2018 Penn State Dairy Nutrition Workshop

What Can Rumination Tell Us about Managing Nutrition?

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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?

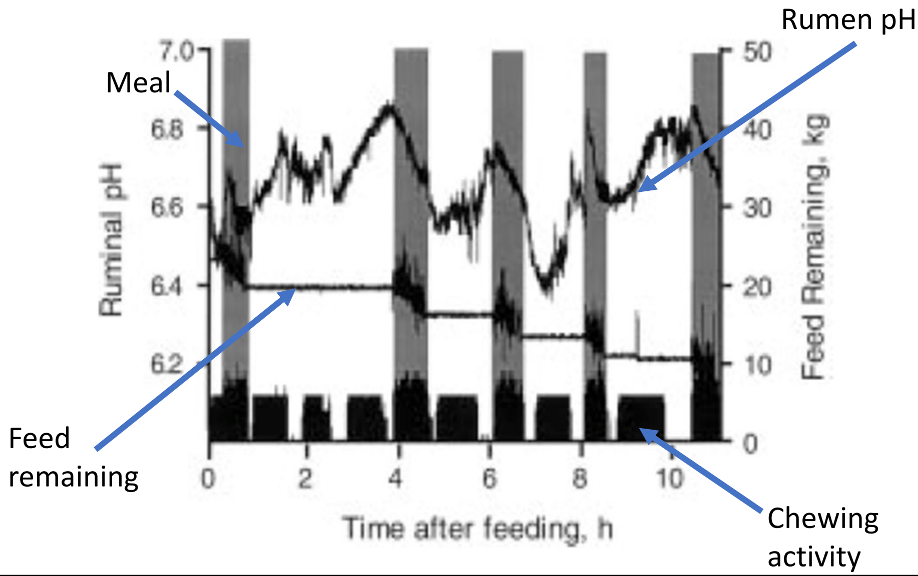
1. Reduce particle size
2. Increase surface area for microbial digestion
3. Supports optimal rumen function

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

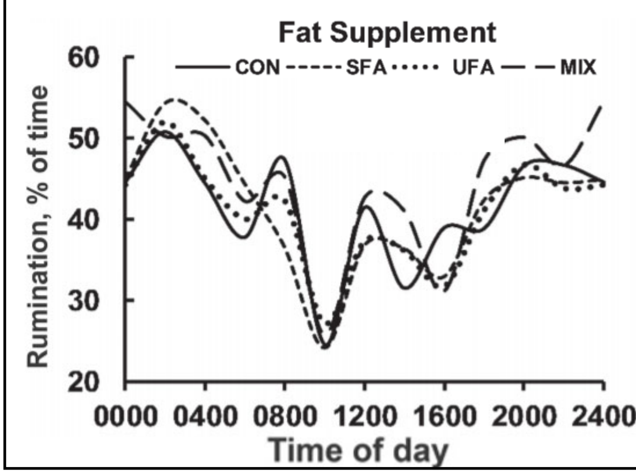
→ **There is <u>no perfect time budget</u> for all cows**

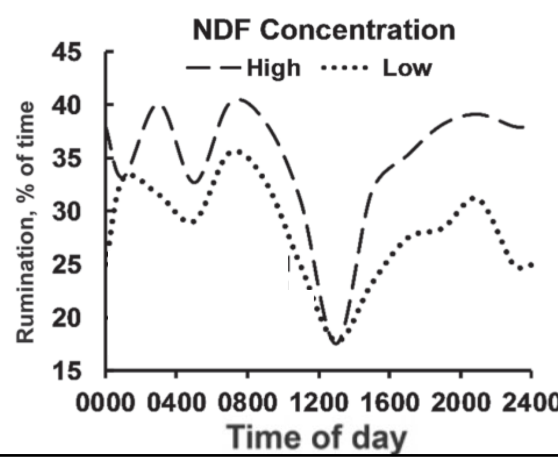
Rumination is cyclical and based on intake



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**

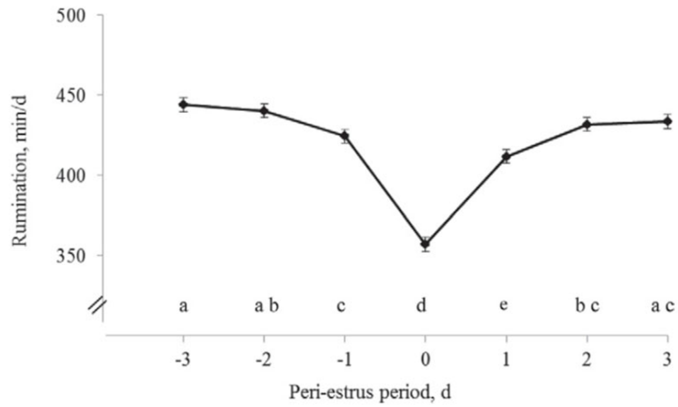
Dado and Allen, 1994; Byskov et al. 2015

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!

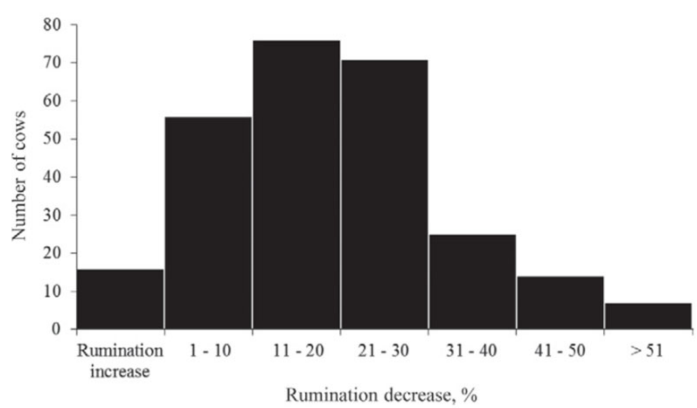
Rumination decreases before and during estrus



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

Reith et al. JDS 2012

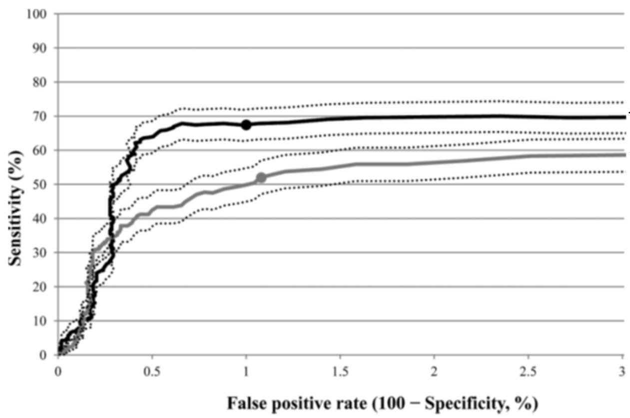
Change in rumination time during estrus is not uniform across all cows



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



← **Activity + Rumination**

← **Activity Only**

- **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**

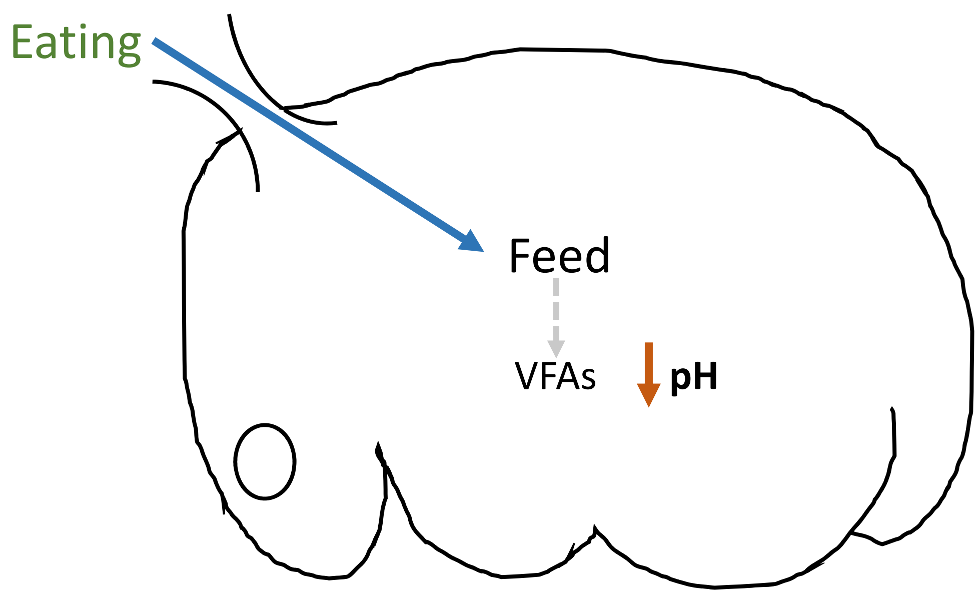
Rumination

VS:

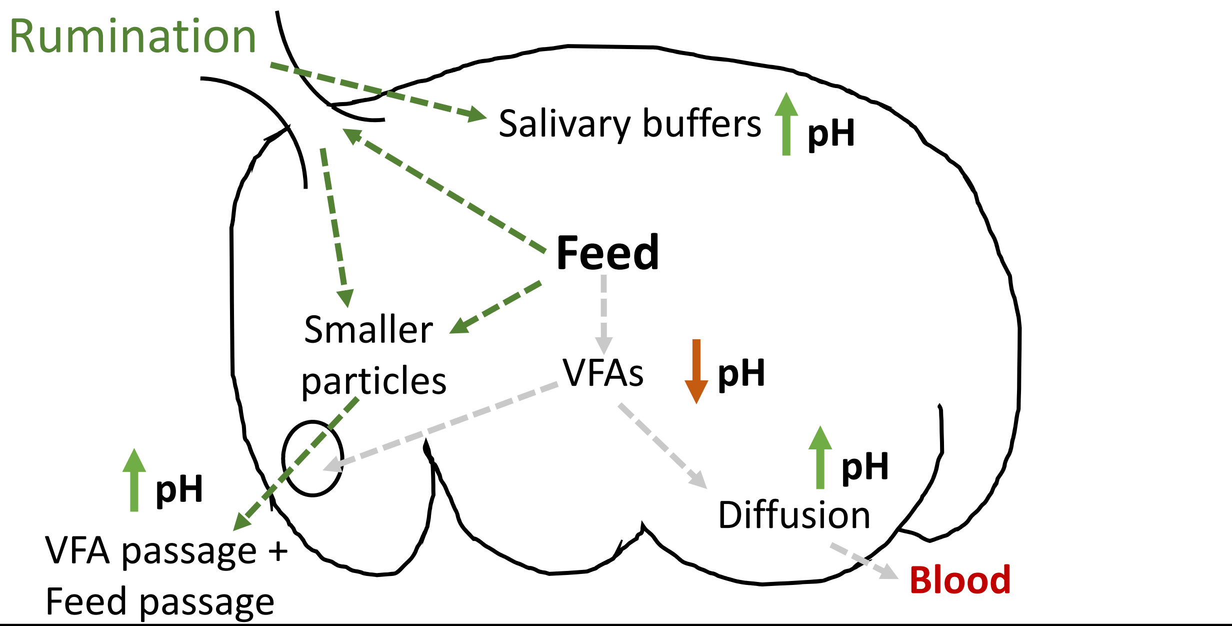
↑ pH

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

Rumination is essential to rumen function



Rumination is essential to rumen function



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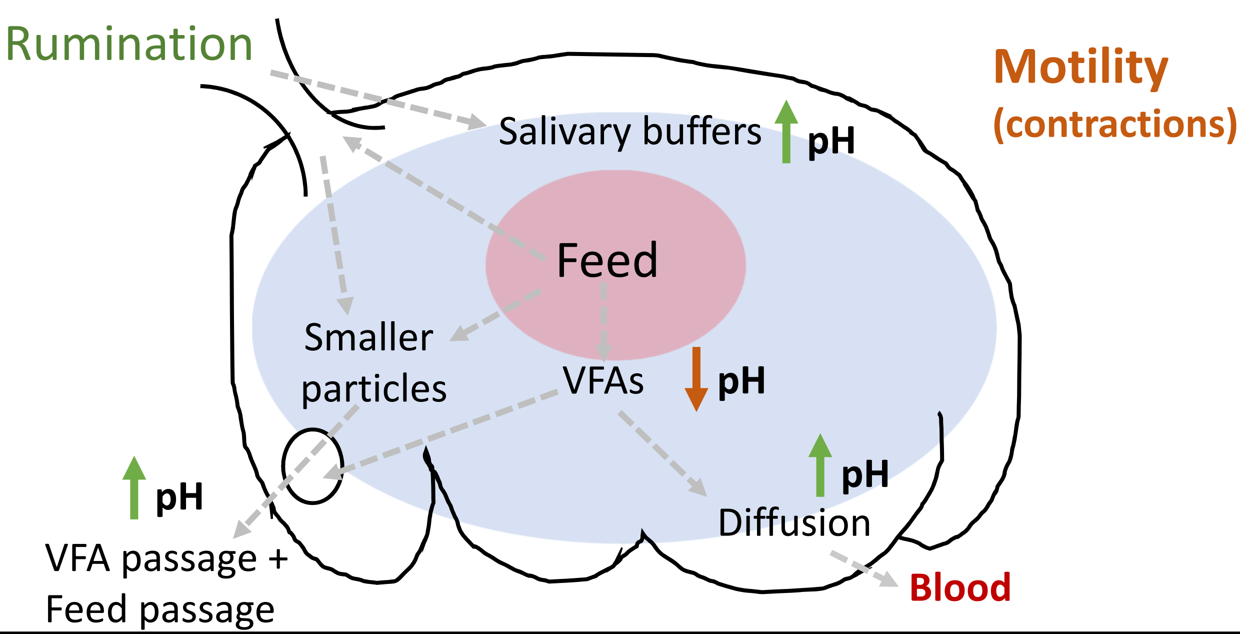

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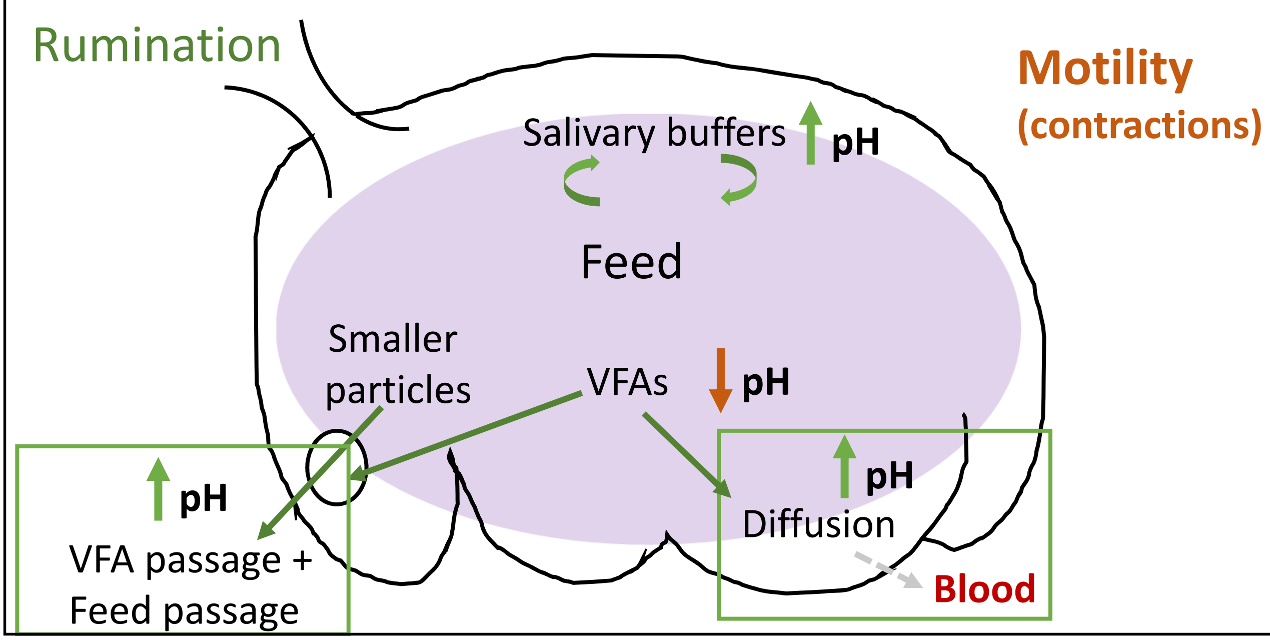


Disrupted rumen function can disrupt production of milk and components

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.

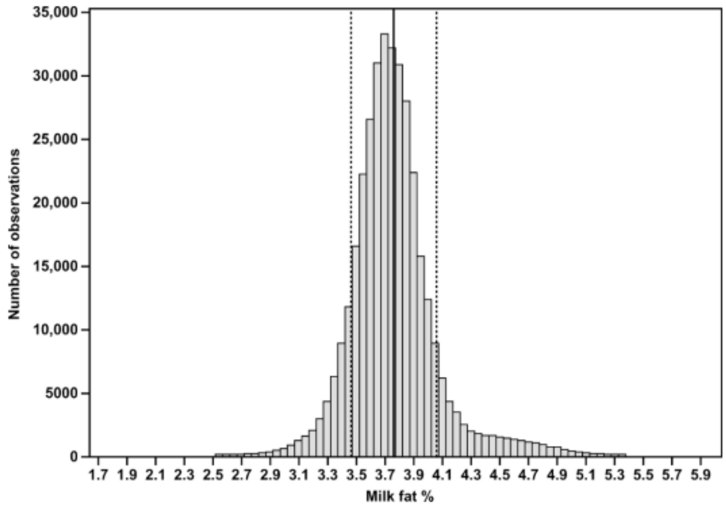
Milk fat varies between and within herds

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

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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

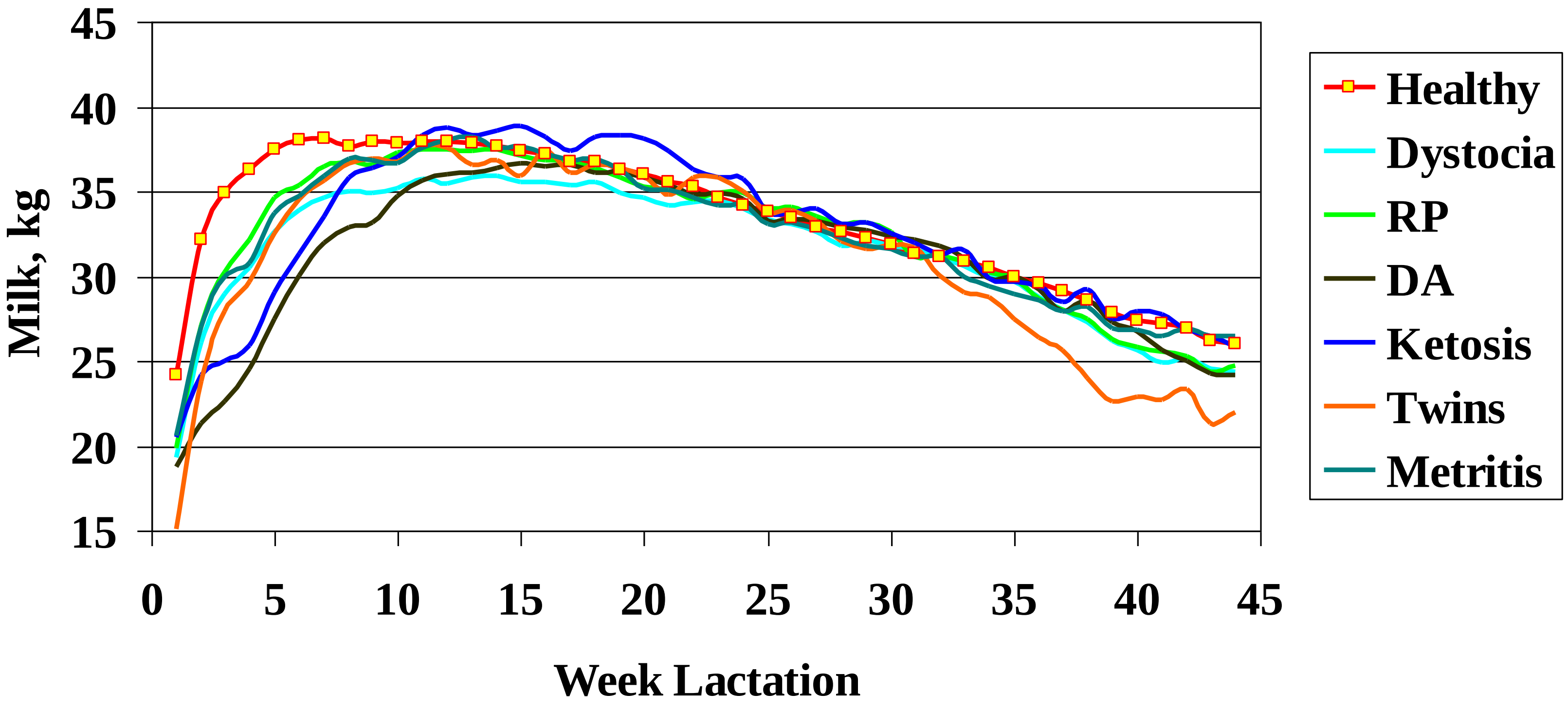
Dystocia
Retained fetal membranes (RFM)
Milk fever (MF)
Metritis
Mastitis
Ketosis
Displaced abomasum (DA)
Fatty liver
Indigestion

