2018 Penn State Dairy Nutrition Workshop

What Can Rumination Tell Us about Managing Nutrition?

Elle Andreen, Masters Student
Dr. Kevin Harvatine, Assistant Professor of Nutritional Physiology
Penn State University

PennState
College of Agricultural Sciences

What we will discuss today:

- What is rumination and why is it important?
- What influences rumination time?
- Monitoring rumination on-farm using technology
- The importance of rumination in rumen function and production of milk and components
- New research on rumination and milk fat
- Future directions

The purpose of rumination is to improve feed digestion

How?

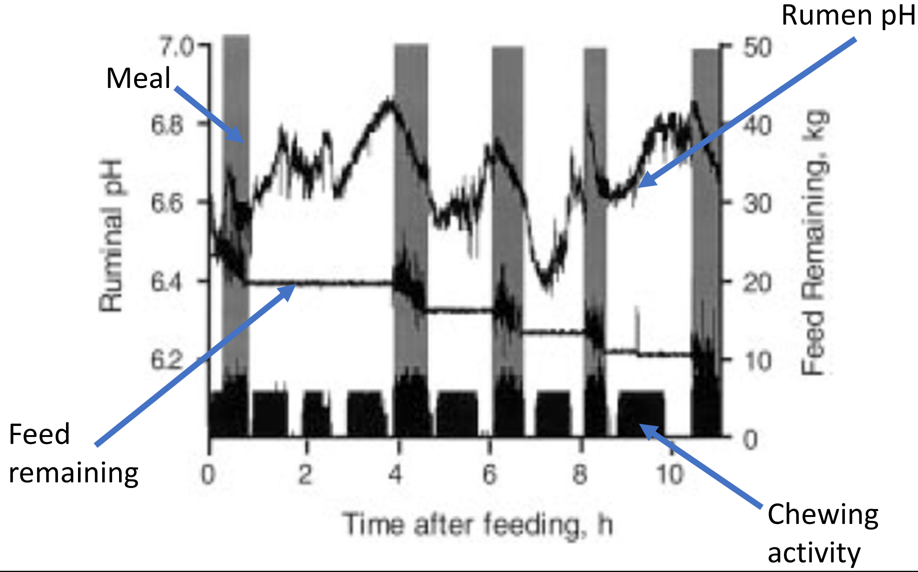
1. Reduce particle size
2. Increase surface area for microbial digestion
3. Supports optimal rumen function

Rumination is an essential part of the digestive process

- Regurgitation of partially digested feed through contractions of the reticulorumen
- Occurs usually while at rest
- Enables rapid consumption followed by leisurely breakdown
- Rumination is key part of the time budget between ruminating, eating, and resting
- These variables are often reciprocal – especially rumination and eating

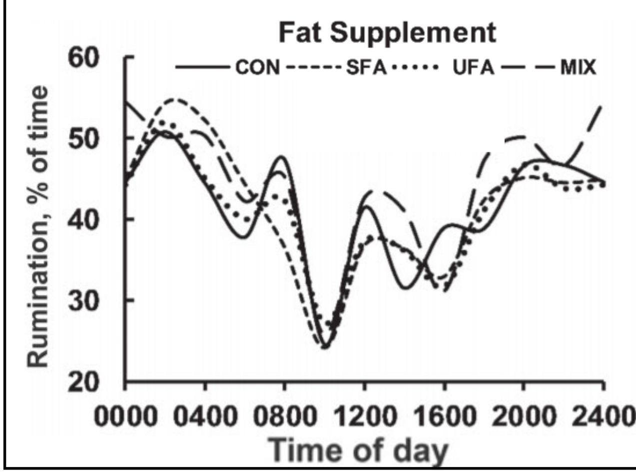
→ **There is <u>no perfect time budget</u> for all cows**

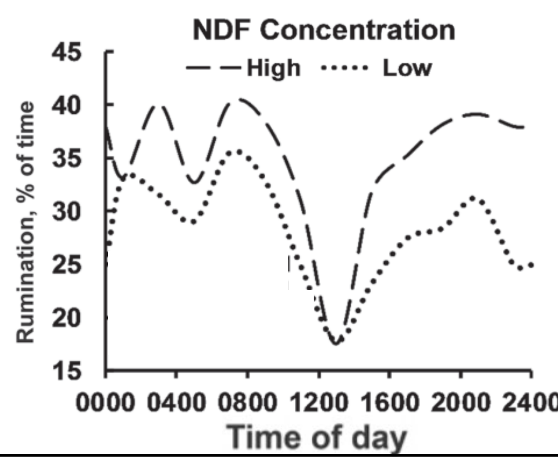
Rumination is cyclical and based on intake



Rumination has a daily pattern that is minimally influenced by diet

Salfer et al. 2018: Minimal impact of diet NDF, fatty acids, or starch concentration on daily rhythm of rumination





Rumination time can be assessed in two ways:

1. Baseline or average rumination time (e.g. min/d)
2. Deviation (Δ) from baseline rumination time
   - These is what rumination sensor algorithms for heat detection and health alerts are built around

Baseline rumination time is driven by multiple factors:

- Diet
  - Forage to concentrate ratio
  - Particle size
  - Feed fragility (e.g. straw vs silage)
- Milk production → Dry matter intake
- Individual cow variability

Baseline rumination time is driven only partly by diet and DMI:

Variable	Correlation coefficient for Rumination time (mid/d)
DMI	0.19
Eating time (min/d)	0.27
NDF, % of DM	-0.15
Forage NDF, % of DM	0.19
Forage, % of DM	0.15
Silage, % DM	0.21
TMR particles on 8mm sieve, % of DM	0.38

Diet factors interact with one another and with DMI – this dilutes each variable's direct correlation with rumination time.

Beauchemin (2018)

Particle size is important but is not a great predictor of rumination

- Cow rumination responses to particle size are often not repeatable in research trials
- Recent meta-analysis of particle size research indicated additional factors that modulate cow response to particle size:

  Forage source
  Forage:Concentrate ratio
  Ensiling method

Nasrollahi et al. (2016)

Baseline rumination time is impacted by inherent animal variability

- Cows ruminate for widely variable amounts of time each day, even when environment, diet, DIM, parity, and production level are accounted for
- Variation attributable to Cow ranges in the literature from **16%** to **48%**
  - 12 cows on same diet monitored with halter pressure monitors vs 79 cows on varied diets monitored with a commercially available microphone-based system

Take-homes:

- **No single factor predominantly determines baseline rumination time!**
- **The impact of higher or lower baseline rumination time on production is not well understood**

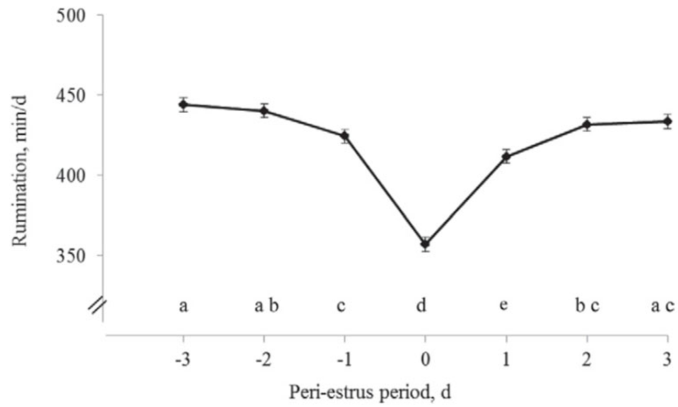
Dado and Allen, 1994; Byskov et al. 2015

Specific events cause rumination to deviate from the baseline:

- Estrus
- Calving
- Metabolic conditions
  - Transition period
- Gastric/other illness
- Changes in milking or feeding frequency

Current rumination sensors are quite effective at detecting and identifying these events!

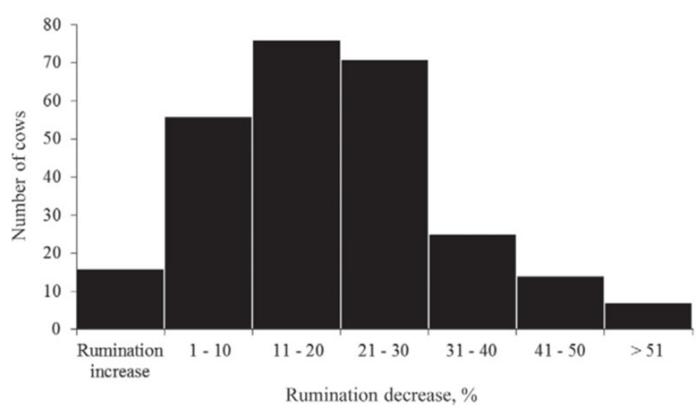
Rumination decreases before and during estrus



Dynamics of rumination time during the estrus period for 265 estrus events leading to pregnancy of the cow.

Reith et al. JDS 2012

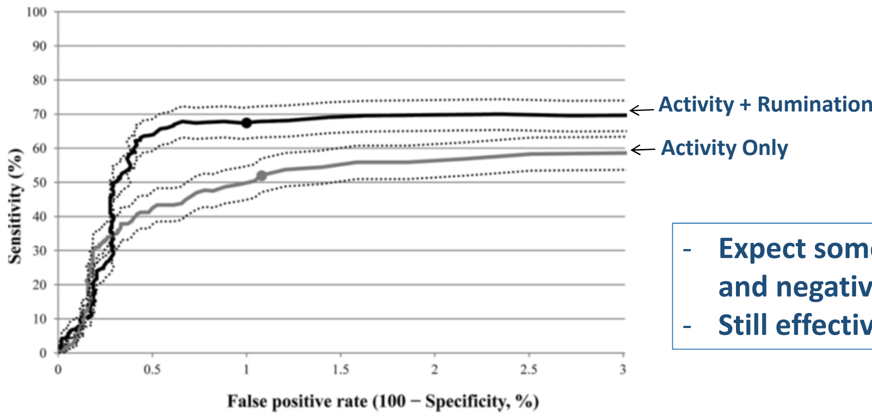
Change in rumination time during estrus is not uniform across all cows



Distribution of the number of cows with different decreases (%) in rumination time during estrus.

Reith et al. JDS 2012

Rumination data do improve sensitivity of heat detection and reduce false positives



- Expect some false positives and negatives
- Still effective systems!

Receiver operating characteristic (ROC) curves (restricted to a maximum false positive rate of 3%, equivalent to a minimum specificity of 97%) and their 95% CI bands represented by dashed lines (......): The gray line is for collars measuring activity only, the black line is for collars measuring activity and rumination characteristics. The curves are based on time window TW24–0, in which an activity alert was considered true positive when it occurred within 24 h preceding a gold standard positive a.m. milking. The dots ( ) on each ROC curve represent detection performance at the manufacturer's recommended default threshold value of 5.2.

Kamphuis et al. JDS 2012

How do we measure rumination?

1. Visually count number ruminating
   - Daily patterns!
2. Video recording
3. **Rumination monitoring systems**

Multiple rumination monitors are commercially available

- Heatime HR Tags (neck collar) - SCR
- SensOor (ear tag) – CowManager/Select Sires
- MooMonitor+ (neck collar) - DairyMaster

Systems use accelerometer to detect motion, and algorithm to interpret movements as behaviors

Rumination monitoring systems are accurate

Publication	Cow hours observed	Observers	Housing	System	R^2 of system vs visual observer
Pereira et al. 2018	144	1	Grazing	CowManager	0.72
Borchers et al. 2016	192	42	Freestall	CowManager	0.69
Bikker et al. 2015	327	3	Freestall	CowManager	0.93
Schirmann et al. 2009	102	2	Freestall	SCR	0.96

Detection of rumination may vary by system; for cows wearing both CowManager and SCR sensors, SCR reported 39% greater rumination times on average (Dolecheck, 2015)

We have successfully incorporated rumination data into reproduction and health monitoring….

What about nutrition?

(rumination is digestive process after all!)

Rumination contributes to and is an indicator of proper rumen function

Optimal rumination

↘

Optimal feed digestion

↘

Optimum production

Rumination impacts rumen function:

1. Increases rumen pH
2. Encourages motility and mixing
3. Increases availability of substrate for microbes

Rumen pH is a balance of production and absorption of VFAs and rumen buffering

↓ pH

1. VFA production

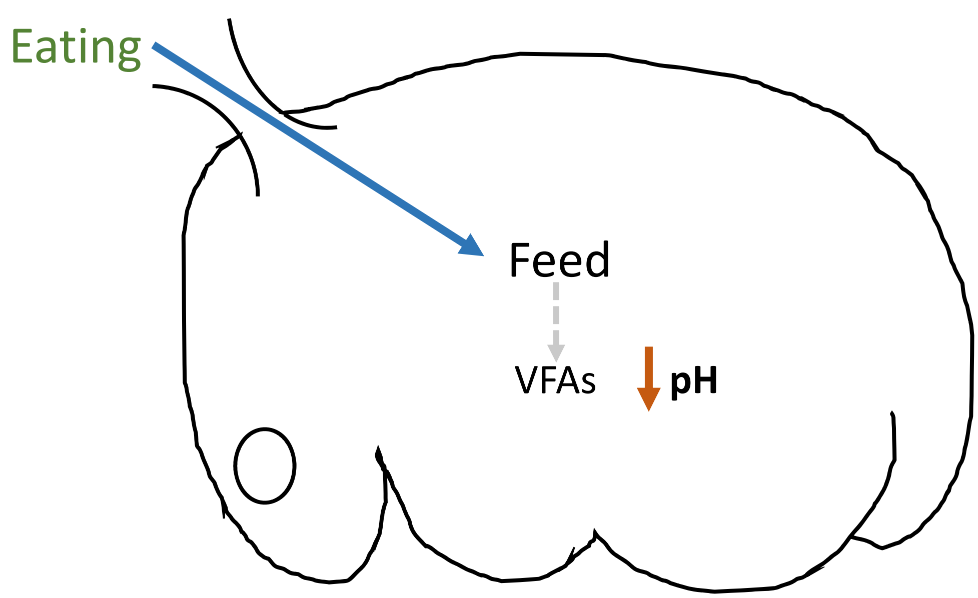
Rumination

VS:

↑ pH

1. Buffering: saliva production, rumen fill/mixing, and buffering capacity of feeds
2. VFA absorption rate

Rumination is essential to rumen function



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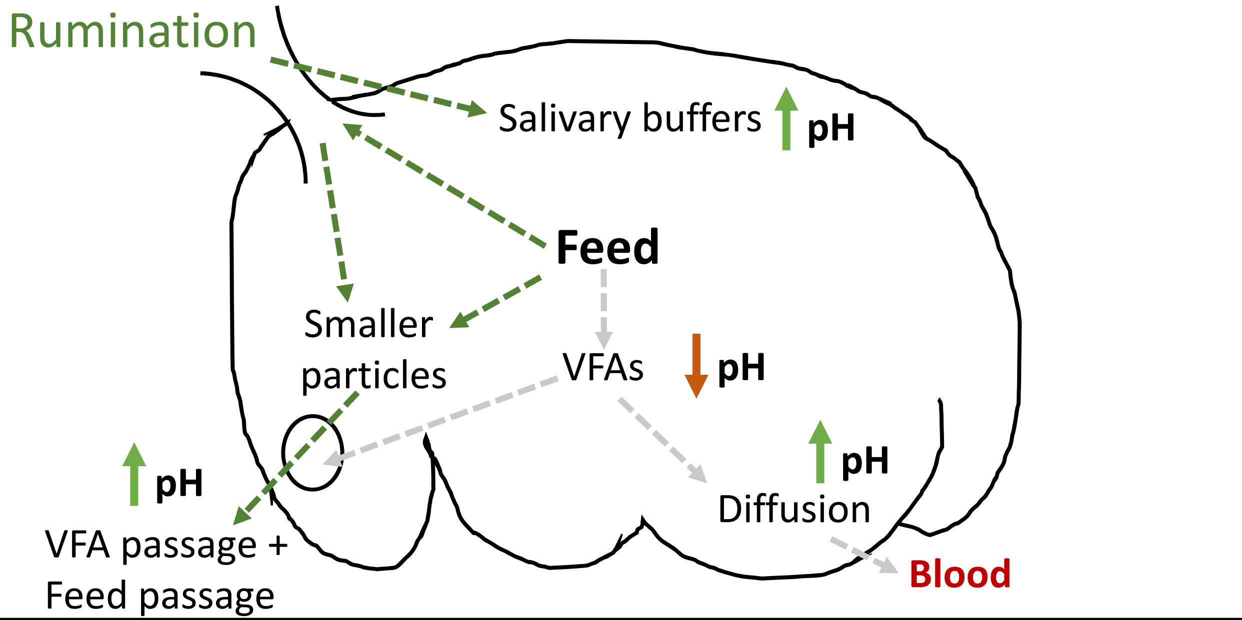

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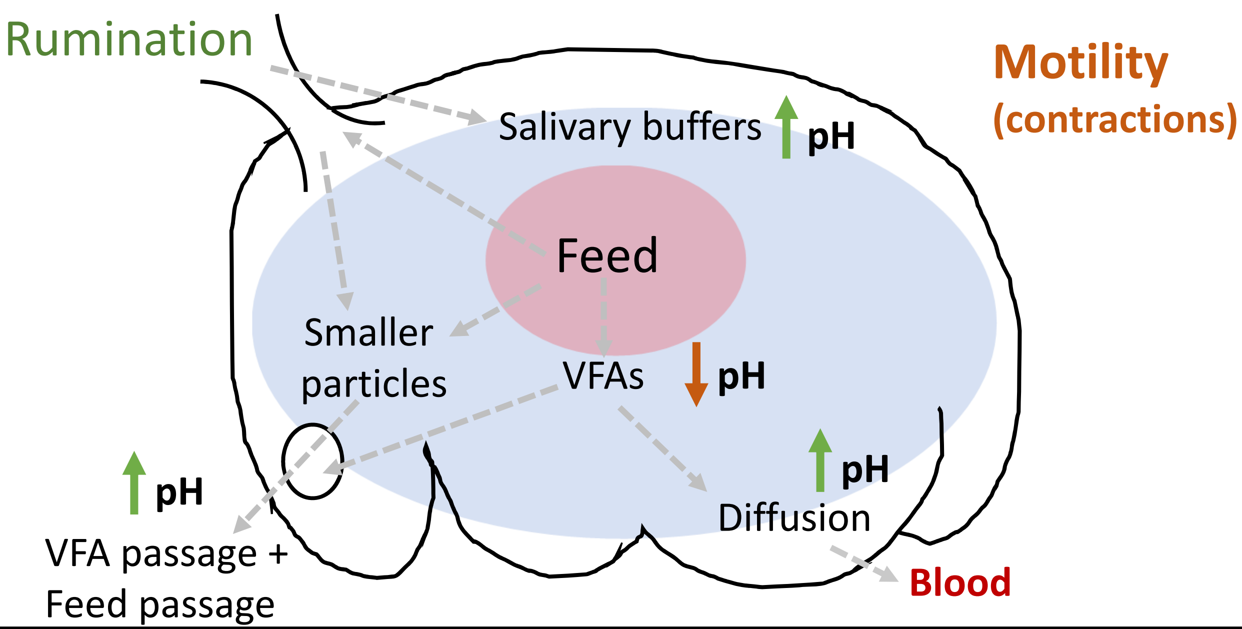
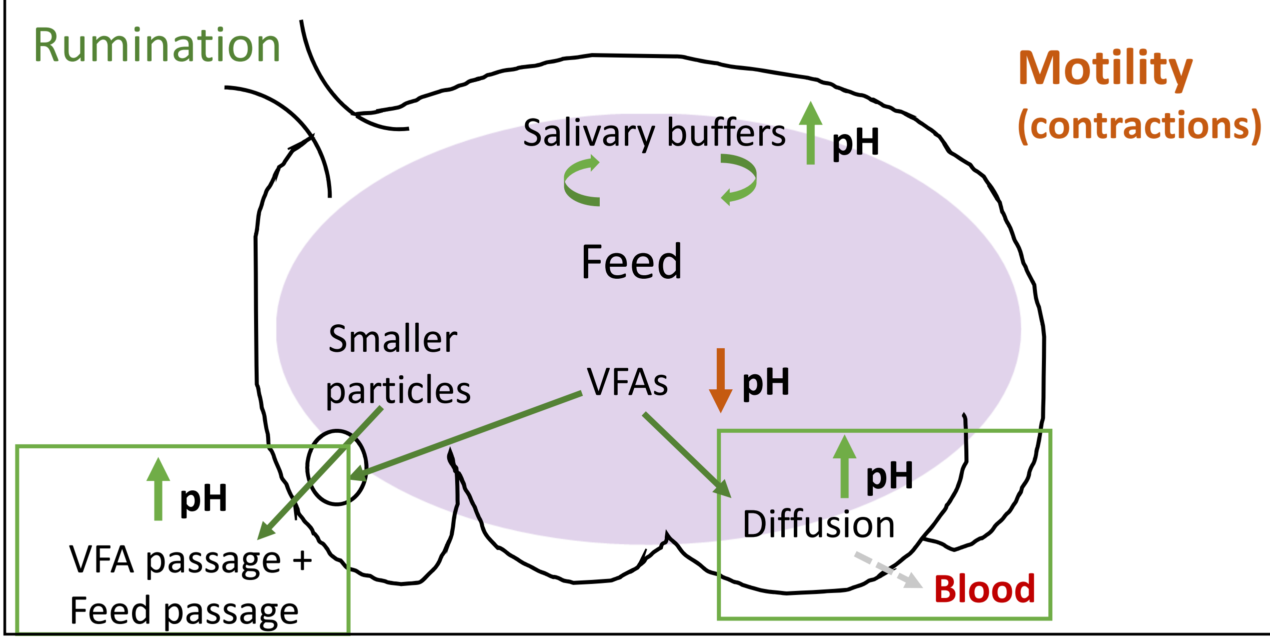


Rumination is essential to rumen function



Disrupted rumen function can disrupt production of milk and components

Two examples of affecting milk fat production specifically:

- **Milk fat depression:** altered fermentation causes formation of fatty acids that inhibit milk fat synthesis
- **Subacute ruminal acidosis (SARA):** prolonged low rumen pH damages rumen papillae and reduces health and productivity (primarily **milk fat** and yield)

Do not understand prevalence of these conditions, and if/how rumination may play a role.

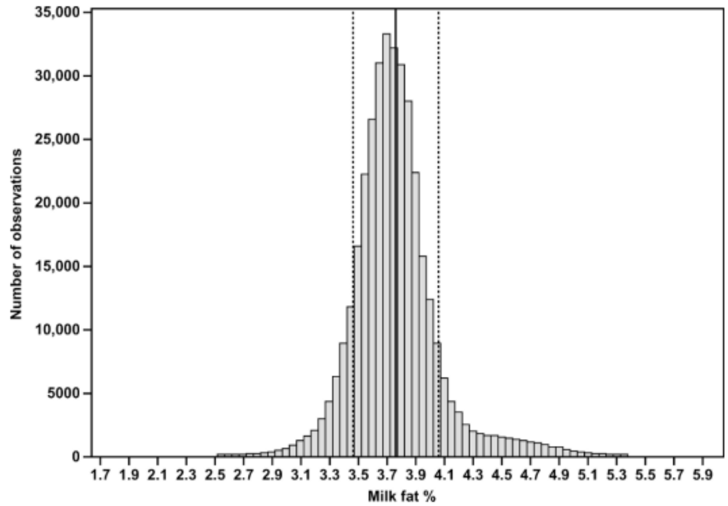
Milk fat varies between and within herds

The "known" factors:

- Diet
- Season
- Stage of lactation, parity

The "unknown" factors:

- **Genetics**
- **Milk fat depression**
- ***Rumination?***



Distribution of milk fat % in Mideast market over 3 year period between 2000 and 2002. Adjusted for seasonal effect. Mean 3.76% ± 0.30% (SD)

Bailey et al. 2005

Nutritional Implications of Metabolic Diseases in Dairy Cows

Linda D. Baker VMD, MS, diplomate ACVN
Associate Professor of Dairy Production Medicine
University of Pennsylvania, School of Veterinary Medicine

Brianna Parsons, VMD
Intern in Dairy Production Medicine and Field Service

Parturient Period

- High risk for ill health – first two weeks

Metabolic

- Milk fever
- Ketosis
- Fatty liver

Infectious

- Metritis
- Mastitis
- Pneumonia

Gastrointestinal

- Rumen upset/acidosis
- Indigestion

Physical Problems

- Displaced abomasun
- Retained placenta
- Lameness

Postpartum Cow

~50% of cows have at least one health problem post-calving

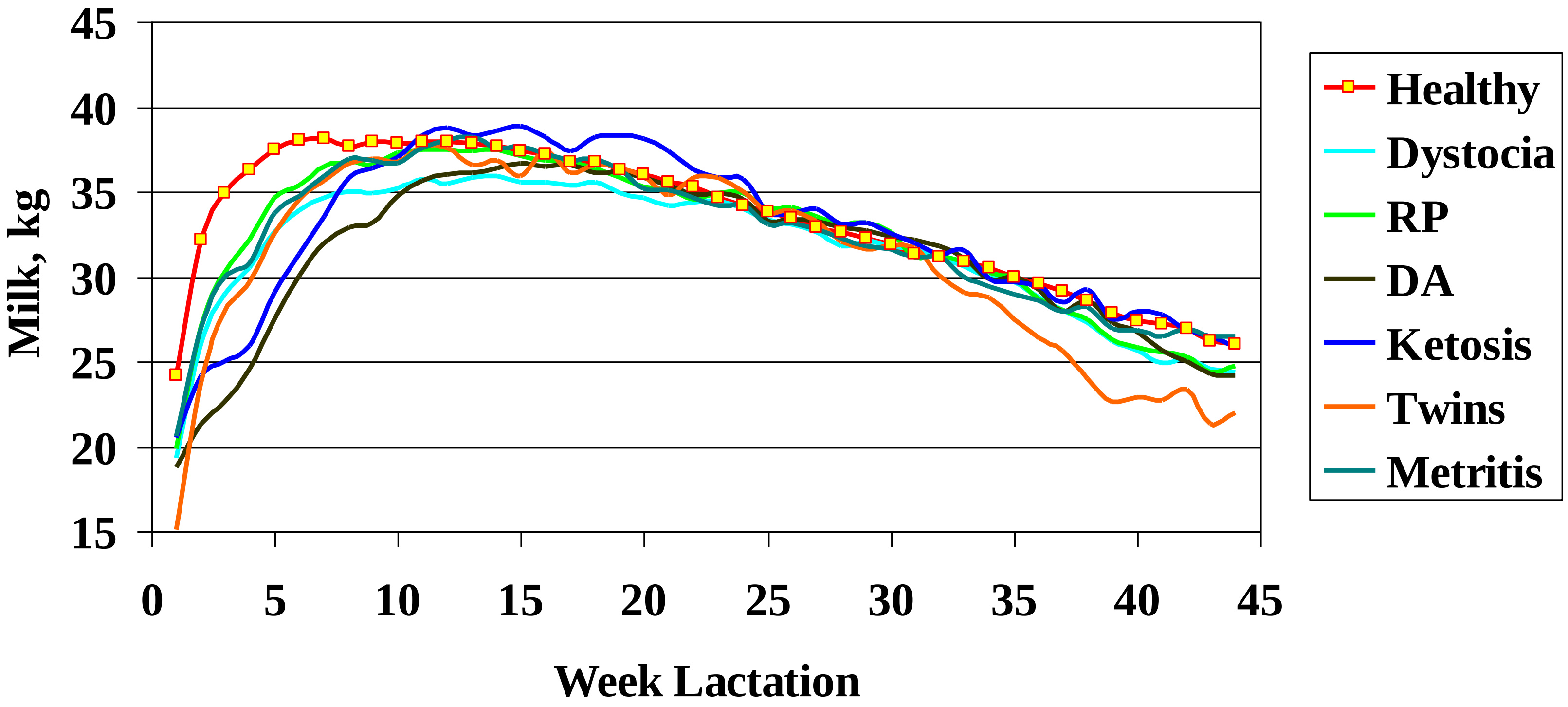
Dystocia
Retained fetal membranes (RFM)
Milk fever (MF)
Metritis
Mastitis
Ketosis
Displaced abomasum (DA)
Fatty liver
Indigestion

Often cows have multiple problems that occur as a complex

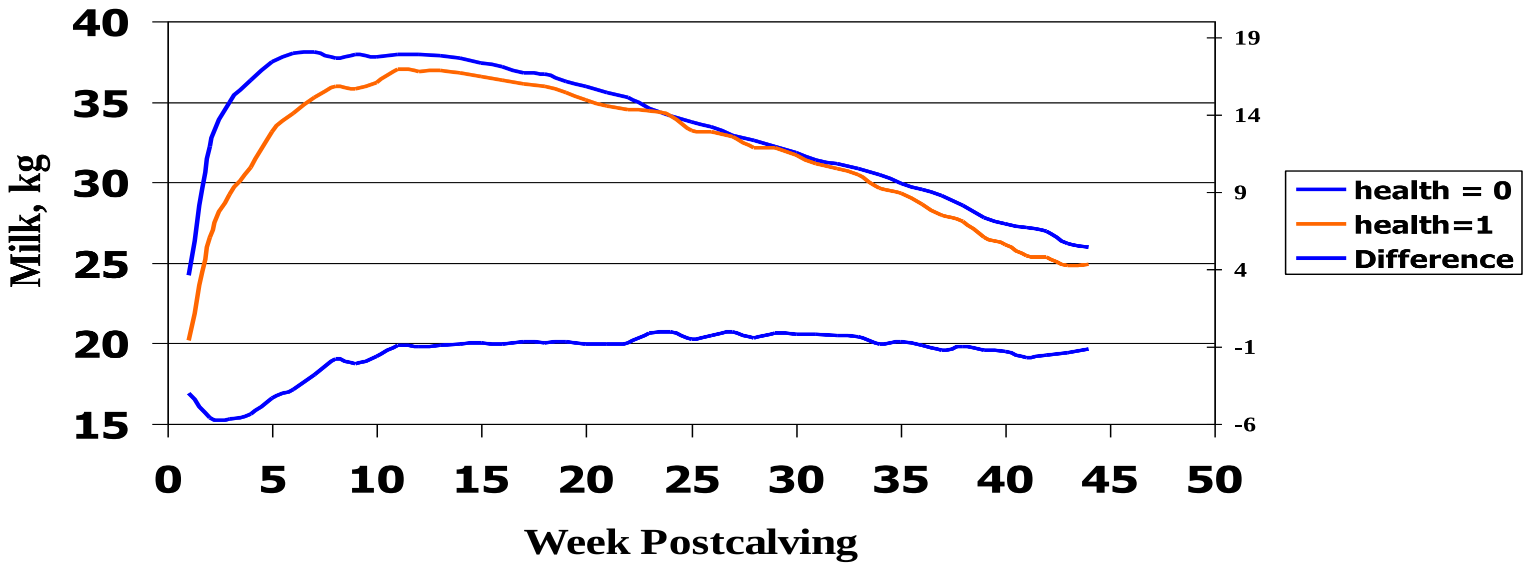
RFM → metritis → ketosis → DA

Cows with parturient problems have reduced milk yield, reduced fertility and increased risk of culling or death

Health and milk production

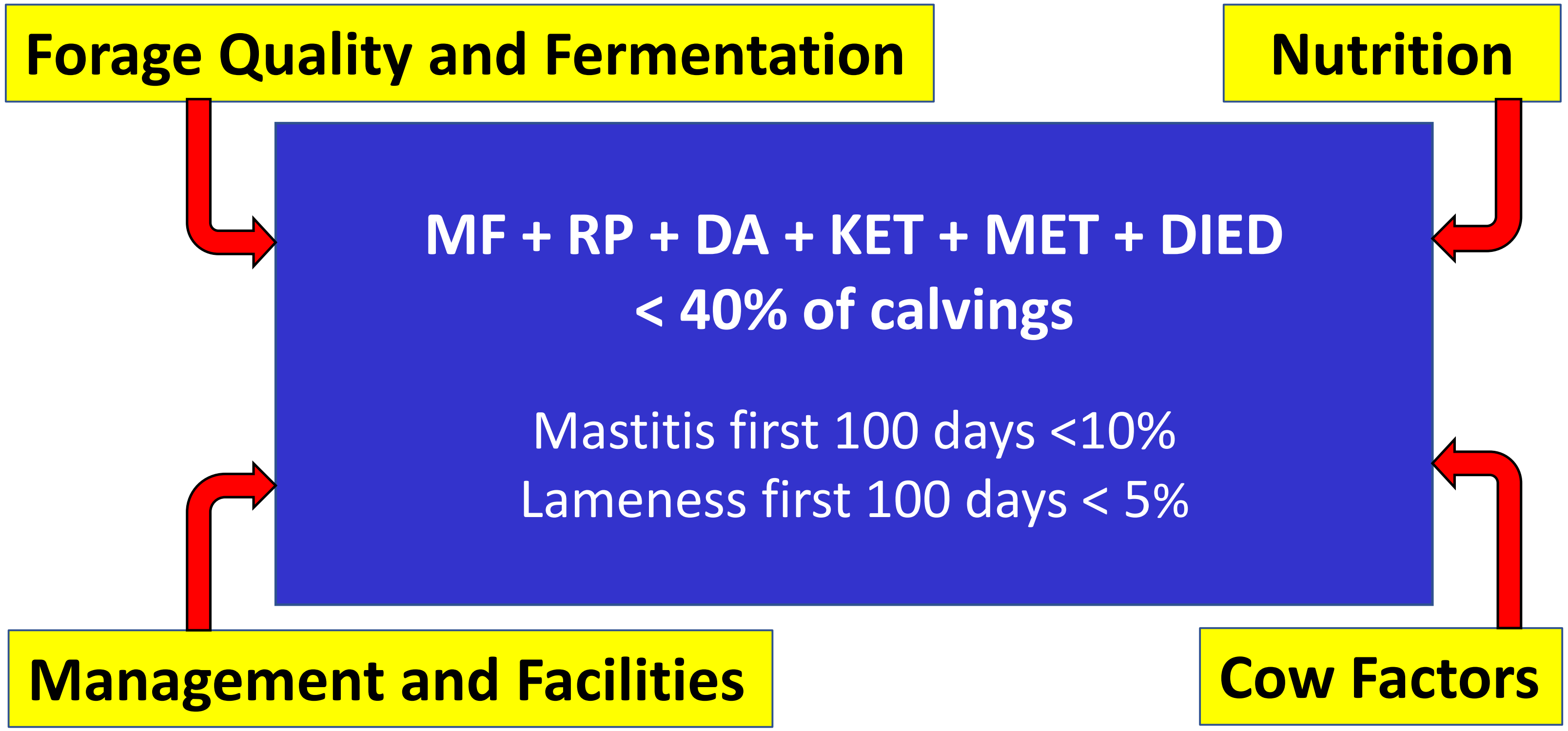


Health and milk production



No problem:	M305	9514	
Problem:	M305	9310	-204 kg ns

Transition Goals



Hypocalcemia and Calcium Regulation

Serum Calcium

- The precise control of calcium ion in extracellular fluid (ECF) is vital to the health of the cow
- Key role in biological processes
  - Muscle contraction, blood coagulation
- Total mean Ca in blood ~9-10 mg/dl
  - 2.25-2.50 mmole/liter
- Serum calcium is bound to albumin and globulin (~50%)
- Biologically active free ionic calcium (~50%)

Acute decline in blood calcium with onset of lactation/parturition

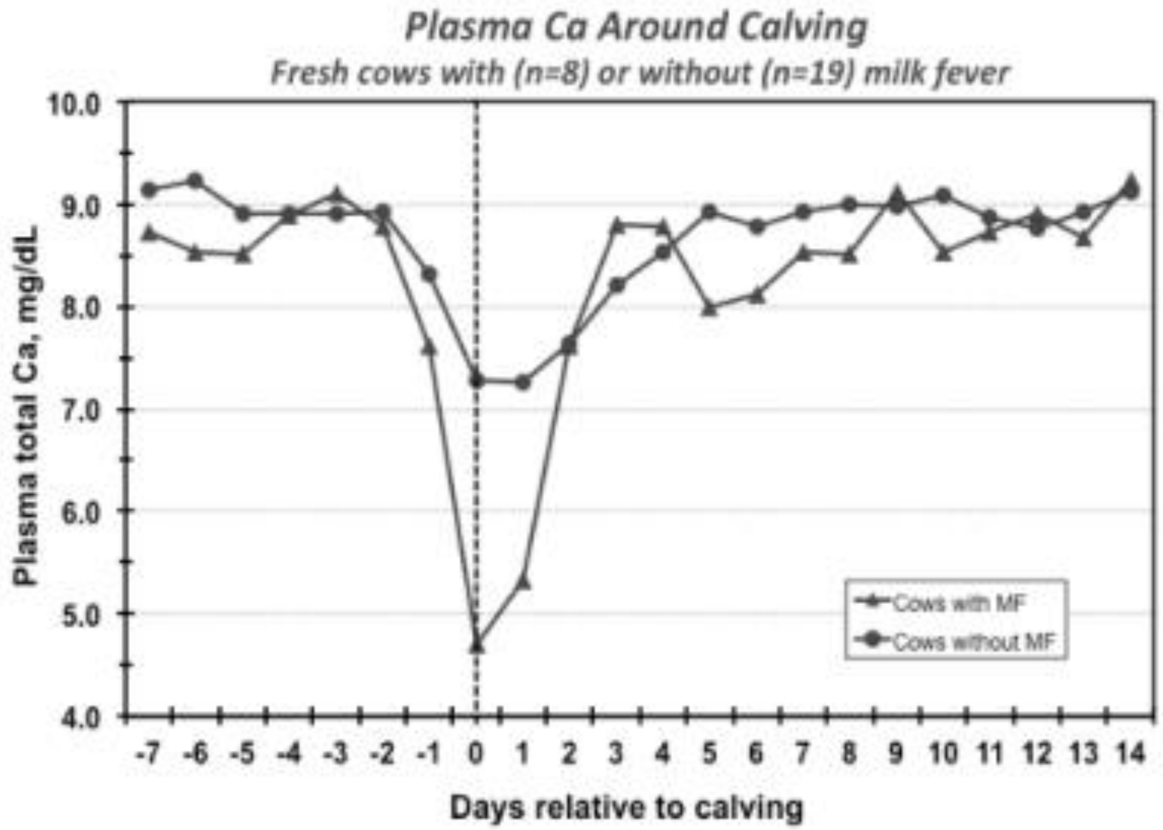
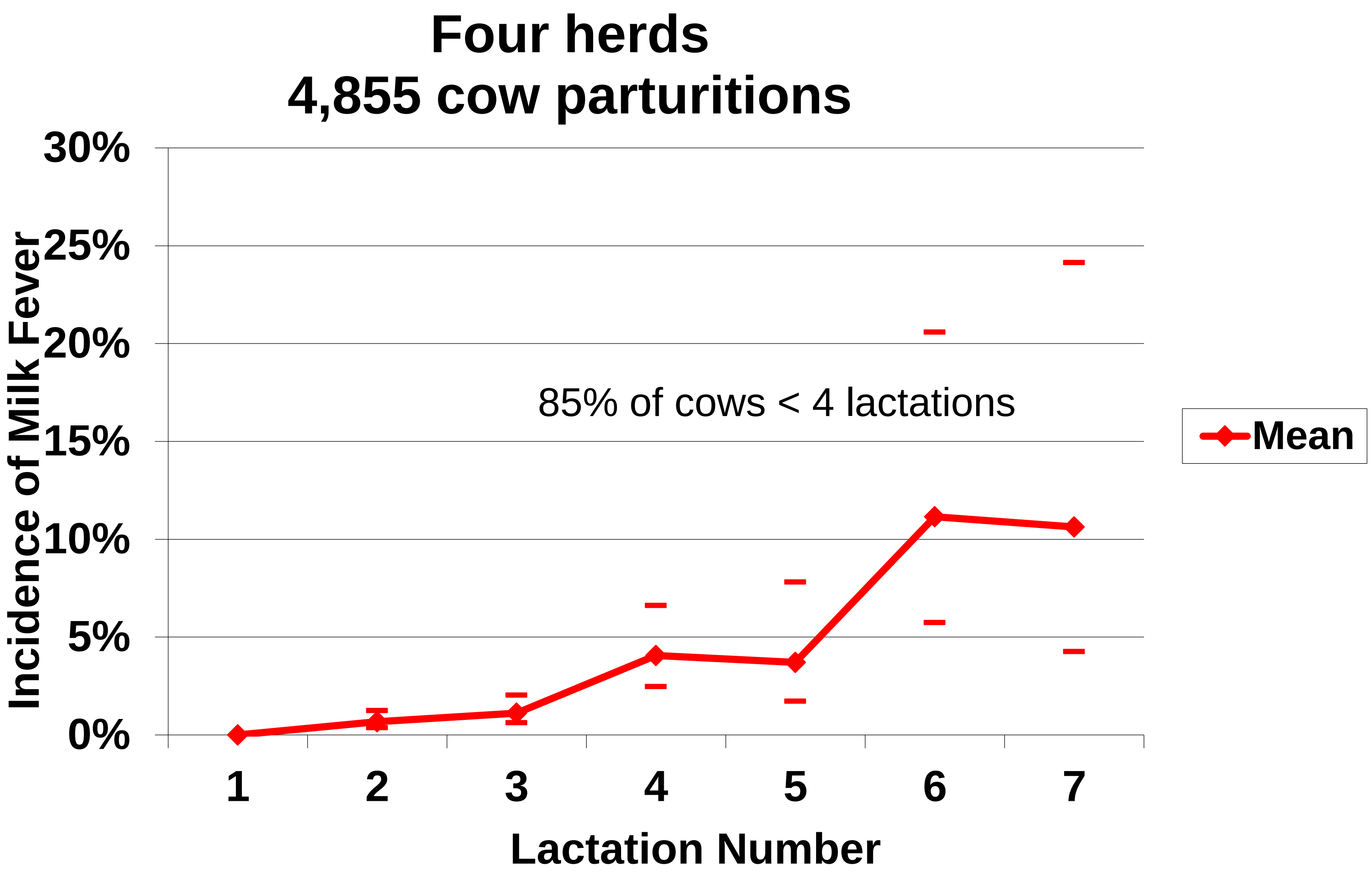


Figure 4. Period of greatest clinical occurrence of milk fever in cows post calving (Adapted Kimura et al. 2006)

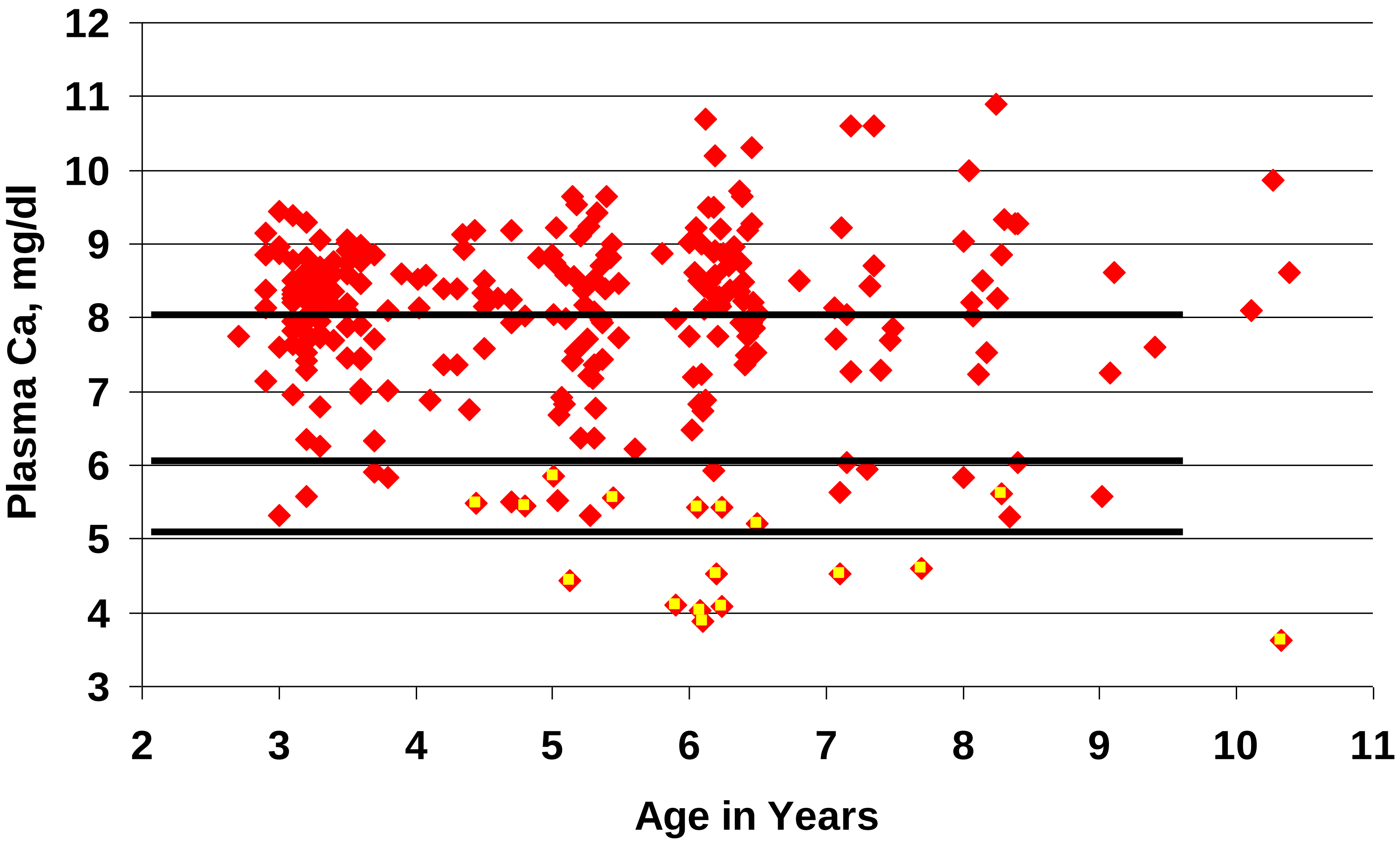
Parturient Hypocalcemia (“Milk Fever”)

- Serum Ca < 5.6mg/dl (individual variation)
- Recumbent, depressed, gut stasis, hypothermic
- Require intravenous calcium treatment to survive
- Incidence ~5%
- Risk of MF increases with age
    - 9% per lactation (Lean et at., 2006)

Milk fever by lactation



Plasma Ca Day of Calving



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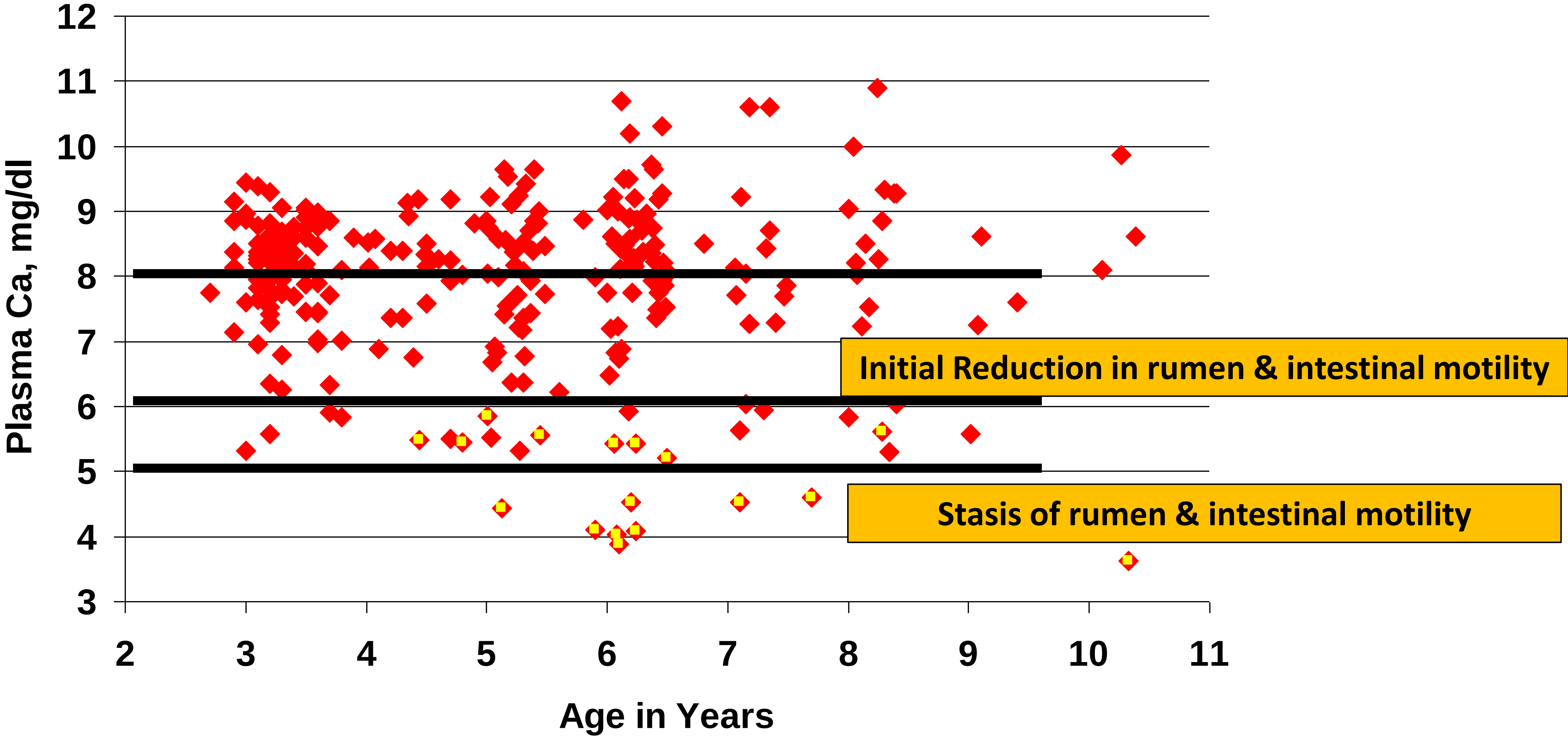


Reduction in motility will impair Ca absorption

Calcium homeostasis

- Blood calcium is maintained within a narrow range of 8-10 mg/dl.
- Calcitonin is secreted plasma iCa is elevated
  - Increases deposition of Ca and P into bone
- PTH secreted with lowered palsma iCa
  - Increases Ca mobilization from bone
  - Increases intestinal absorption of Ca

Calcium homeostasis

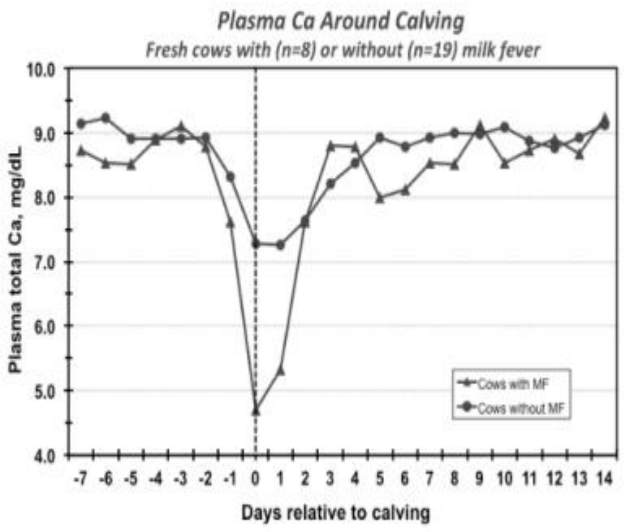
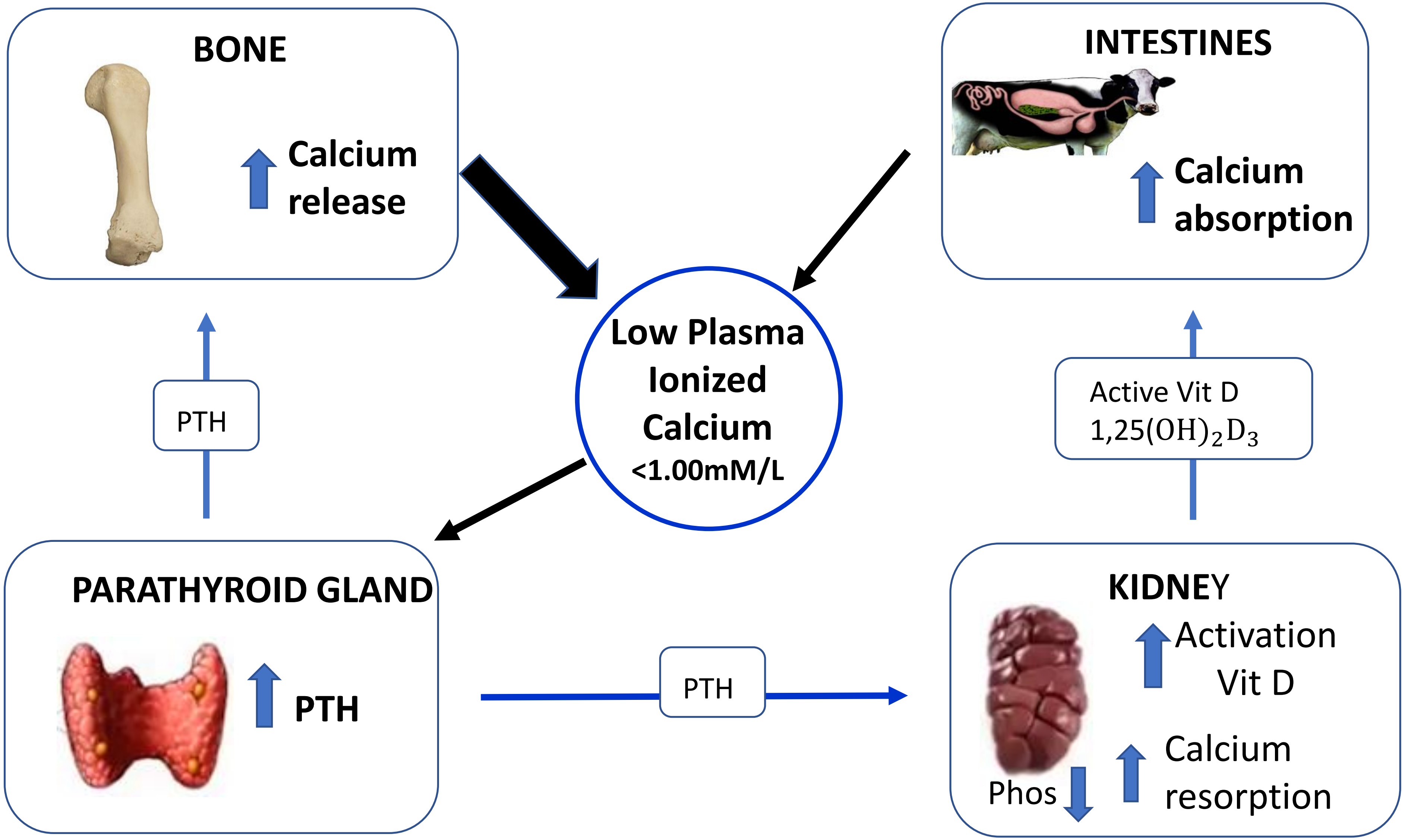


Figure 4. Period of greatest clinical occurrence of milk fever in cows post calving (Adapted Kimura et al. 2006)

Kinetics (Ramberg)

- Sudden but temporary decrease in Ca at calving
- Decline in plasma Ca for 1-2 days post calving
- Followed by a recovery in homeostasis 2-3 days

Calcium regulation, periparturient cow



Minerals modifying response to calcium regulation

- **Magnesium**
  - Critical for the release of PTH from the gland
  - Involved in the synthesis of the active form of Vit D
  - If Mg is low, kidney and bone are less responsive to PTH.

- **Phosphorus**
  - Increasing dietary P increases the risk for milk fever
  - P regulated by directly by $1{,}25(\mathrm{OH})_2\mathrm{D}_3$
  - P regulated indirectly by the PTH/Ca neg. feedback loop

Subclinical Hypocalcemia

- Serum Ca >5.6 –? (8.0, 8.5)mg/dl
- Cut off value influences % of cows with SCH after calving
- Associated risks depend on timing of blood sampling after calving.
- More subtle signs
- To treat or not to treat with calcium
  - Intravenously
  - Subcutaneously
  - Orally

Hypocalcemia

- Calcium is needed for normal muscular function
- The uterus, rumen, abomasum contain smooth muscle which can be weak/less tone
- Increased risk of
  - Dytocia
  - Uterine prolapse
  - Retained fetal membranes (RP)
  - Reduced rumen function and DMI
  - Displaced abomasum (DA)
  - Ketosis
  - Mastitis

Pre-Partum dietary management

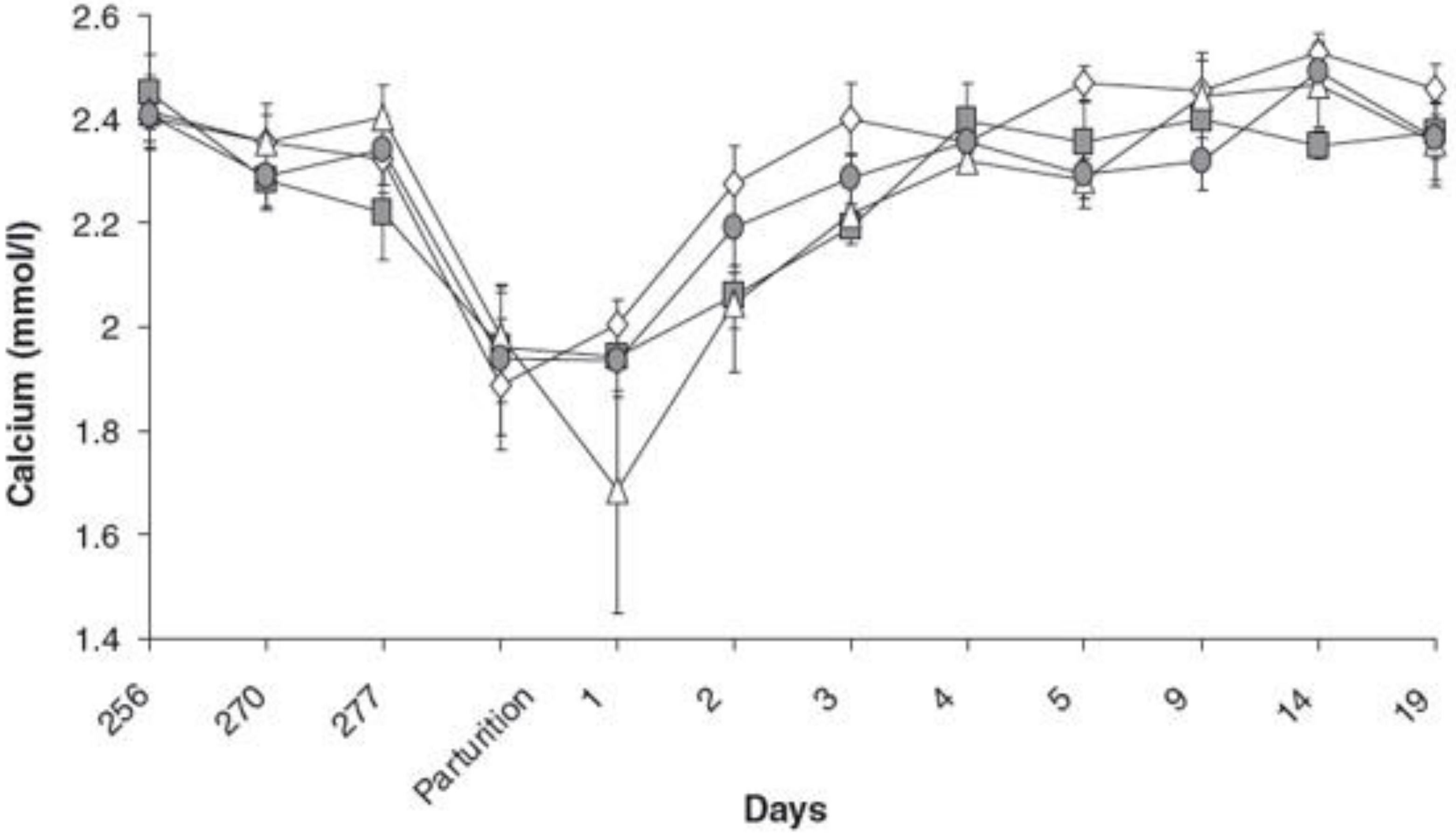
- Manipulate dietary cation anion difference (DCAD)
  - Limit cations (K^{+} + Na^{+}), Supplement anionic salts (Cl^{-} + S^{-2})
  - Metabolic acidosis and increased urinary Ca excretion
  - Urinary pH acidic (6.0-7.0)
  - Often calcium fed at 1.0 to 1.8% DM (180 gms)
- Low dietary calcium diets
  - Limit calcium to <0.4% DM
  - No supplemental calcium added
  - Calcium binder to decrease Ca absorption (Zeolite A)

Influence of different calcium contents and anionic salts fed pre-partum and plasma changes through parturition

A.Liesegang et al.

- ◇ 43.5 g Ca/day
- ■ 40.5 g Ca/day + anionic salts
- △ 100.9 g Ca/day
- ● 98.5 g Ca/day plus anionic salts

24 Holstein Cows
2-4th lactation



Acidogenic Diets

- Benefit may be the increase in urinary Ca
- Amount can be about 5 to 8 grams/day rapid recovery
- May be sufficient for rapid reabsorption to maintain ECF Ca concentrations

Low Calcium Diets

- Boda - < 30g/d will prevent MF
  - < 50 g/d will minimize MF cases and improve response to treatment
- Our goal - $\leq$ 40 g/d at 22 lbs of DMI in close-up cows
  - No supplemental Ca (or P)
  - Mg 0.40% to 0.50% of DM

Meta Analysis – Lean et al. 2006

Equation (1)

Predictor	Coefficient	SEM	OR	95% CL	.
Intercept	-5.76	1.028			
Ca	5.48	1.729	239.4	8.082,	7,089.244
Mg	-5.05	1.618	0.006	0.001,	0.152
Ca x Ca	-2.03	0.819	0.131	0.026,	0.654
P	1.85	0.716	6.376	1.566,	25.958
DCAD 1	0.02	0.007	1.015	1.001,	1.030
	Risks: Ca, P, DCAD		Protective: Mg	Priority: Ca &Mg> P> DCAD	

Equation (2)

Predictor	Coefficient	SEM	OR	95% CL	.
Intercept	-5.17	1.048			
Ca	5.74	1.788	309.6	9.306,	10,298.0
Mg	-8.66	2.007	0.001	.001,	.009
Ca x Ca	-2.16	.844	0.115	.022,	.601
P	2.29	.717	9.9	2.423,	40.2
K	0.78	.313	2.2	1.183,	4.036
S	-3.48	1.513	0.031	0.002,	0.598
	Risks: Ca, P, K		Protective: Mg, S	Priority: Ca &Mg>S> P> K	

DCAD 1 = (Na + K) – (Cl + S) in meq/100 g DM
(only equation of four that was significant)
87 trials out of 137 trials
Breed adjustment, exposure, and Trial not included

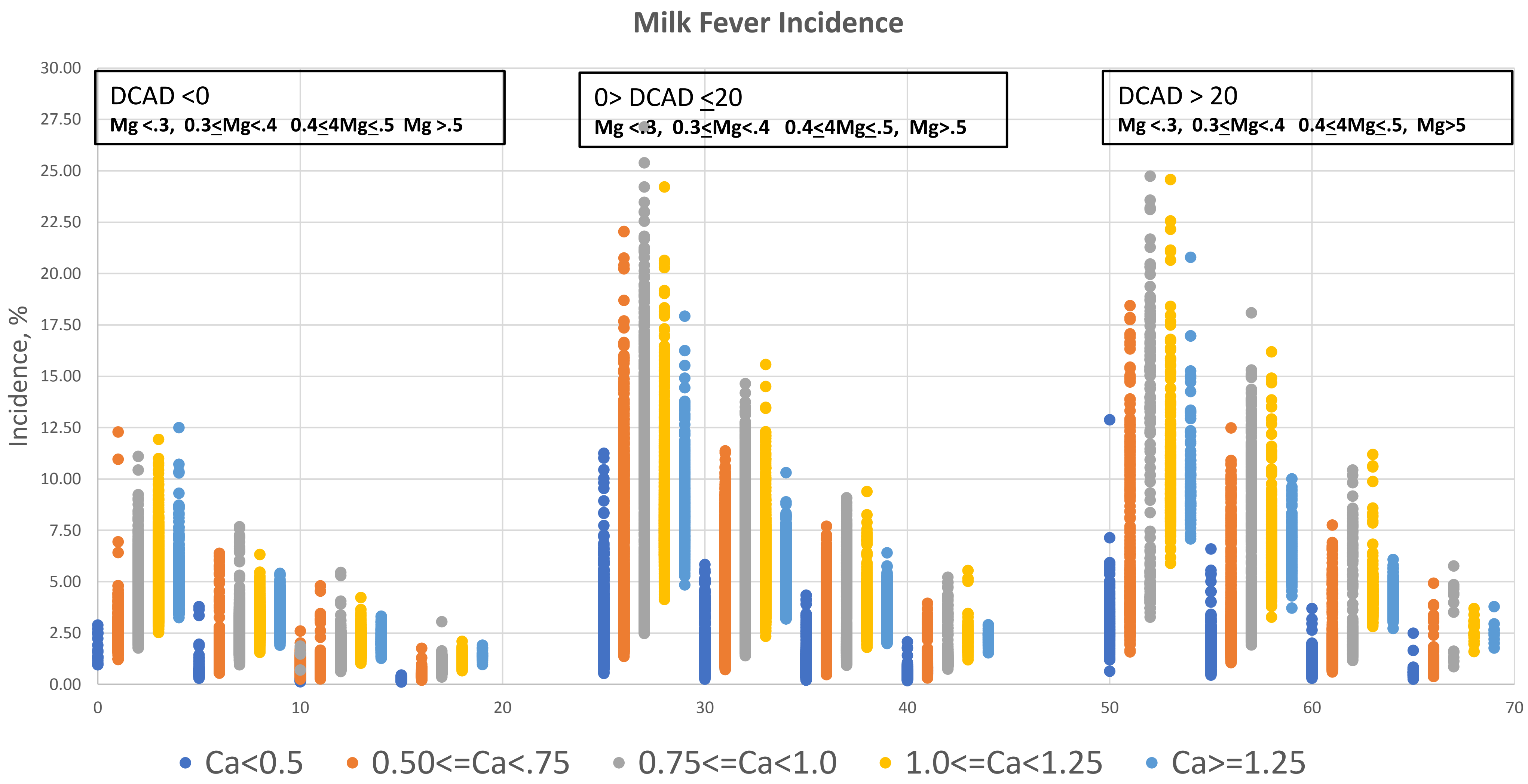
To Investigate Interactions

Stochastic mineral content of dry cow diets using
Lean et al. Milk Fever model – 76,000 simulations

- % DM--

Item	Mean	STD	min	max
Ca	0.79	0.27	0.12	1.61
P	0.31	0.05	0.08	0.71
Mg	0.38	0.08	0.06	0.70
K	1.21	0.34	0.37	2.34
Cl	0.70	0.26	0.10	1.39
DCAD (meq%)	3.59	13.78	-33.78	36.27

Stochastic Model based on Lean et al.



Results of the model

- Milk Fever incidence lowest with
  - Low DCAD <0
  - Mg > 0.5
  - Ca < 0.5
- High urinary Ca excretion – rapid pool of resorbable Ca
  - Maintain gut motility
- Mg – responsive PTH system and target cells
  - Enhance Calcitriol production
- Low Ca – stimulation of bone resorption
- Up regulation of Ca homeostasis

DCAD feeding regimen have potential drawbacks

- Reduced palatability leading to reduced feed intake
- Increased labor to monitor urine pH
- Exclusion of springing heifers in close up cow groups
  - Not necessary
  - Not recommended

Low Calcium Dry Diets

- Corn Silage
- Low Calcium Forage
  - Grass hay works well – if truly grass hay
  - Straw diets provide an excellent way to reduce Ca
- NO SUPPLEMENTAL CALCIUM or PHOSPHORUS
- Calcium <.40   Calcium intake at 10 kg DM ≤40 g
- Phosphorus <.35
- Magnesium .45-.50   Magnesium sulfate, MagOxide
- Potassium usually 1.3-1.6
- Sulfur .25-.30
- NaCl .025% of DM (NRC, .06-.10lb/cow)

Goal of dry cow programs

- Whether low calcium dry cow diets or low alkaline diets, the goal is to create a responsive system to a decline in plasma Ca.

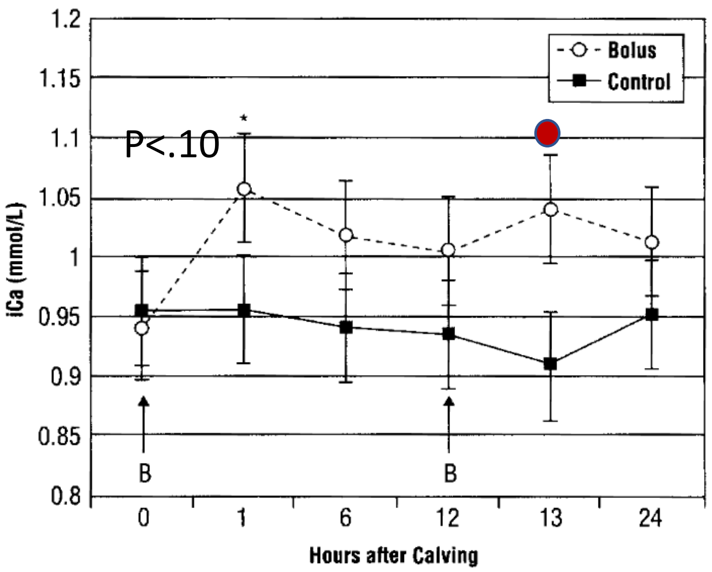
Calcium bolus containing anionic salts

- Bovikalc Bolus (Boehringer Ingelheim Vetmedica)
  - 70% calcium chloride
  - 30% calcium sulfate
  - Contains a fat wax coating to protect cow from caustic salts
- Dissolves in 30 minutes
  - Calcium chloride readily absorbed
  - Calcium sulfate absorbed more slowly
- Label direction
  - 1 bolus given at calving, a second bolus given 12 hours later
  - 43 grams of calcium per bolus, cost $8.00/bolus

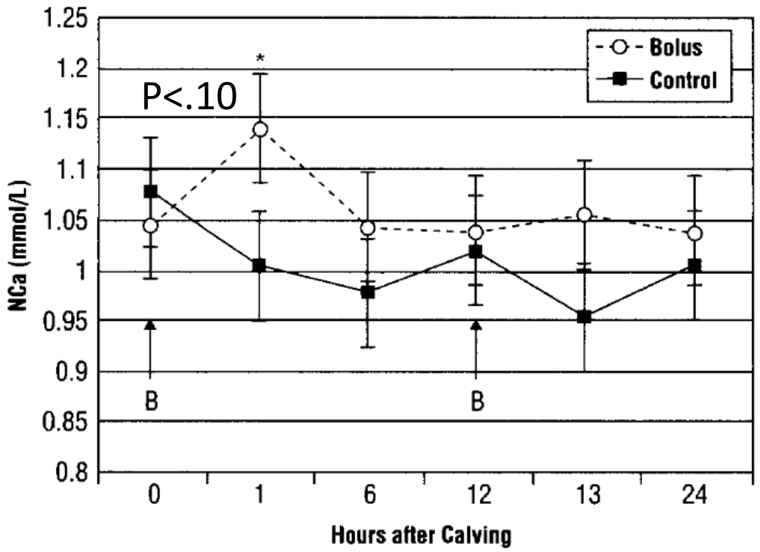
20 cow, no anionic salts, only cows iCa <1.10mg/dl

Sampson et al

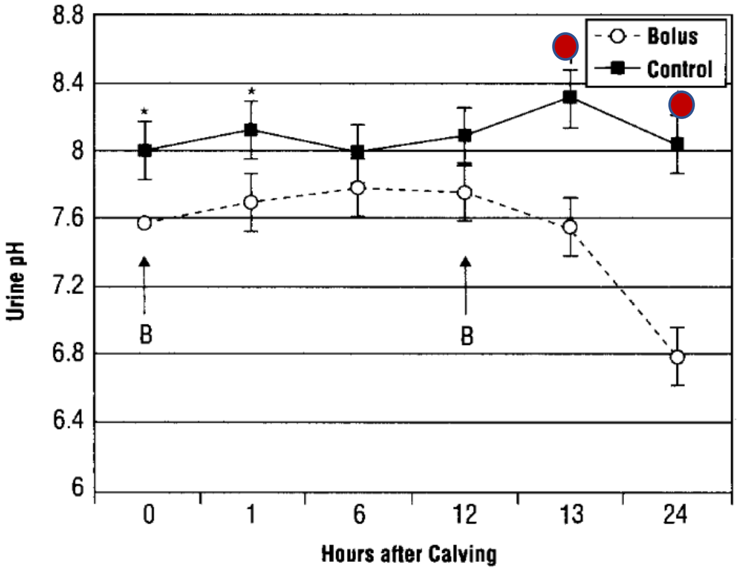
Ionized Calcium



Ionized Calcium (pH adjusted)



Urine pH



● P<.05

Calcium secreted in urine
was not different between groups

Ca bolus treatment

- Questionable benefits to a “blanket” treatment approach ($16/cow)
  - Majority of cows< 4rth lactation are responsive and have normal Ca levels within 2-4 days
  - Any detrimental effects?
    - Does it blunt the normal PTH response mechanisms to improve Ca homeostasis?
    - Does it delay or help the cow return and maintain Ca homeostasis?
    - Do cows on DCAD diets need to be acidified for another day?
- Possible target cows
  - Lactation 4 and greater with delay in osteoclasts and Ca homeostasis
  - Lactation 3 and greater if BCS >3.5 or are lame, limiting DMI post-calving

Ketosis in Dairy Cows

Bovine Ketosis

- Primarily seen the first 2 weeks post-calving
- The clinical syndrome is characterized by
  - Anorexia
  - Depression
  - Ketonemia
  - Ketonuria
  - Hypoglycemia
  - Decreased milk production
- Ketones found in blood, milk, urine

Bovine Ketosis

- Ketone bodies-interconversions
  - Acetoacetate
  - β−hydroxybutyrate
  - Acetone (on breath of cows)
  - Isopropanol (fermentation product)
- Sources of ketone production in the cow
  - Ruminal epithelium
  - Liver
  - Mammary gland
- Normal blood ketones < 10 mg/dl (1.0 mM/L)

Glucose metabolism

- Gluconeogenesis−synthesis of glucose from non-CHO sources
- Large amounts of glucose must be produced by the liver to meet the heavy demands for lactose, particularly early lactation
- Precursors for gluconeogenesis
    - propionate production (rumen) CHO
    - amino acids (tissue storage, diet) PRO
    - glycerol (triglycerides) FAT
- Failure to have adequate gluconeogenic precursors results in hypoglycemia

Hypoglycemia, lipogenesis and ketone production

In hypoglycemic state-

- pancreas releases less insulin and more glucagon
- hormone activates lipase in adipose cells
- triglycerides are hydrolyzed and release LCFA and glycerol
  - Fatty acid oxidation for energy for tissues
- Excessive fat mobilization as NEFA's enter the liver and get directed to ketones

Ketosis can result from many causes

1. Inadequate supply of MP in pre-calving diet
2. Underfeeding or nutritional ketosis
3. Alimentary ketosis from abnormally fermented forages
4. Spontaneous ketosis in high producing dairy cows at peak lactation

Ketosis can result from many causes

1. Inadequate supply of MP in pre-calving diet

MP Requirements

1400 lb dry cow 270 days pregnant

1100 g/d	Metabolizable Protein (g/d)
Maintenance	450
Pregnancy	340
Mammary	270
Growth	40

Mp Requirements

1400 lb dry cow 270 days pregnant

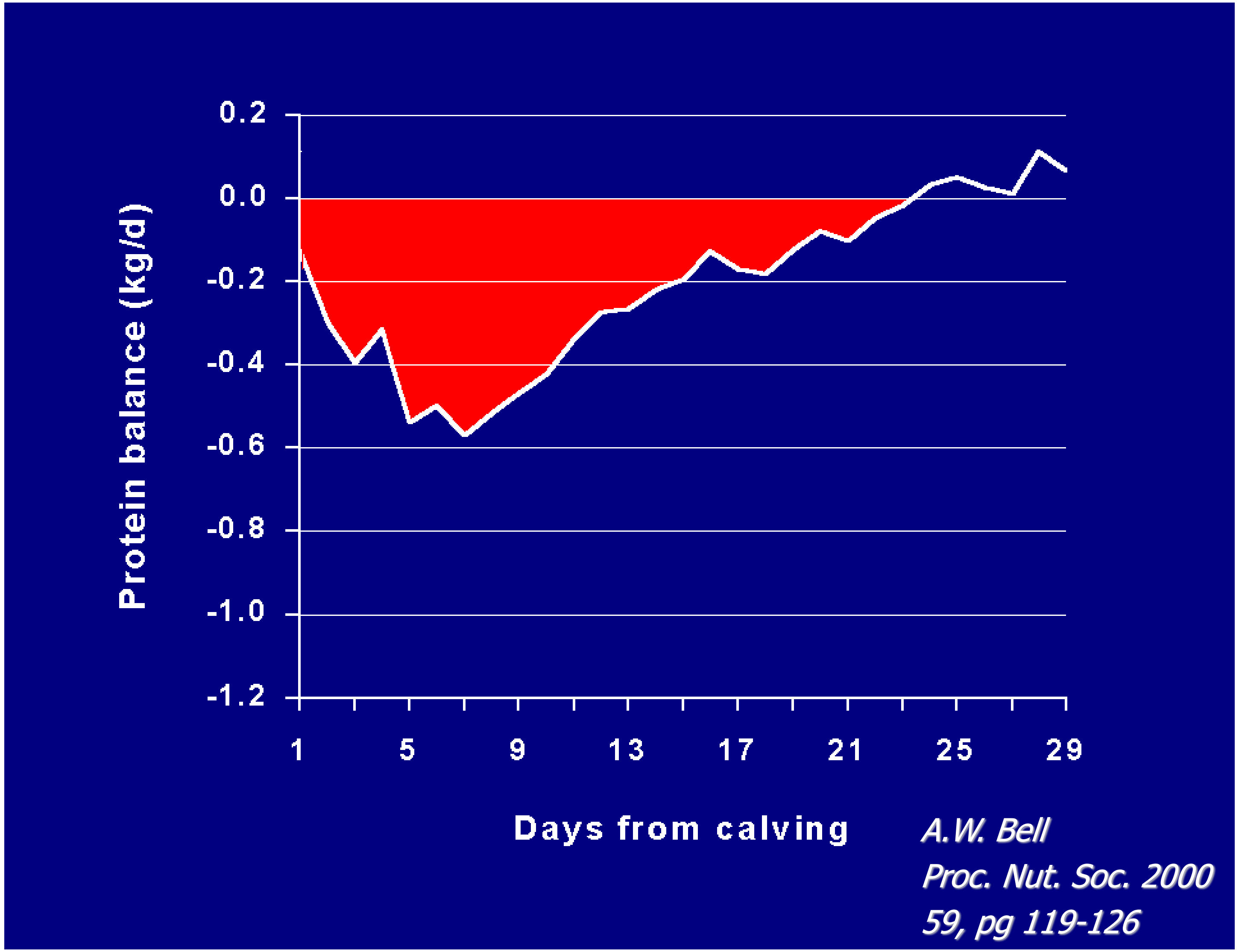
1100 g/d	Metabolizable Protein (g/d)
Maintenance	450
Pregnancy	340
Mammary	270
Growth	40

1400 lb , 80lb milk, 3.0% protein

2300 g/d	Metabolizable Protein (g/d)
Maintenance	640
Lactation	1620
Mammary	
Growth	40

