Lactic acid < 1%
- Butyric acid > 0.3%
- % N as Ammonia >15%
- Ash > 11%



Testing Baleage is Essential

- Forage quality
  - Moisture
  - ***Ash***
- Fermentation Panel
  - pH
  - Concentrations of volatile fatty acids
    - Lactic, acetic, propionic
    - Butyric
  - % Crude Protein as ammonia

Questions?