Often cows have multiple problems that occur as a complex

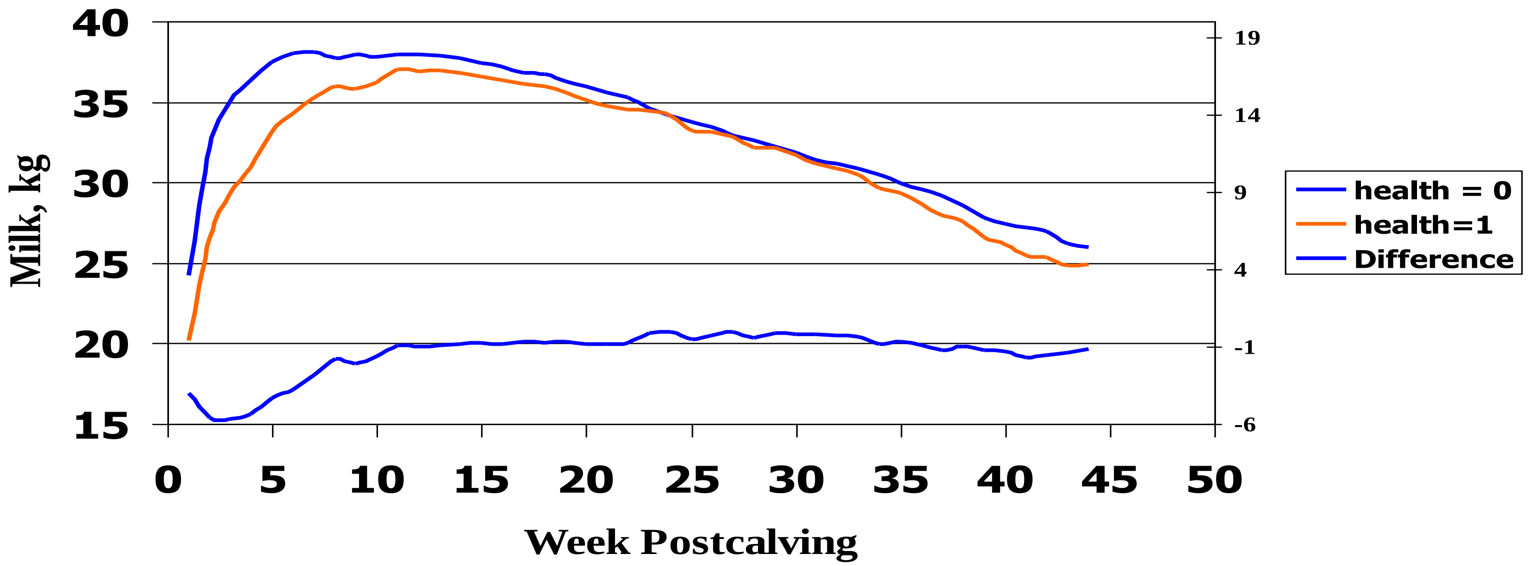
RFM → metritis → ketosis → DA

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

Health and milk production

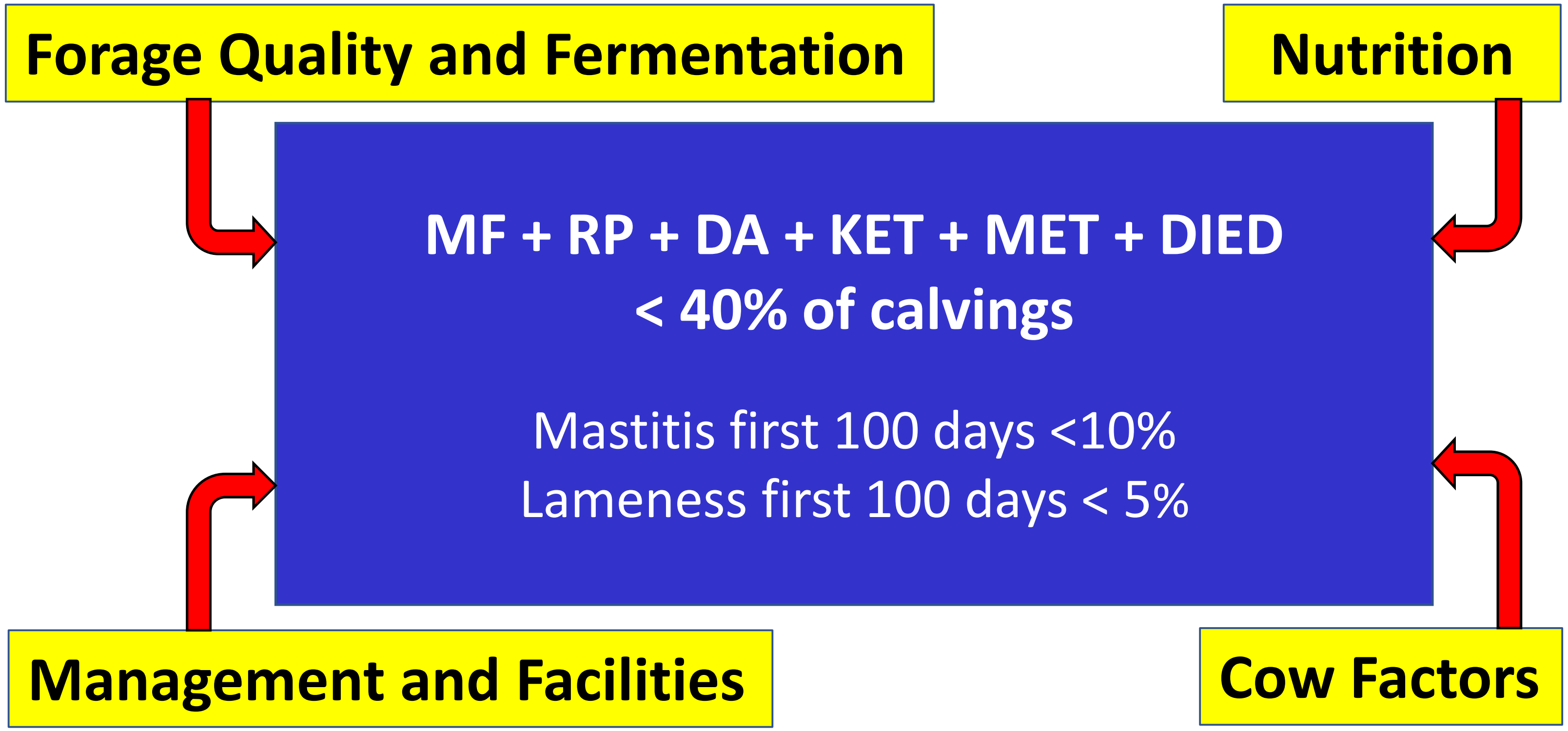


Health and milk production



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

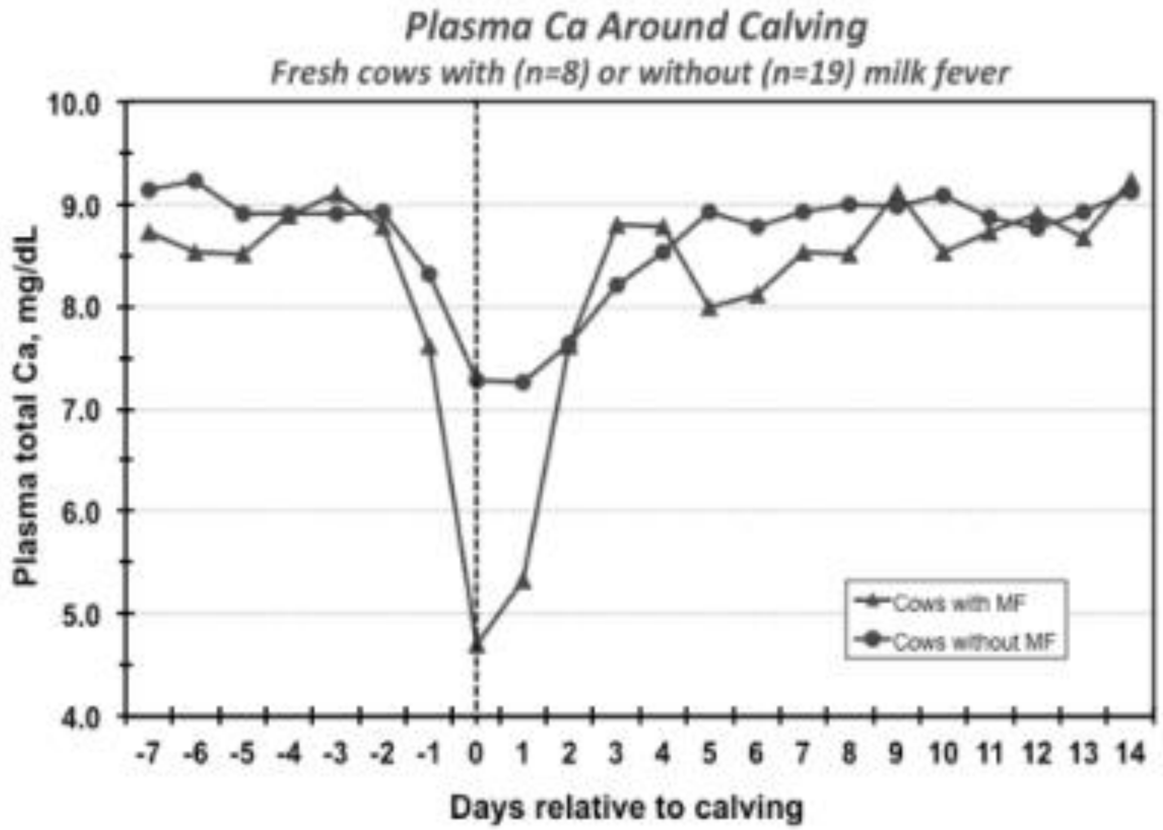
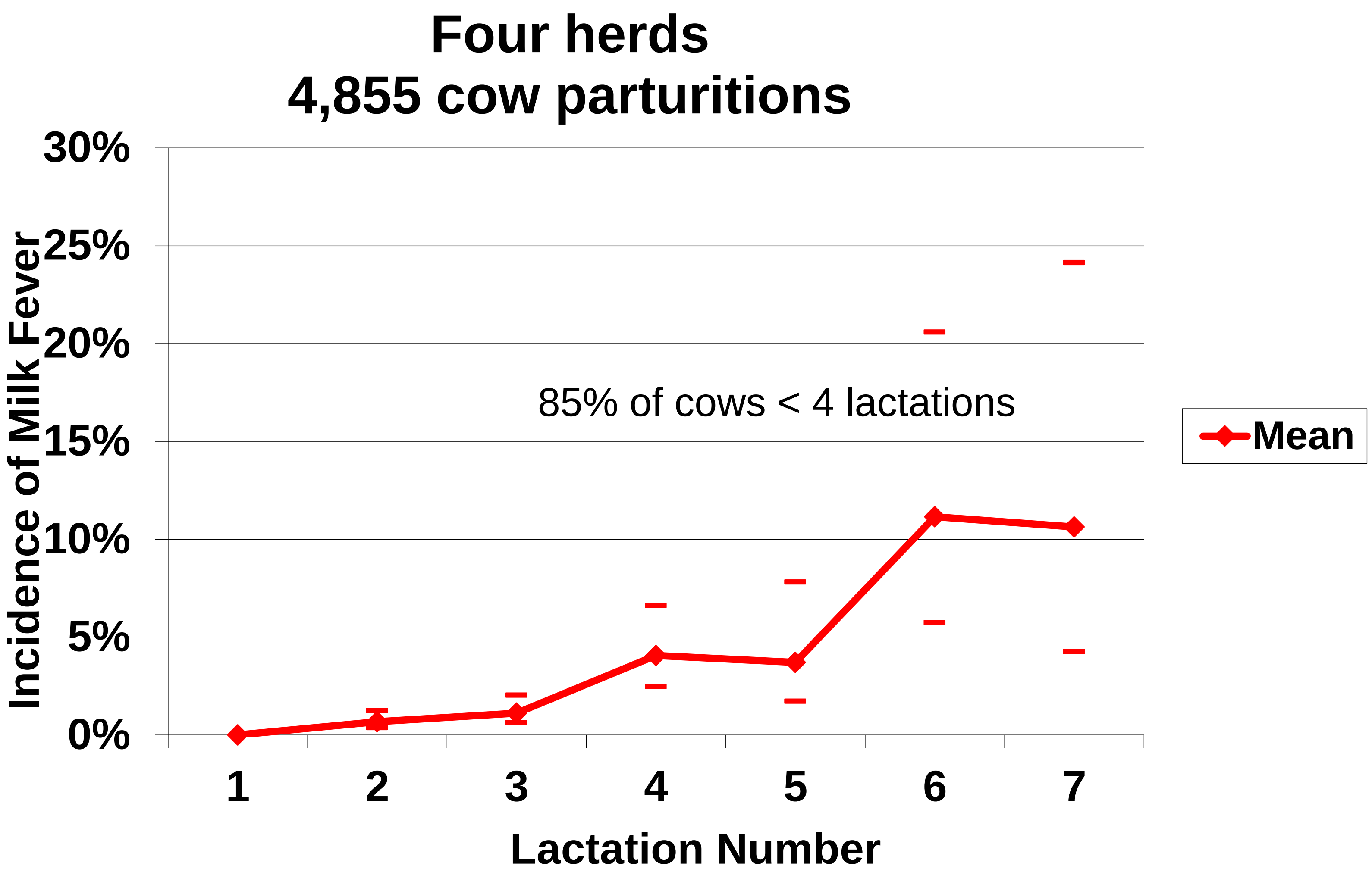


Figure 4. Period of greatest clinical occurrence of milk fever in cows post calving (Adapted Kimura et al. 2006)

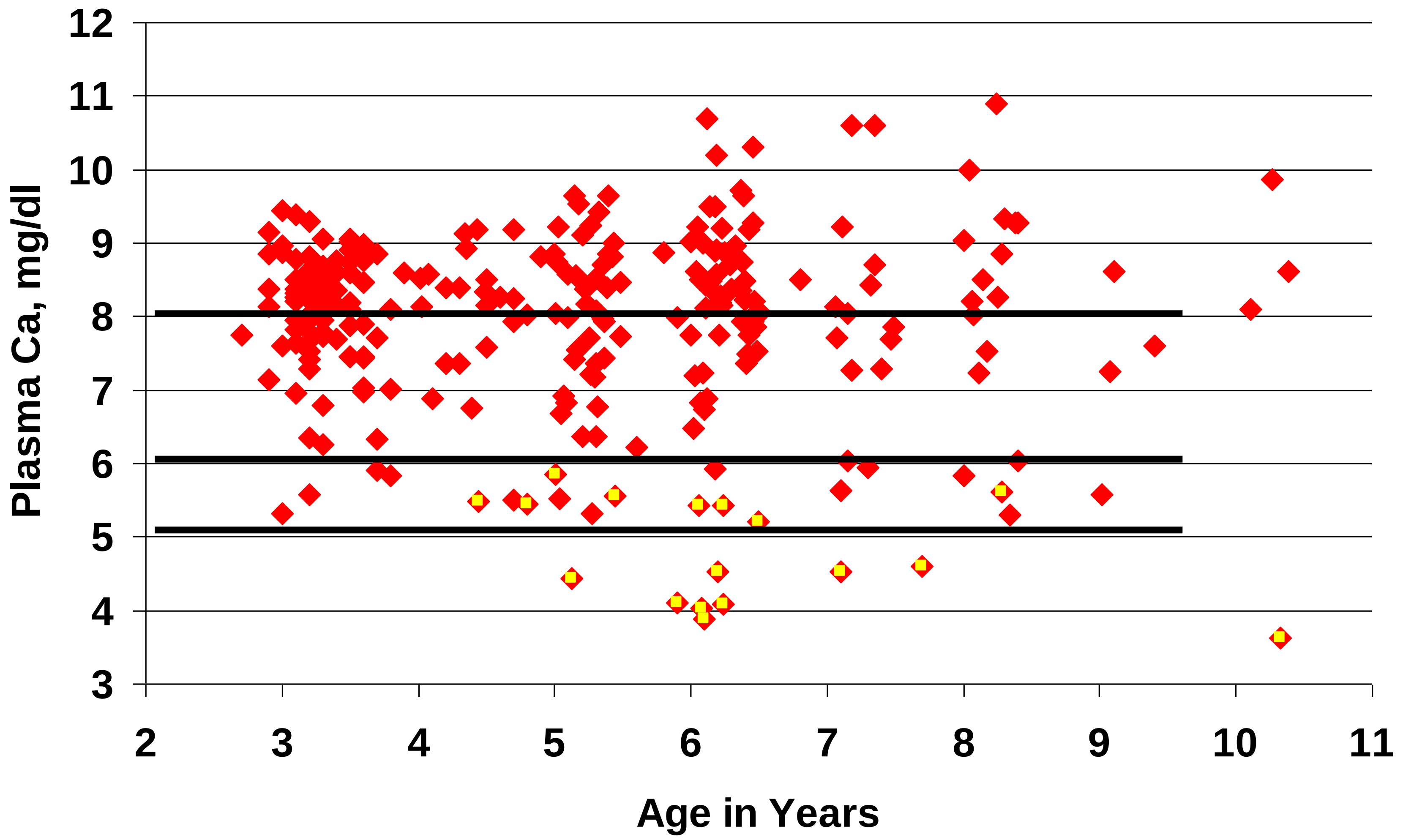
Parturient Hypocalcemia (“Milk Fever”)

- 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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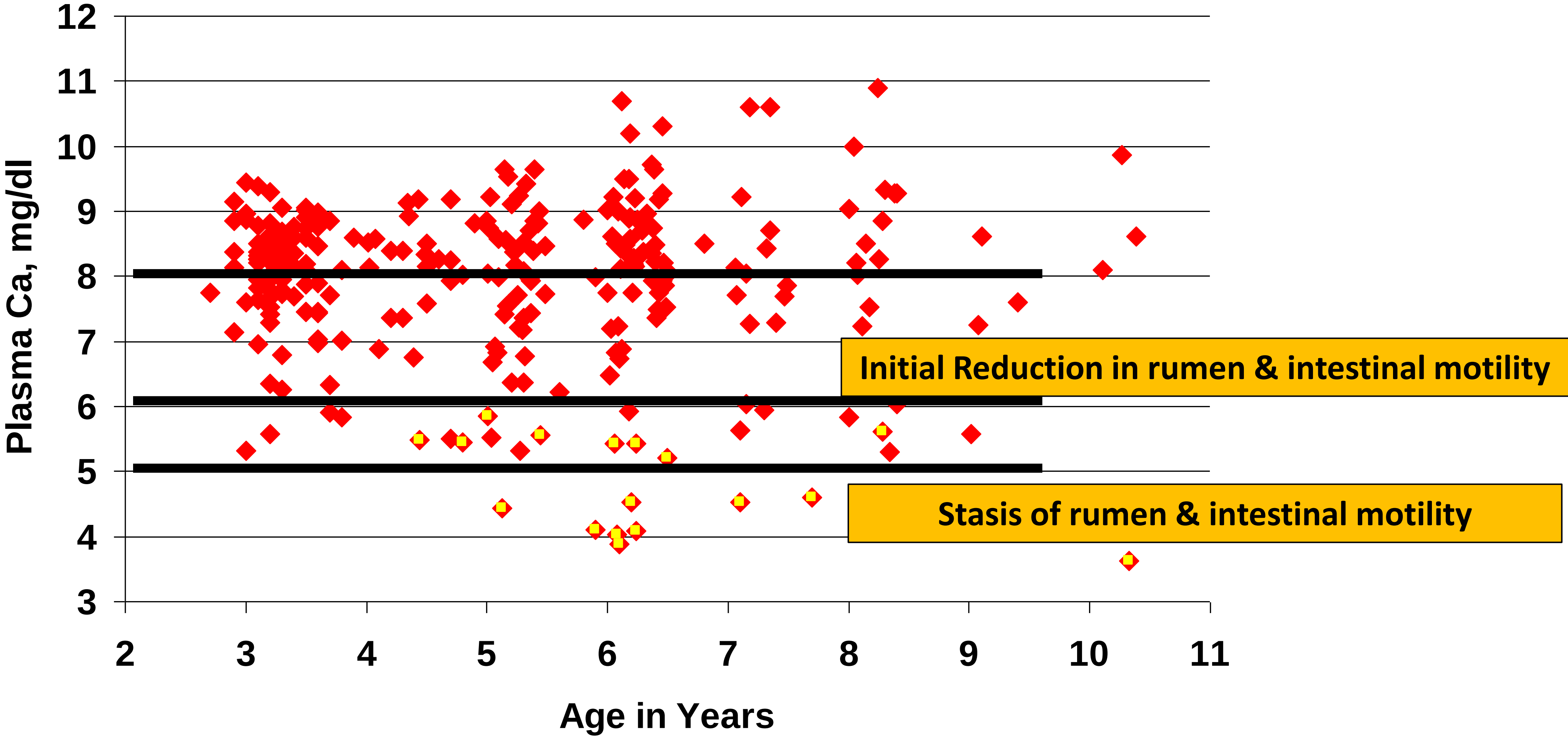


Reduction in motility will impair Ca absorption

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

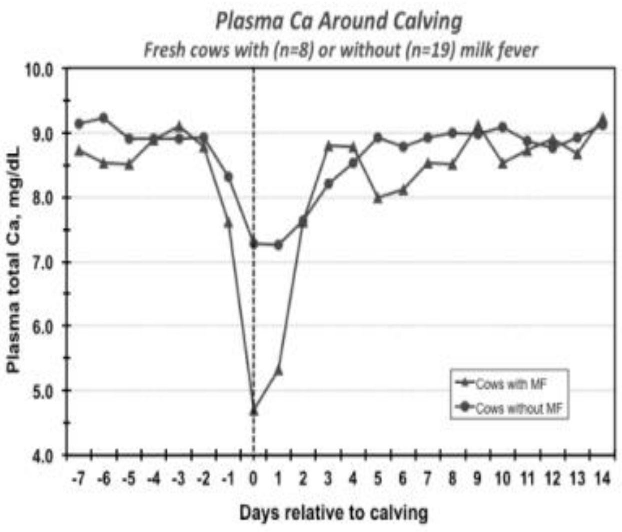
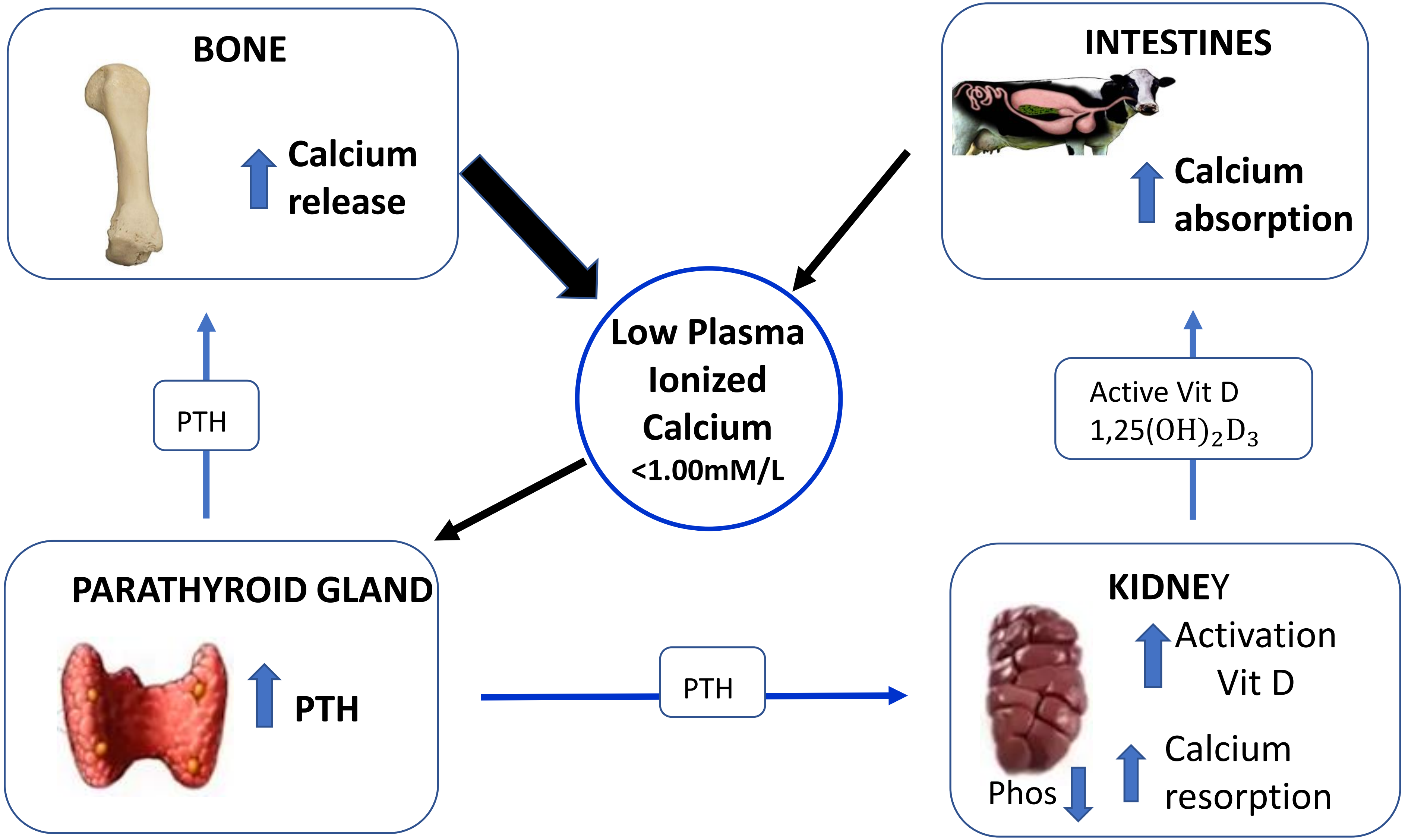


Figure 4. Period of greatest clinical occurrence of milk fever in cows post calving (Adapted Kimura et al. 2006)

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

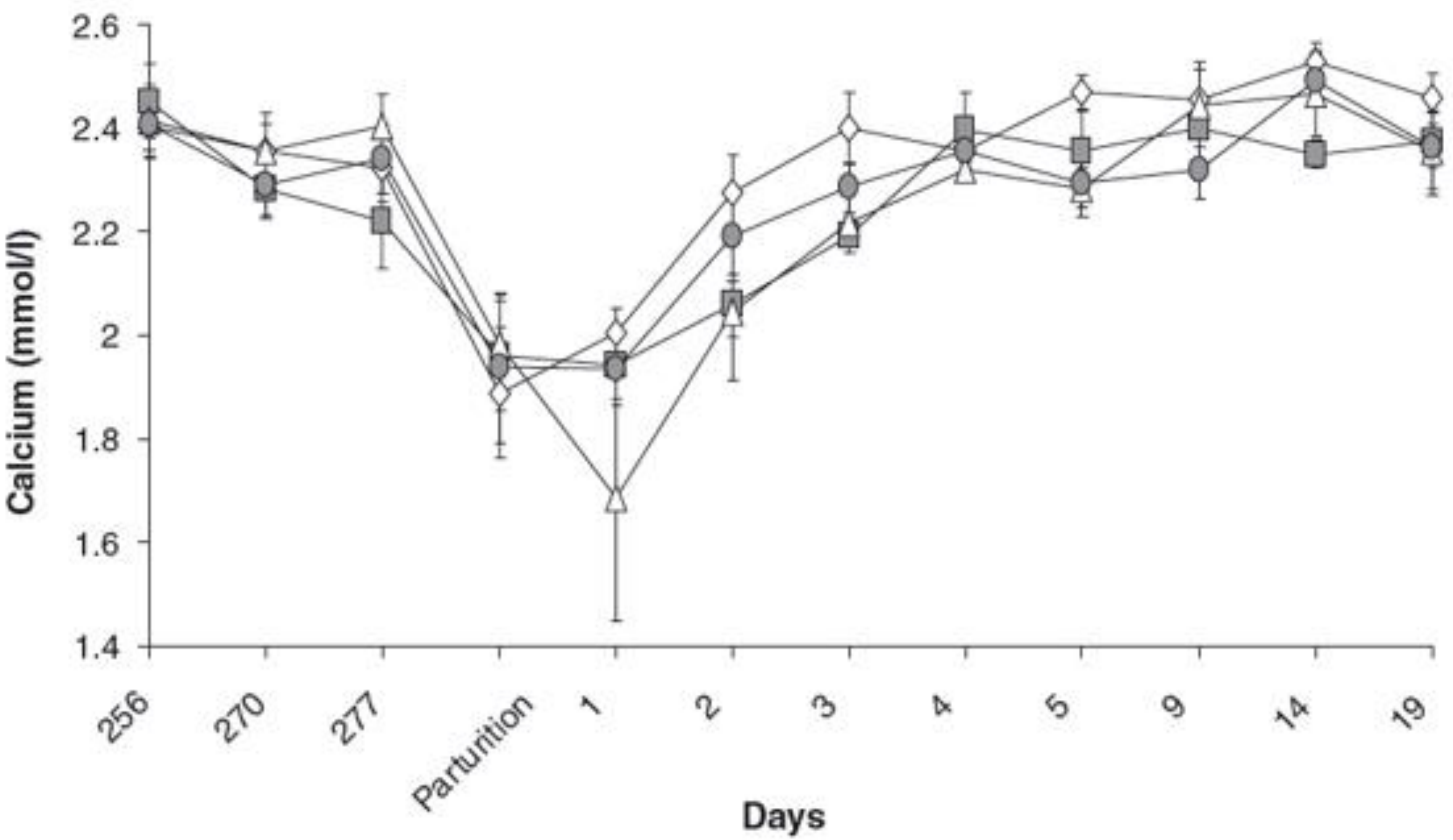
- Manipulate dietary cation anion difference (DCAD)
  - Limit cations ($K^+ + Na^+$), Supplement anionic salts ($Cl^- + S^{-2}$)
  - Metabolic acidosis and increased urinary Ca excretion
  - Urinary pH acidic (6.0-7.0)
  - Often calcium fed at 1.0 to 1.8% DM (180 gms)
- Low dietary calcium diets
  - 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 - ≤ 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

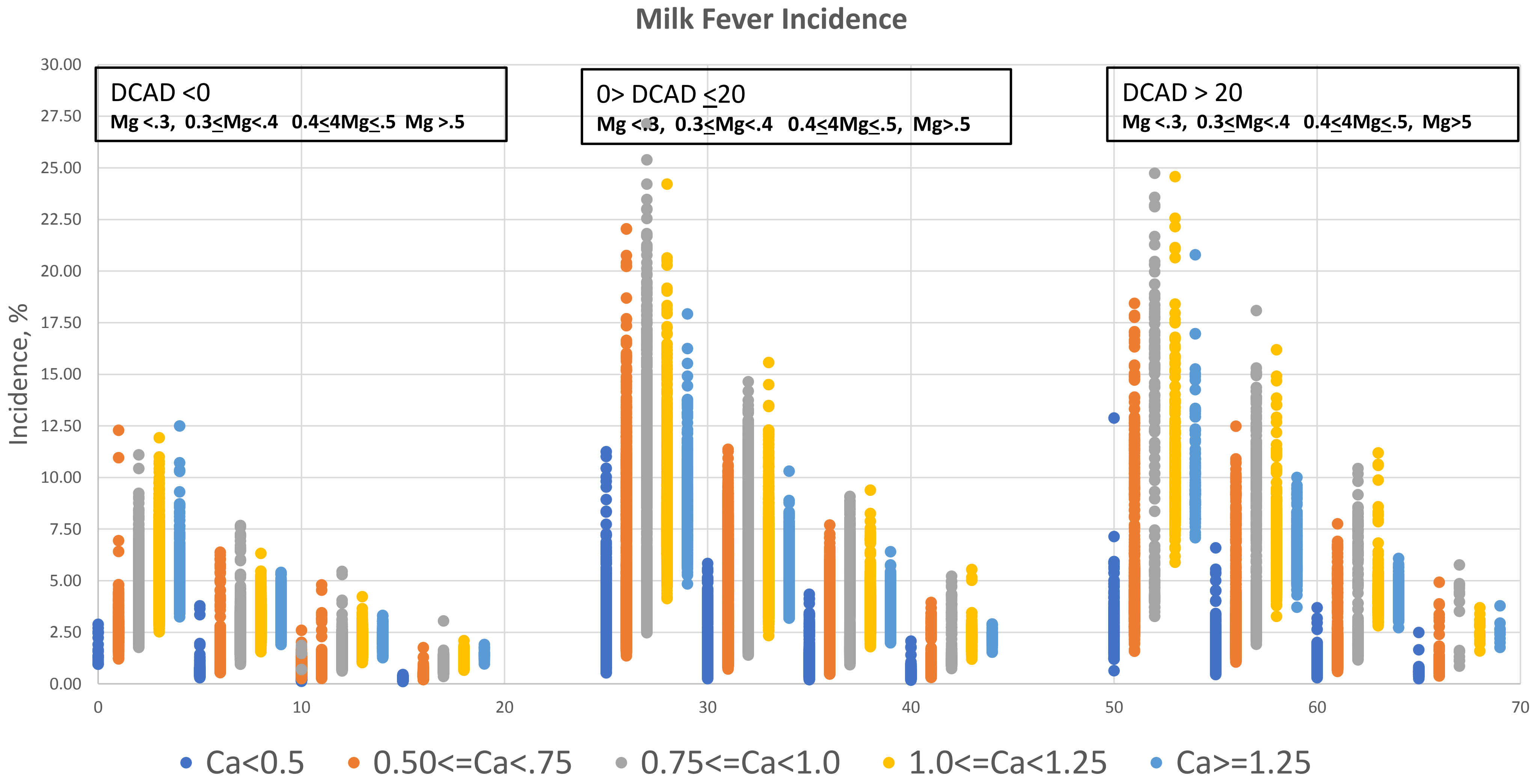
To Investigate Interactions

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 $\leq$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.