Protein difference of 1200 grams/day from calving to lactation

Metabolizable Protein Balance
Periparturient Period

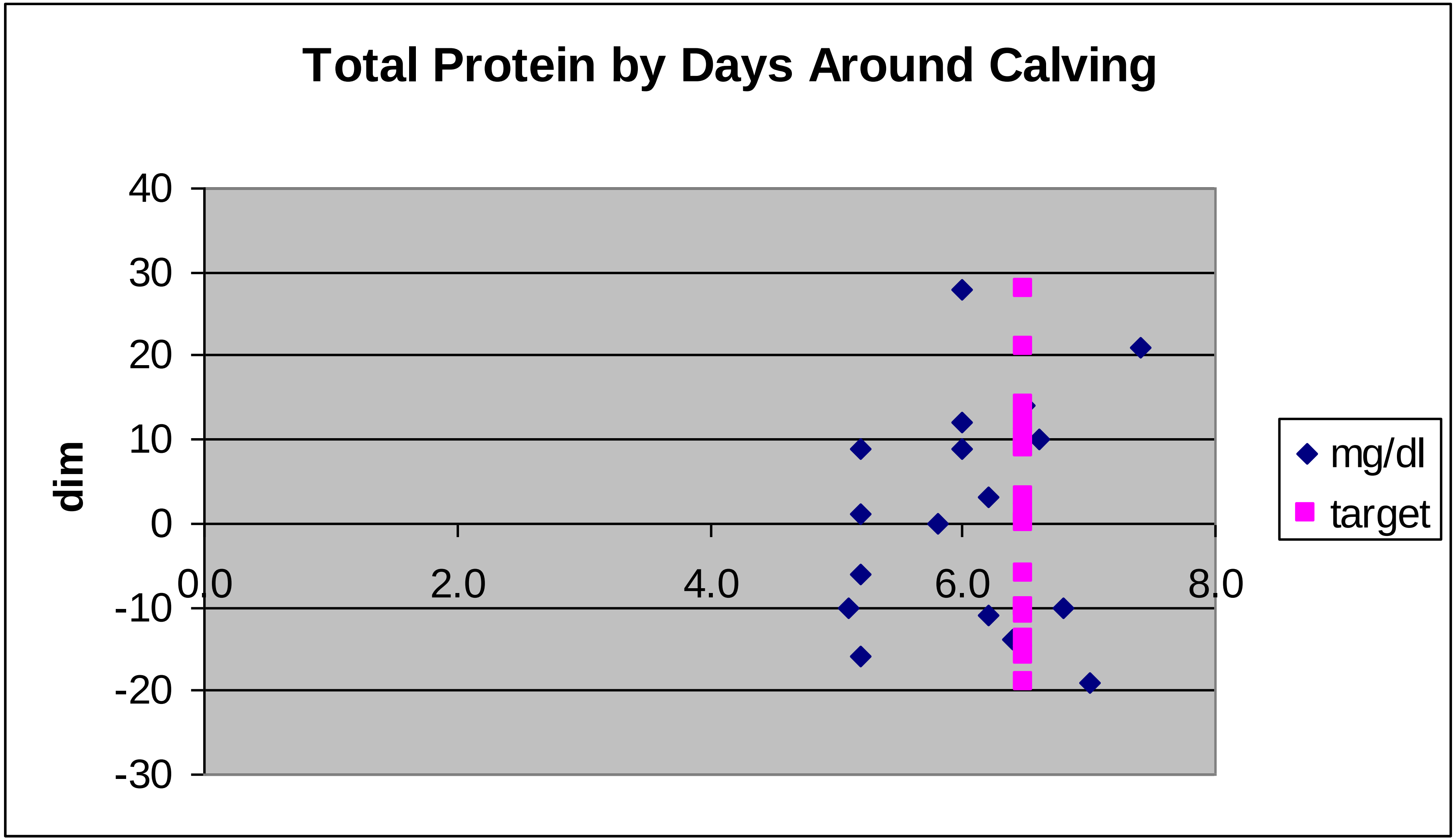


Protein and Ketosis

- The cow relies on amino acids for gluconeogenesis to make up the short fall of rumen propionate
- Estimated 500-1000 gm of endogenous protein mobilized per day to satisfy mammary gland's need for amino acids and glucose precursors during first 7-10 days
- If protein stores are limited, gluconeogenesis is limited
- Hypoglycemia and ketogenesis

Serum Total Protein

Herd data7-10 days post fresh



Considerations for MP formulation of dry cow diets

- Far-off dry cow (27-32 lbs dm)
  - MP requirement ≈ 800 grams/day (240 days pregnant)
  - 12%-13% crude protein

- Close-up dry cow (21-25 lbs dm)
  - MP requirement 1100 gms minimum at calving (280 days)
  - 1100-1300 in 22lb DM
  - 15-16% crude protein diet
  - Supply methionine if feeding bloodmeal (L:M ratio close to 3:0)

Ketosis can result from many causes

2. **Underfeeding ketosis**–insufficient calories to meet demands lactation and body maintenance

- Insufficient quantity of feed or diets low in metabolic energy density
- Reduced DMI secondary to illness
  - hypocalcemia, metritis, mastitis, DA

Ketosis can result from many causes

3. **Alimentary Ketosis**

- Consumption of excessive amounts of silage high in butyric acid
- Problems in fresh cows with abnormally fermented forages
- Increased β-hydroxybutyrate released into the circulation and ketosis
- Alimentary Ketosis is really “butyrate toxicosis”

Ketosis can result from many causes

4. **Spontaneous Ketosis**

- Seen in very high producing cows at peak production with abundance of high quality feed
- Postulated a signal for lipolysis to meet LCFA demand for milk fat
- LCFA's lead to liver ketogenesis, independent of plasma glucose (Kronfeld)
- Ketosis responds to protected fats
    - Absorbed from small intestine as chylomicrons
    - Removed by mammary gland for incorporation into milk fat(Palmquist and Jenkins)

Close-up ration composition

- CP to supply 1,100 to 1,300 gm MP at 22 lbs DMI
  - 14% to 16% CP
- NDF 40 to 46% (NRC 36 to 38%)
- NFC 30 to 35%
  - Starch 18 to 21%
  - Sugar 3 to 5%
- Calcium <.4
- Magnesium >.45
- Phosphorus <.35

Trace Minerals and Vitamins for Close-up Dry Cows

- Antioxidant system and Immune function
  - Vitamin A - 70,000 to 100,000 IU per day
  - Vitamin D – 24,000 to 30,000 IU per day
  - Vitamin E – 1000 to 2000 IU per day

  - Se – 0.3 ppm
  - Cu, Zn, Cr
  - I, Mn, Fe,
- Benefit of complexed trace minerals

Post-calving group

- DMI 43-44lb (80lb milk)
- CP 16%-16.5%
- NDF 30-31%
- NFC ≤40
  - Starch 27-28%
  - Sugar 3-5%
- FAT 5.0-5.6%
- High or low energy diets first three weeks?
  - positive influence on reducing liver lipid, BHBA, and sole hemorrhages
  - Increased milk production first three weeks to six weeks postcalving

Conclusion

- Good nutritional management of dairy cattle during the transition period can improve their responses to the metabolic challenges posed by late pregnancy and early lactation

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Monitoring Uterine Diseases and On-Farm Records for Troubleshooting Reproductive Performance

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Adrian A. Barragan, DVM, MS, PhD
Assistant Clinical Professor – Extension Veterinarian
Department of Veterinary and Biomedical Science
Penn State University

extension.psu.edu

Outline

- Overview of Uterine Diseases: Impacts on Reproduction
- Monitoring Uterine Diseases
  - Diagnostic Methods
- On-Farm Record Analysis
- Troubleshooting Process

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Uterine Disease Overview

- Some of the most prevalent diseases in dairy farms (8.6% - 50%)
- Costs between $106 and $360/case (direct and indirect costs)
- Negatively affects
  - Milk production (3 lbs/d-12.5 lbs/d)
  - Reproductive performance (↓15 CR, ↓31 PR, ↑15% PL)
  - Culling rate (↑2.2 risk)
  - Animal welfare

Rajala and Gröhn, 1998; Han et al., 2005; Ospina et al, 2010; Potter et al., 2010; Gilbert et al., 2012

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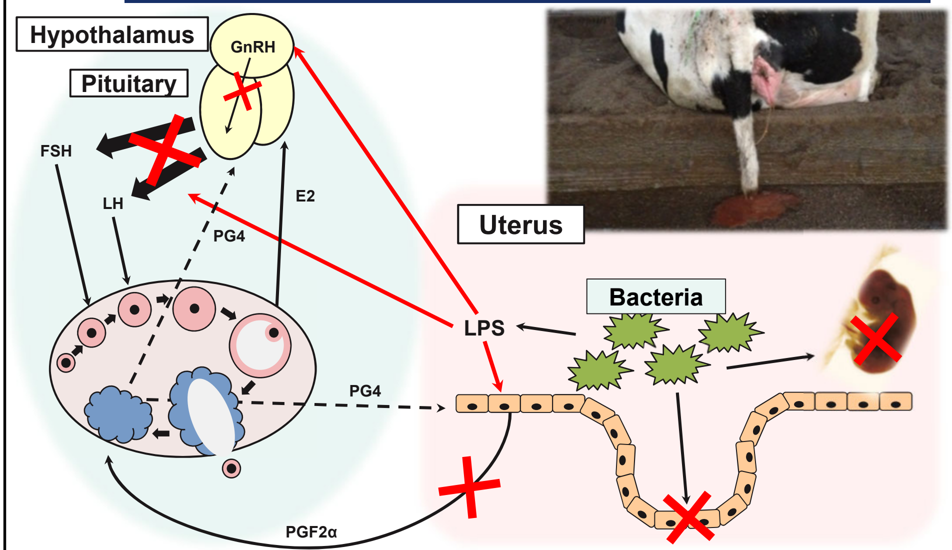
Inflammation Effects on Fertility



Sheldon et al., 2009

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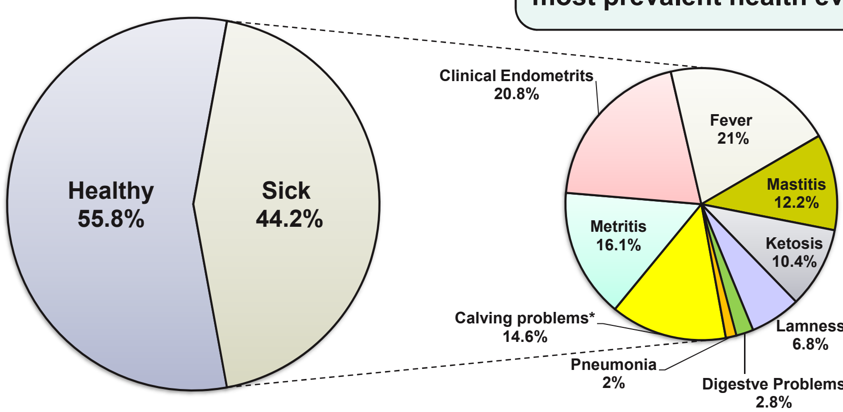
Percentage of Disease During the First 60 DIM

Calving problems and uterine diseases were the most prevalent health events



* Dystocia, twin, stillbirth, retained placenta

Santos et al., 2010

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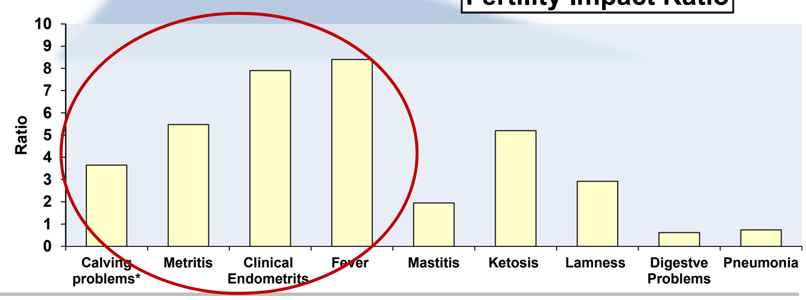
Impact of Diseases on Reproductive Performance

Health Event	Incidence	Odds Ratio
Calving problems*	14.6%	0.75
Metritis	16.1%	0.66
Clinical Endometrits	20.8%	0.62
Fever	21%	0.6
Mastitis	12.2%	0.84
Ketosis	10.4%	0.5
Lamness	6.8%	0.57
Digestve Problems	2.8%	0.78
Pneumonia	2%	0.63

Fertility Impact Ratio



Adapted from santos et al., 2010

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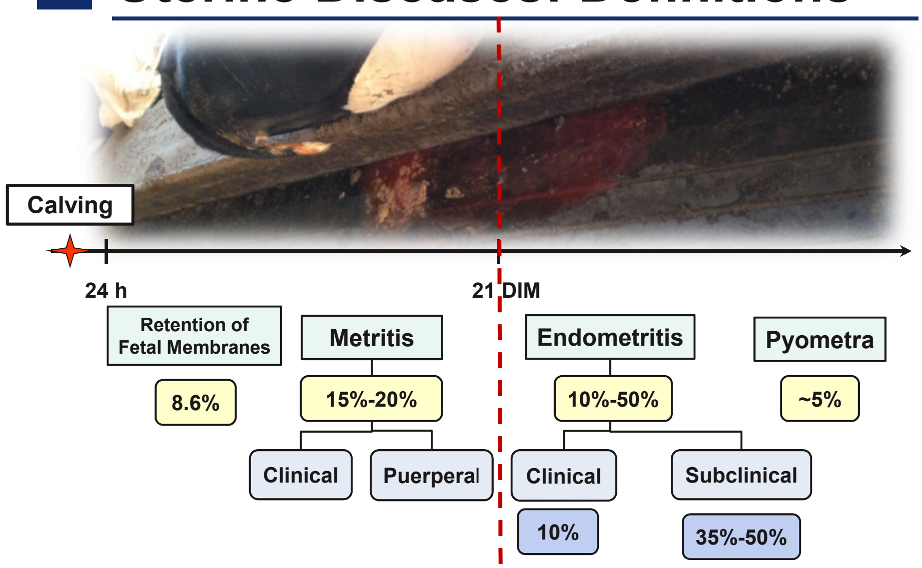
Uterine Diseases: Definitions



Noakes, 2001; Sheldon, 2006; Gilbert et al., 2016

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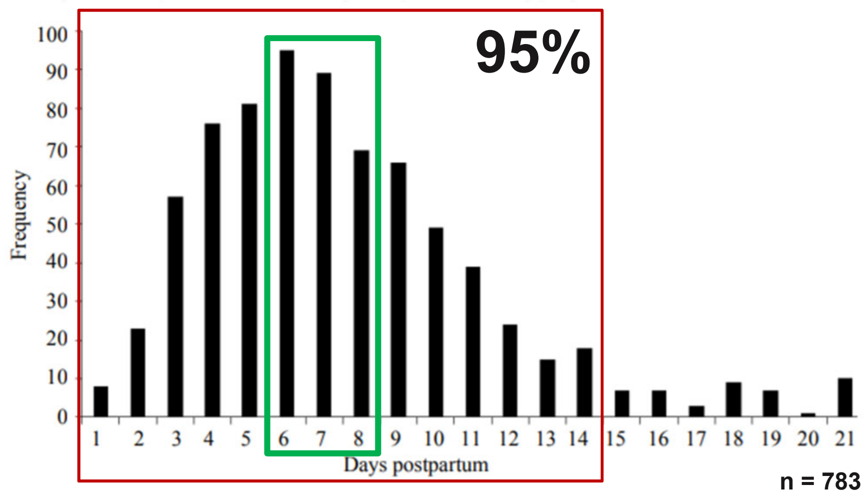
When to Screen for Metritis?



n = 783

Galvao, 2012

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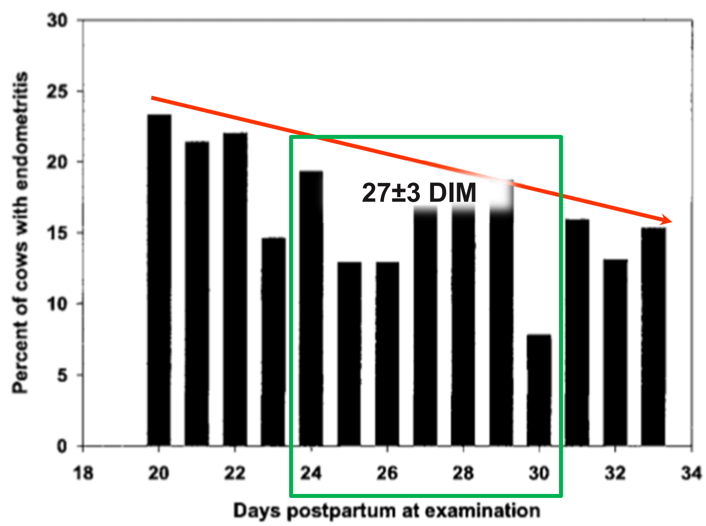
When to Screen for Endometritis?



n =1865

Leblanc et al., 2002

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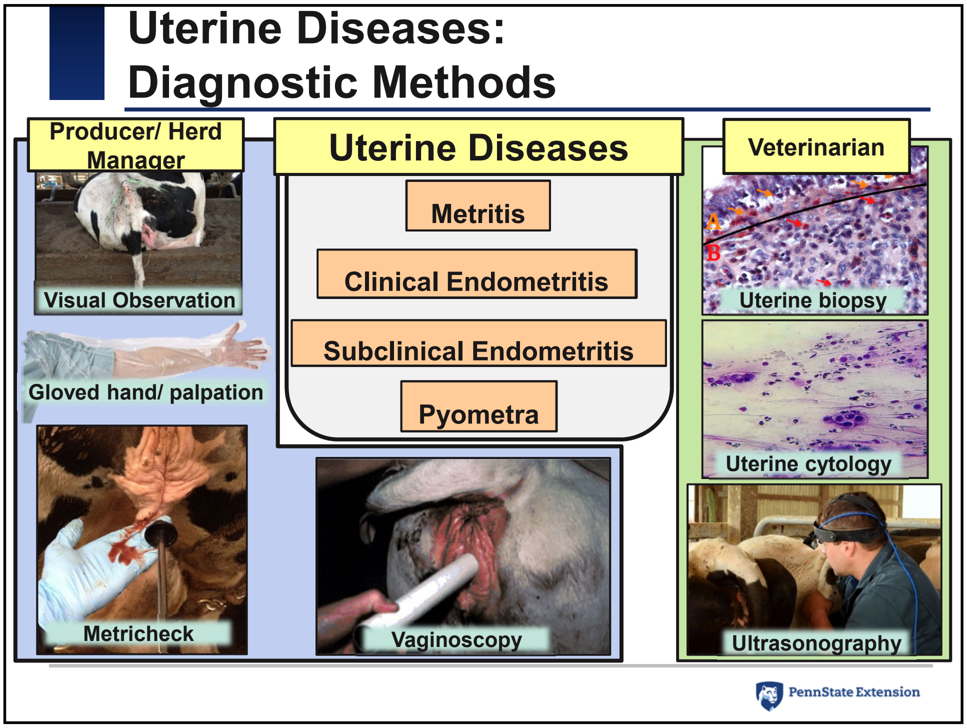
Uterine Diseases:
Diagnostic Methods
Producer/ Herd Manager
Visual Observation
Gloved hand/ palpation
Metricheck
Uterine Diseases
Metritis
Clinical Endometritis
Subclinical Endometritis
Pyometra
Vaginoscopy
Veterinarian
Uterine biopsy
Uterine cytology
Ultrasonography
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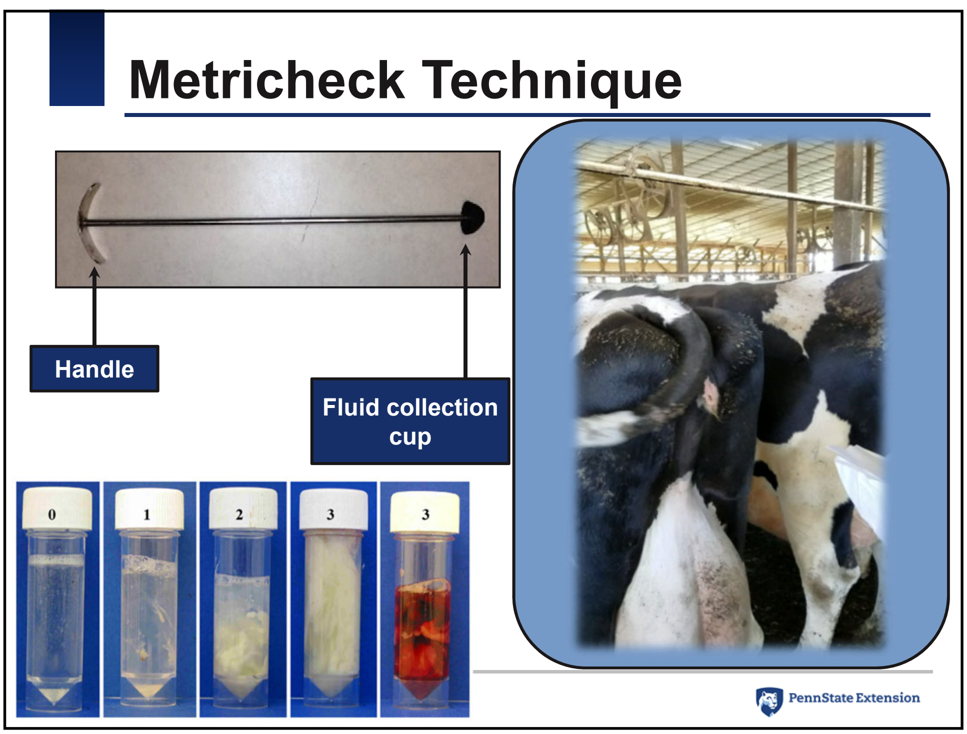
Metricheck Technique
Handle
Fluid collection cup
0
1
2
3
3
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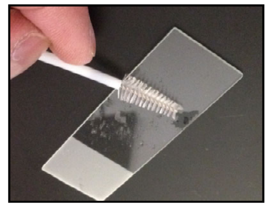
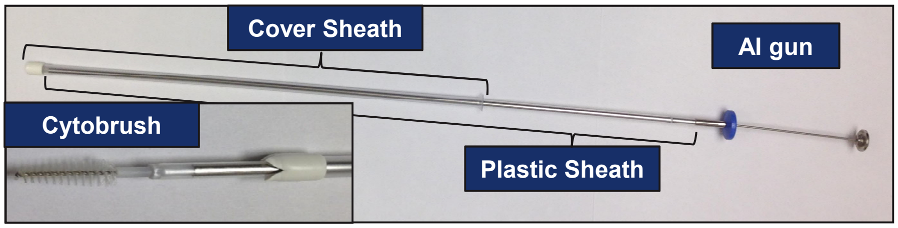
Cytobrush Technique

- Considered to be the "gold standard"
- High sensitivity and specificity
- Relatively inexpensive
- ↑ Labor and training





Kasimanickam et al., 2005

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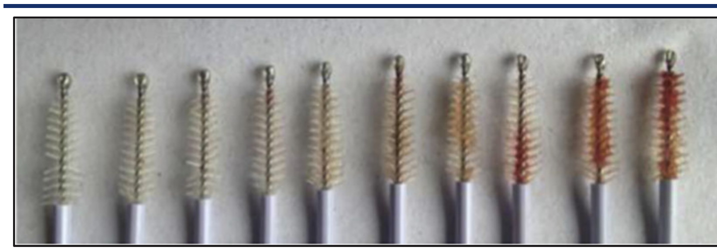
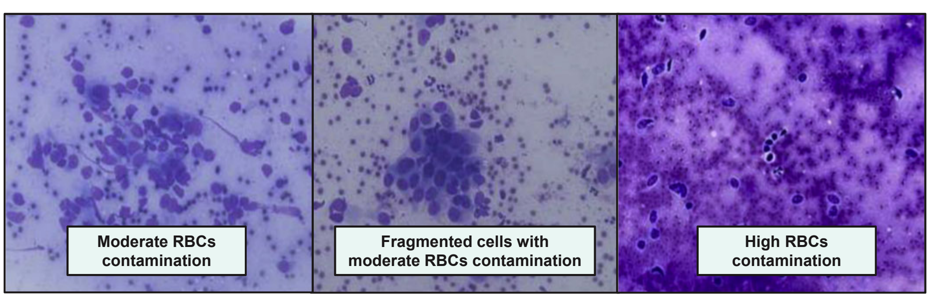
Importance of an Appropriate Technique





Pascottini et al., 2016

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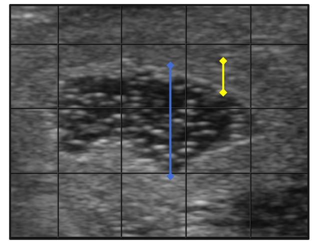
Uterine Ultrasonography

- Identify abnormal fluid in uterus
  - > 1 mm
  - > 3 mm
  - > 5 mm
- Measure thickness of the uterine wall
  - > 7 mm
  - > 8 mm
- Cervix diameter
  - > 7.5 cm



Leblanc et al., 2002; kasimanickam et al., 2004; Gilbert et al., 2005

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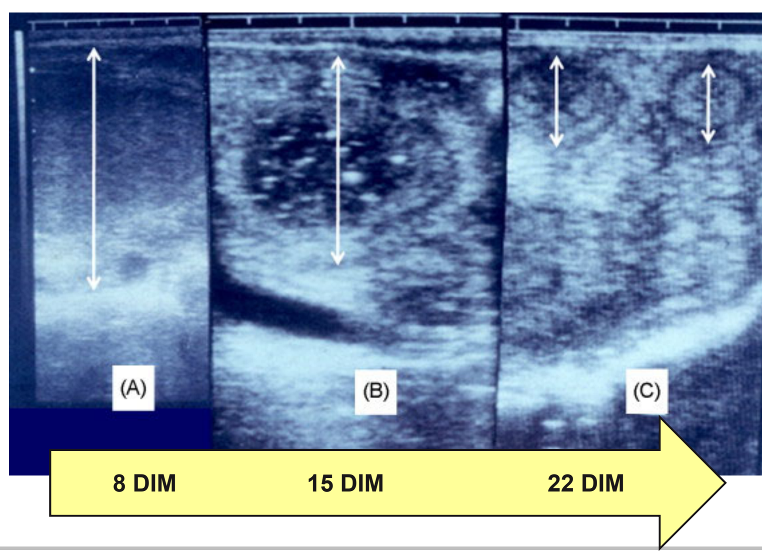
Uterine Ultrasonography



Silvestre et al., 2009

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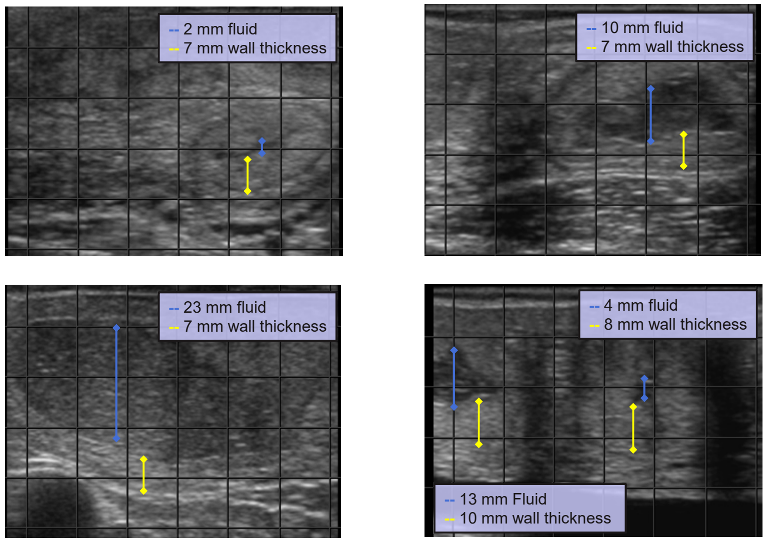
Uterine Ultrasonography



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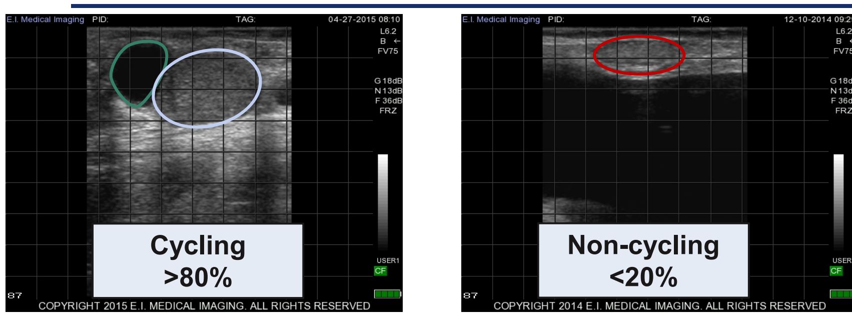
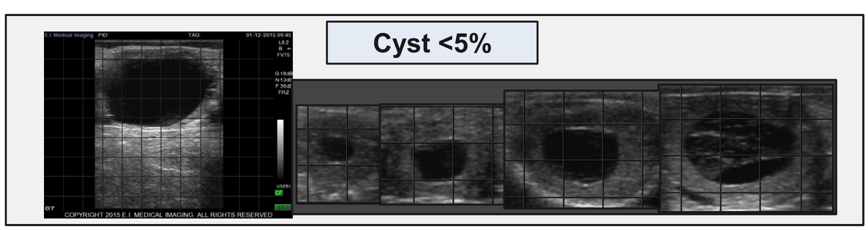
Ovary Ultrasonography: Cyclicity





Walsh et al., 2007

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Record Analysis

DairyCOMP 305

PC DART

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Reproductive Performance Assessment

1. Define the specific reproductive problem
2. Record analysis:
   - Herd assessment
   - Reproductive performance
3. Make and rank recommendations

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Herd Assessment

- Records quality
- Herd Structure
  - Proportion of cows by reproductive code
  - Proportion of cows and heifers
  - Milk production
- Incidence of fresh cow diseases (e.g., uterine diseases)

Herd Assessment

- Records quality

LIST ID LACT PEN DIM RPRO DSLH DCC FOR	
Description	**FOR statement contents**
Cows milking more than 2 years	DIM > 730
Cows with prolonged gestation	DCC > 300
Heat date greater than today	HDAT > TODAY
Pregnant with no conception date	RC= 5-6 CDAT= 0
Conception date greater than today	CDAT > TODAY
Cows with no fresh date	LACT > 0 FDAT= 0
Heifers with a fresh date	LACT= 0 FDAT > 0
Fresh date greater than today	FDAT > TODAY

Herd Assessment

Herd structure

SUM BY RPRO

By RPRO	Pct	Count
	40	1555
NO BRED	1	37
FRESH	10	404
OK/OPEN	1	43
BRED	17	684
PREG	26	1029
DRY	5	177
Total	100	3929

- Calves and heifer included

SUM BY RPRO FOR LACT>0

By RPRO	Pct	Count
NO BRED	2	37
FRESH	18	404
OK/OPEN	2	43
BRED	30	683
PREG	41	949
DRY	8	177
Total	100	2293

- Just cows included

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Herd Assessment

Herd structure

SUM BY LACT FOR LACT>0

By LACT	Pct	Count
1	69	1175
2	26	440
3	4	66
4	1	21
5	0	8
6	0	1
7	0	1
Total	100	1712

By LACT	Pct	Count
1	28	383
2	31	425
3	20	267
4	11	143
5	5	74
6	3	41
7	1	16
8	0	6
9	0	1
10	0	1
Total	100	1357

- **Expanding herd**
- **High Culling rate**

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Herd Assessment

Herd structure

SUM BY RPRO FOR LACT>0

By RPRO	Pct	Count	LCTGP=1	LCTGP=2	LCTGP=3
NO BRED	1	18	8	3	7
FRESH	32	440	142	116	182
OK/OPEN	1	8	3	3	2
BRED	24	328	67	121	140
PREG	30	412	116	138	158
DRY	11	151	47	44	60
Total	100	1357	383	425	549

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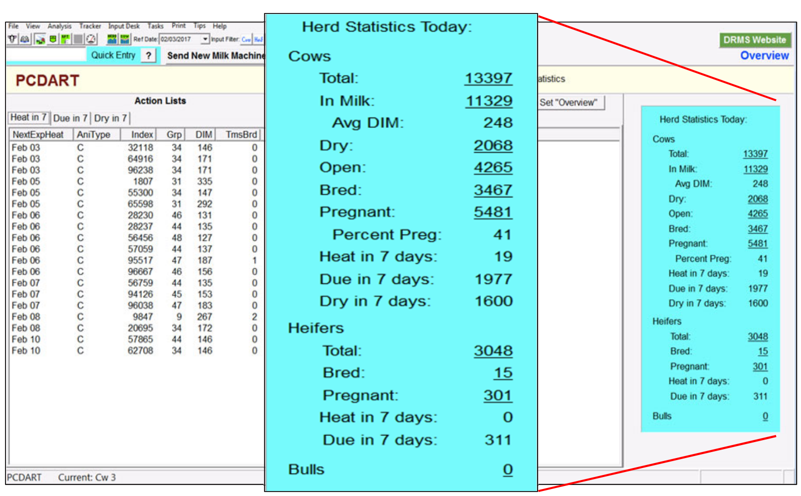
Herd Assessment

Herd structure (PCDART)



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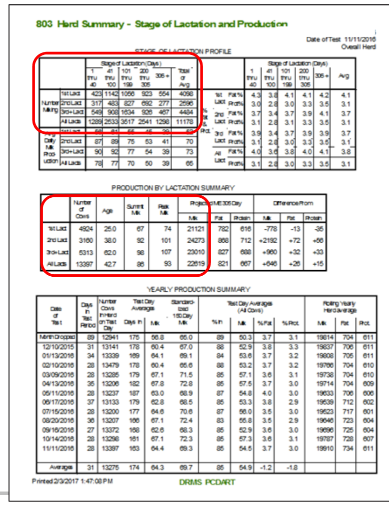
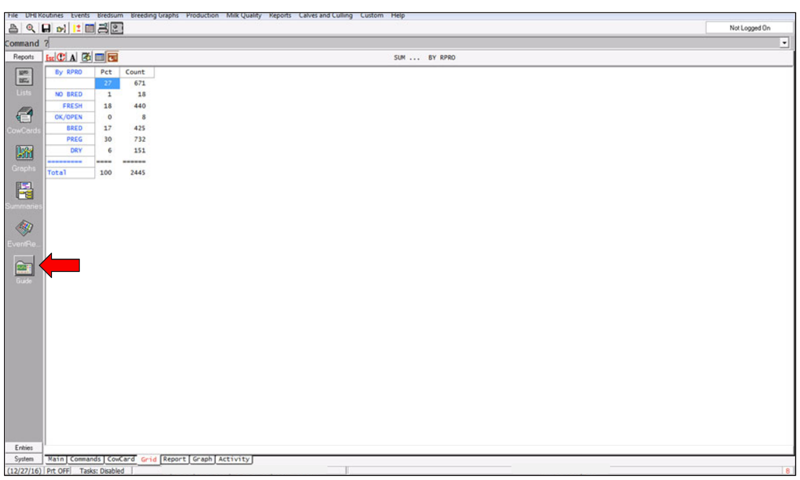
Herd Assessment

Herd structure (PCDART)



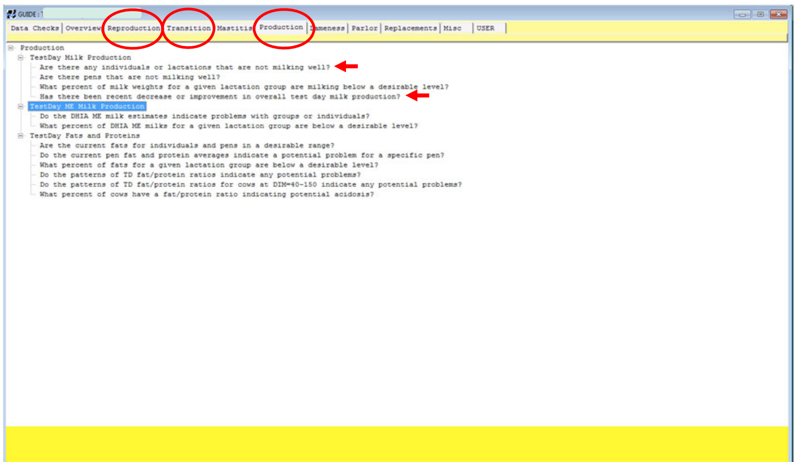
Herd Assessment

Dairycomp 305: Guide



Herd Assessment

Milk production



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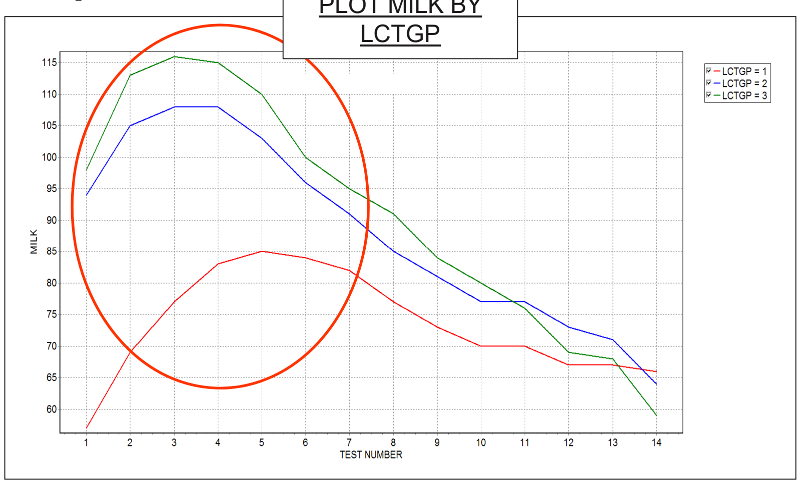
Herd Assessment

Milk production

PLOT MILK BY LCTGP



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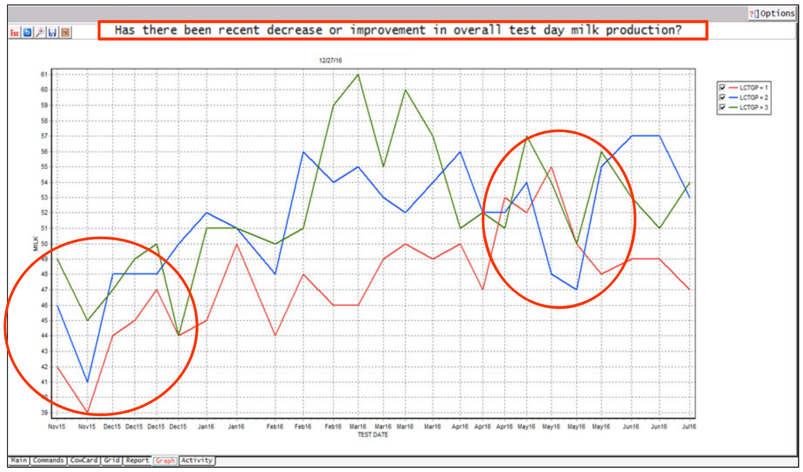
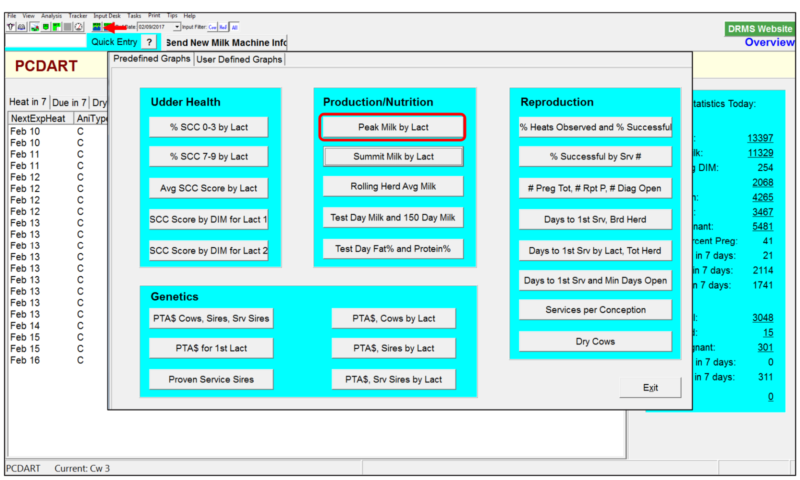
Herd Assessment

Milk production



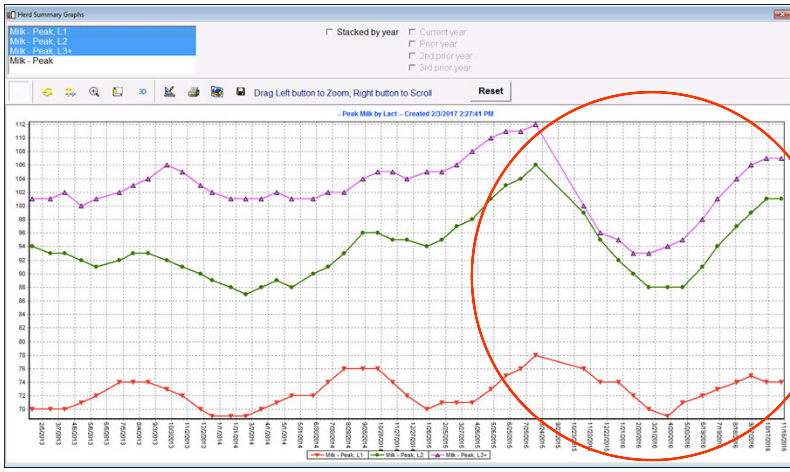
Herd Assessment

Voluntary Waiting Period (PCDART)



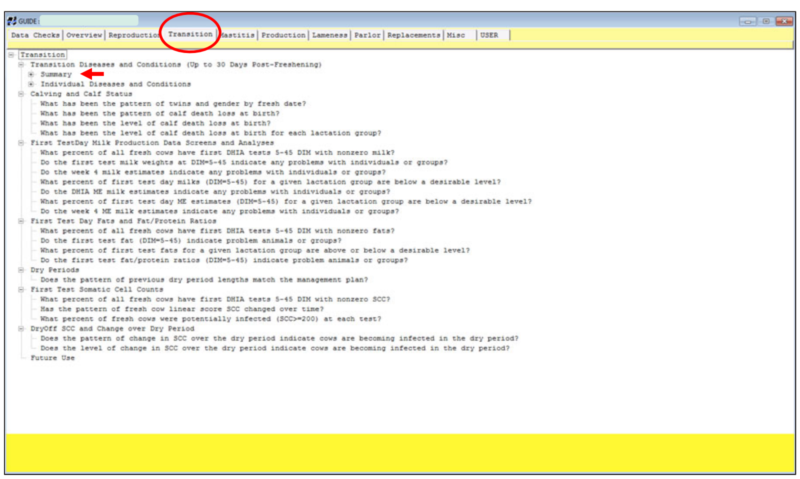
Herd Assessment

Milk production (PCDART)



Herd Assessment

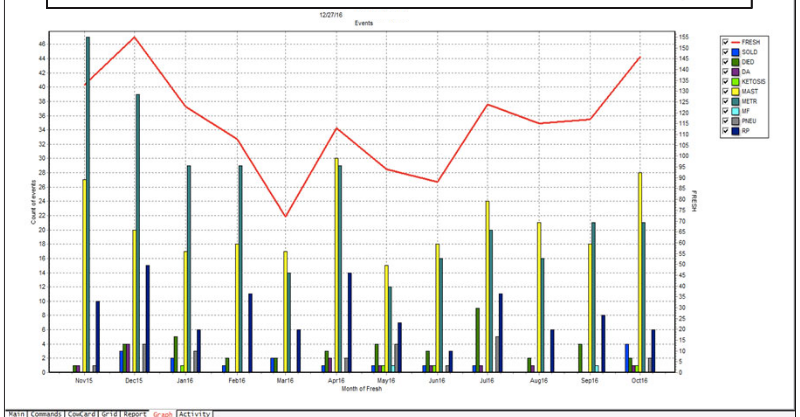
Fresh cow diseases



Herd Assessment

Fresh cow diseases

Does the GRAPHIC incidence count of transition cow events indicate a recent problem?



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Herd Assessment

Fresh cow diseases

Does the GRAPHIC incidence count of transition cow events indicate a recent problem?

Options

- Does the GRAPHIC incidence count of transition cow events indicate a recent -

FDAT	Total	FRESH	SOLD	DIED	DA	KETOSIS	MAST	METR	MF	PNEU	RP
Nov15	133	133	0	1	1	0	27	47	0	1	10
Dec15	155	155	3	4	4	0	20	39	0	4	15
Jan16	123	123	2	5	0	1	17	29	0	3	6
Feb16	108	108	1	2	0	0	18	29	0	0	11
Mar16	72	72	2	2	0	0	17	14	0	0	6
Apr16	113	113	1	3	2	0	30	29	0	2	14
May16	94	94	1	4	1	1	15	12	1	4	7
Jun16	88	88	1	3	1	1	18	16	0	1	3
Jul16	124	124	1	9	1	0	24	20	0	5	11
Aug16	115	115	0	2	1	0	21	16	0	0	6
Sep16	117	117	0	4	0	0	18	21	1	0	8
Oct16	146	146	4	2	1	1	28	21	0	2	6
Total	1388	1388	16	41	12	4	253	293	2	22	103

Main | Commands | CowCard | Grid | Report | Graph | Activity

(12/27/16) | Prt OFF | Tasks: Disabled

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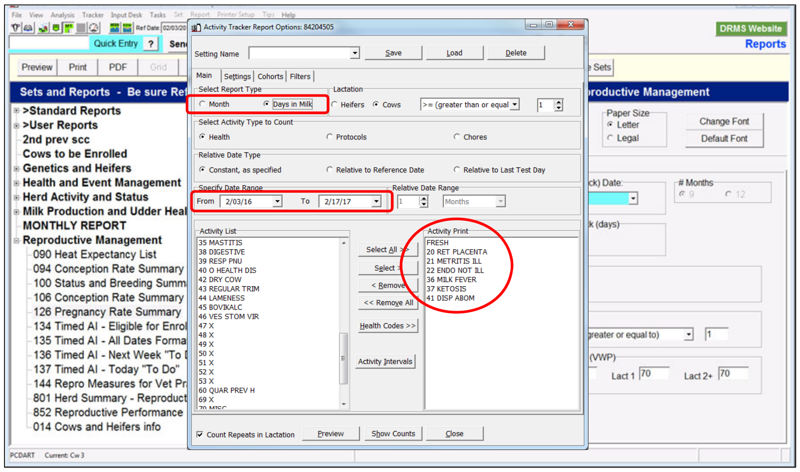
Herd Assessment

Fresh cow diseases (PCDART)



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Herd Assessment

Fresh cow diseases (PCDART)

Show Percentages to Number of Calvings

About

Event	Total	0	1-29	30-59	60-89	90-119	120-149	150-179	180-209	210-239	240-269	270-299	300-329	>= 330
FRESH	100.0	0.0	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
20 RET PLACENTA	2.9	0.0	2.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
21 METRITIS ILL	27.5	0.2	26.4	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1
22 ENDO NOT ILL	3.4	0.0	2.8	0.2	0.0	0.1	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.1
36 MILK FEVER	0.3	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
37 KETOSIS	2.3	0.0	2.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
41 DISP ABOM	1.7	0.0	1.6	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

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Reproductive Performance

- Define Reproductive Program
  - VWP
  - Type of program (e.g., HD, TAI or HD+TAI)
- Reproductive efficiency
  - Service rate
  - Conception rate
    - By service
    - By AI method
    - By AI technician
    - By parity
    - By month (e.g., heat stress)
  - Pregnancy rate

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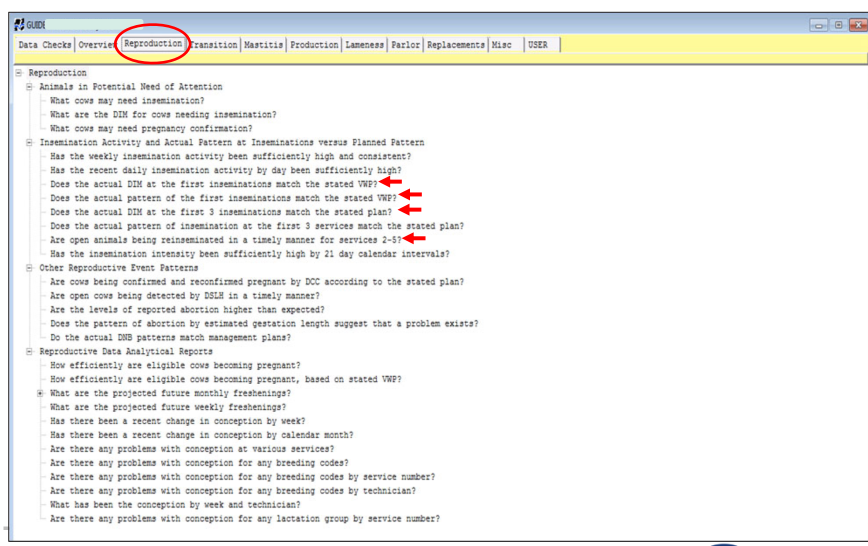
Reproductive Performance



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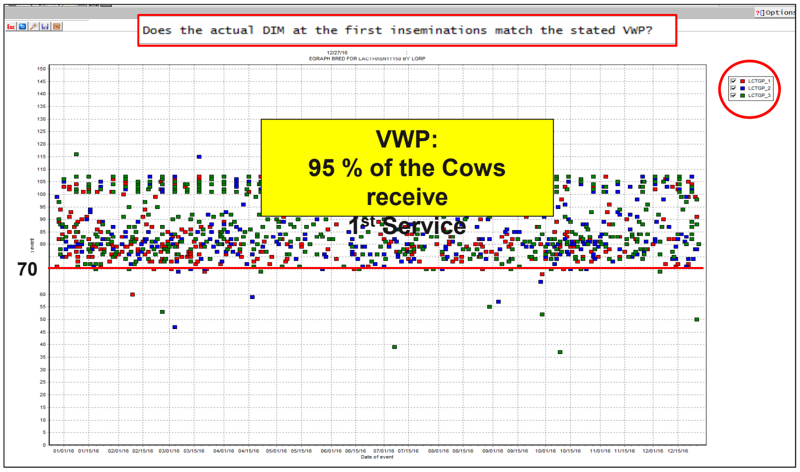
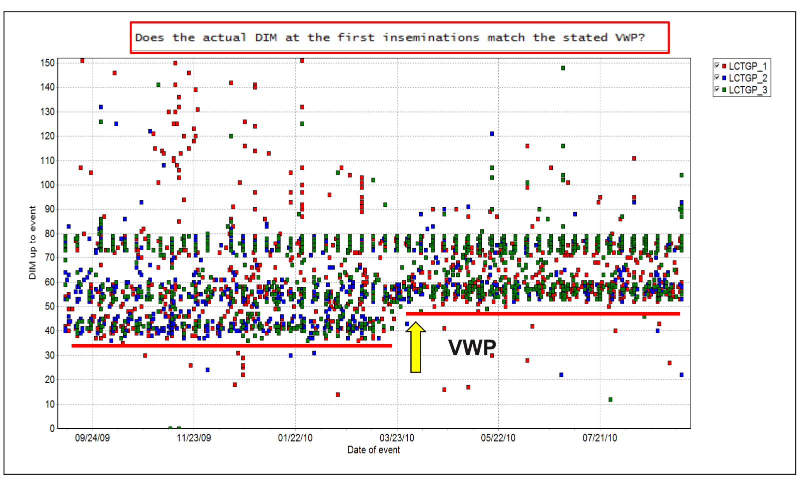
Reproductive Performance

Voluntary waiting period and reproductive program



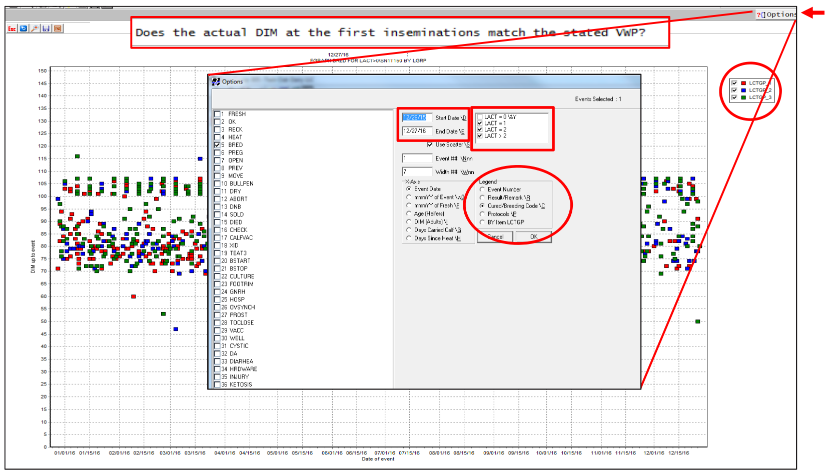
Reproductive Performance

Voluntary waiting period and reproductive program



Reproductive Performance

Voluntary waiting period and reproductive program



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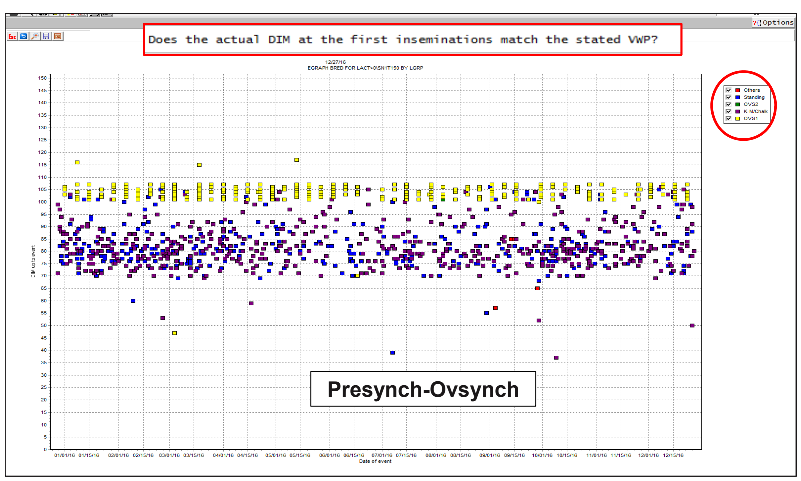
Reproductive Performance

Voluntary waiting period and reproductive program



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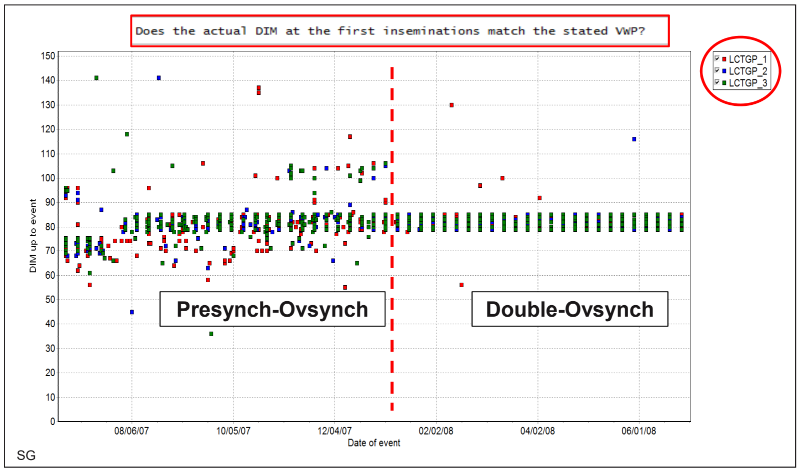
Reproductive Performance

Voluntary waiting period and reproductive program



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Reproductive Performance

Voluntary waiting period

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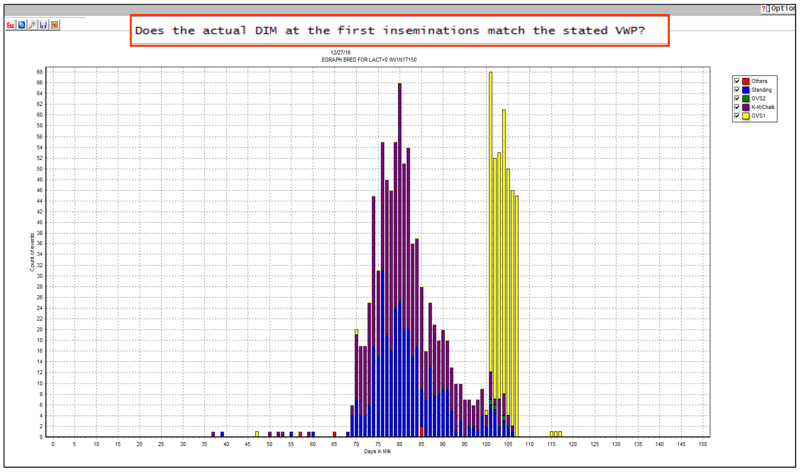
Reproductive Performance

Voluntary waiting period and reproductive program



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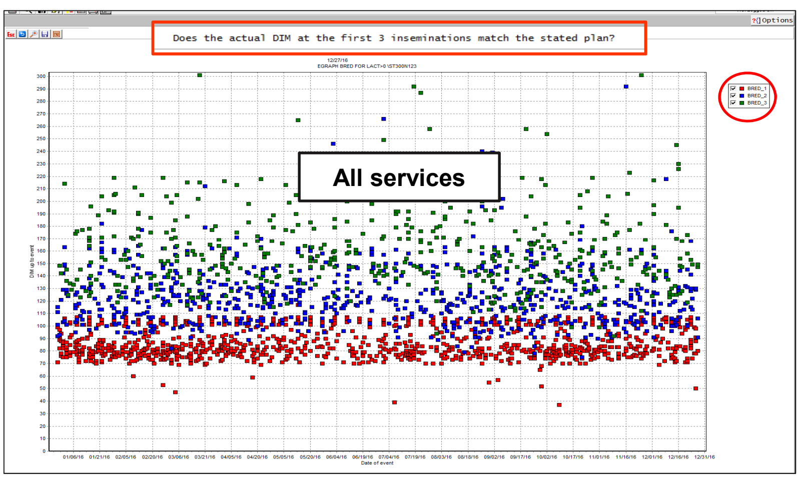
Reproductive Performance

Reproductive program: 1st to 3rd service



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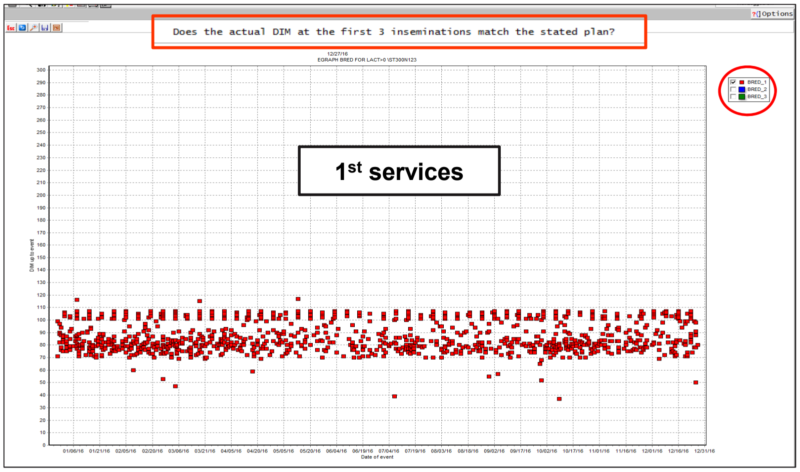
Reproductive Performance

Reproductive program: 1st to 3rd service



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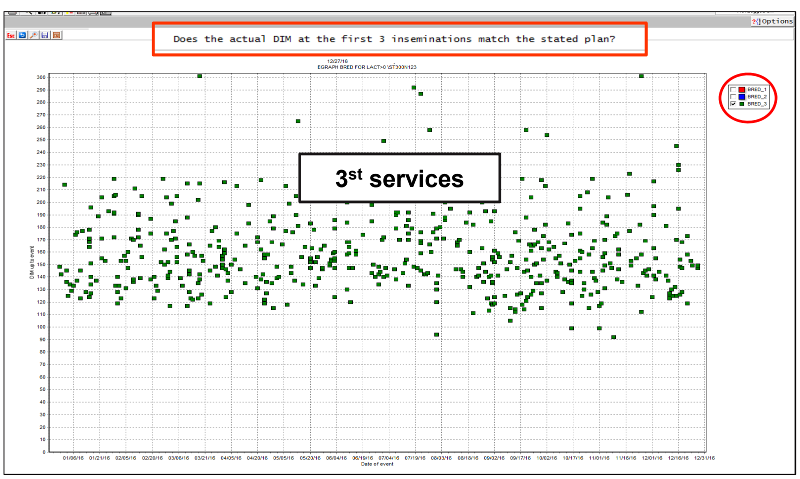
Reproductive Performance

Reproductive program: 1st to 3rd service



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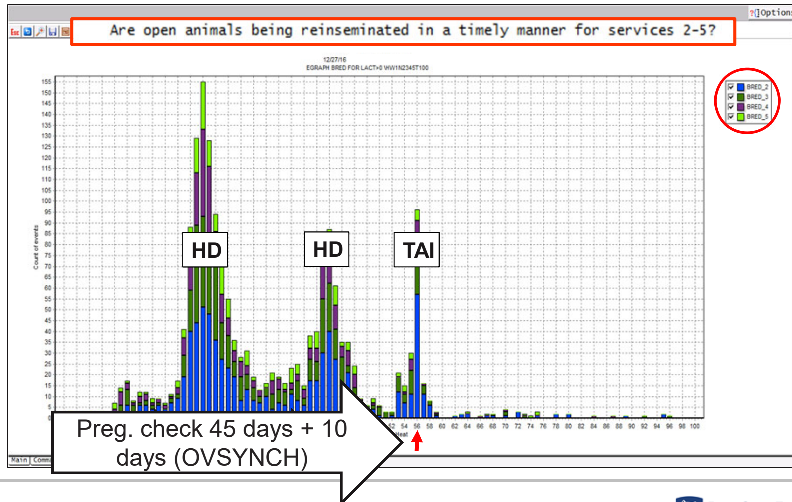
Reproductive Performance

Reproductive program: 2nd and consecutive services



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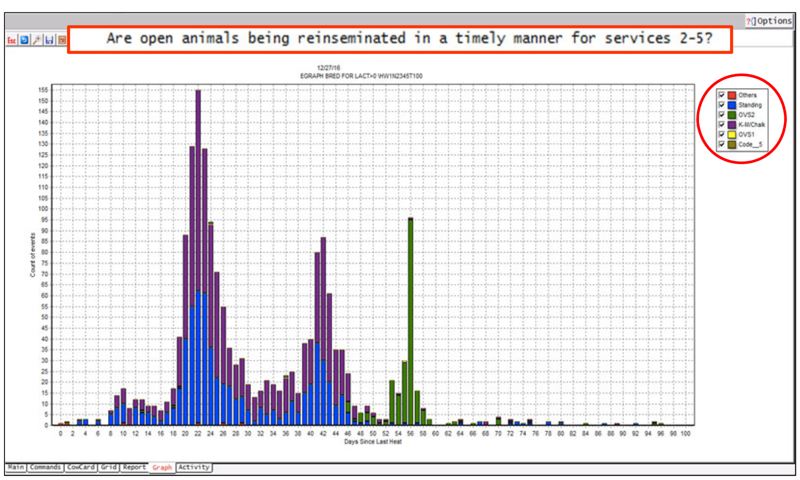
Reproductive Performance

Reproductive program: 2nd and consecutive services



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Reproductive Performance

Service Interval

Interval	Reason(s)	Goal
< 18 Days	Problems in heat detection (inaccuracy)	< 10%
18-24 Days	Good quality of heat detection	> 60%
25-35 Days	Early embryonic death (EED; irregular length of cycles) Problems in heat detection (inaccuracy)	< 10%
36-48 Days	Problems in heat detection (missing previous heats)	< 10%
48+ Days	Problems in heat detection (missing previous heat) Abortion (fetal loss)	< 5%

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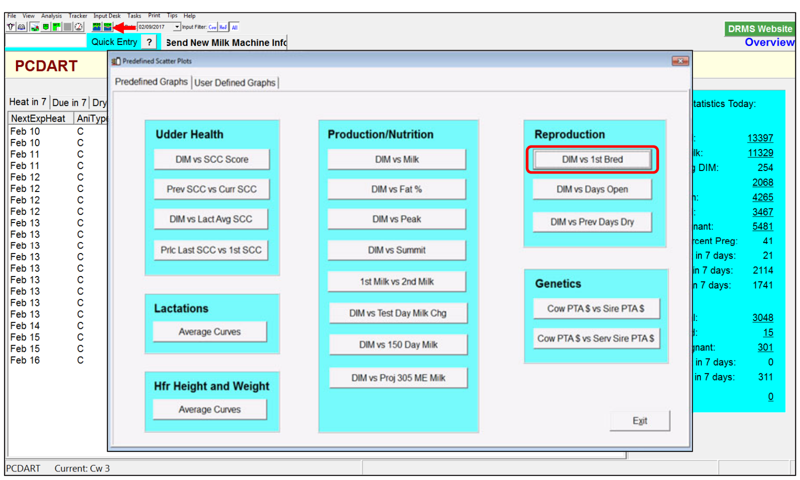
Reproductive Performance

Voluntary Waiting Period (PCDART)



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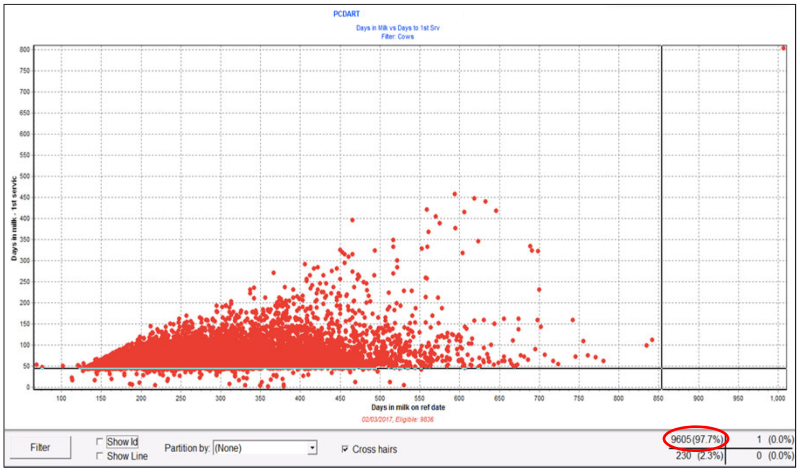
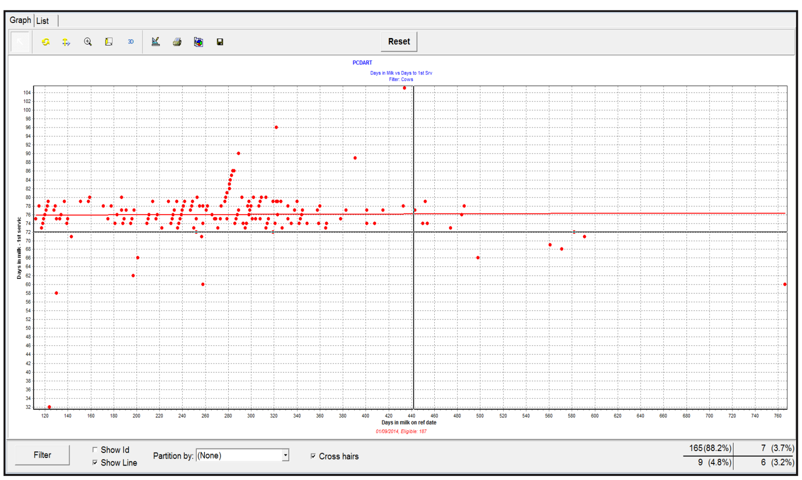
Reproductive Performance

Voluntary Waiting Period (PCDART)

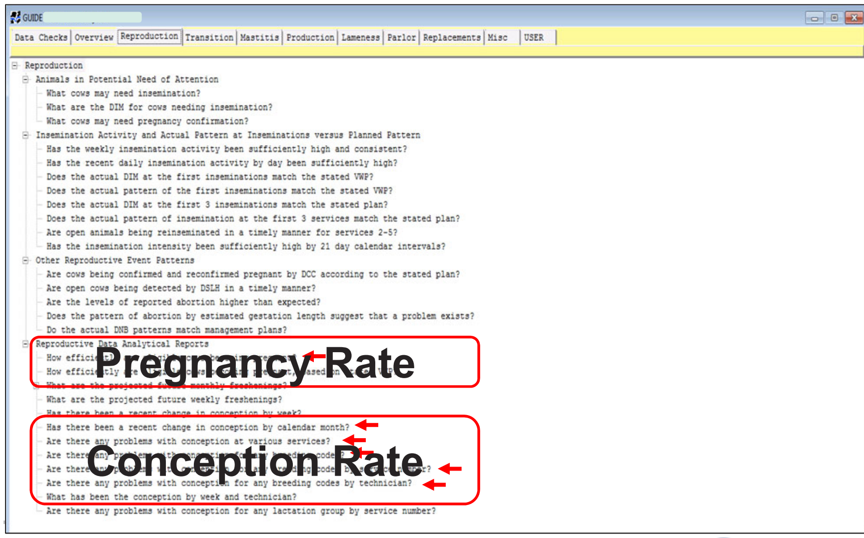


Reproductive Performance

Voluntary Waiting Period and reproductive program (PCDART)



Reproductive Performance



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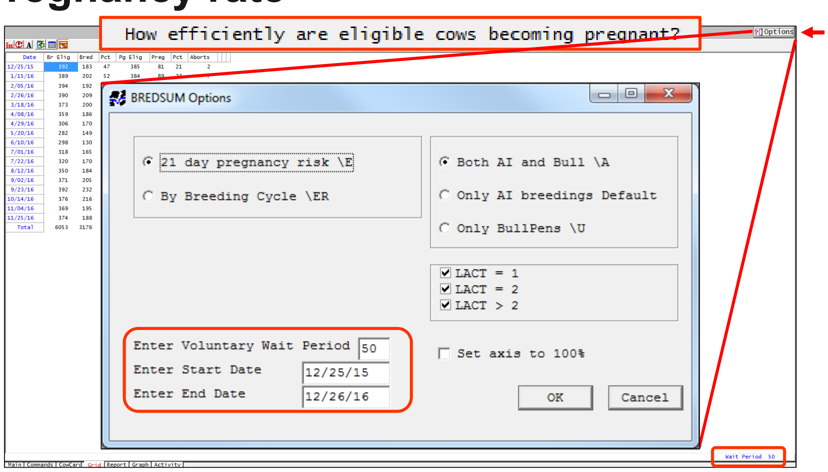
Reproductive Performance

Pregnancy rate



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Reproductive Performance

Pregnancy rate

How efficiently are eligible cows becoming pregnant?

Date	Br Elig	Bred	Pct	Pg Elig	Preg	Pct	Aborts
12/25/15	301	180	60	294	80	27	2
1/15/16	304	200	66	299	88	29	7
2/05/16	302	184	61	293	78	27	8
2/26/16	302	201	67	298	81	27	4
3/18/16	305	198	65	298	74	25	7
4/08/16	293	182	62	286	77	27	4
4/29/16	272	168	62	268	62	23	10
5/20/16	233	147	63	226	53	23	5
6/10/16	222	126	57	221	36	16	2
7/01/16	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	18	4
7/22/16	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	3
8/12/16	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	14	5
9/02/16	303	202	67	291	47	16	2
9/23/16	314	226	72	306	78	25	3
10/14/16	309	213	69	299	69	23	2
11/04/16	302	193	64	295	63	21	0
11/25/16	299	179	60	* 198	17	9	0
Total	4880	3107	64	4674	1017	22	68

Heat stress?

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Reproductive Performance

Conception rate by month

Has there been a recent change in conception by calendar month?

Month	95% CI	%Conc	#Preg	#Open	Other	Abort	Total	%Tot	SPC
2015 December	34-54	44	38	49	4	1	91	3	2.3
2016 January	39-50	45	133	164	10	9	307	9	2.2
2016 February	37-49	43	113	149	13	11	275	8	2.3
2016 March	34-45	39	117	183	10	8	310	9	2.6
2016 April	35-47	41	112	163	9	8	284	8	2.5
2016 May	32-45	38	89	144	9	14	242	7	2.6
2016 June	24-36	30	58	138	5	2	201	6	3.4
2016 July	21-31	26	64	186	10	7	260	8	3.9
2016 August	16-26	20	56	218	8	6	282	8	4.9
2016 September	21-31	26	83	237	19	3	339	10	3.9
2016 October	29-39	34	111	218	11	3	340	10	3.0
2016 November	20-32	26	49	141	* 87	0	277	8	3.9
2016 December	-	0	0	23	* 195	0	218	6	
TOTALS	32-35	34	1023	2013	* 390	72	3426	100	3.0

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Reproductive Performance

Conception rate by service

Are there any problems with conception at various services?

Bred Number	95% CI	%Conc	#Preg	#Open	Other	Abort	Total	%Tot	SPC
1	38-41	40	1478	2238	166	177	3882	39	2.5
2	38-42	40	911	1379	90	105	2380	24	2.5
3	35-40	37	525	878	64	52	1467	15	2.7
4	37-44	40	357	525	32	42	914	9	2.5
5	30-38	34	173	342	27	27	542	5	3.0
6	28-38	33	111	223	15	16	349	3	3.0
7	24-36	30	62	146	14	5	222	2	3.4
8	25-42	33	40	81	* 19	4	140	1	3.0
OTHERS	24-41	32	39	83	* 30	4	152	2	3.1
TOTALS	38-40	39	3696	5895	457	432	10048	100	2.6

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Reproductive Performance

Conception rate by breeding code

Are there any problems with conception for any breeding codes?

Breeding Code	95% CI	%Conc	#Preg	#Open	Other	Abort	Total	%Tot	SPC
Undef Code 5	-	0	0	2	0	0	2	0	
K-M/Chalk	32-37	34	536	1019	79	48	1634	48	2.9
OVS1	26-36	31	106	235	11	6	352	10	3.2
Standing	35-41	38	422	685	52	25	1159	34	2.6
OVS2	21-33	27	63	174	21	4	258	8	3.8
OTHERS	-	0	0	10	1	0	11	0	
TOTALS	33-36	35	1127	2125	164	83	3416	100	2.9

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Reproductive Performance

Conception rate by breeding code by technician

Are there any problems with conception for any breeding codes by technician?

95% CI	Total	Josh Gr	Adam Gr	Jordi V	Jeremy	Teun Ve	OTHERS
K-M/Chalk	32-37	24-32	34-40	-	-	-	-
Standing	35-41	31-41	36-43	-	-	-	-
OVS2	21-33	-	22-33	-	-	-	-
OVS1	26-36	-	26-35	-	-	-	-
OTHERS	-	-	-	-	-	-	-
TOTALS	33-36	28-34	34-38	-	-	-	-
Percent							
K-M/Chalk	34	28	37				
Standing	38	35	39				
OVS2	27		27				
OVS1	31		30				
OTHERS							
TOTALS	35	31	36				
Count							
K-M/Chalk	1555	459	1078	5	9	4	
Standing	1107	350	746	5	4	2	
OVS2	237	12	224	1			
OVS1	341	13	324	4			
OTHERS	12	3					9
TOTALS	3252	837	2372	15	13	6	9
Pregnant							
K-M/Chalk	536	128	400	2	4	2	
Standing	422	124	294	2	2		
OVS2	63	2	61				
OVS1	106	6	98	2			
OTHERS							
TOTALS	1127	260	853	6	6	2	

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Reproductive Performance

Conception rate by breeding code by service

Are there any problems with conception for any breeding codes by service number?

95% CI	Total	1	2	3	4	5	6	7	8	9	10	11	OTHERS
K-M/Chalk	32-37	37-45	30-39	24-36	23-37	23-40	25-48	-	-	-	-	-	-
Standing	35-41	40-50	32-44	32-46	27-43	29-50	20-43	-	-	-	-	-	-
OVS2	21-33	-	18-34	17-40	-	-	-	-	-	-	-	-	-
OVS1	26-36	26-36	-	-	-	-	-	-	-	-	-	-	-
OTHERS	-	-	-	-	-	-	-	-	-	-	-	-	-
TOTALS	33-36	36-42	30-37	29-37	26-36	28-41	25-41	17-35	-	-	-	-	-
Percent													
K-M/Chalk	34	41	34	30	29	31	36						
Standing	38	45	37	39	35	39	30						
OVS2	27		25	27									
OVS1	31	31											
OTHERS													
TOTALS	35	39	34	33	31	34	32	25					
Count													
K-M/Chalk	1555	503	369	247	163	106	64	49	24	17	8	3	2
Standing	1107	358	249	174	124	80	57	28	20	6	6	3	2
OVS2	237	4	114	59	24	17	7	4	1	2	3	2	
OVS1	341	338		2					1				
OTHERS	12	4	5		1							1	1
TOTALS	3252	1207	737	482	312	203	128	81	46	25	17	9	5
Pregnant													
K-M/Chalk	536	205	127	73	48	33	23	14	6	3	3		1
Standing	422	160	93	68	43	31	17	4	5		1		
OVS2	63	2	29	16	5	5	1	2		1	1	1	
OVS1	106	105							1				
OTHERS													
TOTALS	1127	472	249	157	96	69	41	20	12	4	5	1	1

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Reproductive Performance

Conception rate by lactation by service number

Are there any problems with conception for any lactation group by service number?