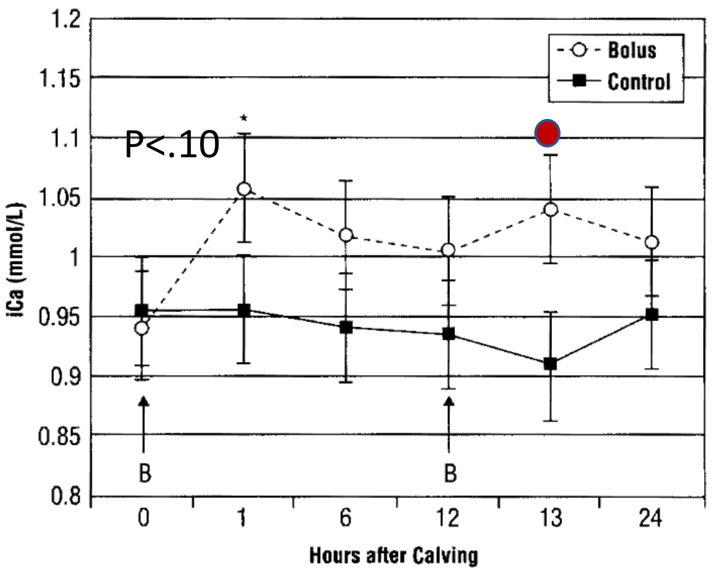
Calcium bolus containing anionic salts

- 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

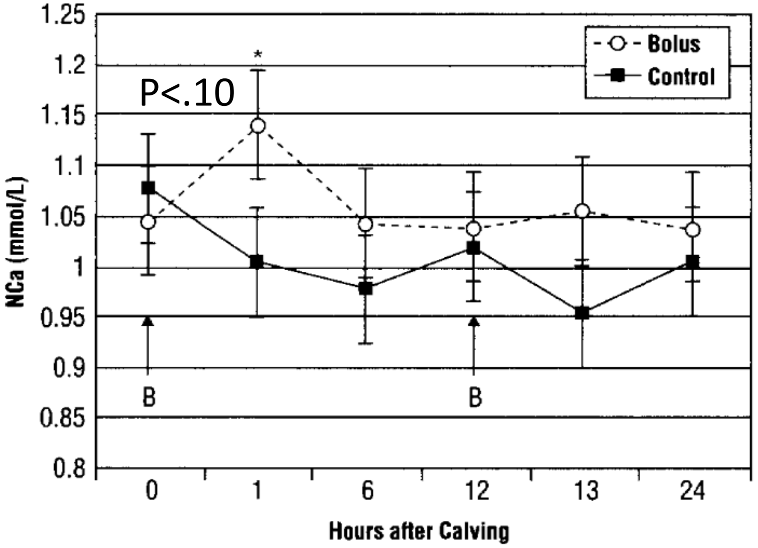
20 cow, no anionic salts, only cows iCa <1.10mg/dl

Sampson et al

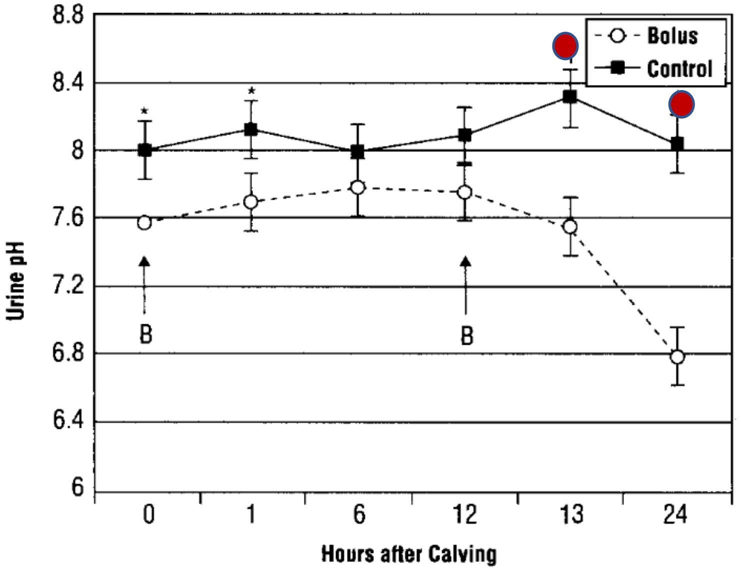
Ionized Calcium



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

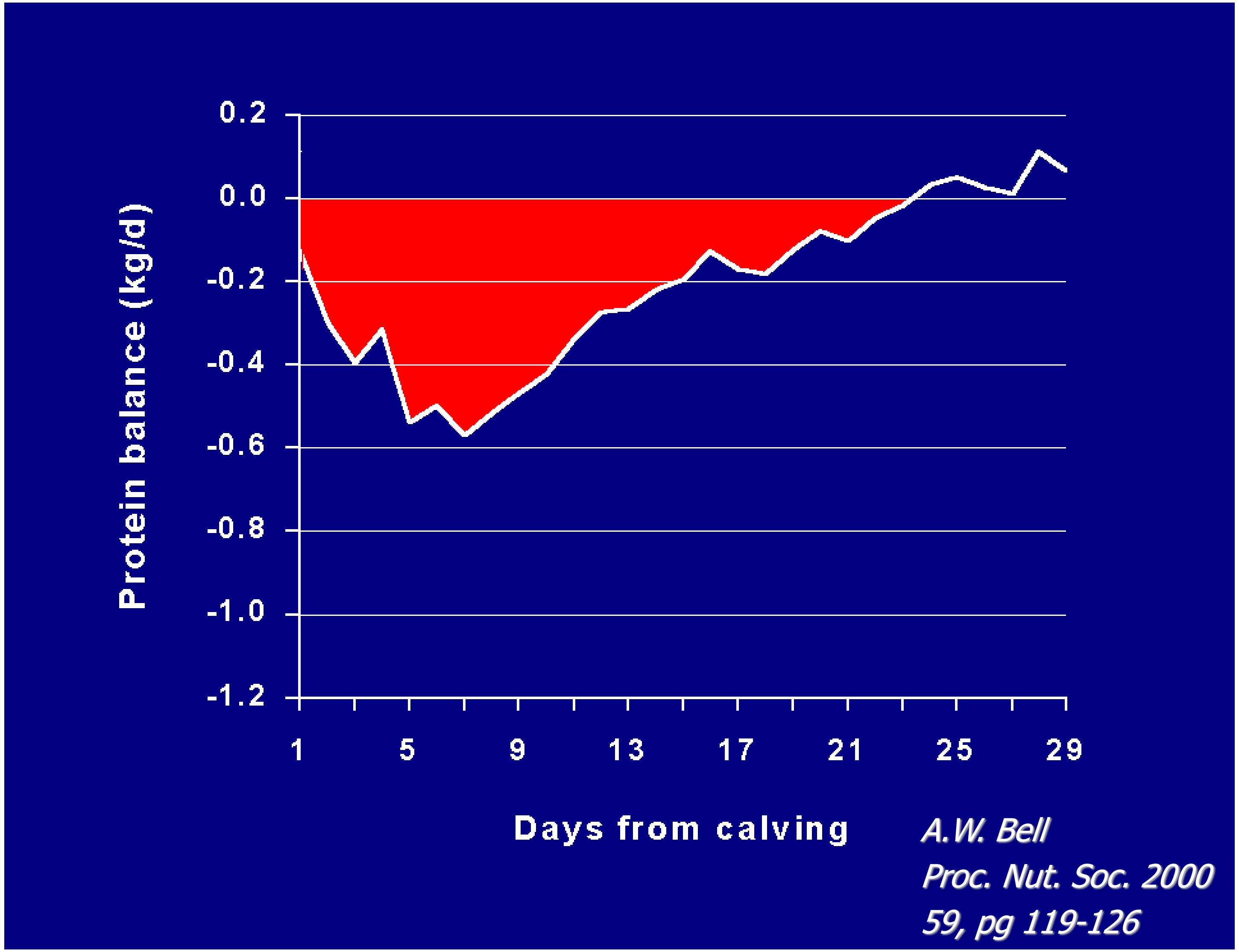
1100 g/d	Metabolizable Protein (g/d)
Maintenance	450
Pregnancy	340
Mammary	270
Growth	40

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

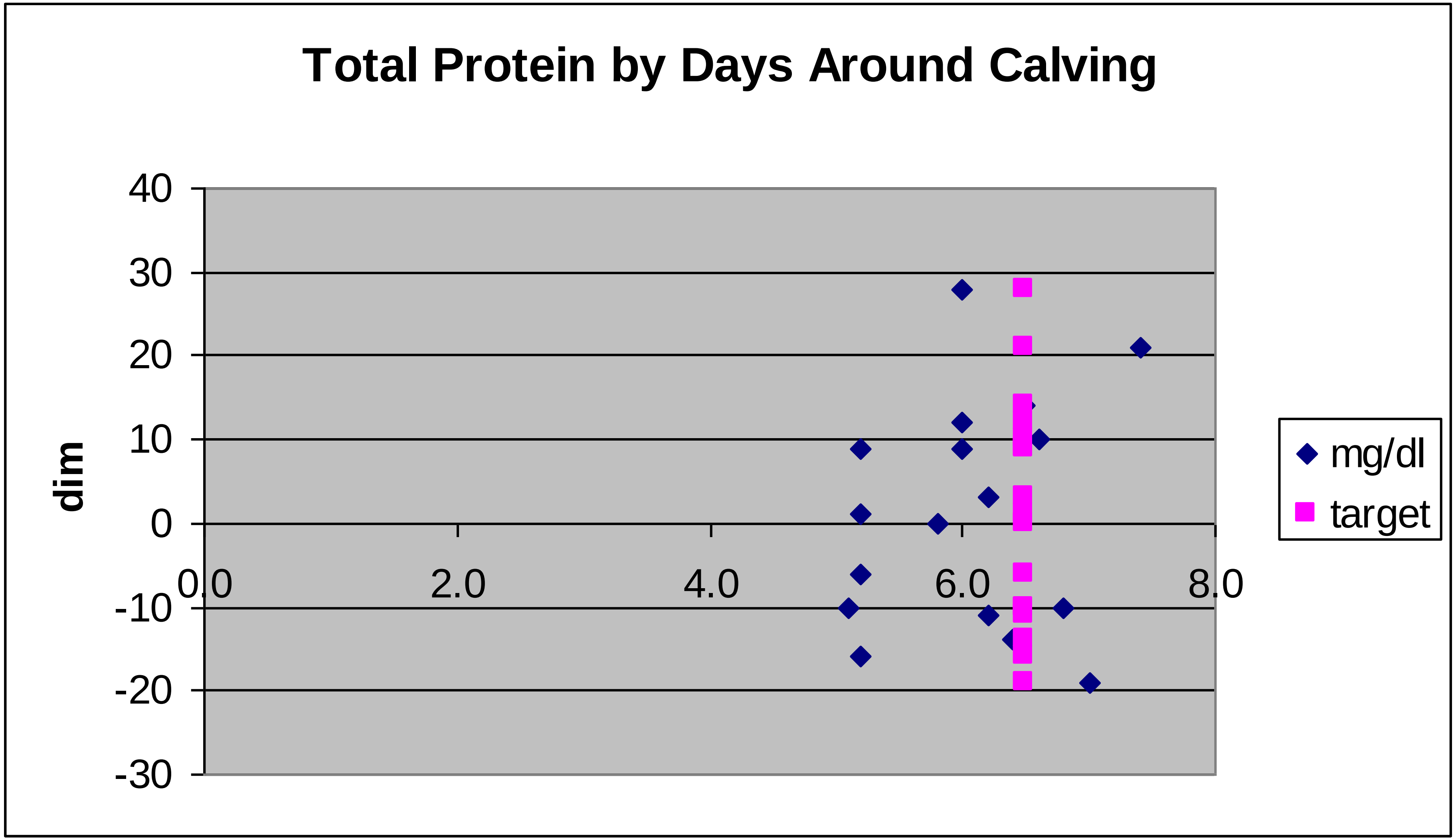


Protein and Ketosis

- 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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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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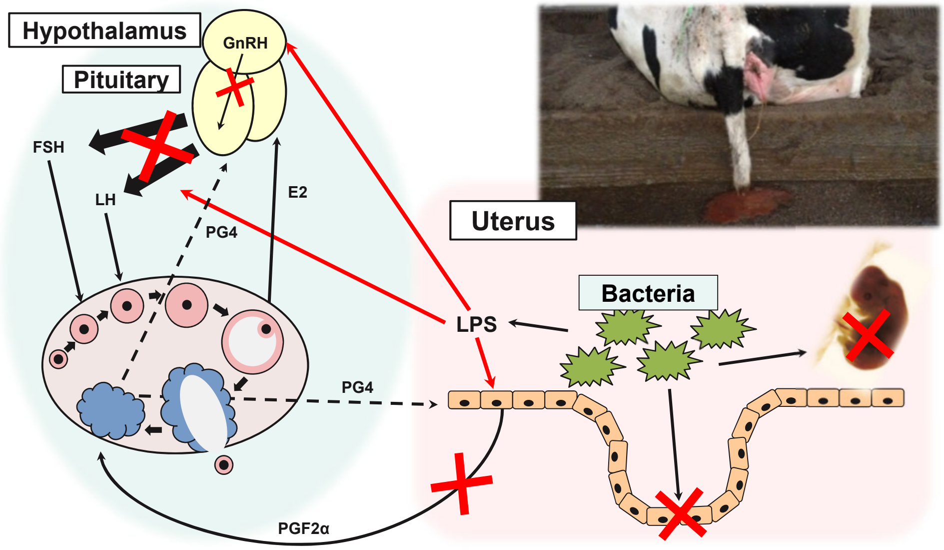
Inflammation Effects on Fertility



Sheldon et al., 2009

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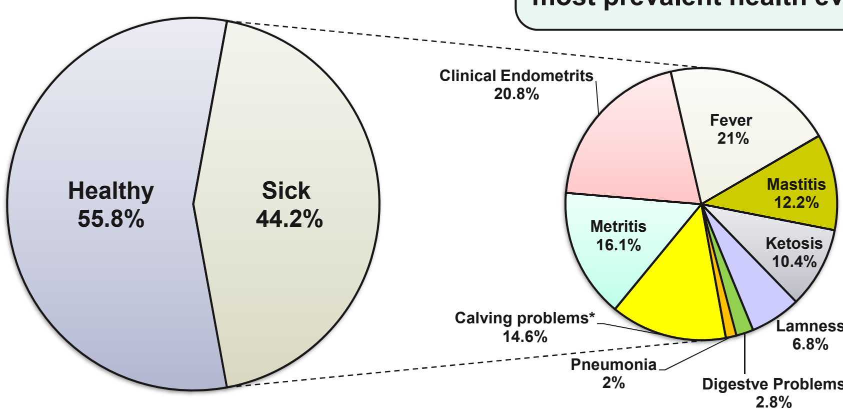
Percentage of Disease During the First 60 DIM

Calving problems and uterine diseases were the most prevalent health events



* Dystocia, twin, stillbirth, retained placenta

Santos et al., 2010

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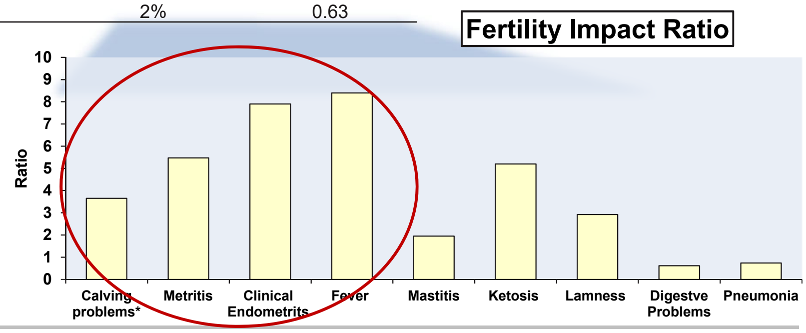
Impact of Diseases on Reproductive Performance

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



Adapted from santos et al., 2010

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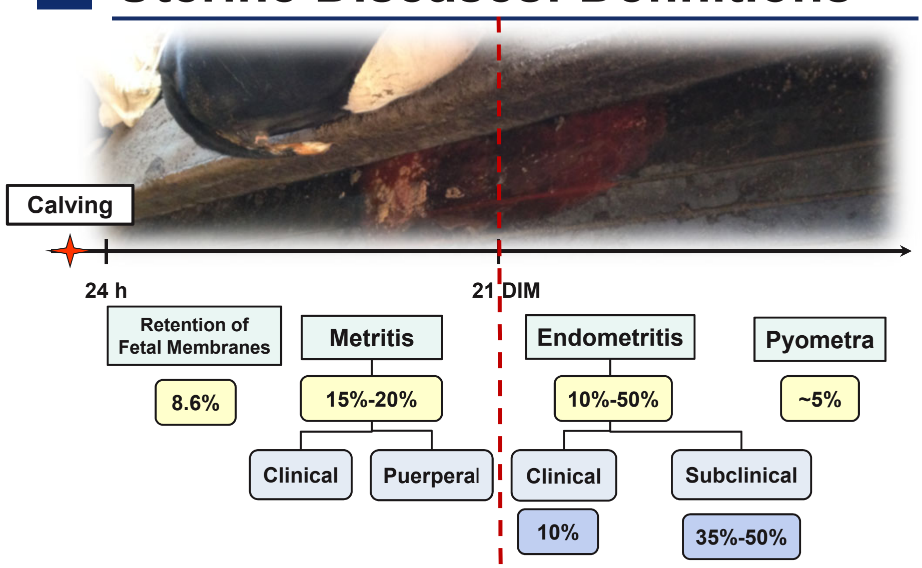
Uterine Diseases: Definitions



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

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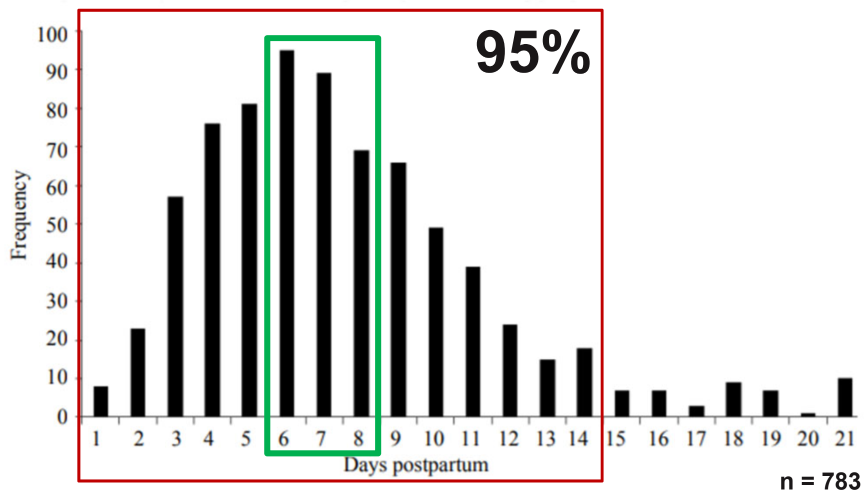
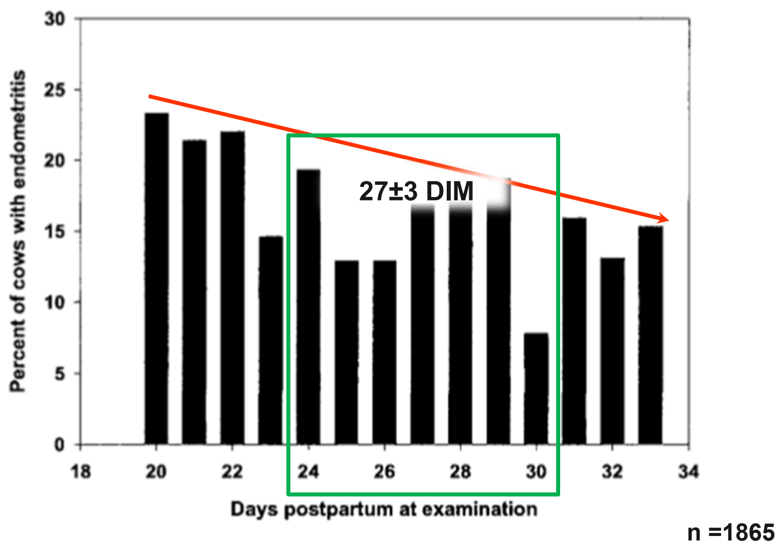
When to Screen for Metritis?



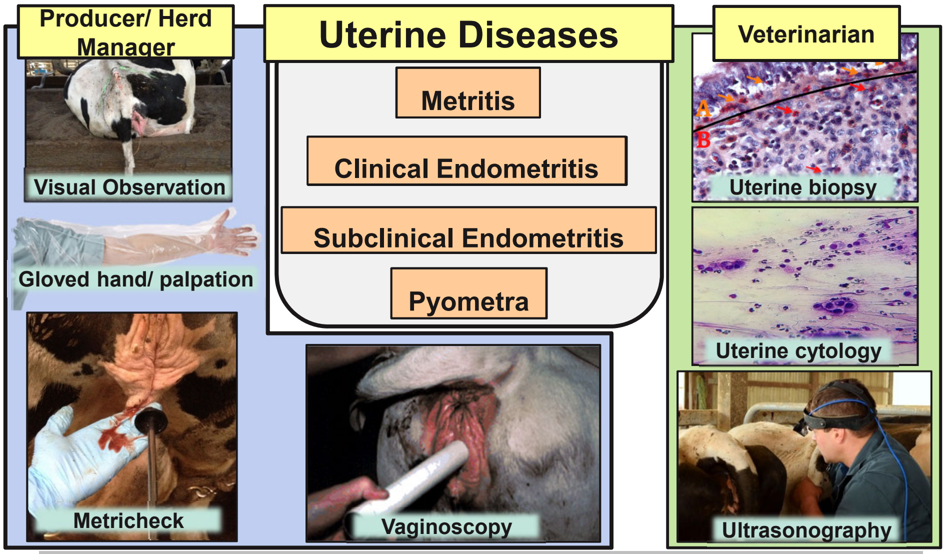
Galvao, 2012

When to Screen for Endometritis?

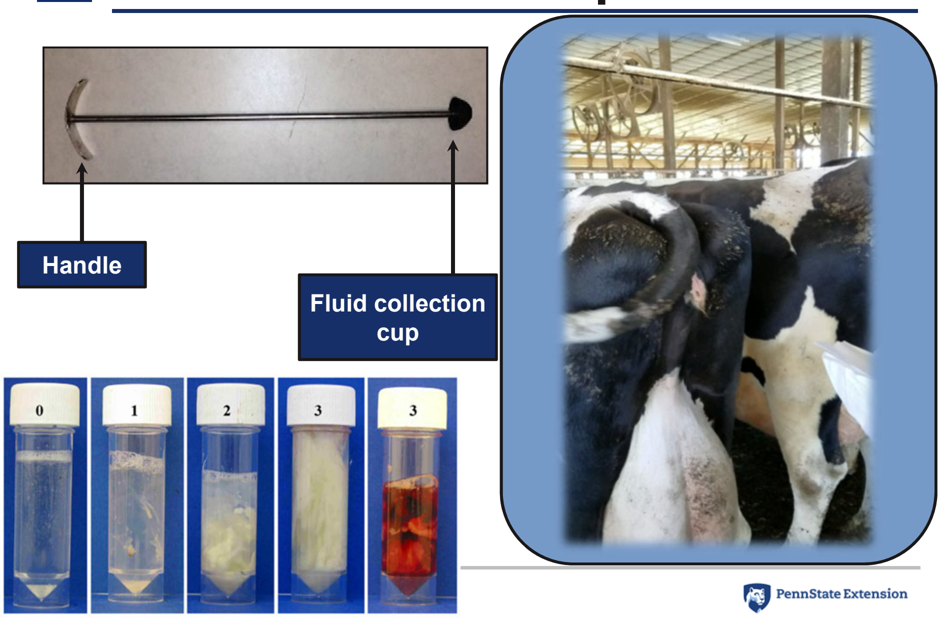


Leblanc et al., 2002

Uterine Diseases: Diagnostic Methods

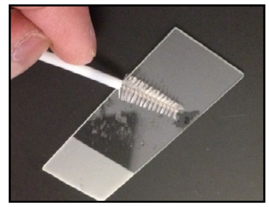


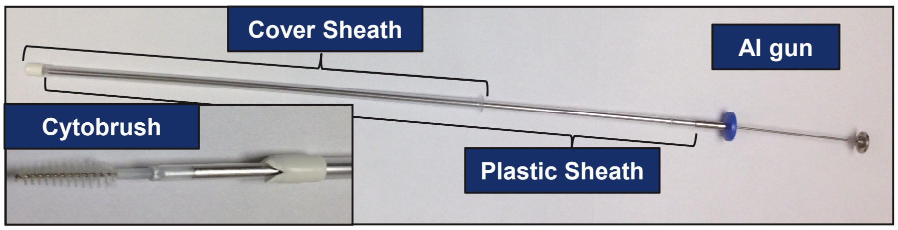
Metricheck Technique



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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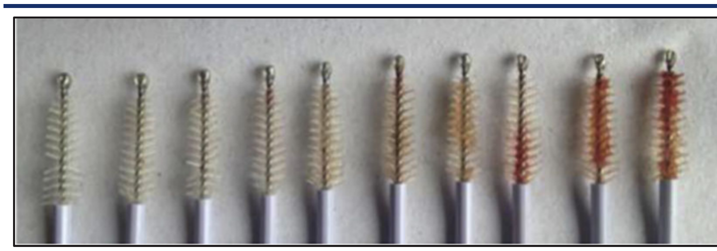
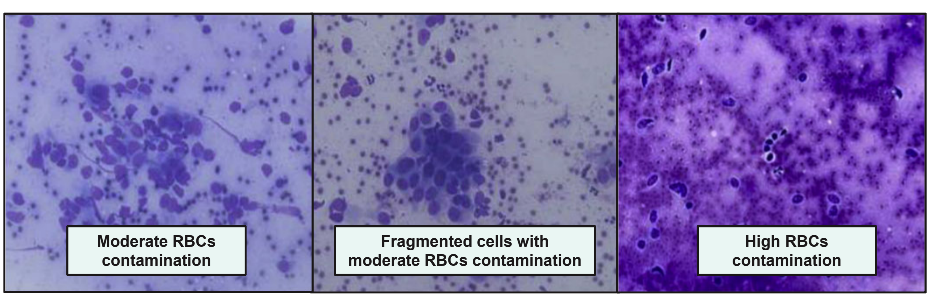
Importance of an Appropriate Technique





Pascottini et al., 2016

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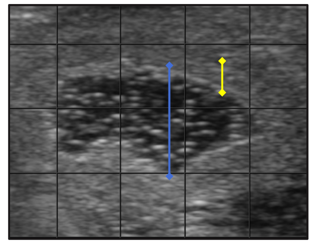
Uterine Ultrasonography

- 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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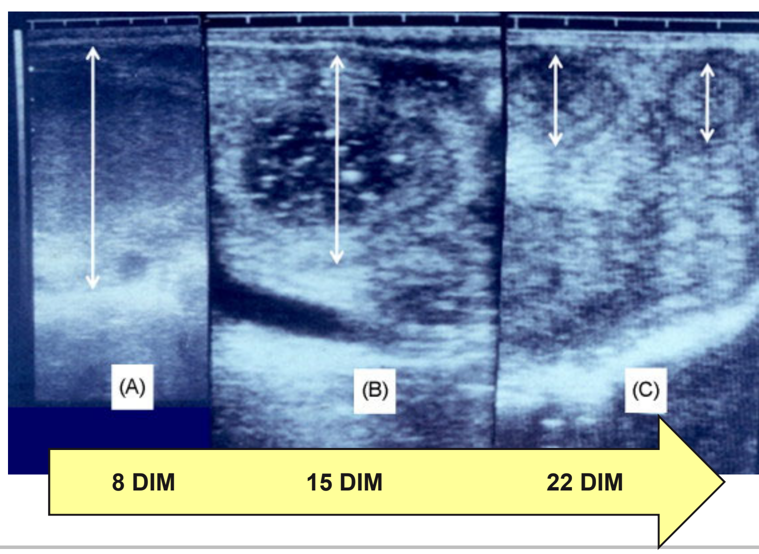
Uterine Ultrasonography



Silvestre et al., 2009

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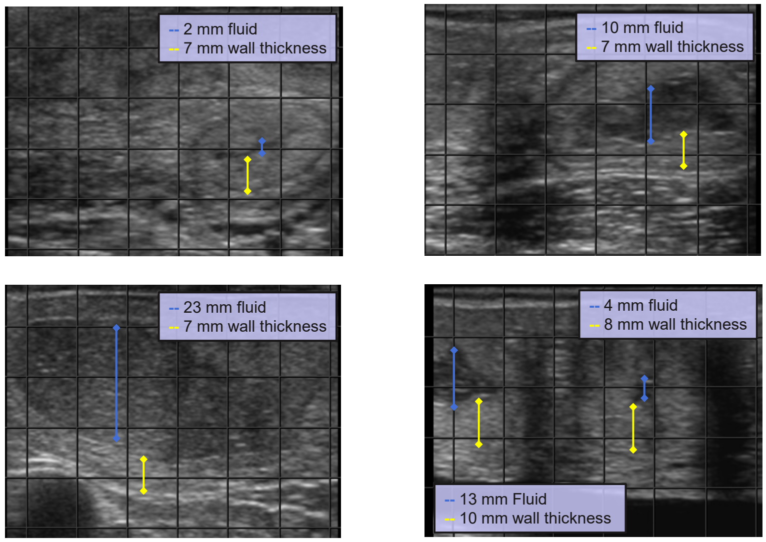
Uterine Ultrasonography



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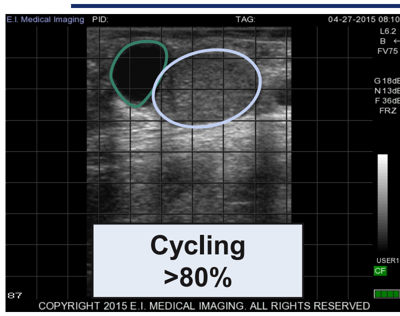
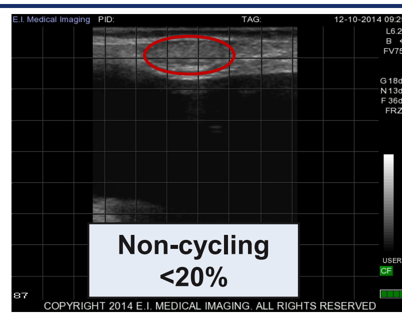
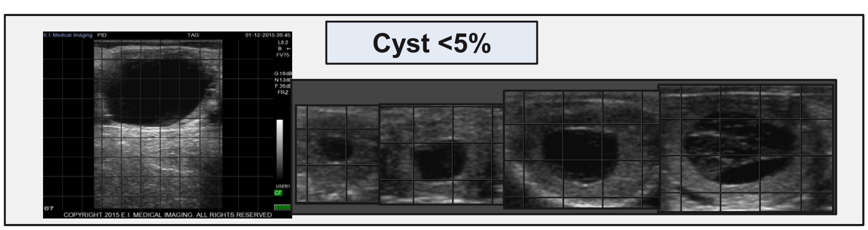
Ovary Ultrasonography: Cyclicity







Walsh et al., 2007

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Record Analysis

DairyCOMP 305

PC DART

Reproductive Performance Assessment

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

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)

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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