95% CI	Total	1	2	3	4	5	6	7	8	9	10	11	OTHERS
1	39-46	46-56	36-50	26-44	26-47	-	-	-	-	-	-	-	-
2	31-37	30-40	26-38	27-42	28-47	28-52	-	-	-	-	-	-	-
3	28-33	30-38	25-35	25-37	17-31	25-43	17-39	-	-	-	-	-	-
TOTALS	33-36	36-42	30-37	29-37	26-36	28-41	25-41	17-35	-	-	-	-	-
Percent													
1	42	51	43	35	36								
2	34	35	32	34	37	39							
3	31	34	30	31	23	33	26						
TOTALS	35	39	34	33	31	34	32	25					
Count													
1	835	353	184	110	75	42	30	18	8	4	4	4	3
2	992	362	233	151	99	59	41	22	13	7	5		
3	1425	492	320	221	138	102	57	41	25	14	8	5	2
TOTALS	3252	1207	737	482	312	203	128	81	46	25	17	9	5
Pregnant													
1	354	180	79	38	27	12	11	5	1			1	
2	336	127	74	51	37	23	15	3	1	1	4		
3	437	165	96	68	32	34	15	12	10	3	1		1
TOTALS	1127	472	249	157	96	69	41	20	12	4	5	1	1

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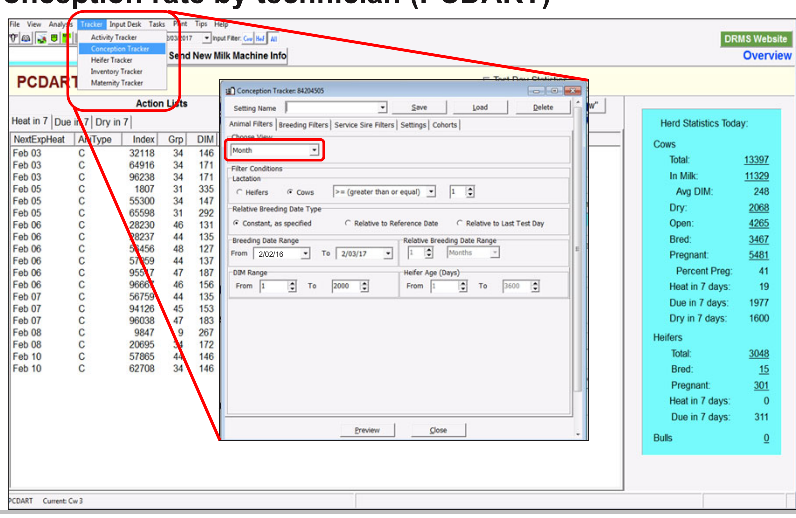
Reproductive Performance

Conception rate by technician (PCDART)



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Reproductive Performance

Conception rate by month (PCDART)

File Print

Choose Another View: Month | Change View | About

Month	%	# Bred	# Preg	# Open	Conc %	SPC	Others
Feb 2016**	11	1968	582	1386	30	3.4	425
Mar 2016	14	2472	748	1724	30	3.3	563
Apr 2016	13	2349	689	1660	29	3.4	531
May 2016	11	2053	535	1518	26	3.8	432
Jun 2016	11	1906	539	1367	28	3.5	319
Jul 2016	11	1989	555	1434	28	3.6	417
Aug 2016	14	2470	618	1852	25	4.0	407
Sep 2016	12	2163	584	1579	27	3.7	567
Oct 2016	4	767	9	758	1	85.2	1855
Nov 2016	0	7	0	7	0	-	999
Dec 2016	0	0	0	0	-	-	0
Jan 2017	0	0	0	0	-	-	0
Feb 2017**	0	0	0	0	-	-	0
TOTAL	100	18144	4859	13285	27	3.7	6515

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Reproductive Performance

Conception rate by technician (PCDART)

Choose Another View: Technician | Change View

Technician	%	# Bred	# Preg	# Open	Conc %	SPC	Others
00	25	4618	1027	3591	22	4.5	3649
19	6	1157	338	819	29	3.4	242
42	0	13	4	9	31	3.3	7
45	1	214	50	164	23	4.3	35
55	1	123	27	96	22	4.6	29
62	3	627	211	416	34	3.0	127
63	8	1382	323	1059	23	4.3	317
70	14	2594	760	1834	29	3.4	490
71	4	642	183	459	29	3.5	165
72	2	451	115	336	25	3.9	83
74	2	405	120	285	30	3.4	83
75	8	1436	434	1002	30	3.3	360
76	0	23	3	20	13	7.7	6
77	13	2360	721	1639	31	3.3	479
79	0	1	1	0	100	1.0	0
80	12	2098	542	1556	26	3.9	443
TOTAL	100	18144	4859	13285	27	3.7	6515

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Reproductive Performance

Conception rate by lactation number (PCDART)

Choose Another View: Lactation Number | Change View | About

Lactation Number	%	# Bred	# Preg	# Open	Conc %	SPC	Others
1	36	6587	1975	4612	30	3.3	2390
2	24	4409	1138	3271	26	3.9	1430
3	20	3600	916	2684	25	3.9	1254
4	11	2066	498	1568	24	4.1	824
5	6	1006	224	782	22	4.5	420
6	2	343	76	267	22	4.5	135
7	0	70	17	53	24	4.1	38
8	0	32	9	23	28	3.6	13
9	0	10	3	7	30	3.3	3
10+	0	21	3	18	14	7.0	8
TOTAL	100	18144	4859	13285	27	3.7	6515

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Reproductive Performance

Conception rate by service number (PCDART)

Choose Another View: Service Number | Change View | About

Service Number	%	# Bred	# Preg	# Open	Conc %	SPC	Others
1	41	7415	2056	5359	28	3.6	1373
2	24	4406	1201	3205	27	3.7	1837
3	15	2728	734	1994	27	3.7	1524
4	9	1710	453	1257	26	3.8	671
5	5	921	243	678	26	3.8	579
6	3	455	89	366	20	5.1	252
7	1	246	45	201	18	5.5	126
8	1	115	17	98	15	6.8	73
9	0	62	13	49	21	4.8	39
10+	0	86	8	78	9	10.8	41
TOTAL	100	18144	4859	13285	27	3.7	6515

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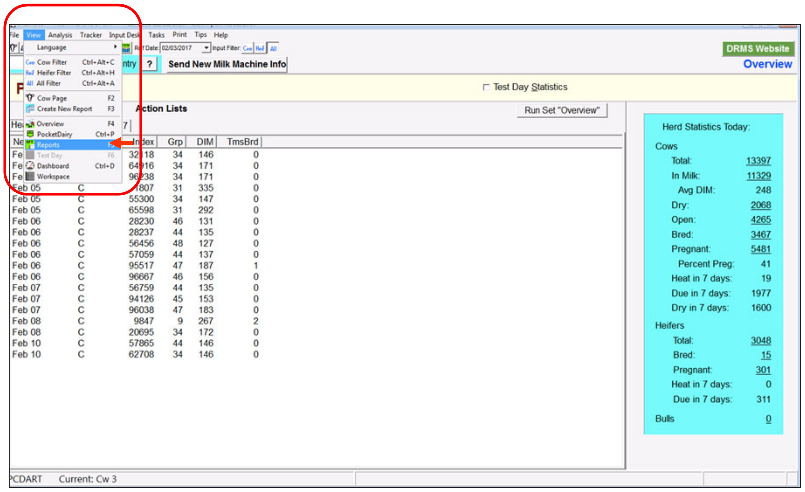
Reproductive Performance

Conception rate by technician (PCDART)



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Reproductive Performance

Pregnancy rate(PCDART)

126 9 Month 21-Day Pregnancy Rate by Date

Ref Date: 11/11/2016
No Exclusions
Lact>=1 L1VWP:45 L2+VWP:45 PgCk:40

Last Date of 21 Days	Bred #Eligible	Bred #Reported	Bred Pct	Pregnancies #Eligible	Pregnancies #Reported	Pregnancies Rate	#Abort
3/4/2016	4588	1616	35	4549	526	12	12
3/25/2016	4628	1772	38	4592	579	13	20
4/15/2016	4497	1649	37	4453	529	12	14
5/6/2016	4398	1611	37	4364	506	12	10
5/27/2016	4384	1482	34	4355	484	11	13
6/17/2016	4414	1499	34	4384	514	12	29
7/8/2016	4502	1520	34	4476	551	12	45
7/29/2016	4596	1405	31	4534	476	10	52
8/19/2016	4760	1840	39	4738	545	12	7
9/9/2016	4846	1901	39	4821	565	12	0
9/30/2016	4864	1788	37	4846	436	9	0
10/21/2016	5061	1714	34	0	0		0
11/11/2016	4574	1642	36	0	0		0
Total	60112	21439	36	50112	5711	11	202

Service Rate

Pregnancy Rate

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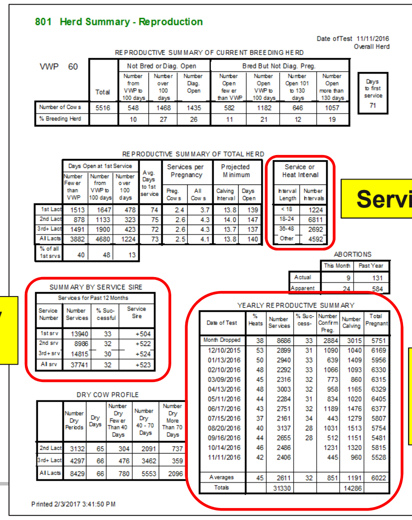
Reproductive Performance

Repro summary (PCDART)



801 Herd Summary - Reproduction

Date ofTest 11/11/2016
Overall Herd

REPRODUCTIVE SUMMARY OF CURRENT BREEDING HERD

VWP 60

	Total	Not Bred or Diag. Open			Bred But Not Diag. Preg.			
		Number from VWP to 100 days	Number over 100 days	Number Diag. Open	Number Open fewer than VWP	Number Open VWP to 100 days	Number Open 101 to 130 days	Number Open more than 130 days
Number of Cows	5516	548	1468	1435	582	1182	646	1057
% Breeding Herd		10	27	26	11	21	12	19

Days to first service
71

REPRODUCTIVE SUMMARY OF TOTAL HERD

	Days Open at 1st Service			Avg. Days to 1st service	Services per Pregnancy		Projected Minimum	
	Number Fewer than VWP	Number from VWP to 100 days	Number over 100 days		Preg. Cows	All Cows	Calving Interval	Days Open
1st Lact	1513	1647	478	74	2.4	3.7	13.8	139
2nd Lact	878	1133	323	75	2.6	4.3	14.0	147
3rd+ Lact	1491	1900	423	72	2.6	4.3	13.7	137
All Lacts	3882	4680	1224	73	2.5	4.1	13.8	140
% of all 1st srvs	40	48	13					

Service or Heat Interval	
Interval Length	Number Intervals
< 18	1224
18-24	6811
36-48	2692
Other	4592

ABORTIONS

	This Month	Past Year
Actual	9	131
Apparent	24	584

SUMMARY BY SERVICE SIRE

Services for Past 12 Months			
Service Number	Number Services	% Successful	Service Sire
1st srv	13940	33	+504
2nd srv	8986	32	+522
3rd+ srv	14815	30	+524
All srv	37741	32	+523

YEARLY REPRODUCTIVE SUMMARY

Date of Test	% Heats	Number Services	% Success-	Number Confirm Preg.	Number Calving	Total Pregnant
Month Dropped	38	8686	33	2884	3015	5751
12/10/2015	53	2899	31	1090	1040	6169
01/13/2016	50	2940	33	639	1409	5956
02/10/2016	48	2292	33	1066	1093	6330
03/09/2016	45	2316	32	773	860	6315
04/13/2016	48	3003	32	958	1165	6329
05/11/2016	44	2284	31	834	1020	6405
06/17/2016	43	2751	32	1189	1476	6377
07/15/2016	37	2161	34	443	1279	5807
08/20/2016	40	3137	28	1031	1513	5754
09/16/2016	44	2655	28	512	1151	5481
10/14/2016	46	2486		1231	1320	5815
11/11/2016	42	2406		445	960	5528
Averages	45	2611	32	851	1191	6022
Totals		31330			14286	

DRY COW PROFILE

	Number Dry Periods	Dry Days	Number Dry Fewer Than 40 Days	Number Dry 40 - 70 Days	Number Dry More Than 70 Days
2nd Lact	3132	65	304	2091	737
3rd+ Lact	4297	66	476	3462	359
All Lacts	8429	66	780	5553	2096

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Service Interval

Conception Rate by Service #

Conception Rate and Service Rate

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Troubleshooting Process

- Step-by-step approach
  - Meeting with the producer
  - Farm walk-through: field data collection
  - Record analysis
- Identify risk factors and rank them in order of importance
- Provide recommendations
  - Be aware of operation limitations
  - Set small goals for reaching your benchmarks (avoid producer's frustration)

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Hands-On Lab : Uterine Disease Diagnosis

Objectives:

- Perform calving diagnostic methods described in the oral presentation

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Follow-up

EMAIL

skype

WhatsApp

WeChat

TeamViewer

Dropbox

Tel: 814.863.5849
Email: axb779@psu.edu

PennState Extension

Adrian A. Barragan, DVM, MS, PhD
Assistant Clinical Professor
Tel: 814.863.5849
Email: axb779@psu.edu

Thank you

PennState Extension

Department of Veterinary and Biomedical Sciences
College of Agricultural Sciences
Penn State University

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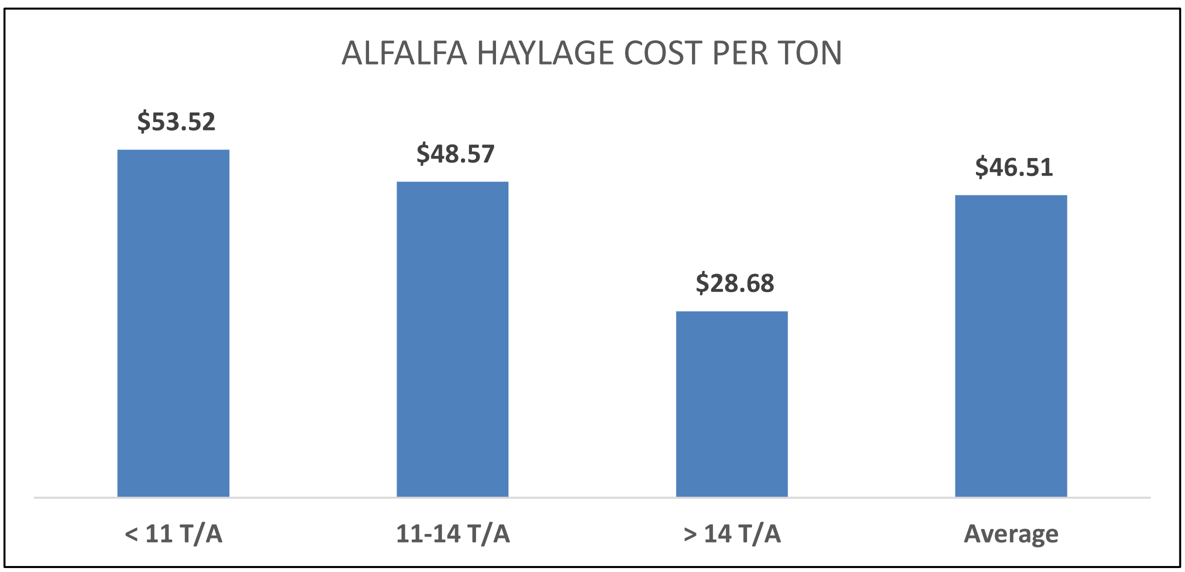
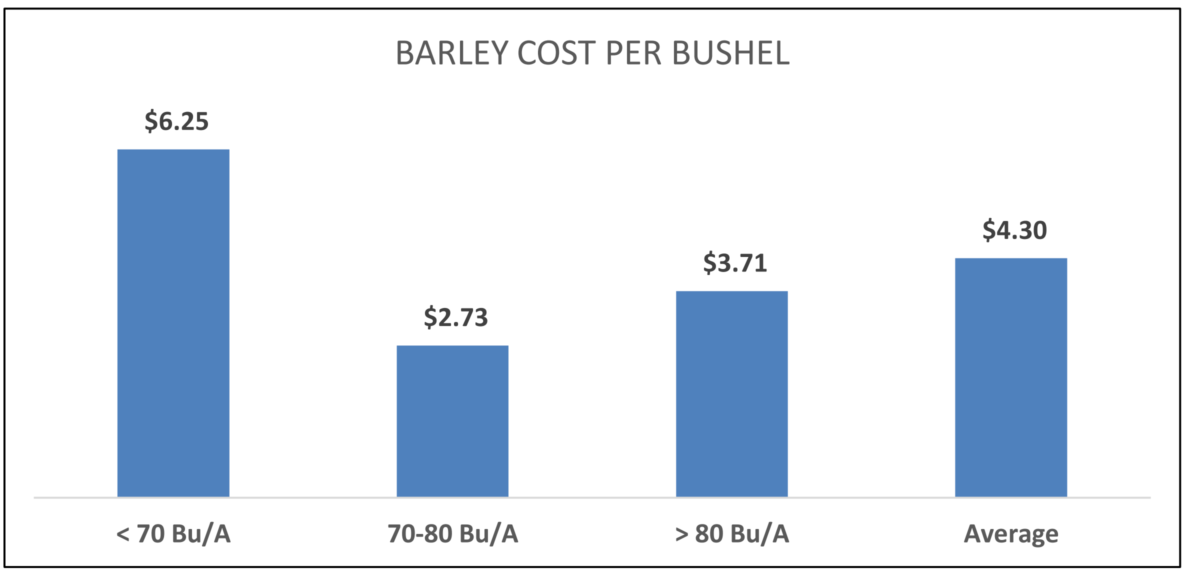
ALFALFA HAYLAGE COST PER TON

Yield Group		< 11 T/A		11-14 T/A		> 14 T/A		Average
Yield per Acre		7.4		12.1		17.5		10.0
Acres Owned		15		24		12		17
Acres Rented		29		13		24		24
Total Acres		44		37		36		41
Seed/Acre	$	23	$	27	$	31	$	25
Fertilizer/Acre	$	37	$	60	$	42	$	44
Chemical/Acre	$	8	$	11	$	26	$	11
Custom Hire/Acre	$	25	$	86	$	38	$	44
*Land Rent/Acre	$	74	$	105	$	82	$	83
Total Direct Costs/Acre	**$**	**166**	**$**	**289**	**$**	**219**	**$**	**208**
Total Direct Costs/Ton	$	33.93	$	27.01	$	39.78	$	32.66
Percent of Crop Labor		30%		36%		33%		32%
Total Overhead Costs/Acre	**$**	**99**	**$**	**140**	**$**	**171**	**$**	**119**
Total Overhead Costs/Ton	$	17.31	$	13.77	$	11.65	$	15.62
Owner Draw/Acre	$	47	$	51	$	40	$	47
Loan Payments/Acre	$	82	$	109	$	73	$	89
Total Costs/Acre	**$**	**394**	**$**	**589**	**$**	**502**	**$**	**463**
Total Costs/Ton	**$**	**53.52**	**$**	**48.57**	**$**	**28.68**	**$**	**46.51**
Average % Rented Land		*67%*		*35%*		*66%*		*58%*
**Avg. Land Rent on Rented Acres*	*$*	*108*	*$*	*167*	*$*	*100*	*$*	*120*
Number of Farms		*54*		*26*		*11*		*91*



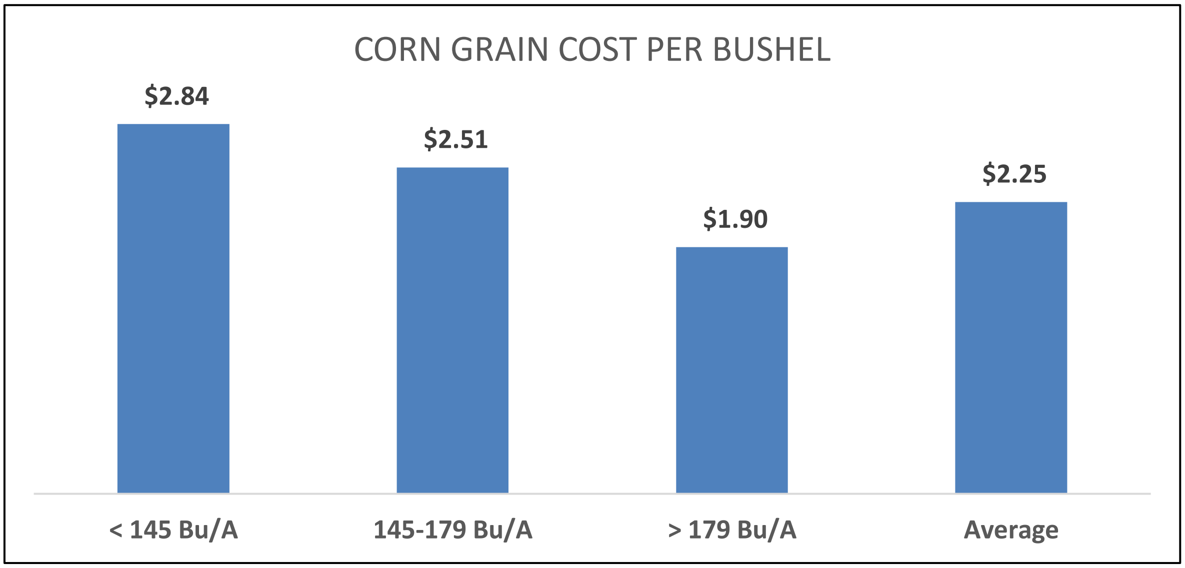
BARLEY COST PER BUSHEL

Yield Group	< 70 Bu/A	70-80 Bu/A	> 80 Bu/A	Average
Yield per Acre	58.3	76.7	89.5	73.3
Acres Owned	7	13	6	8
Acres Rented	10	6	35	17
Total Acres	17	19	41	26
Seed/Acre	$ 32	$ 39	$ 25	$ 31
Fertilizer/Acre	$ 24	$ 13	$ 36	$ 25
Chemical/Acre	$ 32	$ 1	$ 12	$ 18
Custom Hire/Acre	$ 47	$ 12	$ 43	$ 37
*Land Rent/Acre	$ 134	$ 36	$ 140	$ 111
Total Direct Costs/Acre	**$ 269**	**$ 100**	**$ 256**	**$ 222**
Total Direct Costs/Bushel	$ 4.10	$ 0.96	$ 3.08	$ 2.98
Percent of Crop Labor	3%	4%	7%	4%
Total Overhead Costs/Acre	**$ 64**	**$ 58**	**$ 38**	**$ 54**
Total Overhead Costs/Bushel	$ 1.08	$ 0.75	$ 0.42	$ 0.78
Owner Draw/Acre	$ 11	$ 11	$ 16	$ 13
Loan Payments/Acre	$ 21	$ 41	$ 21	$ 26
Total Costs/Acre	**$ 365**	**$ 209**	**$ 332**	**$ 315**
Total Costs/Bushel	**$ 6.25**	**$ 2.73**	**$ 3.71**	**$ 4.30**
Average % Rented Land	*60%*	*30%*	*85%*	*68%*
**Avg. Land Rent on Rented Acres*	*$ 179*	*$ 60*	*$ 140*	*$ 144*
Number of Farms	*5*	*3*	*4*	*12*



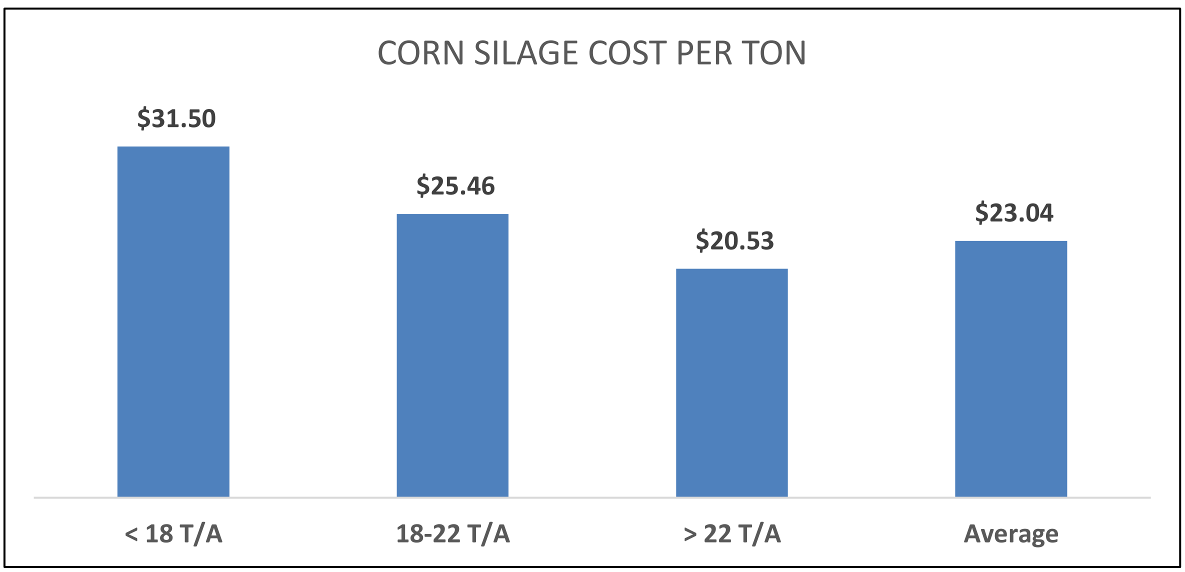
CORN GRAIN COST PER BUSHEL

Yield Group	< 145 Bu/A	145-179 Bu/A	> 179 Bu/A	Average
Yield per Acre	123.6	162.1	219.6	177.7
Acres Owned	14	8	14	11
Acres Rented	47	23	30	31
Total Acres	60	30	44	43
Seed/Acre	$ 74	$ 91	$ 87	$ 86
Fertilizer/Acre	$ 55	$ 73	$ 61	$ 64
Chemical/Acre	$ 38	$ 39	$ 33	$ 36
Custom Hire/Acre	$ 25	$ 36	$ 23	$ 28
*Land Rent/Acre	$ 53	$ 76	$ 117	$ 88
Total Direct Costs/Acre	**$ 245**	**$ 315**	**$ 321**	**$ 302**
Total Direct Costs/Bushel	$ 19.76	$ 17.20	$ 10.47	$ 14.95
Percent of Crop Labor	11%	10%	10%	10%
Total Overhead Costs/Acre	**$ 49**	**$ 48**	**$ 47**	**$ 48**
Total Overhead Costs/Bushel	$ 3.02	$ 2.09	$ 1.24	$ 1.94
Owner Draw/Acre	$ 22	$ 14	$ 15	$ 16
Loan Payments/Acre	$ 36	$ 30	$ 34	$ 33
Total Costs/Acre	**$ 352**	**$ 407**	**$ 417**	**$ 399**
Total Costs/Bushel	**$ 2.84**	**$ 2.51**	**$ 1.90**	**$ 2.25**
Average % Rented Land	*77%*	*75%*	*69%*	*73%*
**Avg. Land Rent on Rented Acres*	*$ 64*	*$ 90*	*$ 146*	*$ 105*
Number of Farms	*13*	*22*	*25*	*60*



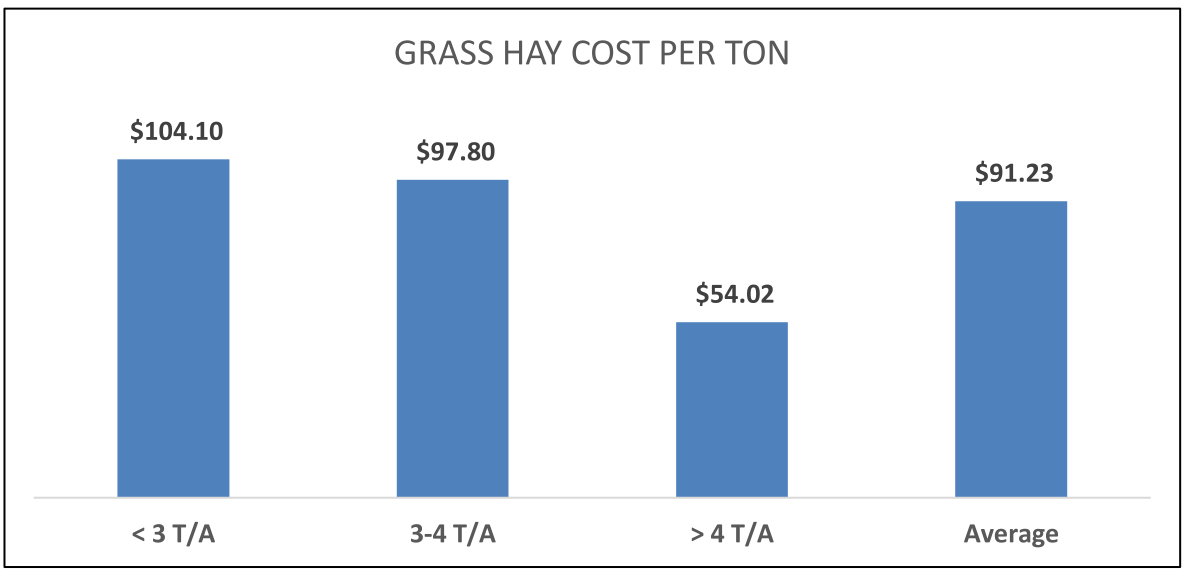
CORN SILAGE COST PER TON

Yield Group		< 18 T/A		18-22 T/A		> 22 T/A		Average
Yield per Acre		15.0		19.7		25.8		22.2
Acres Owned		65		35		23		33
Acres Rented		161		39		41		58
Total Acres		227		74		64		92
Seed/Acre	$	72	$	73	$	91	$	82
Fertilizer/Acre	$	75	$	69	$	67	$	69
Chemical/Acre	$	57	$	28	$	40	$	39
Custom Hire/Acre	$	69	$	85	$	80	$	80
*Land Rent/Acre	$	47	$	87	$	90	$	83
Total Direct Costs/Acre	**$**	**320**	**$**	**342**	**$**	**368**	**$**	**352**
Total Direct Costs/Ton	$	24.32	$	18.76	$	15.10	$	17.65
Percent of Crop Labor		35%		32%		28%		31%
Total Overhead Costs/Acre	**$**	**92**	**$**	**79**	**$**	**77**	**$**	**80**
Total Overhead Costs/Ton	$	6.31	$	4.01	$	3.02	$	3.83
Owner Draw/Acre	$	17	$	32	$	26	$	27
Loan Payments/Acre	$	44	$	49	$	59	$	54
Total Costs/Acre	**$**	**472**	**$**	**502**	**$**	**530**	**$**	**513**
Total Costs/Ton	**$**	**31.50**	**$**	**25.46**	**$**	**20.53**	**$**	**23.04**
Average % Rented Land		*71%*		*52%*		*64%*		*64%*
**Avg. Land Rent on Rented Acres*	*$*	*48*	*$*	*121*	*$*	*146*	*$*	*119*
Number of Farms		*15*		*32*		*53*		*100*



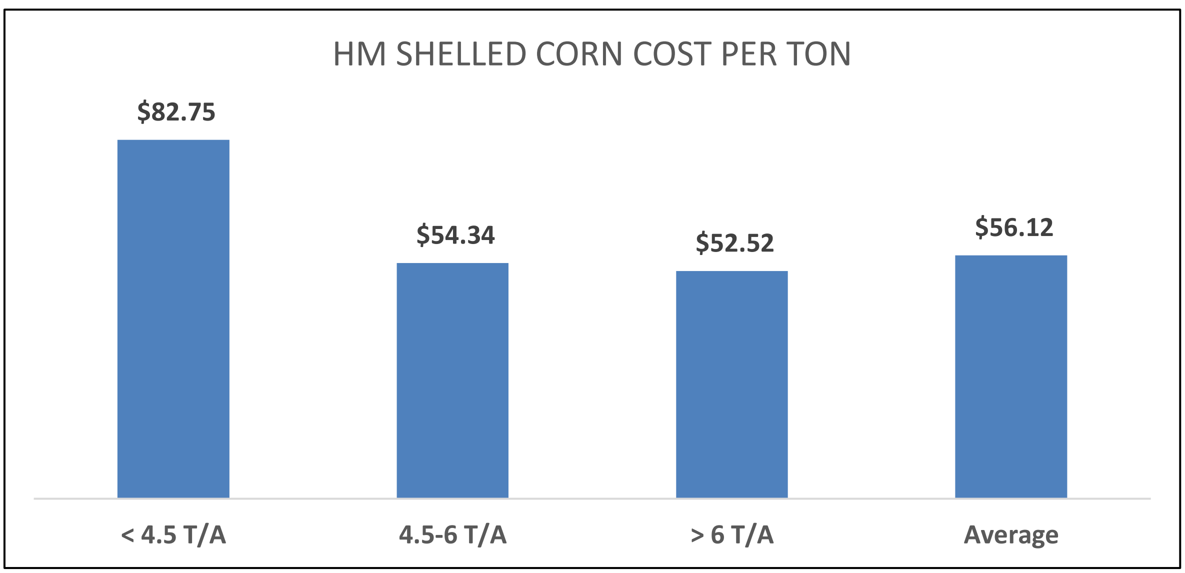
GRASS HAY COST PER TON

Yield Group		< 3 T/A		3-4 T/A		> 4 T/A		Average
Yield per Acre		1.7		3.4		4.9		2.6
Acres Owned		16		14		9		14
Acres Rented		19		29		68		27
Total Acres		34		42		77		41
Seed/Acre	$	12	$	10	$	9	$	11
Fertilizer/Acre	$	26	$	36	$	18	$	28
Chemical/Acre	$	1	$	4	$	-	$	2
Custom Hire/Acre	$	13	$	37	$	49	$	24
*Land Rent/Acre	$	45	$	93	$	45	$	59
Total Direct Costs/Acre	**$**	**98**	**$**	**179**	**$**	**120**	**$**	**124**
Total Direct Costs/Ton	$	41.88	$	45.28	$	27.79	$	41.38
Percent of Crop Labor		9%		10%		14%		10%
Total Overhead Costs/Acre	**$**	**41**	**$**	**85**	**$**	**102**	**$**	**60**
Total Overhead Costs/Ton	$	17.33	$	24.03	$	19.52	$	19.56
Owner Draw/Acre	$	12	$	20	$	18	$	15
Loan Payments/Acre	$	25	$	50	$	26	$	33
Total Costs/Acre	**$**	**176**	**$**	**334**	**$**	**266**	**$**	**233**
Total Costs/Ton	**$**	**104.10**	**$**	**97.80**	**$**	**54.02**	**$**	**91.23**
Average % Rented Land		*55%*		*67%*		*88%*		*65%*
**Avg. Land Rent on Rented Acres*	*$*	*69*	*$*	*102*	*$*	*67*	*$*	*80*
Number of Farms		*50*		*25*		*9*		*84*



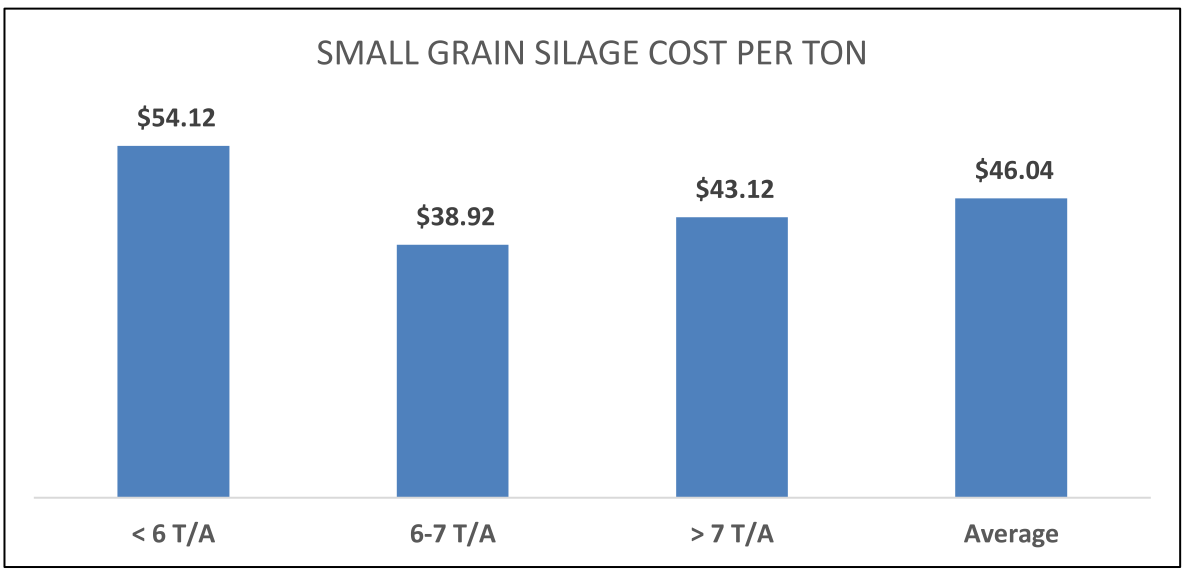
HM SHELLED CORN COST PER TON

Yield Group		< 4.5 T/A		4.5-6 T/A		> 6 T/A		Average
Yield per Acre		3.8		5.2		8.2		6.8
Acres Owned		23		10		9		12
Acres Rented		49		15		19		24
Total Acres		72		26		28		36
Seed/Acre	$	74	$	68	$	91	$	83
Fertilizer/Acre	$	41	$	72	$	72	$	66
Chemical/Acre	$	12	$	20	$	29	$	24
Custom Hire/Acre	$	36	$	17	$	83	$	61
*Land Rent/Acre	$	85	$	25	$	66	$	62
Total Direct Costs/Acre	**$**	**248**	**$**	**201**	**$**	**341**	**$**	**296**
Total Direct Costs/Ton	$	74.76	$	33.03	$	33.03	$	41.14
Percent of Crop Labor		7%		6%		6%		6%
Total Overhead Costs/Acre	**$**	**32**	**$**	**29**	**$**	**47**	**$**	**41**
Total Overhead Costs/Ton	$	8.41	$	2.99	$	5.33	$	5.48
Owner Draw/Acre	$	14	$	17	$	15	$	15
Loan Payments/Acre	$	23	$	33	$	28	$	28
Total Costs/Acre	**$**	**317**	**$**	**280**	**$**	**431**	**$**	**380**
Total Costs/Ton	**$**	**82.75**	**$**	**54.34**	**$**	**52.52**	**$**	**56.12**
Average % Rented Land		*69%*		*60%*		*68%*		*67%*
**Avg. Land Rent on Rented Acres*	*$*	*99*	*$*	*43*	*$*	*95*	*$*	*88*
Number of Farms		*7*		*7*		*22*		*36*



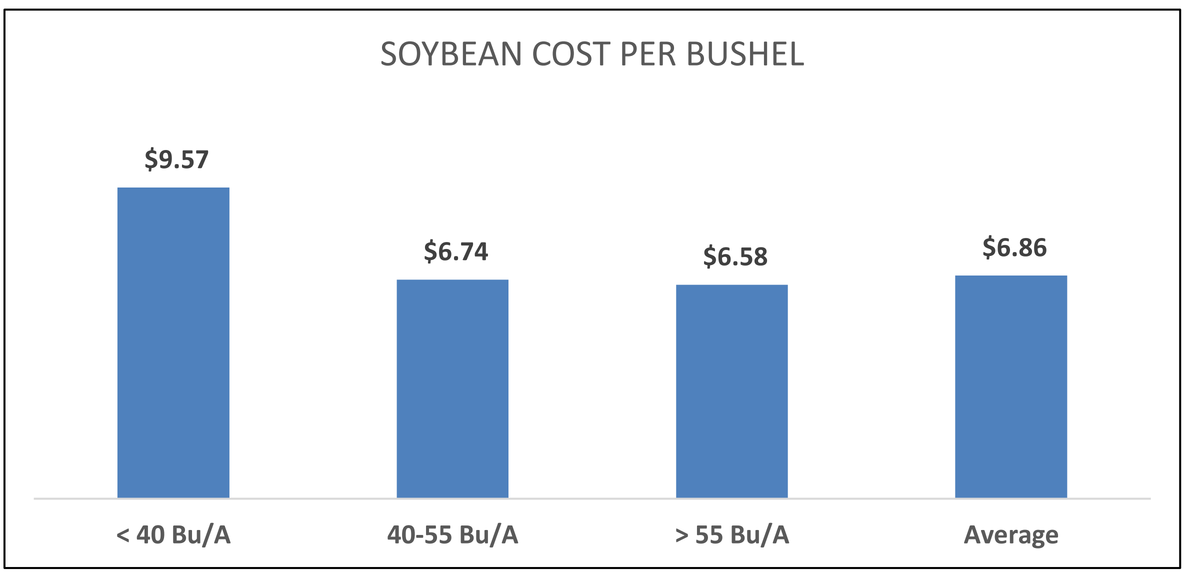
SMALL GRAIN SILAGE COST PER TON

Yield Group		< 6 T/A		6-7 T/A		> 7 T/A		Average
Yield per Acre		3.8		6.3		8.1		5.4
Acres Owned		15		32		37		24
Acres Rented		28		67		66		47
Total Acres		43		100		104		71
Seed/Acre	$	31	$	33	$	64	$	40
Fertilizer/Acre	$	23	$	34	$	48	$	31
Chemical/Acre	$	2	$	2	$	4	$	2
Custom Hire/Acre	$	19	$	32	$	69	$	34
*Land Rent/Acre	$	57	$	57	$	83	$	63
Total Direct Costs/Acre	**$**	**131**	**$**	**159**	**$**	**268**	**$**	**171**
Total Direct Costs/Ton	$	35.99	$	25.38	$	29.90	$	32.04
Percent of Crop Labor		9%		13%		15%		11%
Total Overhead Costs/Acre	**$**	**34**	**$**	**41**	**$**	**46**	**$**	**39**
Total Overhead Costs/Ton	$	9.17	$	6.59	$	5.79	$	7.75
Owner Draw/Acre	$	15	$	11	$	12	$	13
Loan Payments/Acre	$	26	$	34	$	26	$	28
Total Costs/Acre	**$**	**206**	**$**	**245**	**$**	**351**	**$**	**250**
Total Costs/Ton	**$**	**54.12**	**$**	**38.92**	**$**	**43.12**	**$**	**46.04**
Average % Rented Land		*66%*		*68%*		*64%*		*66%*
**Avg. Land Rent on Rented Acres*	*$*	*54*	*$*	*79*	*$*	*106*	*$*	*76*
Number of Farms		*63*		*28*		*29*		*120*



SOYBEAN COST PER BUSHEL

Yield Group		< 40 Bu/A		40-55 Bu/A		> 55 Bu/A		Average
Yield per Acre		32.0		47.5		62.7		50.6
Acres Owned		12		12		11		12
Acres Rented		42		53		33		45
Total Acres		53		65		43		57
Seed/Acre	$	62	$	65	$	78	$	69
Fertilizer/Acre	$	20	$	9	$	0	$	8
Chemical/Acre	$	17	$	22	$	28	$	23
Custom Hire/Acre	$	12	$	38	$	51	$	39
*Land Rent/Acre	$	120	$	93	$	138	$	110
Total Direct Costs/Acre	**$**	**231**	**$**	**227**	**$**	**295**	**$**	**249**
Total Direct Costs/Bushel	$	6.56	$	4.94	$	4.16	$	4.87
Percent of Crop Labor		11%		183%		7%		111%
Total Overhead Costs/Acre	**$**	**21**	**$**	**51**	**$**	**70**	**$**	**54**
Total Overhead Costs/Bushel	$	1.14	$	1.08	$	1.12	$	1.10
Owner Draw/Acre	$	14	$	16	$	9	$	14
Loan Payments/Acre	$	40	$	26	$	39	$	31
Total Costs/Acre	**$**	**306**	**$**	**320**	**$**	**413**	**$**	**347**
Total Costs/Bushel	**$**	**9.57**	**$**	**6.74**	**$**	**6.58**	**$**	**6.86**
Average % Rented Land		*78%*		*81%*		*75%*		*79%*
**Avg. Land Rent on Rented Acres*	*$*	*120*	*$*	*99*	*$*	*157*	*$*	*116*
Number of Farms		*3*		*17*		*9*		*29*



All Breeds	19%	27%	20%	10%	12%	13%	
			Breakeven Milk Price				
Dairy Summary per Cow:	**< $16**	**$16-$18**	**$18-$19**	**$19-$20**	**$20-$22**	**>$22**	**Average**
Total Number of Cows	177	118	109	121	280	81	142
Number of Cows Milking	157	103	94	106	246	69	124
Percent in Milk	88%	87%	87%	87%	87%	86%	87%
Milk Sold per Total Cows	23,690	23,161	22,494	23,326	22,603	21,581	22,882
Milk Sold per Milking Cow	27,056	26,695	25,982	26,901	25,885	25,113	26,349
Average Lbs Milk per Day	74	73	71	74	71	69	72
Average Milk Price Planned	$ 17.13	$ 17.28	$ 17.39	$ 17.50	$ 17.67	$ 17.97	$ 17.43
Milk Inflow	**$ 4,062**	**$ 4,001**	**$ 3,916**	**$ 4,080**	**$ 3,994**	**$ 3,877**	**$ 3,987**
Cull Cow Sales	$ 247	$ 240	$ 240	$ 260	$ 234	$ 232	$ 242
Bull Calf Sales	$ 113	$ 65	$ 93	$ 73	$ 70	$ 94	$ 85
Misc. Dairy Sales	$ 39	$ 44	$ 55	$ 12	$ 22	$ 109	$ 48
Total Inflow	**$ 4,461**	**$ 4,350**	**$ 4,305**	**$ 4,425**	**$ 4,320**	**$ 4,311**	**$ 4,361**
Milking Cow Home Raised Feeds	$ 237	$ 592	$ 640	$ 897	$ 929	$ 919	$ 642
Milking Cow Purchased Concentrates	$ 981	$ 943	$ 1,039	$ 956	$ 1,000	$ 1,050	$ 991
Milking Cow Pur Forages	$ 38	$ 107	$ 66	$ 7	$ 3	$ 58	$ 58
Heifer and Dry Cow Home Raised Feed	$ 35	$ 73	$ 68	$ 141	$ 133	$ 136	$ 86
Heifer and Dry Cow Pur Concentrates	$ 285	$ 283	$ 243	$ 318	$ 262	$ 275	$ 275
Heifer and Dry Cow Pur Forages	$ 120	$ 117	$ 123	$ 41	$ 17	$ 87	$ 96
Total Feed	**$ 1,695**	**$ 2,114**	**$ 2,180**	**$ 2,359**	**$ 2,344**	**$ 2,525**	**$ 2,148**
Percent of Milk Inflow (Milking Cows)	31%	41%	45%	46%	48%	52%	42%
Home Raised Feeds	$ 272	$ 665	$ 708	$ 1,037	$ 1,061	$ 1,055	$ 728
Purchased Concentrates	$ 1,266	$ 1,226	$ 1,282	$ 1,274	$ 1,263	$ 1,325	$ 1,266
Purchased Forages	$ 158	$ 224	$ 190	$ 47	$ 20	$ 145	$ 154

104 Farms

Dairy Direct Expenses:	**< $16**	**$16-$18**	**$18-$19**	**$19-$20**	**$20-$22**	**>$22**	**Average**
Breeding and Registration	$ 76	$ 72	$ 83	$ 60	$ 82	$ 77	$ 76
Vet and Medicine	$ 103	$ 107	$ 104	$ 94	$ 146	$ 127	$ 111
bST	$ -	$ -	$ 3	$ 9	$ 13	$ -	$ 3
Supplies	$ 173	$ 143	$ 183	$ 161	$ 168	$ 195	$ 168
DHIA	$ 22	$ 24	$ 25	$ 29	$ 26	$ 25	$ 25
Contract Heifer Raising	$ 40	$ 41	$ 10	$ 29	$ 108	$ 77	$ 46
Dairy Custom Hire	$ 38	$ 44	$ 25	$ 45	$ 42	$ 58	$ 40
Milk Hauling	$ 218	$ 211	$ 216	$ 235	$ 206	$ 212	$ 215
Milk Marketing	$ 60	$ 84	$ 89	$ 44	$ 56	$ 66	$ 71
Bedding	$ 59	$ 54	$ 71	$ 89	$ 70	$ 127	$ 73
Dairy Expenses per Cow	**$ 789**	**$ 780**	**$ 808**	**$ 797**	**$ 916**	**$ 964**	**$ 828**

Overhead Expenses:	**< $16**	**$16-$18**	**$18-$19**	**$19-$20**	**$20-$22**	**>$22**	**Average**
Fuel and Oil	$ 103	$ 106	$ 124	$ 83	$ 138	$ 107	$ 111
Repairs	$ 126	$ 126	$ 154	$ 201	$ 209	$ 182	$ 155
Hired Labor, Witholding	$ 185	$ 139	$ 107	$ 179	$ 301	$ 327	$ 187
Machinery Leases	$ 3	$ 27	$ 29	$ 6	$ 12	$ 12	$ 17
Building Leases	$ 96	$ 91	$ 55	$ 74	$ 55	$ 16	$ 70
Real Estate Taxes	$ 60	$ 52	$ 54	$ 62	$ 46	$ 96	$ 60
Farm Insurance	$ 34	$ 37	$ 31	$ 34	$ 60	$ 60	$ 41
Utilities	$ 53	$ 64	$ 69	$ 73	$ 92	$ 97	$ 71
Risk Mgt. and Advertizing	$ 5	$ 6	$ 7	$ 4	$ 4	$ 4	$ 5
Dues and Professional Fees	$ 11	$ 9	$ 16	$ 21	$ 18	$ 19	$ 14
Miscellaneous	$ 34	$ 31	$ 67	$ 36	$ 52	$ 46	$ 44
Overhead Expenses per Cow:	**$ 711**	**$ 688**	**$ 714**	**$ 774**	**$ 989**	**$ 966**	**$ 775**
Owner Draw per Cow	$ 218	$ 286	$ 326	$ 333	$ 254	$ 408	$ 297
Loan Payments per Cow	$ 498	$ 489	$ 525	$ 638	$ 540	$ 785	$ 555
Total Outflow per Cow	**$ 3,912**	**$ 4,358**	**$ 4,552**	**$ 4,901**	**$ 5,044**	**$ 5,649**	**$ 4,604**
Gross Milk Price Farm Breakeven	$ 14.67	$ 17.27	$ 18.48	$ 19.44	$ 20.89	$ 24.03	$ 18.48
IOFC Breakeven	$ 6.96	$ 7.44	$ 7.62	$ 8.46	$ 8.73	$ 10.09	$ 7.96
Gross Margin to Guarantee	$ 9.38	$ 10.16	$ 10.71	$ 11.49	$ 12.28	$ 14.66	$ 11.06
Total Inflow - Total Outflow	**$ 549**	**$ (8)**	**$ (247)**	**$ (476)**	**$ (724)**	**$ (1,337)**	**$ (243)**

104 Farms

Breakeven Milk Price

Dairy Enterprise per Cow:	**< $16**	**$16-$18**	**$18-$19**	**$19-$20**	**$20-$22**	**>$22**	**Average**
Milk Sold per Total Cows	23,690	23,161	22,494	23,326	22,603	21,581	22,882
Total Milk Inflow	$ 4,062	$ 4,001	$ 3,916	$ 4,080	$ 3,994	$ 3,877	$ 3,987
Total Dairy Non-Milk Inflow	$ 399	$ 349	$ 388	$ 345	$ 326	$ 435	$ 374
Total Inflow	**$ 4,461**	**$ 4,350**	**$ 4,305**	**$ 4,425**	**$ 4,320**	**$ 4,311**	**$ 4,361**
Milking Cow Home Raised Feeds	$ 237	$ 592	$ 640	$ 897	$ 929	$ 919	$ 642
Milking Cow Purchased Concentrates	$ 981	$ 943	$ 1,039	$ 956	$ 1,000	$ 1,050	$ 991
Milking Cow Purchased Forages	$ 38	$ 107	$ 66	$ 7	$ 3	$ 58	$ 58
Heifer and Dry Cow Home Raised Feeds	$ 35	$ 73	$ 68	$ 141	$ 133	$ 136	$ 86
Heifer and Dry Cow Purchased Concentrates	$ 285	$ 283	$ 243	$ 318	$ 262	$ 275	$ 275
Heifer and Dry Cow Purchased Forages	$ 120	$ 117	$ 123	$ 41	$ 17	$ 87	$ 96
Total Feed	**$ 1,695**	**$ 2,114**	**$ 2,180**	**$ 2,359**	**$ 2,344**	**$ 2,525**	**$ 2,148**
Dairy Expenses	$ 789	$ 780	$ 808	$ 797	$ 916	$ 964	$ 828
Overhead Expenses	$ 711	$ 688	$ 714	$ 774	$ 989	$ 966	$ 775
Owner Draw	$ 218	$ 286	$ 326	$ 333	$ 254	$ 408	$ 297
Loan Payments	$ 498	$ 489	$ 525	$ 638	$ 540	$ 785	$ 555
Expenses Other than Feed	**$ 2,216**	**$ 2,244**	**$ 2,372**	**$ 2,542**	**$ 2,700**	**$ 3,123**	**$ 2,456**
Total Outflow	**$ 3,912**	**$ 4,358**	**$ 4,552**	**$ 4,901**	**$ 5,044**	**$ 5,649**	**$ 4,604**
Gross Milk Price Breakeven per CWT.	$ 14.67	$ 17.27	$ 18.48	$ 19.44	$ 20.89	$ 24.03	$ 18.48
IOFC Breakeven (per Cow per day)	$ 6.96	$ 7.44	$ 7.62	$ 8.46	$ 8.73	$ 10.09	$ 7.96
Gross Margin to Guarantee per CWT.	$ 9.38	$ 10.16	$ 10.71	$ 11.49	$ 12.28	$ 14.66	$ 11.06
Total Inflow - Total Outflow	**$ 549**	**$ (8)**	**$ (247)**	**$ (476)**	**$ (724)**	**$ (1,337)**	**$ (243)**

All Breeds	19%	27%	20%	10%	13%	12%	
			Breakeven Milk Price				
Dairy Summary per CWT:	**< $16**	**$16-$18**	**$18-$19**	**$19-$20**	**$20-$22**	**>$22**	**Average**
Total Number of Cows	177	118	109	121	272	81	143
Number of Cows Milking	157	103	94	106	239	69	125
Percent in Milk	88%	87%	87%	87%	87%	86%	87%
Milk Sold per Total Cows	23,690	23,161	22,494	23,326	23,075	21,635	22,957
Milk Sold per Milking Cow	27,056	26,695	25,982	26,901	26,406	25,142	26,425
Average Lbs Milk per Day	74	73	71	74	72	69	72
Average Milk Price Planned	$ 17.13	$ 17.28	$ 17.39	$ 17.50	$ 17.65	$ 17.18	$ 17.33
Milk Inflow	$ 17.13	$ 17.28	$ 17.39	$ 17.50	$ 17.65	$ 17.18	$ 17.33
Cull Cow Sales	$ 1.03	$ 1.03	$ 1.06	$ 1.13	$ 1.02	$ 1.07	$ 1.05
Bull Calf Sales	$ 0.48	$ 0.28	$ 0.41	$ 0.32	$ 0.30	$ 0.47	$ 0.37
Misc. Dairy Sales	$ 0.16	$ 0.21	$ 0.25	$ 0.05	$ 0.09	$ 0.49	$ 0.21
Total Inflow	**$ 18.81**	**$ 18.79**	**$ 19.11**	**$ 18.99**	**$ 19.07**	**$ 19.21**	**$ 18.96**
Milking Cow Home Raised Feeds	$ 1.01	$ 2.55	$ 2.81	$ 3.83	$ 4.29	$ 4.00	$ 2.81
Milking Cow Pur Concentrates	$ 4.12	$ 4.08	$ 4.65	$ 4.10	$ 4.25	$ 4.76	$ 4.30
Milking Cow Pur Forages	$ 0.16	$ 0.48	$ 0.31	$ 0.03	$ 0.01	$ 0.30	$ 0.26
Heifer and Dry Cow Home Raised Feed	$ 0.15	$ 0.31	$ 0.30	$ 0.61	$ 0.56	$ 0.58	$ 0.37
Heifer and Dry Cow Pur Concentrates	$ 1.22	$ 1.23	$ 1.09	$ 1.37	$ 1.17	$ 1.38	$ 1.22
Heifer and Dry Cow Pur Forages	$ 0.50	$ 0.51	$ 0.57	$ 0.18	$ 0.10	$ 0.42	$ 0.43
Total Feed	**$ 7.16**	**$ 9.17**	**$ 9.73**	**$ 10.11**	**$ 10.39**	**$ 11.45**	**$ 9.40**
Home Raised Feeds	$ 1.16	$ 2.86	$ 3.11	$ 4.43	$ 4.86	$ 4.58	$ 3.18
Purchased Concentrates	$ 5.34	$ 5.32	$ 5.74	$ 5.47	$ 5.41	$ 6.15	$ 5.53
Purchased Forages	$ 0.66	$ 0.99	$ 0.88	$ 0.20	$ 0.12	$ 0.72	$ 0.69

Dairy Direct Expenses:	**< $16**	**$16-$18**	**$18-$19**	**$19-$20**	**$20-$22**	**>$22**	**Average**
Breeding and Registration	$ 0.32	$ 0.31	$ 0.36	$ 0.26	$ 0.38	$ 0.35	$ 0.33
Vet and Medicine	$ 0.44	$ 0.46	$ 0.46	$ 0.40	$ 0.63	$ 0.58	$ 0.49
bST	$ -	$ -	$ 0.01	$ 0.04	$ 0.05	$ -	$ 0.01
Supplies	$ 0.74	$ 0.61	$ 0.82	$ 0.70	$ 0.75	$ 0.97	$ 0.75
DHIA	$ 0.09	$ 0.10	$ 0.11	$ 0.13	$ 0.11	$ 0.12	$ 0.11
Contract Heifer Raising	$ 0.17	$ 0.18	$ 0.04	$ 0.12	$ 0.42	$ 0.41	$ 0.20
Dairy Custom Hire	$ 0.15	$ 0.18	$ 0.11	$ 0.19	$ 0.19	$ 0.25	$ 0.17
Milk Hauling	$ 0.93	$ 0.92	$ 0.96	$ 1.01	$ 0.89	$ 1.09	$ 0.95
Milk Marketing	$ 0.26	$ 0.37	$ 0.40	$ 0.19	$ 0.24	$ 0.33	$ 0.32
Bedding	$ 0.25	$ 0.23	$ 0.31	$ 0.37	$ 0.30	$ 0.55	$ 0.31
Dairy Expenses per CWT.	**$ 3.36**	**$ 3.36**	**$ 3.58**	**$ 3.40**	**$ 3.95**	**$ 4.66**	**$ 3.63**

Overhead Expenses:	**< $16**	**$16-$18**	**$18-$19**	**$19-$20**	**$20-$22**	**>$22**	**Average**
Fuel and Oil	$ 0.44	$ 0.46	$ 0.57	$ 0.37	$ 0.61	$ 0.50	$ 0.49
Repairs	$ 0.52	$ 0.54	$ 0.68	$ 0.87	$ 0.92	$ 0.87	$ 0.68
Hired Labor, Witholding	$ 0.73	$ 0.57	$ 0.46	$ 0.74	$ 1.34	$ 0.94	$ 0.73
Machinery Leases	$ 0.01	$ 0.11	$ 0.13	$ 0.03	$ 0.05	$ 0.07	$ 0.07
Building Leases	$ 0.38	$ 0.39	$ 0.24	$ 0.30	$ 0.30	$ 0.05	$ 0.30
Real Estate Taxes	$ 0.26	$ 0.22	$ 0.24	$ 0.28	$ 0.19	$ 0.49	$ 0.27
Farm Insurance	$ 0.14	$ 0.16	$ 0.15	$ 0.14	$ 0.30	$ 0.25	$ 0.18
Utilities	$ 0.22	$ 0.28	$ 0.30	$ 0.31	$ 0.42	$ 0.41	$ 0.31
Risk Mgt. and Advertizing	$ 0.02	$ 0.02	$ 0.03	$ 0.02	$ 0.02	$ 0.02	$ 0.02
Dues and Professional Fees	$ 0.05	$ 0.04	$ 0.07	$ 0.09	$ 0.08	$ 0.07	$ 0.06
Miscellaneous	$ 0.15	$ 0.13	$ 0.31	$ 0.16	$ 0.22	$ 0.21	$ 0.19
Overhead Expenses per CWT.	**$ 2.91**	**$ 2.92**	**$ 3.18**	**$ 3.30**	**$ 4.43**	**$ 3.89**	**$ 3.31**
Owner Draw per CWT.	$ 0.94	$ 1.23	$ 1.44	$ 1.45	$ 1.16	$ 2.13	$ 1.33
Loan Payments per CWT.	$ 2.12	$ 2.14	$ 2.30	$ 2.76	$ 2.37	$ 3.74	$ 2.44
Total Outflow per CWT.	**$ 16.49**	**$ 18.83**	**$ 20.22**	**$ 21.02**	**$ 22.31**	**$ 25.87**	**$ 20.12**
Gross Milk Price Farm Breakeven	$ 14.67	$ 17.27	$ 18.48	$ 19.44	$ 20.89	$ 23.74	$ 18.42
IOFC Breakeven	$ 6.96	$ 7.44	$ 7.62	$ 8.46	$ 8.96	$ 10.11	$ 7.98
Gross Margin to Guarantee	$ 9.38	$ 10.16	$ 10.71	$ 11.49	$ 12.33	$ 14.68	$ 11.04
Total Inflow - Total Outflow	**$ 2.32**	**$ (0.03)**	**$ (1.11)**	**$ (2.03)**	**$ (3.24)**	**$ (6.66)**	**$ (1.16)**

Breakeven Milk Price

Dairy Enterprise per CWT.	< $16	$16-$18	$18-$19	$19-$20	$20-$22	>$22	Average
Milk Sold per Total Cows	23,690	23,161	22,494	23,326	23,075	21,635	22,957
Total Milk Inflow	$ 17.13	$ 17.28	$ 17.39	$ 17.50	$ 17.65	$ 17.18	$ 17.33
Total Dairy Non-Milk Inflow	$ 1.68	$ 1.52	$ 1.72	$ 1.49	$ 1.42	$ 2.03	$ 1.63
Total Inflow	**$ 18.81**	**$ 18.79**	**$ 19.11**	**$ 18.99**	**$ 19.07**	**$ 19.21**	**$ 18.96**
Milking Cow Home Raised Feeds	$ 1.01	$ 2.55	$ 2.81	$ 3.83	$ 4.29	$ 4.00	$ 2.81
Milking Cow Purchased Concentrates	$ 4.12	$ 4.08	$ 4.65	$ 4.10	$ 4.25	$ 4.76	$ 4.30
Milking Cow Purchased Forages	$ 0.16	$ 0.48	$ 0.31	$ 0.03	$ 0.01	$ 0.30	$ 0.26
Heifer and Dry Cow Home Raised Feeds	$ 0.15	$ 0.31	$ 0.30	$ 0.61	$ 0.56	$ 0.58	$ 0.37
Heifer and Dry Cow Purchased Concentrates	$ 1.22	$ 1.23	$ 1.09	$ 1.37	$ 1.17	$ 1.38	$ 1.22
Heifer and Dry Cow Purchased Forages	$ 0.50	$ 0.51	$ 0.57	$ 0.18	$ 0.10	$ 0.42	$ 0.43
Total Feed	**$ 7.16**	**$ 9.17**	**$ 9.73**	**$ 10.11**	**$ 10.39**	**$ 11.45**	**$ 9.40**
Dairy Expenses	$ 3.36	$ 3.36	$ 3.58	$ 3.40	$ 3.95	$ 4.66	$ 3.63
Overhead Expenses	$ 2.91	$ 2.92	$ 3.18	$ 3.30	$ 4.43	$ 3.89	$ 3.31
Owner Draw	$ 0.94	$ 1.23	$ 1.44	$ 1.45	$ 1.16	$ 2.13	$ 1.33
Loan Payments	$ 2.12	$ 2.14	$ 2.30	$ 2.76	$ 2.37	$ 3.74	$ 2.44
Expenses Other than Feed	**$ 9.33**	**$ 9.66**	**$ 10.49**	**$ 10.91**	**$ 11.92**	**$ 14.42**	**$ 10.72**
Total Outflow	**$ 16.49**	**$ 18.83**	**$ 20.22**	**$ 21.02**	**$ 22.31**	**$ 25.87**	**$ 20.12**
Gross Milk Price Breakeven per CWT.	$ 14.67	$ 17.27	$ 18.48	$ 19.44	$ 20.89	$ 23.74	$ 18.42
IOFC Breakeven (per Cow per day)	$ 6.96	$ 7.44	$ 7.62	$ 8.46	$ 8.96	$ 10.11	$ 7.98
Gross Margin to Guarantee per CWT.	$ 9.38	$ 10.16	$ 10.71	$ 11.49	$ 12.33	$ 14.68	$ 11.04
Total Inflow - Total Outflow	**$ 2.32**	**$ (0.03)**	**$ (1.11)**	**$ (2.03)**	**$ (3.24)**	**$ (6.66)**	**$ (1.79)**

PennState Extension

Dairy Enterprise
Summary per Cow
by Farm Size
2016 Plans
8/16/2016

All Breeds by Farm Size	17%	30%	13%	22%	9%	10%	100%
	Farm Size Grouping						
Dairy Enterprise per Cow by Farm Size:	**30-50**	**52-70**	**71-100**	**105-176**	**180-289**	**>290**	**Average**
Total Number of Cows	45	59	80	137	234	592	143
Number of Cows Milking	39	51	69	120	207	523	125
Percent in Milk	87%	86%	85%	87%	88%	88%	87%
Milk Sold per Total Cows	21,994	22,508	22,798	23,453	22,675	25,403	22,957
Milk Sold per Milking Cow	25,201	26,135	26,645	26,899	25,631	28,865	26,425
Average Lbs Milk per Day	69	72	73	74	70	79	72
Average Milk Price Planned	$ 17.57	$ 17.16	$ 17.29	$ 17.36	$ 17.48	$ 17.26	$ 17.33
Milk Inflow	$ 3,872	$ 3,863	$ 3,949	$ 4,072	$ 3,962	$ 4,384	$ 3,980
Cull Cow Sales	$ 237	$ 234	$ 235	$ 245	$ 191	$ 322	$ 242
Bull Calf Sales	$ 106	$ 96	$ 69	$ 76	$ 65	$ 71	$ 85
Misc. Dairy Sales	$ 64	$ 74	$ 21	$ 41	$ 20	$ 8	$ 48
Total Inflow	**$ 4,279**	**$ 4,268**	**$ 4,275**	**$ 4,434**	**$ 4,238**	**$ 4,784**	**$ 4,354**
Milking Cow Home Raised Feeds	$ 544	$ 597	$ 614	$ 771	$ 768	$ 630	$ 646
Milking Cow Pur Concentrates	$ 1,009	$ 940	$ 995	$ 967	$ 914	$ 1,150	$ 983
Milking Cow Pur Forages	$ 34	$ 54	$ 143	$ 67	$ 6	$ 25	$ 58
Heifer and Dry Cow Home Raised Feed	$ 75	$ 72	$ 66	$ 84	$ 139	$ 121	$ 85
Heifer and Dry Cow Pur Concentrates	$ 293	$ 307	$ 271	$ 229	$ 304	$ 259	$ 278
Heifer and Dry Cow Pur Forages	$ 136	$ 132	$ 125	$ 47	$ 23	$ 68	$ 97
Total Feed	$ 2,091	$ 2,102	$ 2,214	$ 2,166	$ 2,153	$ 2,253	$ 2,147
Percent of Milk Inflow	41%	41%	44%	44%	43%	41%	42%

104 Farms

Dairy Direct Expenses:	**30-50**	**52-70**	**71-100**	**105-176**	**180-289**	**>290**	**Average**
Breeding and Registration	$ 59	$ 89	$ 76	$ 78	$ 82	$ 63	$ 77
Vet and Medicine	$ 93	$ 112	$ 107	$ 111	$ 131	$ 131	$ 111
bST	$ 8	$ 3	$ -	$ -	$ -	$ 8	$ 3
Supplies	$ 212	$ 194	$ 149	$ 156	$ 112	$ 112	$ 168
DHIA	$ 21	$ 27	$ 28	$ 26	$ 21	$ 22	$ 25
Contract Heifer Raising	$ 53	$ 51	$ 49	$ 17	$ 12	$ 109	$ 46
Dairy Custom Hire	$ 18	$ 27	$ 17	$ 61	$ 81	$ 70	$ 40
Milk Hauling	$ 235	$ 233	$ 211	$ 198	$ 202	$ 198	$ 217
Milk Marketing	$ 66	$ 87	$ 79	$ 57	$ 62	$ 65	$ 71
Bedding	$ 44	$ 61	$ 84	$ 73	$ 150	$ 70	$ 72
Dairy Expenses per Cow	**$ 809**	**$ 884**	**$ 799**	**$ 777**	**$ 854**	**$ 848**	**$ 830**

Overhead Expenses:	**30-50**	**52-70**	**71-100**	**105-176**	**180-289**	**>290**	**Average**
Fuel and Oil	$ 164	$ 111	$ 138	$ 70	$ 100	$ 83	$ 111
Repairs	$ 121	$ 160	$ 137	$ 160	$ 192	$ 194	$ 157
Hired Labor, Witholding	$ 32	$ 65	$ 87	$ 268	$ 388	$ 512	$ 178
Machinery Leases	$ 8	$ 14	$ 8	$ 19	$ 3	$ 64	$ 17
Building Leases	$ 96	$ 49	$ 61	$ 60	$ 99	$ 110	$ 71
Real Estate Taxes	$ 72	$ 81	$ 55	$ 40	$ 37	$ 43	$ 60
Farm Insurance	$ 8	$ 22	$ 40	$ 77	$ 71	$ 59	$ 42
Utilities	$ 15	$ 50	$ 73	$ 118	$ 90	$ 118	$ 72
Risk Mgt. and Advertizing	$ -	$ 5	$ 1	$ 7	$ 4	$ 21	$ 5
Dues and Professional Fees	$ 11	$ 10	$ 9	$ 19	$ 14	$ 23	$ 14
Miscellaneous	$ 65	$ 53	$ 32	$ 36	$ 24	$ 28	$ 44
Overhead Expenses per Cow	**$ 592**	**$ 622**	**$ 640**	**$ 873**	**$ 1,022**	**$ 1,256**	**$ 770**
Owner Draw per Cow	$ 387	$ 369	$ 304	$ 253	$ 181	$ 152	$ 301
Loan Payments per Cow	$ 627	$ 562	$ 599	$ 563	$ 397	$ 500	$ 558
Total Outflow per Cow	**$ 4,506**	**$ 4,538**	**$ 4,556**	**$ 4,632**	**$ 4,607**	**$ 5,009**	**$ 4,607**

	30-50	**52-70**	**71-100**	**105-176**	**180-289**	**>290**	**Average**
Gross Milk Price Farm Breakeven	$ 18.72	$ 18.31	$ 18.52	$ 18.19	$ 19.18	$ 17.96	$ 18.42
IOFC Breakeven	$ 7.85	$ 8.04	$ 7.88	$ 7.73	$ 8.19	$ 8.55	$ 7.98
Gross Margin to Guarantee	$ 11.48	$ 11.24	$ 10.78	$ 10.43	$ 11.66	$ 10.84	$ 11.04
Total Inflow - Total Outflow	**$ (227)**	**$ (270)**	**$ (281)**	**$ (199)**	**$ (369)**	**$ (225)**	**$ (252)**

104 Farms

Dairy Enterprise
Summary per Cow
by Farm Size
2016 Plans
8/16/2016

Breakeven Milk Price

Dairy Enterprise per Cow:	**30-50**	**52-70**	**71-100**	**105-176**	**180-289**	**>290**	**Average**
Milk Sold per Total Cows	21,994	22,508	22,798	23,453	22,675	25,403	22,957
Total Milk Inflow	$ 3,872	$ 3,863	$ 3,949	$ 4,072	$ 3,962	$ 4,384	3,980
Total Dairy Non-Milk Inflow	$ 408	$ 405	$ 325	$ 362	$ 276	$ 401	$ 375
Total Inflow	**$ 4,279**	**$ 4,268**	**$ 4,275**	**$ 4,434**	**$ 4,238**	**$ 4,784**	**4,354**
Milking Cow Home Raised Feeds	$ 544	$ 597	$ 614	$ 771	$ 768	$ 630	$ 646
Milking Cow Purchased Concentrates	$ 1,009	$ 940	$ 995	$ 967	$ 914	$ 1,150	$ 983
Milking Cow Purchased Forages	$ 34	$ 54	$ 143	$ 67	$ 6	$ 25	$ 58
Heifer and Dry Cow Home Raised Feeds	$ 75	$ 72	$ 66	$ 84	$ 139	$ 121	$ 85
Heifer and Dry Cow Purchased Concentrates	$ 293	$ 307	$ 271	$ 229	$ 304	$ 259	$ 278
Heifer and Dry Cow Purchased Forages	$ 136	$ 132	$ 125	$ 47	$ 23	$ 68	$ 97
Total Feed	**$ 2,091**	**$ 2,102**	**$ 2,214**	**$ 2,166**	**$ 2,153**	**$ 2,253**	**$ 2,147**
Dairy Expenses	$ 809	$ 884	$ 799	$ 777	$ 854	$ 848	$ 830
Overhead Expenses	$ 592	$ 622	$ 640	$ 873	$ 1,022	$ 1,256	$ 770
Owner Draw	$ 387	$ 369	$ 304	$ 253	$ 181	$ 152	$ 301
Loan Payments	$ 627	$ 562	$ 599	$ 563	$ 397	$ 500	$ 558
Expenses Other than Feed	**$ 2,415**	**$ 2,436**	**$ 2,342**	**$ 2,467**	**$ 2,454**	**$ 2,756**	**$ 2,460**
Total Outflow	**$ 4,506**	**$ 4,538**	**$ 4,556**	**$ 4,632**	**$ 4,607**	**$ 5,009**	**$ 4,607**
Gross Milk Price Breakeven per CWT.	**$ 18.72**	**$ 18.31**	**$ 18.52**	**$ 18.19**	**$ 19.18**	**$ 17.96**	$ 18.42
IOFC Breakeven (per Cow per day)	$ 7.85	$ 8.04	$ 7.88	$ 7.73	$ 8.19	$ 8.55	$ 7.98
Gross Margin to Guarantee per CWT.	$ 11.48	$ 11.24	$ 10.78	$ 10.43	$ 11.66	$ 10.84	$ 11.04
Total Inflow - Total Outflow	**$ (227)**	**$ (270)**	**$ (281)**	**$ (199)**	**$ (369)**	**$ (225)**	**$ (252)**

104 Farms

8/16/2016

	26%	36%	14%	15%	4%	5%	
			Breakeven Milk Price				
Whole Farm per Cow:	**< $16**	**$16-$18**	**$18-$19**	**$19-$20**	**$20-$22**	**>$22**	**Average**
Total Number of Cows	135	129	102	238	144	102	143
Number of Cows Milking	119	113	90	209	125	89	125
Percent in Milk	87%	87%	87%	87%	88%	88%	87%
Milk Sold per Total Cows	22,555	23,326	22,315	23,311	23,856	22,470	22,957
Milk Sold per Milking Cow	26,066	26,879	25,559	26,886	27,147	25,550	26,425
Average Lbs Milk per Day	71	74	70	74	74	70	72
Average Milk Price Planned	$ 17.07	$ 17.33	$ 17.50	$ 17.59	$ 17.63	$ 17.13	$ 17.33
Milk Inflow	$ 3,851	$ 4,044	$ 3,907	$ 4,105	$ 4,194	$ 3,849	$ 3,980
Patronage Dividends	$ 6	$ 11	$ 19	$ 19	$ 39	$ 57	$ 15
Cull Cow Sales	$ 232	$ 246	$ 241	$ 258	$ 230	$ 226	$ 242
Bull Calf Sales	$ 100	$ 75	$ 95	$ 80	$ 59	$ 83	$ 85
Misc. Dairy Sales	$ 58	$ 24	$ 63	$ 33	$ 19	$ 191	$ 48
Govt. Payments	$ -	$ 1	$ 11	$ -	$ -	$ -	$ 2
Other Govt. Payments	$ 2	$ 10	$ 4	$ 12	$ 15	$ -	$ 7
Crop Sales	$ 278	$ 74	$ 137	$ 282	$ 2	$ 149	$ 169
Custom Work Income	$ 20	$ 18	$ 2	$ 52	$ 29	$ 6	$ 21
Other Farm Income	$ 375	$ 146	$ 72	$ 394	$ 74	$ 29	$ 224
Non Milk Inflow (Subtotal)	$ 1,070	$ 604	$ 644	$ 1,132	$ 467	$ 742	$ 813
Total Inflow	**$ 4,921**	**$ 4,648**	**$ 4,551**	**$ 5,236**	**$ 4,661**	**$ 4,590**	**$ 4,793**

Direct Crop Expenses and Purchased Feed:	**< $16**	**$16-$18**	**$18-$19**	**$19-$20**	**$20-$22**	**>$22**	**Average**
Seed	$ 116	$ 120	$ 157	$ 202	$ 166	$ 207	$ 143
Fertilizer	$ 117	$ 105	$ 171	$ 111	$ 126	$ 151	$ 122
Chemical	$ 32	$ 48	$ 45	$ 62	$ 90	$ 107	$ 50
Custom Hire	$ 131	$ 127	$ 108	$ 115	$ 258	$ 194	$ 132
Land rent	$ 106	$ 107	$ 94	$ 136	$ 144	$ 78	$ 109
Milking Cow Pur Concentrates	$ 964	$ 999	$ 938	$ 1,024	$ 960	$ 981	$ 983
Milking Cow Pur Forages	$ 70	$ 82	$ 41	$ 28	$ -	$ -	$ 58
Heifer and Dry Cow Pur Concentrates	$ 275	$ 286	$ 235	$ 314	$ 242	$ 282	$ 278
Heifer and Dry Cow Pur Forages	$ 125	$ 110	$ 88	$ 77	$ 32	$ 2	$ 97
Total Feed and Direct Crop Expenses	**$ 1,936**	**$ 1,984**	**$ 1,879**	**$ 2,070**	**$ 2,018**	**$ 2,002**	**$ 1,972**

104 Farms

Dairy Direct Expenses:	**< $16**	**$16-$18**	**$18-$19**	**$19-$20**	**$20-$22**	**>$22**	**Average**
Breeding and Registration	$ 82	$ 68	$ 81	$ 77	$ 97	$ 80	$ 77
Vet and Medicine	$ 100	$ 108	$ 102	$ 126	$ 160	$ 159	$ 112
bST	$ -	$ -	$ 4	$ 16	$ -	$ -	$ 3
Supplies	$ 161	$ 169	$ 200	$ 156	$ 163	$ 166	$ 169
DHIA	$ 21	$ 26	$ 25	$ 25	$ 30	$ 34	$ 25
Contract Heifer Raising	$ 30	$ 41	$ 29	$ 122	$ -	$ 10	$ 46
Dairy Custom Hire	$ 22	$ 43	$ 41	$ 48	$ 62	$ 73	$ 40
Milk Hauling	$ 229	$ 209	$ 209	$ 216	$ 222	$ 234	$ 217
Milk Marketing	$ 76	$ 71	$ 84	$ 53	$ 48	$ 87	$ 71
Bedding	$ 51	$ 63	$ 86	$ 78	$ 135	$ 146	$ 72
Dairy Expenses per Cow	**$ 772**	**$ 799**	**$ 859**	**$ 916**	**$ 915**	**$ 989**	**$ 832**

Overhead Expenses:	**< $16**	**$16-$18**	**$18-$19**	**$19-$20**	**$20-$22**	**>$22**	**Average**
Fuel and Oil	$ 130	$ 138	$ 156	$ 161	$ 141	$ 148	$ 143
Repairs	$ 164	$ 177	$ 187	$ 234	$ 413	$ 262	$ 197
Hired Labor, Witholding	$ 134	$ 179	$ 189	$ 374	$ 565	$ 274	$ 218
Machinery Leases	$ 12	$ 35	$ 49	$ 25	$ -	$ 37	$ 28
Building Leases	$ 67	$ 99	$ 75	$ 58	$ 58	$ 70	$ 78
Real Estate Taxes	$ 88	$ 49	$ 82	$ 75	$ 56	$ 137	$ 72
Farm Insurance	$ 25	$ 51	$ 33	$ 62	$ 147	$ 111	$ 50
Utilities	$ 58	$ 81	$ 67	$ 112	$ 178	$ 175	$ 86
Risk Mgt. and Advertizing	$ 1	$ 11	$ 1	$ 5	$ 6	$ 14	$ 6
Dues and Professional Fees	$ 15	$ 11	$ 19	$ 23	$ 34	$ 15	$ 16
Miscellaneous	$ 60	$ 51	$ 65	$ 80	$ 53	$ 51	$ 60
Overhead Expenses per Cow	**$ 754**	**$ 882**	**$ 923**	**$ 1,210**	**$ 1,650**	**$ 1,295**	**$ 955**
Owner Draw per Cow	$ 284	$ 353	$ 426	$ 377	$ 267	$ 605	$ 358
Loan Payments per Cow	$ 614	$ 590	$ 660	$ 926	$ 524	$ 1,181	$ 684
Total Outflow per Cow	**$ 4,360**	**$ 4,608**	**$ 4,748**	**$ 5,498**	**$ 5,375**	**$ 6,071**	**$ 4,801**

	< $16	**$16-$18**	**$18-$19**	**$19-$20**	**$20-$22**	**>$22**	**Average**
Gross Milk Price Farm Breakeven	$ 14.62	$ 17.11	$ 18.38	$ 19.46	$ 20.62	$ 23.94	$ 17.47
IOFC Breakeven	$ 5.56	$ 7.47	$ 7.75	$ 8.24	$ 8.60	$ 10.45	$ 7.32
Gross Margin to Guarantee	$ 7.78	$ 10.09	$ 11.08	$ 11.21	$ 11.44	$ 14.89	$ 10.09
Total Inflow - Total Outflow	**$ 561**	**$ 40**	**$ (196)**	**$ (262)**	**$ (714)**	**$ (1,480)**	**$ (7)**

Whole Farm per Cow:	< $16	$16-$18	$18-$19	$19-$20	$20-$22	>$22	Average
	Breakeven Milk Price						
Milk Sold per Total Cows	22,555	23,326	22,315	23,311	23,856	22,470	22,957
Total Milk Inflow	$ 3,851	$ 4,044	$ 3,907	$ 4,105	$ 4,194	$ 3,849	$ 3,980
Total Dairy and Crop Non-Milk Inflow	$ 1,070	$ 604	$ 644	$ 1,132	$ 467	$ 742	$ 813
Total Inflow	**$ 4,921**	**$ 4,648**	**$ 4,551**	**$ 5,236**	**$ 4,661**	**$ 4,590**	**$ 4,793**
Crop Direct Expenses	$ 502	$ 507	$ 576	$ 627	$ 784	$ 737	$ 556
Milking Cow Purchased Concentrates	$ 964	$ 999	$ 938	$ 1,024	$ 960	$ 981	$ 983
Milking Cow Purchased Forages	$ 70	$ 82	$ 41	$ 28	$ -	$ -	$ 58
Heifer and Dry Cow Purchased Concentrates	$ 275	$ 286	$ 235	$ 314	$ 242	$ 282	$ 278
Heifer and Dry Cow Purchased Forages	$ 125	$ 110	$ 88	$ 77	$ 32	$ 2	$ 97
Total Feed and Crop	**$ 1,936**	**$ 1,984**	**$ 1,879**	**$ 2,070**	**$ 2,018**	**$ 2,002**	**$ 1,972**
Dairy Expenses	$ 772	$ 799	$ 859	$ 916	$ 915	$ 989	$ 832
Overhead Expenses	$ 754	$ 882	$ 923	$ 1,210	$ 1,650	$ 1,295	$ 955
Owner Draw	$ 284	$ 353	$ 426	$ 377	$ 267	$ 605	$ 358
Loan Payments	$ 614	$ 590	$ 660	$ 926	$ 524	$ 1,181	$ 684
Expenses Other than Feed	**$ 2,424**	**$ 2,625**	**$ 2,868**	**$ 3,428**	**$ 3,357**	**$ 4,069**	**$ 2,829**
Total Outflow	**$ 4,360**	**$ 4,608**	**$ 4,748**	**$ 5,498**	**$ 5,375**	**$ 6,071**	**$ 4,801**
Gross Milk Price Breakeven per CWT.	$ 14.62	$ 17.11	$ 18.38	$ 19.46	$ 20.62	$ 23.94	$ 17.47
IOFC Breakeven (per Cow per day)	$ 5.56	$ 7.47	$ 7.75	$ 8.24	$ 8.60	$ 10.45	$ 7.32
Gross Margin to Guarantee per CWT.	$ 7.78	$ 10.09	$ 11.08	$ 11.21	$ 11.44	$ 14.89	$ 10.09
Total Inflow - Total Outflow	**$ 561**	**$ 40**	**$ (196)**	**$ (262)**	**$ (714)**	**$ (1,480)**	**$ (7)**