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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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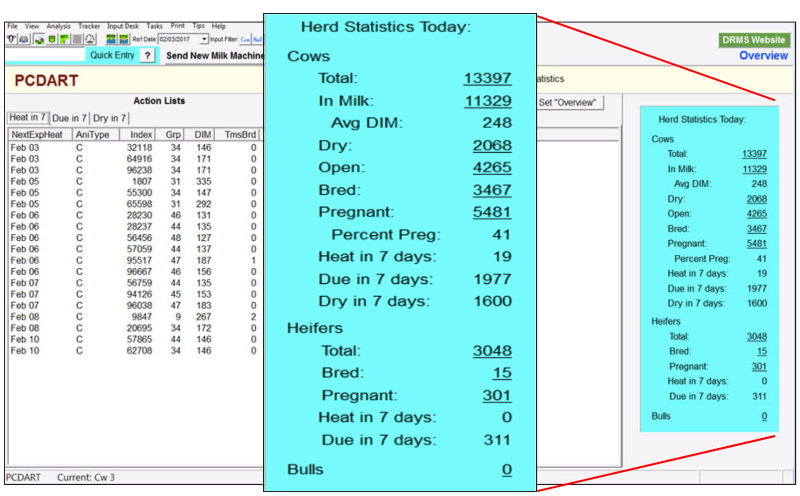
Herd Assessment

Herd structure (PCDART)



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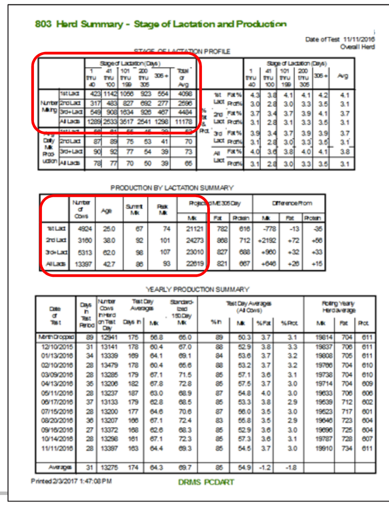
Herd Assessment

Herd structure (PCDART)



803 Herd Summary - Stage of Lactation and Production

Date of Test 11/11/2016
Overall Herd

STAGE OF LACTATION PROFILE

		1 thru 40	41 thru 100	101 thru 199	200 thru 305	305 +	Total or Avg
Number Milking	1st Lact	423	1142	1056	923	554	4098
	2nd Lact	317	483	827	692	277	2596
	3rd+ Lact	549	908	1634	926	467	4484
	All Lacts	1289	2533	3517	2541	1298	11178
Avg Daily Milk Production	1st Lact	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	2nd Lact	87	89	75	53	41	70
	3rd+ Lact	90	92	77	54	39	73
	All Lacts	78	77	70	50	39	65

% Fat & Prot.		1 thru 40	41 thru 100	101 thru 199	200 thru 305	305 +	Avg
1st Lact	Fat %	4.3	3.8	4.1	4.1	4.2	4.1
	Prot%	3.0	2.8	3.0	3.3	3.5	3.1
2nd Lact	Fat %	3.7	3.4	3.7	3.9	4.1	3.7
	Prot%	3.1	2.8	3.1	3.3	3.5	3.1
3rd Lact	Fat %	3.9	3.4	3.7	3.9	3.9	3.7
	Prot%	3.1	2.8	3.0	3.3	3.5	3.1
All Lact	Fat %	4.0	3.6	3.8	4.0	4.1	3.8
	Prot%	3.1	2.8	3.0	3.3	3.5	3.1

PRODUCTION BY LACTATION SUMMARY

	Number of Cows	Age	Summit Milk	Peak Milk	Projected ME 305 Day			Difference From		
					Milk	Fat	Protein	Milk	Fat	Protein
1st Lact	4924	25.0	67	74	21121	782	616	-778	-13	-35
2nd Lact	3160	38.0	92	101	24273	868	712	+2192	+72	+56
3rd+ Lact	5313	62.0	98	107	23010	827	688	+960	+32	+33
All Lacts	13397	42.7	86	93	22619	821	667	+646	+26	+15

YEARLY PRODUCTION SUMMARY

Date of Test	Days in Test Period	Number Cows in Herd on Test Day	Test Day Averages		Standardized 150 Day Milk	Test Day Averages (All Cows)				Rolling Yearly Herd average		
			Days In	Milk		% In	Milk	% Fat	% Prot.	Milk	Fat	Prot.
Month Dropped	89	12941	175	56.8	65.0	89	50.3	3.7	3.1	19814	704	611
12/10/2015	31	13141	178	60.4	67.0	88	52.9	3.8	3.3	19837	706	611
01/13/2016	34	13339	169	64.1	69.1	84	53.6	3.7	3.2	19808	705	611
02/10/2016	28	13479	178	60.4	65.6	88	53.2	3.7	3.2	19766	704	610
03/09/2016	28	13285	179	67.1	71.5	85	57.1	3.6	3.1	19738	704	610
04/13/2016	35	13206	182	67.8	72.8	85	57.5	3.7	3.0	19714	704	609
05/11/2016	28	13237	187	63.0	68.9	87	54.8	4.0	3.0	19633	706	606
06/17/2016	37	13133	179	62.8	68.5	85	53.3	3.8	2.9	19539	712	602
07/15/2016	28	13200	177	64.6	70.6	87	56.0	3.5	3.0	19523	717	601
08/20/2016	36	13207	166	67.1	72.4	83	55.8	3.5	2.9	19646	723	604
09/16/2016	27	13372	168	62.6	68.3	85	52.9	3.6	3.0	19696	725	604
10/14/2016	28	13298	161	67.1	72.3	85	57.3	3.6	3.1	19787	728	607
11/11/2016	28	13397	163	64.4	69.3	85	54.5	3.7	3.0	19910	734	611
Averages	31	13275	174	64.3	69.7	85	54.9	-1.2	-1.8			

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DRMS PCDART

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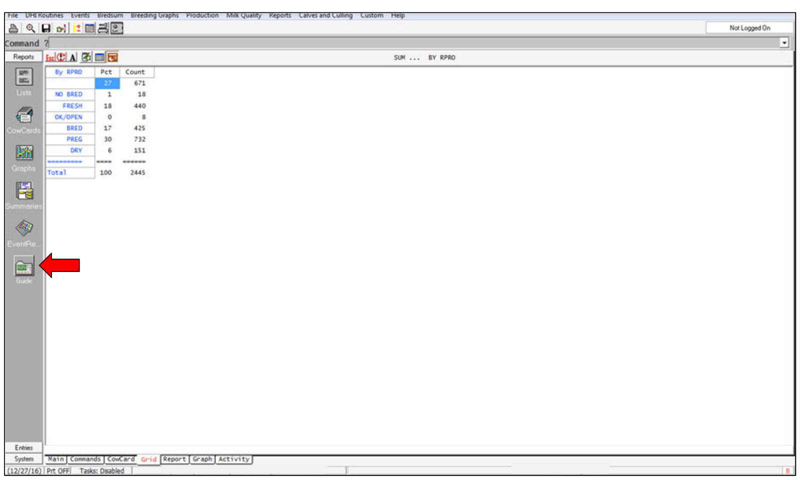
Herd Assessment

Dairycomp 305: Guide



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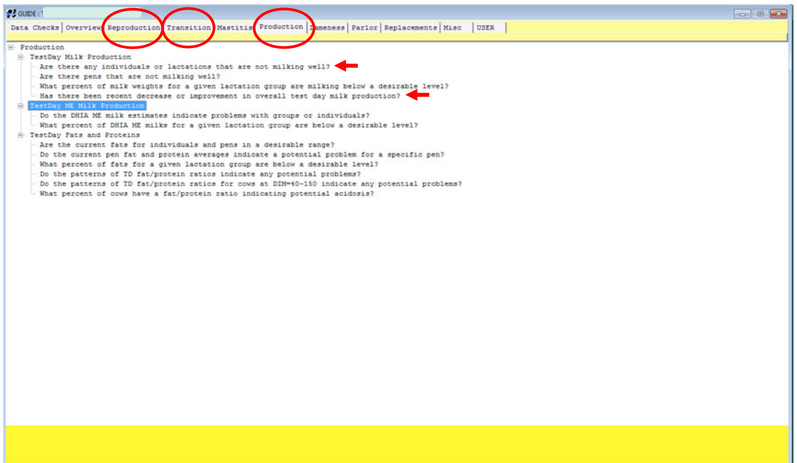
Herd Assessment

Milk production



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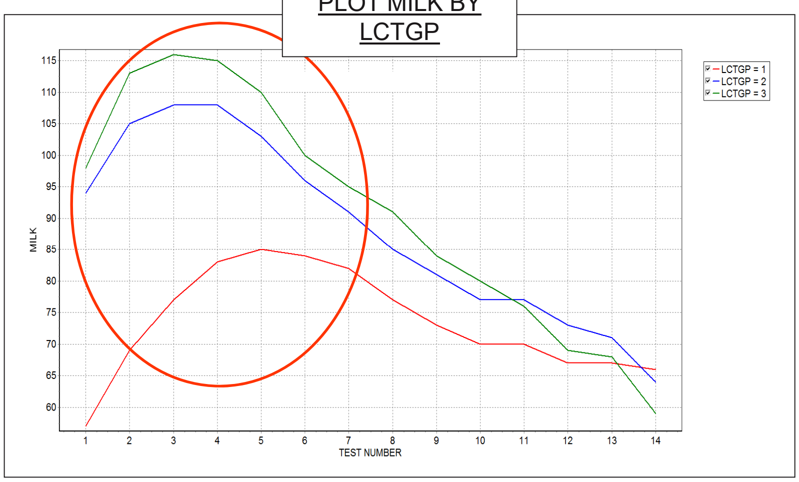
Herd Assessment

Milk production

PLOT MILK BY LCTGP



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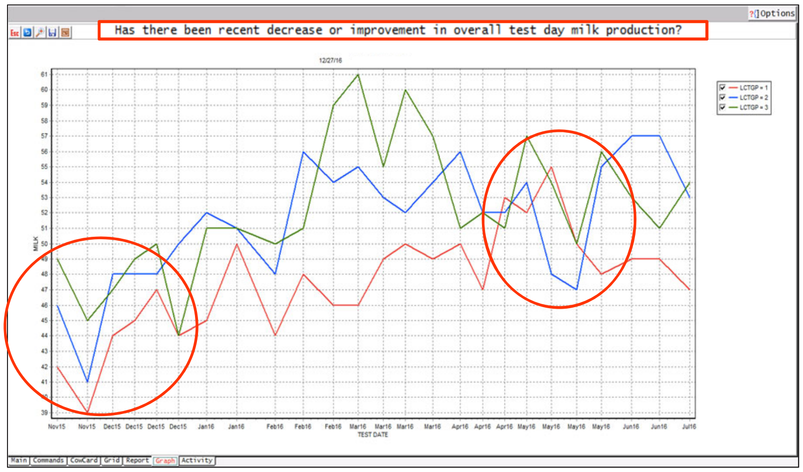
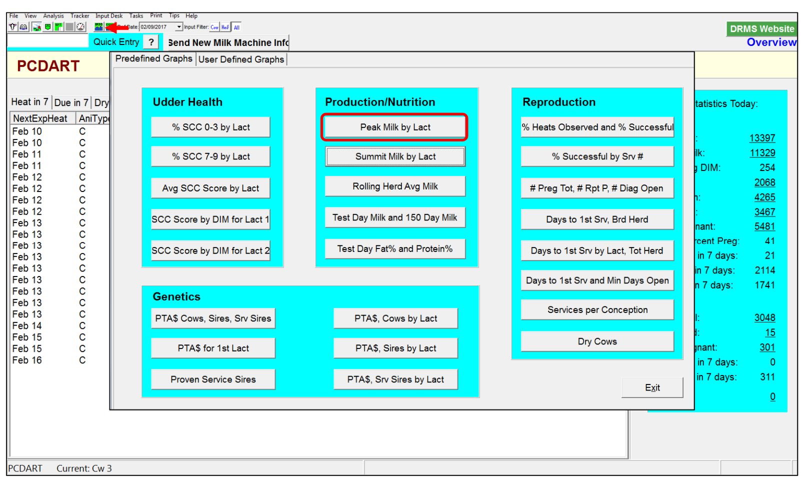
Herd Assessment

Milk production



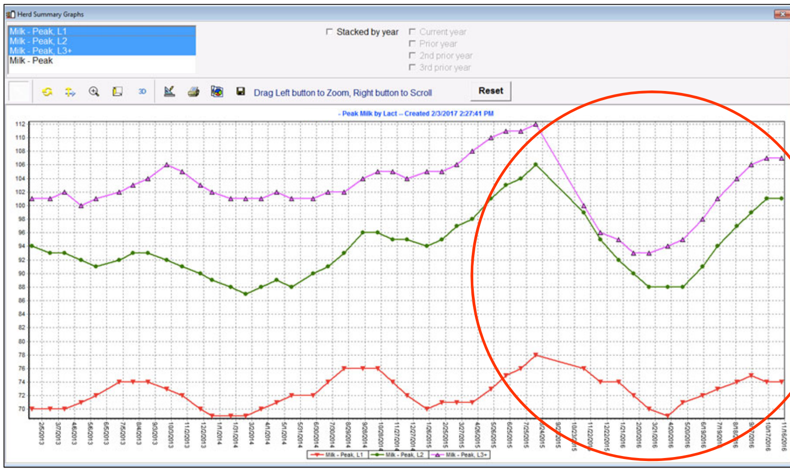
Herd Assessment

Voluntary Waiting Period (PCDART)



Herd Assessment

Milk production (PCDART)



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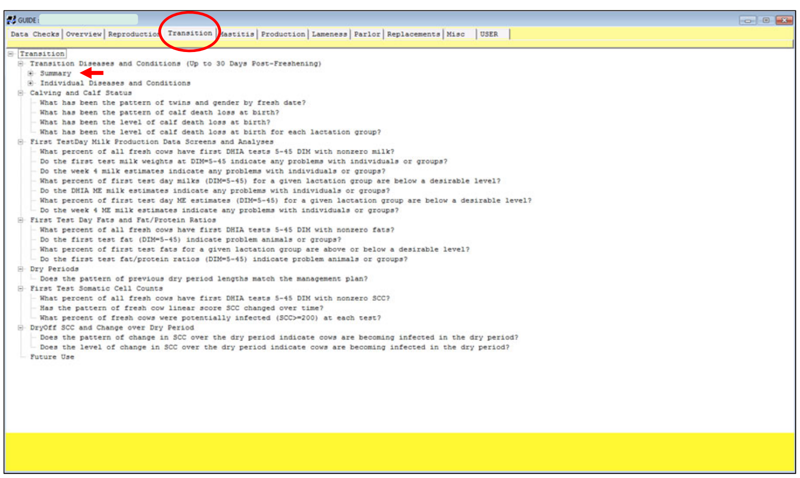
Herd Assessment

Fresh cow diseases



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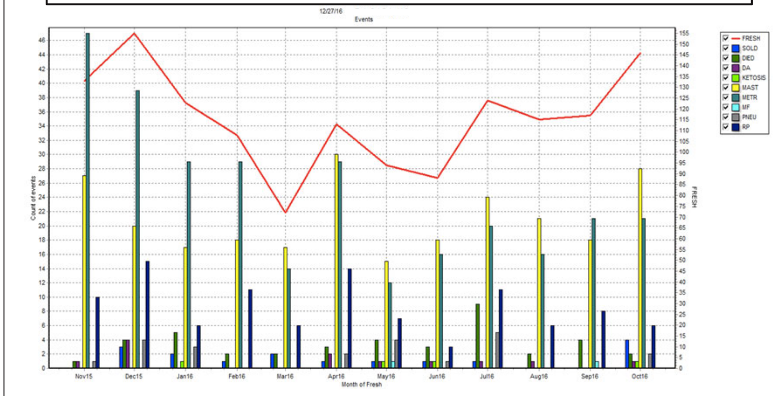
Herd Assessment

Fresh cow diseases

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



Herd Assessment

Fresh cow diseases

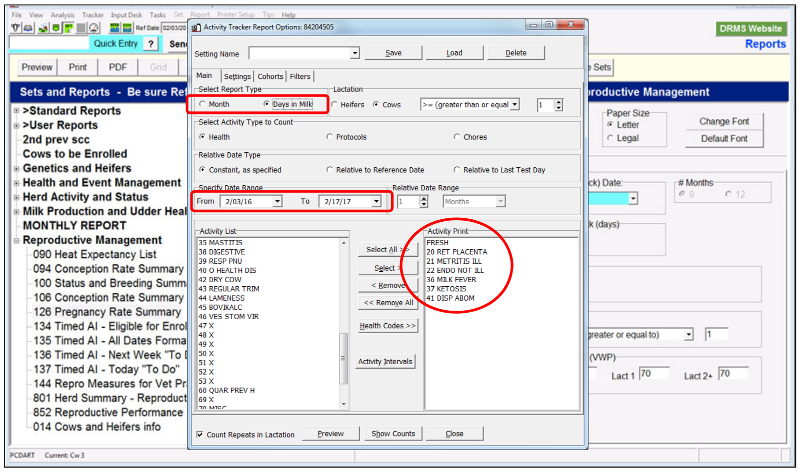
Does the GRAPHIC incidence count of transition cow events indicate a recent problem?

- 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

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

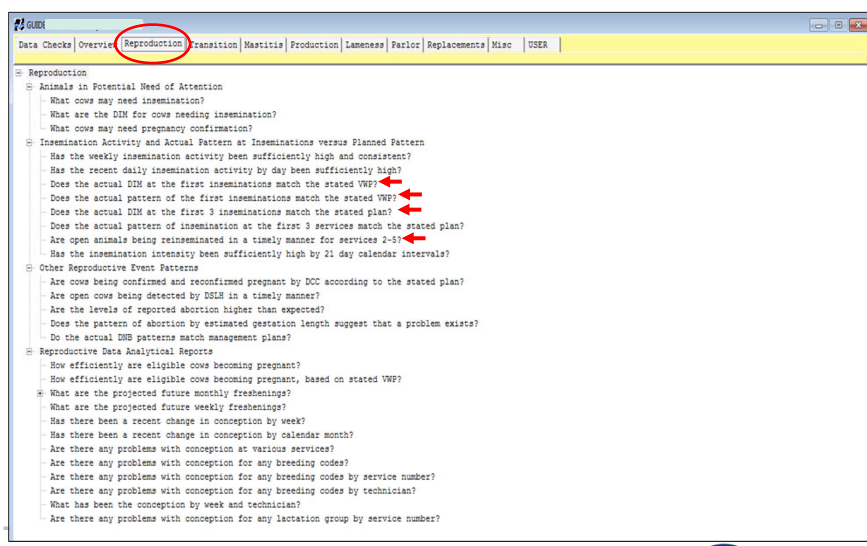
PennState Extension

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

PennState Extension

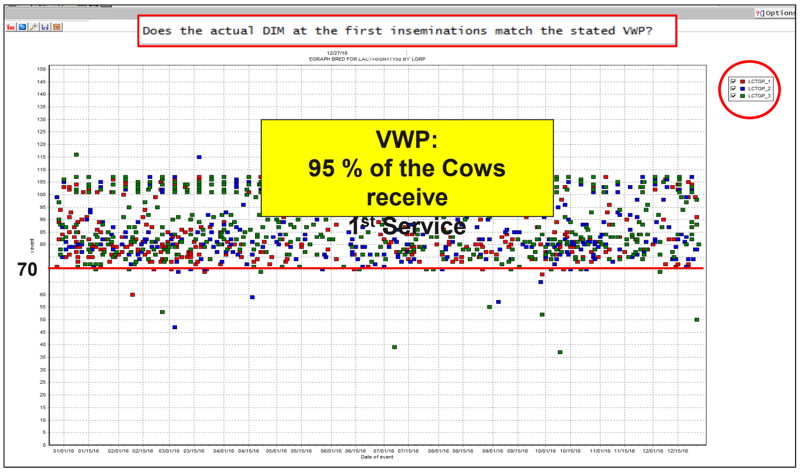
Reproductive Performance



PennState Extension

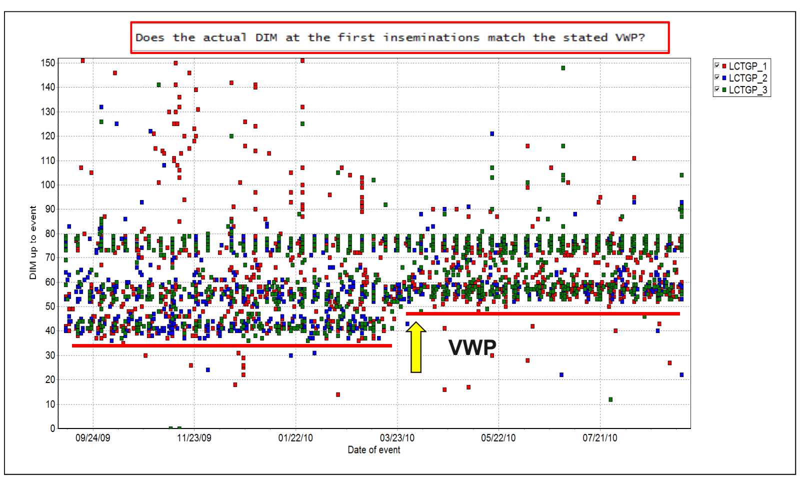
Reproductive Performance

Voluntary waiting period and reproductive program



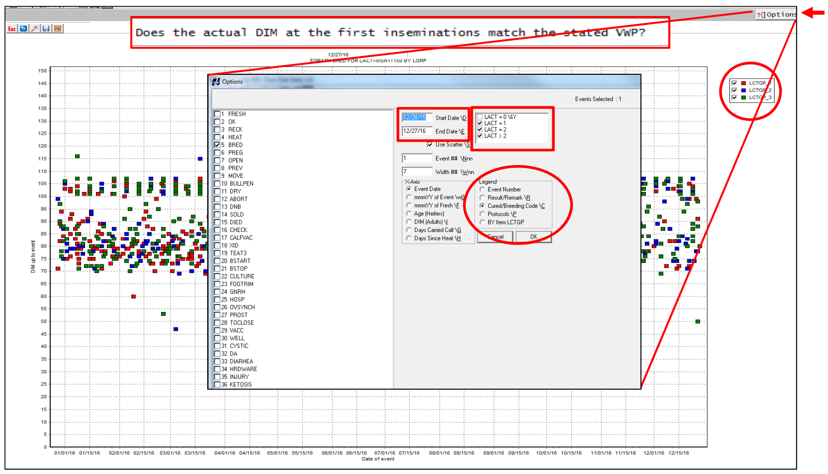
Reproductive Performance

Voluntary waiting period and reproductive program



Reproductive Performance

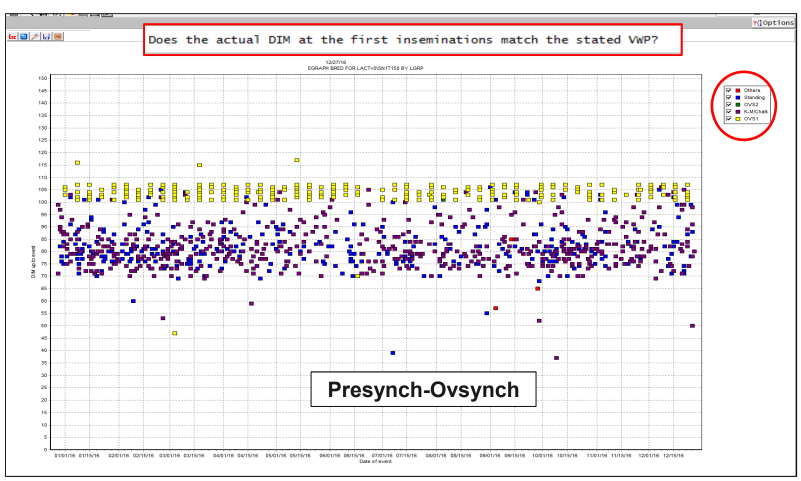
Voluntary waiting period and reproductive program



PennState Extension

Reproductive Performance

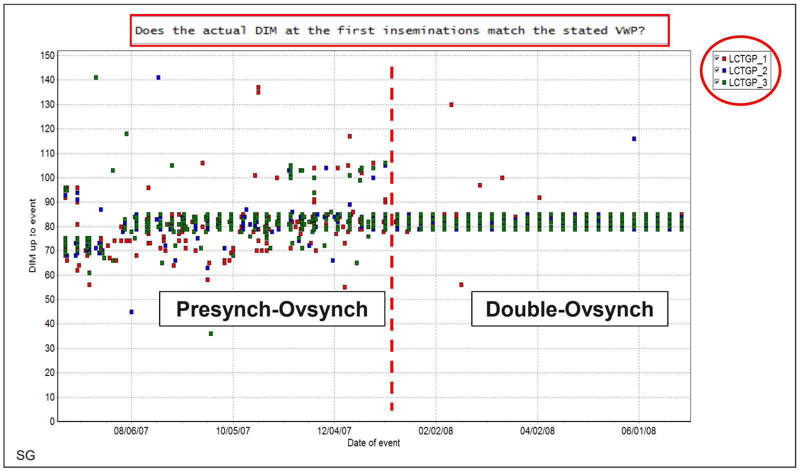
Voluntary waiting period and reproductive program