Whole Farm per CWT:	26%	36%	14%	15%	4%	5%	
	Breakeven Milk Price						
	< $16	$16-$18	$18-$19	$19-$20	$20-$22	>$22	Average
Total Number of Cows	135	129	102	238	144	102	143
Number of Cows Milking	119	113	90	209	125	89	125
Percent in Milk	87%	87%	87%	87%	88%	88%	87%
Milk Sold per Total Cows	22,555	23,326	22,315	23,311	23,856	22,470	22,957
Milk Sold per Milking Cow	26,066	26,879	25,559	26,886	27,147	25,550	26,425
Average Lbs Milk per Day	71	74	70	74	74	70	72
Average Milk Price Planned	$ 17.07	$ 17.33	$ 17.50	$ 17.59	$ 17.63	$ 17.13	$ 17.33
Milk Inflow	**$ 17.07**	**$ 17.33**	**$ 17.50**	**$ 17.59**	**$ 17.63**	**$ 17.13**	**$ 17.33**
Patronage Dividends	$ 0.02	$ 0.05	$ 0.08	$ 0.08	$ 0.16	$ 0.25	$ 0.07
Cull Cow Sales	$ 1.02	$ 1.05	$ 1.09	$ 1.11	$ 0.94	$ 1.00	$ 1.05
Bull Calf Sales	$ 0.44	$ 0.32	$ 0.43	$ 0.35	$ 0.25	$ 0.37	$ 0.37
Misc. Dairy Sales	$ 0.27	$ 0.10	$ 0.27	$ 0.13	$ 0.09	$ 0.82	$ 0.21
Govt Payments (MILC)	$ -	$ 0.00	$ 0.05	$ -	$ -	$ -	$ 0.01
Other Govt. Payments	$ 0.01	$ 0.05	$ 0.02	$ 0.05	$ 0.06	$ -	$ 0.03
Crop Sales	$ 1.27	$ 0.32	$ 0.74	$ 1.21	$ 0.01	$ 0.69	$ 0.77
Custom Work Income	$ 0.09	$ 0.08	$ 0.01	$ 0.20	$ 0.11	$ 0.02	$ 0.09
Other Farm Income	$ 1.69	$ 0.64	$ 0.36	$ 1.66	$ 0.29	$ 0.13	$ 0.99
Non Milk Inflow	$ 4.81	$ 2.62	$ 3.05	$ 4.79	$ 1.90	$ 3.28	$ 3.59
Total Inflow	**$ 21.88**	**$ 19.95**	**$ 20.54**	**$ 22.38**	**$ 19.53**	**$ 20.41**	**$ 20.91**

Direct Crop Expenses and Purchased Feed:	< $16	$16-$18	$18-$19	$19-$20	$20-$22	>$22	Average
Seed	$ 0.51	$ 0.51	$ 0.71	$ 0.87	$ 0.71	$ 0.93	$ 0.62
Fertilizer	$ 0.52	$ 0.45	$ 0.78	$ 0.49	$ 0.54	$ 0.67	$ 0.54
Chemical	$ 0.14	$ 0.21	$ 0.20	$ 0.26	$ 0.36	$ 0.48	$ 0.22
Custom Hire	$ 0.57	$ 0.54	$ 0.47	$ 0.49	$ 1.09	$ 0.87	$ 0.56
Land rent	$ 0.45	$ 0.46	$ 0.39	$ 0.56	$ 0.54	$ 0.34	$ 0.46
Milking Cow Pur Concentrates	$ 4.28	$ 4.32	$ 4.21	$ 4.39	$ 4.23	$ 4.35	$ 4.30
Milking Cow Pur Forages	$ 0.34	$ 0.36	$ 0.18	$ 0.12	$ -	$ -	$ 0.26
Heifer and Dry Cow Pur Concentrates	$ 1.24	$ 1.23	$ 1.08	$ 1.37	$ 1.00	$ 1.24	$ 1.22
Heifer and Dry Cow Pur Forages	$ 0.55	$ 0.48	$ 0.40	$ 0.33	$ 0.11	$ 0.01	$ 0.43
Total Feed and Direct Crop Expenses	**$ 8.61**	**$ 8.57**	**$ 8.41**	**$ 8.88**	**$ 8.57**	**$ 8.91**	**$ 8.62**

Dairy Direct Expenses:	**< $16**	**$16-$18**	**$18-$19**	**$19-$20**	**$20-$22**	**>$22**	**Average**
Breeding and Registration	$ 0.36	$ 0.29	$ 0.36	$ 0.33	$ 0.39	$ 0.35	$ 0.33
Vet and Medicine	$ 0.46	$ 0.46	$ 0.45	$ 0.54	$ 0.66	$ 0.71	$ 0.49
bST	$ -	$ -	$ 0.02	$ 0.06	$ -	$ -	$ 0.01
Supplies	$ 0.72	$ 0.74	$ 0.95	$ 0.68	$ 0.68	$ 0.73	$ 0.75
DHIA	$ 0.09	$ 0.11	$ 0.11	$ 0.11	$ 0.13	$ 0.15	$ 0.11
Contract Heifer Raising	$ 0.14	$ 0.18	$ 0.12	$ 0.52	$ -	$ 0.04	$ 0.20
Dairy Custom Hire	$ 0.09	$ 0.18	$ 0.17	$ 0.20	$ 0.26	$ 0.34	$ 0.17
Milk Hauling	$ 1.02	$ 0.90	$ 0.95	$ 0.94	$ 0.96	$ 1.04	$ 0.95
Milk Marketing	$ 0.35	$ 0.31	$ 0.38	$ 0.23	$ 0.18	$ 0.39	$ 0.32
Bedding	$ 0.22	$ 0.27	$ 0.36	$ 0.33	$ 0.59	$ 0.64	$ 0.31
Dairy Expenses per CWT.	**$ 3.45**	**$ 3.44**	**$ 3.87**	**$ 3.93**	**$ 3.85**	**$ 4.41**	**$ 3.83**

Overhead Expenses:	**< $16**	**$16-$18**	**$18-$19**	**$19-$20**	**$20-$22**	**>$22**	**Average**
Fuel and Oil	$ 0.58	$ 0.61	$ 0.72	$ 0.70	$ 0.61	$ 0.66	$ 0.63
Repairs	$ 0.73	$ 0.76	$ 0.85	$ 1.01	$ 1.72	$ 1.17	$ 0.86
Hired Labor, Witholding	$ 0.54	$ 0.73	$ 0.79	$ 1.54	$ 2.34	$ 1.23	$ 0.90
Machinery Leases	$ 0.05	$ 0.15	$ 0.21	$ 0.10	$ -	$ 0.17	$ 0.12
Building Leases	$ 0.28	$ 0.42	$ 0.33	$ 0.25	$ 0.20	$ 0.30	$ 0.33
Real Estate Taxes	$ 0.39	$ 0.21	$ 0.39	$ 0.33	$ 0.23	$ 0.61	$ 0.32
Farm Insurance	$ 0.11	$ 0.23	$ 0.14	$ 0.26	$ 0.58	$ 0.50	$ 0.22
Utilities	$ 0.26	$ 0.34	$ 0.28	$ 0.47	$ 0.72	$ 0.78	$ 0.37
Risk Mgt. and Advertizing	$ 0.01	$ 0.04	$ 0.00	$ 0.02	$ 0.02	$ 0.06	$ 0.02
Dues and Professional Fees	$ 0.07	$ 0.05	$ 0.08	$ 0.10	$ 0.15	$ 0.07	$ 0.07
Miscellaneous	$ 0.26	$ 0.23	$ 0.31	$ 0.34	$ 0.21	$ 0.23	$ 0.26
Overhead Expenses per CWT.	**$ 3.28**	**$ 3.76**	**$ 4.11**	**$ 5.11**	**$ 6.78**	**$ 5.77**	**$ 4.11**
Owner Draw per CWT.	$ 1.27	$ 1.52	$ 2.02	$ 1.64	$ 1.06	$ 2.74	$ 1.59
Loan Payments per CWT.	$ 2.80	$ 2.49	$ 2.99	$ 4.00	$ 2.26	$ 5.17	$ 2.99
Total Outflow per CWT.	**$ 19.41**	**$ 19.79**	**$ 21.41**	**$ 23.56**	**$ 22.52**	**$ 26.99**	**$ 21.14**

	< $16	**$16-$18**	**$18-$19**	**$19-$20**	**$20-$22**	**>$22**	**Average**
Gross Milk Price Farm Breakeven	$ 14.62	$ 17.11	$ 18.38	$ 19.46	$ 20.62	$ 23.94	$ 17.47
IOFC Breakeven	$ 5.56	$ 7.47	$ 7.75	$ 8.24	$ 8.60	$ 10.45	$ 7.32
Gross Margin to Guarantee	$ 7.78	$ 10.09	$ 11.08	$ 11.21	$ 11.44	$ 14.89	$ 10.09
Total Inflow - Total Outflow	**$ 2.47**	**$ 0.16**	**$ (0.87)**	**$ (1.18)**	**$ (2.99)**	**$ (6.59)**	**$ (0.22)**

	Breakeven Milk Price						
Whole Farm per CWT:	**< $16**	**$16-$18**	**$18-$19**	**$19-$20**	**$20-$22**	**>$22**	**Average**
Milk Sold per Total Cows	22,555	23,326	22,315	23,311	23,856	22,470	22,957
Total Milk Inflow	$ 17.07	$ 17.33	$ 17.50	$ 17.59	$ 17.63	$ 17.13	$ 17.33
Total Dairy and Crop Non-Milk Inflow	$ 4.81	$ 2.62	$ 3.05	$ 4.79	$ 1.90	$ 3.28	$ 3.59
Total Inflow	**$ 21.88**	**$ 19.95**	**$ 20.54**	**$ 22.38**	**$ 19.53**	**$ 20.41**	**$ 20.91**
Crop Direct Expenses	$ 2.19	$ 2.18	$ 2.55	$ 2.67	$ 3.22	$ 3.30	$ 2.40
Milking Cow Purchased Concentrates	$ 4.28	$ 4.32	$ 4.21	$ 4.39	$ 4.23	$ 4.35	$ 4.30
Milking Cow Purchased Forages	$ 0.34	$ 0.36	$ 0.18	$ 0.12	$ -	$ -	$ 0.26
Heifer and Dry Cow Purchased Concentrates	$ 1.24	$ 1.23	$ 1.08	$ 1.37	$ 1.00	$ 1.24	$ 1.22
Heifer and Dry Cow Purchased Forages	$ 0.55	$ 0.48	$ 0.40	$ 0.33	$ 0.11	$ 0.01	$ 0.43
Total Feed and Crop	**$ 8.61**	**$ 8.57**	**$ 8.41**	**$ 8.88**	**$ 8.57**	**$ 8.91**	**$ 8.62**
Dairy Expenses	$ 3.45	$ 3.44	$ 3.87	$ 3.93	$ 3.85	$ 4.41	$ 3.83
Overhead Expenses	$ 3.28	$ 3.76	$ 4.11	$ 5.11	$ 6.78	$ 5.77	$ 4.11
Owner Draw	$ 1.27	$ 1.52	$ 2.02	$ 1.64	$ 1.06	$ 2.74	$ 1.59
Loan Payments	$ 2.80	$ 2.49	$ 2.99	$ 4.00	$ 2.26	$ 5.17	$ 2.99
Expenses Other than Feed	**$ 10.80**	**$ 11.22**	**$ 13.00**	**$ 14.67**	**$ 13.95**	**$ 18.09**	**$ 12.51**
Total Outflow	**$ 19.41**	**$ 19.79**	**$ 21.41**	**$ 23.56**	**$ 22.52**	**$ 26.99**	**$ 21.14**
Gross Milk Price Breakeven per CWT.	$ 14.62	$ 17.11	$ 18.38	$ 19.46	$ 20.62	$ 23.94	$ 17.47
IOFC Breakeven (per Cow per day)	$ 5.56	$ 7.47	$ 7.75	$ 8.24	$ 8.60	$ 10.45	$ 7.32
Gross Margin to Guarantee per CWT.	$ 7.78	$ 10.09	$ 11.08	$ 11.21	$ 11.44	$ 14.89	$ 10.09
Total Inflow - Total Outflow	**$ 2.47**	**$ 0.16**	**$ (0.87)**	**$ (1.18)**	**$ (2.99)**	**$ (6.59)**	**$ (0.22)**

	17%	30%	13%	22%	9%	10%	
Whole Farm per Cow by Farm Size:	**30-50**	**52-70**	**71-100**	**105-176**	**180-289**	**>290**	**Average**
Total Number of Cows	45	59	80	137	234	592	143
Number of Cows Milking	39	51	69	120	207	523	125
Percent in Milk	87%	86%	85%	87%	88%	88%	87%
Milk Sold per Total Cows	21,994	22,508	22,798	23,453	22,675	25,403	22,957
Milk Sold per Milking Cow	25,201	26,135	26,645	26,899	25,631	28,865	26,425
Average Lbs Milk per Day	69	72	73	74	70	79	72
Average Milk Price Planned	$ 17.57	$ 17.16	$ 17.29	$ 17.36	$ 17.48	$ 17.26	$ 17.33
Milk Inflow	$ 3,872	$ 3,863	$ 3,949	$ 4,072	$ 3,962	$ 4,384	$ 3,980
Patronage Dividends	$ 11	$ 11	$ 6	$ 20	$ 29	$ 25	$ 15
Cull Cow Sales	$ 237	$ 234	$ 235	$ 245	$ 191	$ 322	$ 242
Bull Calf Sales	$ 106	$ 96	$ 69	$ 76	$ 65	$ 71	$ 85
Misc. Dairy Sales	$ 64	$ 74	$ 21	$ 41	$ 20	$ 8	$ 48
Govt. Payments	$ 9	$ -	$ -	$ 1	$ -	$ -	$ 2
Other Govt. Payments	$ 2	$ 6	$ 14	$ 10	$ 3	$ 8	$ 7
Crop Sales	$ 294	$ 238	$ 75	$ 132	$ 67	$ 28	$ 169
Custom Work Income	$ 18	$ 22	$ 20	$ 32	$ 7	$ 16	$ 21
Other Farm Income	$ 409	$ 230	$ 171	$ 178	$ 139	$ 128	$ 224
Non Milk Inflow	$ 1,150	$ 913	$ 611	$ 735	$ 521	$ 606	$ 813
Total Inflow	**$ 5,022**	**$ 4,775**	**$ 4,560**	**$ 4,807**	**$ 4,482**	**$ 4,989**	**$ 4,793**

Direct Crop Expenses and Purchased Feed:	**30-50**	**52-70**	**71-100**	**105-176**	**180-289**	**>290**	**Average**
Seed	$ 153	$ 136	$ 120	$ 158	$ 146	$ 141	$ 143
Fertilizer	$ 120	$ 130	$ 131	$ 121	$ 132	$ 78	$ 122
Chemical	$ 30	$ 42	$ 32	$ 66	$ 80	$ 68	$ 50
Custom Hire	$ 73	$ 110	$ 117	$ 180	$ 194	$ 159	$ 132
Land rent	$ 109	$ 88	$ 47	$ 171	$ 96	$ 128	$ 109
Milking Cow Pur Concentrates	$ 1,009	$ 940	$ 995	$ 967	$ 914	$ 1,150	$ 983
Milking Cow Pur Forages	$ 34	$ 54	$ 143	$ 67	$ 6	$ 25	$ 58
Heifer and Dry Cow Pur Concentrates	$ 293	$ 307	$ 271	$ 229	$ 304	$ 259	$ 278
Heifer and Dry Cow Pur Forages	$ 136	$ 132	$ 125	$ 47	$ 23	$ 68	$ 97
Total Feed and Direct Crop Expenses	$ 1,958	$ 1,939	$ 1,981	$ 2,007	$ 1,893	$ 2,076	$ 1,972

Dairy Direct Expenses:	**30-50**	**52-70**	**71-100**	**105-176**	**180-289**	**>290**	**Average**
Breeding and Registration	$ 59	$ 89	$ 76	$ 78	$ 82	$ 63	$ 77
Vet and Medicine	$ 93	$ 115	$ 107	$ 111	$ 131	$ 131	$ 112
bST	$ 8	$ 3	$ -	$ -	$ -	$ 8	$ 3
Supplies	$ 214	$ 194	$ 154	$ 156	$ 112	$ 112	$ 169
DHIA	$ 21	$ 27	$ 28	$ 26	$ 21	$ 22	$ 25
Contract Heifer Raising	$ 53	$ 51	$ 49	$ 17	$ 12	$ 109	$ 46
Dairy Custom Hire	$ 18	$ 27	$ 17	$ 61	$ 81	$ 70	$ 40
Milk Hauling	$ 236	$ 233	$ 211	$ 198	$ 202	$ 198	$ 217
Milk Marketing	$ 66	$ 87	$ 79	$ 57	$ 62	$ 65	$ 71
Bedding	$ 44	$ 61	$ 84	$ 73	$ 150	$ 70	$ 72
Dairy Expenses per Cow	**$ 812**	**$ 886**	**$ 804**	**$ 777**	**$ 854**	**$ 848**	**$ 832**

Overhead Expenses:	**30-50**	**52-70**	**71-100**	**105-176**	**180-289**	**>290**	**Average**
Fuel and Oil	$ 198	$ 137	$ 155	$ 119	$ 139	$ 104	$ 143
Repairs	$ 159	$ 190	$ 164	$ 226	$ 235	$ 229	$ 197
Hired Labor, Witholding	$ 43	$ 81	$ 129	$ 335	$ 459	$ 585	$ 218
Machinery Leases	$ 23	$ 17	$ 10	$ 48	$ 13	$ 67	$ 28
Building Leases	$ 102	$ 57	$ 71	$ 62	$ 108	$ 120	$ 78
Real Estate Taxes	$ 95	$ 96	$ 63	$ 48	$ 45	$ 48	$ 72
Farm Insurance	$ 9	$ 28	$ 47	$ 92	$ 83	$ 69	$ 50
Utilities	$ 18	$ 61	$ 98	$ 139	$ 106	$ 133	$ 86
Risk Mgt. and Advertizing	$ -	$ 5	$ 2	$ 7	$ 4	$ 23	$ 6
Dues and Professional Fees	$ 13	$ 13	$ 10	$ 22	$ 17	$ 25	$ 16
Miscellaneous	$ 80	$ 80	$ 43	$ 52	$ 28	$ 31	$ 60
Overhead Expenses per Cow	**$ 739**	**$ 765**	**$ 792**	**$ 1,151**	**$ 1,236**	**$ 1,435**	**$ 955**
Owner Draw per Cow	$ 465	$ 443	$ 352	$ 301	$ 213	$ 170	$ 358
Loan Payments per Cow	$ 810	$ 678	$ 711	$ 691	$ 534	$ 561	$ 684
Total Outflow per Cow	**$ 4,785**	**$ 4,712**	**$ 4,639**	**$ 4,926**	**$ 4,730**	**$ 5,089**	**$ 4,801**

	30-50	**52-70**	**71-100**	**105-176**	**180-289**	**>290**	**Average**
Gross Milk Price Farm Breakeven	**$ 17.25**	**$ 16.86**	**$ 17.66**	**$ 17.82**	**$ 18.89**	**$ 17.43**	**$ 17.47**
IOFC Breakeven	$ 6.91	$ 7.01	$ 7.24	$ 7.49	$ 8.01	$ 8.15	$ 7.32
Gross Margin to Guarantee	$ 10.00	$ 9.79	$ 9.92	$ 10.06	$ 11.37	$ 10.30	$ 10.09
Total Inflow - Total Outflow	**$ 237**	**$ 64**	**$ (79)**	**$ (119)**	**$ (247)**	**$ (100)**	**$ (7)**

PennState Extension

Whole Farm
Summary per Cow
by Farm Size
2016 Plans
8/16/2016

	Breakeven Milk Price						
Whole Farm per Cow:	**30-50**	**52-70**	**71-100**	**105-176**	**180-289**	**>290**	**Average**
Milk Sold per Total Cows	21,994	22,508	22,798	23,453	22,675	25,403	22,957
Total Milk Inflow	$ 3,872	$ 3,863	$ 3,949	$ 4,072	$ 3,962	$ 4,384	3,980
Total Dairy and Crop Non-Milk Inflow	$ 1,150	$ 913	$ 611	$ 735	$ 521	$ 606	813
Total Inflow	**$ 5,022**	**$ 4,775**	**$ 4,560**	**$ 4,807**	**$ 4,482**	**$ 4,989**	**4,793**
Crop Direct Expenses	$ 486	$ 506	$ 447	$ 696	$ 647	$ 573	$ 556
Milking Cow Purchased Concentrates	$ 1,009	$ 940	$ 995	$ 967	$ 914	$ 1,150	$ 983
Milking Cow Purchased Forages	$ 34	$ 54	$ 143	$ 67	$ 6	$ 25	$ 58
Heifer and Dry Cow Purchased Concentrates	$ 293	$ 307	$ 271	$ 229	$ 304	$ 259	$ 278
Heifer and Dry Cow Purchased Forages	$ 136	$ 132	$ 125	$ 47	$ 23	$ 68	$ 97
Total Feed and Crop	**$ 1,958**	**$ 1,939**	**$ 1,981**	**$ 2,007**	**$ 1,893**	**$ 2,076**	**$ 1,972**
Dairy Expenses	$ 812	$ 886	$ 804	$ 777	$ 854	$ 848	$ 832
Overhead Expenses	$ 739	$ 765	$ 792	$ 1,151	$ 1,236	$ 1,435	$ 955
Owner Draw	$ 465	$ 443	$ 352	$ 301	$ 213	$ 170	$ 358
Loan Payments	$ 810	$ 678	$ 711	$ 691	$ 534	$ 561	$ 684
Expenses Other than Feed	**$ 2,827**	**$ 2,772**	**$ 2,659**	**$ 2,920**	**$ 2,837**	**$ 3,014**	**$ 2,829**
Total Outflow	**$ 4,785**	**$ 4,712**	**$ 4,639**	**$ 4,926**	**$ 4,730**	**$ 5,089**	**$ 4,801**
Gross Milk Price Breakeven per CWT.	$ 17.25	$ 16.86	$ 17.66	$ 17.82	$ 18.89	$ 17.43	$ 17.47
IOFC Breakeven (per Cow per day)	$ 6.91	$ 7.01	$ 7.24	$ 7.49	$ 8.01	$ 8.15	$ 7.32
Gross Margin to Guarantee per CWT.	$ 10.00	$ 9.79	$ 9.92	$ 10.06	$ 11.37	$ 10.30	$ 10.09
Total Inflow - Total Outflow	**$ 237**	**$ 64**	**$ (79)**	**$ (119)**	**$ (247)**	**$ (100)**	**$ (7)**

This tool is provided for general informational purposes only and The Pennsylvania State University shall have no liability whatsoever for the use of or reliance on this tool.

104 Farms

PennState Extension

Penn State Dairy Cattle Nutrition Conference

Red Lion Hotel, Harrisburg PA

November 1, 2018




Competitive Advantages for Farms of Different Sizes

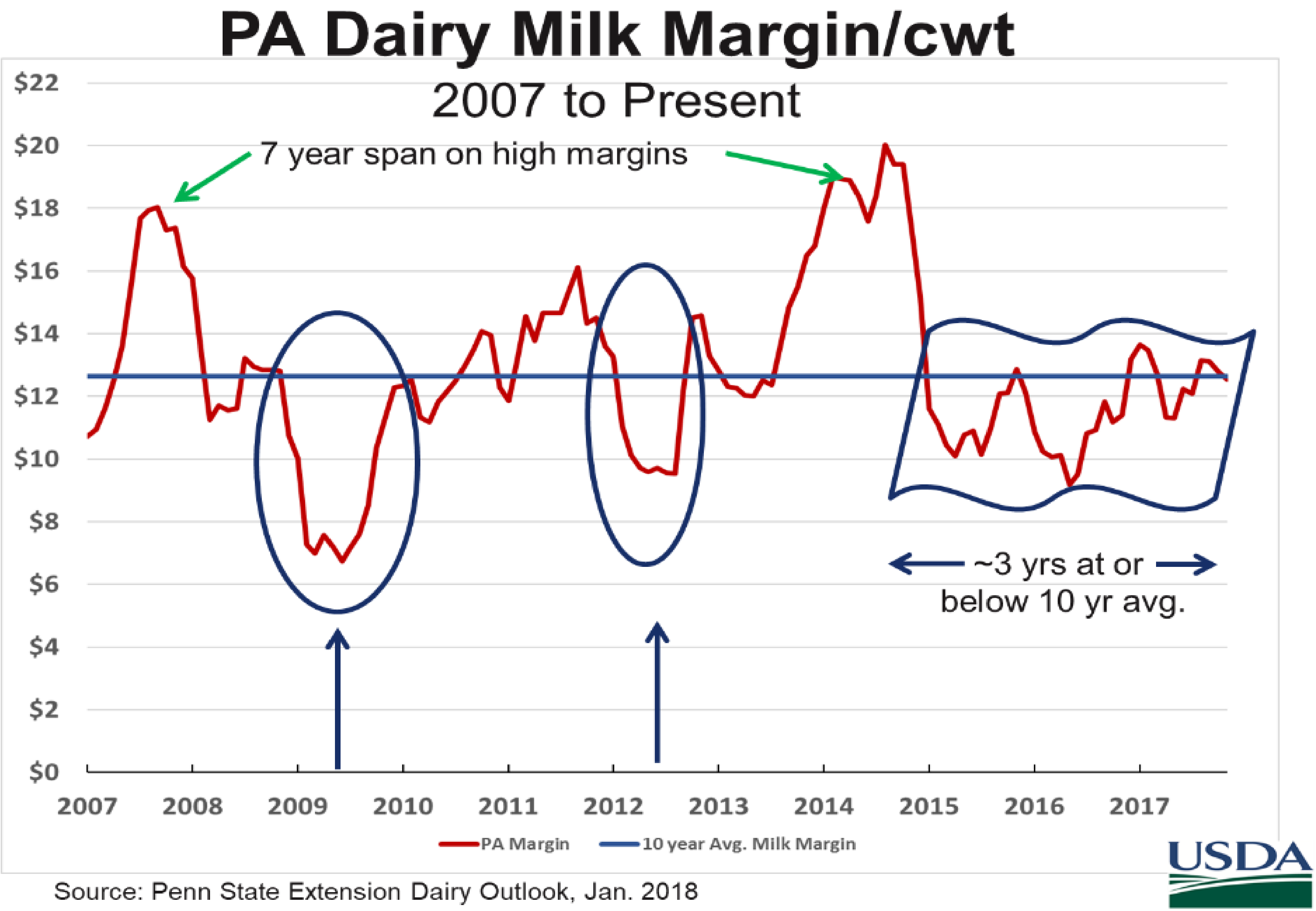
T. Beck, R. Goodling, M. Haan, **V. Ishler**, M. Rosales, A. Sandeen & C. Williams

PennState Extension

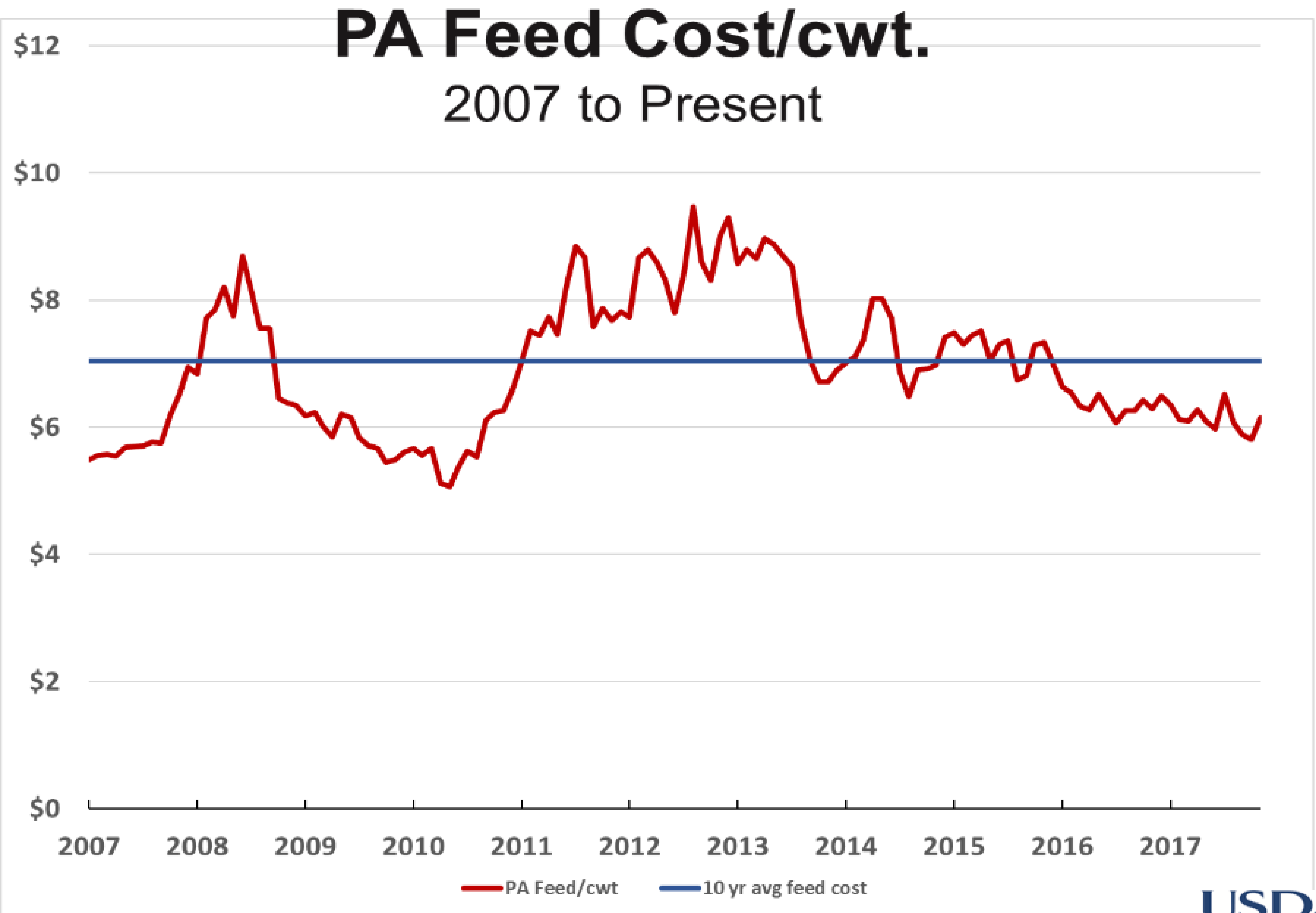
Project supported in part by:

NORTHEAST SARE Sustainable Agriculture Research & Education

USDA Risk Management Agency (RMA)



Source: Penn State Extension Dairy Outlook, Jan. 2018



Source: Penn State Extension Dairy Outlook, Jan. 2018

Cash Flow "Mechanics"

Micro Issues

	Per Total Cows	Dairy Total	Per CWT.
Milk Price			$ 22.00
Total Cows			320
Cows Milking			280
Milk/Cow/Day	80.00		
Projected Milk Sales	25,550	$ 1,798,720	8,176,000

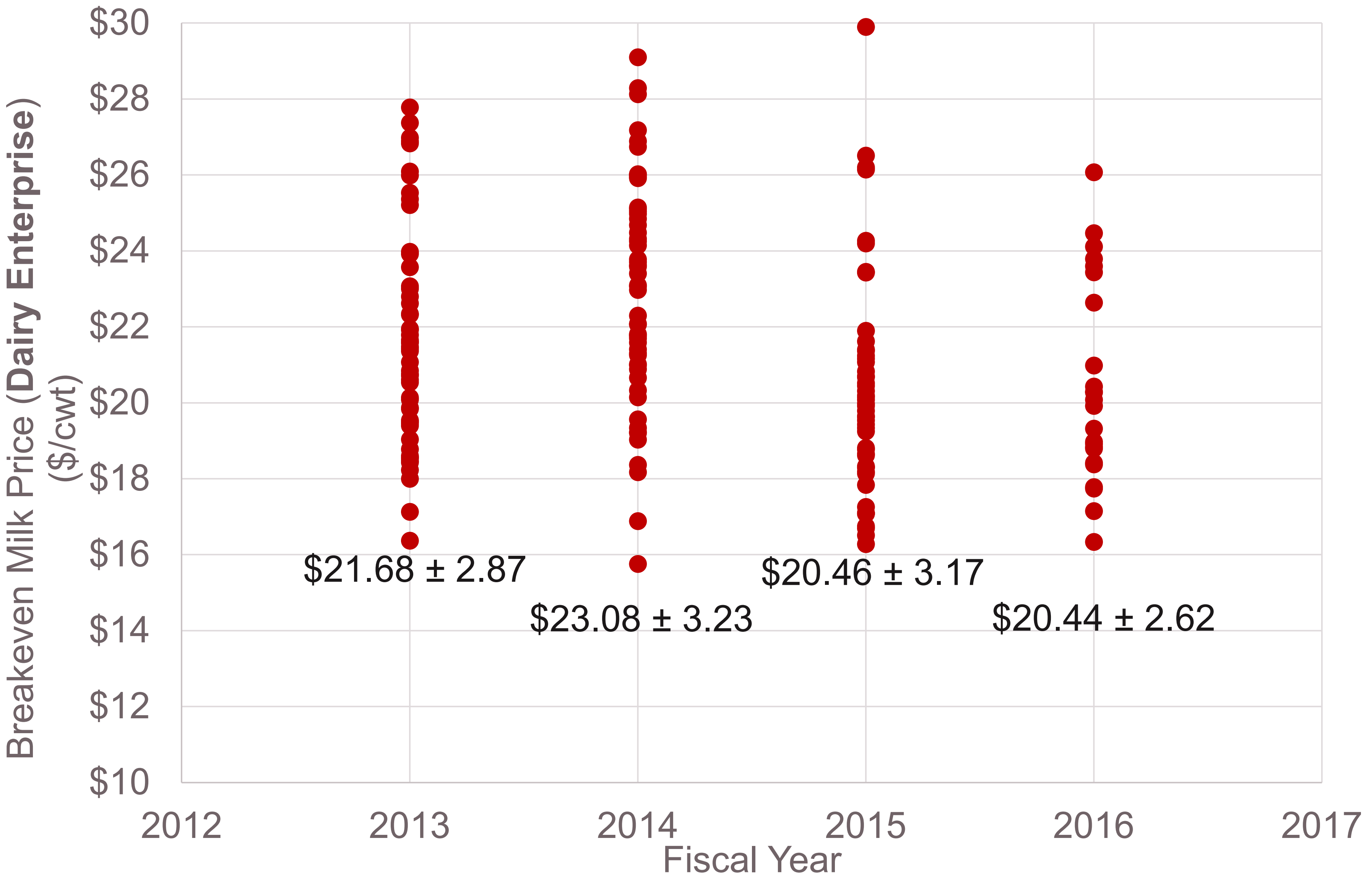
Milk Components
Milk Quality
Risk Management

Forage Quality
Forage Inventory /
Cropping Program
Feeding
Management
Cow Comfort
Ration Formulation

Reproductive Mgt.
Cull Rate
Heifer Program

Macro Issues

4 Year Actuals: Dairy Breakeven/CWT



Crops to Cow Farms 2016 & 2017

Item	2017 – 27 farms		2016 – 20 farms	
	Quantity	Value	Quantity	Value
Milk sold/cow	24,643	$4,568	24,623	$4,256
Gross income/cow		$4,896		$4,665
Total direct expenses/cow		$3,220		$3,314
Total overhead expenses/cow		$1,694		$1,535
Net return/cow		-$18.71		-$184.80
Labor & mgt. charge		$217		$205
Return over labor & mgt.		-$236		-$390
COP w/ Labor & Mgt./cwt (Dairy Enterprise Only)		**$19.50**		**$18.87**
Feed cost/cow		$2,312		$2,315
Milk price/feed margin (cwt)		$9.15		$7.88

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Dairy Industry in Transition

PennState Extension

NORTHEAST SARE Sustainable Agriculture Research & Education

Milk Price Variation--2018

Milk Buyer	2018 Avg YTD Gross	Location Adjustment	Market Adjustment	Hauling	Marketing	Mailbox Price	Total Deductions
Rutter's	$ 17.62			$ 0.57	$ 0.06	$ 16.98	$ 0.63
Rutter's	$ 16.50			$ 0.56	$ 0.30	$ 15.64	$ 0.86
Rutter's	$ 17.30			$ 0.57	$ 0.33	$ 16.40	$ 0.90
Clover	$ 16.91			$ 0.73	$ 0.20	$ 15.98	$ 0.93
Land O Lakes	$ 17.30	$ 0.450		$ 0.51	$ 0.51	$ 16.29	$ 1.46
Land O Lakes	$ 17.12	$ 0.450	$ 0.20	$ 0.63	$ 0.51	$ 15.77	$ 1.79
DFA	$ 15.62	$ 0.450	$ 0.43	$ 0.51	$ 0.41	$ 14.70	$ 1.80
Lanco-Pennland	$ 16.65		$ 1.40	$ 1.05	$ 0.38	$ 13.83	$ 2.82
MD-Va	$ 15.09	$ 0.400	$ 1.20	$ 1.13	$ 0.37	$ 13.59	$ 3.10
MD-Va	$ 14.57	$ 0.400	$ 1.20	$ 1.18	$ 0.33	$ 13.06	$ 3.11
MD-Va	$ 14.73	$ 0.400	$ 1.20	$ 1.10	$ 0.77	$ 12.86	$ 3.48
11	**$ 16.31**	**$ 0.425**	**$ 0.94**	**$ 0.78**	**$ 0.38**	**$ 15.01**	**$ 1.90**

Average Mailbox			Average Deductions
$	**16.25**	Class I Fluid market	**$ 0.83**
$	**16.03**	Land O Lakes average	**$ 1.63**
$	**13.61**	Other Coops	**$ 2.86**
$	**2.64**	Fluid compared to Other Coops	
$	**2.42**	LOL compared to Other Coops	

Maryland and Virginia Milk Producers Coop. Assn. Inc.
08/17/2018

July 2018 Final Payroll

Butterfat Test	3.47	
FO 1 3.5% Uniform Price		
Your Gross Price at Test		
MdVa 3.5% Blend Price		YTD
Pounds Delivered	404,428	3,079,993

Pounds Delivered:

1st	0	11th	0	21st	0
2nd	27,204	12th	26,893	22nd	27,003
3rd	0	13th	0	23rd	0
4th	25,633	14th	26,856	24th	27,698
5th	0	15th	0	25th	0
6th	25,518	16th	27,113	26th	27,479
7th	0	17th	0	27th	0
8th	25,939	18th	27,168	28th	27,589
9th	0	19th	0	29th	0
10th	27,076	20th	27,278	30th	27,981
				31st	0

Premiums and Penalties	Rate/CWT	Total Amt	YTD Amt
Quality Premium/Penalty	0.7977	3,226.12	28,517.47
AQP		0.00	1,900.00
Total Amount		3,226.12	30,417.47

		Pounds	Rate	Month	Year To Date
Producer Price Diff		404,428	2.0400	8,250.33	38,020.17
Butterfat		14,034	2.5287	35,487.78	269,948.30
Protein	2.9100	11,769	1.4827	17,449.90	155,794.61
Other Solids	5.7400	23,214	0.1422	3,301.03	14,650.30
Location Adjustment		404,428	-0.4000	-1,617.71	-12,319.98
Market Adjustment		404,428	-1.2000	-4,853.14	-36,959.92
Premiums / Penalties				3,226.12	30,417.47
2018 Mar PPD		0	0.0000	$0.00	$3,343.83
Gross Value				61,244.31	462,894.78
Less Advance				27,601.24	0
Less Hauling				4,742.56	34,840.24
Less Assignments				1,530.72	11,250.39
Net Earnings				27,369.79	416,804.15

RPTS091MV

	Assembly Charges	Destination Charges	Total Amount	Year To Date
TRANSPORTATION CHARGES	718.10	4,024.46	4,742.56	34,840.24

Assignee	Per CWT	Base Amt	Total Amount	Year To Date
00001 NATIONAL DAIRY PROMO & RESEARC	0.0500	202.21	202.21	1,539.99
00012 MARKETING EXPENSE		762.31	762.31	5,398.39
20606 MID-ATLANTIC DAIRY ASSOCIATION	0.1000	404.43	404.43	3,080.01
30615 CWT	0.0400	161.77	161.77	1,232.00
Total Amount			1,530.72	11,250.39

LAND O'LAKES, INC. - CHECK REMITTANCE DETAIL
PAY PERIOD: 08/01 - 08/31, 2018
SETTLEMENT CHECK

Payment Date: 09/17/2018 **FARM ID:** **FARM NAME:**
Payment ID: **PAYOUT ID:** **PAYOUT NAME:**

TEST AVERAGES:	**Bfat:** 3.557	**PROT:** 2.97	**OSOL:** 5.745	
QUALITY AVERAGES:	**SCC:** 177	**BAC:** 3	**PI:** 4	**CRYOS:** 538
CHARGEABLE STOPS:	46			
DAILY BASE LBS:	43,939			
PROD % OF BASE:	97.5%			

PRODUCTION	POUNDS	RATE	TYPE	YOUR TOTAL	FARM TOTAL
Grade A Pounds	1,327,918.00				
Grade A Bfat	47,234.04	2.6009	per lb bfat	122,851.02	122,851.02
Grade A Protein	39,439.16	1.6245	per lb protein	64,068.92	64,068.92
Grade A Other Solids	76,288.89	0.1741	per lb o-sol	13,281.90	13,281.90
Producer Price Diff @ Bos	1,327,918.00	1.2600	per cwt	16,731.77	16,731.77
Loc adj to PPD	1,327,918.00	-0.4500	per cwt	-5,975.63	-5,975.63
Volume	1,327,918.00	0.2500	per cwt	3,319.80	3,319.80
Quality	1,327,918.00	0.2000	per cwt	2,655.84	2,655.84
LOL Premium	1,327,918.00	0.6000	per cwt	7,967.51	7,967.51
Variable Hauling Cost	1,327,918.00	-0.1650	per cwt	-2,191.06	-2,191.06
CWT Program Cost	1,327,918.00	-0.0400	per cwt	-531.17	-531.17
Gross Amount			per cwt	222,178.88	222,178.88
Total Deductions				124,897.50	
Bank Deposit				97,281.38	
Your Mailbox Price			per cwt		

Payment Date: 09/17/2018 **FARM ID:** **FARM NAME:**
Payment ID: **PAYOUT ID:** **PAYOUT NAME:**

Advance Deductions	**Dollars**
BANK	802.04
BANK	9,128.86
ADVANCE PAYMENT	79,424.19
	89,355.09
Final Deductions	
HAULING	8,365.88
NATIONAL DAIRY PROMO	663.96
LOCAL DAIRY PROMO	1,327.92
ADMINISTRATIVE FEES	250.00
MARKET ADJ.	2,655.84
ADVANCE 08/30/18	20,000.00
OTHER	676.00
OTHER	265.58
BANK	1,337.23
	35,542.41
TOTAL DEDUCTIONS:	**124,897.50**

YEAR TO DATE TOTALS:	
POUNDS	10,147,874.00
GROSS DOLLARS	1,736,855.86
ADA/LDP	10,147.88
HAULING	63,931.60
MKT/ADM	36,761.05
NDPO	5,073.94

2016 Whole Farm Income by Farm Size

Whole Farm per Cow:	30-50	52-70	71-100	105-176	180-289	>290	Average
Milk sold per milking cow	25,201	26,135	26,645	26,899	25,631	28,865	26,425
Avg. Lbs. Milk per cow	69	72	73	74	70	79	72
Total Inflow	$ 5,022	$ 4,775	$ 4,560	$ 4,807	$ 4,482	$ 4,989	$ 4,793
Total Outflow	$ 4,785	$ 4,712	$ 4,639	$ 4,926	$ 4,730	$ 5,089	$ 4,801
Gross Milk Price Breakeven	$ 17.25	$ 16.86	$ 17.66	$ 17.82	$ 18.89	$ 17.43	$ 17.47
Total Inflow – Total Outflow	$ 237	$ 64	$ (79)	$ (119)	$ (247)	$ (100)	$ (7)

(104 farms)

2016 Whole Farm Overhead Expenses by Farm Size

Whole Farm per Cow:	30-50	52-70	71-100	105-176	180-289	>290	Average
Fuel and oil	$ 198	$ 137	$ 155	$ 119	$ 139	$ 104	$ 143
Repairs	$ 159	$ 190	$ 164	$ 226	$ 235	$ 229	$ 197
Hired labor	$ 43	$ 81	$ 129	$ 335	$ 459	$ 585	$ 218
Farm insurance	$ 9	$ 28	$ 47	$ 92	$ 83	$ 69	$ 50
Utilities	$ 18	$ 61	$ 98	$ 139	$ 106	$ 133	$ 86
Dues and fees	$ 13	$ 13	$ 10	$ 22	$ 17	$ 25	$ 16
Misc	$ 80	$ 80	$ 43	$ 52	$ 28	$ 31	$ 60
Total Overhead Costs	$ 739	$ 765	$ 792	$ 1,151	$ 1,236	$ 1,435	$ 955

(104 farms)

2016 Whole-Farm Breakeven Inflow Summary

Whole-Farm per Cow:	< $16	$16-$18	$18-$19	$19-$20	$20-$22	>$22	Average
Milk Inflow/Cow/Year	**$ 3,851**	**$ 4,044**	**$ 3,907**	**$ 4,105**	**$ 4,194**	**$ 3,849**	**$ 3,980**
Cull Cow Sales	$ 232	$ 246	$ 241	$ 258	$ 230	$ 226	$ 242
Bull Calf Sales	$ 100	$ 75	$ 95	$ 80	$ 59	$ 83	$ 85
Crop Sales	$ 278	$ 74	$ 137	$ 282	$ 2	$ 149	$ 169
Other Farm Income	$ 375	$ 146	$ 72	$ 394	$ 74	$ 29	$ 224
Non-Milk Inflow (subtotal)	**$ 1,070**	**$ 604**	**$ 644**	**$ 1,132**	**$ 467**	**$ 742**	**$ 813**
Total Inflow	**$ 4,921**	**$ 4,648**	**$ 4,551**	**$ 5,236**	**$ 4,661**	**$ 4,590**	**$ 4,793**
Gross Milk Price Breakeven	**$ 14.62**	**$ 17.11**	**$ 18.38**	**$ 19.46**	**$ 20.62**	**$ 23.94**	**$ 17.47**

(104 farms)

2016 Dairy Compared to Whole-Farm Data

Per Cow/Year	< $16	$16-$18	$18-$19	$19-$20	$20-$22	>$22	Average
Total Inflow--Dairy	$ 4,461	$ 4,350	$ 4,305	$ 4,425	$ 4,320	$ 4,311	$ 4,361
Total Inflow—Whole Farm	$ 4,921	$ 4,648	$ 4,551	$ 5,236	$ 4,661	$ 4,590	$ 4,793
Difference	**$ 460**	**$ 298**	**$ 246**	**$ 811**	**$ 341**	**$ 279**	**$ 432**
Dairy Breakeven Price	14.67	17.27	18.48	19.44	20.89	24.03	18.48
Whole-Farm Breakeven Price	14.62	17.11	18.38	19.46	20.62	23.94	17.47
Difference	**.05**	**.16**	**.10**	**-.02**	**.27**	**.09**	**$ 1.01**

How Much Milk Does a Herd Need to Breakeven?

PennState Extension

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10/29/18

Clear Form

Determining milk income needed

	Dairy Enterprise Only*			
Number of milking cows	125			
Expenses:			Farm Total	Dairy Enterprise Percentage
Direct costs	$ 152,124			
Overhead costs	$ 207,391		$ 243,989	85.00
Family living expense	$ 65,000			
Taxes				
Loan payments (principal + Interest)	$ 45,557			
Total feed cost	$ 365,318	home raised and purchased feed		
Total outflow	**$ 835,390**			
Non-Milk Income	$ 83,539			
Minus non-milk income	**$ 751,851**			

*Do not include custom work or other farm income

Average milk price

Minimum pounds of milk shipped/year

Average production, lbs/day

PennState Extension

10/30/18

Clear Form

Determining milk income needed	Dairy Enterprise Only*	*Do not include custom work or other farm income	
Number of milking cows	270		
			Dairy Enterprise Percentage
Expenses:		Farm Total	
Direct costs	$ 245,830		
Overhead costs	$ 459,391	$ 524,000	87.67
Family living expense	$ 70,000		
Taxes			
Loan payments (principal + Interest)	$ 84,854		
Total feed cost	$ 551,153	home raised and purchased feed	
Total outflow	**$ 1,411,228**		
Non-Milk Income	$ 220,250		
Minus non-milk income	**$ 1,190,978**		

Average milk price

Minimum pounds of milk shipped/year

Average production, lbs/day

2016 Corn Silage Production Costs by Farm Size

Per Acre	30-50	52-70	71-100	105-176	180-289	>290	Average
Average Number of Cows	45	58	80	139	230	543	135
Yield Per Acre	**23.7**	**23.1**	**21.8**	**21.6**	**19.2**	**24.3**	**22.5**
Cost per Ton	**$19.18**	**$20.57**	**$28.08**	**$30.67**	**$28.69**	**$27.67**	**$24.55**
Total Direct Costs/Acre	**$307**	**$303**	**$429**	**$442**	**$354**	**$455**	**$364**
Seed/Acre	$76	$75	$106	$99	$61	$100	$84
Fertilizer/Acre	$67	$71	$106	$77	$57	$42	$72
Chemical/Acre	$23	$27	$45	$51	$53	$70	$39
Custom Hire/Acre	$41	$30	$138	$128	$97	$143	$81
Overhead Costs/Acre	**$60**	**$63**	**$70**	**$118**	**$122**	**$130**	**$85**

(98 farms)

2016 Dairy Breakeven Summary

Dairy Enterprise per Cow:	< $16	$16-$18	$18-$19	$19-$20	$20-$22	>$22	Average
Total Inflow/Cow/Year	$ 4,461	$ 4,350	$ 4,305	$ 4,425	$ 4,320	$ 4,311	$ 4,361
Total Feed ($/Cow/Year)	$ 1,695	$ 2,114	$ 2,180	$ 2,359	$ 2,344	$ 2,525	$ 2,148
Dairy Expenses	$ 789	$ 780	$ 808	$ 797	$ 916	$ 964	$ 828
Overhead Expenses	$ 711	$ 688	$ 714	$ 774	$ 989	$ 966	$ 775
Owner Draw	$ 218	$ 286	$ 326	$ 333	$ 254	$ 408	$ 297
Loan Payments	$ 498	$ 489	$ 525	$ 638	$ 540	$ 785	$ 555
Expenses Other than Feed	$ 2,216	$ 2,244	$ 2,372	$ 2,542	$ 2,700	$ 3,123	$ 2,456
Total Inflow – Total Outflow	$ 549	$ (8)	$ (247)	$ (476)	$ (724)	$ (1,337)	$ (243)

(104 farms)

2016 Dairy Breakeven Summary

Dairy Enterprise per Cow:	< $16	$16-$18	$18-$19	$19-$20	$20-$22	>$22	Average
Gross Milk Price Farm Breakeven	$ 14.67	$ 17.27	$ 18.48	$ 19.44	$ 20.89	$ 24.03	$ 18.48
IOFC Breakeven	$ 6.96	$ 7.44	$ 7.62	$ 8.46	$ 8.73	$ 10.09	$ 7.96
Total Inflow - Total Outflow	**$ 549**	**$ (8)**	**$ (247)**	**$ (476)**	**$ (724)**	**$ (1,337)**	**$ (243)**
Total Feed ($/Cow/Year)	**$ 1,695**	**$ 2,114**	**$ 2,180**	**$ 2,359**	**$ 2,344**	**$ 2,525**	**$ 2,148**

(104 farms)

PennState Extension

Conclusion

No One Approach to Success

Management

Crops – Cow – Cash = All intertwined

Good management allows various strategies to work.

Balance

Forage quality with quantity

Formulated diet with actual

Herd management with feeding management

Income and expenses

Assets

Need to keep adequate assets – animals, facilities, equipment, land to remain profitable.

LAND O'LAKES, INC. - CHECK REMITTANCE DETAIL
PAY PERIOD: 08/01 - 08/31, 2018
SETTLEMENT CHECK

Payment Date: 09/17/2018	**FARM ID:**	**FARM NAME:**
Payment ID:	**PAYOUT ID:**	**PAYOUT NAME:**

TEST AVERAGES:	**Bfat:** 3.557	**PROT:** 2.97	**OSOL:** 5.745	
QUALITY AVERAGES:	**SCC:** 177	**BAC:** 3	**PI:** 4	**CRYOS:** 538
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DAILY BASE LBS:	43,939			
PROD % OF BASE:	97.5%			

PRODUCTION	**POUNDS**	**RATE**	**TYPE**	**YOUR TOTAL**	**FARM TOTAL**
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Loc adj to PPD	1,327,918.00	-0.4500	per cwt	-5,975.63	-5,975.63
Volume	1,327,918.00	0.2500	per cwt	3,319.80	3,319.80
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CWT Program Cost	1,327,918.00	-0.0400	per cwt	-531.17	-531.17
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	89,355.09
Final Deductions	
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LOCAL DAIRY PROMO	1,327.92
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MARKET ADJ.	2,655.84
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TOTAL DEDUCTIONS:	**124,897.50**

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Maryland and Virginia Milk Producers Coop. Assn., Inc.

08/17/2018

Direct Deposit Advice

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3rd	0	13th	0	23rd	0
4th	25,633	14th	26,856	24th	27,698
5th	0	15th	0	25th	0
6th	25,518	16th	27,113	26th	27,479
7th	0	17th	0	27th	0
8th	25,939	18th	27,168	28th	27,589
9th	0	19th	0	29th	0
10th	27,076	20th	27,278	30th	27,981
				31st	0

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Less Hauling				4,742.56	34,840.24
Less Assignments				1,530.72	11,250.39
Net Earnings				27,369.79	416,804.15

Premiums and Penalties:	Rate/CWT	Total Amt	YTD Amt
Quality Premium/Penalty	0.7977	3,226.12	28,517.47
AQP		0.00	1,900.00
Total Amount		3,226.12	30,417.47

RPTS091MV

	Assembly Charges	Destination Charges	Total Amount	Year To Date
TRANSPORTATION CHARGES	718.10	4,024.46	4,742.56	34,840.24

Assignee	Per CWT	B: Amt	Total Amount	Year To Date
00001 NATIONAL DAIRY PROMO & RESEARC	0.0500	202.21	202.21	1,569.99
00012 MARKETING EXPENSE		762.31	762.31	5,398.39
20806 MID-ATLANTIC DAIRY ASSOCIATION	0.1000	404.43	404.43	3,080.01
30615 CWT	0.0400	161.77	161.77	1,232.00
Total Amount			1,530.72	11,250.39

PennState Extension

Determining milk income needed

	Dairy Enterprise Only*			
		*Do not include custom work or other farm income		
Number of milking cows				
Expenses:				
Direct costs			Farm Total	Dairy Enterprise Percentage
Overhead costs				
Family living expense				
Taxes				
Loan payments (principal + Interest)				
Total feed cost		home raised and purchased feed		
Total outflow				
Non-Milk Income				
Minus non-milk income				
Average milk price				
Minimum pounds of milk shipped/year				
Average production, lbs/day				

Determining milk income needed

	Dairy Enterprise Only*			
		*Do not include custom work or other farm income		
Number of milking cows				
Expenses:			Farm Total	Dairy Enterprise Percentage
Direct costs				
Overhead costs				
Family living expense				
Taxes				
Loan payments (principal + Interest)				
Total feed cost		home raised and purchased feed		
Total outflow				
Non-Milk Income				
Minus non-milk income				
Average milk price				
Minimum pounds of milk shipped/year				
Average production, lbs/day				

Precision Dairy Health Monitoring Opportunities and Challenges

Jeffrey Bewley, PhD, PAS
Dairy Housing and Analytics Specialist

Alltech®


2713

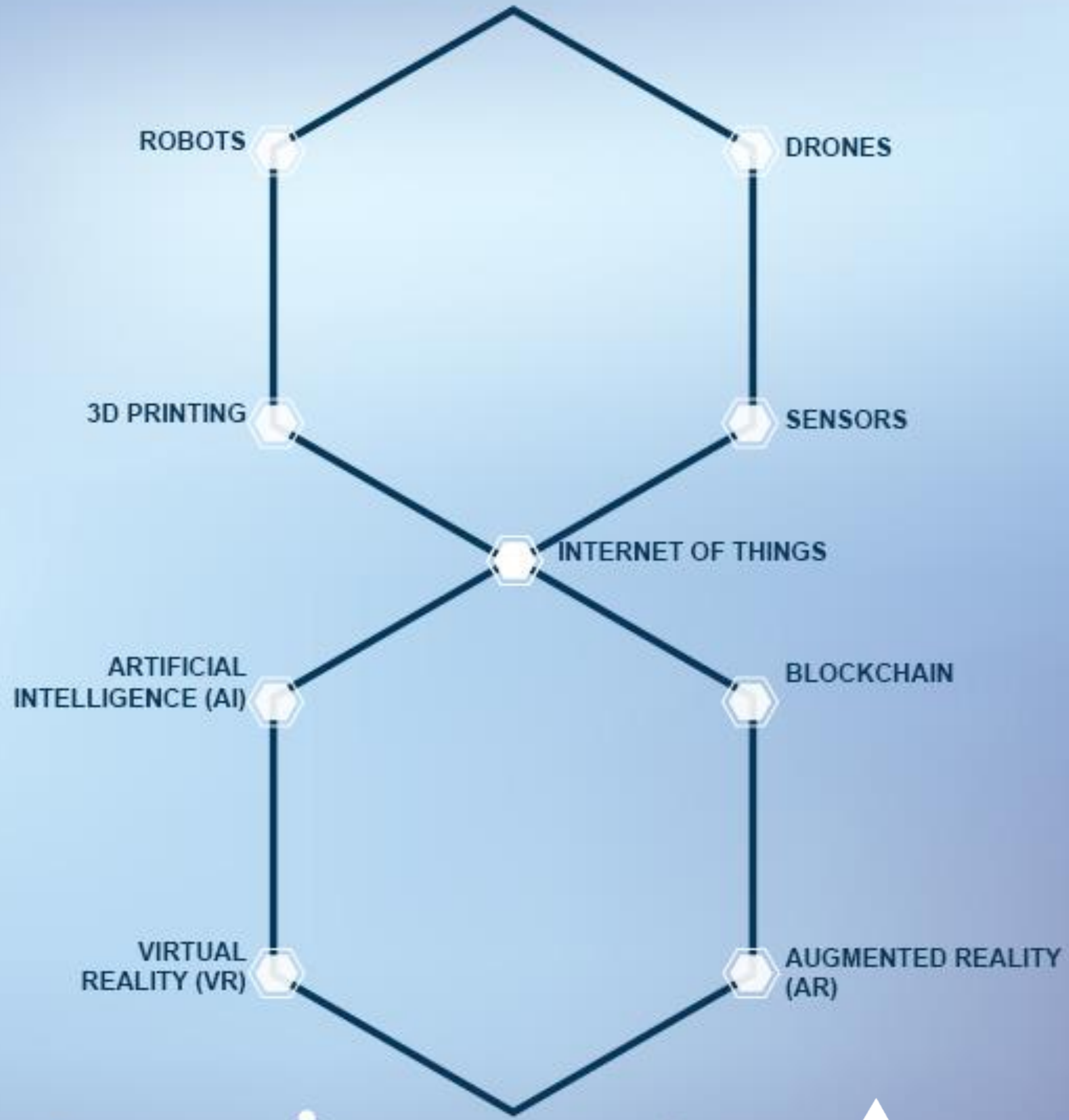
Today’s Progressive Dairy

- Well Managed Nutrition
- Excellent Cow Comfort
- Top Genetics
- Low Somatic Cell Count
- Disease and Reproduction Under Control

Analytics is The Next Scientific Breakthrough

Disruptive Digital Technologies

... with the power to transform Agriculture



Professor Aidan Connolly
Chief Innovation Officer
Global Vice-President Corporate Accounts
Alltech

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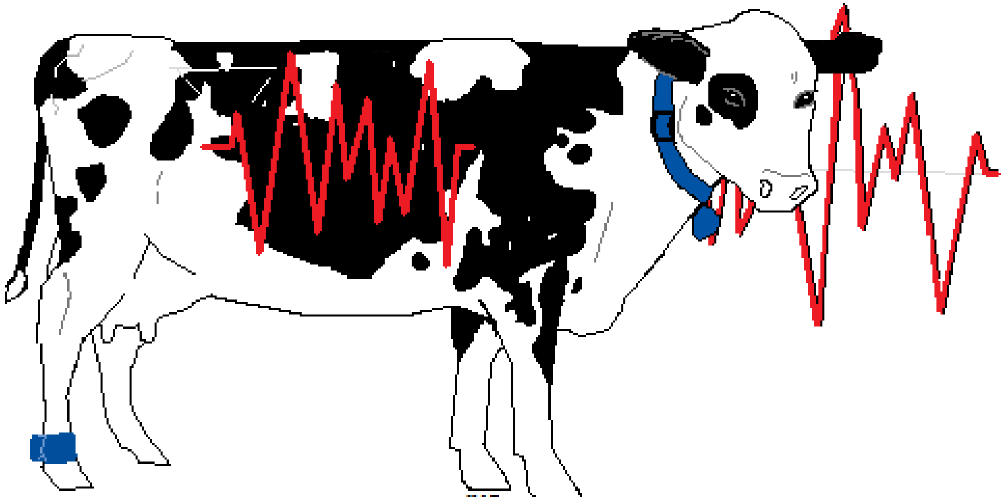
Precision Dairy Management



The use of automated, mechanized technologies toward refinement of dairy management processes, procedures, or information collection

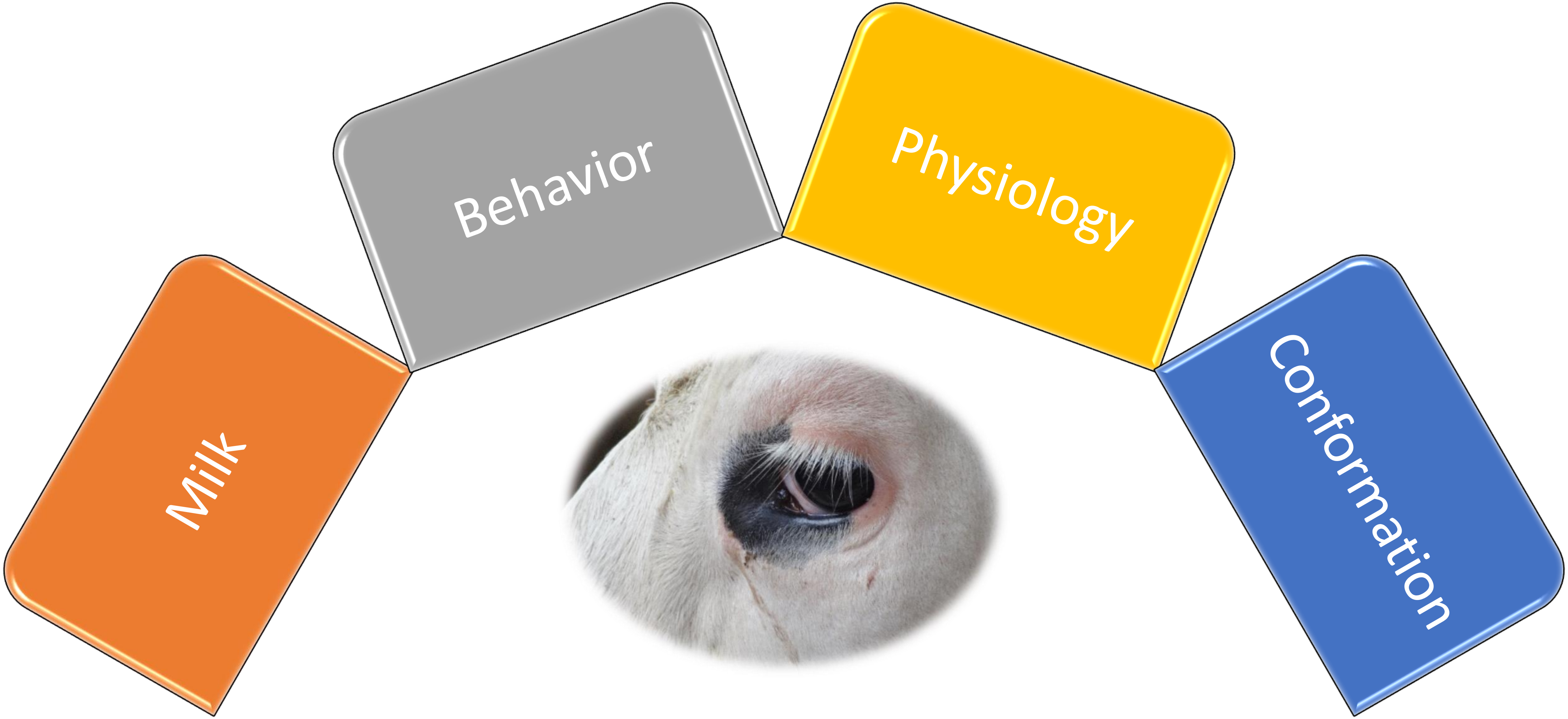
Alltech®

Automated Milking Systems

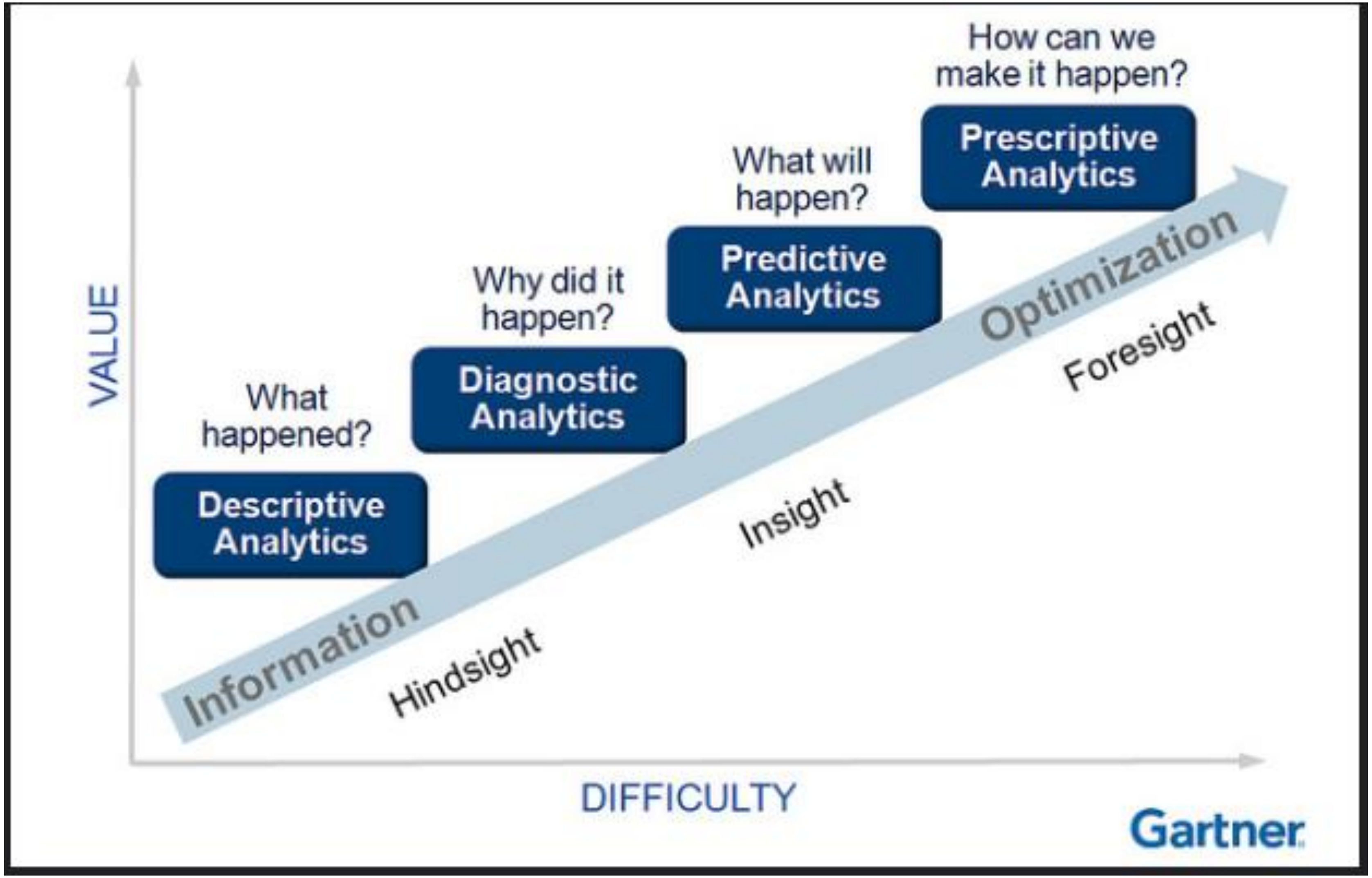
Automated Calf Feeding

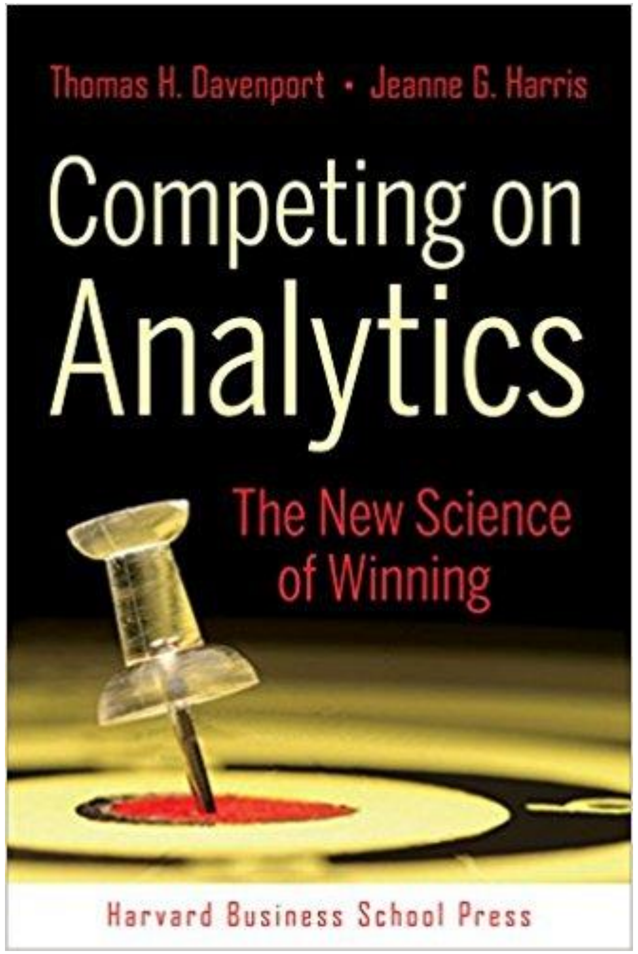
Precision Feeding

Precision Dairy Monitoring



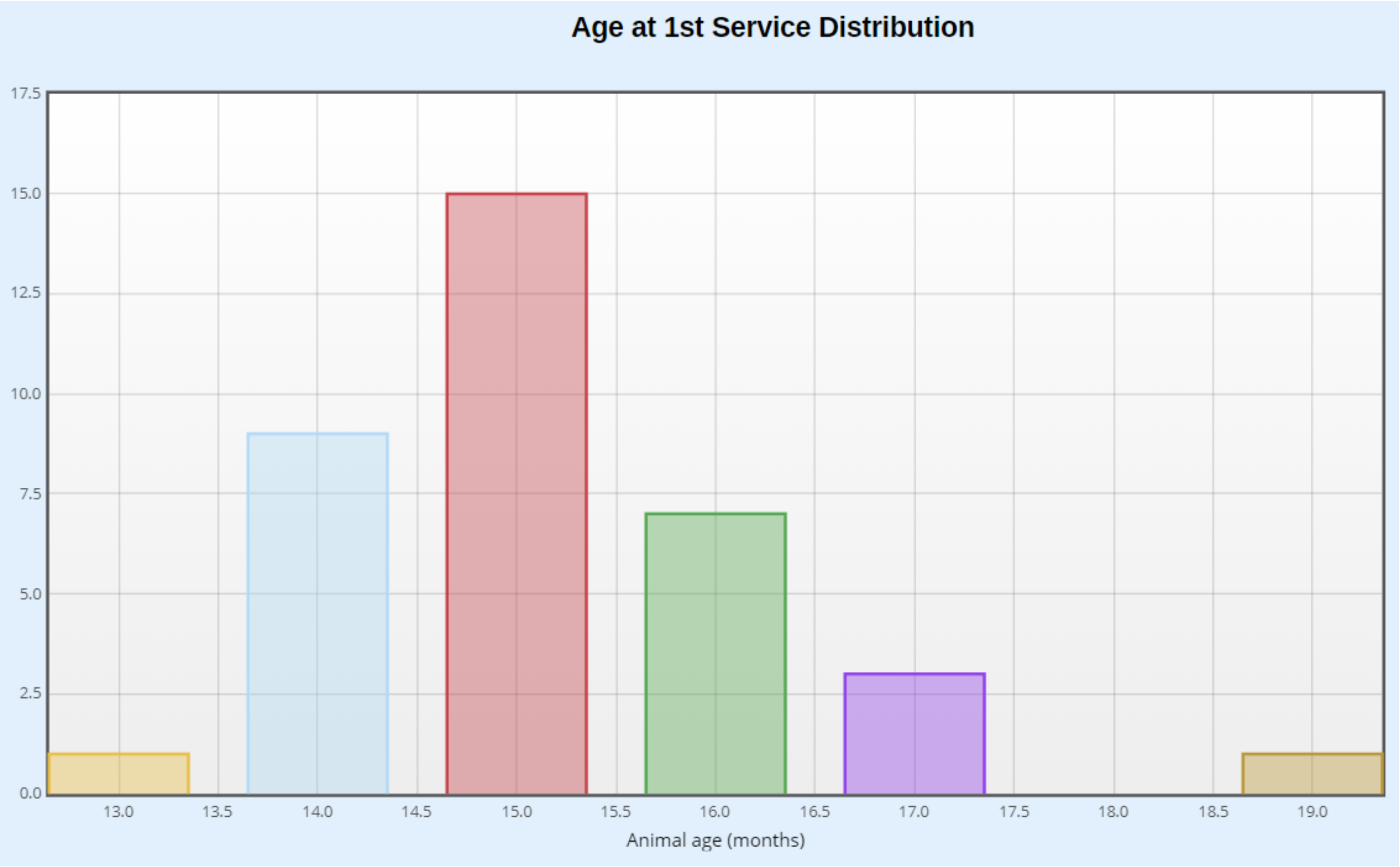
Gartner's™ Data Analytics Maturity Model





Descriptive Analytics

- Summarize what happened
  - Bar charts
  - Pie charts
  - Line graphs
- Typical herd management software tasks



Diagnostic and Prescriptive Analytics

- Why did something happen?
- Answer specific, precise questions
- In dairy, often lacking additional necessary data
    - Weather changes
    - Human resource changes
    - Disease diagnostics
    - Causal analysis tools within software

Exploratory Analytics

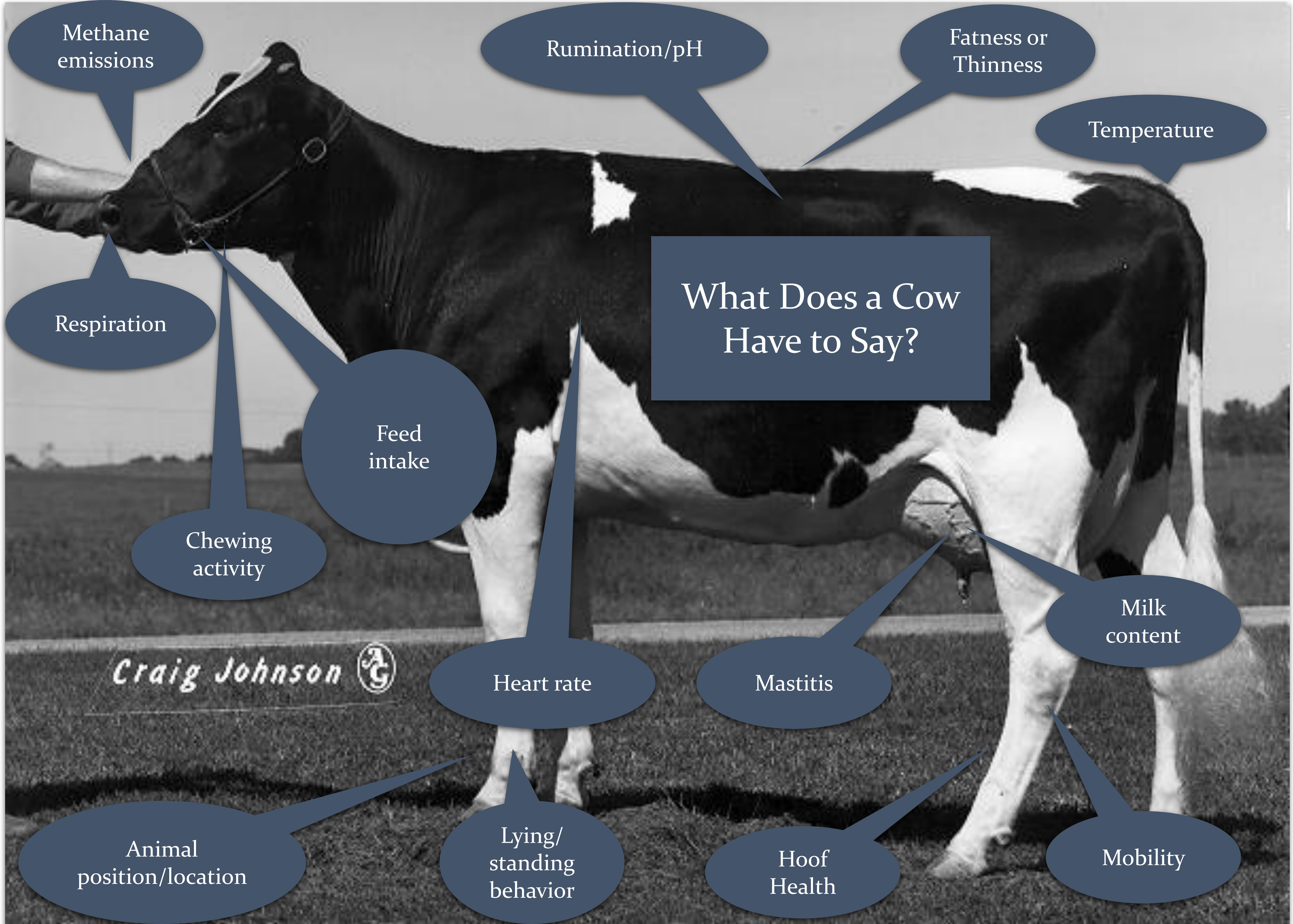
- Identifying patterns in data to identify outliers
  - Management by exception
  - Statistical process control
  - Used by sensor systems
  - Potential for weather, nutrition, economic, and human resource data

Predictive Analytics

- Machine learning and statistical algorithms
- Likelihood of future results
- Provide best possible assessment of future
- Could be used for likelihood of conception, disease recovery, intervention success, survival, etc.