PennState Extension

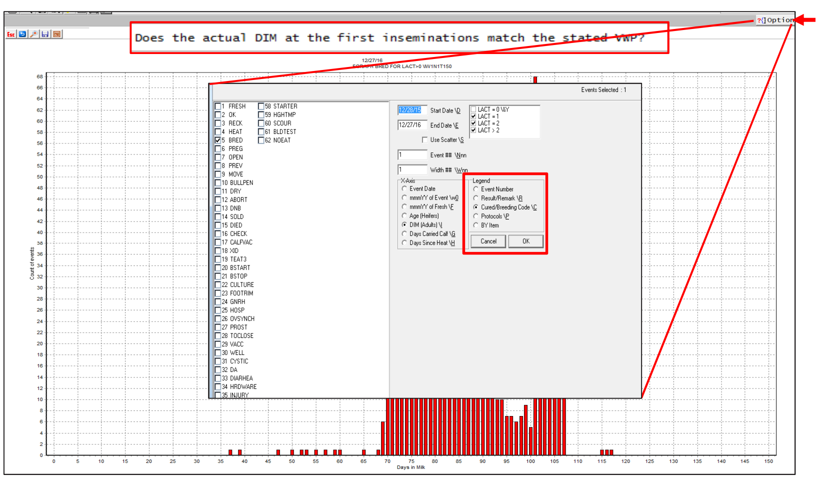
Reproductive Performance

Voluntary waiting period and reproductive program



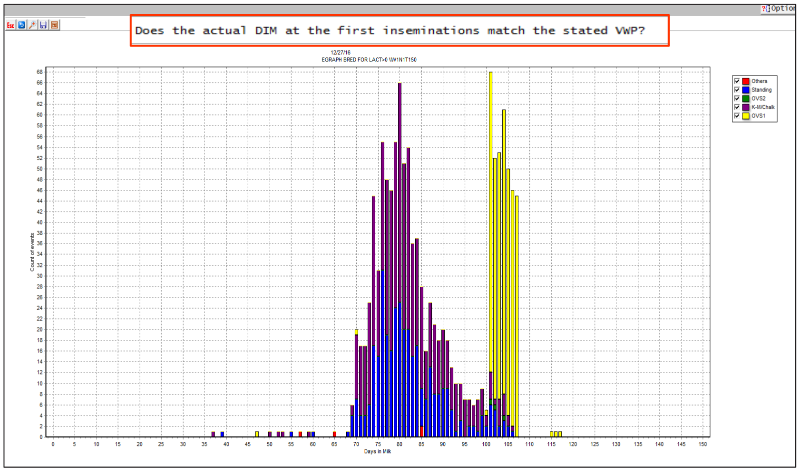
Reproductive Performance

Voluntary waiting period



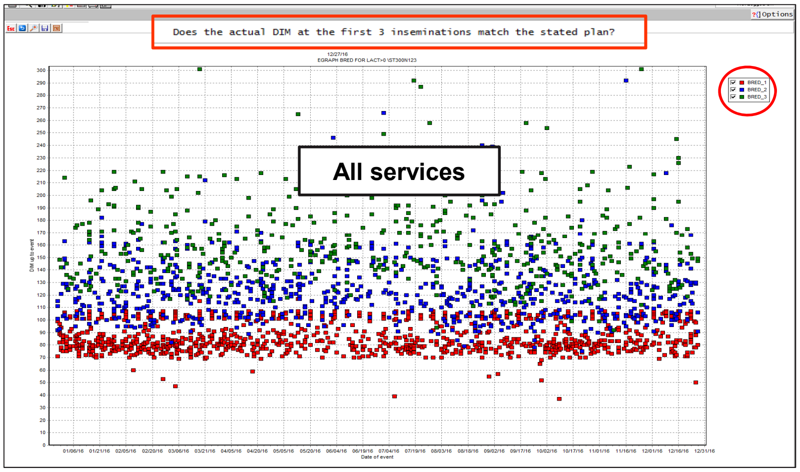
Reproductive Performance

Voluntary waiting period and reproductive program



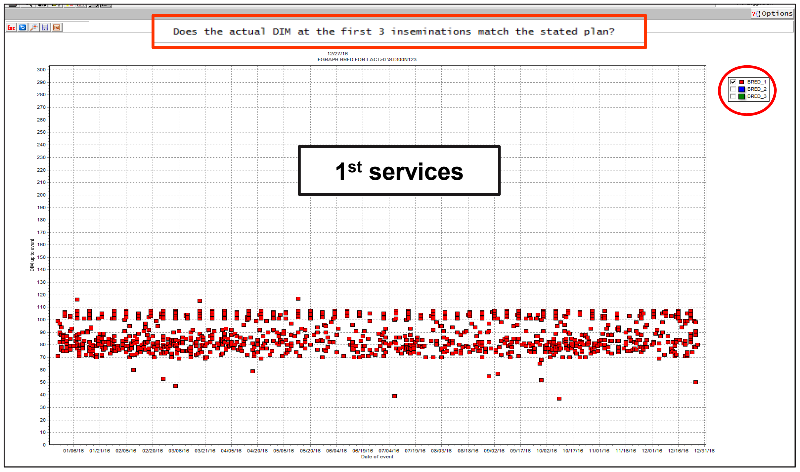
Reproductive Performance

Reproductive program: 1st to 3rd service



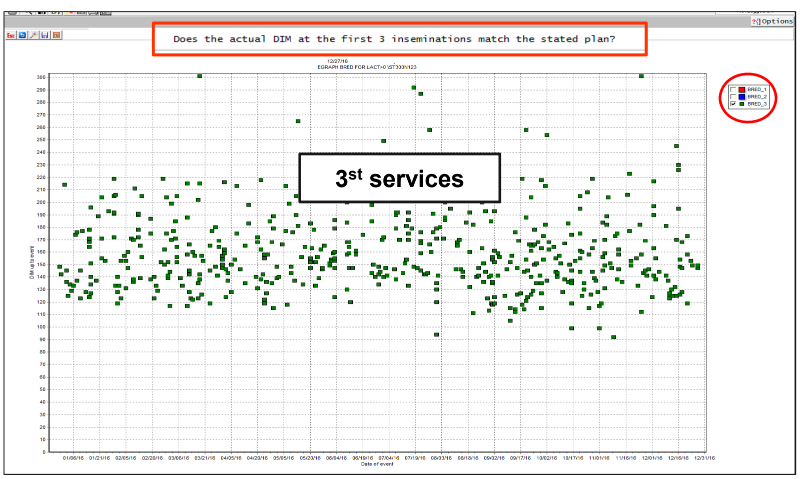
Reproductive Performance

Reproductive program: 1st to 3rd service



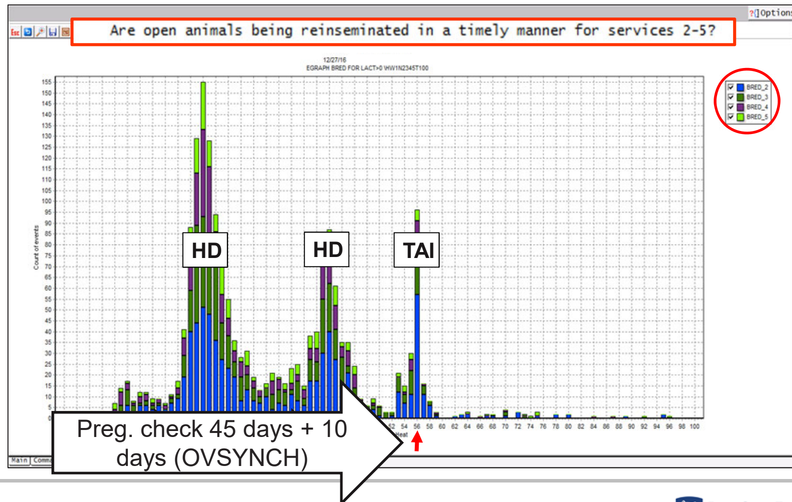
Reproductive Performance

Reproductive program: 1st to 3rd service



Reproductive Performance

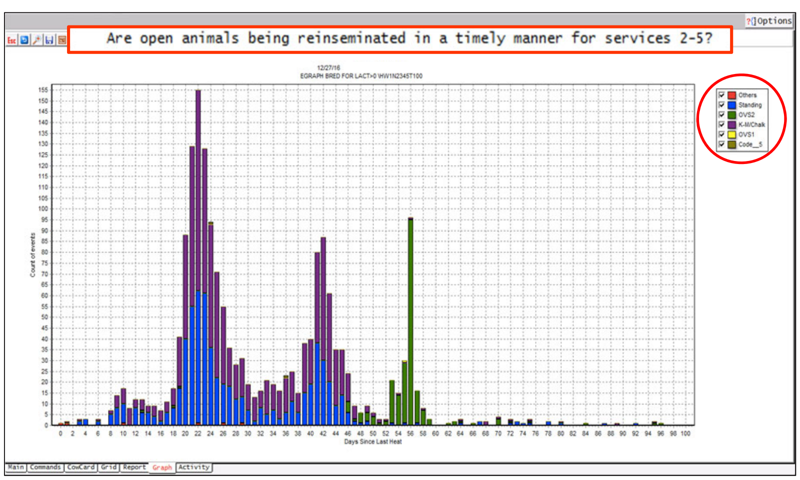
Reproductive program: 2nd and consecutive services



PennState Extension

Reproductive Performance

Reproductive program: 2nd and consecutive services



PennState Extension

Reproductive Performance

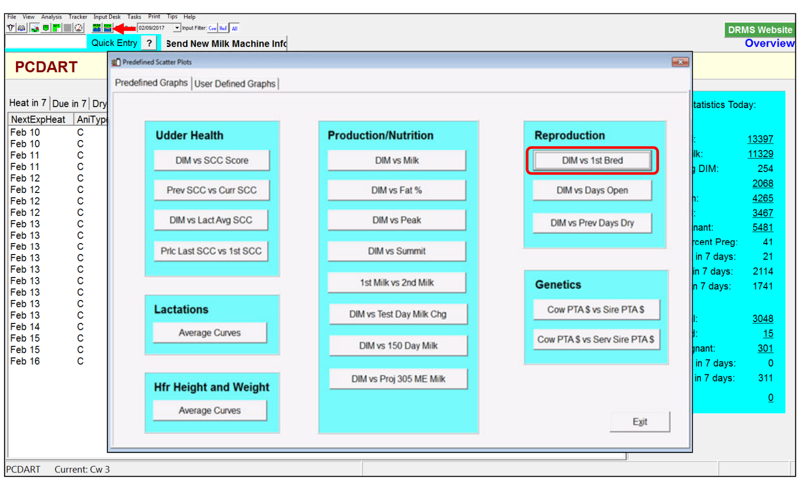
Service Interval

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%

PennState Extension

Reproductive Performance

Voluntary Waiting Period (PCDART)



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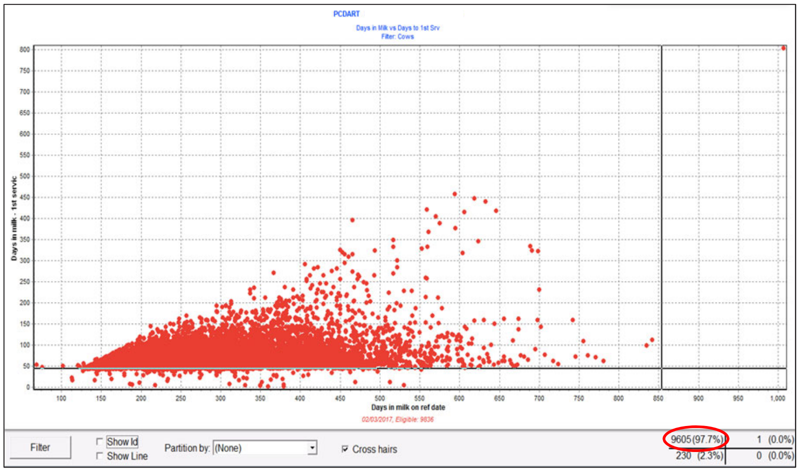
Reproductive Performance

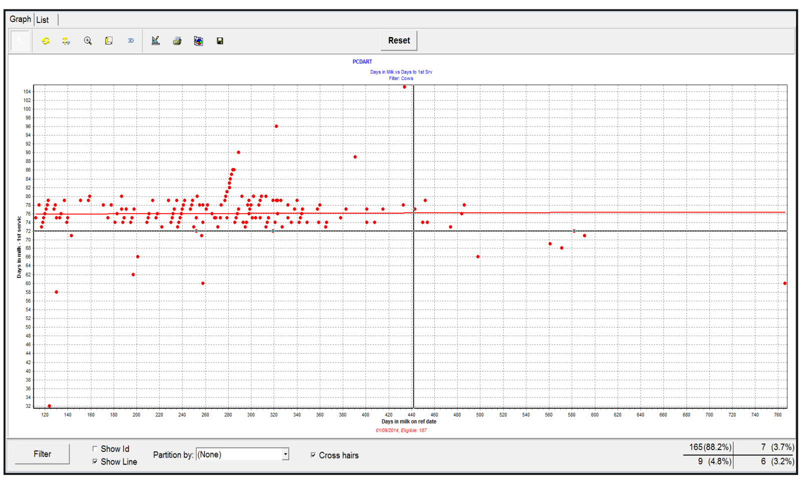
Voluntary Waiting Period (PCDART)



PennState Extension

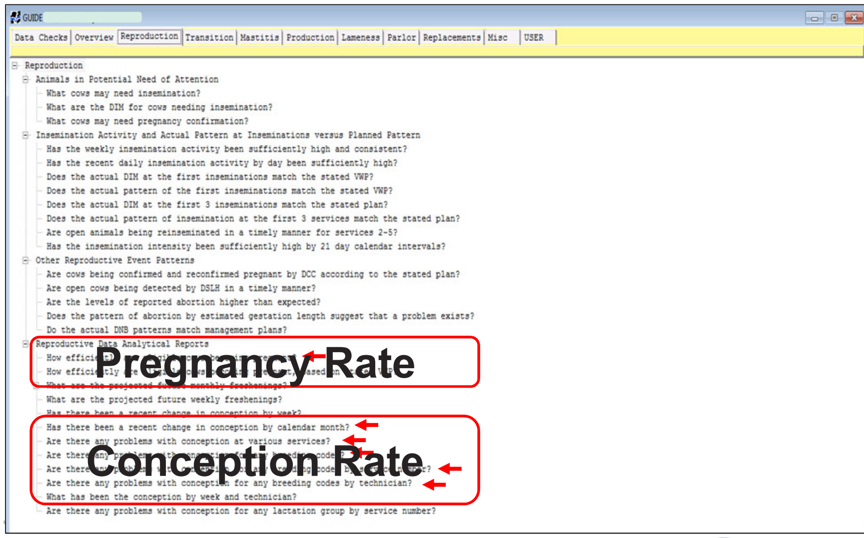
Reproductive Performance

Voluntary Waiting Period and reproductive program (PCDART)



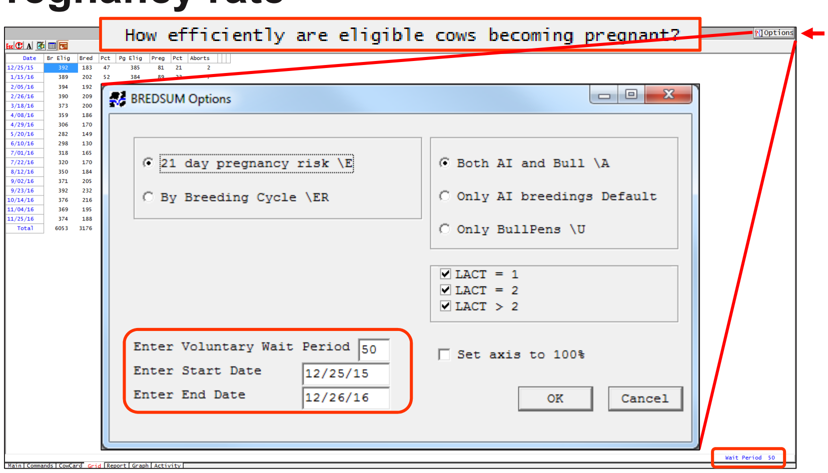
PennState Extension

Reproductive Performance



Reproductive Performance

Pregnancy rate



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?

PennState Extension

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

PennState Extension

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

PennState Extension

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

PennState Extension

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	

PennState Extension

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

PennState Extension

Reproductive Performance

Conception rate by lactation by service number

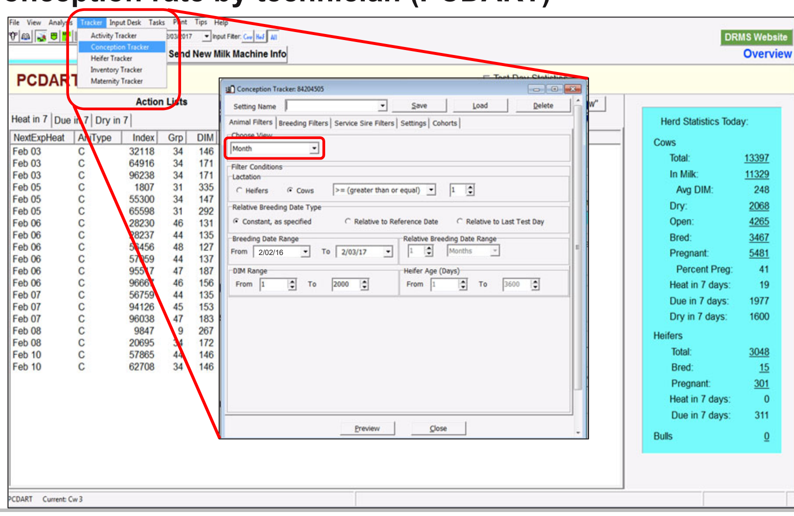
Are there any problems with conception for any lactation group by service number?

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

PennState Extension

Reproductive Performance

Conception rate by technician (PCDART)



PennState Extension

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

PennState Extension

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

PennState Extension

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

PennState Extension

Reproductive Performance

Conception rate by service number (PCDART)

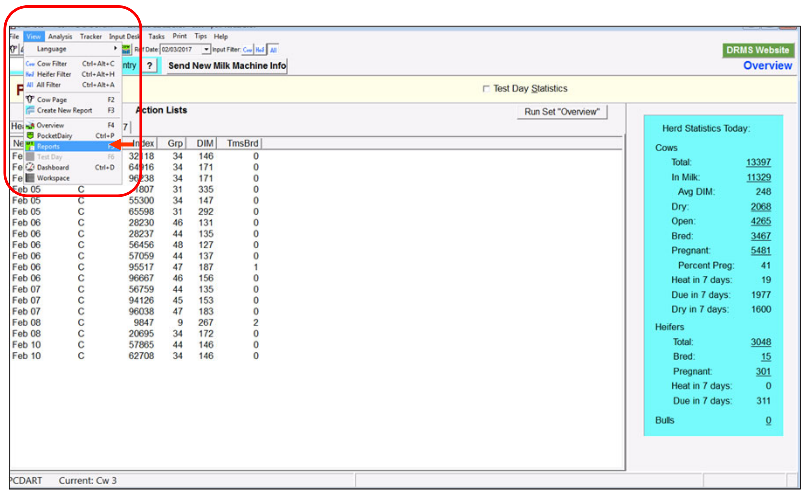
Choose Another View: Service Number | Change View | About

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

PennState Extension

Reproductive Performance

Conception rate by technician (PCDART)



PennState Extension

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: Number from VWP to 100 days	Not Bred or Diag. Open: Number over 100 days	Not Bred or Diag. Open: Number Diag. Open	Bred But Not Diag. Preg.: Number Open fewer than VWP	Bred But Not Diag. Preg.: Number Open VWP to 100 days	Bred But Not Diag. Preg.: Number Open 101 to 130 days	Bred But Not Diag. Preg.: 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: Number Fewer than VWP	Days Open at 1st Service: Number from VWP to 100 days	Days Open at 1st Service: Number over 100 days	Avg. Days to 1st service	Services per Pregnancy: Preg. Cows	Services per Pregnancy: All Cows	Projected Minimum: Calving Interval	Projected Minimum: 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

Service Interval

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

Conception Rate by Service #

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	

Conception Rate and Service Rate

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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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
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PennState Extension

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Thank you

PennState Extension

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

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

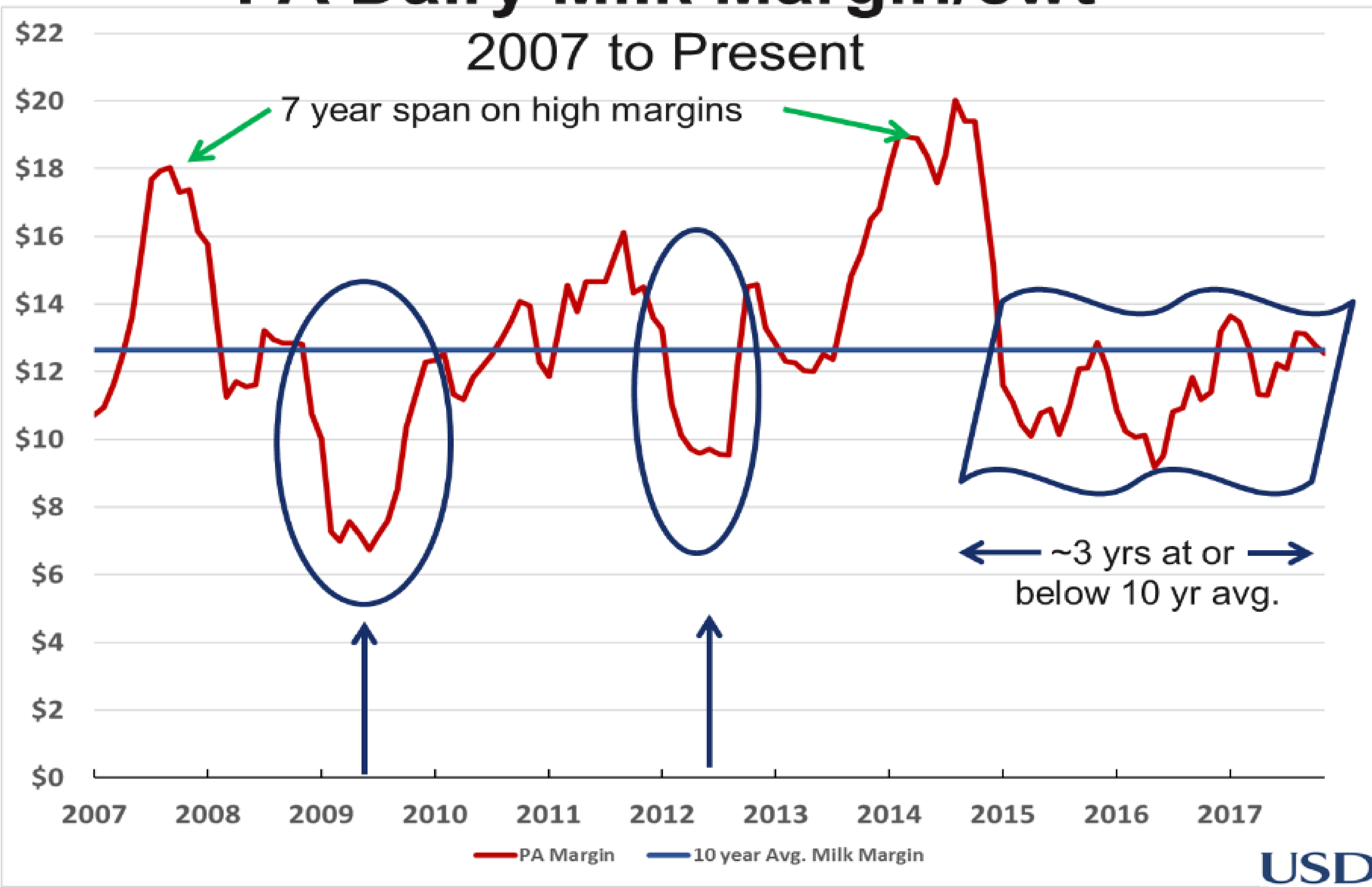
Project supported in part by:

NORTHEAST SARE Sustainable Agriculture Research & Education

USDA Risk Management Agency (RMA)

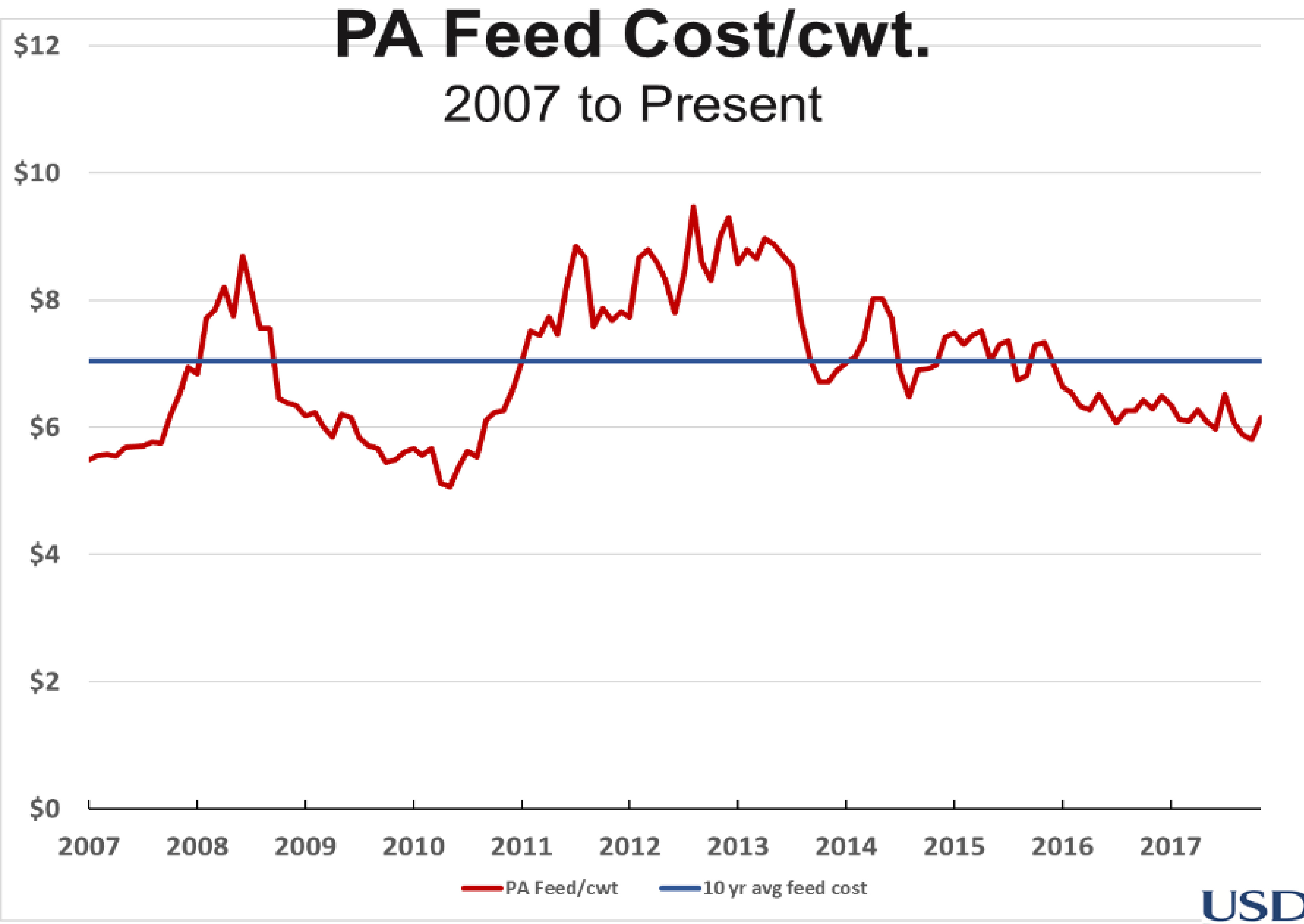
PA Dairy Milk Margin/cwt

2007 to Present



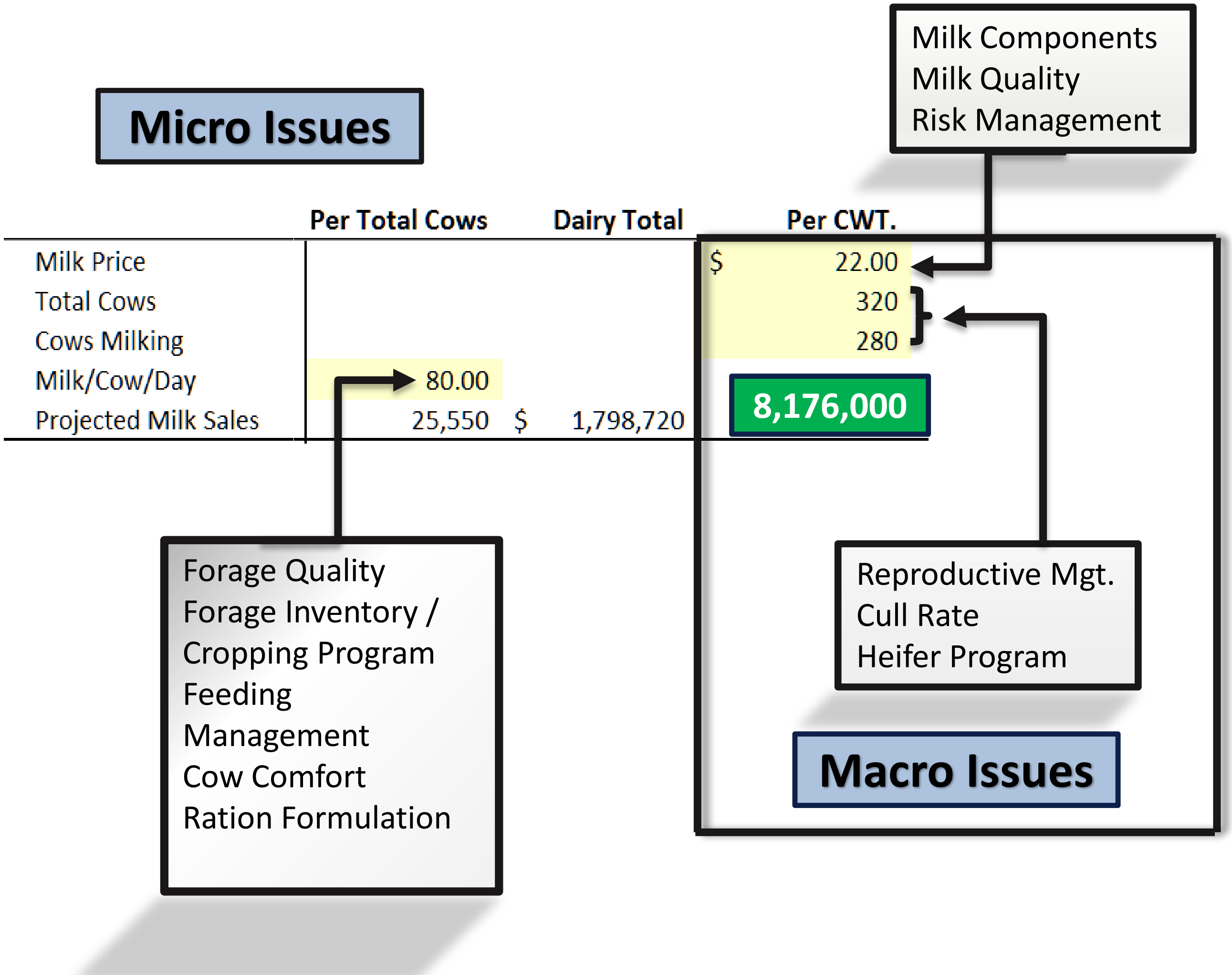
Source: Penn State Extension Dairy Outlook, Jan. 2018

USDA

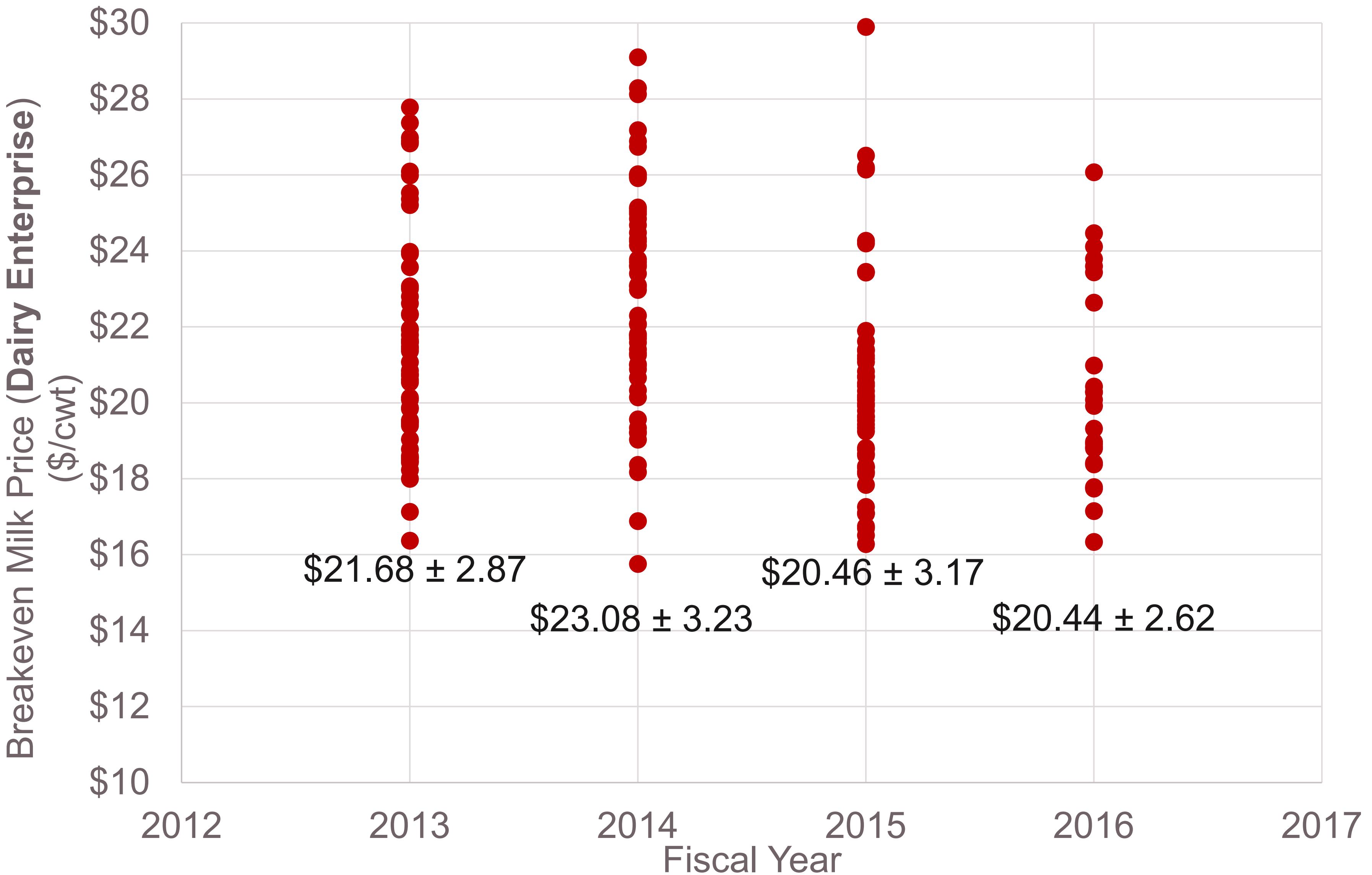


Source: Penn State Extension Dairy Outlook, Jan. 2018

Cash Flow “Mechanics”



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

RankEm®University of Minnesota

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

Assi Size	Per CWT	B 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

PennState Extension

10/29/18

Clear Form

Determining milk income needed

	Dairy Enterprise Only*		
Number of milking cows	125		

*Do not include custom work or other farm income

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**		

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*			
Number of milking cows	270			
Expenses:			Farm Total	Dairy Enterprise Percentage
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**			

*Do not include custom work or other farm income

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)

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

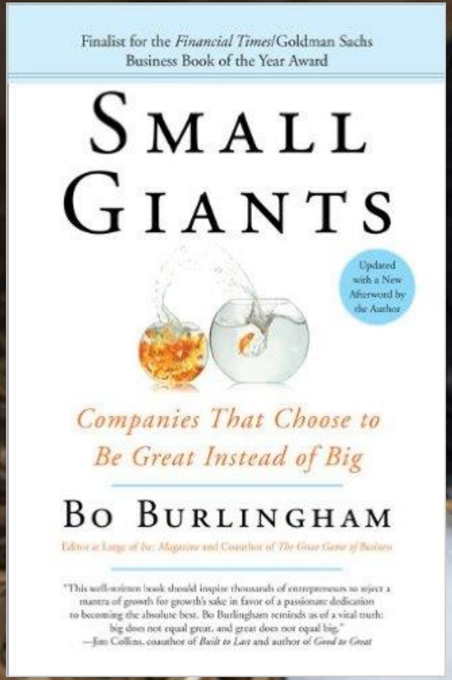
Herd management with feeding management

Income and expenses

Assets

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

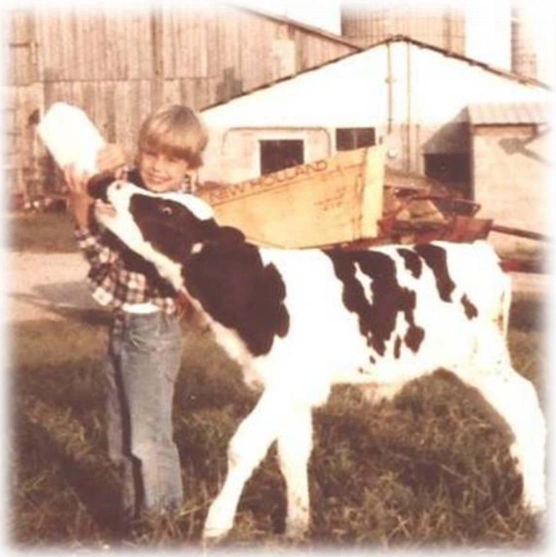
Small Giants: Strategies for Small Farm Competitiveness

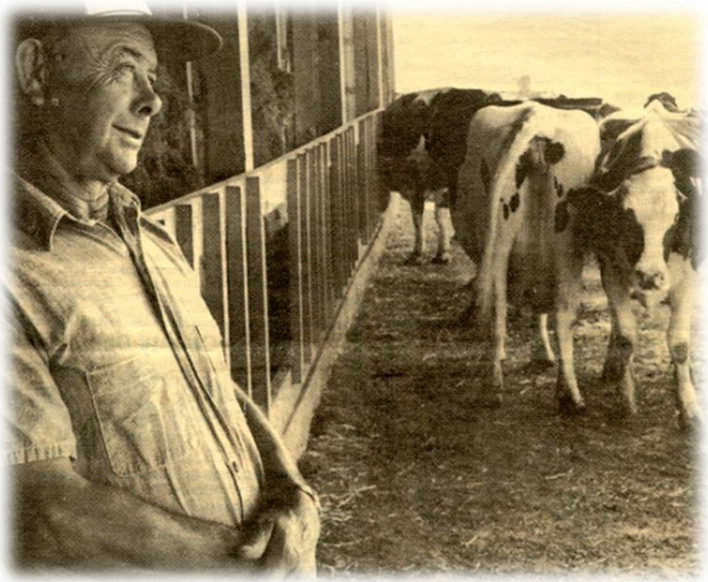


Jeffrey Bewley, PhD

Alltech®

I Come From a Small Farm





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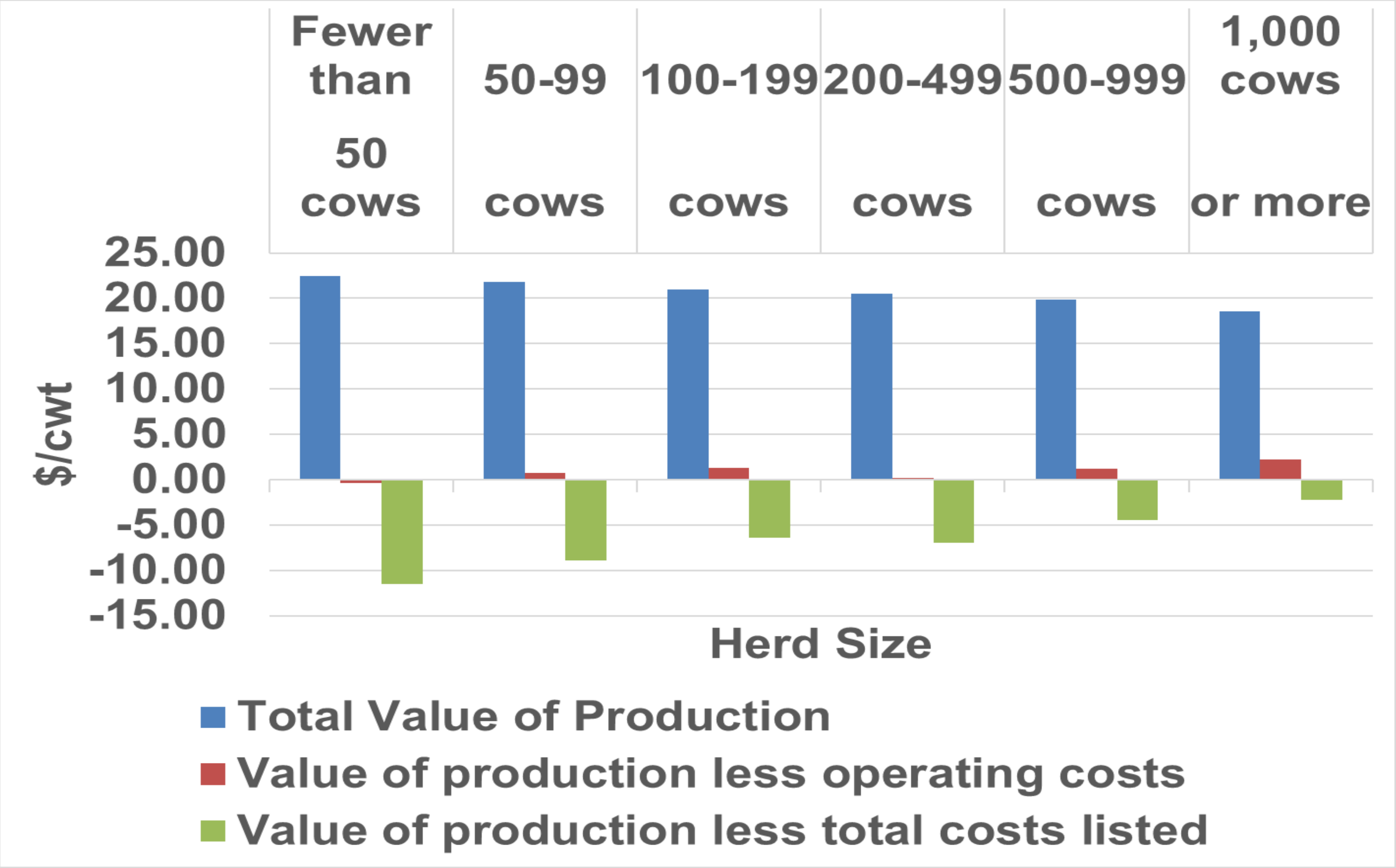
I Understand the Realities



USDA ERS, 2015

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

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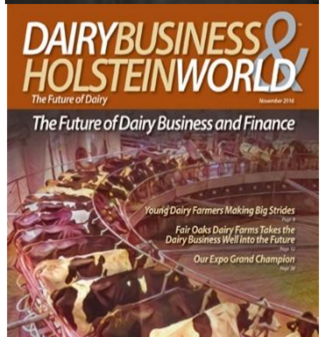
Read More than Just Dairy



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

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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

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

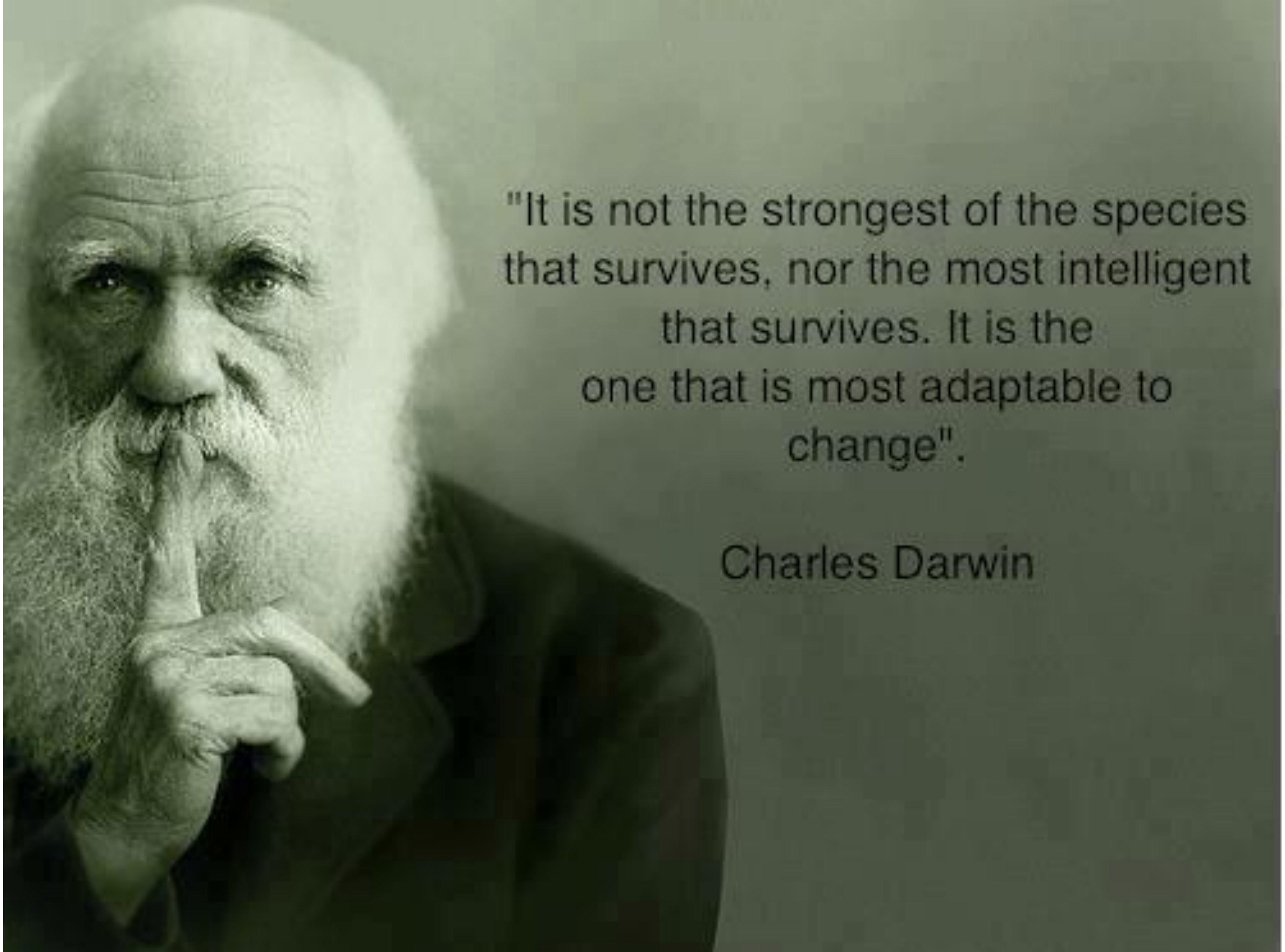
Darnhofer, 2009

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

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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

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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

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	Costs
Increased revenue	Decreased revenue
+ Decreased costs	+ Increased Costs
=	=
Total benefit	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

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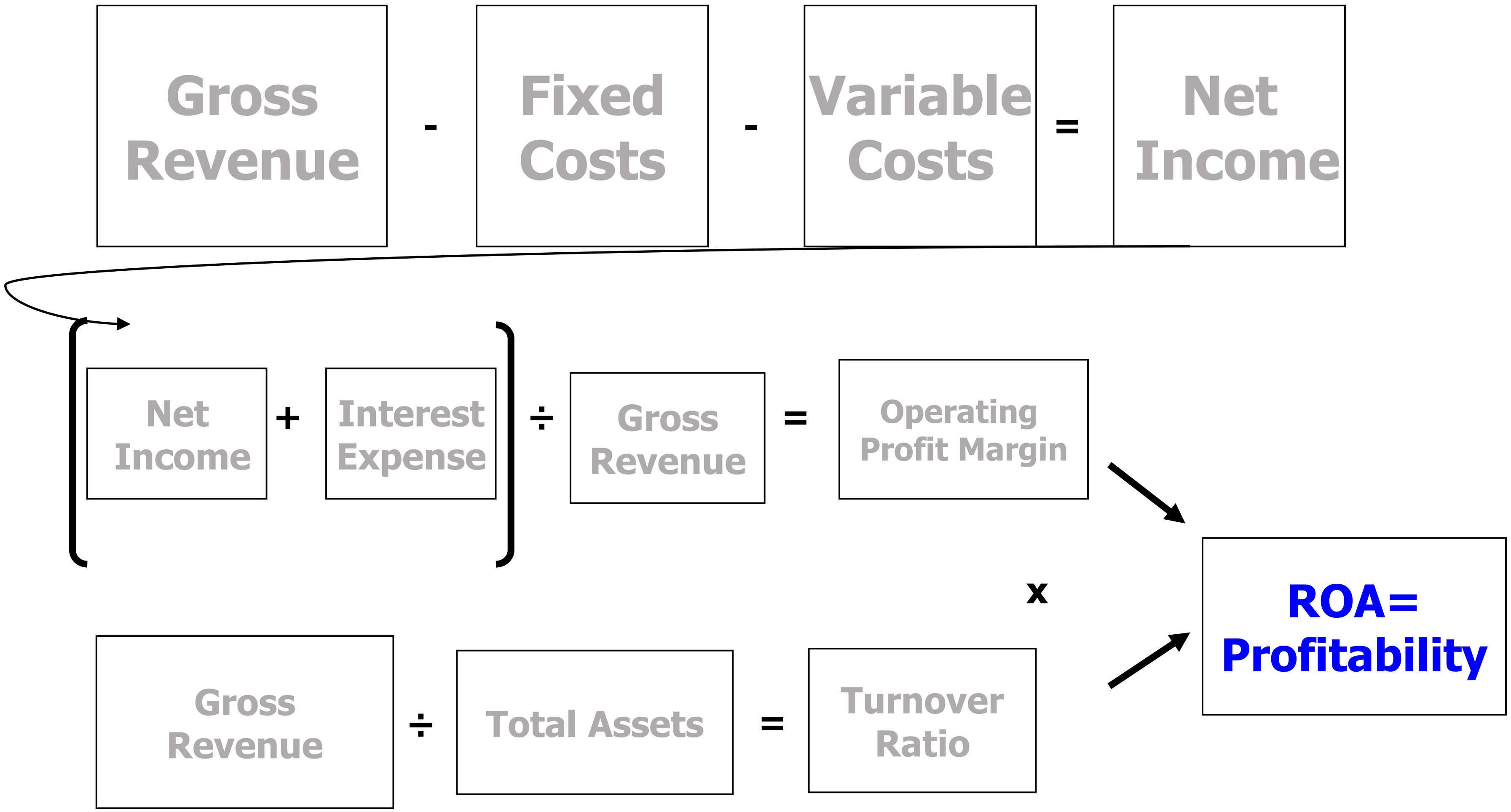
Agriculture has Low Margins

- 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



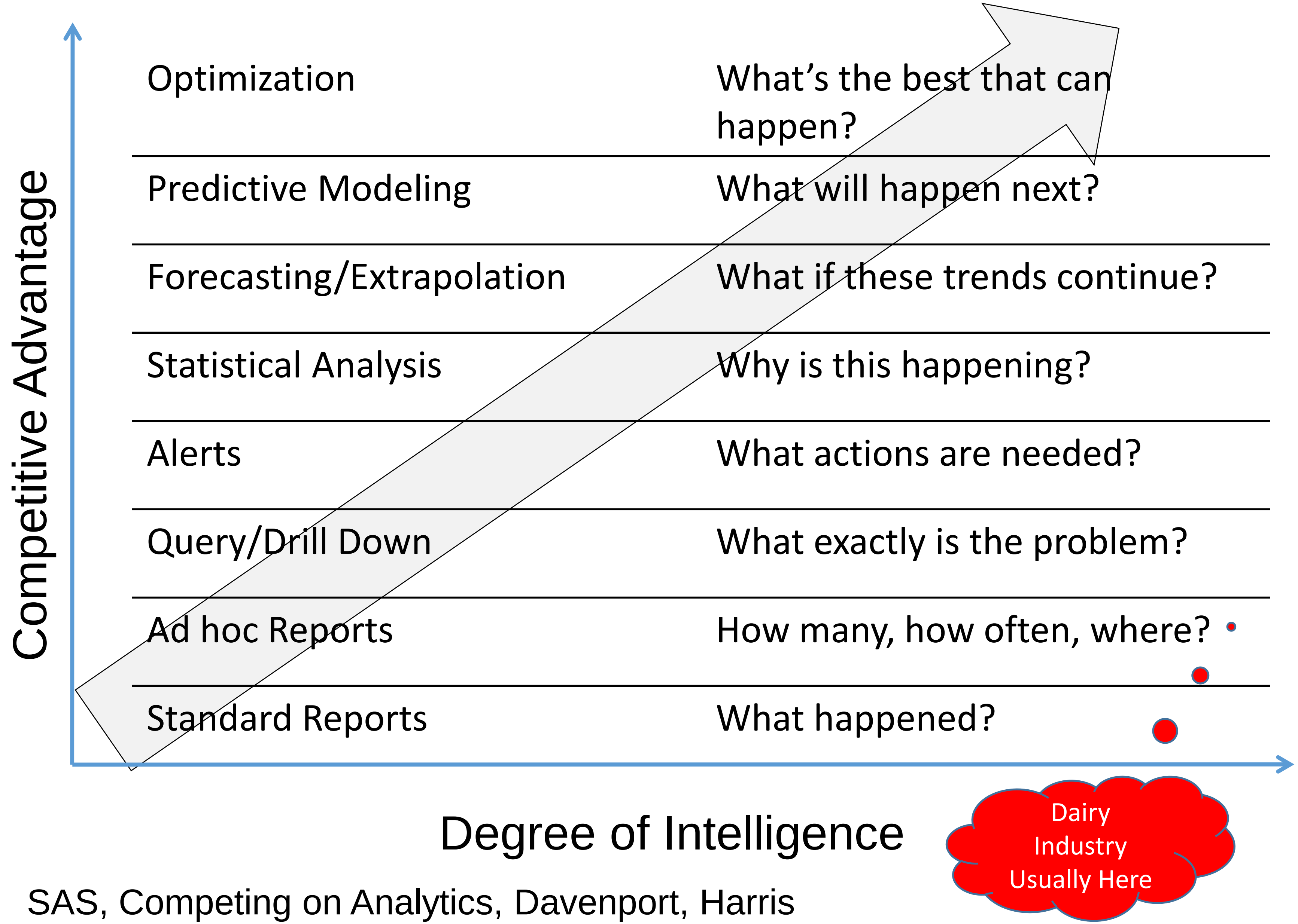
Revenues or Costs?

- 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



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

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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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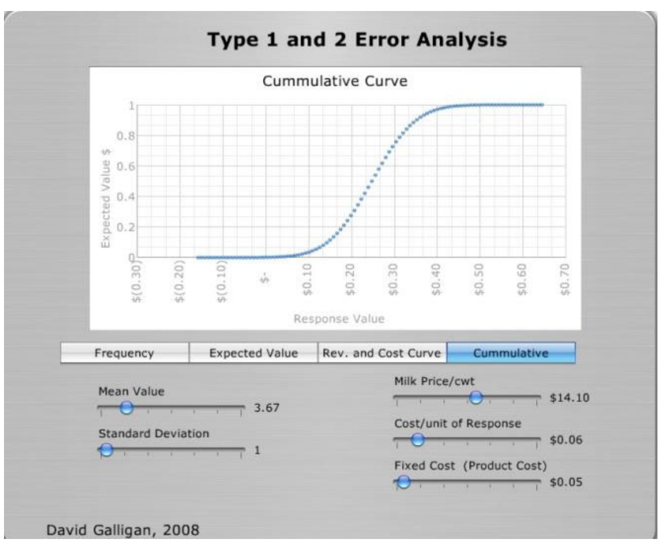
Risk of less than break even < .6%



Dr. Dave Galligan

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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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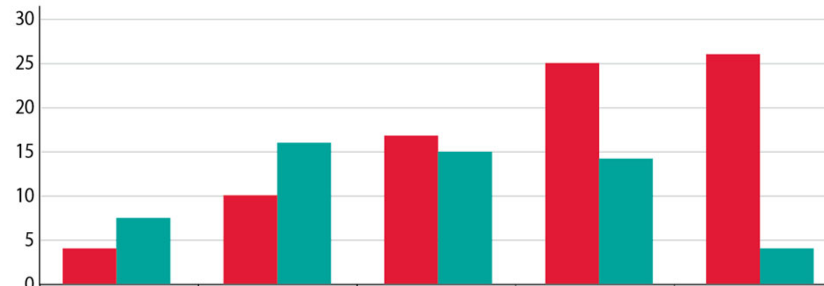
Effect of NutriTek® on New Mastitis Cases



	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

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Clinical case defined…

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

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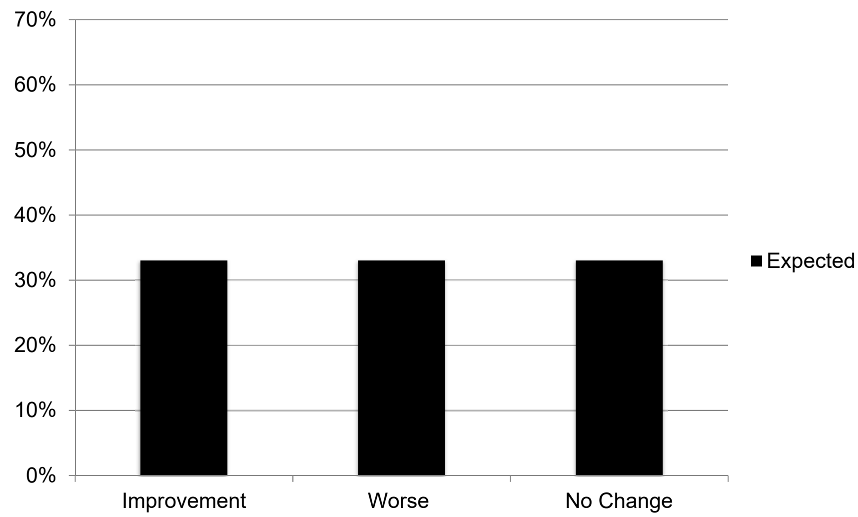
Biology would predict….



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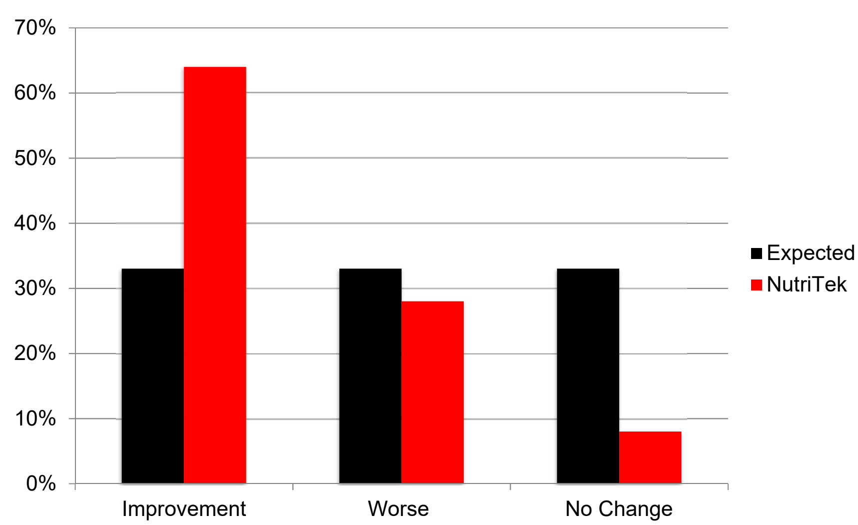
LS changes….