Causal Analytics

- What is likely to happen with a change
  - Infer causations from previous experience, other farms, research, etc.
  - Nutrition changes
  - Reproduction programs
  - Technology adoptions
  - Management techniques


What Does a Cow Have to Say?
Methane emissions
Rumination/pH
Fatness or Thinness
Temperature
Respiration
Feed intake
Chewing activity
Heart rate
Mastitis
Milk content
Animal position/location
Lying/ standing behavior
Hoof Health
Mobility
Craig Johnson

Wearables, Images, and Milk Analyses

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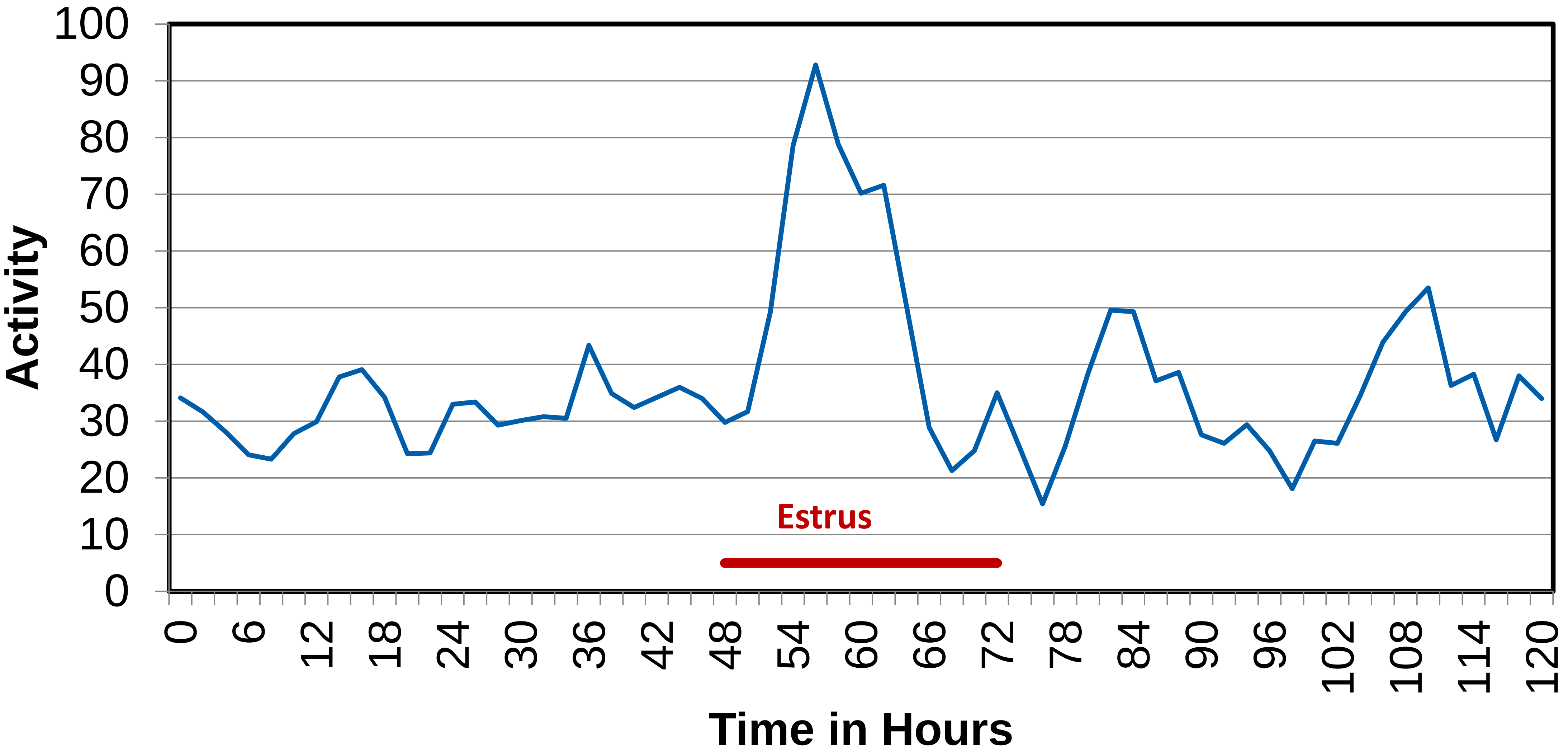
Management by Exception



Precision Dairy Monitoring Applications

- Estrus Detection
- Mastitis Detection
- Fresh Cow Disease Detection
- Lameness Detection
- Calving Detection
- Genetic Traits
- Management Monitoring

J. Dairy Sci. 100:1472–1486
https://doi.org/10.3168/jds.2016-11565

Estimating US dairy clinical disease costs with a stochastic simulation model

D. Liang,* L. M. Arnold,† C. J. Stowe,‡ R. J. Harmon,* and J. M. Bewley*[1]
*Department of Animal and Food Sciences,
†Veterinary Science Department, and
‡Department of Agricultural Economics, University of Kentucky, Lexington 40546

Disease	Parity	Mean ± SD
Mastitis	Primiparous	$325.76 ± 71.12
	Multiparous	$426.50 ± 80.27
Lameness	Primiparous	$185.10 ± 64.46
	Multiparous	$333.17 ± 68.76
Metritis	Primiparous	$171.69 ± 47.88
	Multiparous	$262.65 ± 56.15
Retained placenta	Primiparous	$150.41 ± 51.43
	Multiparous	$313.49 ± 64.66
Left-displaced abomasum	Primiparous	$432.48 ± 101.94
	Multiparous	$639.51 ± 114.10
Ketosis	Primiparous	$77.00 ± 24.00
	Multiparous	$180.91 ± 63.74
Hypocalcemia	Multiparous	$246.23 ± 52.25

Early Disease Detection

MAY ALLOW PRODUCERS TO DETECT DISEASES EARLIER THAN WITH VISUAL OBSERVATION ALONE

MAY IMPROVE INDIVIDUAL COW TREATMENT RESULTS BY DETECTING DISEASE EARLIER

MAY ALERT PRODUCERS TO A LARGER, HERD-LEVEL, PROBLEM SO THAT THE PRODUCER CAN CONSIDER MANAGEMENT CHANGES FOR BETTER DISEASE PREVENTION

Detection Benefits

- Reduced labor (pre-select examination cows)
- Early treatment and intervention
    - Cultured based therapy?
    - NSAID administration?
    - Pathogen-specific approach?

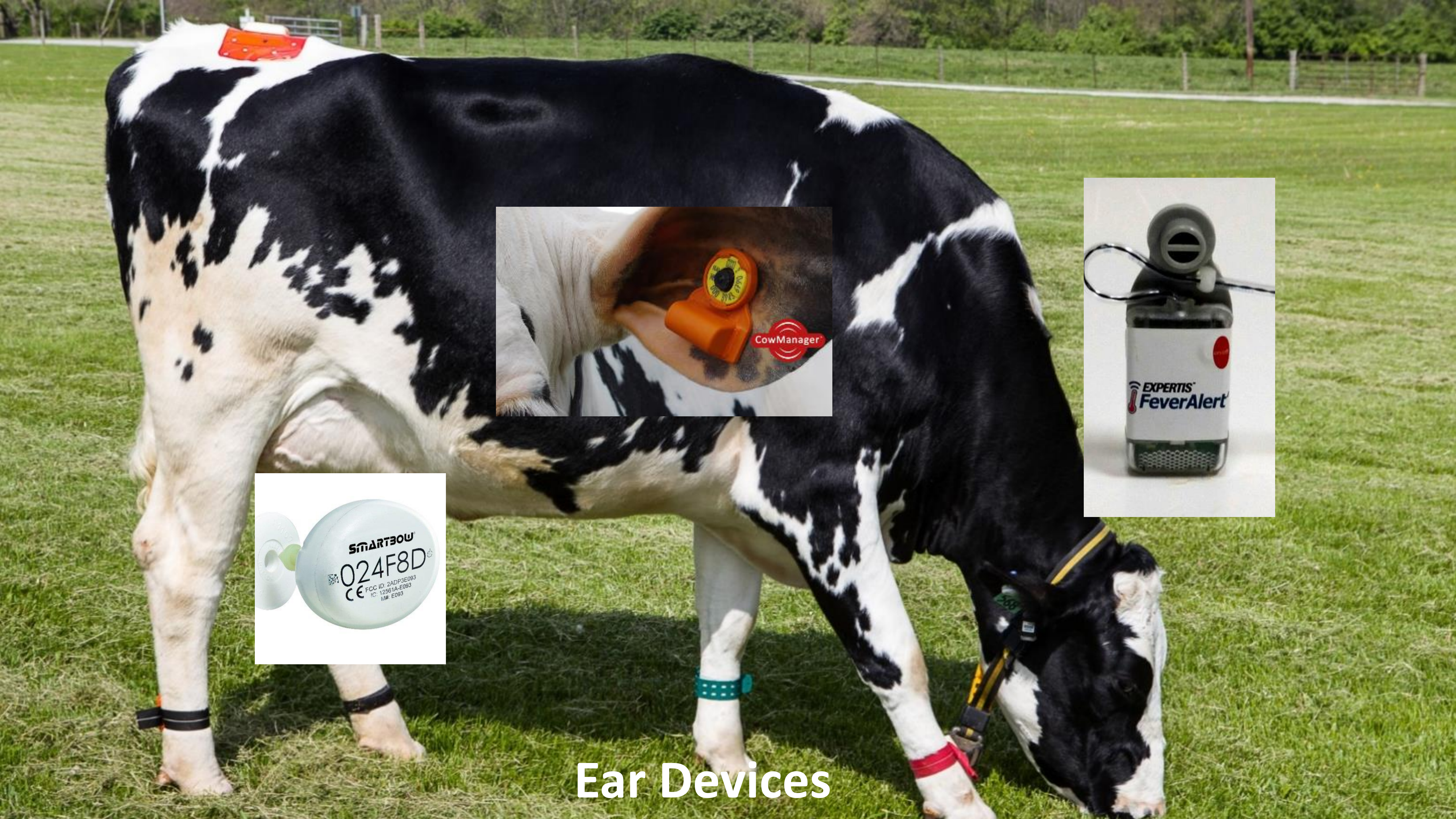
Detection Benefits

- Increase in cures
  - Less chronic cases?
- Increase in well-being
  - Fewer severe cases
  - Preemptive NSAID administration based on culture results
- Reduced chronic cases
  - Faster more appropriate treatment regimes

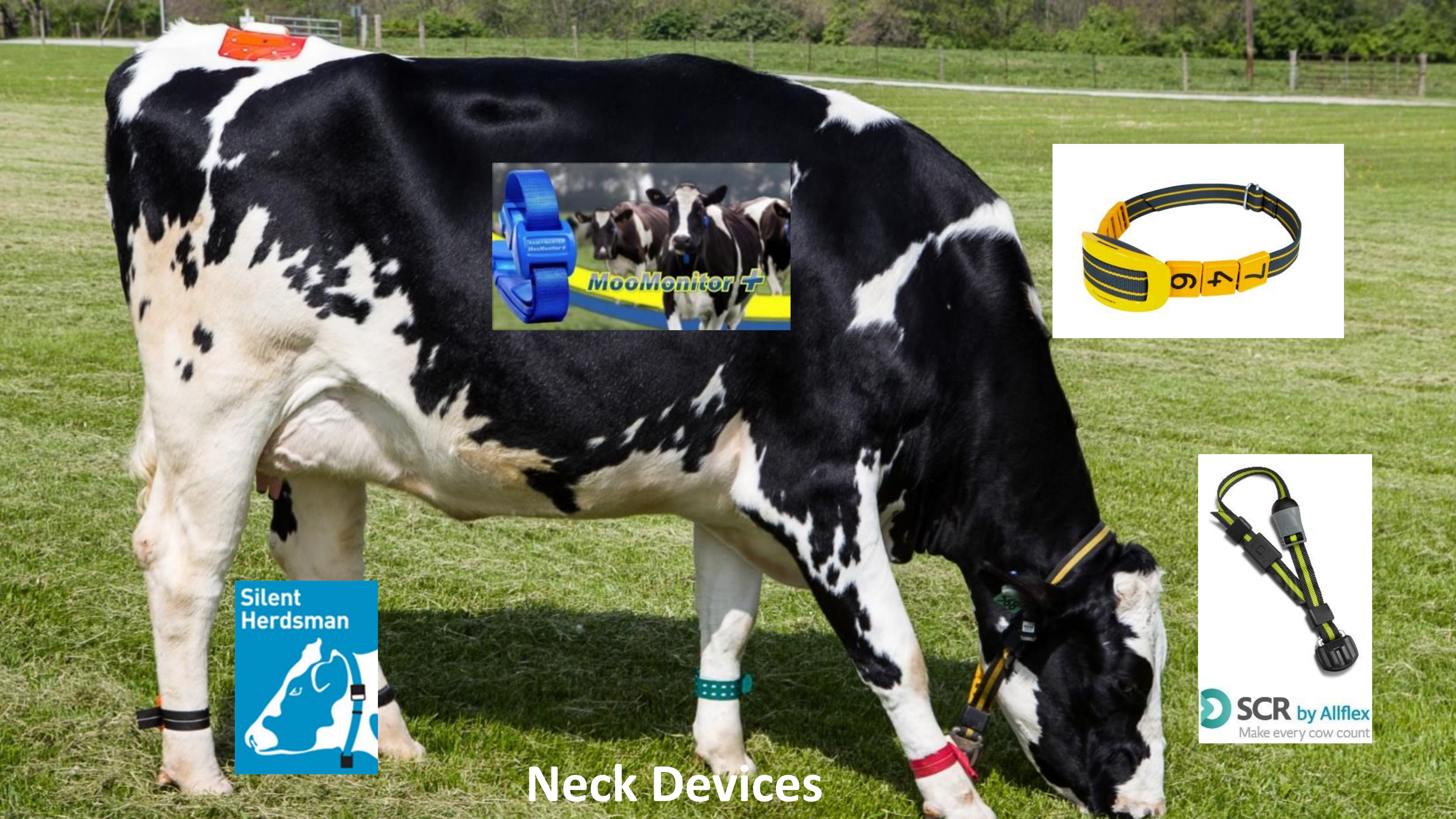
Detection Benefits

- Reduced disease transmission
  - Contagious animals separated sooner
- Separate abnormal milk
  - Threshold in component changes
    - For example, presence of blood
- Use of management protocols already in place to address sick cows


ICEQUBE
GEA
Leg Devices


CowManager
EXPERTIS
FeverAlert
SMARTBOW
024F8D
FCC ID: 2ADP3E093
IC: 12561A-E093
M#: E093

Ear Devices



Neck Devices

Rumen Devices

Calving Devices

Wearable Technology Attributes

EASY TO ATTACH TO COW

STAYS ATTACHED TO COW WITHOUT ABRASIONS OR INJURIES

BATTERY LIFE = 3 TO 5 YEARS

TRANSMITS DATA WITHOUT INTERRUPTION

STORES ENOUGH DATA TO WITHSTAND SYSTEM FAILURES

LESS THAN 3% OF DEVICES FAIL PER YEAR

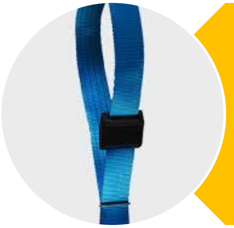
Best Place to Put a Tag?

Ear

+ Easy to put on
+ Small size
- Easily caught and torn out

Leg

+ Stays on well
- Harder to put on
- May collect manure



Neck

+ Logical location for behavior
+ Stays on well
- Neck growth

Tail

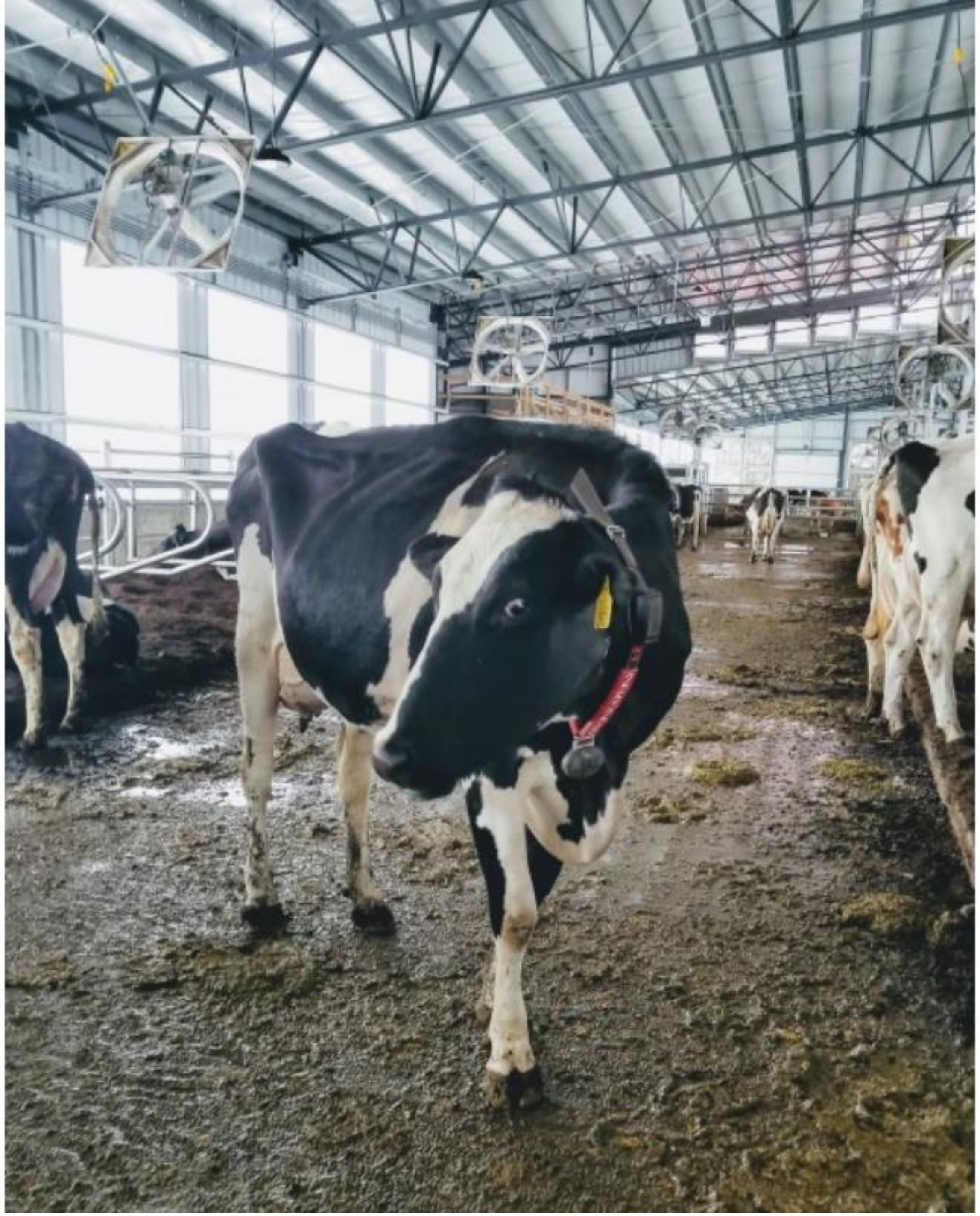
+ Good location for calving behavior
- Falls off
- May cut off blood flow

Connectivity

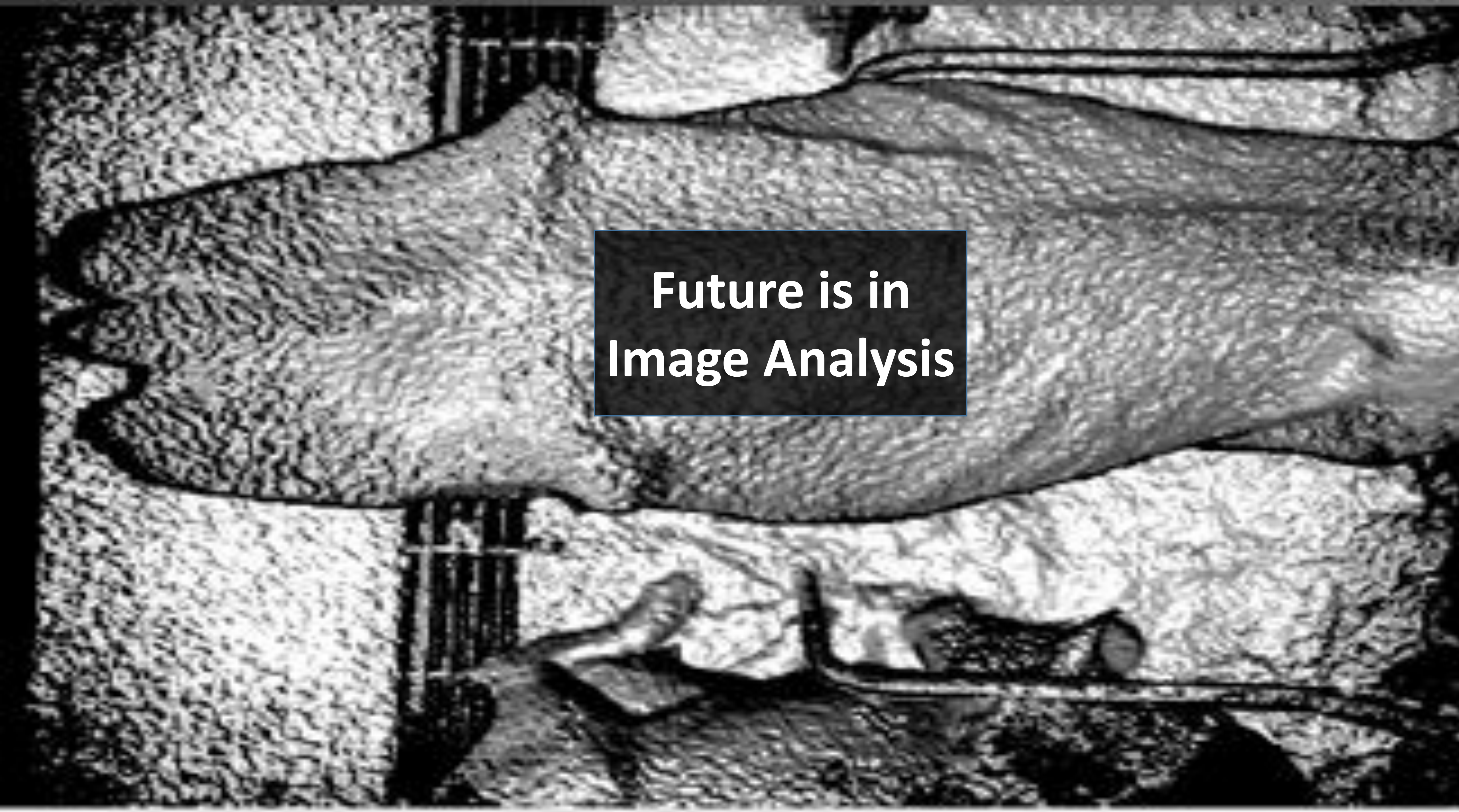
Subcutaneous Fitbits? These cows are modeling the tracking technology of the future

Livestock Labs is getting bio-monitors under cows' skin in hopes of helping farmers spot disease earlier, and it wants to bring its tech to people, too.

by Rachel Metz May 15, 2018




Herd Navigator
DeLaval
afimilk
Parlor and Image Devices


Future is in
Image Analysis

And Milk Analysis

J. Dairy Sci. 99:8477–8485
http://dx.doi.org/10.3168/jds.2015-10695

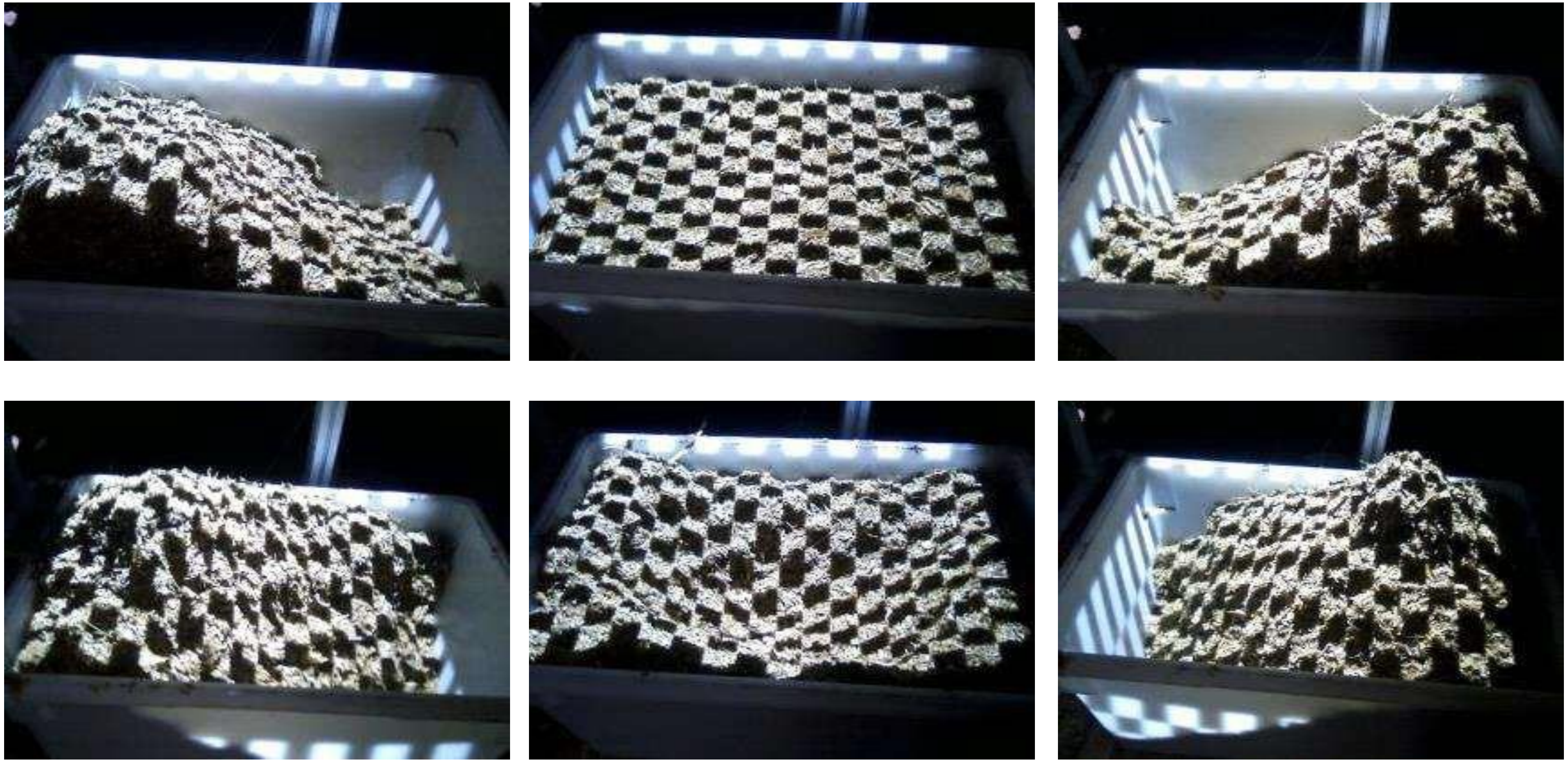
Development of a noninvasive system for monitoring dairy cattle sleep

J. M. Klefot,* J. L. Murphy,* K. D. Donohue,† B. F. O'Hara,‡ M. E. Lhamon,§ and J. M. Bewley*[1]

J. Dairy Sci. 99:386–391
http://dx.doi.org/10.3168/jds.2014-8964

Short communication: Measuring feed volume and weight by machine vision

A. N. Shelley,* D. L. Lau,* A. E. Stone,† and J. M. Bewley†[1]



Computers and Electronics in Agriculture 148 (2018) 226–236

Contents lists available at ScienceDirect

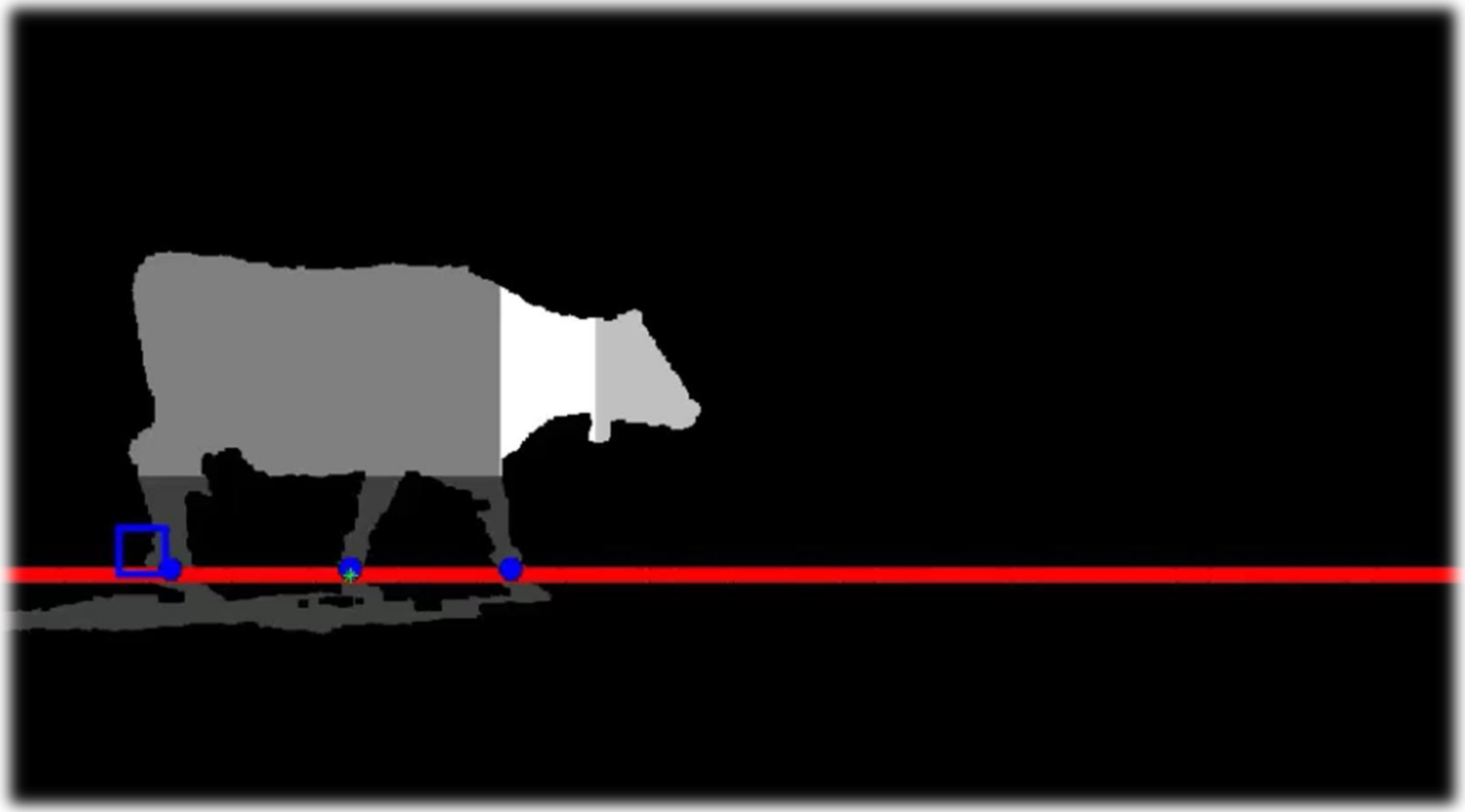
Computers and Electronics in Agriculture

journal homepage: www.elsevier.com/locate/compag

Original papers

Automatic lameness detection in dairy cattle based on leg swing analysis with an image processing technique

K. Zhao[a,b], J.M. Bewley[c], D. He[a,d,e,*], X. Jin[b]



Genetic Evaluations

- May provide information previously unavailable for genetic evaluations
- New or improved traits (i.e. feed intake, lameness, BCS, heat tolerance, fertility)
- Improved data accuracy (i.e. yield, fat, protein, SCC, health traits)
- More data, fewer erroneous measurements

Washington Post @washingtonpost

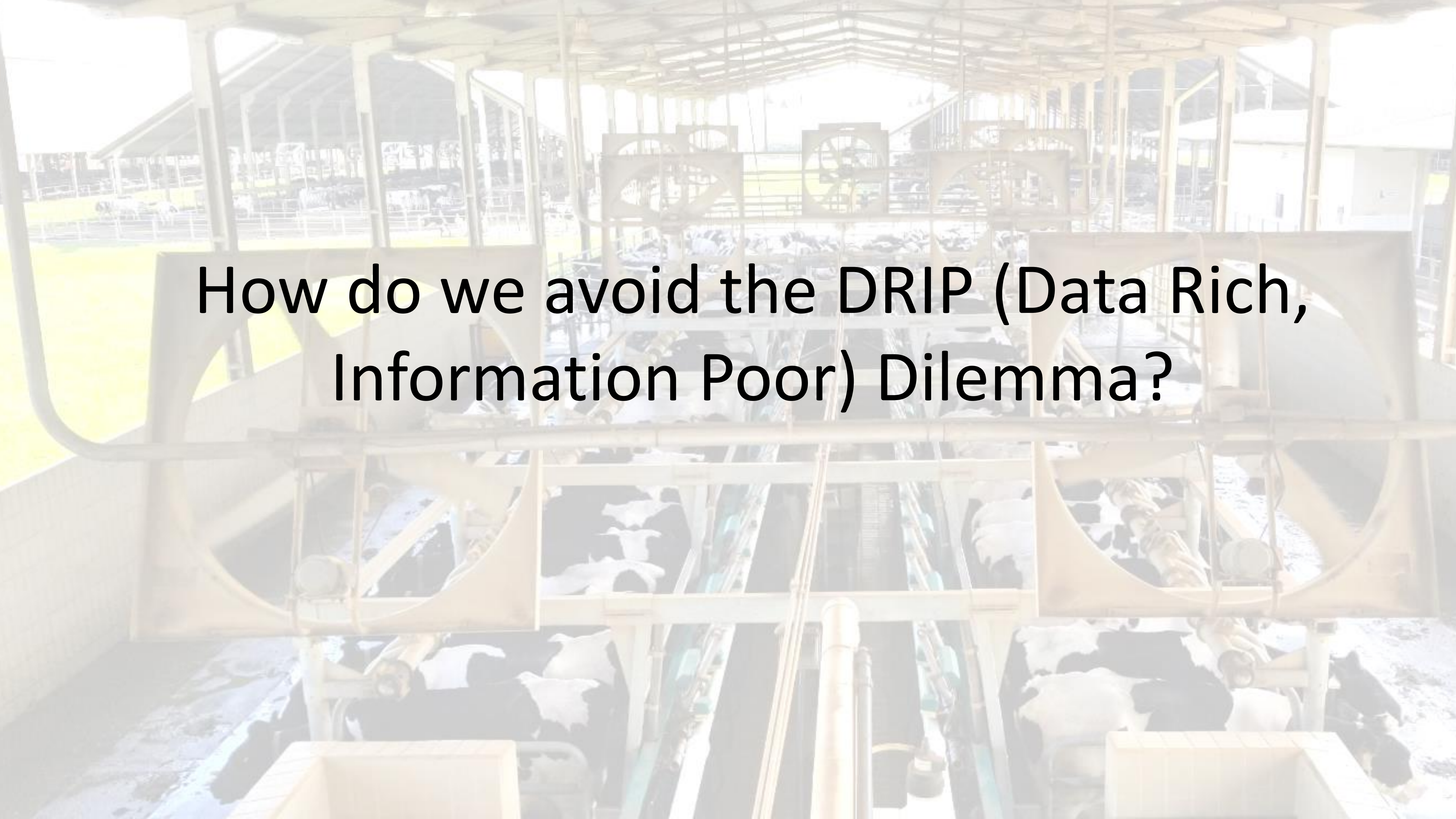
Follow

"Cow Fitbits" and artificial intelligence are coming to the dairy farm. But some farmers aren't so impressed.

'Cow Fitbits' and artificial intelligence are coming to the dairy farm. But some...

Farmers might be tackling a critical question before much of the rest of the workforce: Can new technology ever beat old intuition — even when it comes to a bunch of co...

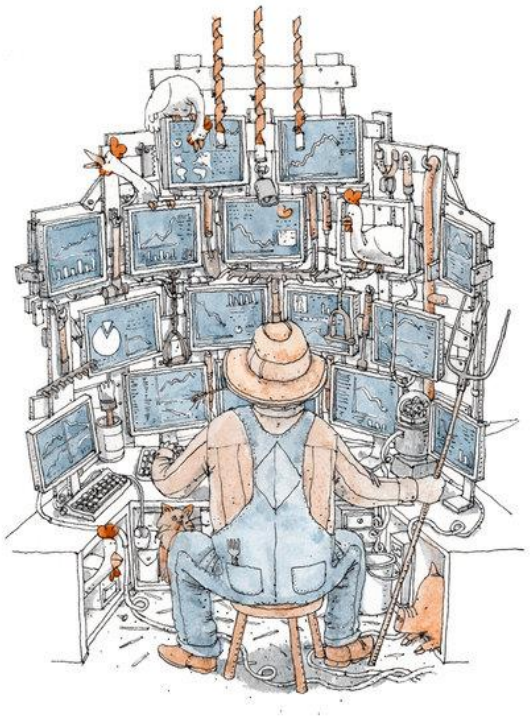
washingtonpost.com



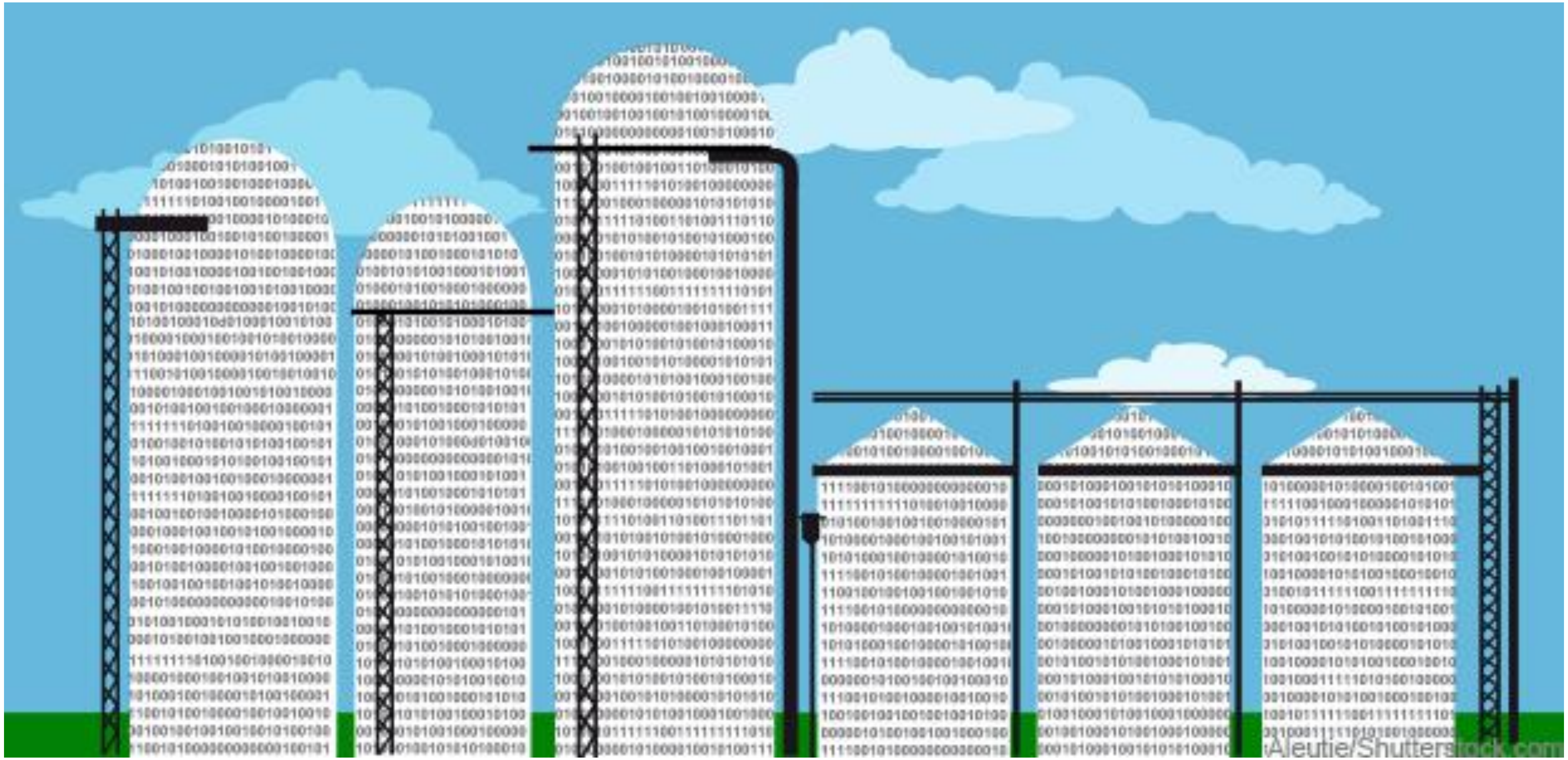
How do we avoid the DRIP (Data Rich, Information Poor) Dilemma?

Big Data Challenges

- Financial and production data are largely disconnected
- Inconsistent data entry
- Paper trails
- Rural connectivity
- Lack of standardization
- Advisory network is also confused



Data Silos



DHIA | Sensors | Genetics | Milk Buyer | Nutrition | Financial

Handling Data

- PROTOCOLS FOR HANDLING ALERTS
- NATURAL REACTIONS OF HEALTHY COWS
- REPEAT ALERTS
- FAILED DEVICES
- BACKUP PLAN FOR SYSTEM OUTAGE
- DATA SECURITY/OWNERSHIP

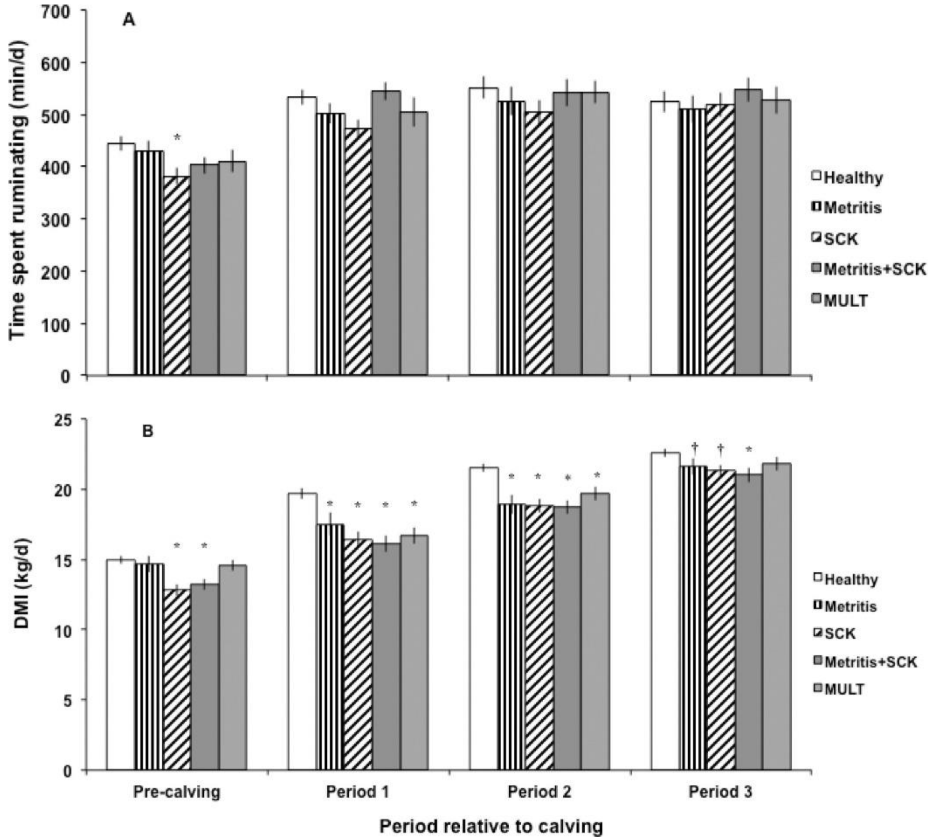
Software Interface Attributes

- Cloud based interface
- Smartphone application
- Addresses needs of visual and verbal learners
- Intuitive user interface
- Interconnectivity with herd management software
- Real-time data display
- Customer focused training and support
- Refined alert list

Technology Challenges and Limitations

- Brand differences in measures
- Technology failures
- Standardization
- Calibration
- Integration

British Columbia: Pre-calving Data Potential



Schirmann, D.M. Weary, W. Heuwieser, N. Chapinal, R.L.A. Cerri, M.A.G. von Keyserlingk
Journal of Dairy Science
Volume 99, Issue 12, Pages 9917-9924
(December 2016)

Cornell Research: Metritis Detection

Table 1. Incidence of metritis, DIM at clinical diagnosis, sensitivity of health index score (HIS) to detect cows with metritis, and interval between the first HIS-positive outcome and clinical diagnosis (CD) of metritis by farm personnel

Item	Events (no.)[1]	Incidence (%)	DIM at event (mean ± SD)	Sensitivity		HIS-positive to CD[2]		
				% (no./no.)	95% CI	Days	95% CI	*P*-value
Metritis[3]	349	32	6.8 ± 2.6	55 (191/349)	49, 60	−1.2	−1.6, −0.7	<0.01
Metritis only[4]	322	30	6.8 ± 2.6	53 (170/322)[a]	47, 58	−1.2	−1.6, −0.7	<0.01
Metritis with other disorders[5]	27	2	7.0 ± 2.4	78 (21/27)[b]	62, 91	−1.3	−2.4, −0.2	0.03
Metritis by rectal temperature								
≤39.4°C	165	52	7.2 ± 1.8	56 (92/165)	48, 64	−1.4	−1.9, −1.0	<0.01
39.5–39.9°C	79	25	6.2 ± 2.0	49 (39/79)	38, 61	−1.3	−2.9, 0.4	0.13
≥40.0°C	74	23	5.2 ± 1.8	58 (43/74)	46, 70	−0.2	−0.9, 0.4	0.46

[a,b]Different superscripts indicate differences ($P \leq 0.05$) between means based on mean separation with the LSD test.

[1]Number of events diagnosed (331 and 9 cows with 1 or 2 events of metritis, respectively).

[2]HIS-positive to CD = interval in days between the first positive HIS outcome (positive outcomes only) and clinical diagnosis.

[3]All metritis events recorded.

[4]Cows diagnosed with only metritis from −5 to 2 d relative to CD.

[5]Cows diagnosed with metritis and at least another health disorder from −5 to 2 d relative to CD.

M.L. Stangaferro, R. Wijma, L.S. Caixeta, M.A. Al-Abri, J.O. Giordano

Journal of Dairy Science

Volume 99, Issue 9, Pages 7422-7433

(September 2016)

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Cornell Research: Metabolic Disease Detection

Table 2. Incidence of metabolic and digestive disorders, DIM at clinical diagnosis, sensitivity of health index score (HIS) to detect cows with disorders, and interval between the first HIS-positive outcome and clinical diagnosis (CD) of disorders by farm personnel

				Sensitivity		HIS-positive to CD[2]		
Disorder	Cows (no.)[1]	Incidence (%)	DIM at event (mean ± SD)	% (no./no.)	95% CI	Days	95% CI	*P*-value
Displaced abomasum	41	3.8	14.9 ± 10.5	98 (40/41)	93, 100	−3.0	−3.7, −2.3	<0.01
Displaced abomasum only[3]	20	1.9	19.2 ± 13.1	100 (20/20)	83, 100	−3.2	−4.1, −2.2	<0.01
Displaced abomasum with other disorders[4]	21	1.9	10.9 ± 4.8	95 (20/21)	76, 100	−2.8	−3.9, −1.7	<0.01
Ketosis	54	5.0	9.3 ± 5.4	91 (49/54)	83, 99	−1.6	−2.3, −1.0	<0.01
Ketosis only	28	2.6	10.1 ± 6.7	89 (25/28)	72, 98	−0.9	−1.8, 0.1	0.06
Ketosis with other disorders	26	2.4	8.3 ± 3.4	92 (24/26)	75, 99	−2.4	−3.3, −1.5	<0.01
Indigestion	9	0.8	8.3 ± 6.9	89 (8/9)	68, 100	−0.5	−1.5, 0.5	0.28
Indigestion only	7	0.6	7.8 ± 6.1	86 (6/7)	60, 100	−0.7	−2.1, −0.8	0.29
Indigestion with other disorders	2	0.2	6.0 ± 0.0	100 (2/2)	16, 100	0.0	—	—
All metabolic-digestive[5]	104	9.6	11.4 ± 8.3	93 (97/104)	89, 98	−2.1	−2.5, −1.6	<0.01
Metabolic-digestive only	55	5.1	13.2 ± 10.5	93 (51/55)	82, 98	−1.7	−2.4, −1.1	<0.01
Metabolic-digestive with other disorders	49	4.5	9.3 ± 4.2	94 (46/49)	83, 99	−2.5	−3.1, −1.8	<0.01

[1]Number of events diagnosed.

[2]HIS-positive to CD = interval in days between the first positive HIS outcome (positive outcomes only) and CD.

[3]Cows diagnosed with the disease of interest only from −5 to 2 d relative to CD.

[4]Cows diagnosed with the disease of interest and at least another health disorder from −5 to 2 d relative to CD.

[5]Metabolic-digestive = metabolic and digestive disorders combined (displaced abomasum, ketosis, and indigestion).

M.L. Stangaferro, R. Wijma, L.S. Caixeta, M.A. Al-Abri, J.O. Giordano
Journal of Dairy Science
Volume 99, Issue 9, Pages 7422-7433
(September 2016)

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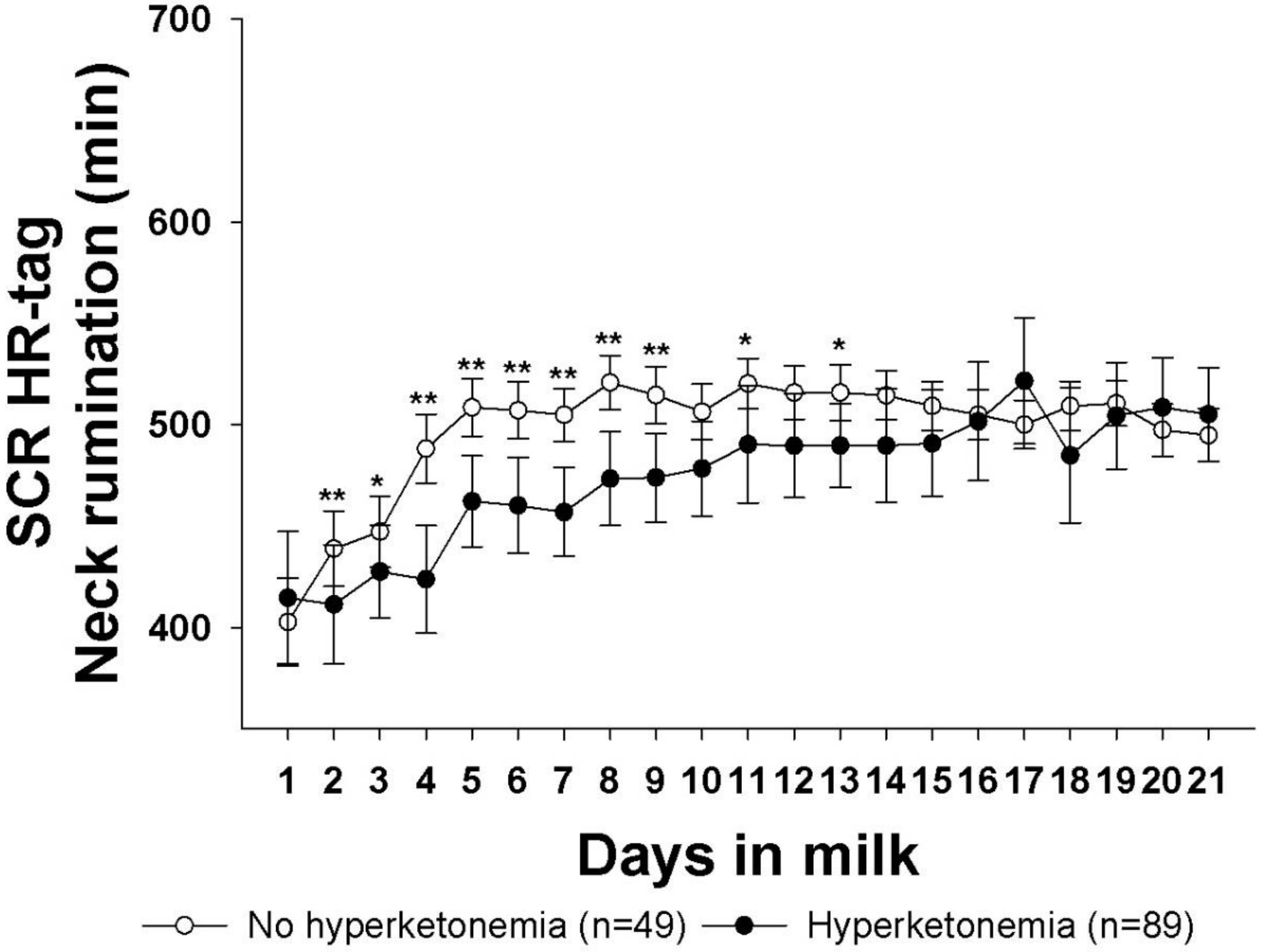
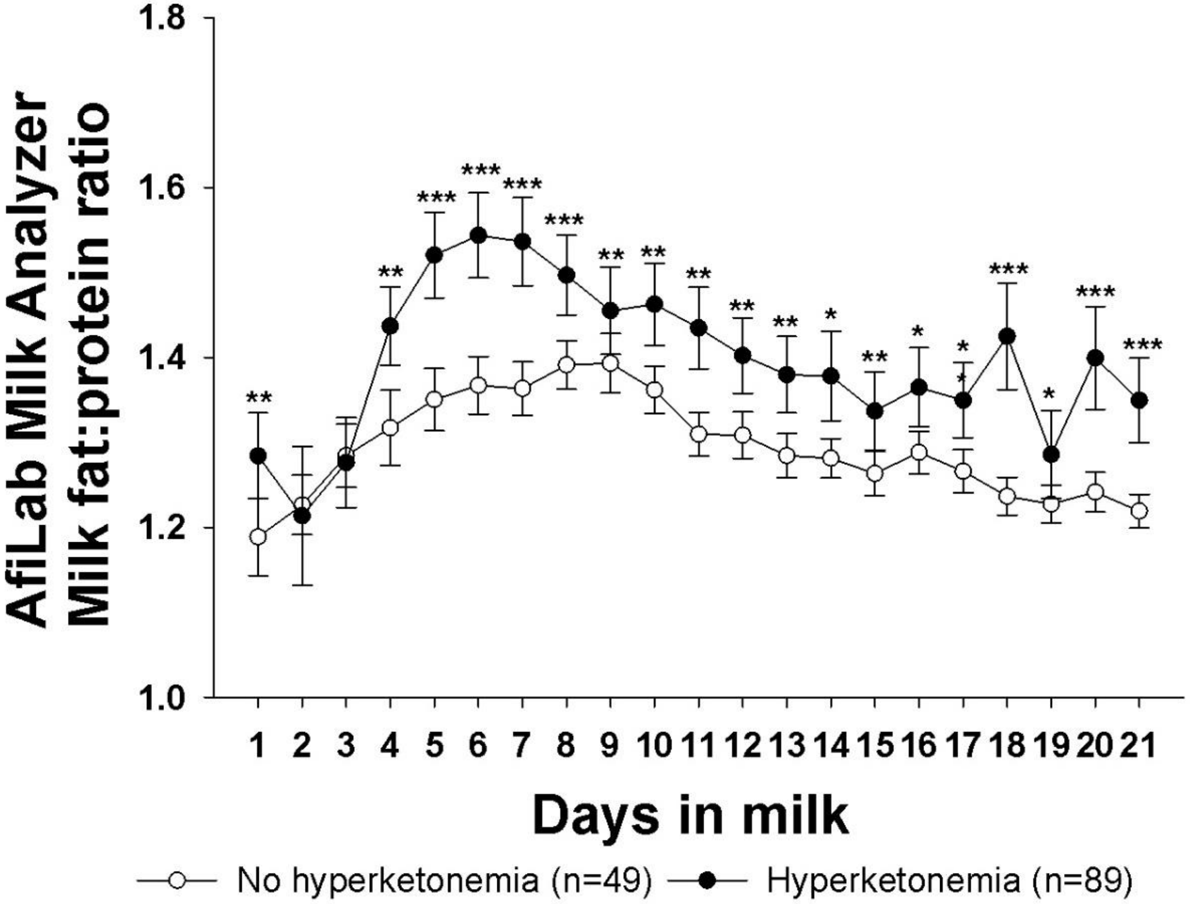
Hyperketonemia: Increased rumination time



† $P < 0.1$, * $P < 0.05$, ** $P < 0.01$, *** $P < 0.001$

Tsai et al. 2016, unpublished

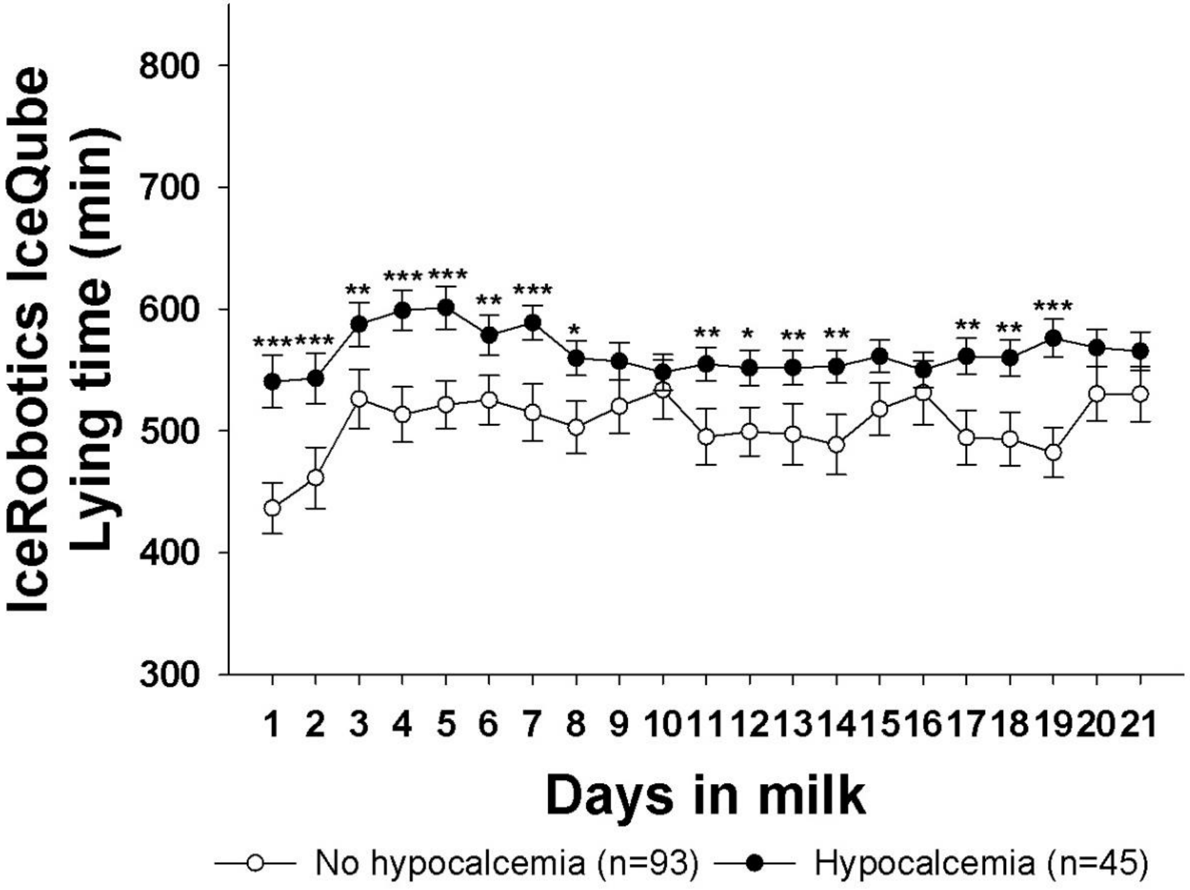
Hyperketonemia: Higher fat:protein



† *P* < 0.1, * *P* < 0.05, ** *P* < 0.01, *** *P* < 0.001

Tsai et al. 2016, unpublished

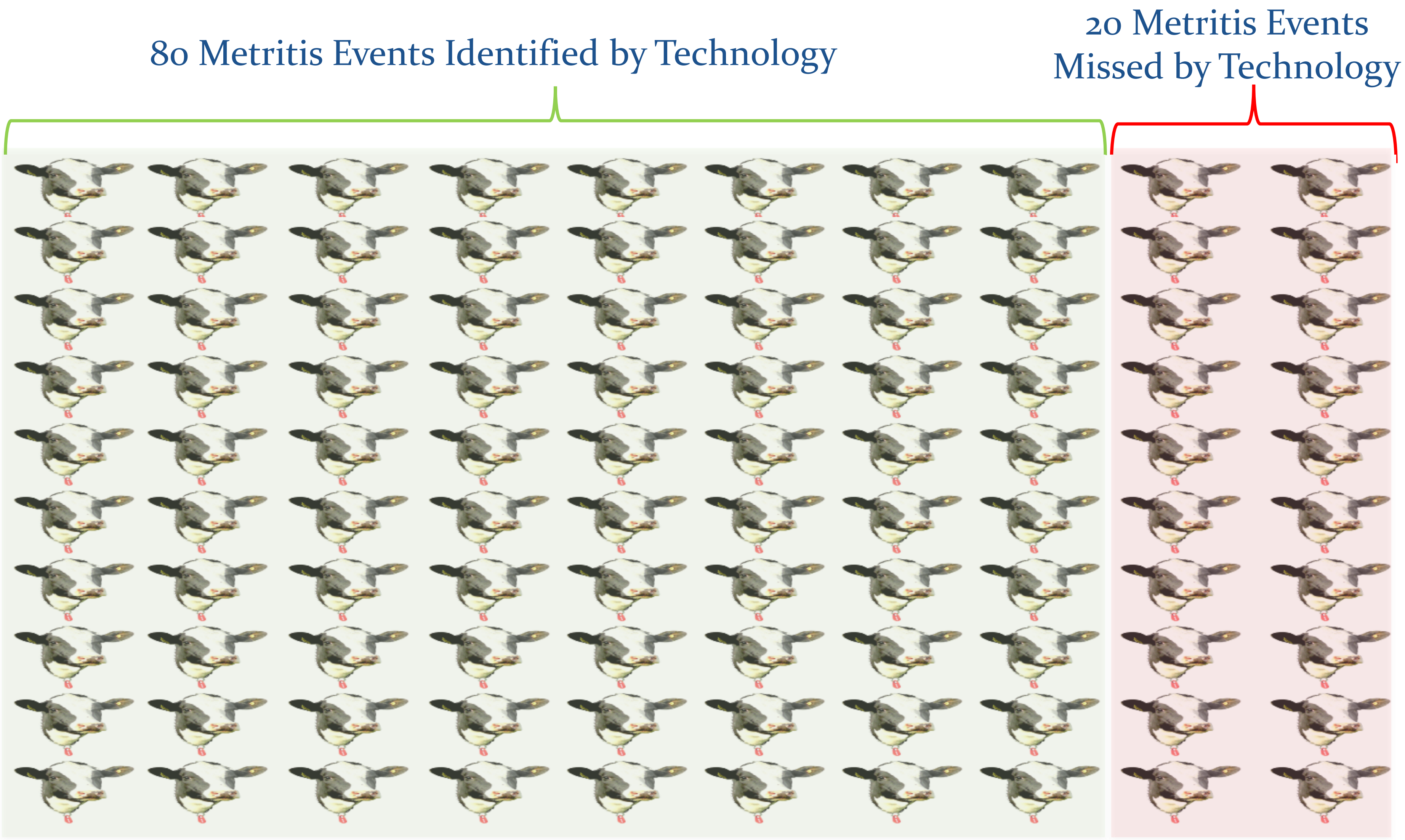
Hypocalcemia: Increased lying



† *P* < 0.1, * *P* < 0.05, ** *P* < 0.01, *** *P* < 0.001

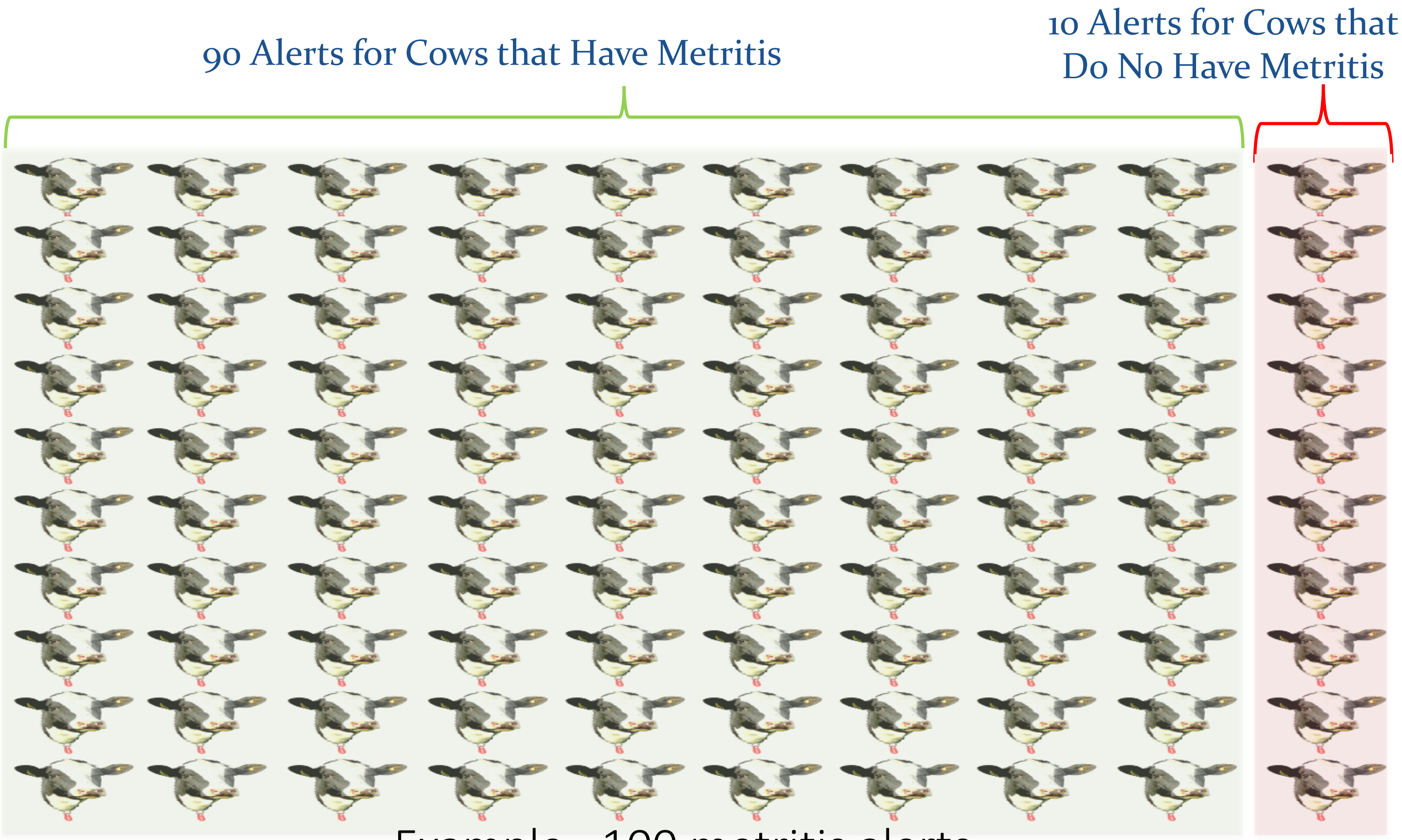
Tsai et al. 2016, unpublished

How Many Cows With Condition Do We Find?



Example: 100 metritis events

How Many Alerts Coincide with an Actual Event?



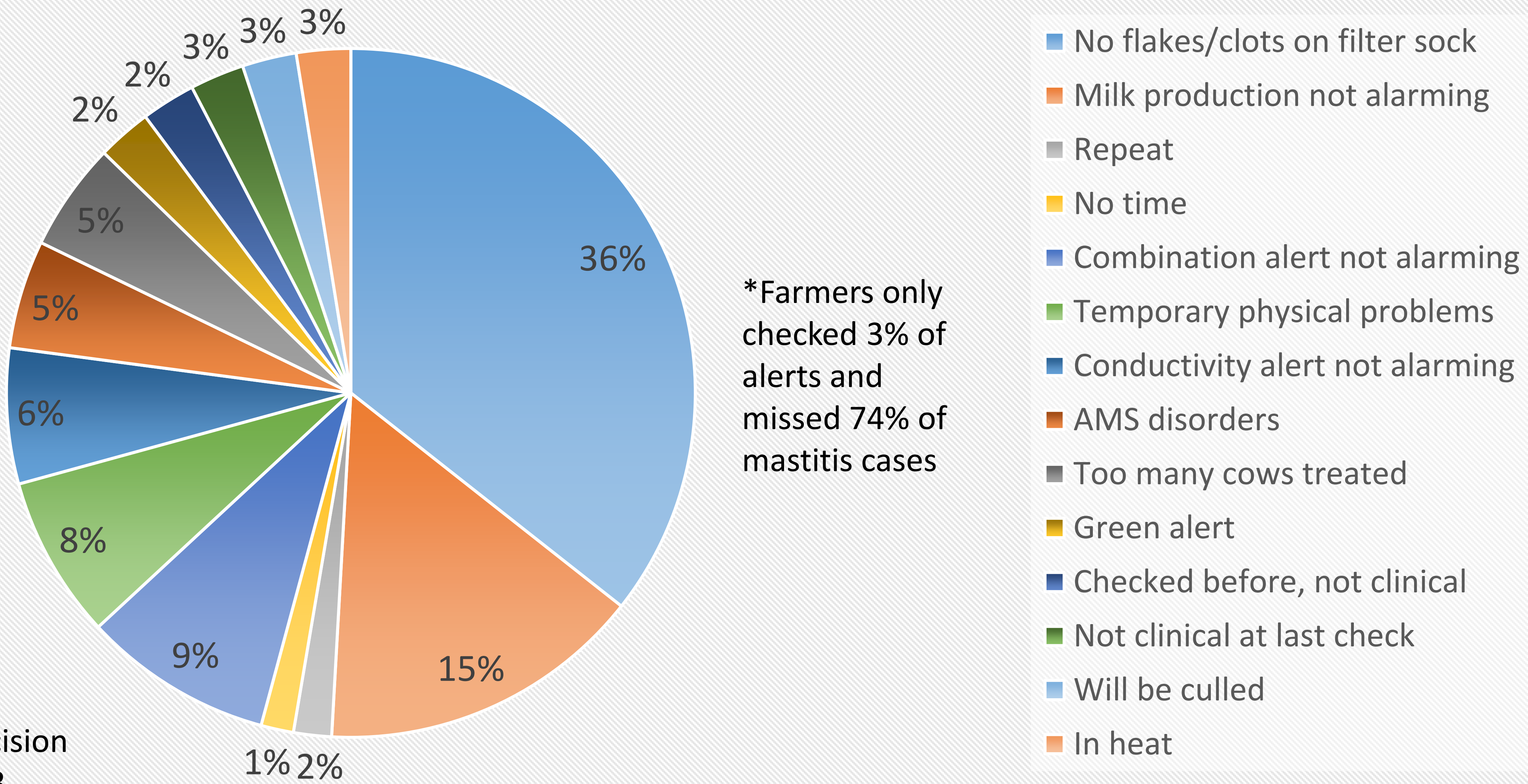
Example: 100 metritis alerts

Sensitivity and Specificity

Technology	Disease		
	Se (%)	Sp (%)	Acc (%)
System 1	80	85	83
System 2	80	81	81
System 3	70	77	75
System 4	78	82	80
System 5	76	80	78
System 6	46	88	77
System 7	60	85	75

Tsai et al. 2016, unpublished

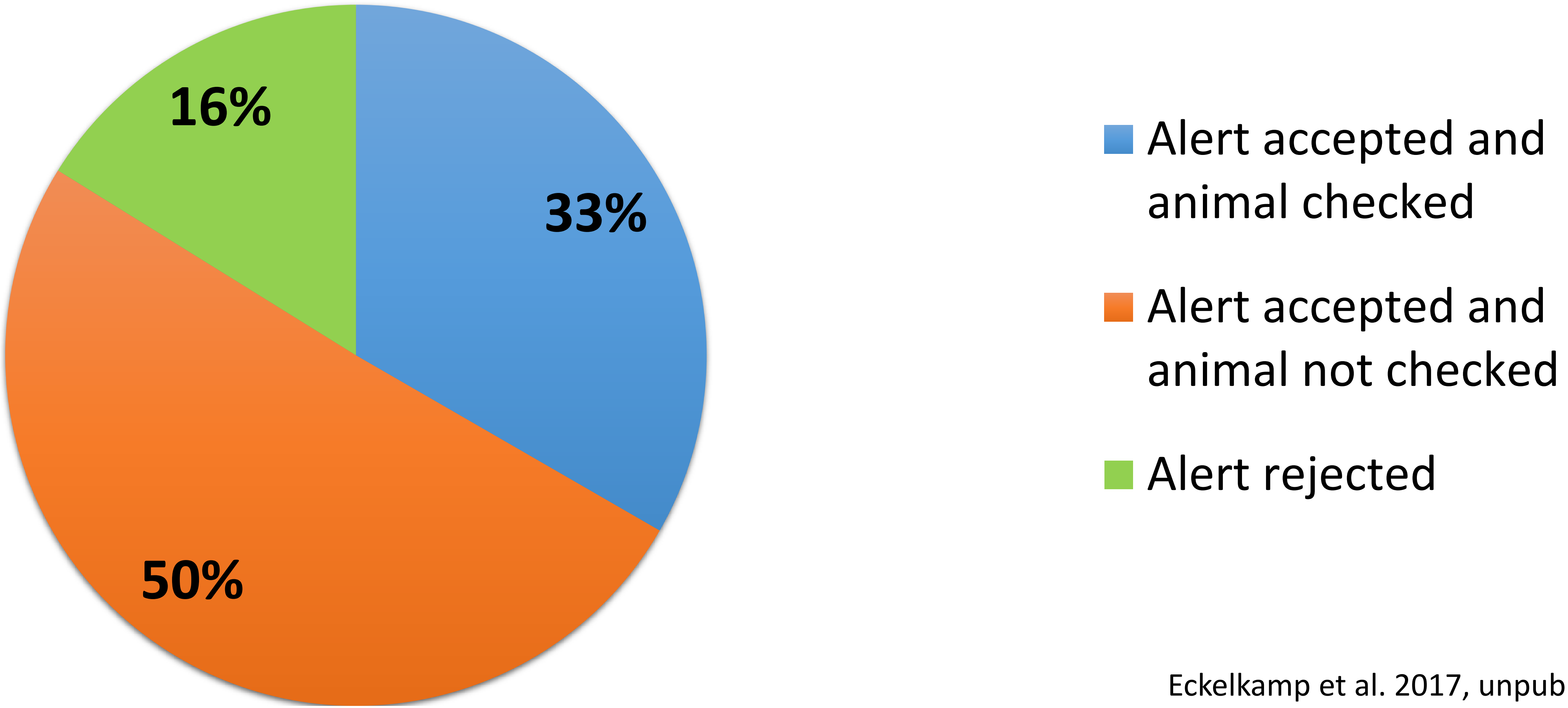
Reasons alerts were not checked



*Farmers only checked 3% of alerts and missed 74% of mastitis cases

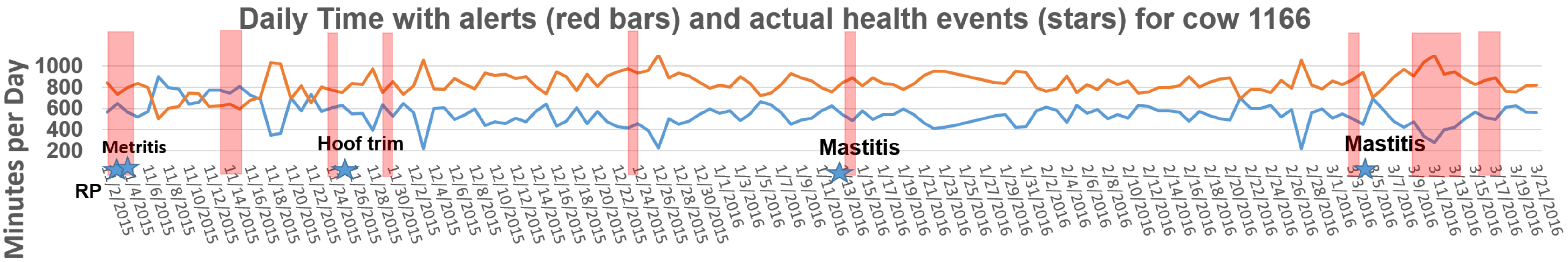
Hogeveen et al., Precision Livestock Farming '13

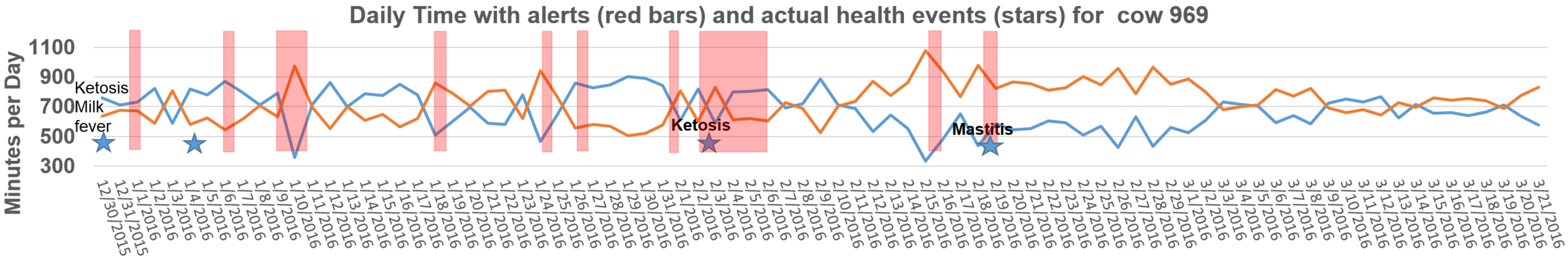
Farmer Handling of Sensor Alerts



Eckelkamp et al. 2017, unpublished

Timeline Alert/Event Comparisons



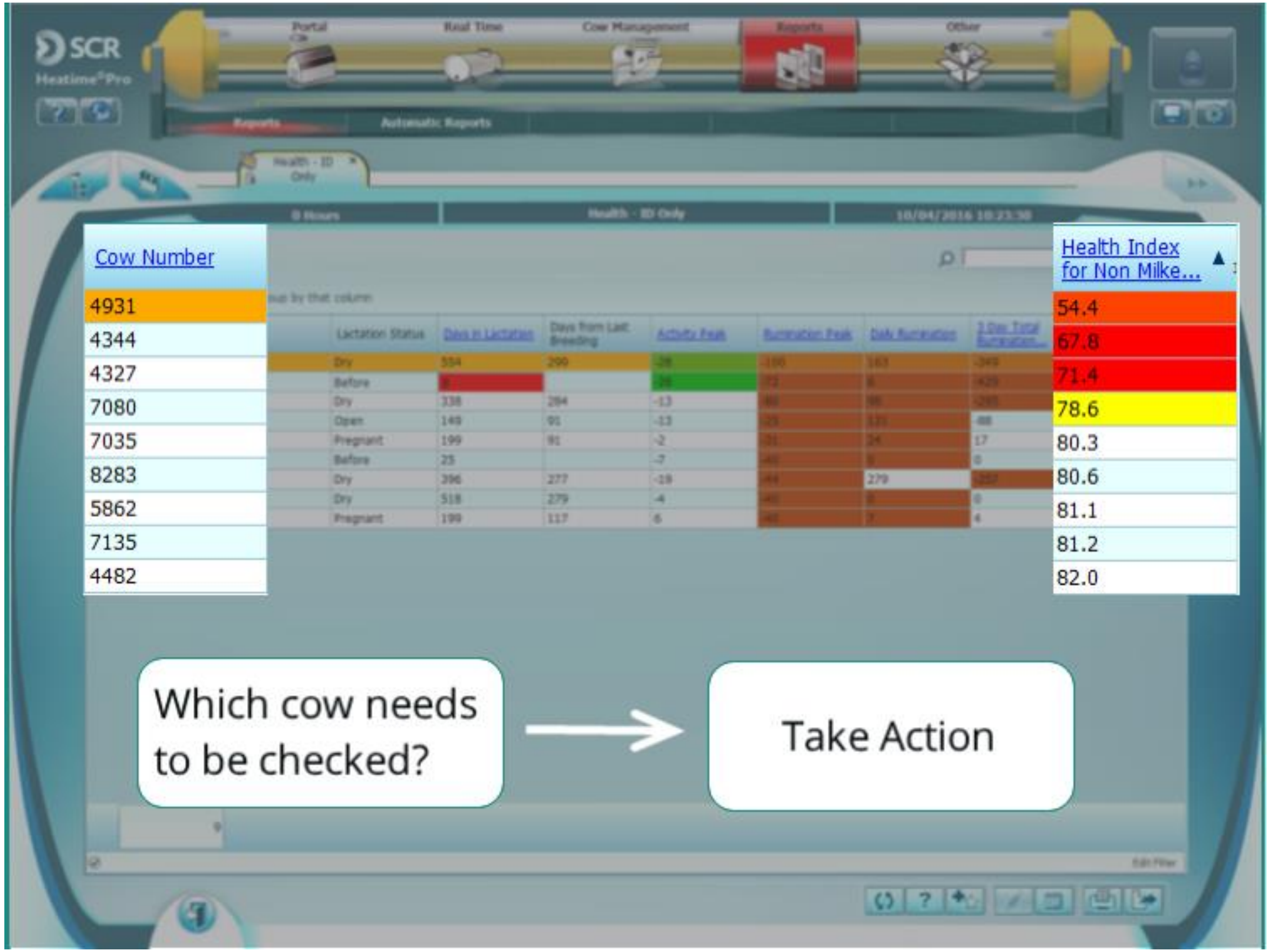


Eckelkamp et al. 2017, unpublished

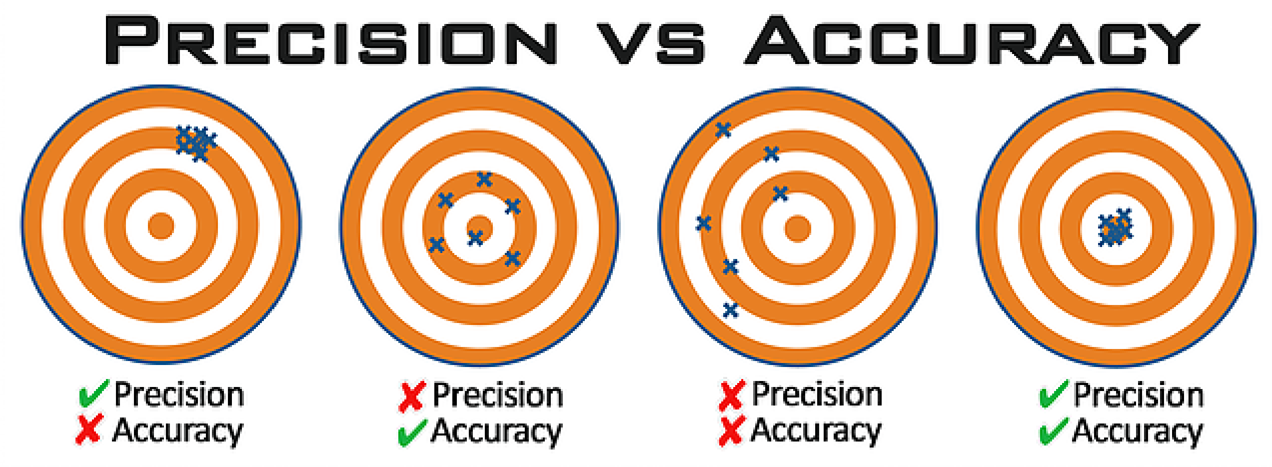
Alert Definition Dilemma

- Systems may alert subclinical conditions that end users view as false positive
- Systems may provide alerts sooner than physical signs appear
- Systems may provide alerts after clinical symptoms have been observed

Health Index Solves Some Concerns

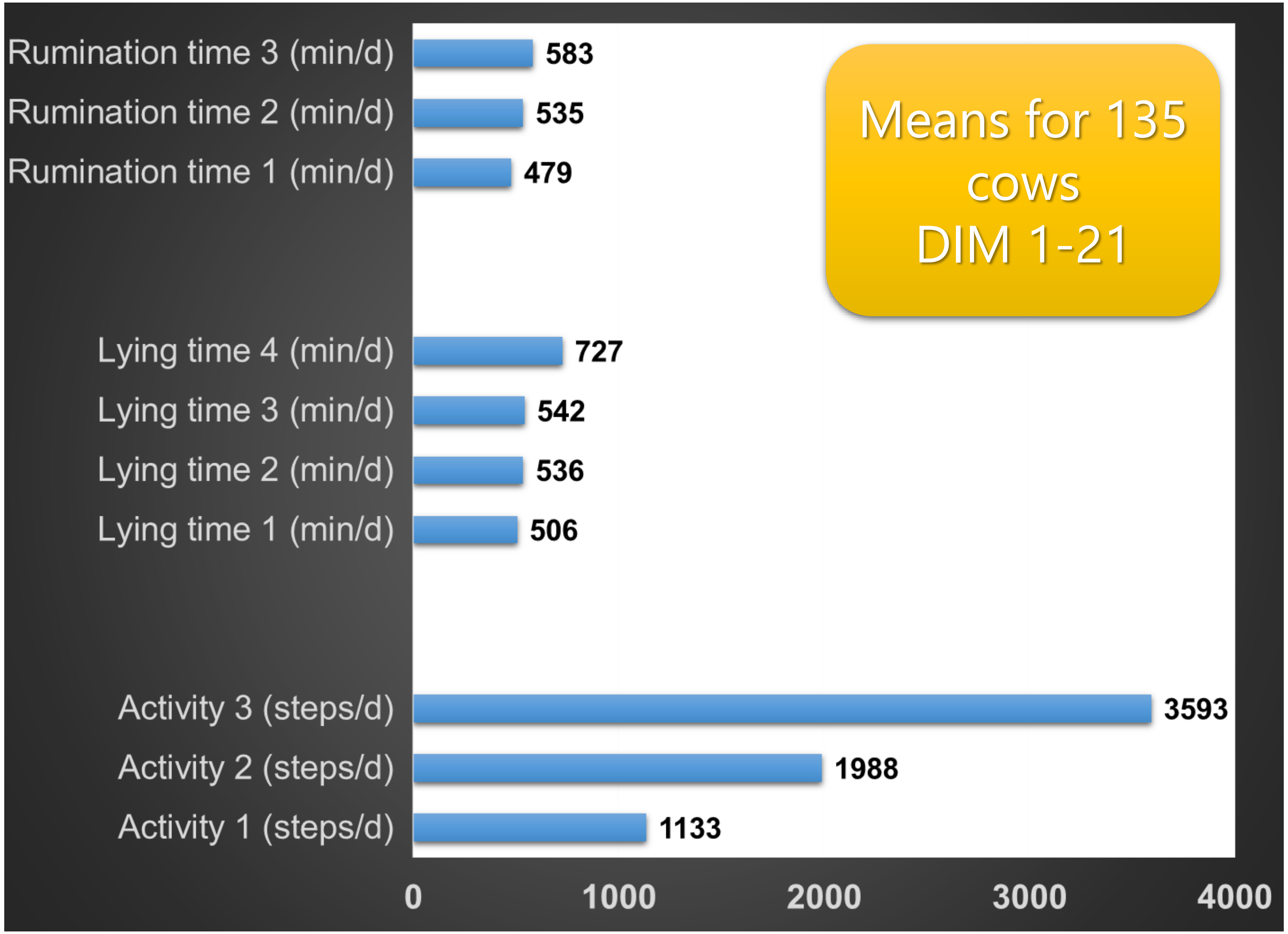


Are we measuring the targets we intend to?



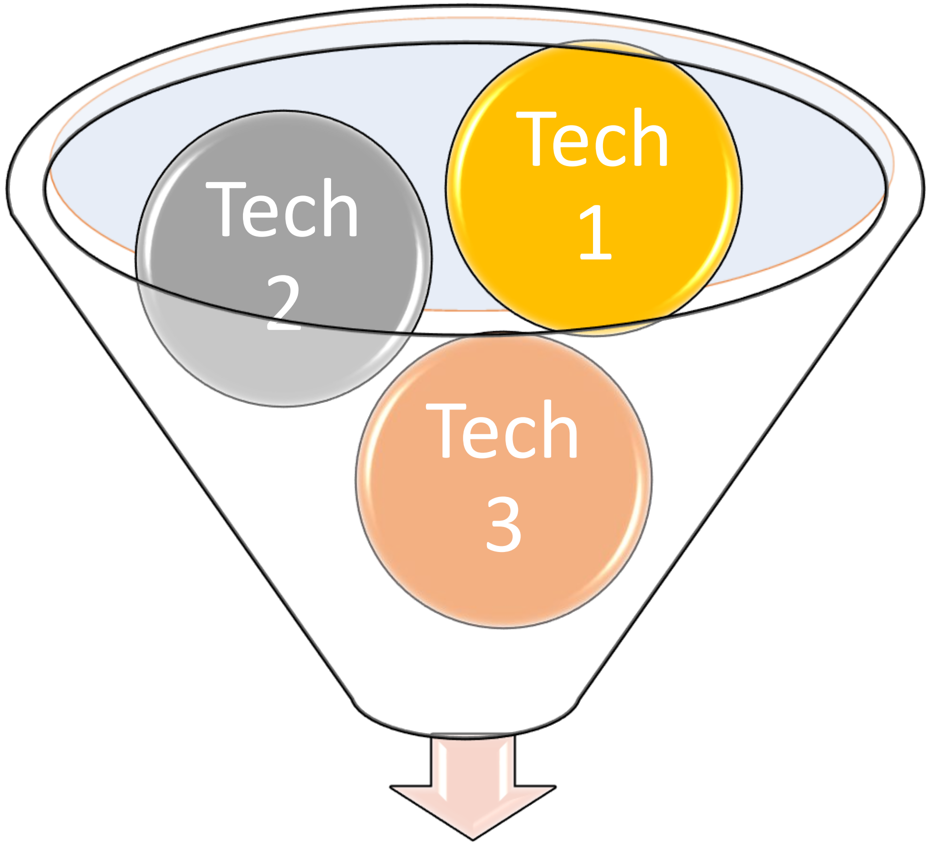
Can’t forget the need for third party validations

X ≠ X and Y ≠ Y



Tsai et al., 2016

Disappearing Data



847 cow days (29%) out of possible 2898

- **138 cows**
- **DIM 1 to 21**
- **2898 cow days**
- **7 technologies**

Tsai et al., 2016

Disease Challenges

- Meeting sensitivity (80%) and specificity (99%) goals (Rasmussen, 2004)
- Calibration across time
- Automatic diversion or alert?
- Recommended action when an alert occurs with no clinical signs

Disease Challenges

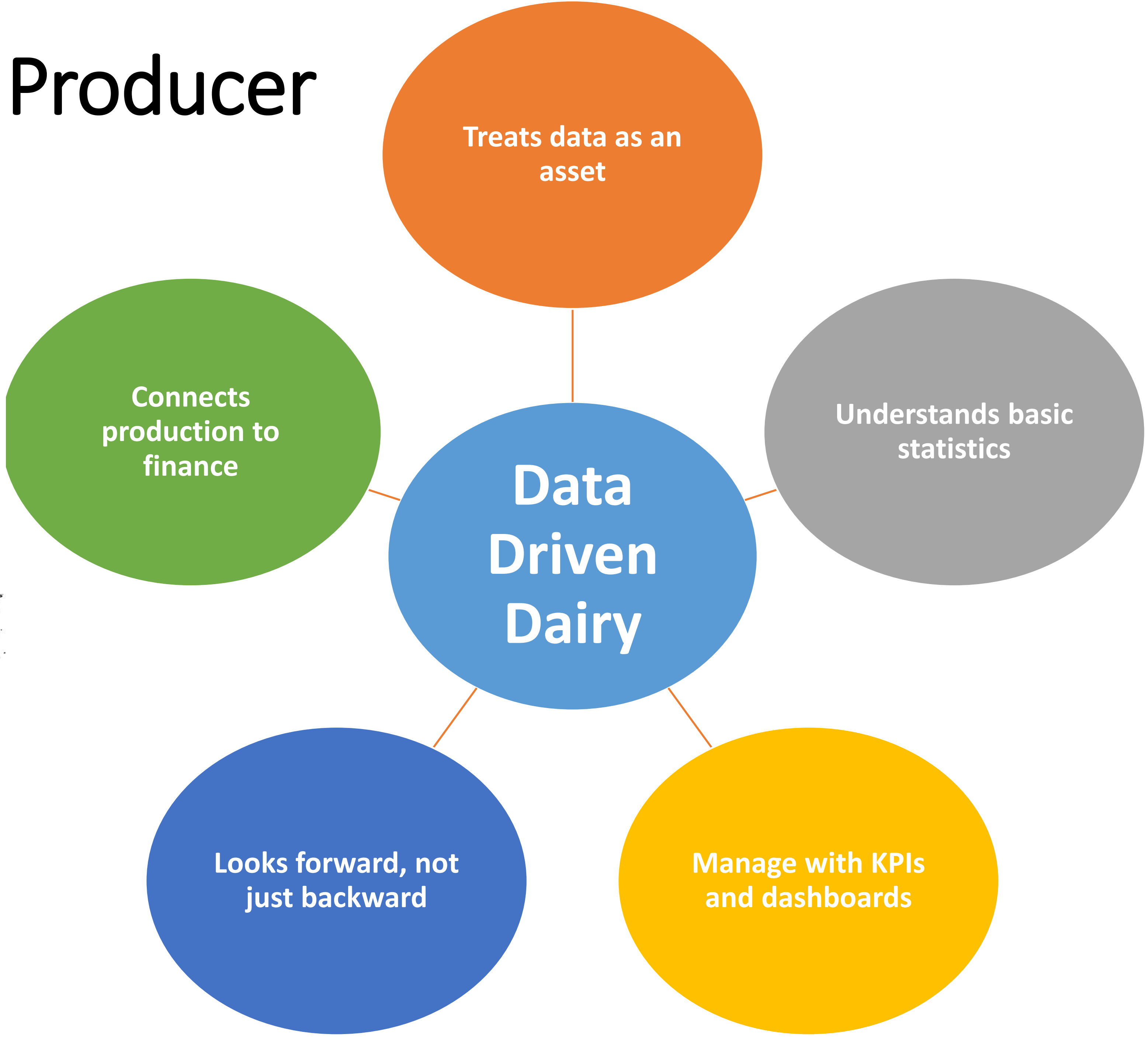
- Dynamics of clinical and subclinical states
- Potential for overtreatment
- Employee education
- Gold standards imperfect

Other Cautions

- Huge within cow and within herd variation
- Many management factors and environmental conditions affect these variables
- Group/pen changes affect behaviors
- Some cows don’t read the book
- Not all changes are linear

David Corbin (top) is able to track the health of his dairy herd with RFID trackers on the cow's legs.

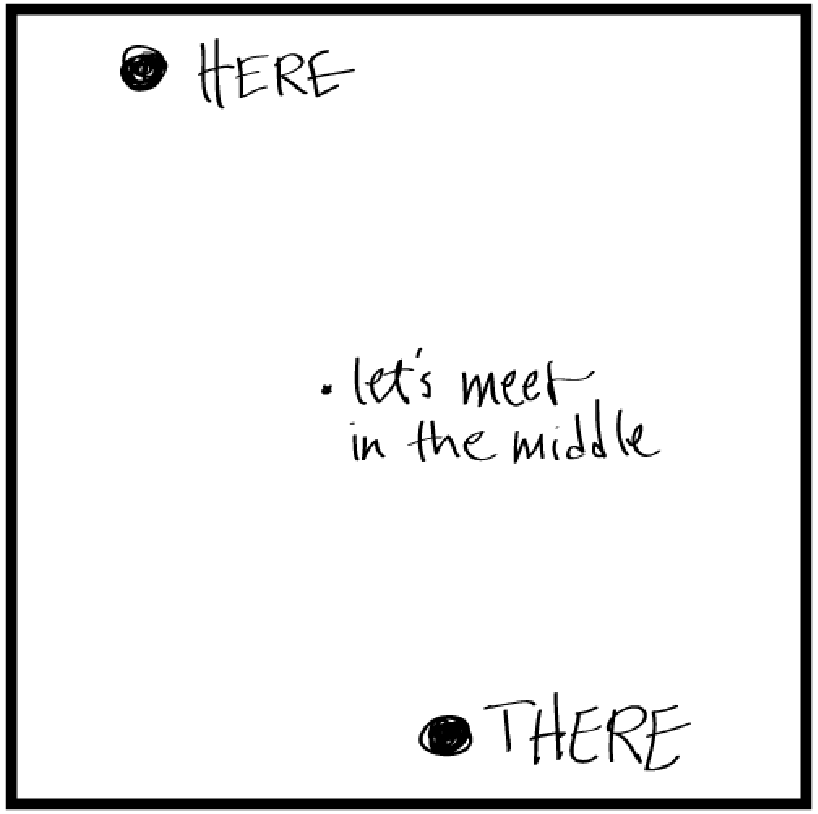
Data Driven Dairy Producer



Where do we go from here?

- Identify disease prospectively
- Determine course of action after alert
  - Culture?
  - Treatment?
  - Another intervention?
- Assess economic benefit of identification

Possible Future?



- Develop standards for assessing monitoring technology usefulness
- Address farmer need for meaningful alerts
- Account for degree of infection
- Capture the complexity of clinical and subclinical disease

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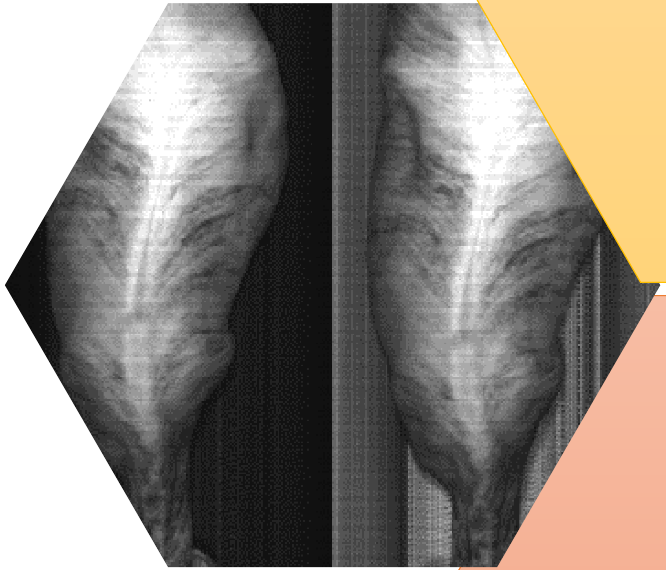
How Can Advisors Help?

- Understand pros and cons of systems
- Understand investment economics
- Create a plan for using data
- Develop protocols for therapeutics, treatment, culling



Health Detection Technologies

Realistic Expectations

Exciting Opportunities


Jeffrey Bewley, PhD, PAS
jbewley@alltech.com
533
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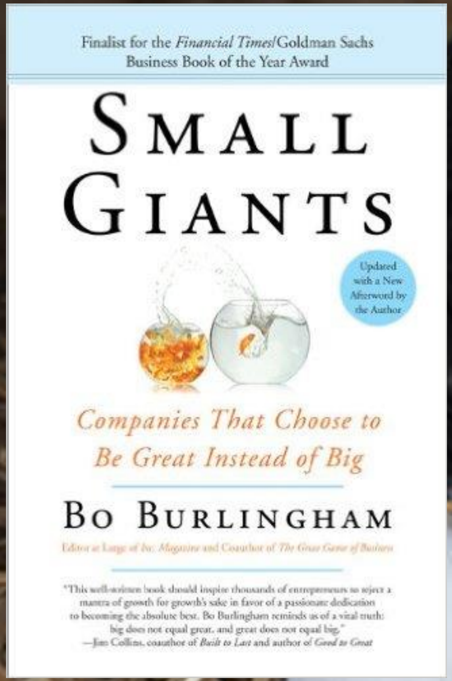
Small Giants: Strategies for Small Farm Competitiveness

Jeffrey Bewley, PhD



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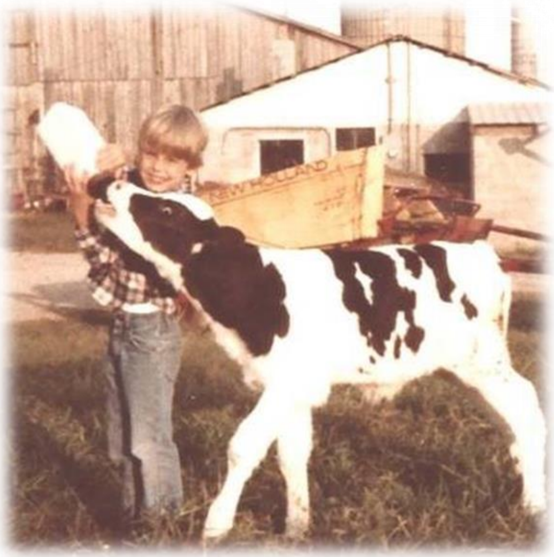
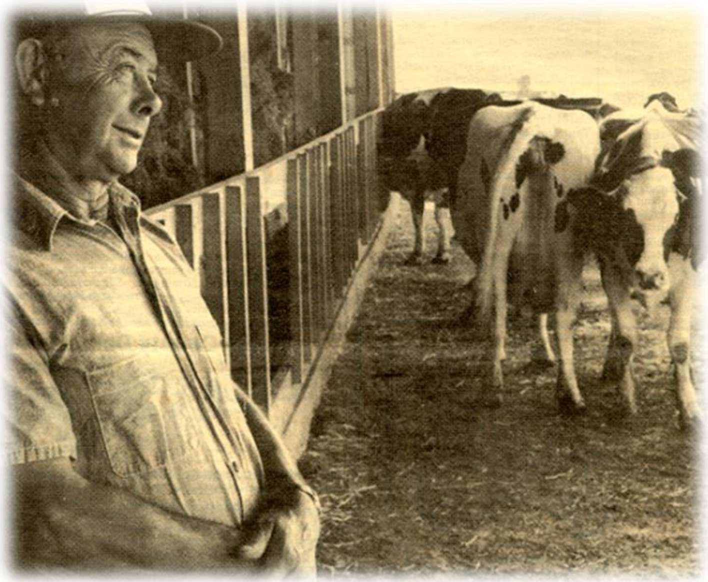
I Come From a Small Farm





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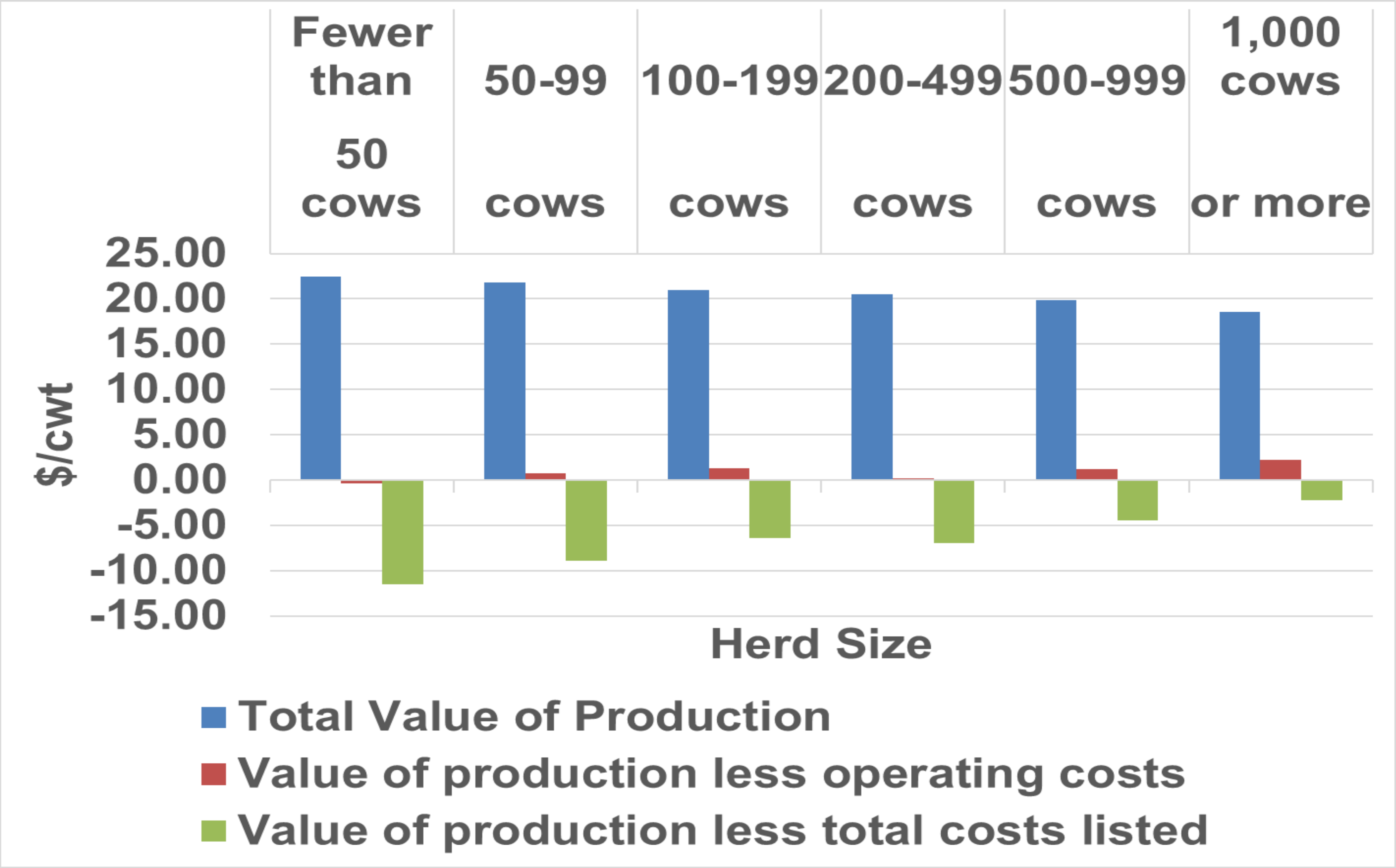
I Understand the Realities



USDA ERS, 2015

What is a Small Dairy? Anyone Who Can’t Ship a Tanker Load Each Day?

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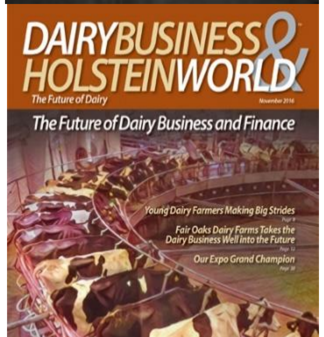
Read More than Just Dairy



SMALL GIANTS

Companies That Choose to Be Great Instead of Big

Small Giant Characteristics

1. ***The Leader Factor.*** Self-aware leaders with a vision

2. ***The Community Factor.*** Rooted within their local communities

3. ***Employee Factor.*** Engaged and valued employees

Small Giant Characteristics

4. ***The Customer/Supplier Factor.*** Personal ties to customers and suppliers

5. ***The Margin Factor.*** Sound business models with some margin protection

6. ***The Passion Factor.*** "They have the soul of an artist, but happen to be in business"

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Mojo---the corporate equivalent of charisma in a person

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Five Mojo Elements

1. Be the best
2. Know your business and its limitations
3. Be responsive to consumer demands
4. Build relationships
5. Stay privately held

How Will You Be Great?

- High yield
- Marketing genetics
- On-farm processing
- Grazing
- Organic
- Agri-tourism
- Partnerships with other farmers
- Contract heifer raising (either direction)
- Contract feed
- Strategic investments

Strive for Farm Resilience

1. Learn to live with change and uncertainty
    - Expect the unexpected
    - Learn from crises
    - Remain flexible
    - Spread risk

Darnhofer, 2009

Strive for Farm Resilience

2. Nurture Diversity

- Diversity of crops, animals, breed, products, and enterprises
- Look for ways to rely less on others for labor, nutrient management, energy use or money

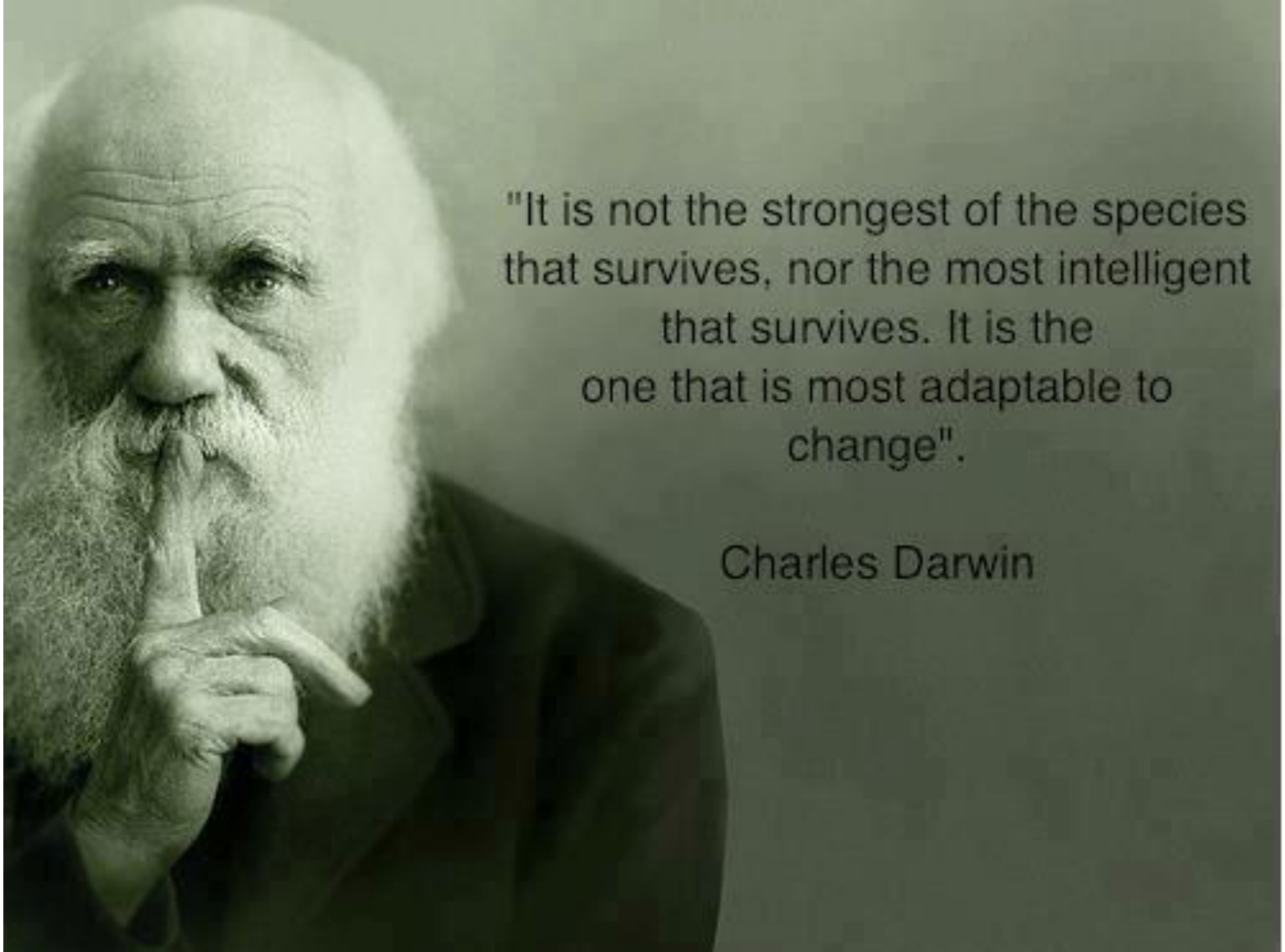
Darnhofer, 2009

Strive for Farm Resilience

3. Create opportunities for organizing yourself and links with others

- Strong network of friends, family, and contacts
- Political organizations help deal with change through collective action
- Be involved in community groups (church, local sports, civic organizations

Darnhofer, 2009


"It is not the strongest of the species
that survives, nor the most intelligent
that survives. It is the
one that is most adaptable to
change".
Charles Darwin

Dairy Business Management

Owners/Managers should have a CEO/CFO mentality

Consider biological parameters and economic considerations simultaneously

Detailed financial and economic information systems have not been adopted by dairy managers as well as production or simple accounting information systems

Economies of size----it's just basic math

Spreading Fixed Costs over More Animals

$100,000 ÷ 50 cows = $2000 per cow

$100,000 ÷ 250 cows = $400 per cow

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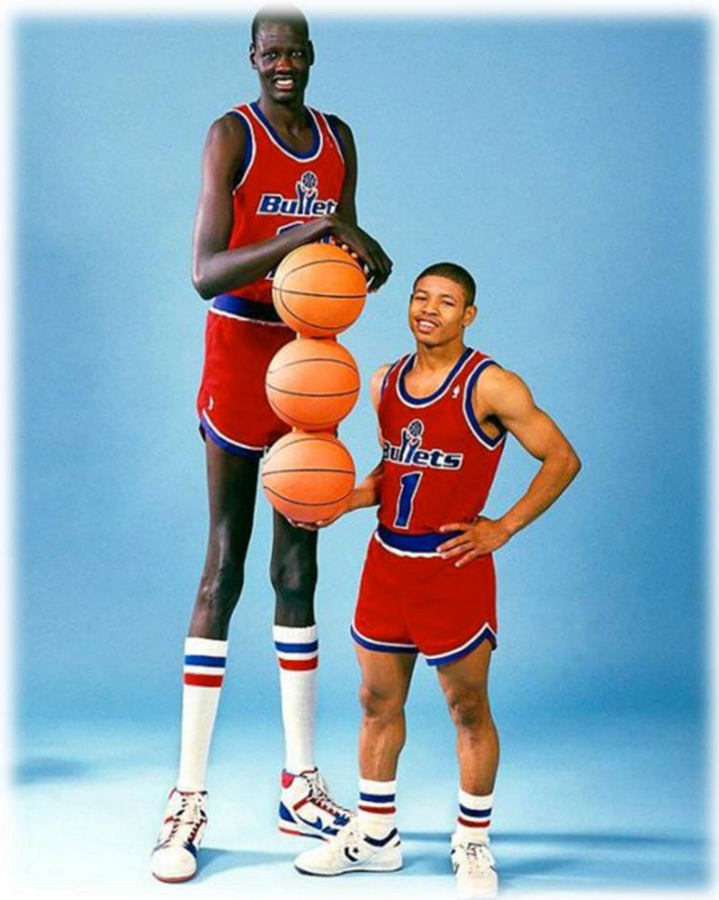
Economies of Size

- Average cost of production per cow declines as the size of the operation grows
- Increasing returns to size
- Economies of size result from:
  - Full utilization of labor, machinery, buildings
  - Ability to afford specialized labor and machinery and new technology
  - Price discounts for volume purchasing of inputs
  - Price advantages when selling large amounts of output

Starting Out At a Competitive Disadvantage



Don't Shoot Yourself in the Foot Through Your Cost of Production

Cost of Production Overcapitalization Example

	Full use	Half use	Quarter use
Cows milked per milk stall	30	15	7.5
Parlor investment per stall per cow	$600	$1200	$2400
Repayment cost ($/cow/yr)*	$116	$232	$463
Parlor labor cost ($/cow/yr)*	$218	$233	$264
Total cost ($/cow/yr)	$334	$465	$727
Cost per cwt to harvest milk	$1.67	$2.33	$3.63

Based on 9% interest and 7-year repayment, 20,000 lb annual milk production and $10/hr labor

***** Roger Palmer, Dairy Modernization, 2005***

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Financial records are as important as production records

Do you know?

- Rolling herd average
- Bulk tank average
- Culling rate
- Calving interval
- SCC
- Return on assets
- Asset turnover ratio
- Operating expense ratio
- Current ratio
- Debt: asset ratio

Calculating Cost of Production

- Collecting the information is the hard part
- Doing the calculations is the easy part
- Important to focus on the right enterprise
- Labor, Depreciation, Inventory adjustments all really need to be included

Reality Check

- We can’t calculate COP with just “3 or 4” numbers
- You probably don’t know some of the numbers you need
- Garbage in, garbage out
- It’s not just the destination, it’s the journey
- An attempt (even if inaccurate) to calculate COP is better than not trying

Investment Types

The Over's

- Investments
  - Land, toys, and parlors
- Labor/owner withdrawals
- Hospital
- Cull rate

The Under's

- Production
- Cow comfort
- Cow cooling
- Forage storage
- Transition cow facilities and nutrition
- Preventive health
- Human resources

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Investment analysis should be more than just gut feel

Partial Budgeting

- Examines the expected economic returns to a specific management change
- Total benefit-Total Costs=Profitability of Intervention
- Used to calculate Benefit: Cost ratios
- Examples: Using sexed semen, adding a feed additive, using a synchronization protocol

Partial Budget Calculations

Benefits

Increased revenue
+ Decreased costs
=
Total benefit

Costs

Decreased revenue
+ Increased Costs
=
Total costs

Profitability=Total benefit-total costs

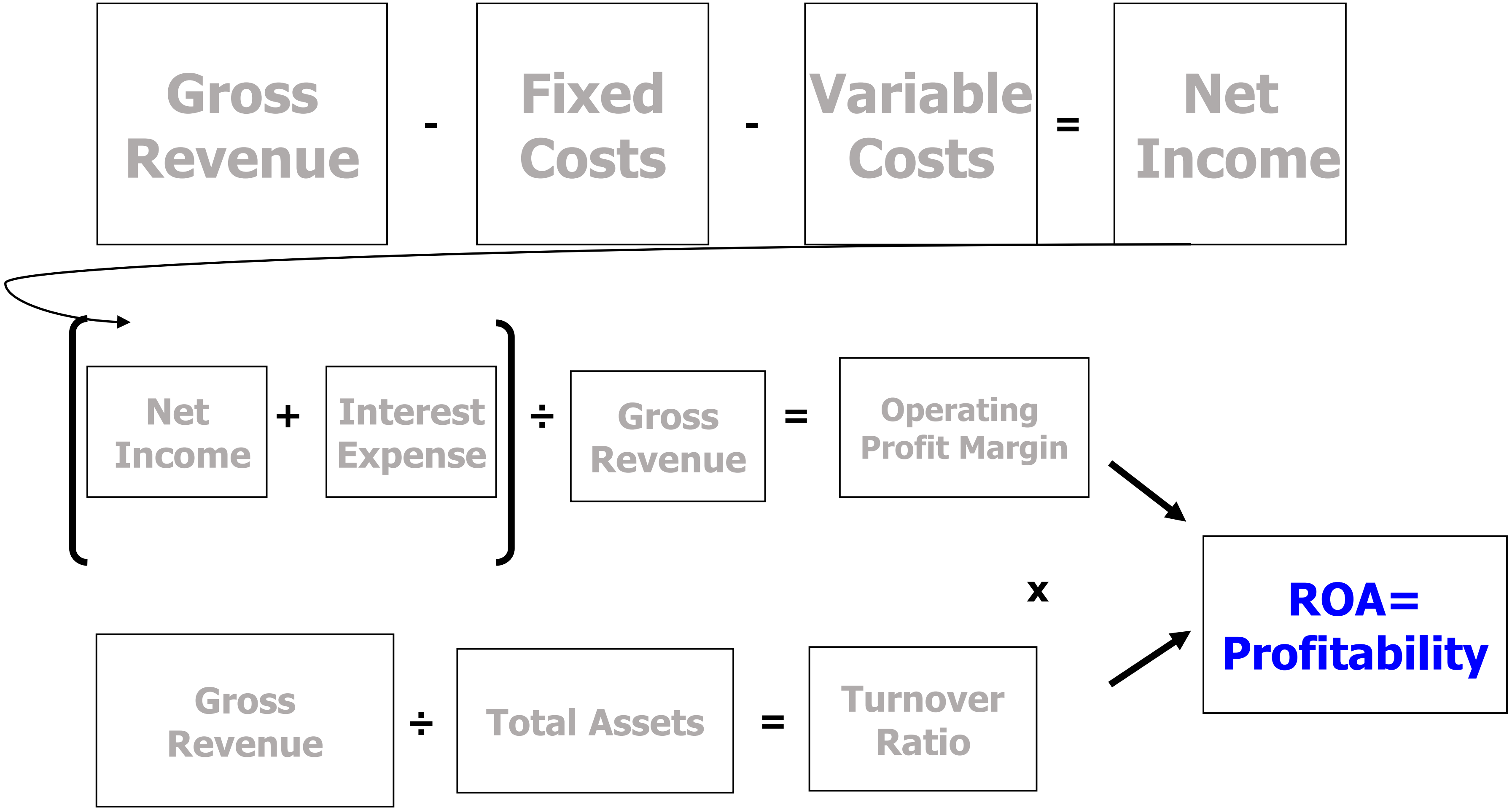
Net Present Value

- Considers the “Time Value of Money”—a dollar today is worth more than a dollar tomorrow
- Considers timing of expenses and income
- More accurate way of examining an investment decision
- A little more complex and time consuming
- Should be used for major capital investments

Agriculture has Low Margins

- FALSE!!!! (OK, maybe not lately)
- Agriculture has high margins (~32%)
- Only computer/software businesses are higher
- Wal-Mart (~3 to 4%-think not much inventory, lots of product out the door)
- Struggle with asset turnover (large proportion of assets in real estate)

DuPont Analysis



Revenues or Costs?

- Most people spend most of their time lowering costs
- Cost control only impacts earns, not turns
- Biggest impact comes from changes that impact both earns and turns
- So, efforts should be focused on
  - Increasing throughput
  - Improving product quality
  - Taking advantage of market price premiums
  - Remove non-productive assets

If you don’t measure it, you can’t manage it

Analytics can be your competitive advantage

Business Intelligence and Analytics

Competitive Advantage

Optimization	What's the best that can happen?
Predictive Modeling	What will happen next?
Forecasting/Extrapolation	What if these trends continue?
Statistical Analysis	Why is this happening?
Alerts	What actions are needed?
Query/Drill Down	What exactly is the problem?
Ad hoc Reports	How many, how often, where?
Standard Reports	What happened?

Degree of Intelligence

Dairy Industry Usually Here

SAS, Competing on Analytics, Davenport, Harris

Be precise. A lack of precision is dangerous when the margin of error is small.

Donald Rumsfeld

Big Data, Small Farms

Trend toward more data and better use of data is rapid

Small dairies can also take advantage of herd and financial data

Too often, we fall into the trap of saying “that only applies to the big guys, not me”

Reality check: biology and business management principles are not size dependent

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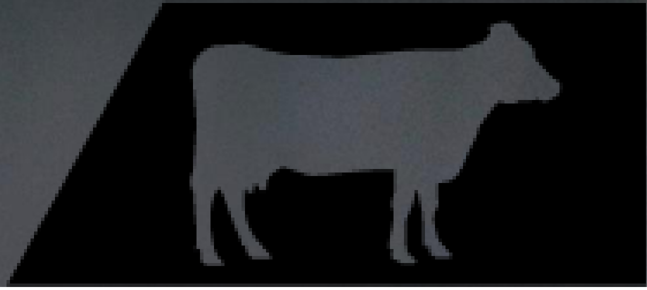

Common Modern Benefits Missed by Small Dairies

- Full use of herd records
- Monitoring technologies
- Financial records
- Genomic testing
- Negotiating semen pricing
- Alternative semen sources (i.e. Amazon)
- Forward contracting
- Raising and storing forages 1980's style
- Comparison shopping inputs
- Purchasing in bulk with neighbors
- Updated vaccination programs
- Comfortable housing
- Prioritizing dry and fresh cows

“You can only do what the markets will let you do, no matter how clever you are”
-Dr. Joseph Steinman

Control the Controllable

- Most of a business manager's energy, time, effort, and thoughts should be focused on the parts of the business over which he/she maintains control

- Limited time dedicated to parts where the manager has no control

- Not saying don't pay attention to policy, just don't let it dominate your thoughts and time

6 Controllables

1. Milk yield

a. More control than price
b. Spreads fixed costs

2. Herd health

a. Healthy cows last longer
b. Be around when things get better
c. Get quality bonuses

3. Reproduction

a. Breakeven milk yield level is higher so consequences are greater
b. Want cows in milk when things get better

6 Controllables

4. Replacement heifer quality

a. Tomorrow's milk cows
b. 24 month age at first calving reduces costs

5. Feed costs

a. Forage quality
b. Byproduct feeds
c. Feed additives
d. Shrink

6. Asset base

a. Non-productive assets
b. Machinery, land, toys
c. Custom hiring possibilities

Know When It's Time to Walk Away

- Don't let "fear of failure" lead to bad decisions
- Run cash flows for next couple years
- Are you better off to sell now or continue until prices are better?
- Don't let the situation take all your equity away
- Don't wait until creditors force you out
- Dream about what else you might like to do
- Develop an exit strategy

Work with Your Banker

- Have conversations before it’s too late
- Bring your balance sheet with you
- See if you can refinance credit card debt
- See if you can refinance loans
- Operating lines of credit
- Don’t let your banker be the captain steering your ship into the iceberg

Potential Reductions

- Cull cows that don't cover variable expenses
- Limit major capital expenditures to necessities
- Purchases that can be delayed because inventory is available
- Volume discounts
- Bargains
- Focus on what you need, not what you want
- Consider high-group/low-group rations

Be Proactive About the Future

- Communicate with consumers
- Environmental issues
- Animal well-being issues
- Dairy consumption promotion
- Financial planning
- Business planning
- Succession plans

Questions?

Biology and business management principles are not size dependent

Jeffrey Bewley, PhD, PAS
jbewley@alltech.com

XPC and NutriTek –
Research backed performance and health outcomes

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DAIRY

OVERWHELMING RESEARCH

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2

Across Species Research

All Products		
	Number of Studies	
	Total	Journal Articles
Aquaculture	21	8
Beef	56	16
Dairy	124	48
Equine	19	6
Pets	9	--
Poultry	82	26
Sheep & Goat	16	5
Swine	75	19
In vitro	103	7
Other	3	2
Total	508	137

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Ruminant Research Alone

Animal Health: 10 Peer-Reviewed Studies

- Bacterial challenges (*Salmonella* and *E. coli*), viral challenges (IBR), dietary challenges (acidosis), physiological challenges (calving), and environmental challenges (heat stress)

Production Efficiency: 50 Peer-Reviewed Studies

- Feed intake; feed conversion, milk production, body weight gain, rumen fermentation (volatile fatty acid production)

Pre-Harvest Food Safety: 4 Peer-Reviewed Studies

- Broad-spectrum protection (*Salmonella*, *Campylobacter*, *E. coli*); reduced prevalence and number, reduced risk of food recall

Antibiotic Stewardship: 8 Peer-Reviewed Studies

- Non-antibiotic technologies that naturally maintain immune strength and digestive health
- Effective in both conventional and antibiotic-free systems
- Enhanced consumer confidence
- Support for environmental conservation

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2012 Meta-analysis

J. Dairy Sci. 95:6027–6041
http://dx.doi.org/10.3168/jds.2012-5577

A meta-analysis of the effects of feeding yeast culture produced by anaerobic fermentation of *Saccharomyces cerevisiae* on milk production of lactating dairy cows

G. D. Poppy,*†[1] A. R. Rabiee,‡ I. J. Lean,‡ W. K. Sanchez,† K. L. Dorton,† and P. S. Morley*
*Department of Clinical Sciences, College of Veterinary Medicine and Biomedical Sciences, Colorado State University, Fort Collins 80523
†Diamond V, Cedar Rapids, IA 52405
‡SBScibus, PO Box 660, Camden 2570, NSW, Australia

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Meta analysis responses in 36 peer reviewed studies

Item	Response	P-value	95% Confidence interval
Milk			
Early lactation (lb.)	3.01	0.001	1.39 to 4.64
Mid-late lactation (lb.)	2.16	0.049	0.02 to 4.29
Dry Matter Intake			
Early lactation (lb.)	+1.36	0.003	0.46 to 2.24
Mid-late lactation(lb.)	-1.72	0.008	-2.99 to -.46

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Economics of Response by Stage of Lactation

Item	Early Lactation	Mid-late Lactation
Milk (lb.)	3.01	2.16
Dry Matter Intake (lb.)	+1.36	-1.72
Milk value @ $15/cwt	$0.45	$.32
DMI value @ $.12/lb. DM	($0.16)	$0.20
Diamond V product cost	$0.05	$0.05
Bottom line IOFC (dollars/cow/day)	$0.24	$0.47

* Poppy et al., 2012, J. Dairy Sci.

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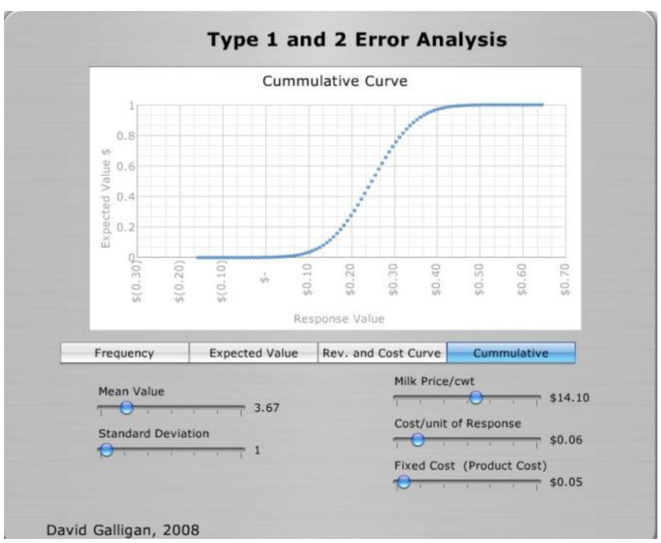
Risk of less than break even < .6%



Dr. Dave Galligan

Diamond V

DAIRY

HEALTH OUTCOMES

ACROSS SPECIES

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Credibility…

Proven in Science

Inhibition of the virulence, antibiotic resistance, and fecal shedding of multiple antibiotic-resistant *Salmonella* Typhimurium in broilers fed Original XPC™

K. M. Feye,* K. L. Anderson,* M. F. Scott,† D. R. McIntyre,† and S. A. Carlson*,1

*Department of Biomedical Sciences, Iowa State University College of Veterinary Medicine, Ames 50011; and †Diamond V, Cedar Rapids, IA 52404

Lessons Learned

" I have never seen a technology that can do what this does in reducing pathogens, reducing virulence and reducing antibiotic resistance"

- Dr. Robert Tauxe, Director of the Foodborne Illness Division, Center for Disease Control

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DAIRY

HEALTH OUTCOMES

RUMINANT – FIELD TRIALS, MASTITIS and RESPIRATORY

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SCC Impacts…

In The Beginning…. Controlled Trial, Fall 2016

- NutriTek
  - 3 mid lactation pens
  - 887 cows
  - 117 ± 22 DIM
  - 2 multiparous pens
  - 1 primiparous pen
  - 19 g of NT
- Control
  - 3 mid lactation pens
  - 836
  - 117 ± 22 DIM
  - 2 multiparous pens
  - 1 primiparous pen
  - 14 g of XPC

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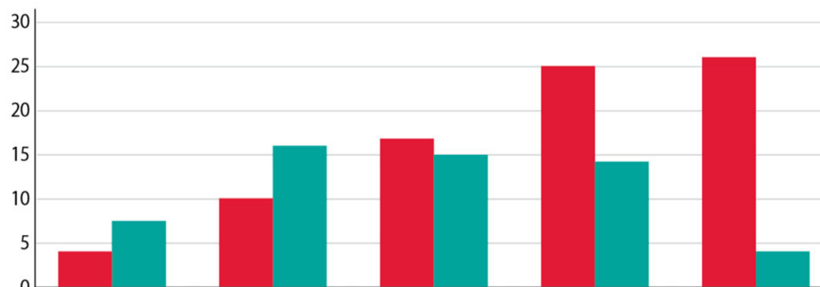
Effect of NutriTek® on New Mastitis Cases



	Oct	Nov	Dec	Jan	Feb
	Before Trial		During Trial		
XPC	4	10	17	25	26
NutriTek	7	16	15	14	4

Diamond V U.S. field trial. 2017

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NutriTek®: Role in Mastitis Reduction

	XPC	NutriTek
Number of cows	836	887
Cases	68	33
Risk[1]	0.08	0.04
RRR/RRI[2]	0.54	

[1.] Incedent cases of mastitis per group
[2.] Relative Risk Reduction (RRR) or Increase (RRI) represents the reduced (or increased) risk of an event occurring vs. Control on this operation. A negative value would indicates a relative risk increase (Ex. RRR of 0.40 = 40% reduced risk.)

NutriTek® Reduced the Relative Risk of Mastitis Cases by 54%

Diamond V U.S. field trial. 2017

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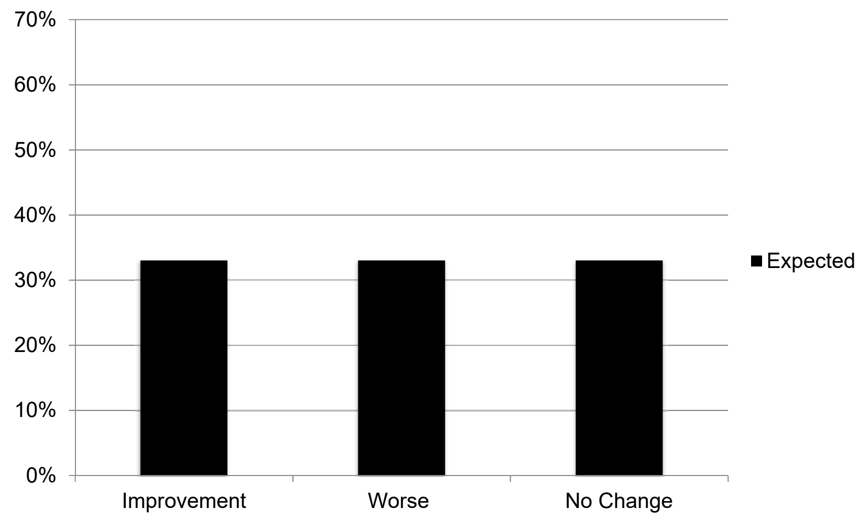
Epi Retrospective Analysis

- Evaluate mastitis incidence and Linear Score on herds with minimum 12 months of feeding NT, 25 herds.
  - Data evaluated the same # days pre/post implementation
- Herds ranged from 880 to 10,727 adult cows and milk production ranged from 17,100 to 27,900 lbs on 305d bases

Clinical case defined…

- Case- Defined as an animal that received treatment for mastitis on farm.
- 10 day interval between incident cases

Biology would predict….



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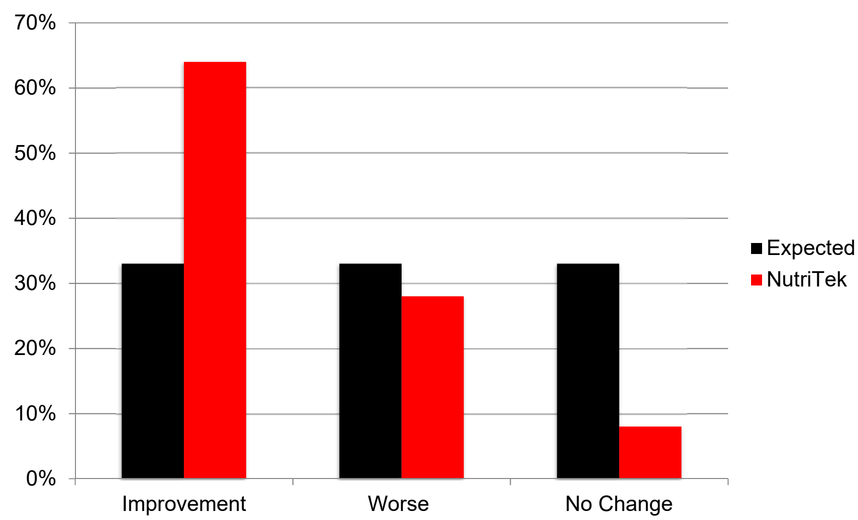
LS changes….



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Clinical incidence…

Clinical Incidence	Percent basis
Decreased	71%
Increased	23.6%
No Change	5.4%
Total	100%

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Respiratory Effects

A Retrospective Study Evaluating the Effects of NaturSafe® on Overall Health and Economics of All-Natural Feedlot Cattle

Part 1 – Montana Origin

Diamond V
The Trusted Experts In Nutrition & Health

NaturSafe Effects On Health Of All-Natural Feedlot Cattle – Montana Origin

	Control	NaturSafe	RRR or RRI[1]	95% CI of RRR or RRI	P-Value	NNT[2]
# Head	2594	1726				
# Lots	5	4				
Average In-weight (lb)	861	878				
Average Days on Feed	166	176				
1st Pulls, %	7.2	2.9	0.60	0.45 to 0.70	<0.01	23.4
2nd Pulls, %	2.4	1.1	0.53	0.22 to 0.72	<0.01	80.0
3+ Pulls, %	1.0	0.6	0.30	-0.40 to 0.65	0.31	361.4
Fallouts, % of all Cattle	6.2	0.9	0.85	0.75 to 0.91	<0.01	19.1
Fallouts, % of 1st Pulls	86.0	32.0	0.63	0.44 to 0.75	<0.01	1.9
Railers, %	0.1	0.5	-1.99	-8.92 to 0.10	0.07	-325.6
Mortality, %	0.5	0.2	0.50	-0.55 to 0.84	0.23	433.2

[1] Relative Risk Reduction/Increase (RRR/RRI) represents the reduced (or increased) risk of an event occurring versus Control. A negative value indicates a relative risk increase (Ex. RRR of 0.40 = 40% reduced risk.).
[2] NNT (Number Needed to Treat) represents the number of animals that would need to be fed NaturSafe in order to increase/decrease case number by one animal. A negative value represents number needed to harm.

Field Trial Report BF031. 2017

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HEALTH OUTCOMES

RUMINANT – JOURNAL SUBMITTED

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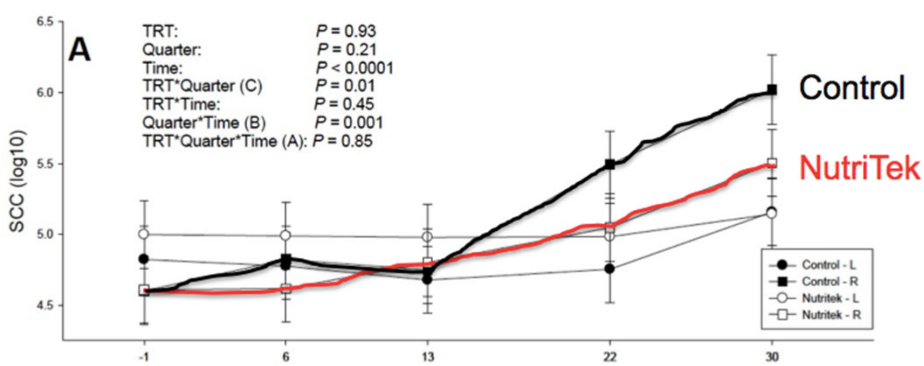
University of Illinois Update

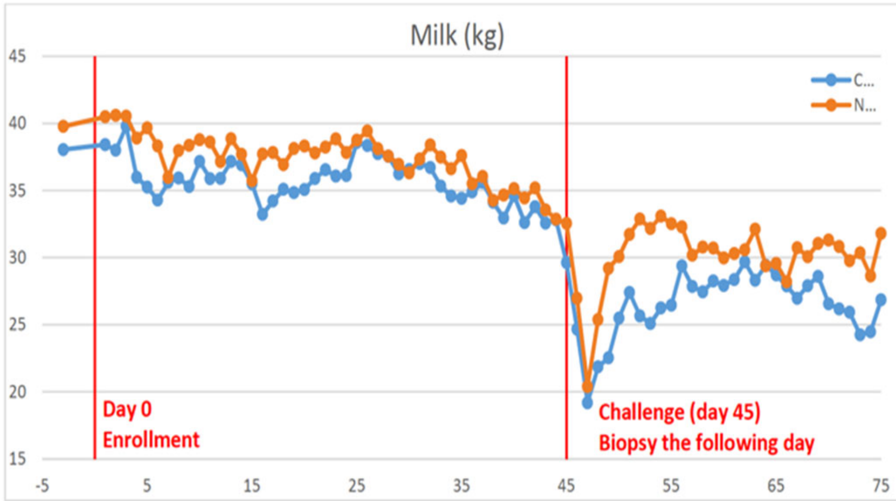
- Mastitis Trial
  - N=16 2nd lact+ cows
    - <200,000 SCC and no history of mastitis trt
    - Approximately 60 DIM at start of trial
- Treatments
  - Control – TMR
  - Experimental – TMR + 19 g/NutriTek/head/d
- Challenge
  - 42 days on trial
  - Strep Uberis, 5,000 CFU, one rear quarter

Streptococcus uberis challenge on SCC



Loor, University of Illinois, preliminary report

Milk Production



Loor, University of Illinois, preliminary report

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Economics Summary from 2018 NutriTek Transition Cow Studies (Universities of Alberta and Kansas)

Overall Average (2 Studies; 3 comparisons)	Control	NutriTek	Diff
Milk, lbs.	84.5	84.6	0.1
Fat, %	4.02	4.19	0.17
SCC, cells/ml	130,943	90,848	-40,095
Fat-Corrected Milk (FCM), lbs. (3.5% FCM basis)	93.8	97.2	3.5
Dry Matter Intake (DMI), lbs.	42.3	42.2	-0.1
FCM/DMI	2.22	2.30	3.9%
Economics	**Control**	**NutriTek**	**Diff**
Fat-Corrected Milk revenue, $/cow/d (FCM @ $14.50/cwt.)	$13.595	$14.099	$0.50
DMI, cost (@ $0.12/lbs. DM)	-$5.073	-$5.065	$0.01
SCC bonus (< 100,000 = $0.10/100 lbs. milk)	$0.00	$0.08	$0.08
Cost of NutriTek ($0.13/hd/d)	$0.00	($0.13)	($0.13)
IOFC (Milk revenue - Feed costs)	$8.522	$8.988	$0.47
Annualized IOFC for 1,000 cow Dairy, $/year			$170,124

Fat-Corrected Milk was used instead of Energy-Corrected milk because both Universities reported FCM and only KSU reported ECM (U of Albert reported Solids-Corrected Milk).

SCC bonus varies throughout the U.S. 10 cents per cwt is a very conservative estimate based on normal bonus incentives (i.e., below 200,000 or below 100,000)

Shi et al., 2018 University of Alberta, preliminary report

Olagary et al., 2018 KSU, preliminary report

26

Diamond V

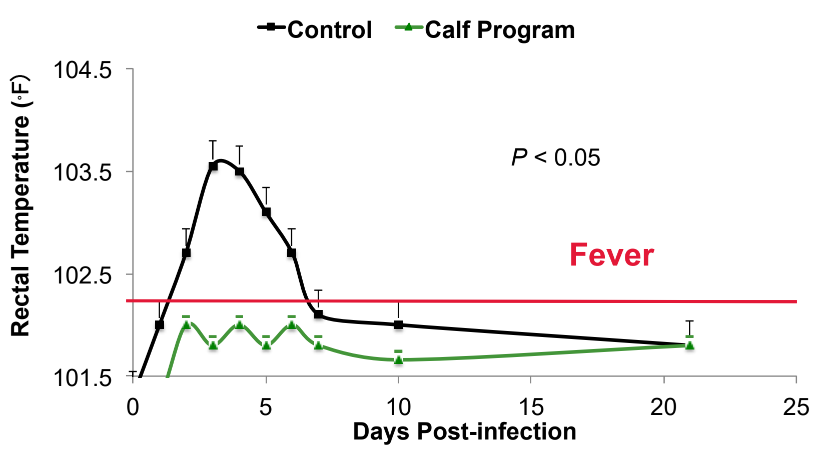
Amelioration of Salmonellosis in Pre-weaned Dairy Calves using Diamond V Calf Program

- N= 40 dairy calves (20/trt), <8 days old at trial initiation
- Treatments 0-35 days post arrival
  - Control – milk replacer + 3.5 g/head/d grain matrix in gelatin capsule given as bolus
  - Experimental – milk replacer with 1 g SmartCare/d + 3.5g/head/d Original XPC in gelatin capsule given as bolus
- 2 Phases
  - Pre-infection 0-14 days post arrival
  - Challenge 14-35 days post arrival
- Challenge
  - Day 14
  - Salmonella typhimurium
    - Gelatin capsule with either control or Original XPC

Brewer et al. 2014. Amelioration of salmonellosis in pre-weaned dairy calves fed *Saccharomyces cerevisiae* fermentation products in feed and milk replacer. Veterinary Microbiology 172:248-255.

Diamond V

Immunity: Reduced Severity/Duration



Brewer et al., 2014

Diamond V

DAIRY

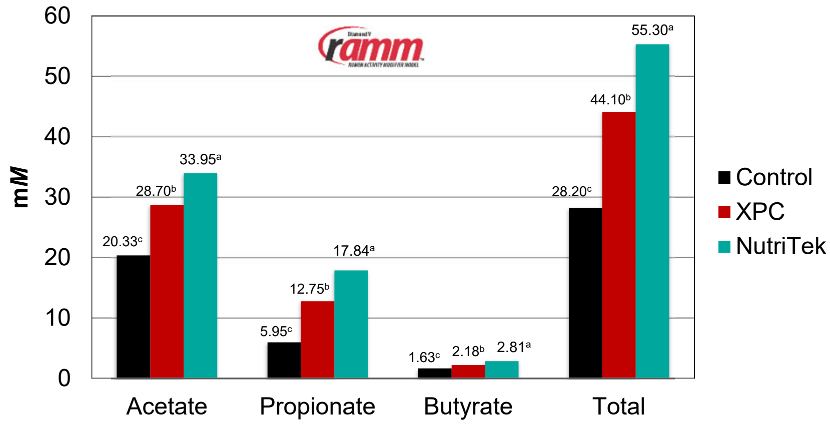
HEALTH OUTCOMES

MODE OF ACTION – WHY DOES IT WORK?

Diamond V
The Trusted Experts In Nutrition & Health™

29

VFA Production (RIC)



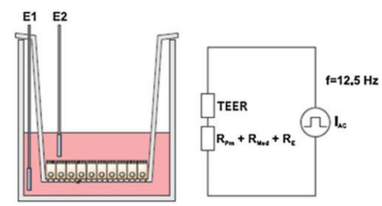
[abc]Means without a common superscript in each column differ by $P < 0.05$

Diamond V Research & Innovation Center, 2014. LA090

Diamond V

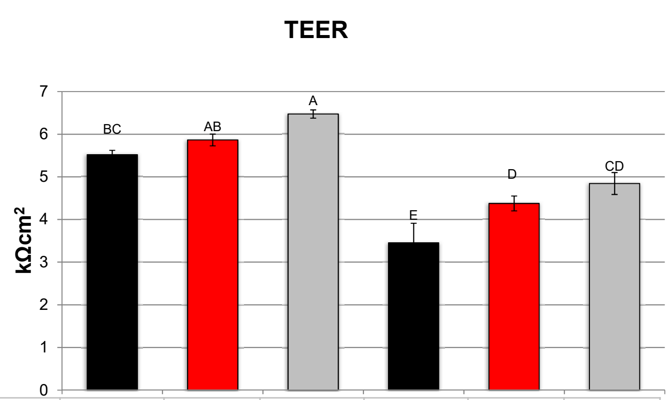
Gut Permeability (RIC)

- TEER – Transepithelial Electrical Resistance
  - Measurement to assess the barrier function of epithelial cell
  - Applied for assessing the permeability of tight junction



Diamond V

NutriTek Protects Gut Integrity (RIC)



H2O2 challenge	-	-	-	+	+	+
Treatment	Control	NutriTek1	NutriTek2	Control	NutriTek1	NutriTek2

Greater resistance = Less permeable

Diamond V

DAIRY

PRODUCTION

FIELD TRIALS

Diamond V
The Trusted Experts In Nutrition & Health™

NutriTek in Lactating Diets: Performance Trends in 34 Dairies

- 34 herd assessment
  - 7 herds were established control and experimental group studies (3+ month duration per site)
  - 27 herds were retrospective summaries of performance 12 month prior to NutriTek compared to 12 months on NutriTek
- In the majority of trials, NutriTek performance was compared to XPC (either in the prior 12 months or in the positive control)

Diamond V

NutriTek has demonstrated consistent increases in ECM/Milk in 6 out of 7 Experimental/Control Group Field Trials

Dairy	Replaced XP/XPC	Milk/ECM
Controlled PNW TRIAL	No	4.4 lbs ECM
Controlled PNW TRIAL	Yes	3.4 lbs ECM
Controlled West TRIAL	Yes	2.3 lbs ECM
Controlled West TRIAL	Yes	3.2 lbs Milk
Controlled SE TRIAL	Yes	4.5 lbs ECM
Controlled PNW TRIAL	Yes	No Change
Controlled PNW TRIAL	Yes	6.4 lbs ECM
Average		**3.5 lbs ECM**

Diamond V

Performance Under Heat Stress

Pacific Northwest NutriTek Controlled Trial

Diamond V
The Trusted Experts In Nutrition & Health

Background

- NutriTek® trial was conducted in summer 2017
- Prior to the trial initiation, Original XPC™ and OmniGen-AF® were fed to all cows
- NutriTek was fed for 90 days to pens 4 & 6
- Original XPC and OmniGen-AF feeding continued for pens 5 & 7
- Cows were moved into treatment pens as they left the fresh pen and remained until dry off

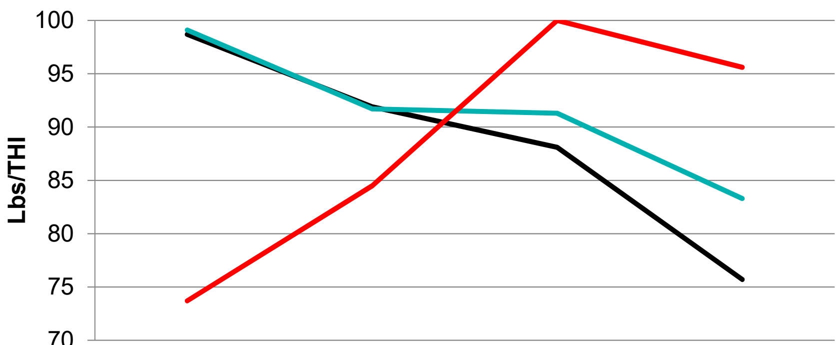
Diamond V

Background

- Premix was used to deliver both treatments to the mixer
- Trial began on May 27, 2017
- Trial ended on August 18, 2017
- Data observations included: Milk, Components, Somatic Cell Count, Health, and Reproduction

Diamond V

Energy Corrected Milk (ECM) lbs & Temperature-Humidity Index[1](THI)



	12-May	11-Jun	14-Jul	11-Aug
Control*	98.7	91.9	88.1	75.7
NutriTek	99.1	91.7	91.3	83.3
THI	73.7	84.5	100	95.6

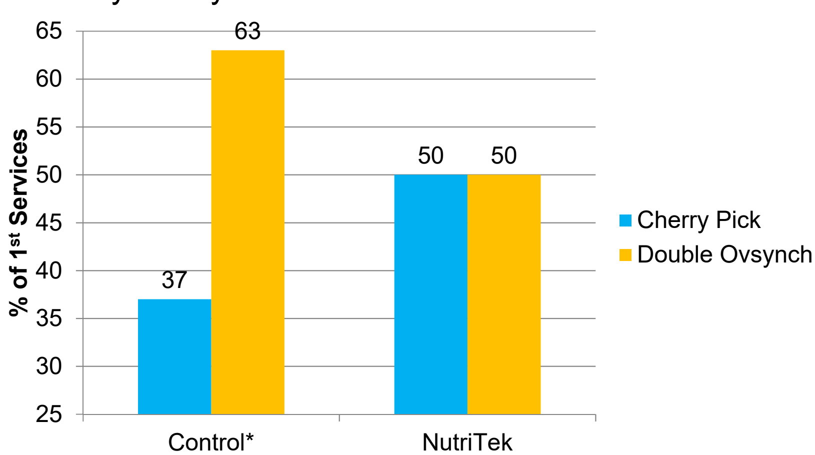
* 14 g/d of Original XPC™ + 56 g/d of OmniGen AF®

[1]High daily temperature used for calculation

Diamond V

Reproduction: 1st Service Breedings

50% of NutriTek cows expressed estrus to 1st Ovsynch Cycle vs. 37% of Control cows

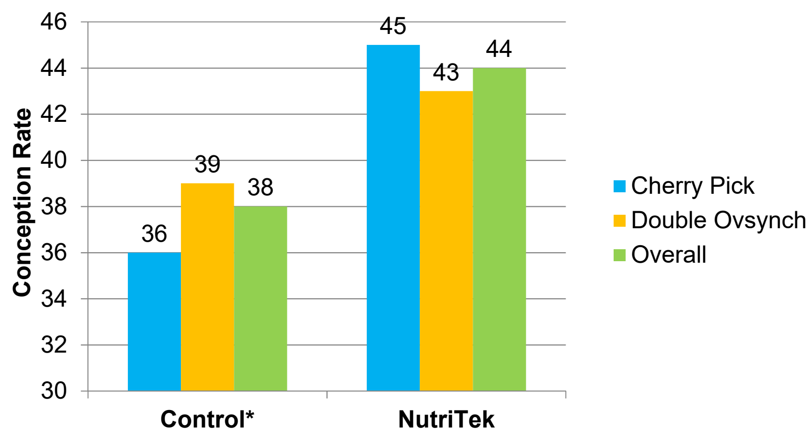


* 14 g/d of Original XPC™ + 56 g/d of OmniGen AF®

Diamond V

Reproduction: 1st Service Conception Rates

- 1st service conception rates were higher for NutriTek

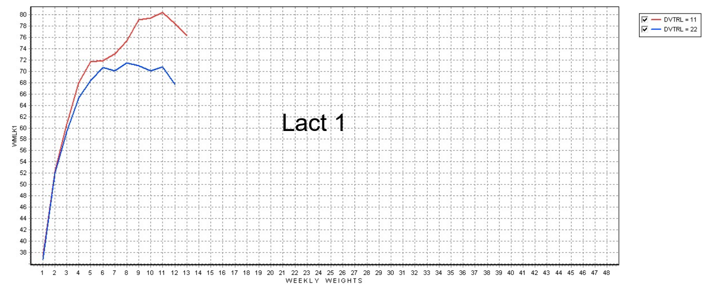


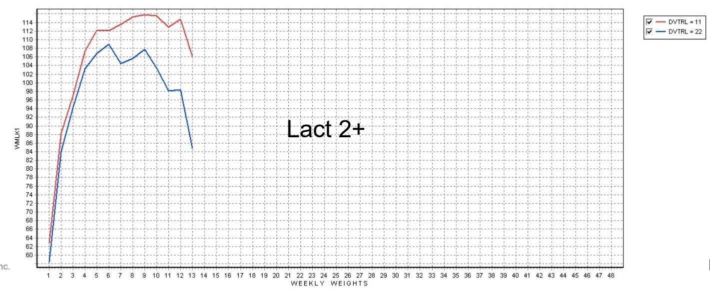
* 14 g/d of Original XPC™ + 56 g/d of OmniGen AF®

Summary

- Trial that compared cows fed Original XPC + OmniGen-AF vs. NutriTek
- Positive outcomes of NutriTek in the diet were multi-factorial:
  - Improvements in milk quality/udder health during heat stress.
  - Stronger milk production persistence, maintenance of milk fat percent, and better overall ECM production through periods of heat stress.
  - Promising trends in reproduction efficiency.

Robot Dairy Field Trial Sneak Peak: Cows exposed to NutriTek starting the day of calving





nd V

DAIRY

PRODUCTION OUTCOMES

RUMINANT – JOURNAL PUBLISHED

Diamond V
The Trusted Experts In Nutrition & Health

NutriTek: *Effects of saccharomyces cerevisiae fermentation products on lactational performance of mid-lactation cows*

- *Acharya et al., American Society of Animal Science* 2017
- South Dakota State University
- N=80 mid lactation cows
- Control vs. NutriTek
- Trial length 8 weeks

Economic Summary from Controlled University Studies	Control	NutriTek	Diff
Acharya et al., 2017 (19.4% starch) 165 days in milk			
Milk, lbs	73.3	81.1	7.7
Fat, %	4.17	3.85	-0.32
SCC, 10^3 cells/ml	Not reported	Not reported	
Fat-Corrected Milk (FCM), lbs (3.5% FCM basis)	81.1	84.6	3.5
Dry Matter Intake (DMI), lbs	56.6	57.7	1.1
FCM/DMI	1.43	1.47	2.4%

Diamond V

2 University trials submitted for publication: Transition Cows

- **University of Alberta; Shi et al. 2018**
  - Transition cow study
    - -28 to 42 d relative to calving
    - Total of 120 cows (n = 30 per treatment)
  - Main effects
    - NutriTek vs. Control
    - Starch level
      - 1–21 DIM: High starch (26.7 %) vs. Low starch (21.4%)
      - 22–42 DIM: High starch diet for all cows
- **Kansas State University; Olagary et al. 2018**
  - Transition cow study
    - -28 to 42 d relative to calving
    - Total of 60 cows (n = 30 per treatment)
  - Control vs. NutriTek

Diamond V

Economics Summary from 2018 NutriTek Transition Cow Studies

Overall Average (2 Studies; 3 comparisons)	Control	NutriTek	Diff
Milk, lbs.	84.5	84.6	0.1
Fat, %	4.02	4.19	0.17
SCC, cells/ml	130,943	90,848	-40,095
Fat-Corrected Milk (FCM), lbs. (3.5% FCM basis)	93.8	97.2	3.5
Dry Matter Intake (DMI), lbs.	42.3	42.2	-0.1
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Fat-Corrected Milk was used instead of Energy-Corrected milk because both Universities reported FCM and only KSU reported ECM (U of Albert reported Solids-Corrected Milk).

SCC bonus varies throughout the U.S. 10 cents per cwt is a very conservative estimate based on normal bonus incentives (i.e., below 200,000 or below 100,000)

In conclusion - why XPC and NutriTek?