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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

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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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DAIRY

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

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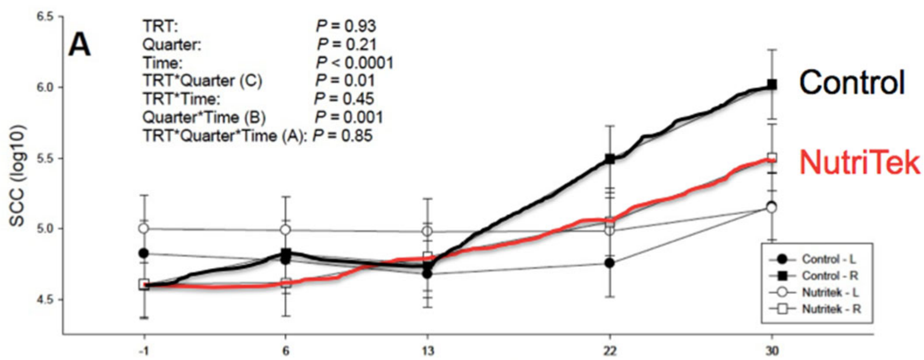
Streptococcus uberis challenge on SCC



Loor, University of Illinois, preliminary report

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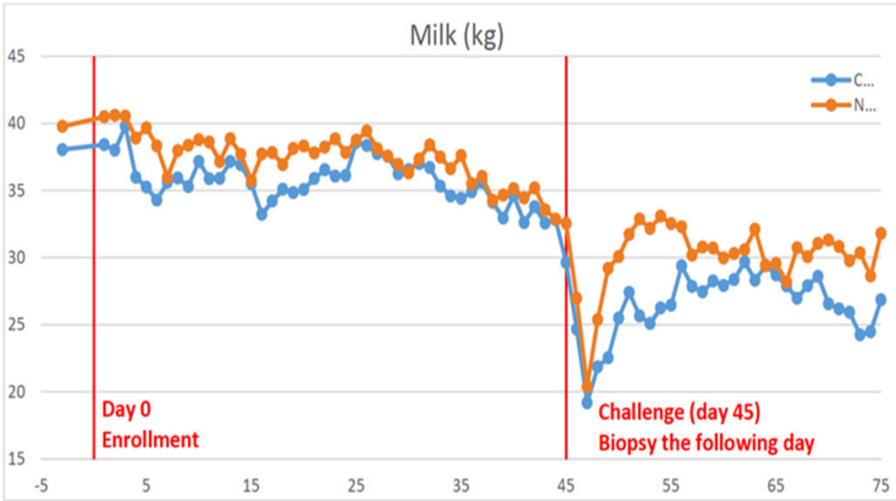
Milk Production



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

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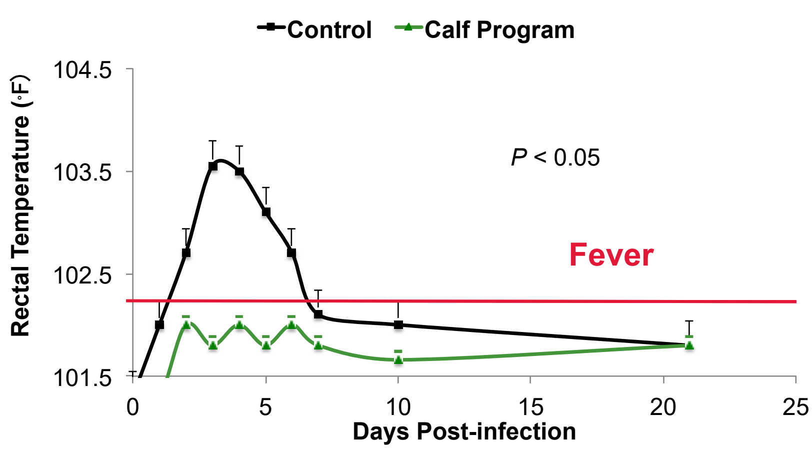
Amelioration of Salmonellosis in Pre-weaned Dairy Calves using Diamond V Calf Program

- 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.

Immunity: Reduced Severity/Duration



Brewer et al., 2014

HEALTH OUTCOMES

MODE OF ACTION – WHY DOES IT WORK?

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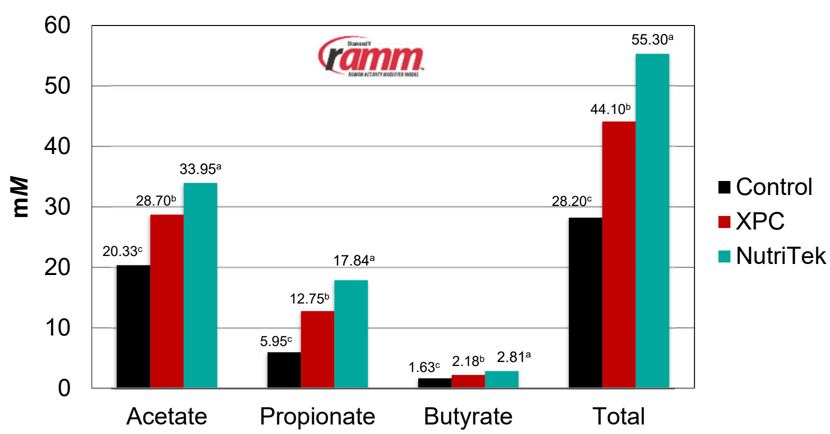
VFA Production (RIC)



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

Diamond V Research & Innovation Center, 2014. LA090

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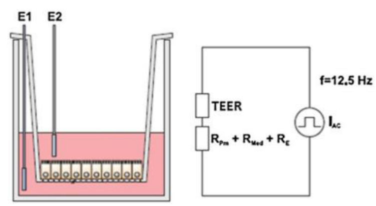
Gut Permeability (RIC)

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



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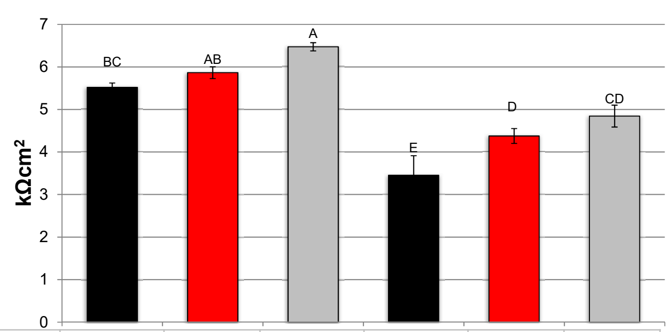
NutriTek Protects Gut Integrity (RIC)

TEER



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

Greater resistance = Less permeable

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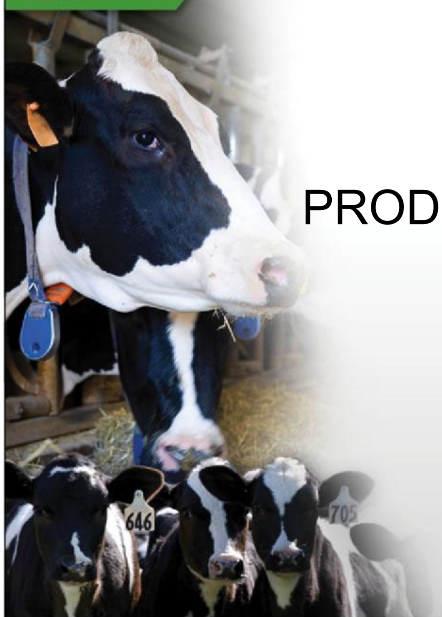
DAIRY



PRODUCTION

FIELD TRIALS

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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)

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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**

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Performance Under Heat Stress

Pacific Northwest NutriTek Controlled Trial

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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

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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

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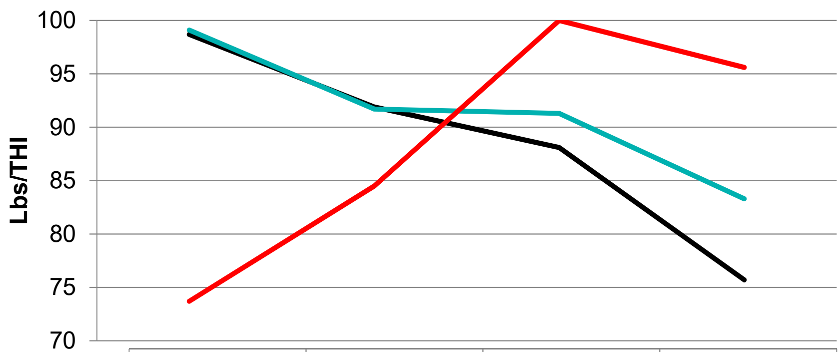
Energy Corrected Milk (ECM) lbs & Temperature-Humidity Index[1](THI)



	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

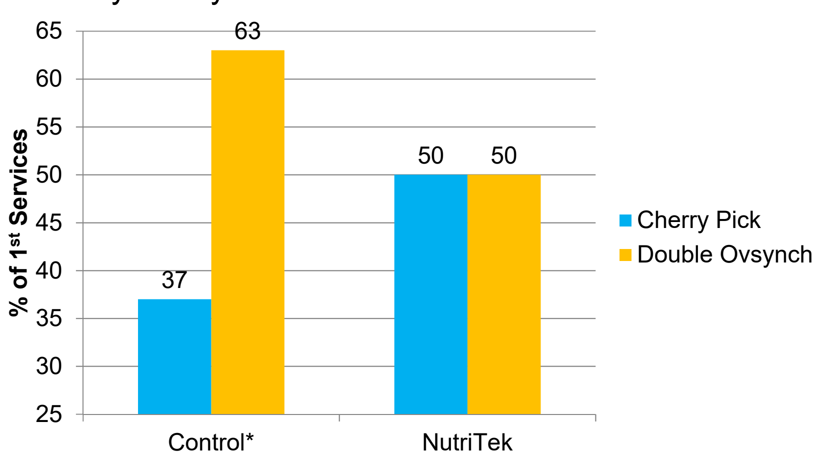
* 14 g/d of Original XPC™ + 56 g/d of OmniGen AF®

[1]High daily temperature used for calculation

39 Diamond V

Reproduction: 1st Service Breedings

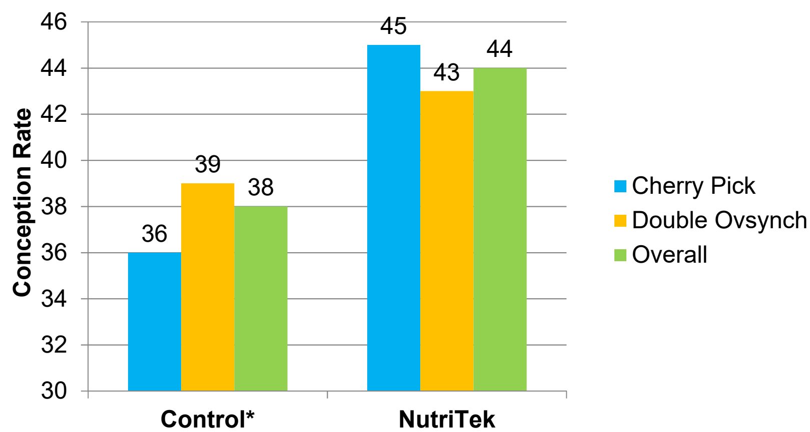
50% of NutriTek cows expressed estrus to 1st Ovsynch Cycle vs. 37% of Control cows



40 * 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®

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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.

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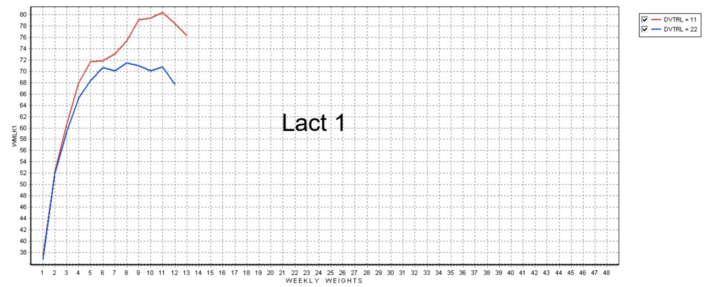
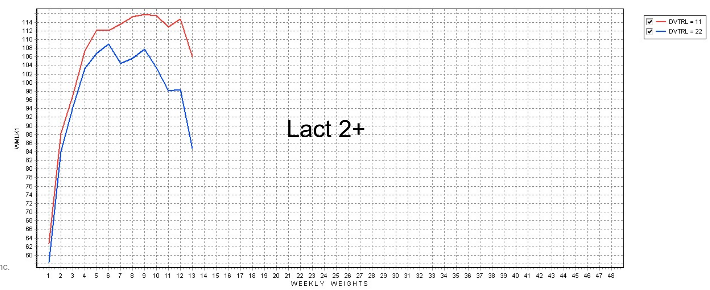
Robot Dairy Field Trial Sneak Peak: Cows exposed to NutriTek starting the day of calving





43 © Diamond V, Inc.

nd V

PRODUCTION OUTCOMES

RUMINANT – JOURNAL PUBLISHED

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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%

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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

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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
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)

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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

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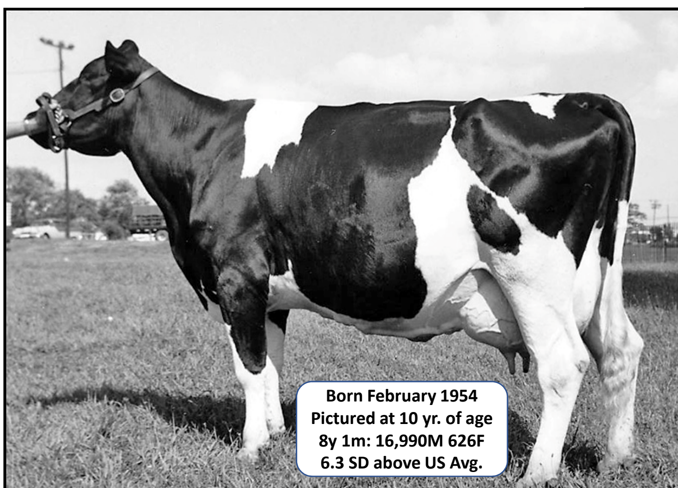
DIAMOND V
Life Stage Solutions™

Diamond V®
The Trusted Experts In Nutrition & Health®

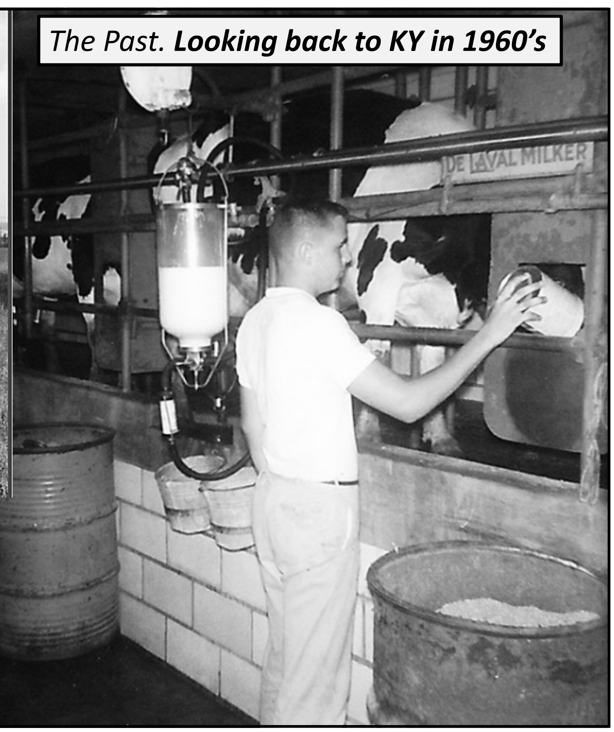
The Dairy Cow and Dairy Farm in 50 Years

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

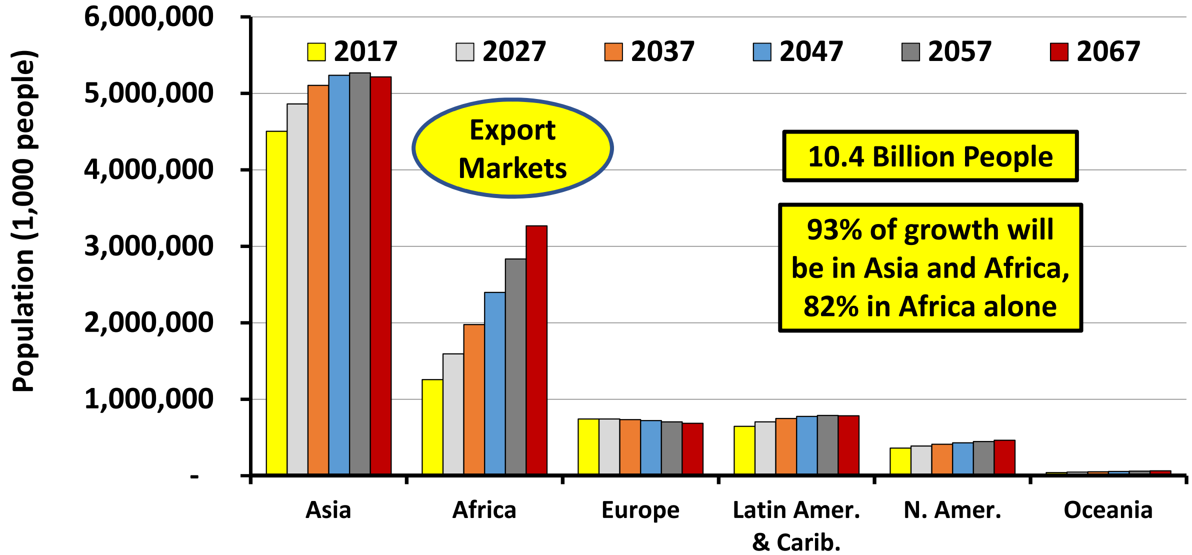
Expert Forecasters: Mike Hutjens, IL; Gordie Jones, WI; Jeff Stevenson, KS; Pam Ruegg, MI; Chad Dechow, PA; George Seidel, CO; Bob Cushman, NB; Tony McNeel, MI; Hilary Dobson, UK; Martin Sheldon, UK; Patrice Humblot; SE



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

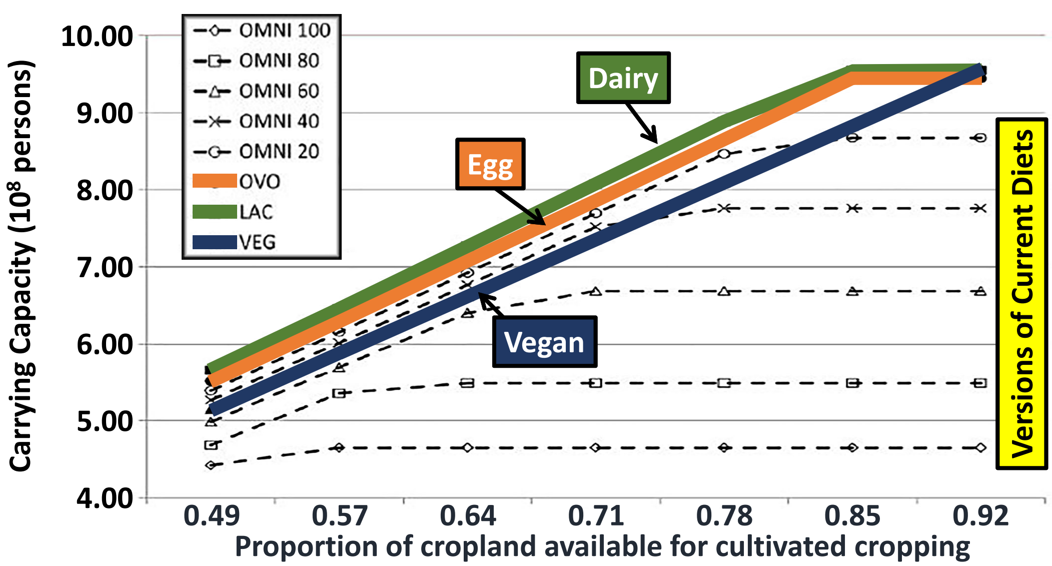


Forecasts. ***Growth of population will be in Africa and Asia***



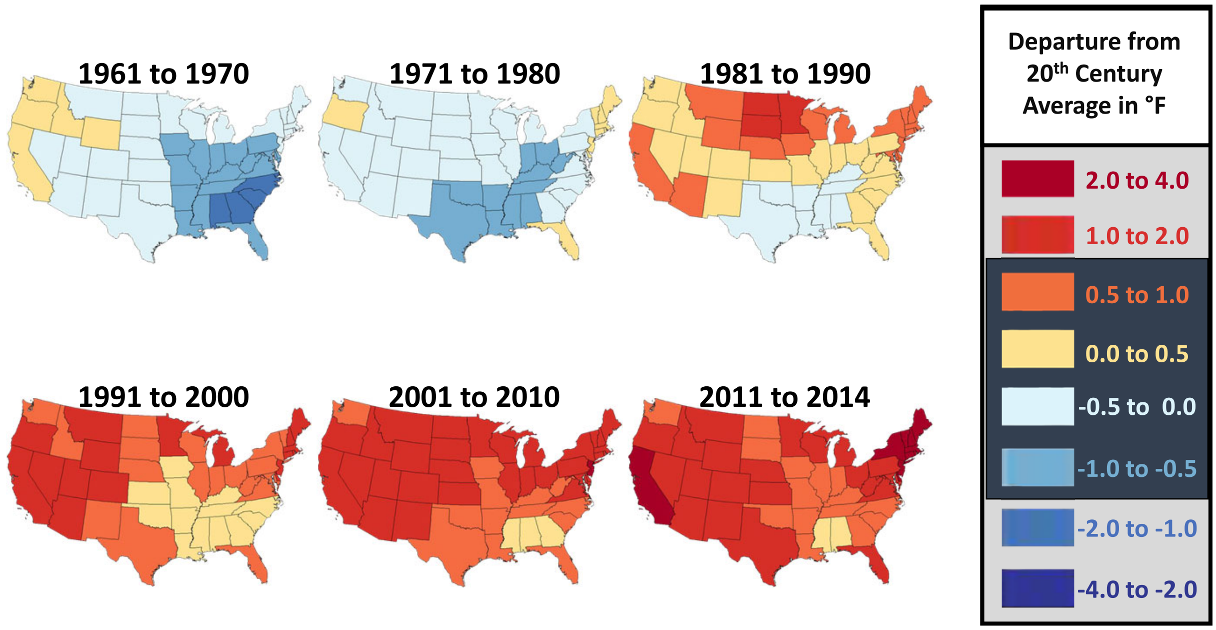
Britt et al. 2018. J. Dairy Sc. 101 (5): 3722-3741. Data source: FAOSTAT 2017.

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

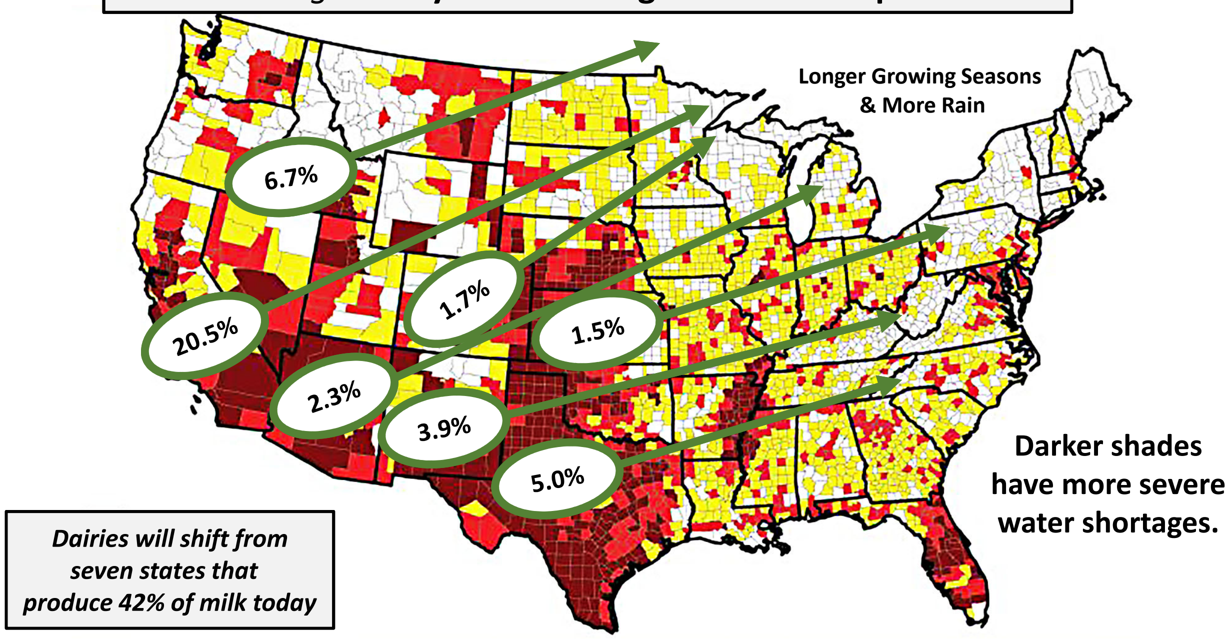


Peters, Christian J., Jamie Picardy, Amelia F. Darrouzet-Nardi, Jennifer L. Wilkins, Timothy S. Griffin, Gary W. Fick. 2016.
Carrying capacity of U.S. agricultural land: Ten diet scenarios. Elementa: Science of the Anthropocene • 4: 000116 • doi: 10.12952/journal.elementa.000116

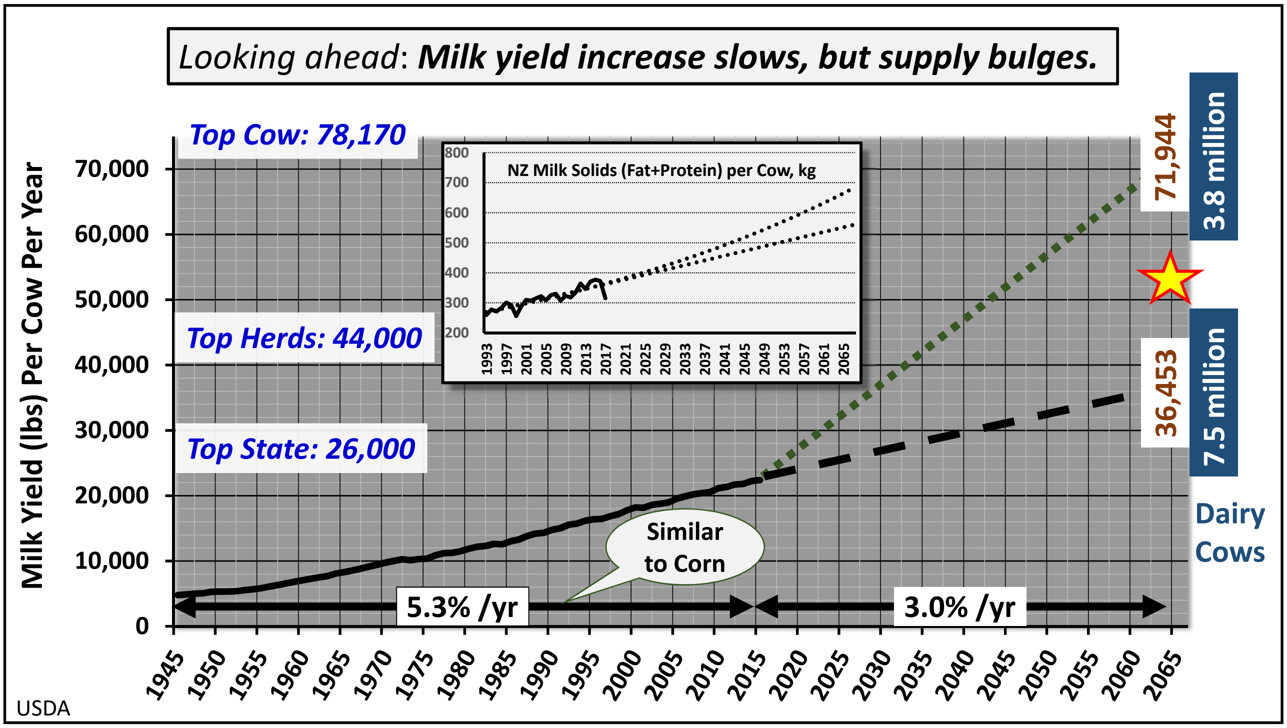
Climate change. ***USA temperature trending <u>above average</u> for 4 decades***