- Most published research for any non-antibiotic feed additive
- Chance of XPC not making your clients money <0.06%
- Proven performance through
  - Altered microbiome and increased VFA production
  - Improved lower gut integrity
  - Pathogen risk mitigation
  - Improved innate immunity

DIAMOND V
Life Stage Solutions™

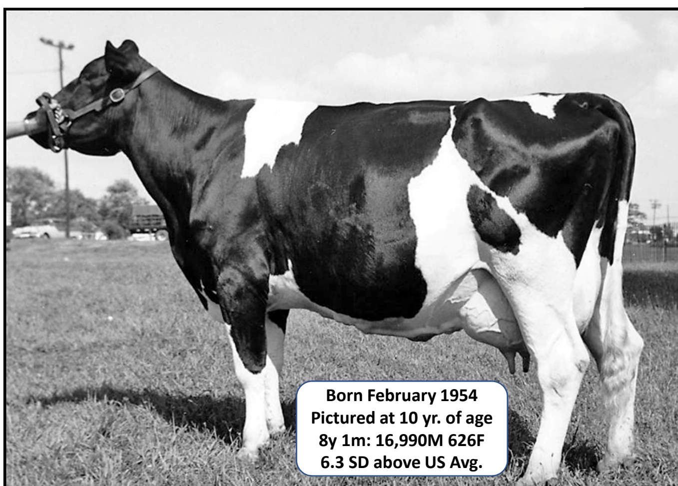
Diamond V®
The Trusted Experts In Nutrition & Health®

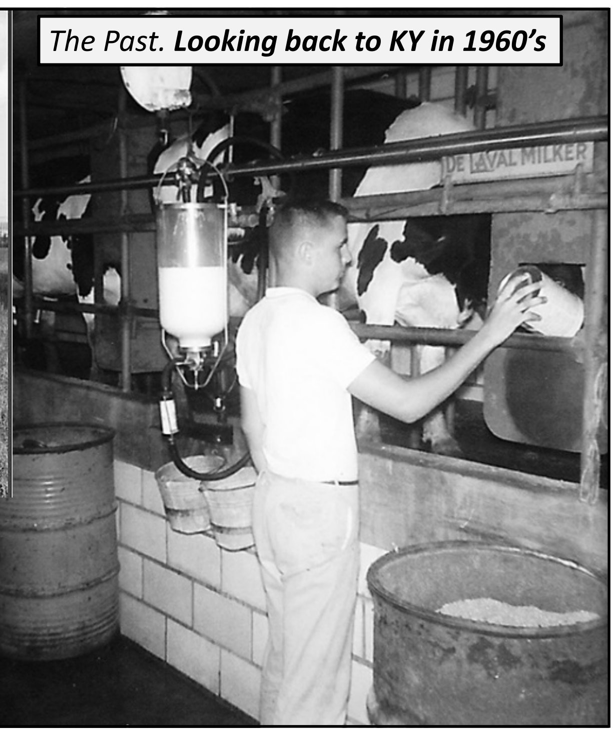
The Dairy Cow and Dairy Farm in 50 Years

Jack H Britt <> Penn State Dairy Cattle Nutrition Workshop <> November 1, 2018

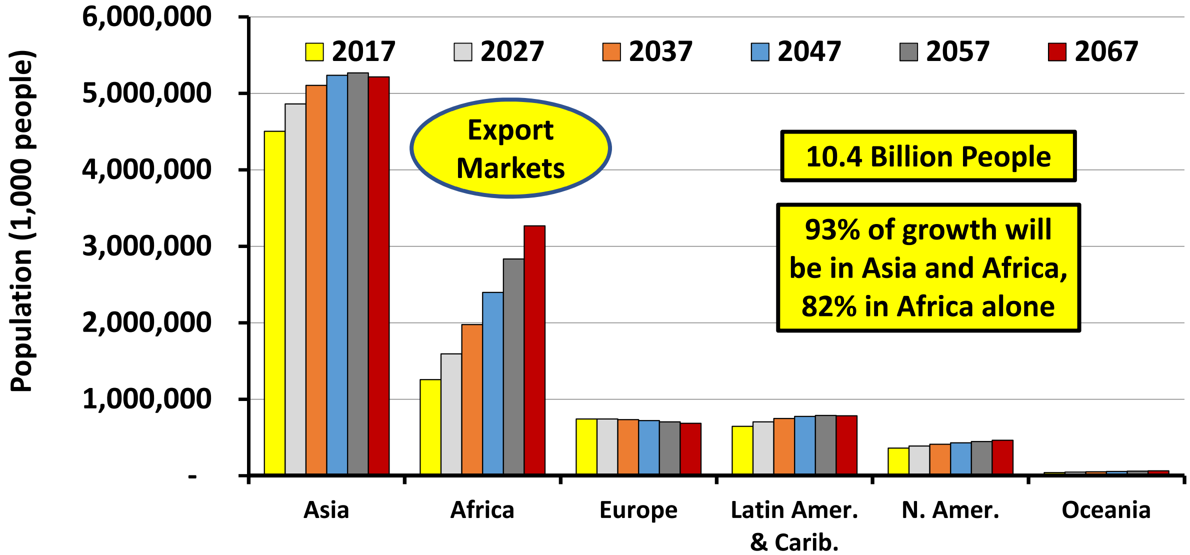
Expert Forecasters: Mike Hutjens, IL; Gordie Jones, WI; Jeff Stevenson, KS; Pam Ruegg, MI; Chad Dechow, PA; George Seidel, CO; Bob Cushman, NB; Tony McNeel, MI; Hilary Dobson, UK; Martin Sheldon, UK; Patrice Humblot; SE

The Past. ***Looking back to KY in 1960's***



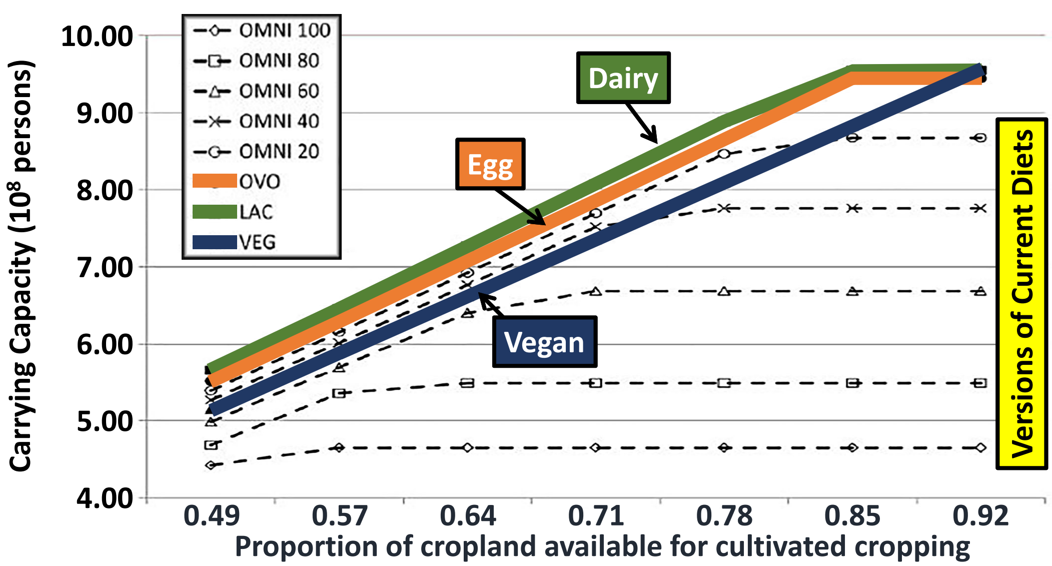


Forecasts. ***Growth of population will be in Africa and Asia***

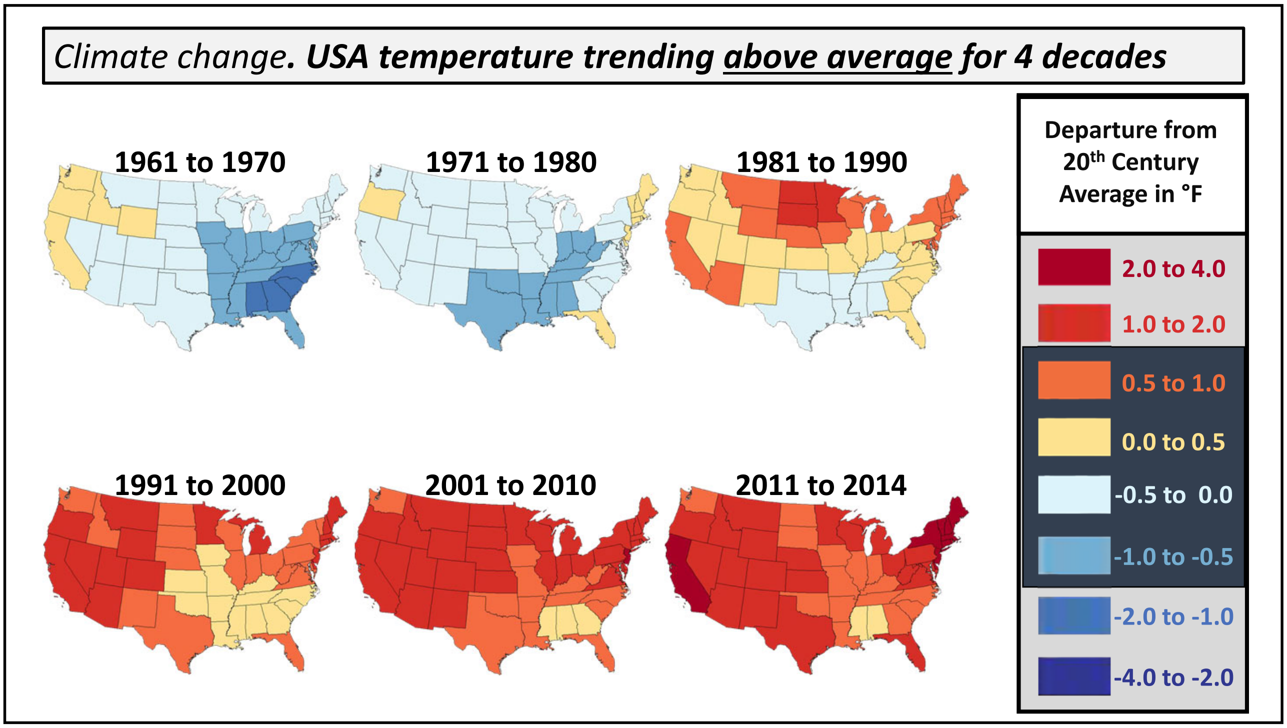


Britt et al. 2018. J. Dairy Sc. 101 (5): 3722-3741. Data source: FAOSTAT 2017.

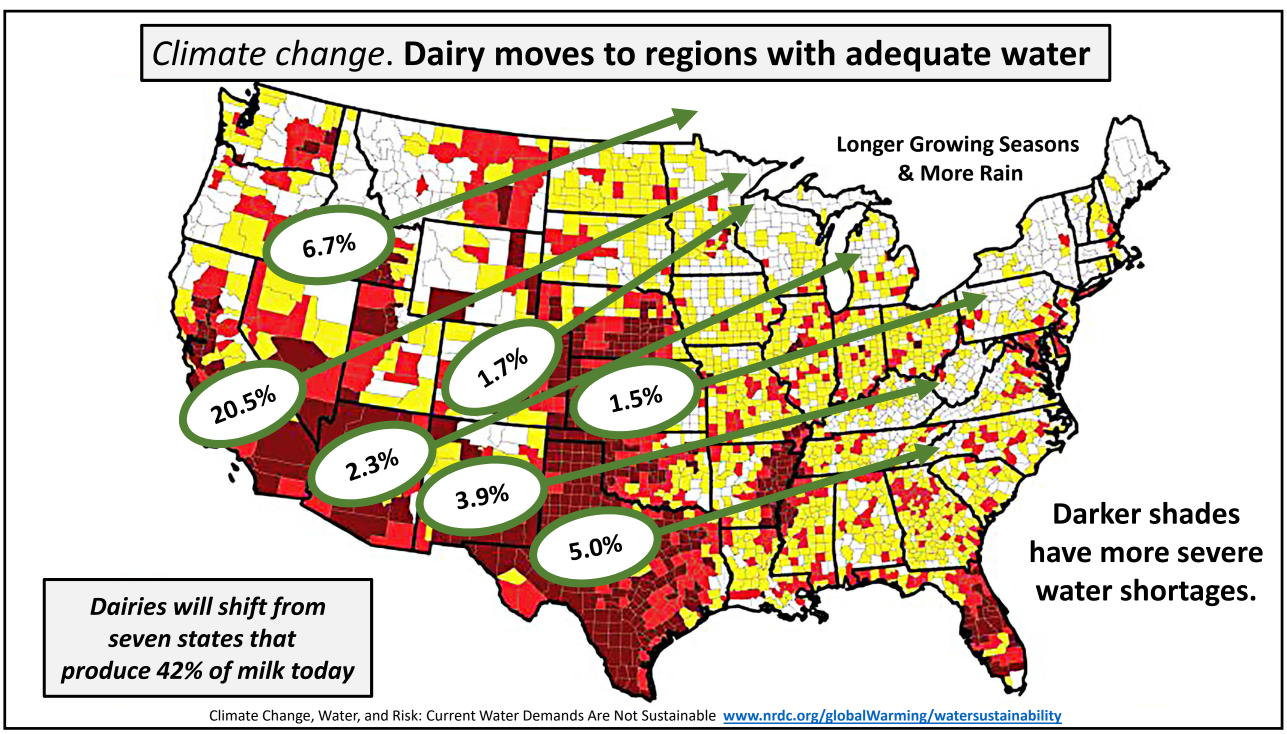
Why Dairy? ***It feeds the most people from our land base.***



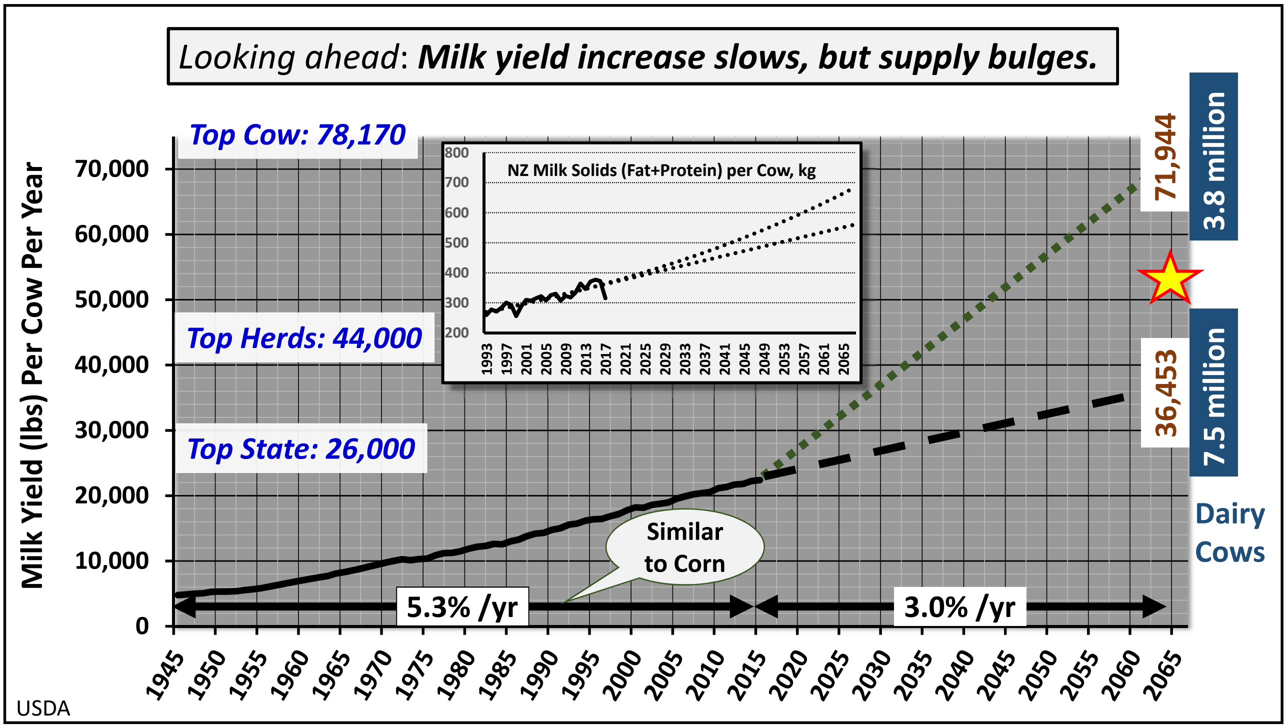
Peters, Christian J., Jamie Picardy, Amelia F. Darrouzet-Nardi, Jennifer L. Wilkins, Timothy S. Griffin, Gary W. Fick. 2016.
Carrying capacity of U.S. agricultural land: Ten diet scenarios. Elementa: Science of the Anthropocene • 4: 000116 • doi: 10.12952/journal.elementa.000116

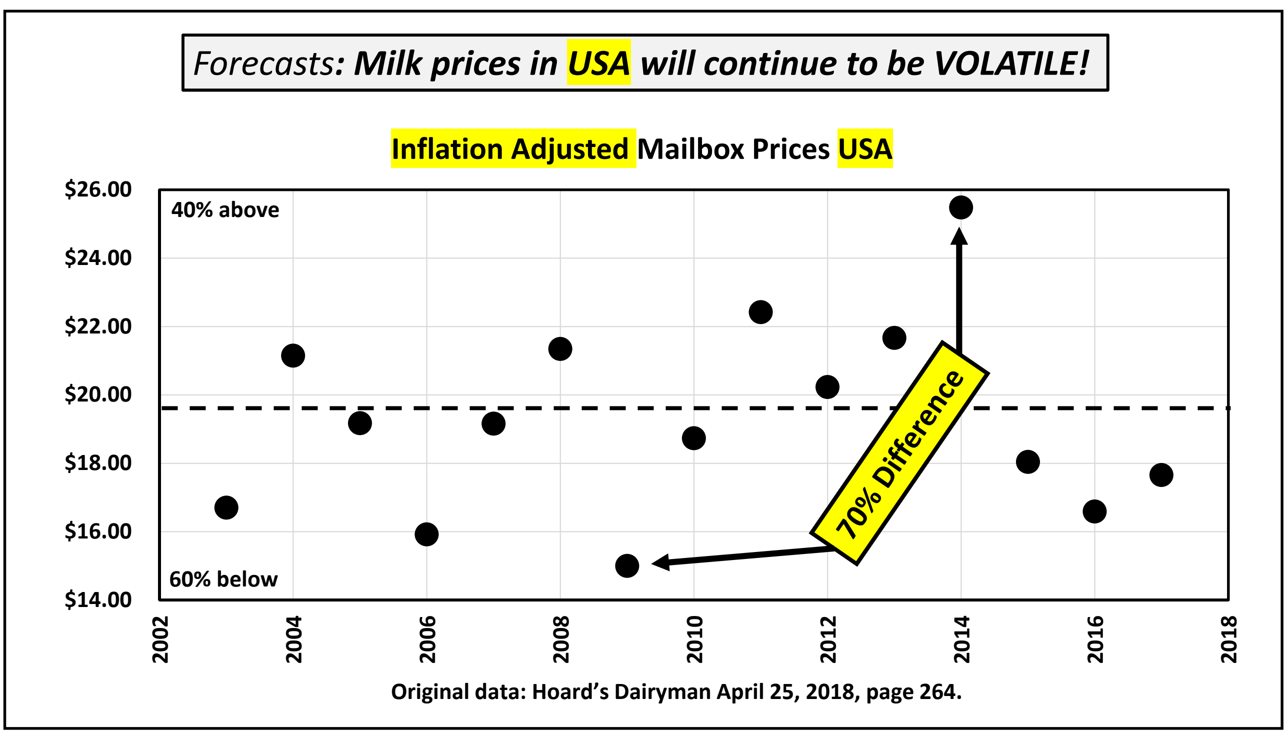


Climate change. ***USA temperature trending above average for 4 decades***
1961 to 1970
1971 to 1980
1981 to 1990
1991 to 2000
2001 to 2010
2011 to 2014
Departure from 20th Century Average in °F
2.0 to 4.0
1.0 to 2.0
0.5 to 1.0
0.0 to 0.5
-0.5 to 0.0
-1.0 to -0.5
-2.0 to -1.0
-4.0 to -2.0

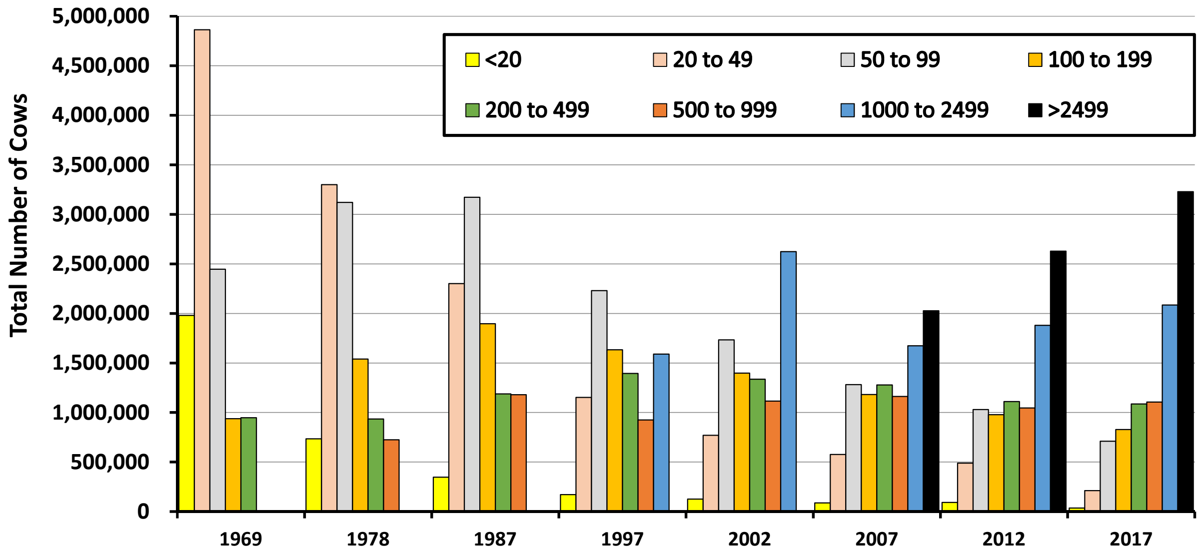


Climate change. **Dairy moves to regions with adequate water**
Longer Growing Seasons & More Rain
6.7%
20.5%
1.7%
1.5%
2.3%
3.9%
5.0%
Darker shades have more severe water shortages.
Dairies will shift from seven states that produce 42% of milk today
Climate Change, Water, and Risk: Current Water Demands Are Not Sustainable www.nrdc.org/globalWarming/watersustainability


Looking ahead: Milk yield increase slows, but supply bulges.
Top Cow: 78,170
Top Herds: 44,000
Top State: 26,000
NZ Milk Solids (Fat+Protein) per Cow, kg
Milk Yield (lbs) Per Cow Per Year
Similar to Corn
5.3% /yr
3.0% /yr
71,944
36,453
3.8 million
7.5 million
Dairy Cows
USDA


Forecasts: Milk prices in USA will continue to be VOLATILE!
Inflation Adjusted Mailbox Prices USA
40% above
60% below
70% Difference
Original data: Hoard's Dairyman April 25, 2018, page 264.

Forecasts. **Cows per herd in USA will continue to INCREASE**

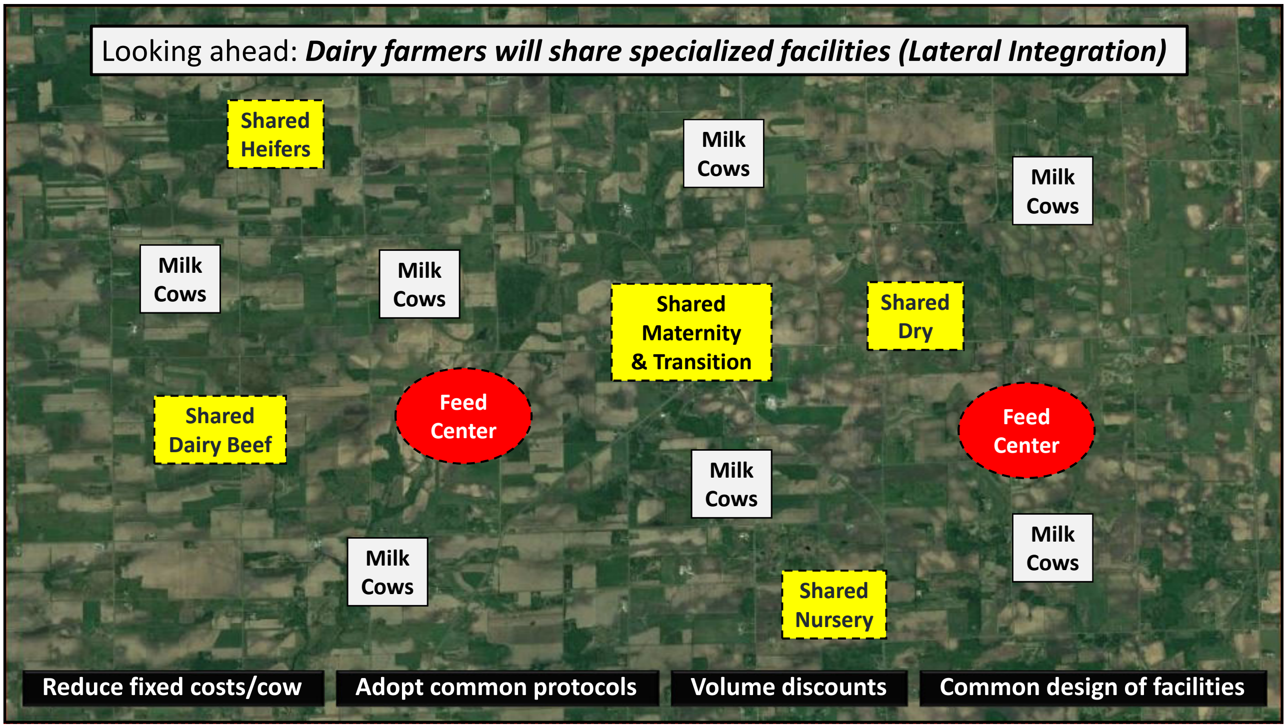


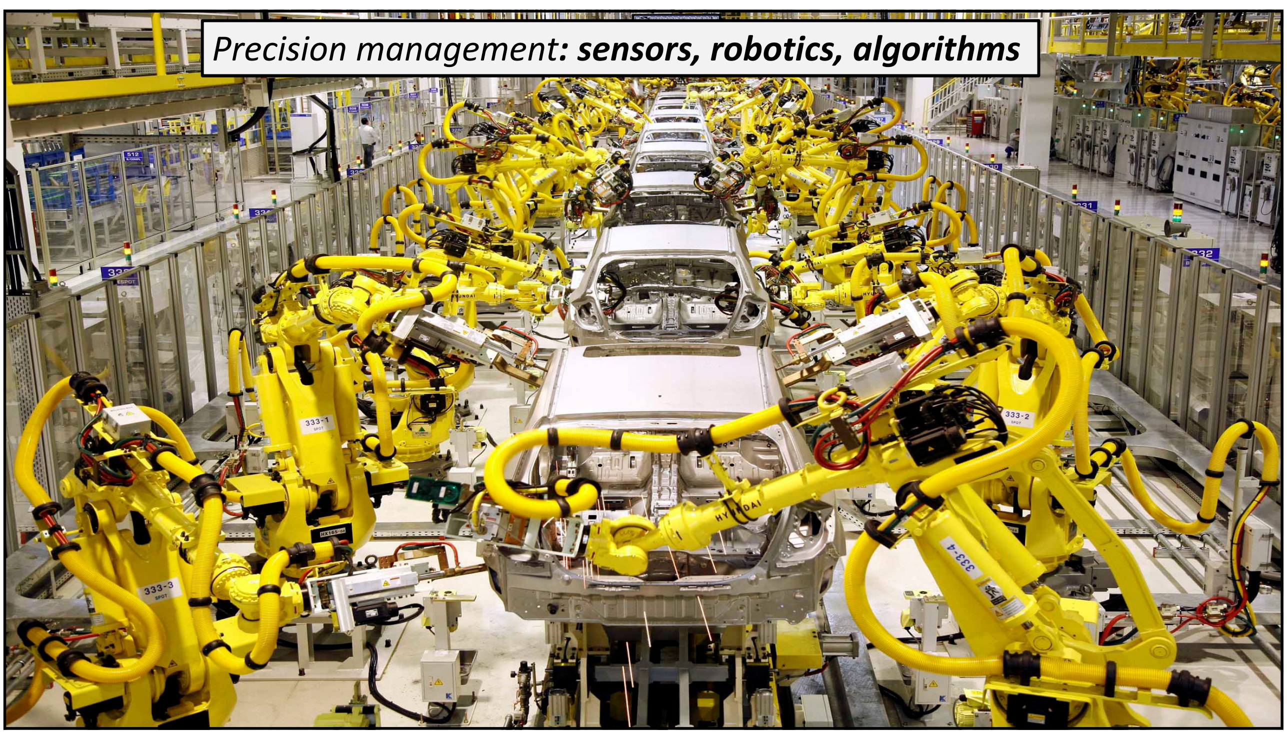
Source: J. S. Stevenson & J. H. Britt, J. Dairy Sci. 100:10292–10313 (2017)

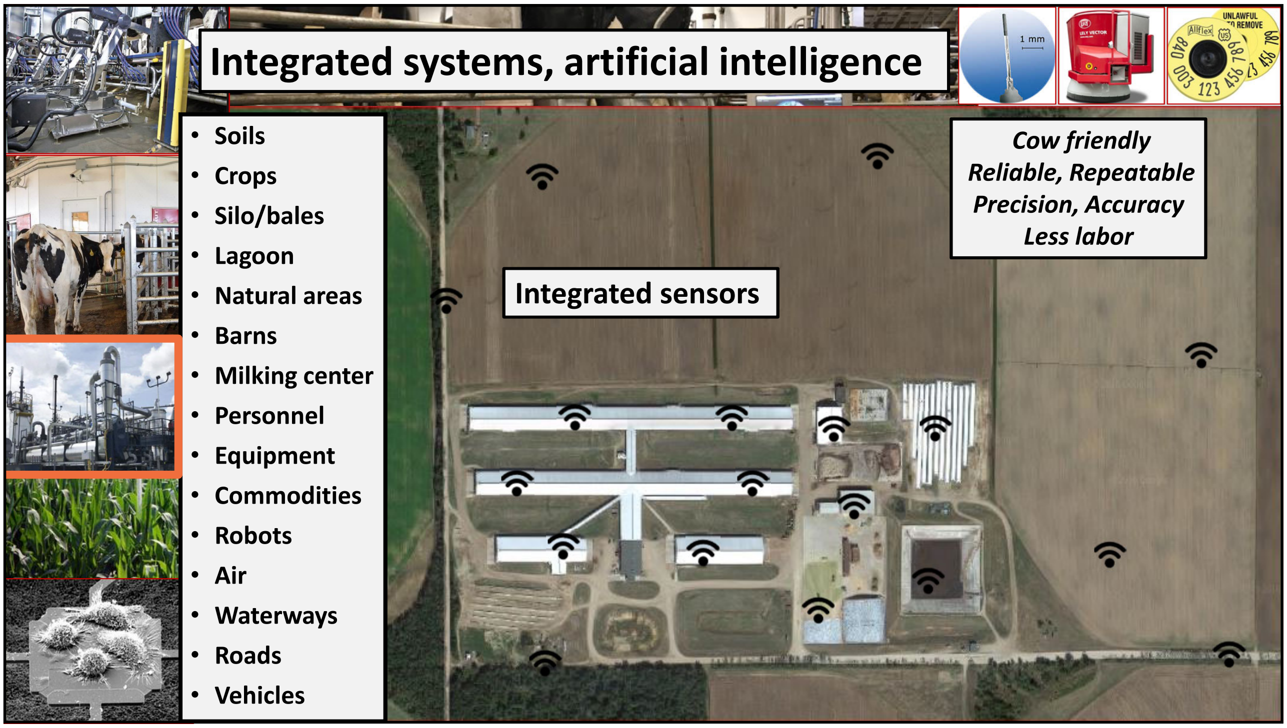
Revenue and expenses for largest herds in USA (2017)

Revenue (ECM adjusted)	**$/100 lbs.**
Net Milk Price per 100 lbs. (Mailbox)	$16.67
Total Revenue per 100 lbs.	***$17.83***
Expenses (ECM adjusted)	
Feed Costs	$7.54
Herd Replacement Costs	$1.86
Labor Costs	$1.75
Other Costs	$5.27
Total Expenses per 100 lbs.	***$16.41***
Net income per 100 lbs	*$1.44*
Net income per cow	*$359*

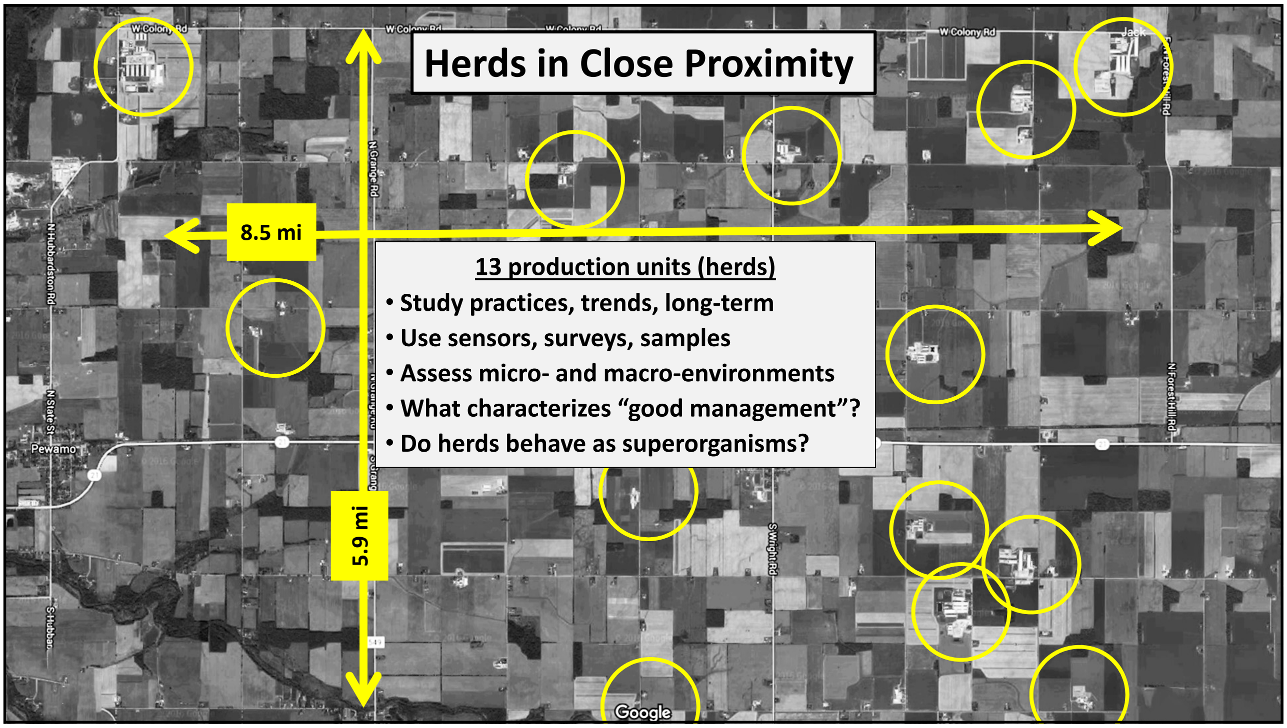
Source: 2017 Dairy Benchmark Summary, Farm Credit Services of America (~103 farms, 4299 cows per farm).

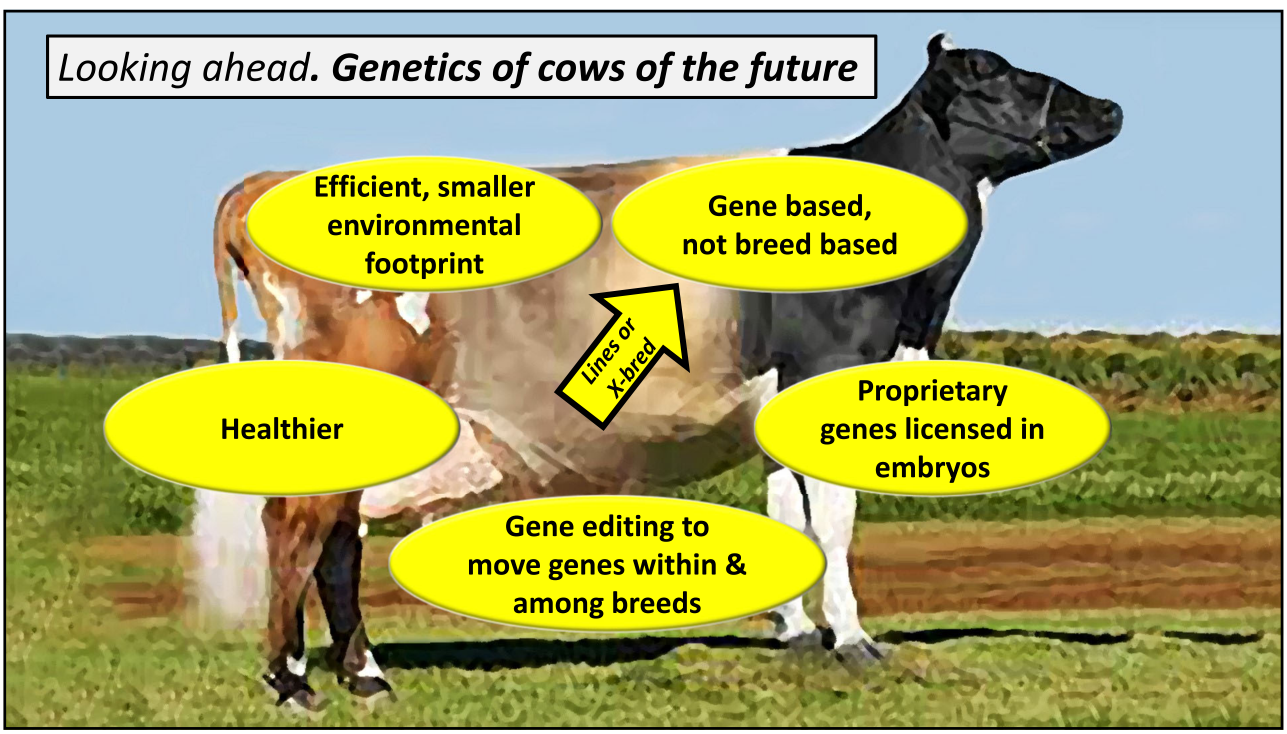

Looking ahead: ***Dairy farmers will share specialized facilities (Lateral Integration)***
Shared Heifers
Milk Cows
Milk Cows
Milk Cows
Milk Cows
Shared Maternity & Transition
Shared Dry
Shared Dairy Beef
Feed Center
Feed Center
Milk Cows
Milk Cows
Milk Cows
Shared Nursery
Reduce fixed costs/cow
Adopt common protocols
Volume discounts
Common design of facilities

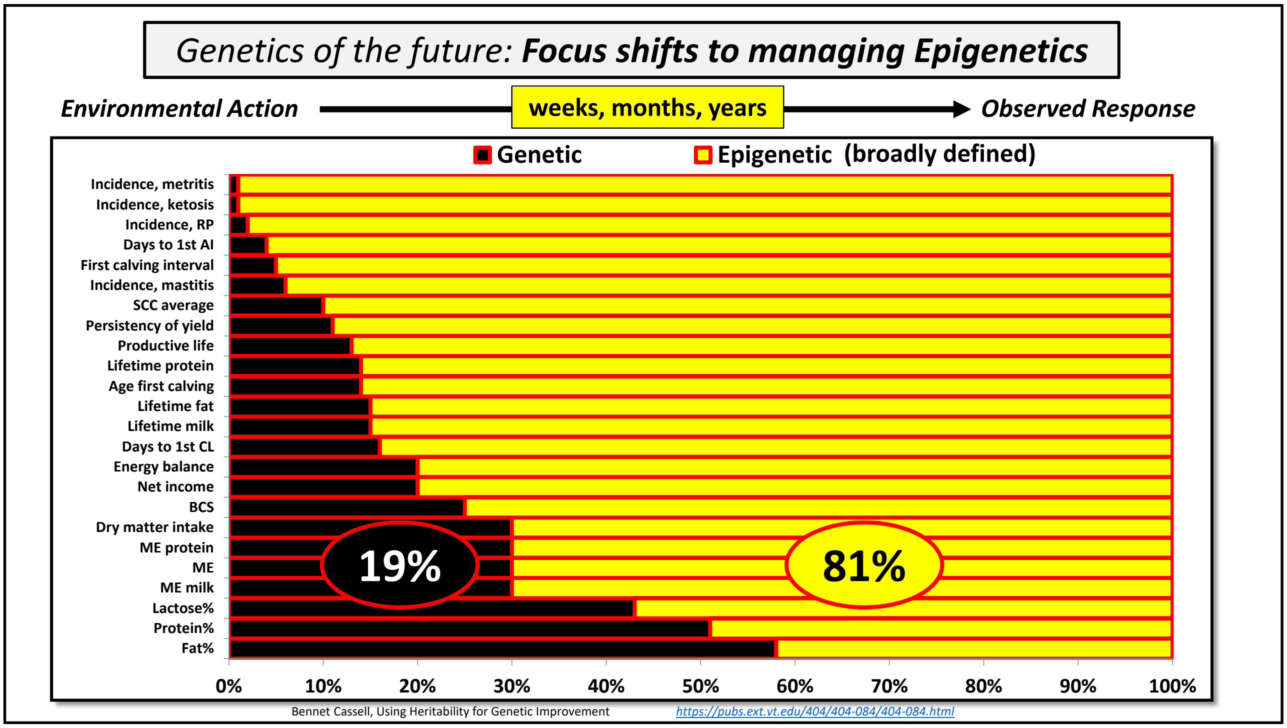

*Precision management: **sensors, robotics, algorithms***

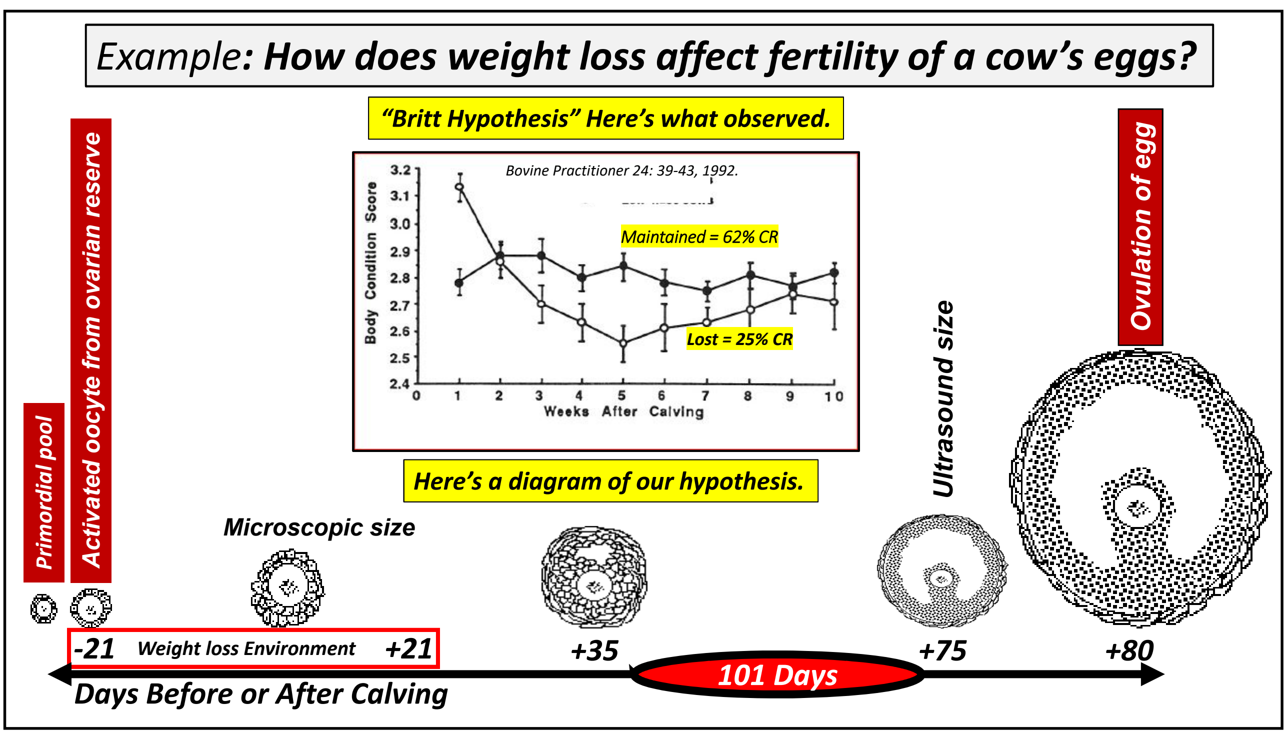

Integrated systems, artificial intelligence
Soils
Crops
Silo/bales
Lagoon
Natural areas
Barns
Milking center
Personnel
Equipment
Commodities
Robots
Air
Waterways
Roads
Vehicles
Integrated sensors
Cow friendly
Reliable, Repeatable
Precision, Accuracy
Less labor
1 mm


Looking ahead: Understanding the dairy herd as a SUPERORGANISM
We cannot learn about herds by studying these:
Gene
Cell
Organ
Animal
DNA
Gene
mRNA
Protein
ncRNA
Function
Function

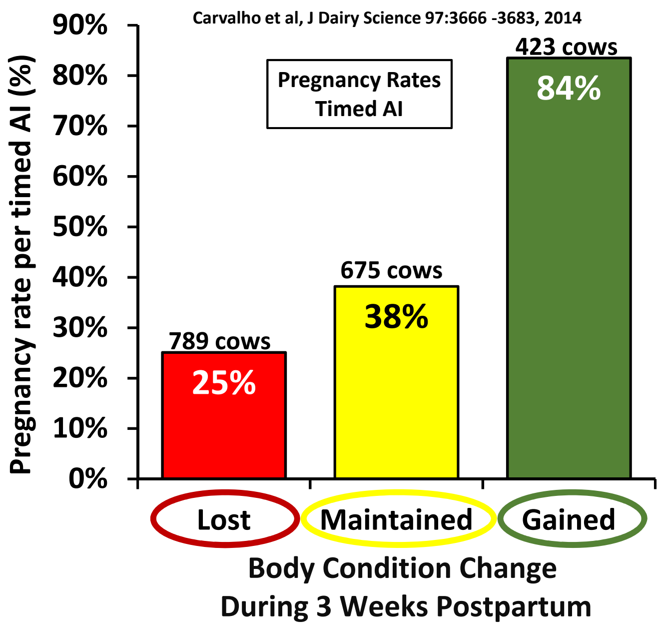

Herds in Close Proximity
8.5 mi
5.9 mi
13 production units (herds)
• Study practices, trends, long-term
• Use sensors, surveys, samples
• Assess micro- and macro-environments
• What characterizes "good management"?
• Do herds behave as superorganisms?
W Colony Rd
N Grange Rd
N Hubbardston Rd
N State St
Pewamo
S Wright Rd
N Forest Hill Rd
Google


Looking ahead. ***Genetics of cows of the future***
Efficient, smaller environmental footprint
Gene based, not breed based
Lines or X-bred
Healthier
Proprietary genes licensed in embryos
Gene editing to move genes within & among breeds


Genetics of the future: Focus shifts to managing Epigenetics
Environmental Action
weeks, months, years
Observed Response
Genetic
Epigenetic (broadly defined)
Incidence, metritis
Incidence, ketosis
Incidence, RP
Days to 1st AI
First calving interval
Incidence, mastitis
SCC average
Persistency of yield
Productive life
Lifetime protein
Age first calving
Lifetime fat
Lifetime milk
Days to 1st CL
Energy balance
Net income
BCS
Dry matter intake
ME protein
ME
ME milk
Lactose%
Protein%
Fat%
19%
81%
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Bennet Cassell, Using Heritability for Genetic Improvement
https://pubs.ext.vt.edu/404/404-084/404-084.html


Example: How does weight loss affect fertility of a cow's eggs?
"Britt Hypothesis" Here's what observed.
Bovine Practitioner 24: 39-43, 1992.
Maintained = 62% CR
Lost = 25% CR
Body Condition Score
Weeks After Calving
Here's a diagram of our hypothesis.
Primordial pool
Activated oocyte from ovarian reserve
Microscopic size
Ultrasound size
Ovulation of egg
-21
Weight loss Environment
+21
+35
+75
+80
101 Days
Days Before or After Calving

The Britt Hypothesis: ***25 years later…***

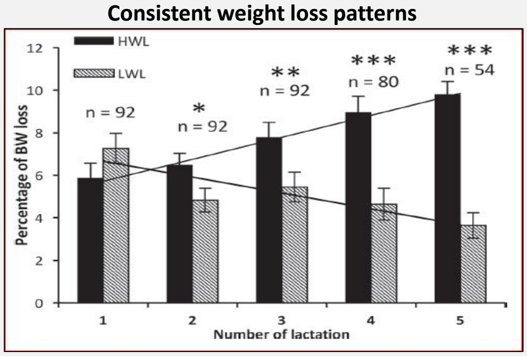


In the future:

1. Selection for cows that don't lose weight (Israel scientists, 2017)
2. Bulls will be indexed on daughter "robustness" (Swiss scientist, 2017)

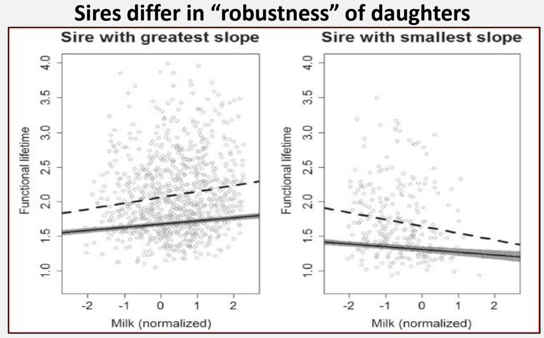
Cows of the future: ***Less weight loss, metabolically robust***

Consistent weight loss patterns



M. Zachut and U. Moallem. 2017.
J. Dairy Sci. 100 (4) 3143–3154

Sires differ in "robustness" of daughters



N.-T. Ha et al. 2017
J. Dairy Sci. 100 (5) 3742–3753.

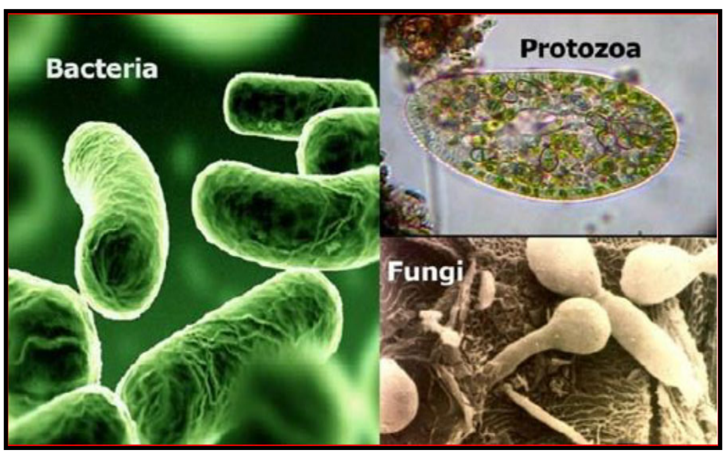
Current examples of epigenetic-like effects

Milk fresh cows 4X for first 3 weeks of lactation

Ensure maximum growth of calves to 70 days of age

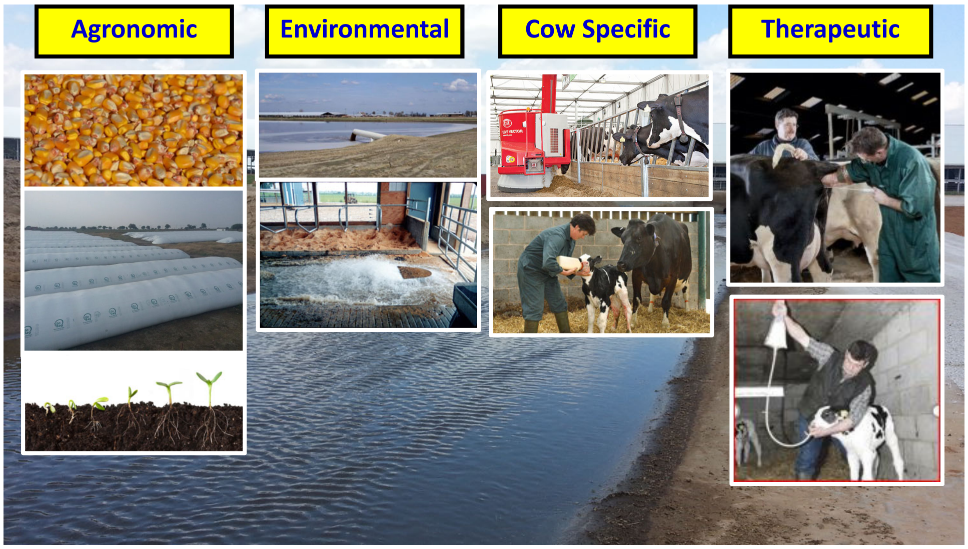
Practices for Managing the Epigenome

Looking ahead: ***Managing the cow's and farm's natural Microbiome***



Microbiomics –relationships with genomically beneficial microbes that live within animals, plants, soils and in all environments

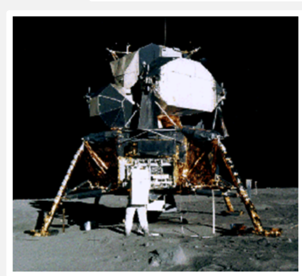
Looking ahead: ***Managing the microbiome to benefit crops and cows.***



What is Dairy's Vision ?

May 25, 1961

July 16, 1969



July 20, 1969

The Dairy Cow and Dairy Farm in 50 Years

Jack H. Britt

Jack H. Britt Consulting
Etowah, NC

Over the next 50 years there will be significant changes in dairy cows and farms in North America and globally. Changes will be driven by population growth and associated increases in consumption of dairy products; climate change and northward migration of growing seasons; growth in herd sizes associated with adoption of automation, robotics and specialized waste processing equipment; increased milk component yields and improvements in cow health and fertility; adoption of new cropping systems; increased management of epigenetics of cows and crops; and increased management of the microbes of animals, crops and farmsteads.

POPULATION GROWTH

Growth in global population to over 10 billion people will push worldwide dairy demand strongly upward. This growth will be almost exclusively in Asia and Africa, outside of dairy's traditional production centers such as Ireland, the European Union, North America, New Zealand, and Australia (Figure 1). Dairy consumption in Africa and Asia will be important because dairy products provide essential amino acids, vitamins, and minerals more efficiently and sustainably than most crops and other animal products.

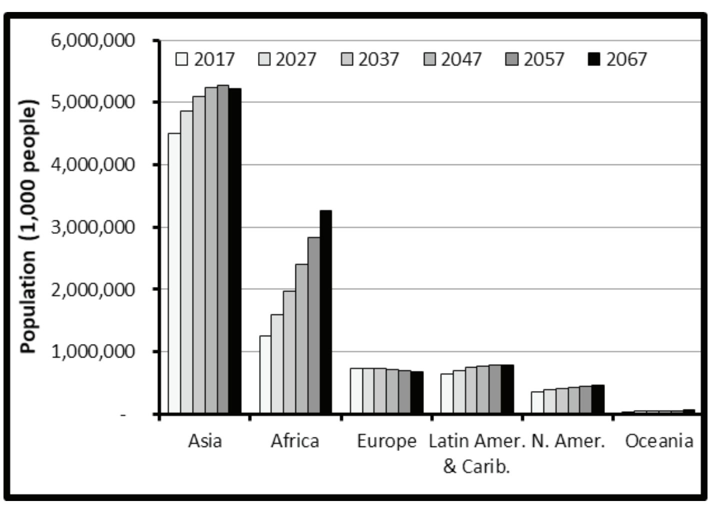


Figure 1. Estimated populations of major regions of the world by 2067. Estimates are from the United Nations. Adapted from Britt et al., 2018.

Countries such as China are increasing output per cow and herd size; however, there will be limits on how much such countries can produce because of limits on land suitable for producing feeds for livestock. There will be substantial opportunities for dairy exporters to provide products to countries and regions that cannot produce milk to meet all of their needs.

Countries that already are developing new products for these growing regions will capture most of this demand. North America is behind other regions in developing products for African and Asian countries. It must up its game if it expects to capture that market in the future.

CLIMATE CHANGE

Climate change will cause dairying to shift in the Northern Hemisphere, mostly because of limits on water availability. In the USA dairying will move away from the west and southwest to the upper Great Lakes region and into Canada (Figure 2). Growing seasons in the upper tier of states and in Canada will increase by 4 to 6 weeks, allowing longer-season corn and other crops to be grown with greater yields.

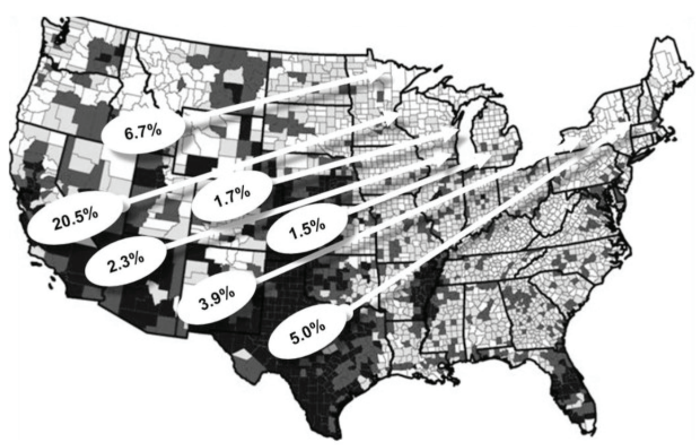


Figure 2. Projected shifts in dairy cattle in the USA associated with climate change. Dark-shaded areas will have limited water resources. Percentages represent the approximate proportion of USA milk produced by associated states in 2016. Source: Britt et al., 2018.

Dairy cows will have genes from within breeds or moved among breeds to enhance tolerance to climate stress. This will allow cows to produce higher yields in hot arid or humid climates. Breeders should be developing these specialized lines now.

Similarly, feed crops that are more tolerant of heat stress will be developed for use worldwide. As the growing season moves north because of climate change, there will be new varieties of crops developed for a broader range of environmental conditions. We will also see some traditional tropical or subtropical crops move northward, providing some new resources for dairy farmers.

MILK YIELD AND COMPOSITION

Milk output per cow will continue to climb across the globe, with average production exceeding 50,000 lbs. per cow annually in the USA (Figure 3). Components will increase and there will be discounts to dairy farms that have too much volume in relation to components. On larger farms, filtration will be used to remove lactose from milk to concentrate protein and fat. The lactose will be used as a source of sugar in rations.

There will be increased differentiation of milk in terms of value, primarily related to genes that control casein, other milk proteins, and fat. Some highly-valued milks with unique genetic traits will be licensed through embryos sold to farmers by genetic companies.

HERD SIZES AND TECHNOLOGY

Average herd size will continue to grow, driven by automation, sensors, and robotics and paid for by reduced fixed cost per unit of milk (Figure 4). Many functions on dairy farms will be done by robots and automated systems that will be controlled by artificial intelligence systems. For example, driverless vehicles and automated equipment will prepare and deliver partial TMR rations to cows that are milked in robotic systems. Cows love robotic systems and automation! Consistency and lack of emotions of robots and automated systems are keys to making cows comfortable.

Manure and waste water on dairy farms will be processed through emerging on-farm systems that convert waste streams into chemical-like fertilizers, energy, and potable water to reduce environmental impacts. Herds will need to be larger for such systems to be operated economically, and environmental regulations may require such systems in areas with heavier livestock concentrations.

Herds will be viewed as superorganisms, and we will understand why herds that use similar genetics and feeds differ in terms of performance, health, and profitability. This will provide information to improve protocols and management and reduce issues associated with lameness and animal welfare.

Smaller-scale farms will utilize lateral integration to share facilities, feed centers, and production facilities to reduce fixed costs per unit of milk produced. Laterally-integrated operations will mimic larger dairy farms and provide some of the benefits of size to owners and operators.

NEW CROPS

New perennial forage crops high in starch will be introduced along with perennial corn (maize) and new legumes to provide feed that is produced with less

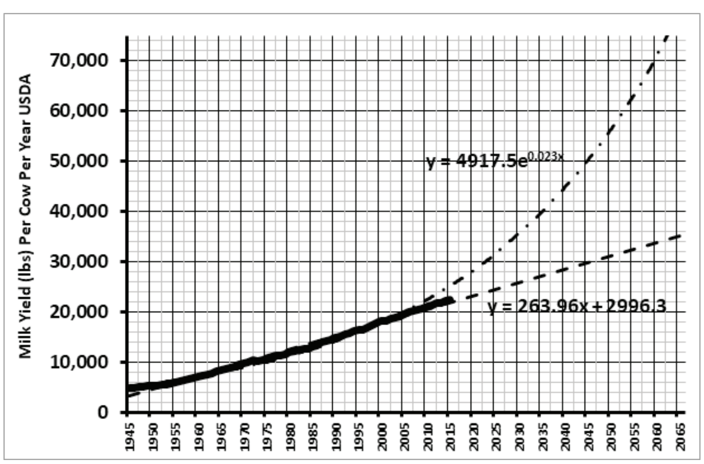


Figure 3. Extrapolation of milk yield using linear (straight line) or exponential (curved line) from existing yield data (heavy black line) in USA. Source: Britt et al., 2018.

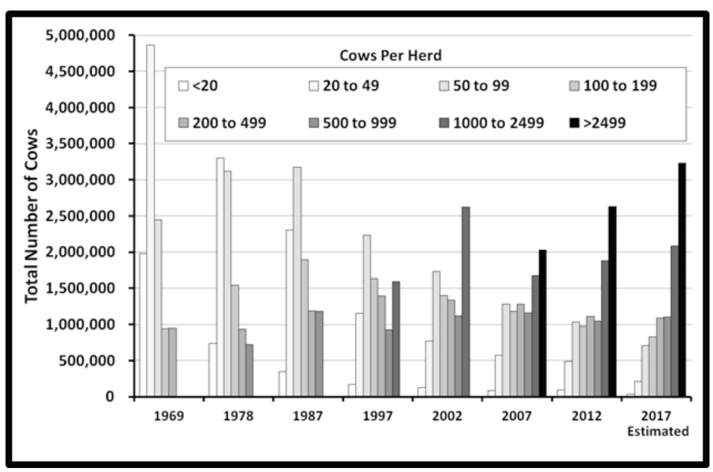


Figure 4. Change in dairy herd sizes in the USA from 1969 to 2017. Projections for the future are that dairy cows will continue to be milked in larger herds. Source: Stevenson and Britt, 2017.

inputs. Digestibility of feeds will continue to improve through manipulation of plant genomes. More crops will be heat- and drought-tolerant.

A challenge in many African and Asian countries will be production of high quality forages with a limited land base. This issue cannot be clearly resolved by technology; therefore, it provides additional opportunities for exporting countries where land resources are available.

MANAGING A COW'S GENOME

Breeds did not evolve naturally—they were created by mankind. Commercial dairy cattle will move from being breed-based to gene-based, with movement of genes among cattle breeds using gene editing and traditional breeding. Cows will be smaller and have smaller environmental footprints.

Cows of the future will have different metabolic profiles during the transition period and will not lose body condition or experience severe negative energy balance—resulting in better health and longer productivity. Overall health and fertility will improve, and some diseases will be reduced greatly or eliminated.

Embryos will replace semen as the major product sold by breeding companies. Multiple generations of embryos will be produced in a few months through cell- and embryo-culture systems before a line of female or male embryos is released for sale.

MANAGING THE EPIGENOME

Cause and effect events that are separated by days, weeks, months, years, or generations reflect epigenetic responses. Epigenetic or environmental-directed gene expression will become a major part of herd management, driven by cloud-based data-mining of records from millions of cows.

We already have examples of how epigenetics affects some important traits.

- Calves fed to gain more weight during the first 10 weeks of life produce more milk in their first lactation, about 2 years later. We are just beginning to understand the mechanisms that control this response.
- We know that oocytes developing in the ovaries of cows that experience greater body weight loss during the transition period are less fertile at 80 days postpartum. These oocytes seem okay at ovulation, but then die during the first week after fertilization (Figure 5).

MANAGING MICROBIOMES

Genomics will expand to include dairy farm microbiomes (genes in the microbes) and the microbiome will be managed to improve health and longevity of cattle, reduce use of antibiotics and drugs, and increase yield and disease resistance in crops.

Commercial microbial products with specified genomes and functions will be used routinely on dairy farms (Figure 6). Seeds will be coated with selected microbes before planting to boost yield, enhance nitrogen efficiency, and control diseases. Microbes will be added to waste water to reduce pollution and improve fermentation for production of energy. Microbial supplements will be given to cows and calves at specific ages to improve health, improve digestibility of feeds, and change milk components. Some special microbial mixtures will be used as prescription drugs to treat diseases.

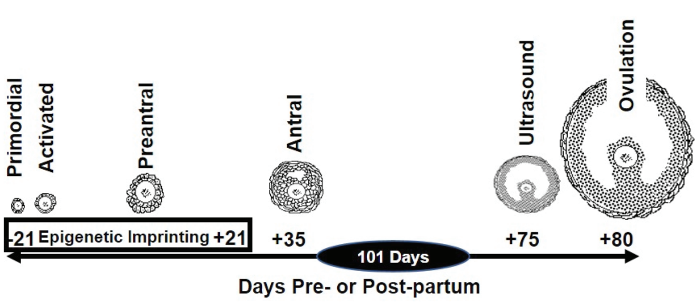


Figure 5. Illustration of how an oocyte exposed to negative energy balance during the transition period is altered by epigenetic mechanisms to be less fertile at breeding about 90 days later. Modified from Britt (1992).

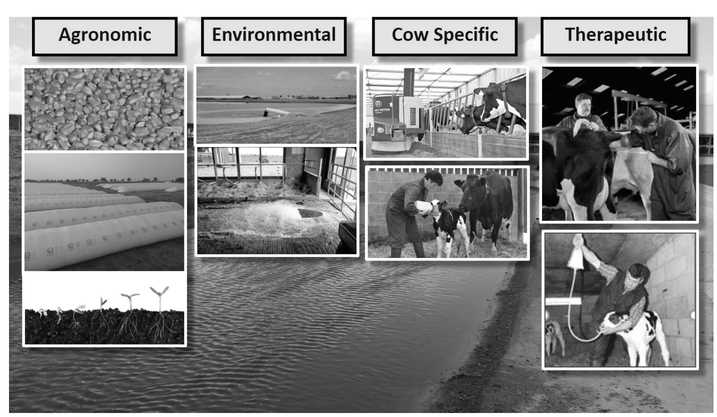


Figure 6. Examples of use of microbiome products for crops, wastewater, calves and cows, and disease treatments.

VISION FOR THE DAIRY INDUSTRY

The most significant challenge for the USA dairy industry will be to develop a vision for what it will be in 50 years. It must be profitable and sustainable, and it must produce products that will be in demand domestically and worldwide. To grow in the future, the USA dairy industry needs to develop new products for domestic use and export that will be sought by consumers worldwide.

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Britt, J. H. 1992. Impacts of early postpartum metabolism on follicular development and fertility. Bovine Practitioner 24:39-43.

Britt, J. H., R. A. Cushman, C. D. Dechow, H. Dobson, P. Humblot, M. F. Hutjens, G. A. Jones, P. S. Ruegg, I. M. Sheldon and J. S. Stevenson. 2018. Invited Review: Learning from the future: A vision for dairy farms and cows in 2067. J. Dairy Sci. 101:3722-3741.

Stevenson, J. S., and J. H. Britt. 2017. A 100-year review: Practical female reproductive management. J. Dairy Sci. 100:10292-10313.

What Is the Right Composition of Milk for the Future?

Farm

Transport

Process

Market

jackhbritt@gmail.com

Jack H Britt <> Penn State Dairy Cattle Nutrition Workshop <> November 1, 2018

Milk is mostly consumed in non-fluid forms in the USA.

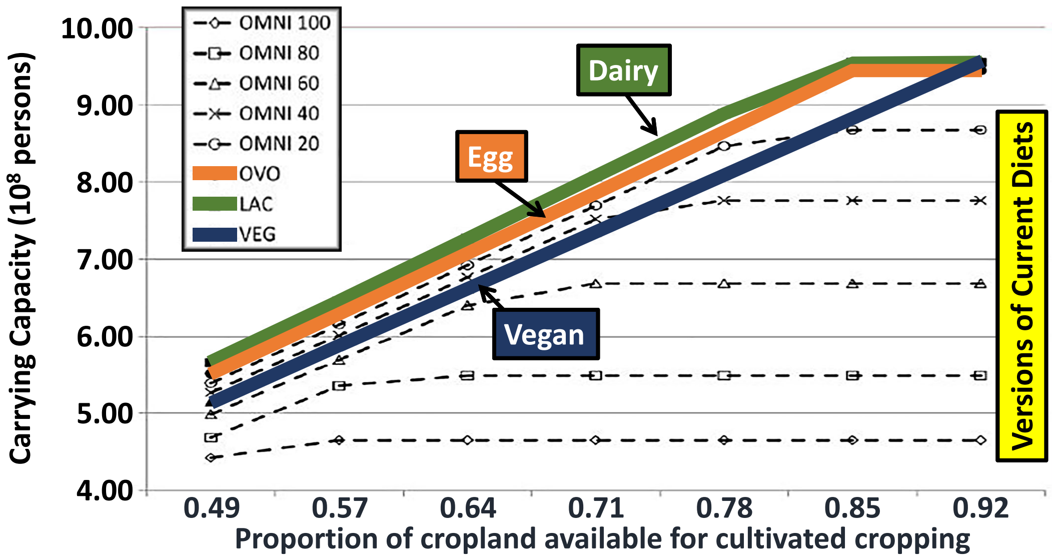
56 billion lbs.

23% vs 77%

Milk vs Other dairy

159 billion lbs.

Why Dairy? **It feeds the most people from our land base**



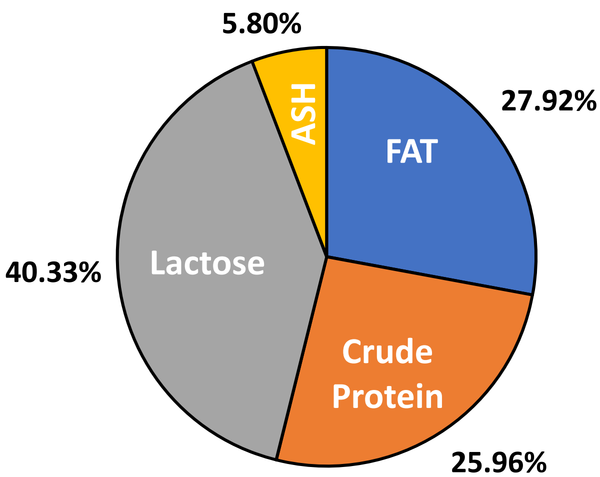
Peters, Christian J., Jamie Picardy, Amelia F. Darrouzet-Nardi, Jennifer L. Wilkins, Timothy S. Griffin, Gary W. Fick. 2016.
Carrying capacity of U.S. agricultural land: Ten diet scenarios. Elementa: Science of the Anthropocene • 4: 000116 • doi: 10.12952/journal.elementa.000116

Cow's milk**: Composition of milk from Holstein cows**

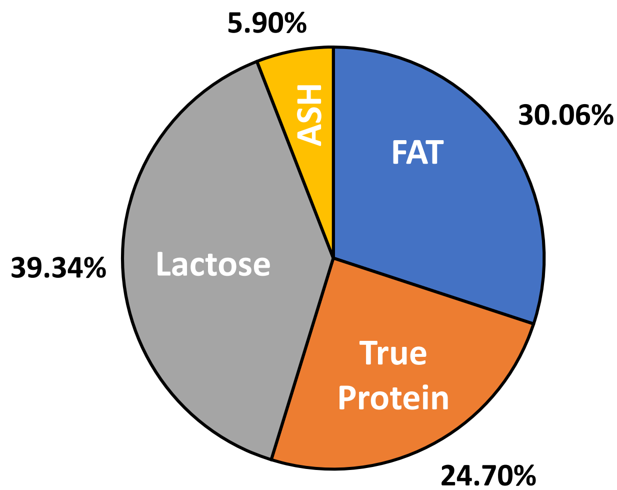
Component	Average	Range
Total solids	12.2%	10.46% - 15.6%
Solids-not-fat	8.8%	7.82% - 10.52%
Milk fat	3.4%	1.60% - 6.40%
Crude protein	3.2%	2.52% - 5.40%
Lactose	4.9%	3.76% - 5.72%
Ash	0.7%	0.54% - 1.00%
Energy, kcal/lb.	314	250 - 445

Source: H.F. Tyrrell and J.T. Reid. 1965. Prediction of the energy value of cow's milk. J. Dairy Sci. 48: 1212-1223. [600 composite samples]

Change over time: **Milk solids composition shifts slightly**

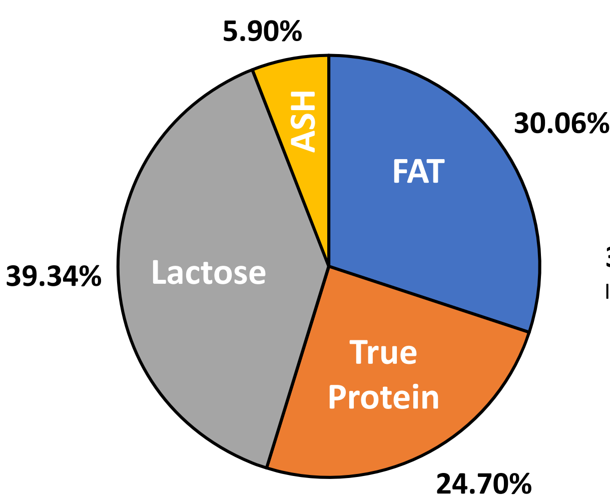


Original Holstein Data from Tyrrell and Reid, 1965

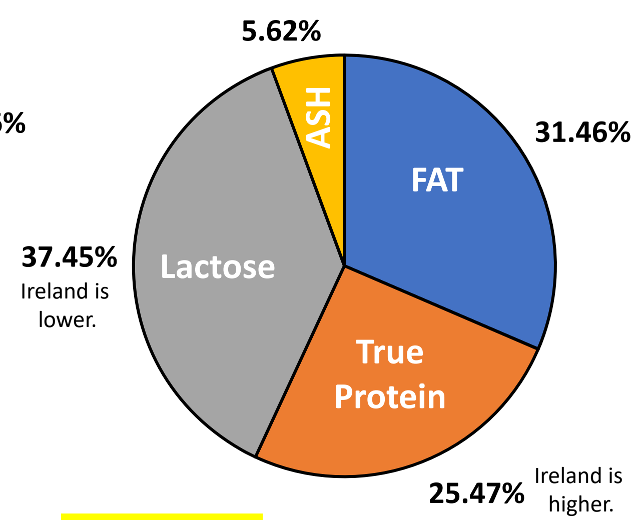


2017 Federal Order Data

Milk solids: **Comparisons USA and NZ**

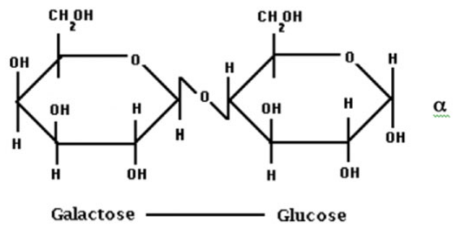


USA 2017 Federal Order Data



New Zealand Fonterra Target for 2018

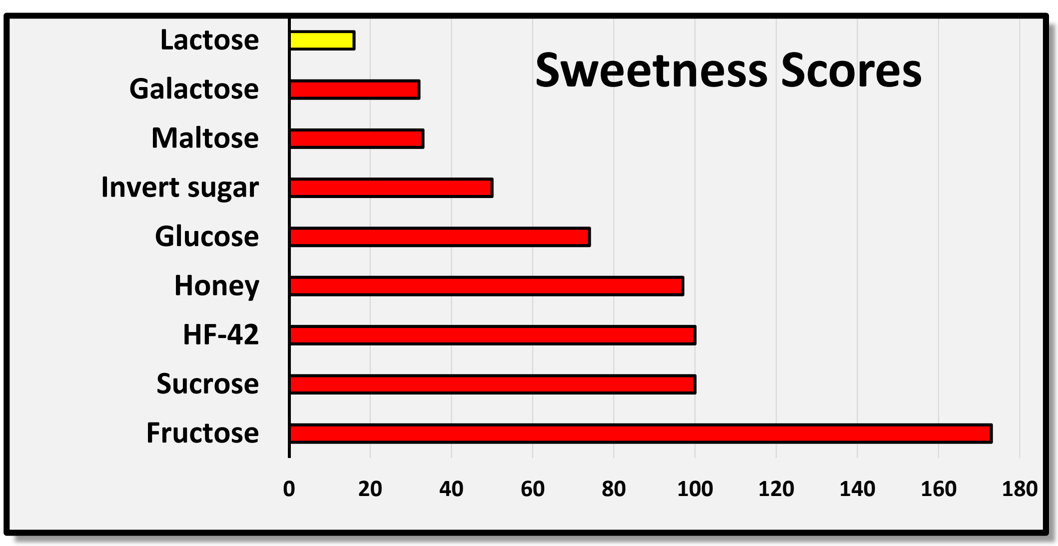
Lactose: **Controls volume, but has least value**



***"Milk yield** greatly depends on mammary **lactose** synthesis due to its osmoregulation of milk, one that induces mammary uptake of water. Therefore, the **rate of lactose synthesis** in the epithelial cells of the mammary gland serves as a **major factor influencing milk volume** production."*

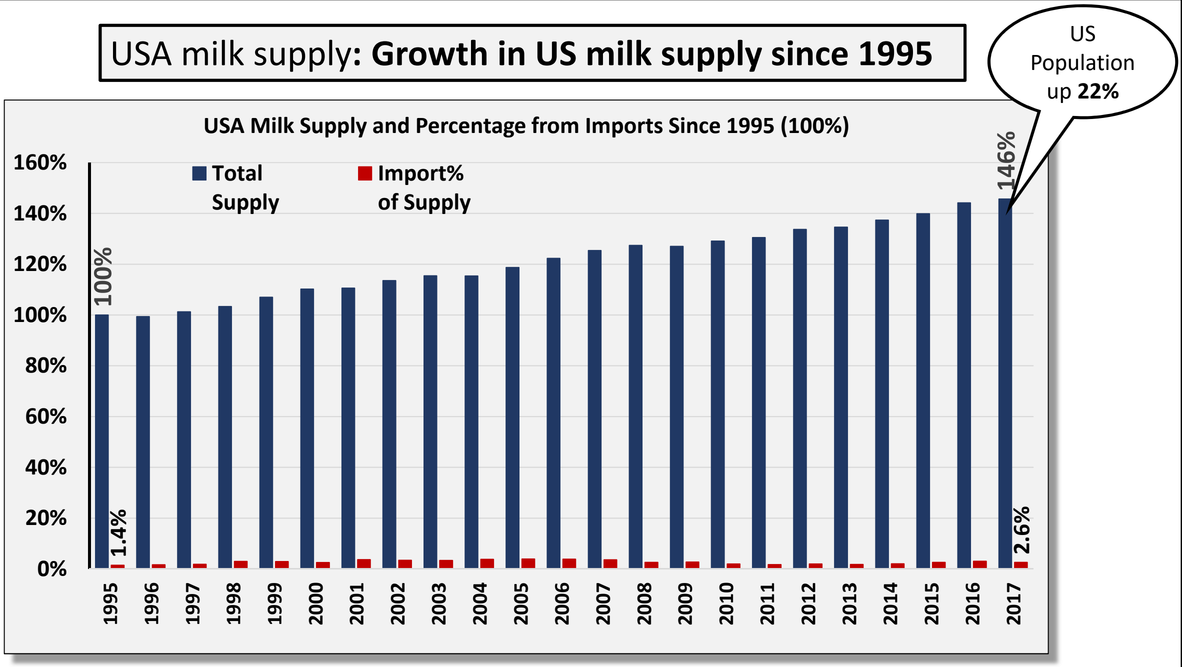
J. S. Osorio, J. Lohakare, and M. Bionaz. 2016. Biosynthesis of milk fat, protein, and lactose: roles of transcriptional and posttranscriptional regulation. Physiological Genomics https://doi.org/10.1152/physiolgenomics.00016.2015

Lactose: **Not as "addictive" as other sugars in foods**



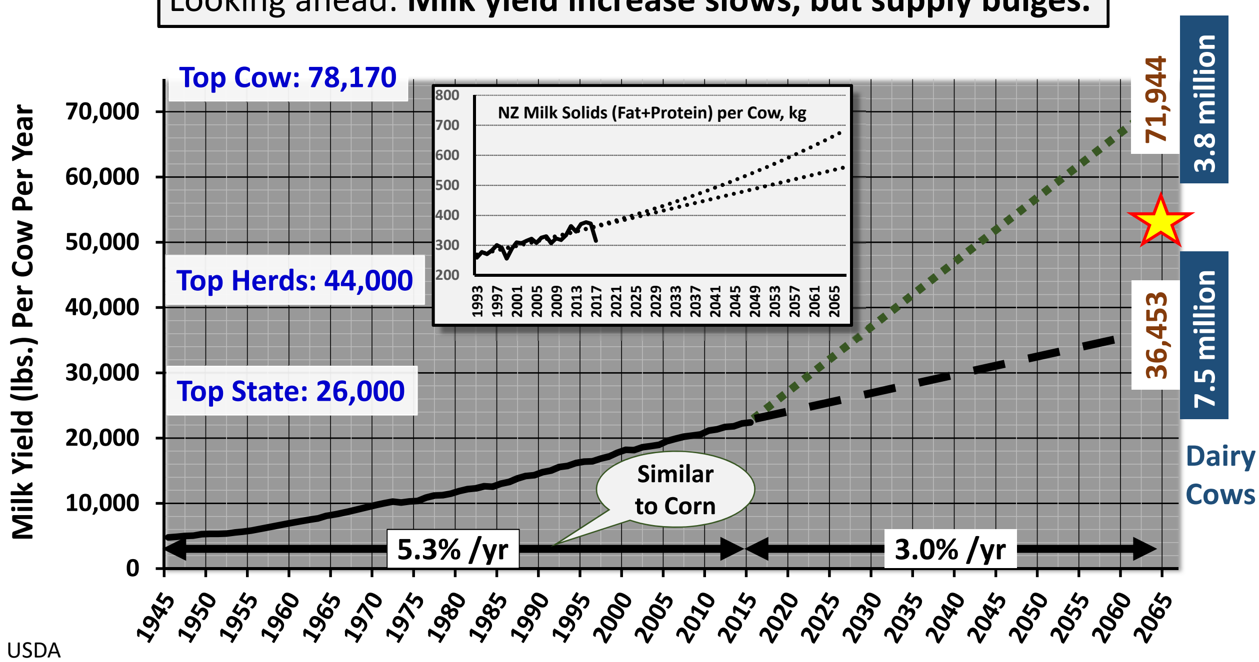
Source: https://en.wikipedia.org/wiki/Sweetness

USA milk supply: **Growth in US milk supply since 1995**

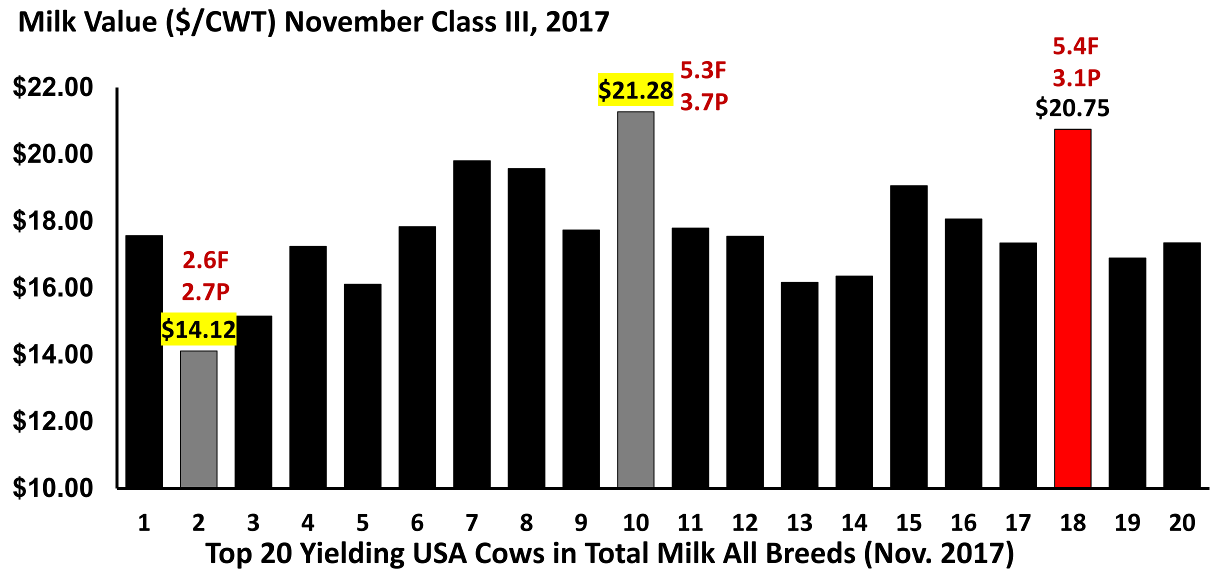


*USDA estimated components of USA milk supply on a milk fat basis are **3.7% fat solids**, **8.8% skim solids**.*

Looking ahead: **Milk yield increase slows, but supply bulges.**



Top cows: **Value of milk for the top 20 highest yielding cows.**



Source: J. H. Britt, Hoard's Dairyman, 2018 in press

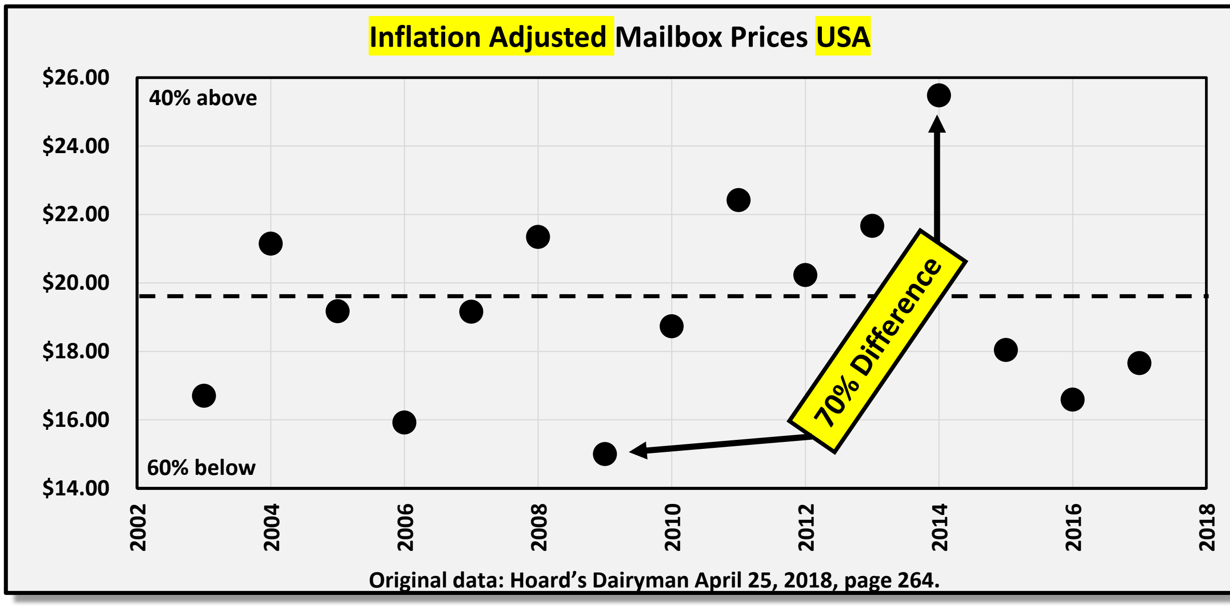
Value of USA milk supply 2017: **$ per CWT in today's market**

US Federal Order 2017 Values

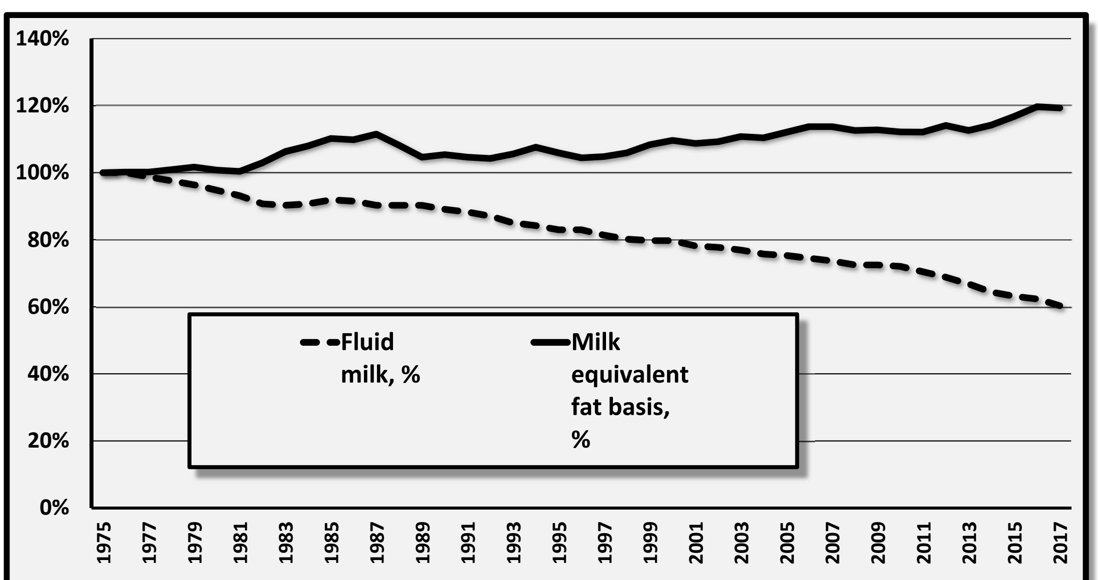
Component	Percentage	Value/Lb.	Value/CWT
Milk fat	3.82%	$2.54	$9.70
True Protein	3.14%	$2.00	$6.28
Lactose	5.00%	$0.35	$1.75
			$17.73

USDA-Agricultural Marketing Service
DAIRY MARKET NEWS , WEEK OF OCTOBER 1 - 5, 2018 , VOLUME 85, REPORT 40

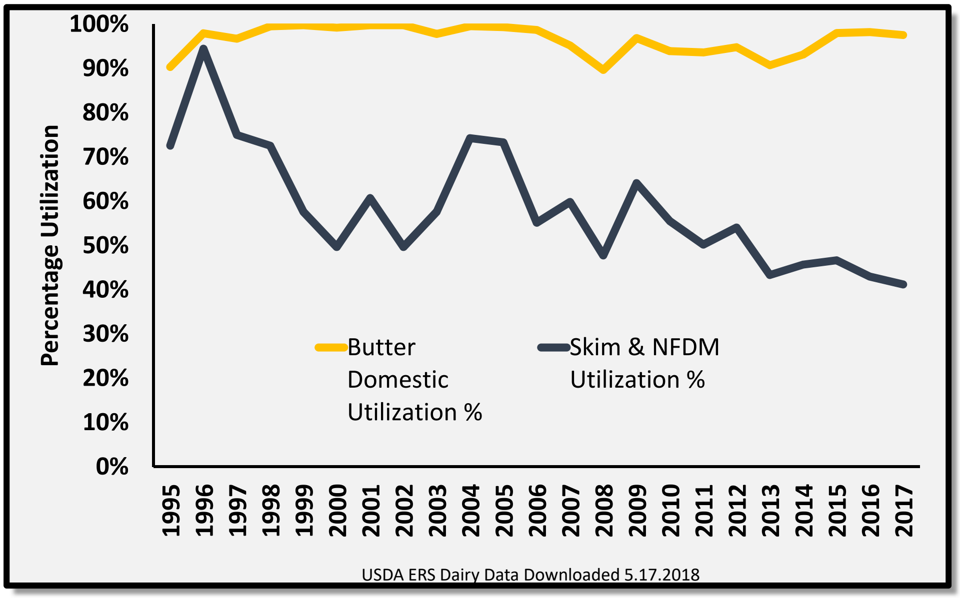
Forecasts: **Milk prices in USA will continue to be VOLATILE!**



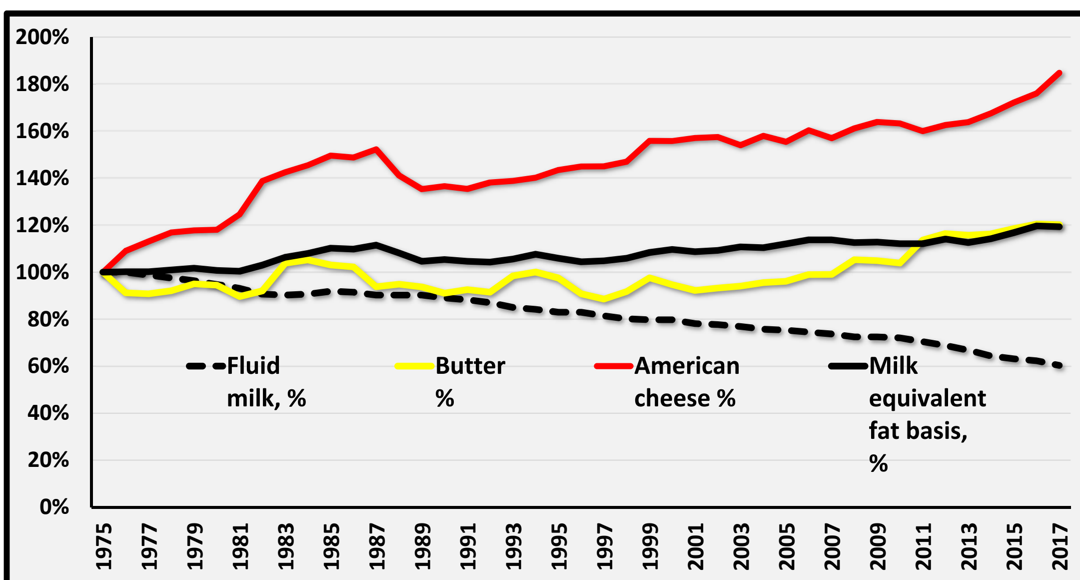
Consumption: **USA per capita dairy consumption (1975 = 100%)**



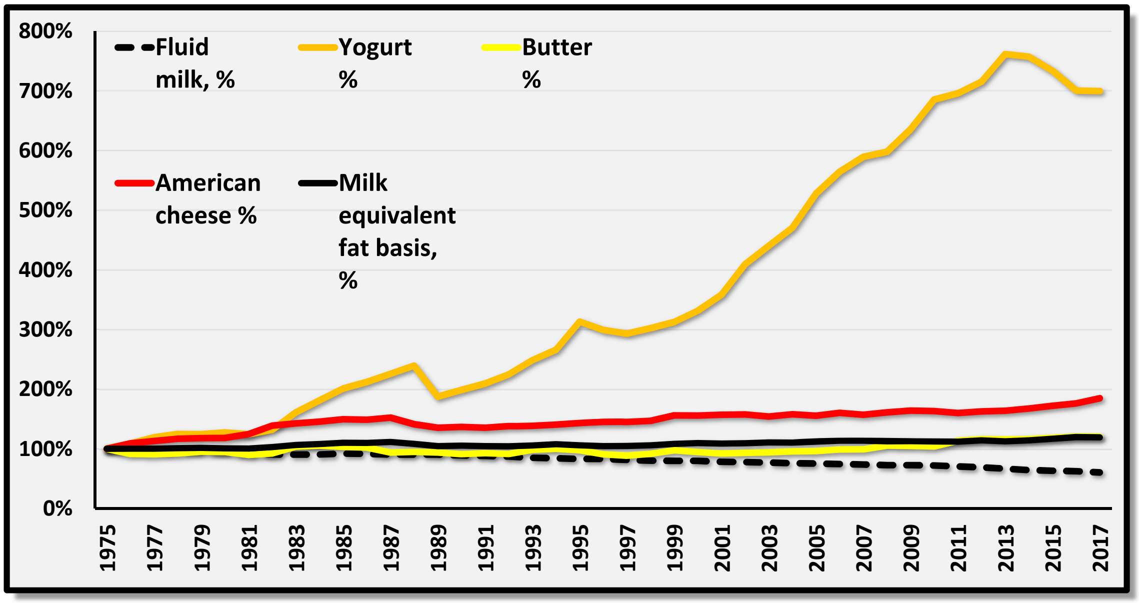
Skim and non-fat domestic utilization: **Declining for 20 years.**



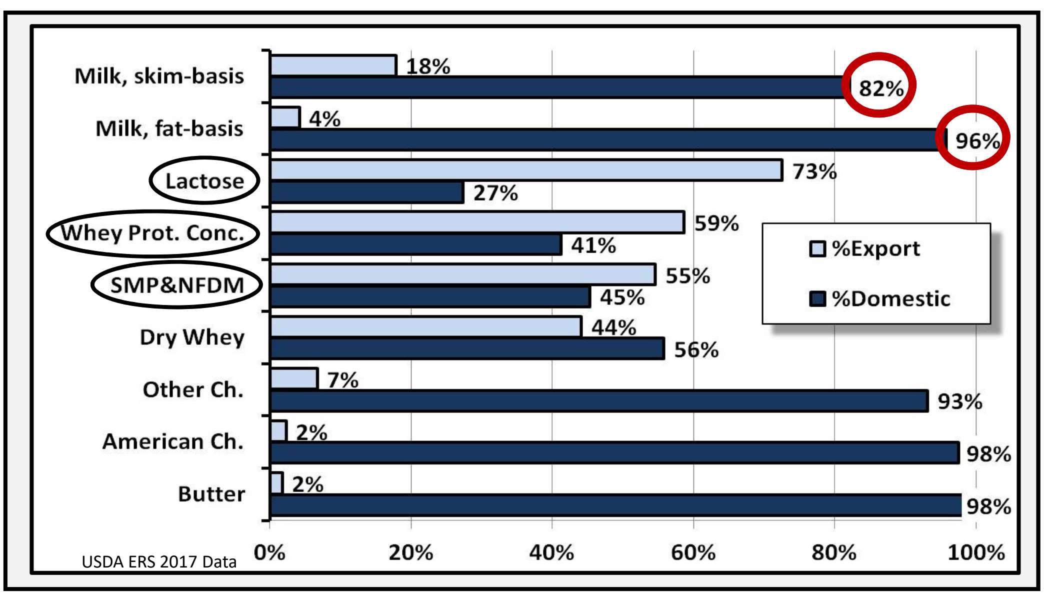
Consumption: **USA Per Capita Dairy Consumption (1975 = 100%)**



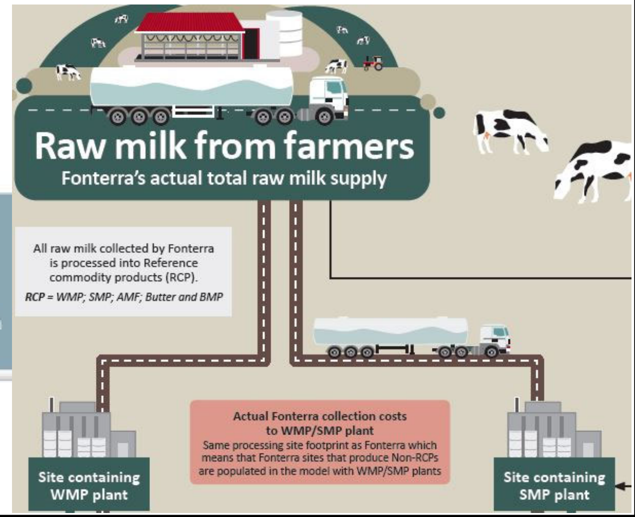
Consumption: **USA Per Capita Dairy Consumption (1975 = 100%)**



Today's dairy marketplace: **Imbalance in domestic utilization**



New Zealand: **Managing milk composition and flow**



Raw Milk Goal: 4.2% Fat and 3.4% Protein (Ireland is 3.5% Protein)

Change in USA supply **with NZ-like standards (4.2%F & 3.3%P)**

Milk supply (-7.0%)	**-14,902,682,078 lbs.**
Lactose supply (-7%)	**-737,682,763 lbs.**
Fat supply (-2.3%)	**-189,138,713 lbs.**
Protein supply (+2.2%)	**148,608,989 lbs.**
Value/CWT (+7.3%)	**$1.29 per CWT**

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Current Value ***vs.*** **a NZ-like Model in USA**

New Zealand-like Model for USA milk		
Component	**Value USA-type**	**Value NZ-type**
Milk fat	**$9.70**	**$10.67**
True Protein	**$6.28**	**$6.60**
Lactose	**$1.75**	**$1.75**
	$17.73	**$19.02**

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Increasing value: **Increasing butterfat and protein levels in milk**

Improving butterfat:

- Genetic selection (h^2=.53)
- Roughage
- peNDF
- Buffers in ration
- Rumen inert fats
- Methionine hydroxy analog

Improving protein:

- Genetic selection (h^2=.56)
- Adequate rumen starch (energy) for rumen organisms
- Adequate protein or nitrogen for rumen organisms
- Adequate by-pass protein
- Protein intake balanced to meet needs without excess
- Avoid slug feeding, especially protein before energy
- Monitor MUN

Source: C. M. Jones, J. Heinrichs and K. Bailey. Milk Components: Understanding Milk Fat and Protein Variation in Your Dairy Herd (updated 2016). https://extension.psu.edu/milk-components-understanding-milk-fat-and-protein-variation-in-your-dairy-herd

Milk**: Other issues.**

- **Caseins:** A1, A2, better yield, etc.
- **SCC**: 400,00 or lower
- **bST**: Mostly a non-issue
- **"Humane" milk**: economically viable ?
- **Processing**: Pasteurized, UHT, Aseptic
- **New Products**: USA is lagging
- **Nut milks**: Innovators are often "nutty"

Let's Talk

jackhbritt@gmail.com

Managing Highly Digestible Alfalfa in the Rations of High Producing NE Dairy Herds

Dr. Dave Combs University of Wisconsin

What makes a better forage?

- High digestibility
  - Fiber (-)
  - Fiber digestibility (+)
- High intake potential
  - Fiber (-)
  - Fiber digestibility (+)

BOTH NDF and NDF digestibility are needed to assess forage quality

Why is fiber digestibility important?

Oba and Allen (1999)
A 1% change in vitro or in situ NDF digestibility (primarily 30-h or 48-h NDFD) was correlated with:

- ✓ 0.4 lb increase in dry matter intake
- ✓ 0.5 lb increase in 4% fat corrected milk yield

Improved fiber digestibility in dairy nutrition also has other benefits

- Energy
- Rumen microbial protein production (lysine/methionine) supply
- Milk components
- Cow health

Assessing fiber digestion

Variations in dietary DE from changes in:
NDF digestibility; up to 8-10 lb milk
Starch digestibility; up to 4-6 lbmilk

Poor digestion < 40%

Excellent digestion > 50%

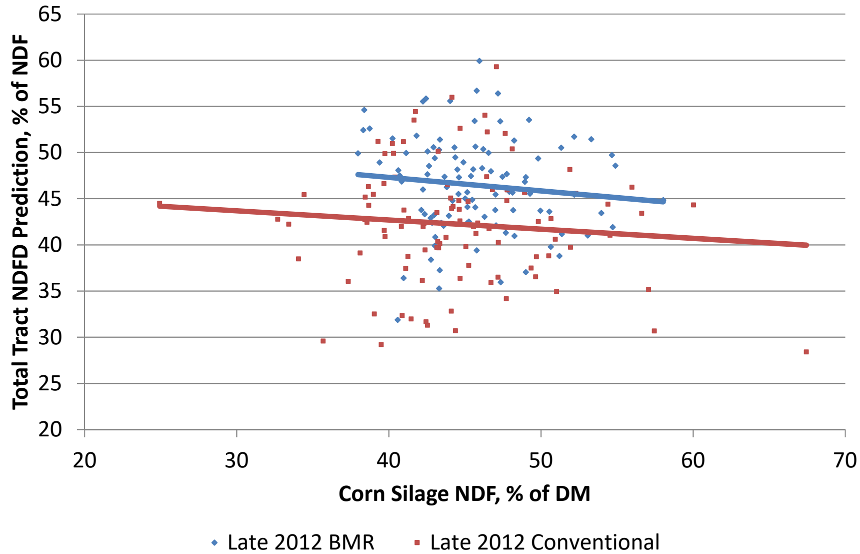
A 2-3 unit change in diet DE digestibility corresponds to 1 lb change in milk yield.

The most well known reduced lignin trait: BMR

- Brown Mid-Rib trait
  - Discovered in 1924 in St. Paul, MN
  - Natural mutation that results in reduced lignin in corn
  - Four BMR mutations known: bm3 is most common in today's corn hybrids
  - Caused by a mutation in the COMT lignin synthetic pathway

Cherney et al, 1991

Fiber digestibility: BMR vs Conventional Corn Silage



RRL Data: 2012

DMI & Milk Yield greater in BMR/HFD

Item	BMR	CONS	HFD	LFY	SEM	P-value
DMI, lb/d	55.2[a]	52.8[b]	54.1[a]	50.6[b]	1.1	0.001
Milk, lb/d	84.9[a]	81.8[b]	83.8[a]	82.3[b]	1.8	0.001
Fat, %	3.55	3.62	3.61	3.64	0.08	0.25
Protein, %	3.07	3.07	3.09	3.07	0.03	0.45

Ferraretto & Shaver, 2013

Methods to improve alfalfa quality

- Harvesting at early maturity
- Selection for high leaf:stem ratio – today's "High Quality" lines
- Selection for reduced lignin in the stem/overall plant
- Harvest technologies that reduce respiration losses, reduce risk of weather (rain), RETAIN LEAVES

Composition and Digestibility of Alfalfa Changes with Maturity

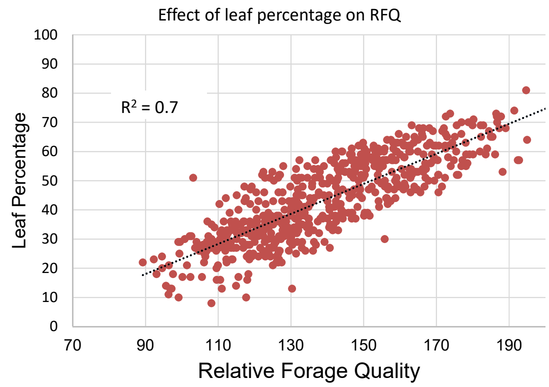
	NDF	Lignin	TTNDFD	DOM
	% of DM	% of DM	% of NDF	% of DM
Immature	33	5.4	54	71
Vegetative	37	6.2	50	67
Mid-maturity	43	7.3	47	63
Mature	50	8.4	46	60

Alfalfa Leaf Loss Effect on Forage Quality

- Leaves higher in quality than stems

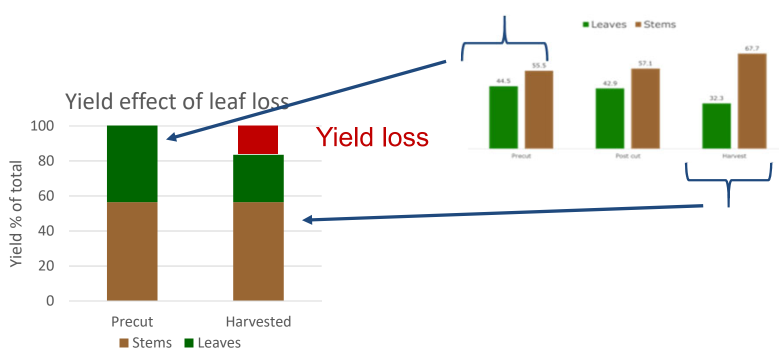
Leaves 15 to 20% NDF
~ 450 RFQ

Stems 60 to 70% NDF
~ 70 RFQ



Retaining leaves increases yield

- Reduced leaf loss
  - 5 to 20% yield reduction



Typical TTNDFD values of forages harvested in 2015

Forage	aNDF	TTNDFD	range in TTNDFD*
Corn silage	41.0	40	30 to 50
Alfalfa silage	41.0	43	30 to 54
Grass silage	52.4	51	31 to 71
Grass hay	61.1	45	24 to 65

* mean value ± 2 standard deviations
Samples submitted to Rock River Laboratories in 2015 and 2016

Variation in iNDF and kd of forages harvested in 2015

Forage	Average iNDF, % of NDF	Range in iNDF	Average kd, %/h	Range in kd
Corn silage	26.5	12.5 to 40.8	2.73	1.7 to 4.7
Alfalfa silage	40.5	26.5 to 54.5	5.3	1.56 to 9.04
Grass silage	25.5	0 to 51.5	4.46	2.08 to 6.84

* mean value ± 2 standard deviations
Samples submitted to Rock River Laboratories in 2015 and 2016

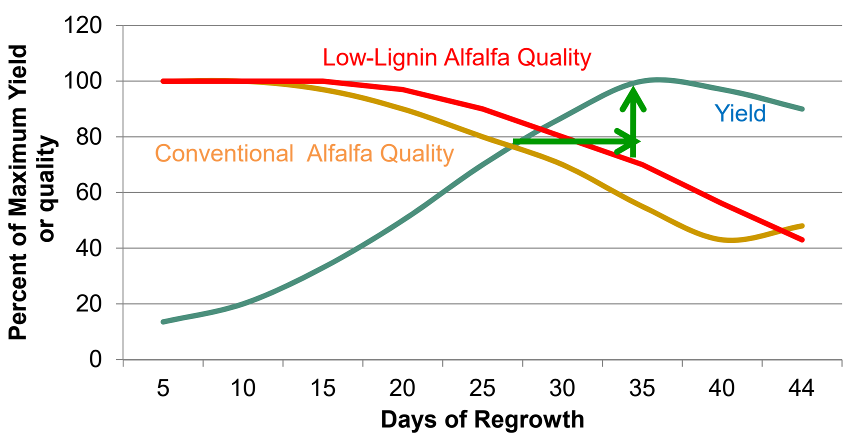
The proportion of iNDF and rate of fiber digestion (kd) vary in forages

High Quality Alfalfa

HiGest™ Alforex

HarvXtra™ Forage Genetics International

Yield and Quality Curve of Alfalfa



Opportunities with Reduced Lignin Alfalfa

- Wider harvest window?
- Later harvest
  - Greater tonnage per cutting
  - Make use of full growing season
  - Reduce number of cuttings
    - a 15 to 18% lignin reduction means we could harvest 8 to 10 days later
- Improved forage quality

Evaluating Reduced Lignin Alfalfa

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How does RL trait affect digestibility?

- HiGest, HarvXtra and a Conventional HQ Alfalfa sampled over first crop 2017
  - Sampled twice a week from May 4th to June 19th
  - Approximately 500 g of fresh alfalfa harvested via scissor clipping
- Leaves and stems were separated manually
- Acid Detergent Lignin (ADL) was conducted on stem samples
- Stems were analyzed Total Tract NDF Digestibility (TTNDFD)

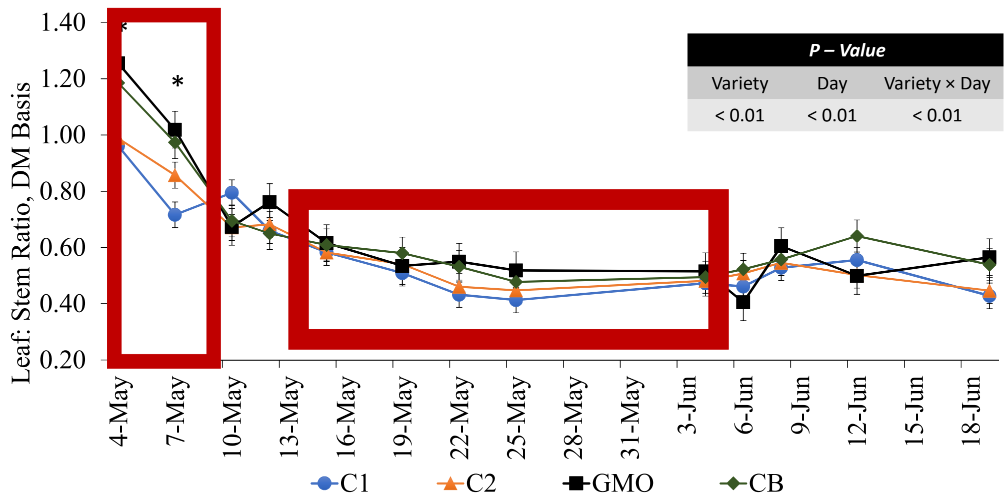
Fiber digestion in Stems of RL and HQ lines of Alfalfa

	Alfalfa variety					*P* - value		
Variable	C1	C2	GMO	CB	SEM	Variety	Day	Variety × day
L:S ratio, DM	0.57[b]	0.59[b]	0.64[a]	0.65[a]	0.01	< 0.01	< 0.01	< 0.01
Stem composition and Digestibility								
ADL, % DM	7.61[b]	7.95[a]	6.74[c]	7.42[b]	0.08	< 0.01	< 0.01	< 0.01
NDF, % DM	46.0	48.4	45.7	45.8	0.8	0.06	< 0.01	0.24
iNDF, % NDF[1]	45.6[ab]	48.8[a]	41.3[b]	45.2[ab]	1.6	< 0.04	< 0.01	0.12
TTNDFD, % NDF	39.5[bc]	37.3[c]	43.5[a†]	41.5[ab]	0.6	< 0.01	< 0.01	0.10

[a,b,c] Means within a row with different superscripts differ (P < 0.05).
[†]The GMO and CB varieties differed by < 0.10, C1 and C2 differed from each other by < 0.10.
[1]Indigestible NDF, based on 240 h in situ incubation.

Donnelly et al. 2018

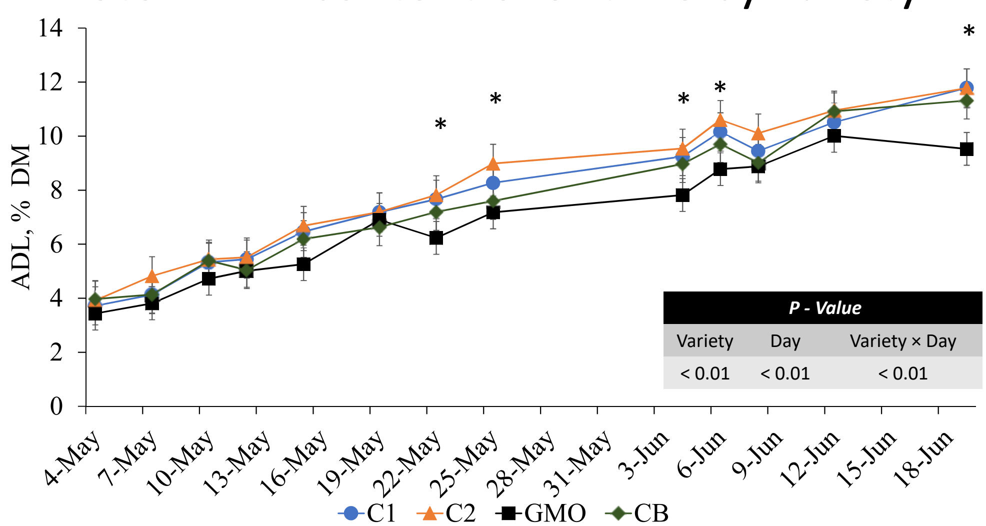
Leaf to Stem ratios over time by variety



P – Value		
Variety	Day	Variety × Day
< 0.01	< 0.01	< 0.01

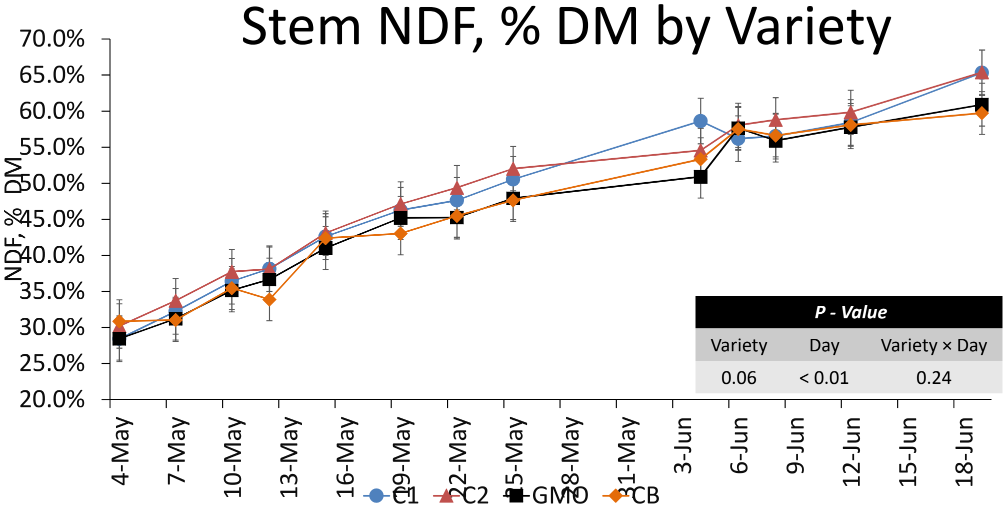
Donnelly et al. 2018

Stem ADL content over time by variety



P - Value		
Variety	Day	Variety × Day
< 0.01	< 0.01	< 0.01

Stem NDF, % DM by Variety



P - Value		
Variety	Day	Variety × Day
0.06	< 0.01	0.24

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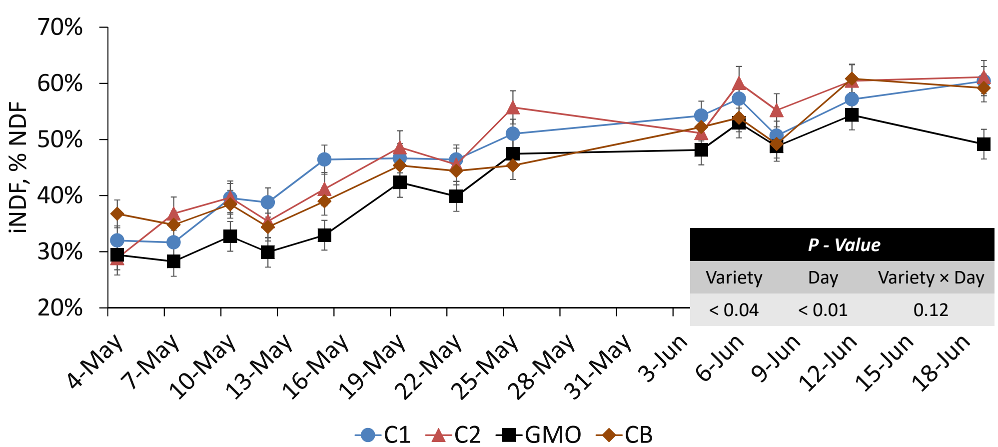
Stem iNDF, % NDF by Variety



P - Value		
Variety	Day	Variety × Day
< 0.04	< 0.01	0.12

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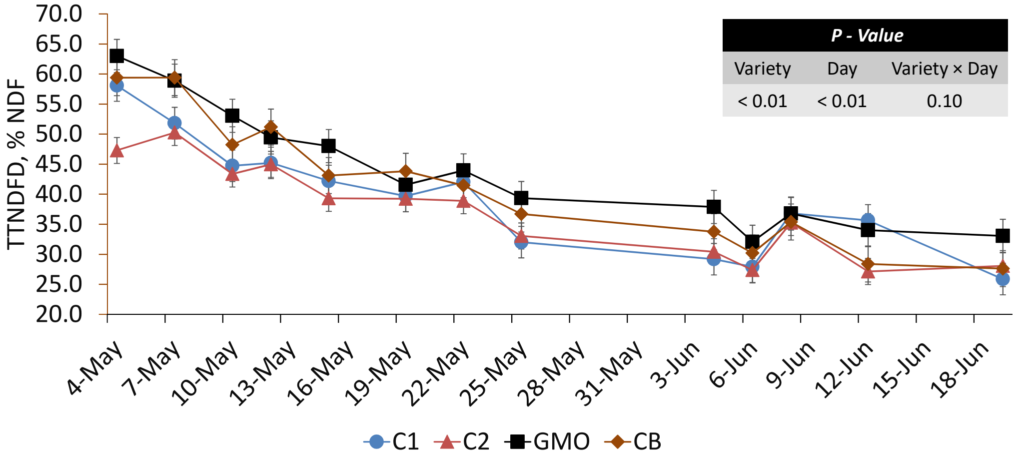
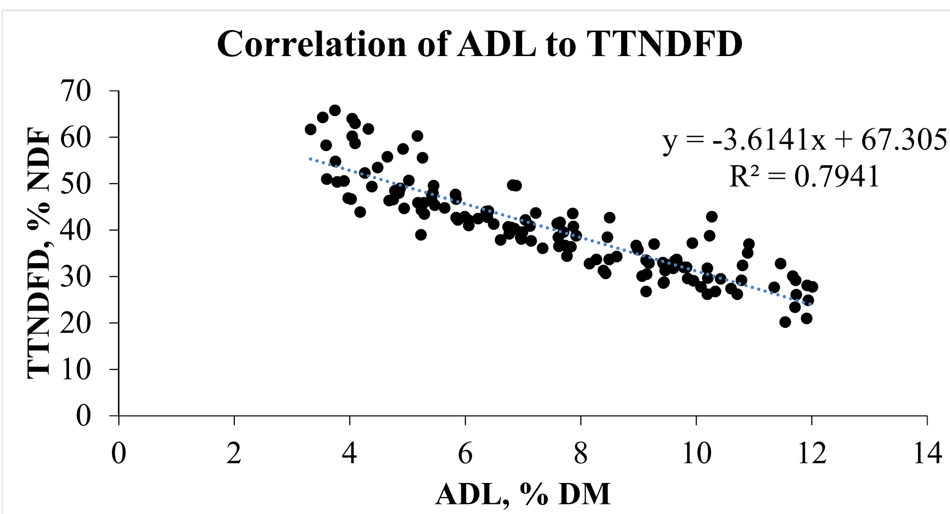
Alfalfa Stem TTNDFD, % NDF by Variety



P - Value		
Variety	Day	Variety × Day
< 0.01	< 0.01	0.10

25



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Can Fiber Digestibility be too High?

What happens if we add grass fiber (high TTNDFD) or wheat straw fiber (low TTNDFD) to a diet with high quality alfalfa and corn silage?

	Control	Tall Fescue	Meadow Fescue	Straw
	----------------------% of Diet DM			------------------------
Corn silage	26	17	17	20
Alfalfa silage	26	17	17	20
Tall Fescue*		17		
Meadow Fescue*			17	
Wheat Straw				8
High Moisture Corn	26	25	26	24
Protein/minerals	22	24	23	28
	100	100	100	100

(Verbeten et al., 2012)

Adding grass or wheat straw to TMR with high quality corn silage and alfalfa

	Control	Tall Fescue	Meadow Fescue	Straw
Diet NDF	24	27	27	28
in Vivo NDFD	25	41	41	29
3.5 % FCM, lb	91	92	95	92
Milk Fat, %	2.9[a]	3.4[b]	3.4[b]	3.2[ab]
DMI, lb	58[ab]	54[a]	59[b]	58[ab]

(Verbeten et al., 2012)

Adding more digestible fiber from grass increased ration fiber digestibility and increased fat test

Animal Response to fiber digestibility in corn silage*

	WPCS	BMR	TOP	TRTCS	SED	P Value Diet
ECM, lb	**93[c]**	**99[b]**	**99[b]**	**103[a]**	0.8	<0.01
(difference from WPCS)		+6	+6	+11		
Rumination min	**510[a]**	**474[bc]**	**459[c]**	**459[c]**	12	0.01
min / NDF intake	**70.3[a]**	**64.0[b]**	**63.6[b]**	**61.4[b]**	2.9	0.05

*No difference in BW, BCS, or BW gain

Digestibility

	WPCS	BMR	TOP	TRTCS	SED	P Value Diet
DM	70.0	70.6	71.0	72.6	0.6	0.07
NDF	51.4[b]	51.7[b]	52.1[b]	58.4[a]	1.2	<0.01

Milk production responses most highly correlated NDF digestibility

Intake, lb/cow/d

	WPCS	BMR	TOP	TRTCS	SED	P value Diet
DMI	52[b]	53[ab]	55[ab]	56[a]	1.1	0.02
(difference from WPCS)		+1	+3	+4		
NDF intake	16.1	16.8	17.1	17.0	0.5	0.21
$uNDF_{240}$ intake	5.3[a]	4.3[b]	5.3[a]	4.2[b]	0.2	<0.001
pdNDF intake	10.7[b]	12.5[a]	11.8[ab]	12.7[a]	0.3	<0.001

Typical dietary profiles for high producing dairy cows

Item	
NDF, % of DM	28-30
TTNDFD, % of NDF	> 42%
Starch, % of DM	21-28
Starch Digestibility, % of starch	>95%
CP, % of DM	16-18% *
Fat, % of DM	3-7%

*The **Wisconsin Idea** is a philosophy embraced by the University of Wisconsin System, which holds that research conducted at the University of Wisconsin System should be applied to solve problems and improve health, quality of life, the environment and agriculture for all citizens of the state.*

Low Lignin Alfalfa (High Digestibility): Dairy Applications

Duarte Diaz
Dairy Extension Specialist
University of Arizona

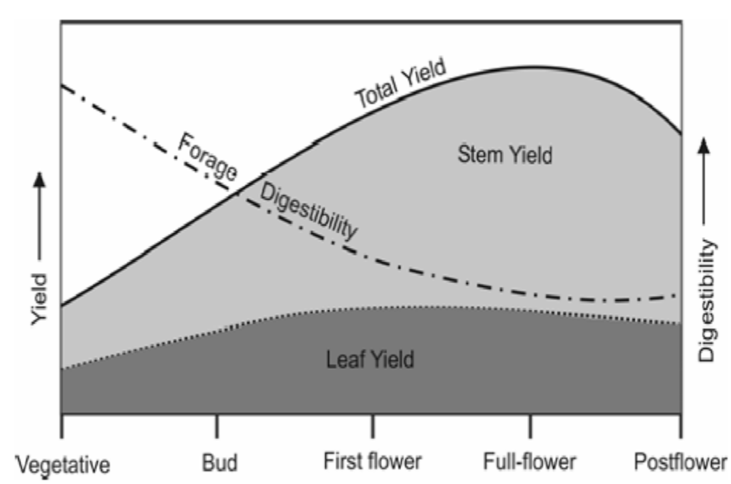
Talking points

- Disclaimers
- Crossroads between agronomy and nutrition
- Analysis of forage digestibility
- Will we be ready to maximize new technologies/climate
- Studies

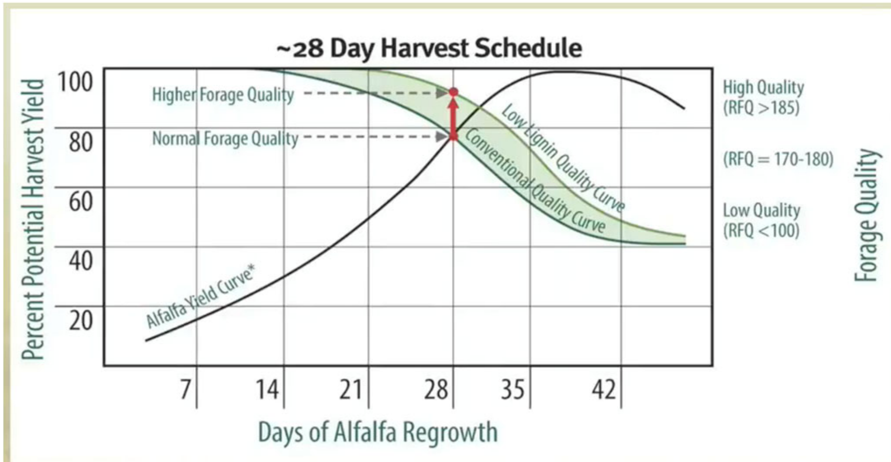
Why Lignin?

- Lignin is an indigestible phenolic compound in alfalfa cell walls
- As alfalfa matures, lignin content increases
- Lignin cross-links with cellulose which decreases digestibility of fiber (dNDF)
- A 10% increase in fiber digestibility
  - Increase milk/beef by 350M/yr
  - Decrease manure by 2.8M T/yr

There is a tradeoff with alfalfa forage yield and quality with advancing stages of maturity



Opportunities



Potential Benefits of reduced lignin alfalfa from an agronomic perspective

- Forage quality advantage
  - Maintain current harvest schedule
  - Higher likelihood of harvesting premium quality hay (Higher NDFd and RFQ)
- Delayed harvest
  - Fewer harvests
  - Higher forage yields
  - Improved resistance
- Flexibility
  - Increased harvest timing flexibility

Feeding recommendations regarding reduced lignin alfalfa

- Neither improved NDFd or milk production should be anticipated if grower is using delayed harvest to increase tons.
- Improved NDFd (and possibly milk production) is anticipated only when grower is using his normal (or early) cutting schedule.

Does increasing NDFd increase energy content of alfalfa?

- YES, but only in small amounts
  - 10 lbs alfalfa DM x 1.0 mcal ME/lb DM x 42% NDF x 10% improvement = 0.42 mcal of ME
  - If we assume that all this ME goes to milk production you would get about 0.8 lbs of milk

The energy response seems small. So, why feed alfalfa of higher NDFd?

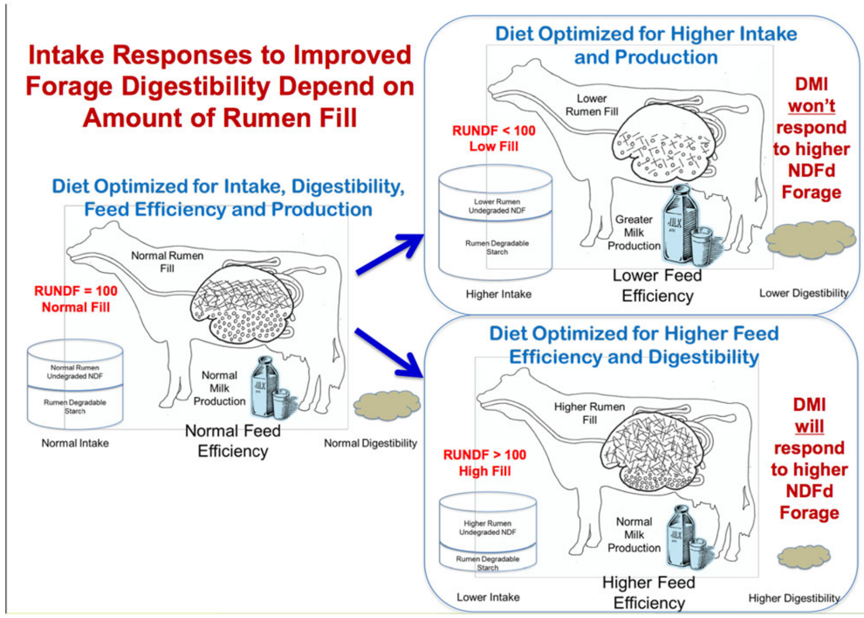
- To reduce rumen fill and increase DM intake
  - The greater impact of higher alfalfa NDFd on milk production is from increasing DM intake, rather than increasing energy concentration

Intake Potential increases with increases in NDFd

» A one unit increase in in-vitro digestibility of NDF was associated with a 0.37 lb/day increase in dry matter intake (DMI) and a 0.55 lb/day increase in 4% fat corrected milk yield per cow (Oba and Allen, 1999)

» Greater DMI responses are observed with early lactation, higher producing cows that are more bulk fill limited.

- Less noticeable with lower producing cows



If I feed alfalfa of a higher NDFd, will I always see an improvement in DM intake?

- No (only when)
  - Rumen fill is excessive
    - Forage levels are greater than 55% and/or
    - Digestibility of forages is below average

When rumen fill is not excessive, will I see a response in DM intake?

- NO
  - When forage levels in the diet are low (less than about 45%) and/or
  - Digestibility of forages is above average, rumen fill is not limiting intake

Does a improvement in DM intake always lead to higher milk production?

- Not always. If cows are in poor body condition or in later lactation, the increased energy intake will be used for tissue growth and not milk production.

Milk response expectation with feeding highly digestible alfalfa

It will depend on intake improvements, body condition and stage of lactation

Chances for more milk are better if:
DM intake increases
Body condition is good
Cows are in early lactation (<150 DIM)

One pound increase in DM intake provides enough energy potential for

2.5 lbs of additional milk production
or
0.35 lbs of body weight gain

If I substitute alfalfa of higher NDFd into the diet and rumen fill is high and body condition is good (>BCS of 3.5) and cows are in early lactation, should I see and improvement in DMI intake and milk production?

Very likely. For every 1 lb. increase in DM intake, you should expect a 2.5 lbs increase in fat corrected milk (FCM)

- Q: Why would a grower ever want to grow alfalfa of higher NDFd, particularly if he doesn't own any cows?
- A: To sell hay of higher quality for a premium price

- Q: So, alfalfa hay of a higher NDFd will have a greater RFV (Relative Feed Value) or TDN (Total Digestible Nutrients), which commands a premium price?
- A: Unfortunately not. Neither of these indexes will reflect the higher NDFd.

RFQ vs. RFV?

- What do the numbers tell me
- Do they provide pertinent information
- Feed quality of alfalfa depends to a great extent on maturity of the stand
- With increased maturity, plant structural carbohydrates, as measured by the ADF and NDF fractions, increase

- Relative Feed Value (RFV) has been used for years to compare the quality of legume and legume/grass hay and silages
- Having one index to price hay and predict animal performance has been very useful for both sides
- RFV estimates forage DM digestibility and filling capacity. Relative Feed Quality improves on RFV by accounting for NDF digestibility

Relative Feed Value (RFV)

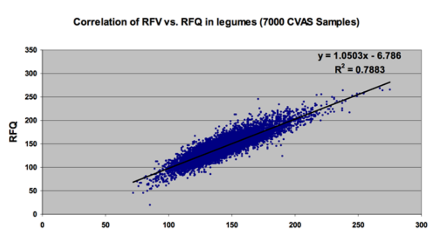
- RFV estimates the digestibility dry matter from the ADF (cellulose and lignin), and calculates the DM intake potential (as % of BW) from NDF (total cell wall portion ADF+ hemicellulose)

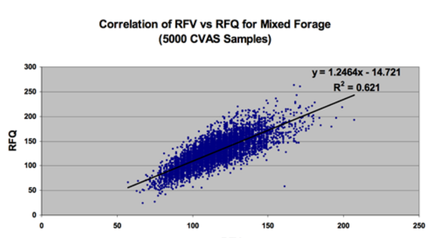
- This index ranks forages relative to the digestible DMI of full bloom alfalfa (assuming 41% ADF and 53% NDF). The RFV index at this growth rate is 100
- Example
  - Alfalfa hay or haylage with 32% ADF and 40% NDF
  - DigDM = 88.9 – (0.779 x32) = 63.97
  - DMI = 120/40=3
  - RFV = (63.97 x 3) / 1.29 = 149

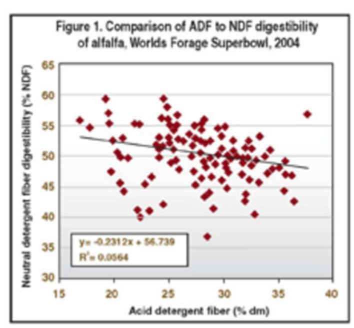
Limitations of RFV 1) DigDM and DMI are assumed constants for all forages 2) ADF and NDF are the only laboratory values used 3) CP concentration of forages is not used 4) RFV cannot be used in ration formulation or evaluation

Relative Forage Quality (RFQ)

- Fiber from grass and legumes naturally differs in digestibility, as it also when grown under different ambient temperatures.
- RFV of first-cutting alfalfa will be similar to that of second and third cutting harvested at similar stages of maturity.
- However fiber fraction digestibility could vary as it is influenced by ambient temperature at the time of growth and development.
- RFQ was therefore designed to account for fiber digestibility to estimate intake as well as the total digestible nutrients (energy) of the forage.
- RFQ Index is and improvement over RFV index for those that buy and sell forages because it better reflects the performance that can be expected from the cattle (It also differentiates legumes from grasses)







RFV and RFQ are closer for alfalfa when fiber digestibility is average. They differ primarily as fiber digestibility varies from average

The handoff between agronomy and nutrition

Agronomy concerns (seed seller, grower)

- Yield (tons/acre)
- RFQ (alfalfa)
- RFV (alfalfa)
- TDN
- Milk/ton (corn silage)

* Did it test correctly????

Nutrition concerns (nutritionist, dairy producers)

- NDF/NDFd
- RDS
- RUNDF
- DM
- Protein

* Are the cows going to perform better????

What should we use?

- TTNDFD

Typical TTNDFD values of corn silage, alfalfa or grass*.

	Mean	SD	Mean – 1SD	Mean + 1 SD	Range
	---------------TTNDFD°, % of NDF---------------				
Corn Silage	42	±6	36	48	20-60
Alfalfa	43	±7	36	50	25-80
Grass	47	±8	39	55	6-80

Samples submitted to Rock River Laboratories, Watertown, WI.

- %ADL – acid detergent lignin
- NDFom/uNDFom – om or ash free – 30/120/240 to calculate rate of fiber digestion (kd)

Summary

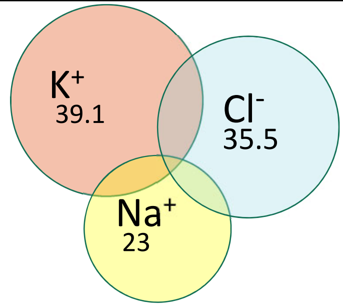
- Should I expect increased milk production?
  - "It depends" Chances are better if:
    - Alfalfa is harvested for quality (normal cutting schedule)
    - DM intake increases
    - Body condition is good (>3.5)
    - Cows are in early lactation (<150 DIM)
  - Can't always expect a milk production response!

Summary

- Is there anything that we need to do to the diet to feed highly digestible alfalfa?
  - Not really. Formulation similar to that used with high NDFd alfalfa
  - If rumen fill amounts are low, there is opportunity to increase forage levels in the diet
  - Do not fall prey to the "add wheat straw" reaction

Take Home

- Crossroads between agronomy and nutrition
- Analysis of forage digestibility
- Will we be ready to maximize new technologies/climate
- Dairy feeding studies still limited

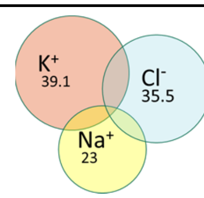


"Coordinating DCAD and the Electrolytes; It's More Important than you Think?"

Rich Erdman
Department of Animal & Avian Sciences
erdman@umd.edu

UNIVERSITY OF MARYLAND

Dietary Cation Anion Difference (DCAD)



DCAD Represents the Relative Difference in (mEq/kg) in the primary dietary electrolytes:

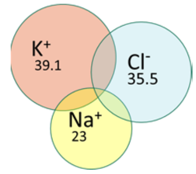
DCAD= mEq K + mEq Na - mEq Cl

DCAD-S = mEq K + mEq Na - mEq Cl – mEq S

Uses of DCAD:

- Dry cows-Low DCAD-preventing milk fever
- Lactating Cows-High DCAD
  - Intake, Milk Production, Rumen pH, Milk Fat, Acid Base Balance

DCAD is a relative Difference in Electrolytes, Not an amount !



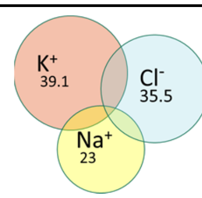
Diet	K%	Na%	Cl%	S%	DCAD, mEq/kg DM	DCAD-S, mEq/kg DM	Electrolytes %	Electrolytes g/d
Basal (Corn Silage)	1.20	0.25	0.40	0.25	303	147	1.85	426
Basal +0.5% Salt	1.20	0.45	0.70	0.25	303	147	2.35	541
Alfalfa/Small Grain + 0.5% Salt	1.53	0.25	1.00	0.25	303	147	2.98	685

Assumes 51 lb DMI

Three diets can have the same [DCAD] but be very different in amounts of electrolyte fed..

Extra electrolytes have to eliminated by the kidney

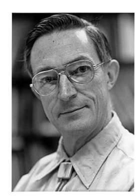
The Electrolytes (Na, K, Cl) are Strong Ions?



The term "Strong Ion" coined by Peter Stewart (Canadian Physiologist) in paper:

- "Strong Ion Theory of Acid-Base Balance"

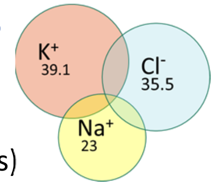
(*Respiration Physiology* (1978) *33, 9-26)*



Peter Stewart

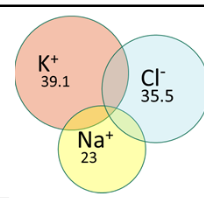
- Strong Ions are completely dissociated n biological fluids
  - Cations: Sodium (Na), Potassium (K) Magnesium (Mg)
  - Anions: Chloride (Cl), Sulfate, Lactate, Volatile Fatty acids, Beta-hydroxy butyrate.
- Dietary K, Na, and Cl are the principal dietary strong ions.

4 Characteristics of Strong Ions?



- Primary Functions:
  - Active Transport of Nutrients (glucose, amino acids)
  - Neural Transmission
  - Osmoregulation: Water balance across tissues
    - Digesta vs intestine, intracellular vs. extracellular, fecal water, etc.
- Minimal reserves
  - Deficiencies manifest themselves quickly (1-2 days)
  - Share common deficiency symptoms:
    - Decreased feed and water intake, dry manure
- Highly available: Nearly 100% absorbed from diet
- Excess Strong Ions are excreted in the urine, Not in the feces

The Strong Ion's Role in Osmoregulation
(Normal Osmotic Pressure: ~300 mOsm)



Ion	Intra-cellular	Blood	Rumen Fluid
		------ mEq/L ------	
Na^+	12	145	84
K^+	139	4	27
Cl^-	4	116	8
HCO_3^-	12	29	6
Amino acids & proteins	138	9	(VFA's) 105
Mg++	0.8	1.5	4.2[1]
Ca++	<0.0002	1.8	3.5[1]
Osmoles	290	290	315[1]

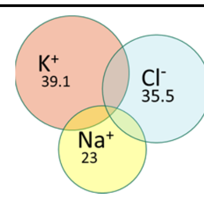
[1]Adapted from Bennick et al. (JDS, 1978)

Ruminants Evolved on Forages

	------- % of DM -------			------- mEq/kg DM -------		
Forage	K	Na	Cl	K	Na	Cl
Corn Silage	1.20	0.01	0.29	307	4	82
Alfalfa Haylage	3.03	0.03	0.55	775	13	155
Grass Silage	2.81	0.05	0.64	795	22	181
Barley Silage	2.42	0.13	0.72	621	57	203
Rye Silage	3.34	0.05	0.90	854	22	253
Orchardgrass	3.58	0.04	0.67	916	17	188

Comments:
- Nutritional environment: High K, Low Na, and Moderate CL
- Ruminant are equipped to get rid of excess K
- Forages are high DCAD feeds

Dietary Electrolytes are not Expensive to Supplement



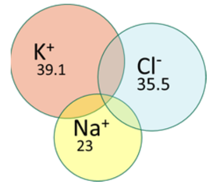
The Relative Costs of Increasing Diet K, Na, and Cl by 100mEq/kg (98, 58, and 89 g/d, respectively)[1,2]

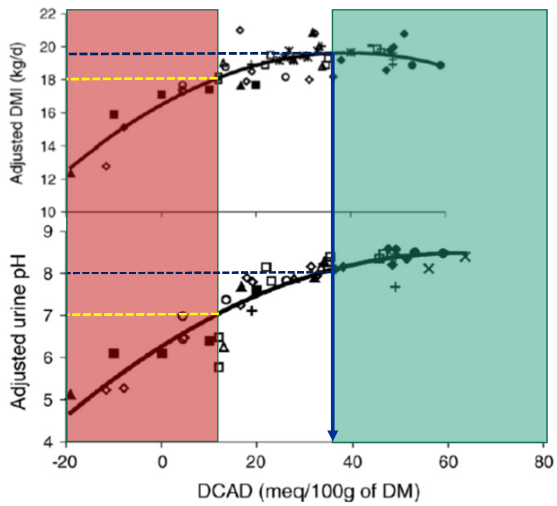
	Added Cost, $ per Cow/Day		
Mineral Supplement	K	Na	Cl
Salt		$0.02	$0.02
Potassium Chloride	$0.10		$0.10
Potassium Sesquicarbonate	$0.25		
Sodium Bicarbonate		$0.13	
Sodium Sesquicarbonate		$0.09	

[1]Cow consuming 25 kg (55 lb) DM per day

[2]Dietary K, Na, and Cl increase by 0.39, 0.23, and 0.35%, respectively

Dairy Cows Like to Operate with an Alkaline Urine (pH=7.5 to 8)

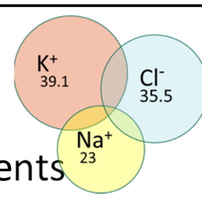




- Peak DMI occurs when urine pH is about 8
- That point is reached with DCAD of ~ 37.5 mEq/100 g
- Dry Matter Intake (DMI) falls off rapidly as urine pH drops to 7 or below.
- Low DCAD diets reduce urine pH (dry cows)
- Don't feed lactating cows for low urine pH!

Mongin DCAD (K + Na –Cl)
Adapted from Hu and Murphy, 2004, J. Dairy Sci. 87:2222

What Regulates Urine pH?

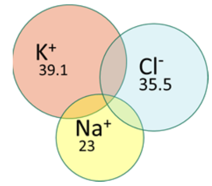


- Strong Ion intakes in excess of requirements
  - Excreted in the urine
- SID (Strong Ion Difference) = $Na^+ + K^+ - Cl^-$
  - DCAD is a Proxy for Urinary SID
- Urinary Strong Ion Excretion (Eq. Basis)
  The cations must equal the anions:

$$Na^+ + K^+ + H^+ + (NH_4^+) = Cl^- + OH^- (HCO_3^-)$$

Cations Anions

Alkaline Urine pH



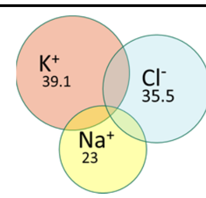
When there are Excess Cations(K,Na)

$Na^+ + K^+ + H+ (NH_4^+) = Cl^- + OH^- (HCO_3^-)$

↑ Urinary Bicarbonate, ↑ urine pH

Results in an alkaline urine: This is normal for ruminants

Acid Urine pH



When there are Excess Anions (Cl)

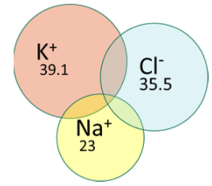
$Na^+ + K^+ + H+ (NH_4^+) = Cl^- + OH^- (HCO_3^-)$

↑ Urinary NH_4^+, ↓ Bicarbonate, ↓ pH

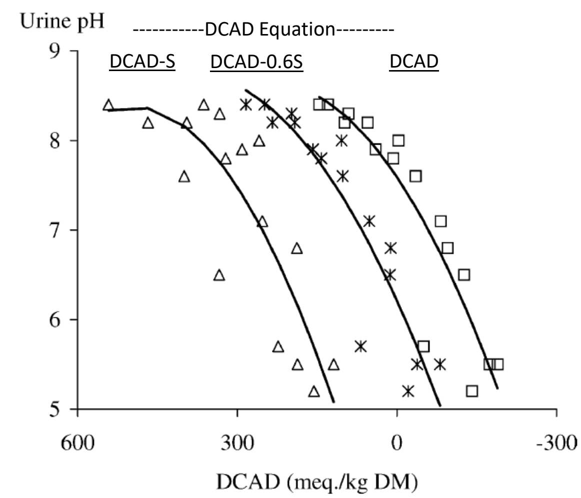
Too much Cl in relation to K and Na results in an Acid Urine (This is abnormal in ruminants)

Remember: Dairy cows like to operate with an alkaline urine (pH=7.5 to 8)

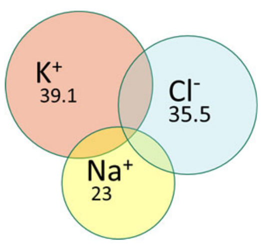
DCAD is strongly related to Urine pH



M. Spanghero/Animal Feed Science and Technology 98 (2002) 153–165



- In low sulfur diets each DCAD equation fits well, but given a different number with each equation.
- DCAD-S may overestimate S effects in diet.



Excess Strong Ions Drive Cows to Drink!!

(OK, Not that kind of drink)

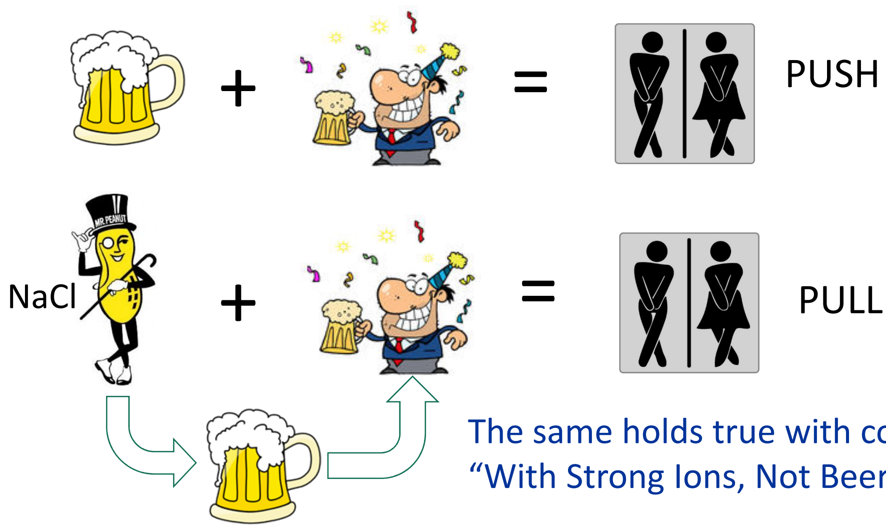
Erdman is a German name.

For those of you who do not know, beer is an important food group for all Germans

Beer is also an Excellent Source of Water!!

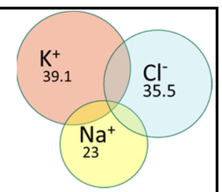
(That must be eliminated)

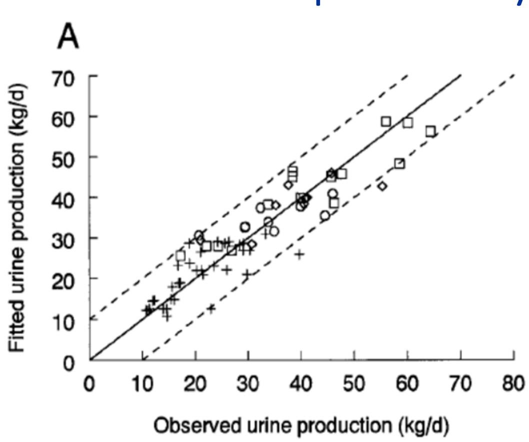
Mechanism



The same holds true with cows!
"With Strong Ions, Not Beer"

Electrolyte (Strong Ion) Intake Drives Urine Output in Dairy Cows





Urine Volume, kg = 0.115 Na Intake, g/d + 0.058 K Intake, g/d

(R^2 = 0.848, SE = 5.16)

From Bannink et al., 1999, J. Dairy Sci 82:1008

9 g/day Excess Na
or
17 g/d Excess K

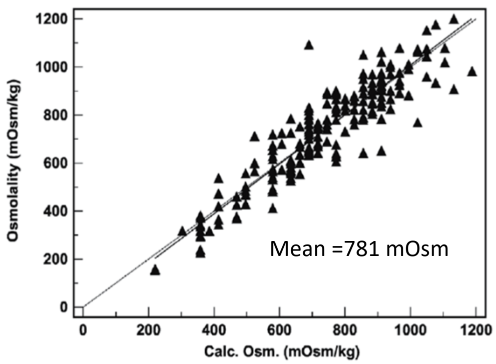
1 Liter Extra Urine

Is this the:

- Push Mechanism?
- Pull Mechanism?

There is a Limit to how Concentrated Urine can be

Observed Range in Urine Concentration
(Milliosmoles/Liter)



In Bannink et al. 1999

The projected urine conc.

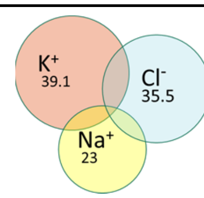
K = 881 mOsm

Na = 756 mOsm

This suggests that the cow is minimizing the amount of water lost in order to get rid of excess K and Na

From Alcántara-Isidro et al. (2015) RRJVS 1:34

Add First Glance, Added K Appears to Improve N Use (lower MUN)



	-------- Added Potassium, mEq/kg DM -------			
Milk	0	125	250	375
MUN, mg/dL	15.5	14.0	13.6	12.0
Protein %	2.95	2.99	2.95	2.92
Protein, g/d	1143	1174	1158	1124

[1]Iwaniuk et al., 2015 J. Dairy Sci. 98:1950

- Don't be fooled: Milk MUN went down because urine volume went up to get rid of excess K.
- Same amount of Urea-N was excreted in a larger urine volume

Summary: Strong Ion Effects on Water Intake, Urine Output and pH

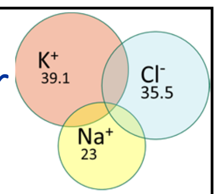
- Excess K and Na, Increases
  - Water Intake
  - Urine Output
  - Urine pH
- If you want cows to drink more, increase diet K and Na
  - More Water Intake, More Watering Space
- Excess Cl:
  - Decreases urine pH (Cows like an alkaline, NOT AN ACID Urine)
  - Increases urine output
  - Requires more K and Na that will also increase water intake

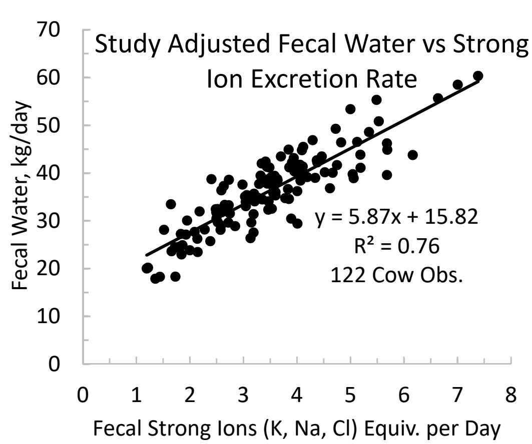
Dumping extra electrolytes (strong ions) in the diet has consequences

Pay attention, especially to Cl!

Cow Manure is 85% Water

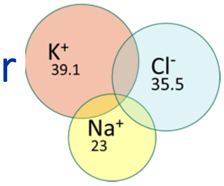
(Something has to hold that water)





- Just like other body fluids:
  - Fecal water is related to osmotic pressure
  - Strong ion (K, Na, and Cl) contents
- Implied Strong Ion Osmotic Effect
  - 170 mOsm (more than 50% of total (300)
  - Other Fecal Minerals (Ca, P, Mg), VFA, bicarbonate contribute
- This suggests a metabolic fecal strong ion requirement to maintain a constant fecal water

Cow Manure is 85% Water



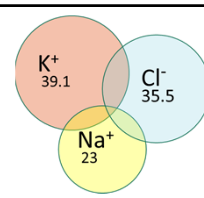
Preliminary Lucas Plot (Regression) Analysis

Apparently Absorbed Ion = Dietary Ion (both as g/kg Diet DM)

Strong Ion	Intercept (Met. Fecal) g/kg DM	Slope (Abs. Coeff.)	RMSE g/kg DM	*P* <
K	-2.48	1.02	0.27	0.001
Na	-1.45	0.98	0.53	0.001
Cl	-1.11	0.92	0.52	0.001

- Implied Absorption Coefficients-Very High
  - ~100 % for K and Na, 92% for Cl
- Most Fecal K, Na, and Cl is Metabolic
  - 2.48, 1.45, and 1.11 g/kg Diet DM, respectively
- Consistent with maintaining constant fecal H_2O

What Do Cows Need for? Milk production

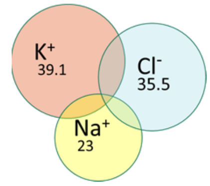


Strong Ion	2001 NRC	Castillo et al., 2013[1]	Difference, g/kg	% Change
K, g/kg milk	1.50	1.54	+0.04	+2.6
Na, g/kg milk	0.65	0.41	-0.24	-37.1
Cl, g/kg milk	1.15	1.03	-0.12	-10.4

[1]Castillo et al., 2013. J. Dairy Sci. 96 :3388; 39 herds averaging 787 cows per herd

- Potassium concentrations seem fine
- More recent data suggests Na = 0.40 and Cl = 1.0
  - Lower than current 1989 NRC
- Why is milk Cl and especially Na so much lower now?

Why are milk Na and Cl so much lower today?

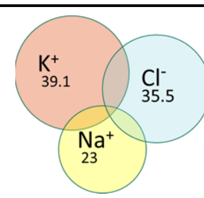


Strong Ion	2001 NRC	Normal Milk[1]	Milk with High SCC[1]	% of Normal
K, g/kg	1.50	1.73	1.54	91
Na, g/kg	0.65	0.57	1.05	184
Cl, g/kg	1.15	0.91	1.47	161

[1]From Review by Harmon, 1994, J. Dairy Sci 77:2103

- 2001 NRC values based on 1965 British estimates
- Mastitis increases milk Na and Cl
- Milk SCC has declined rapidly during the last 50 years?

What Do Cows Need? 2001 NRC Maintenance Req.

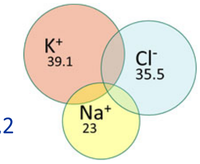


Strong Ion	Endogenous Fecal & Urinary, g/kg BW	Metabolic Fecal (g/kg Diet DM)	Severe Heat Stress g/100 kg BW
K	0.038	6.1 (2.6)	0.40
Na	0.038	--	0.50
Cl	0.0225	--	--

Comments:

- Endogenous Urinary Excretion-Impossible to Measure
  - Dependent on the relative excess of other strong ions
- Metabolic fecal minerals, usually expressed per unit diet DM
- Heat stress values not large nor well defined

What Do Cows Need? 2001 NRC Maintenance + Milk Requirements (g/d)[1,2]



Ion	End. Fecal-Urinary	Met. Fecal	Heat Stress	Total Maint	Milk	Total	% Diet DM	DCAD, mEq/kg
K	29	153	3	185	83	268	1.07	273
Na	29	--	4		32	64	0.26	113
Cl	16	--	--		58	72	0.29	81

[1]1540 lb (700 kg) cow consuming 55 lb (25 kg) DMI producing 110 lb (50 kg) milk

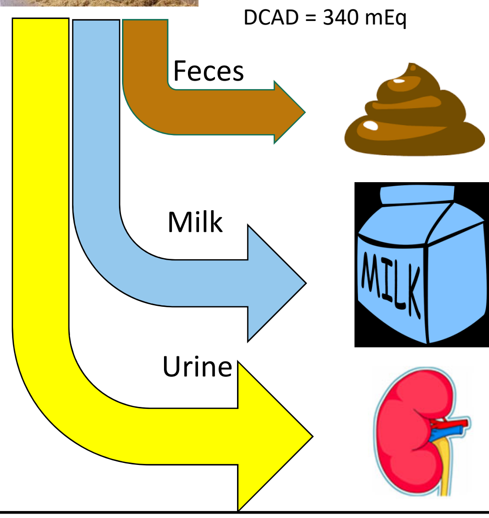
[2]Assumes true absorption coefficient of 90% for each strong ion

Diet DCAD = 304

How many people feed diets with those concentrations of K, Na, and Cl?

The ratios of SI in feed are not the ratio that ends up in urine

1540 lb Cow, 55 lb DMI,
110 lb milk,
Diet K, Na, Cl:
1.20, 0.30, and 0.35%
DCAD = 340 mEq



Ion	g/d	Eq/d	Eq Ratio, K:Na:Cl
K	300	7.7	3.1
Na	75	3.2	1.3
Cl	88	2.5	1.0

Minus

K	63	1.6	1.7
Na	36	1.6	1.6
Cl	34	1.0	1.0

Minus

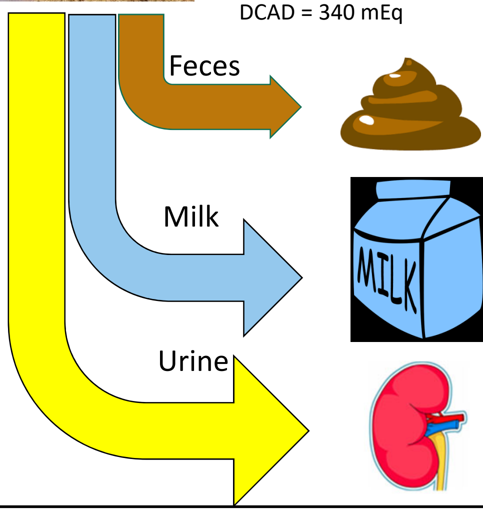
K	75	1.7	1.2
Na	20	0.9	0.6
Cl	50	1.4	1.0

Equals

K	162	4.1	36.7
Na	19	0.8	7.3
Cl	4	0.1	1.0

If we increased diet Cl to 0.6%

1540 lb Cow, 55 lb DMI,
110 lb milk,
Diet K, Na, Cl:
1.2, 0.3, and 0.35%
DCAD = 340 mEq



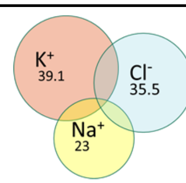
0.35% Dietary Cl
Urinary Bicarbonate:
= Urinary (K + Na – Cl)
= 4.1 + 0.8 – 0.1
= 4.8 equivalents (288 g HCO_3^-)

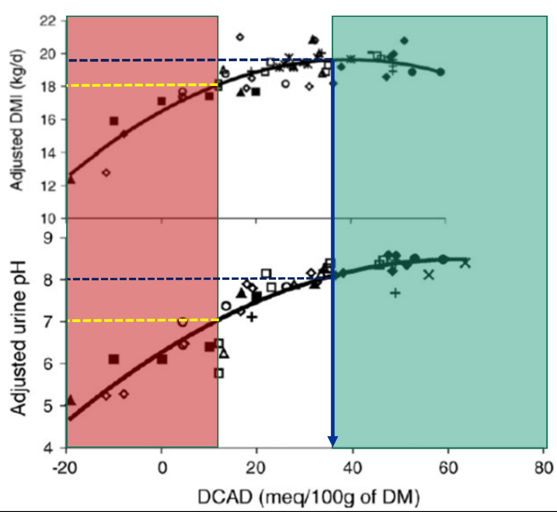
0.60% Dietary Cl (+63 g, +1.8 Eq)
Urinary Bicarbonate:
= 4.1 + 0.8 – 1.9
= 3.0 equivalents (188 g HCO_3^-)

Small change in Cl, Big impact on urinary HCO_3^- and pH

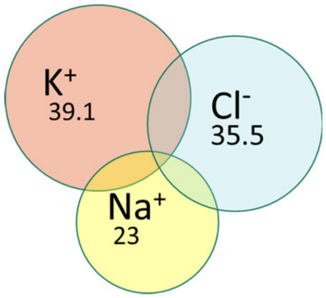
Ion	g/d	Eq/d	Eq Ratio, K:Na:Cl
K	162	4.1	2.4
Na	19	0.8	0.4
Cl	67	1.9	1.0

Again: Milking Cows Like an Alkaline Urine



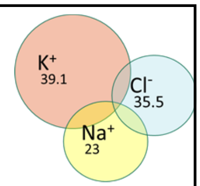


- Alkaline pH requires excess urinary cations, (K + Na) vs anions (Cl)
- Overfeeding Cl will lower DCAD and urine pH



Always Remember:
Excess Strong Ions Drive
Cows to Drink!!

Summary: Coordinating DCAD and the Electrolytes



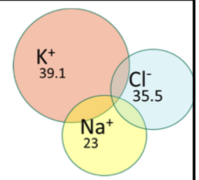
Feed for an alkaline urine (pH ~ 7.5 to 8)

- Remember High DCAD is only a proxy for Urinary SID
- Cows need much more urinary K/Na than Cl
- Adding more NaCl or KCl to diet won't help you!

Watch Cl, Do Feed Analysis!

- Feed enough to meet milk and maintenance needs
- Not too much in excess, leads to lower urine pH
- Small grain and grass silages, can be fairly high in Cl
- If Cl is too high
  - Add Na or K Carbonate/Sesquicarbonate instead of NaCl or KCl

Summary: Coordinating DCAD and the Electrolytes



Water Intake

- 9 grams extra Na, 17 grams extra K increase H2O by 1L.
- If want to increase H2O intake:
- Add dietary K, Na
- Make sure that you have good quality water, adequate watering space

Finally, Pay Attention:

"Dumping extra strong ions in the diet has consequences. The cow can handle extra K and Na, but not Cl."