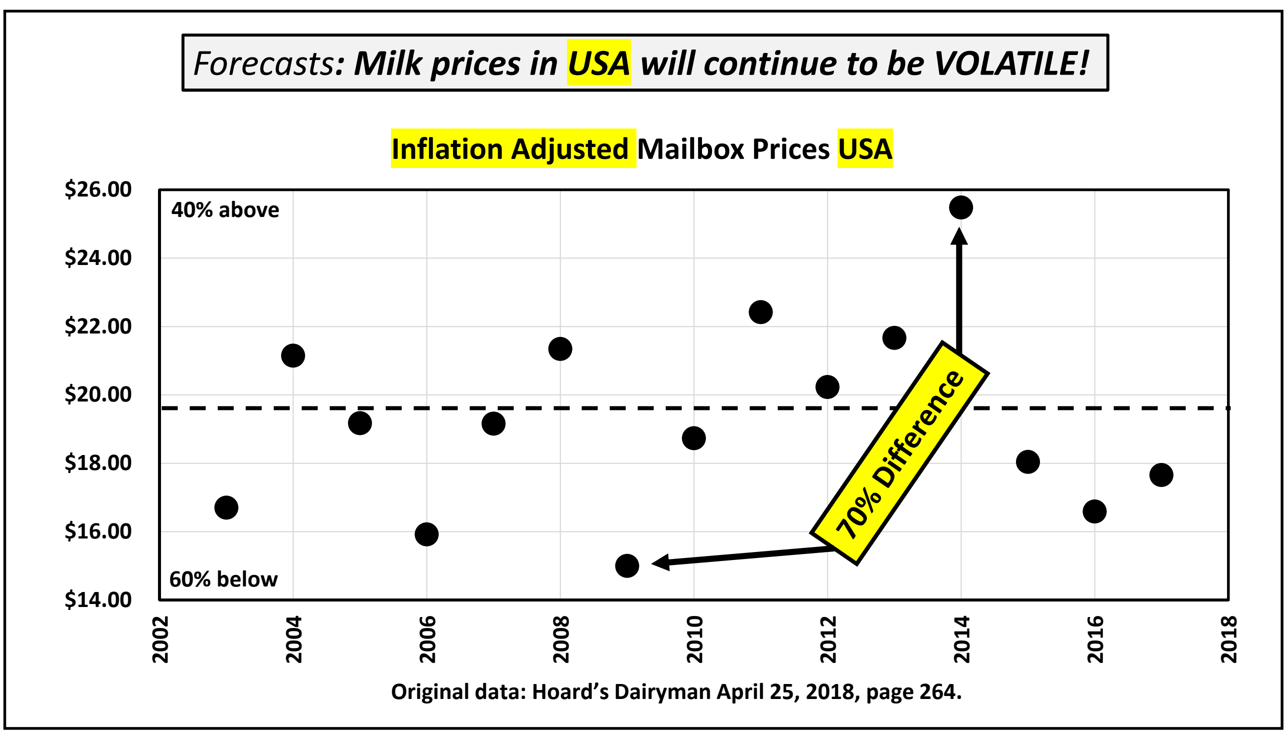


Climate change. **Dairy moves to regions with adequate water**

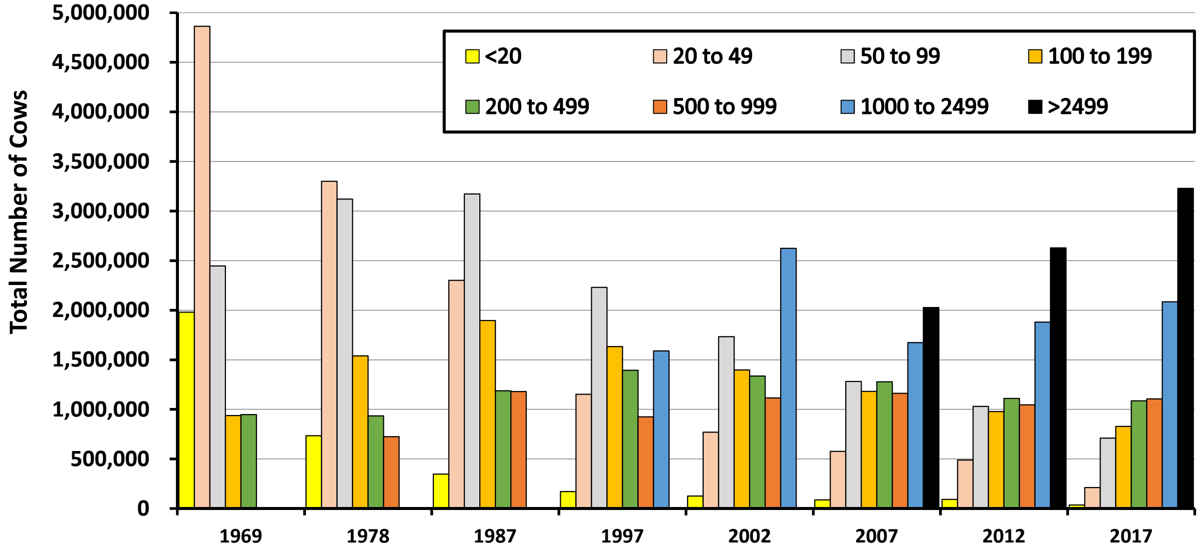


Climate Change, Water, and Risk: Current Water Demands Are Not Sustainable www.nrdc.org/globalWarming/watersustainability


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

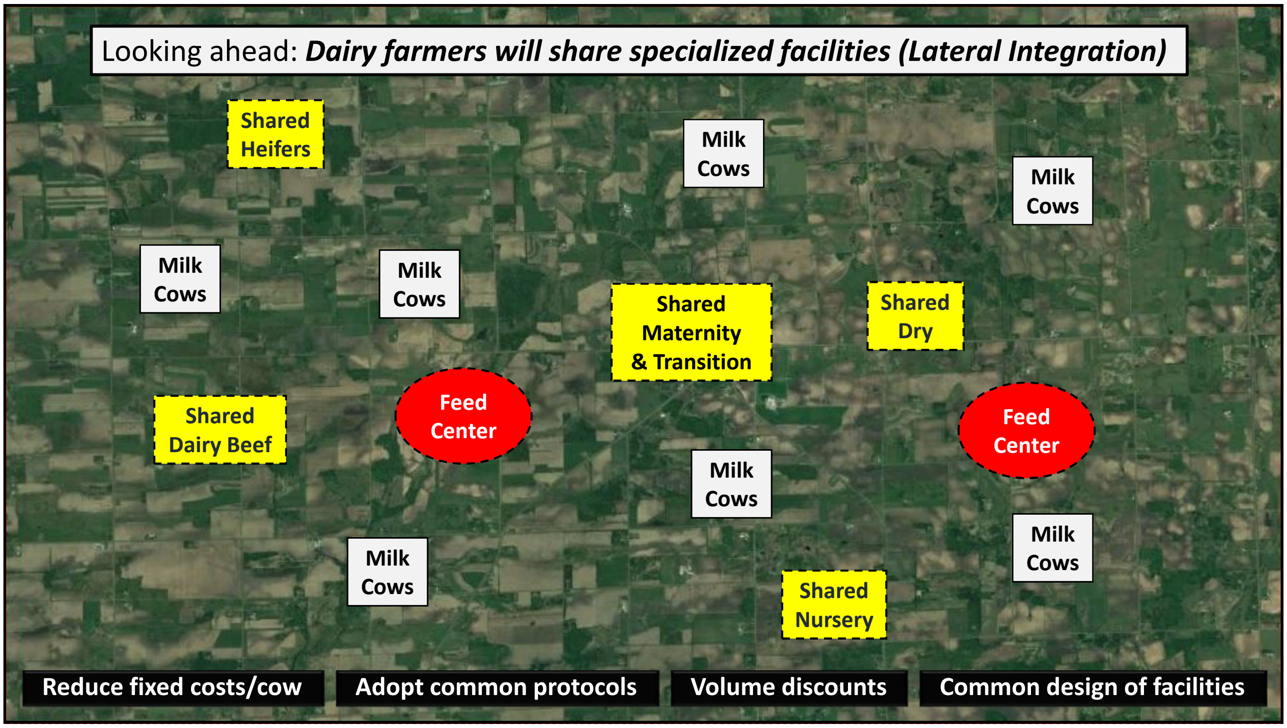


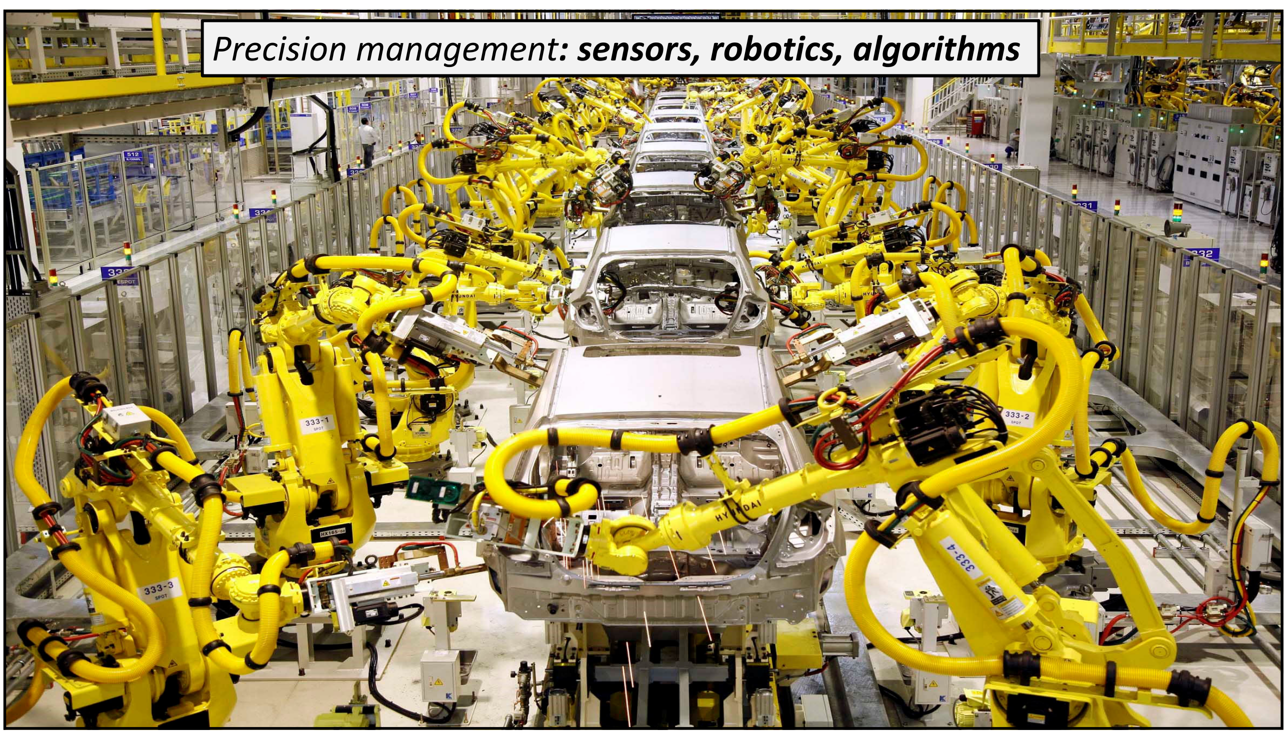
Source: J. S. Stevenson & J. H. Britt, J. Dairy Sci. 100:10292–10313 (2017)

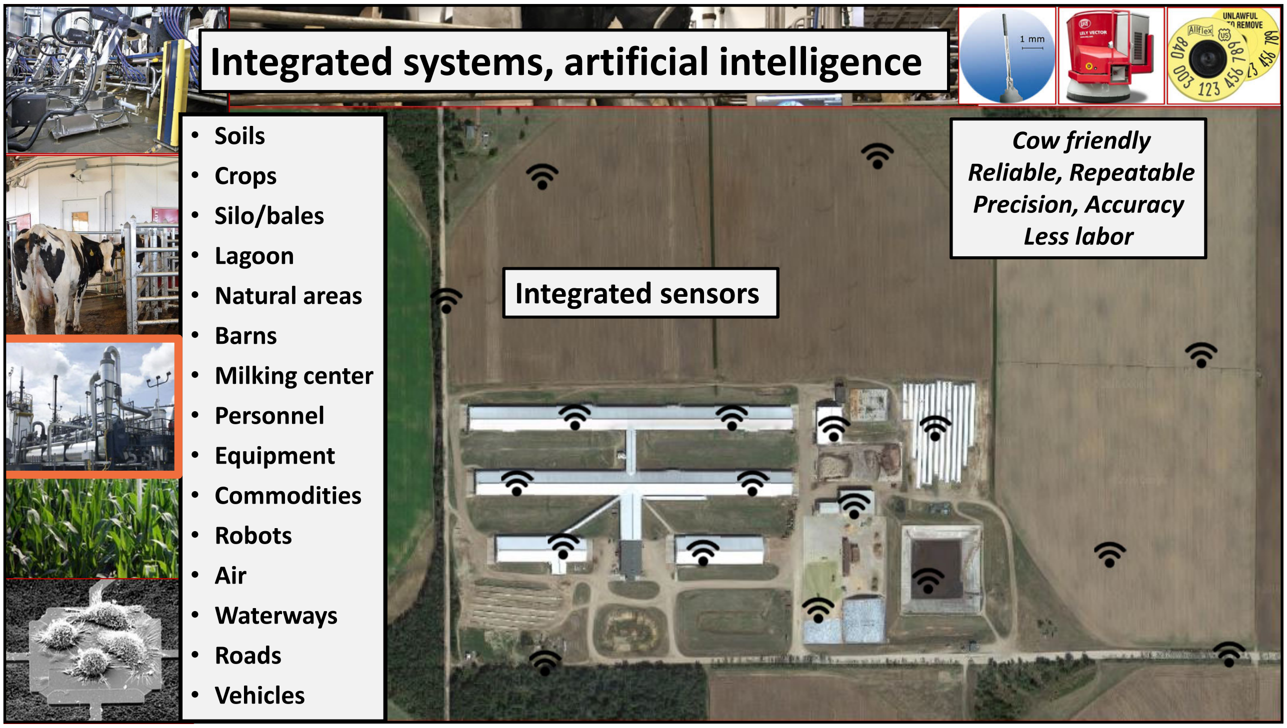
Revenue and expenses for largest herds in USA (2017)

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*

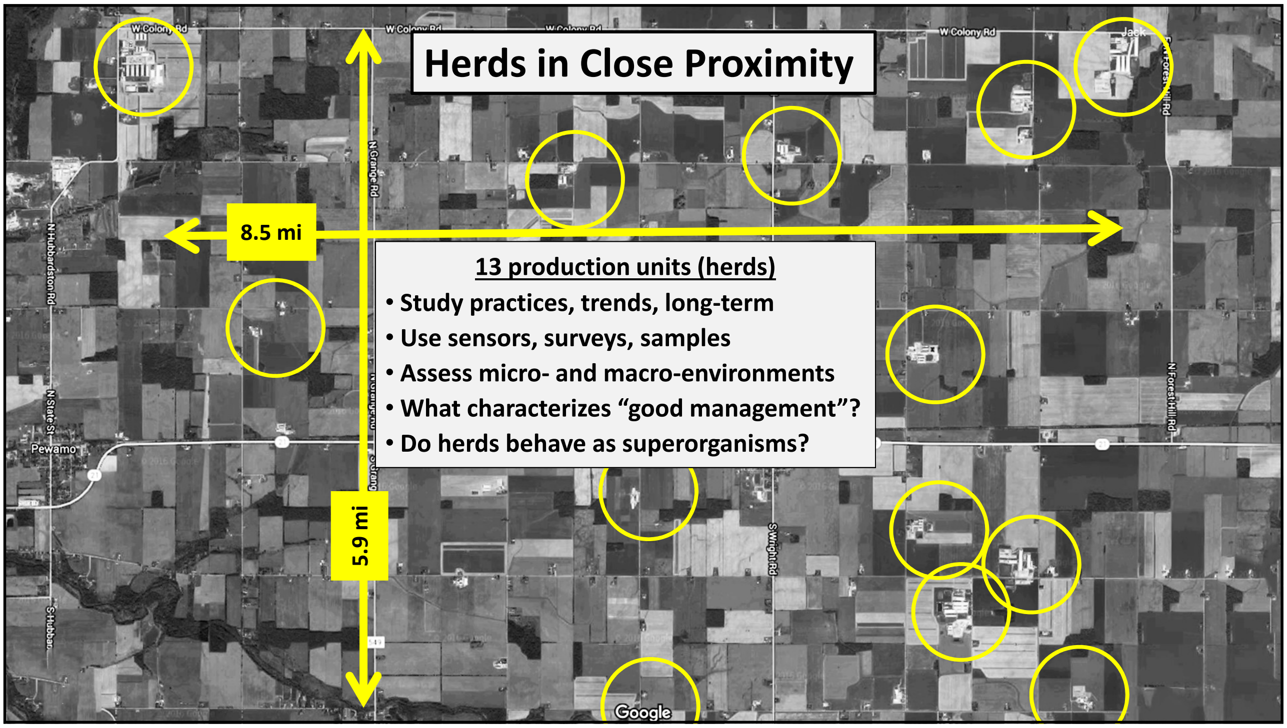
Source: 2017 Dairy Benchmark Summary, Farm Credit Services of America (~103 farms, 4299 cows per farm).

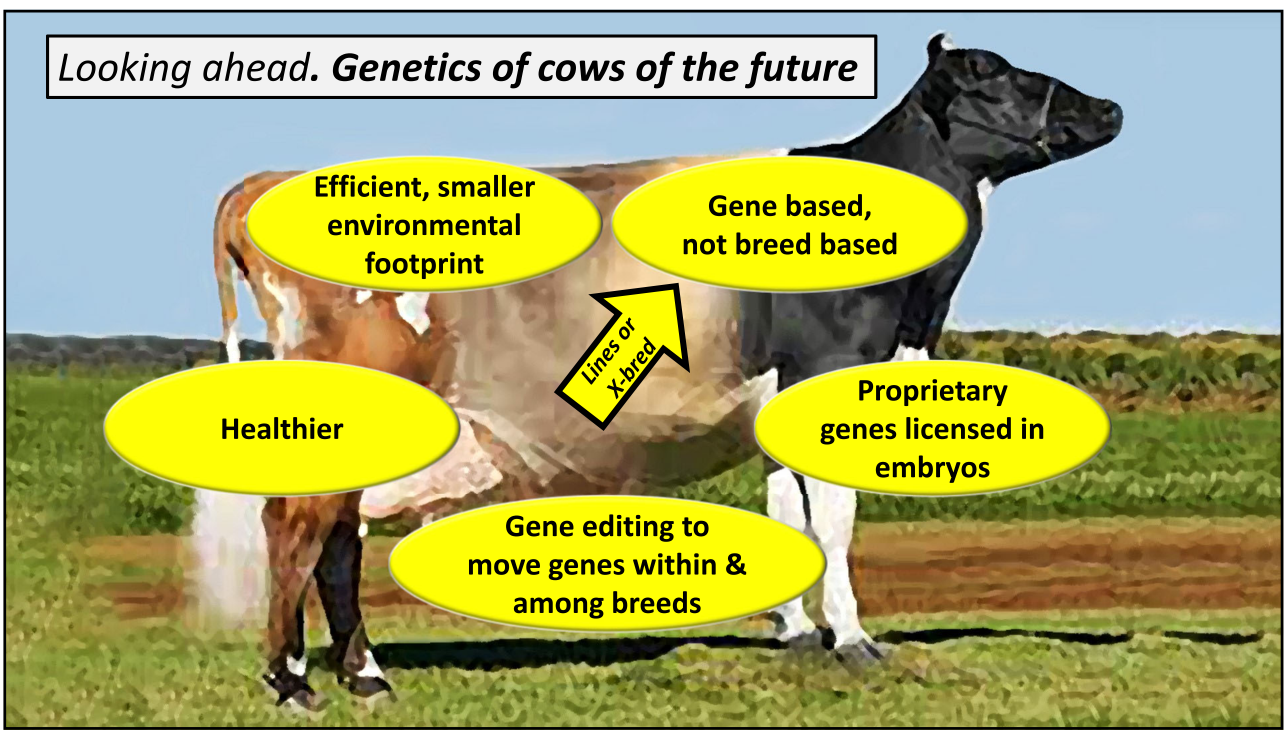

Looking ahead: Dairy farmers will share specialized facilities (Lateral Integration)
Shared Heifers
Milk Cows
Milk Cows
Milk Cows
Milk Cows
Shared Maternity & Transition
Shared Dry
Shared Dairy Beef
Feed Center
Feed Center
Milk Cows
Milk Cows
Milk Cows
Shared Nursery
Reduce fixed costs/cow
Adopt common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

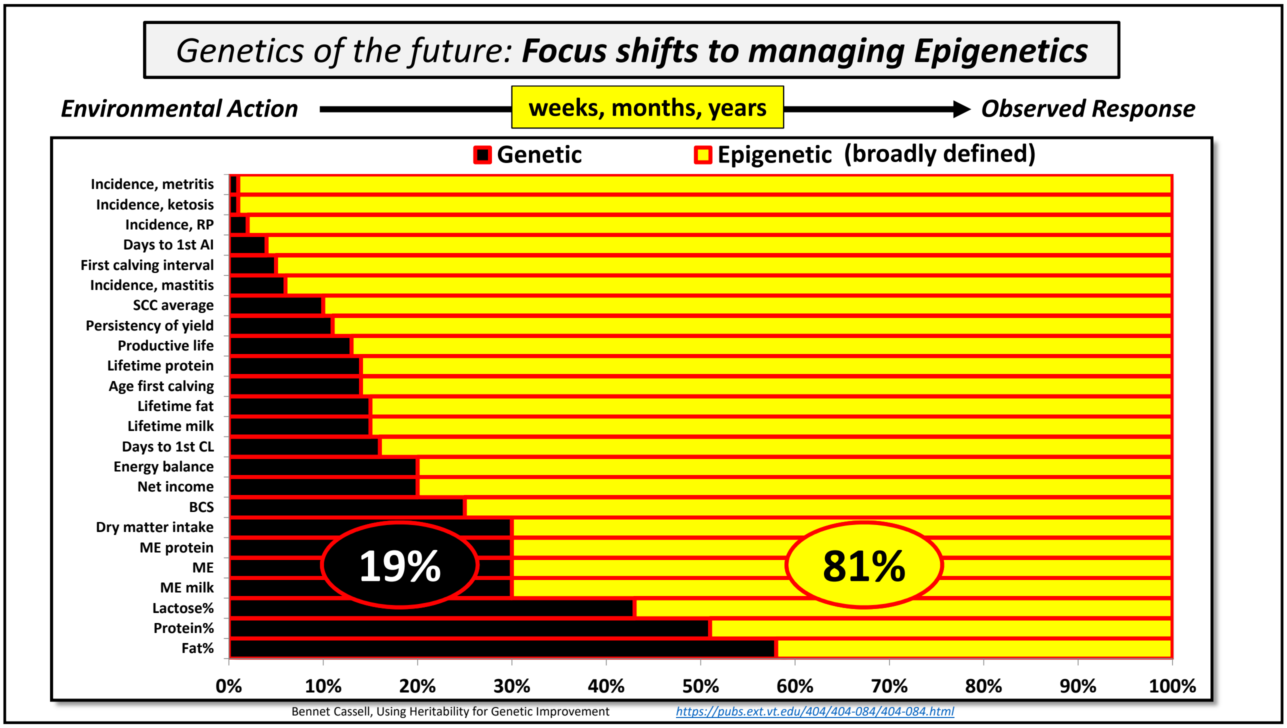

Precision management: sensors, robotics, algorithms

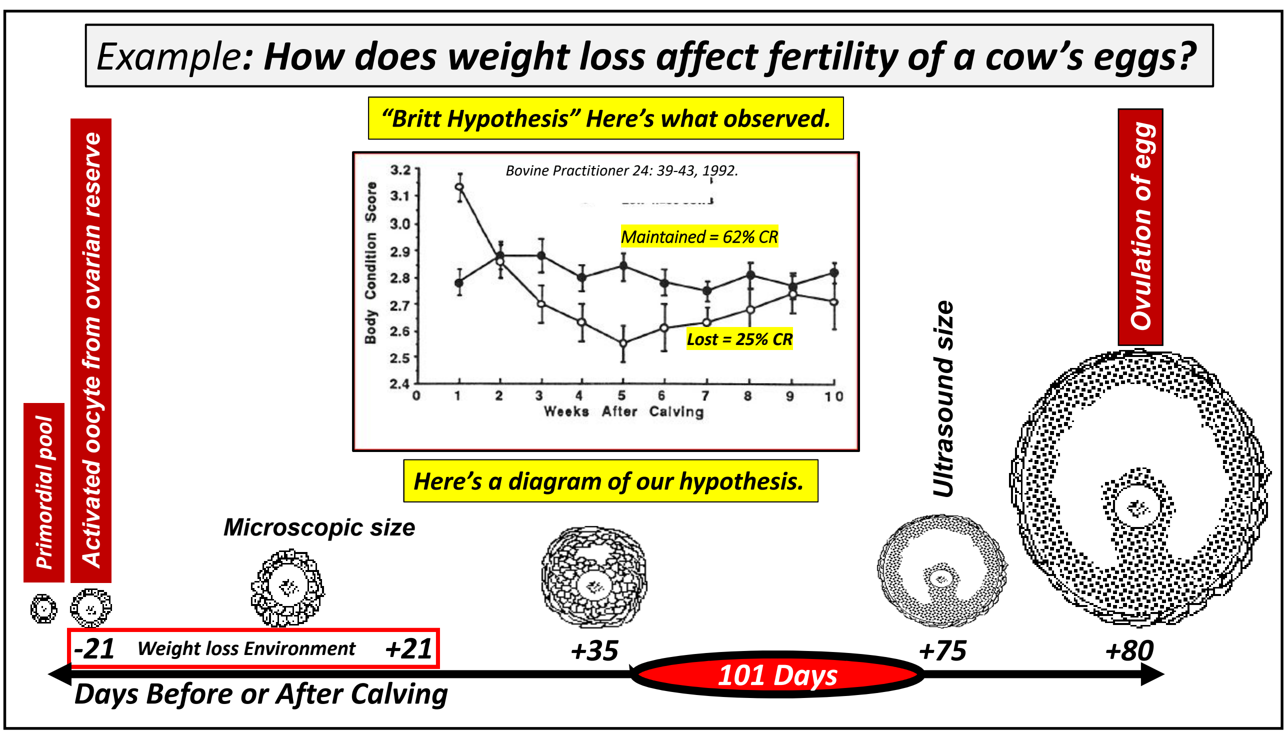

Integrated systems, artificial intelligence
• Soils
• Crops
• Silo/bales
• Lagoon
• Natural areas
• Barns
• Milking center
• Personnel
• Equipment
• Commodities
• Robots
• Air
• Waterways
• Roads
• Vehicles
Integrated sensors
Cow friendly
Reliable, Repeatable
Precision, Accuracy
Less labor


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?
Pewamo
Google

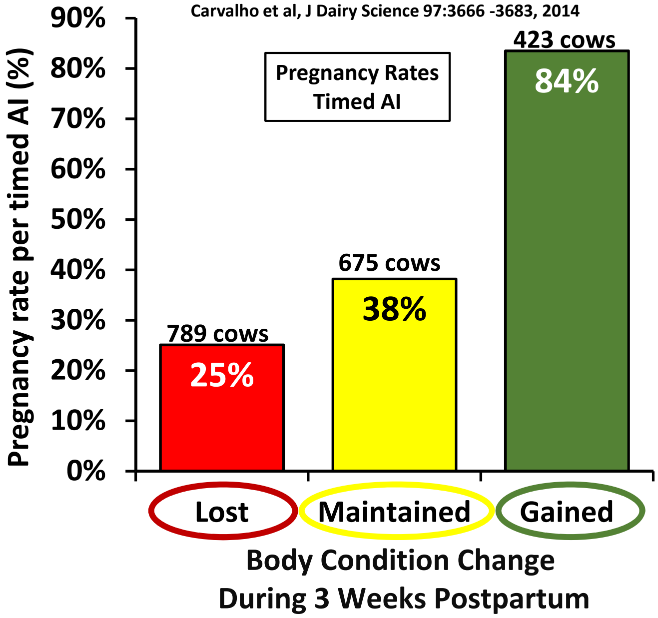

Looking ahead. ***Genetics of cows of the future***
Efficient, smaller environmental footprint
Gene based, not breed based
Lines or X-bred
Healthier
Proprietary genes licensed in embryos
Gene editing to move genes within & among breeds


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.
Body Condition Score
3.2
3.1
3.0
2.9
2.8
2.7
2.6
2.5
2.4
Maintained = 62% CR
Lost = 25% CR
0 1 2 3 4 5 6 7 8 9 10
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…***

Carvalho et al, J Dairy Science 97:3666 -3683, 2014

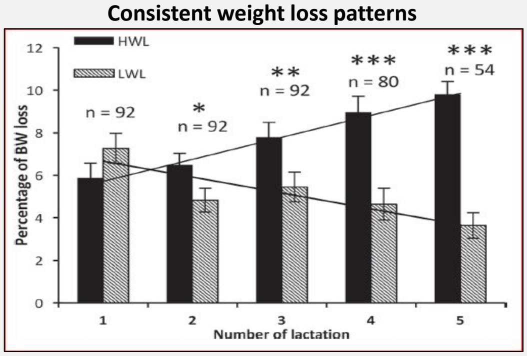


In the future:

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

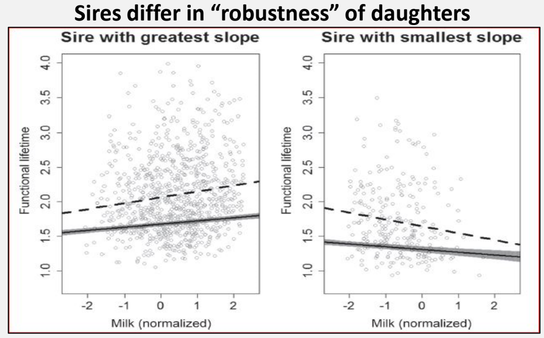
Cows of the future: ***Less weight loss, metabolically robust***

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.

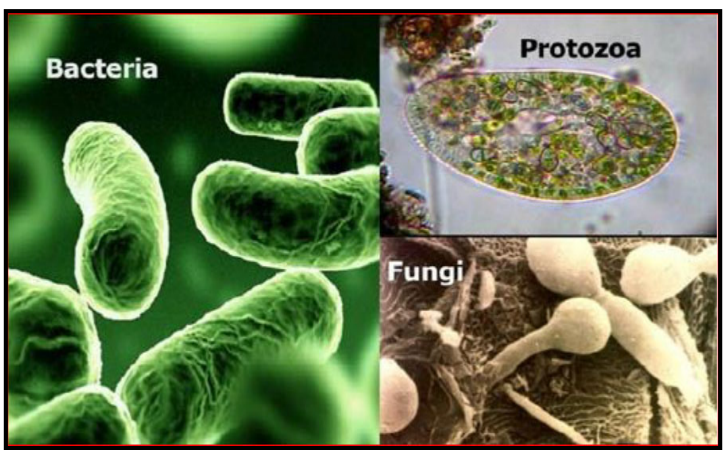
Current examples of epigenetic-like effects

Milk fresh cows 4X for first 3 weeks of lactation

Ensure maximum growth of calves to 70 days of age

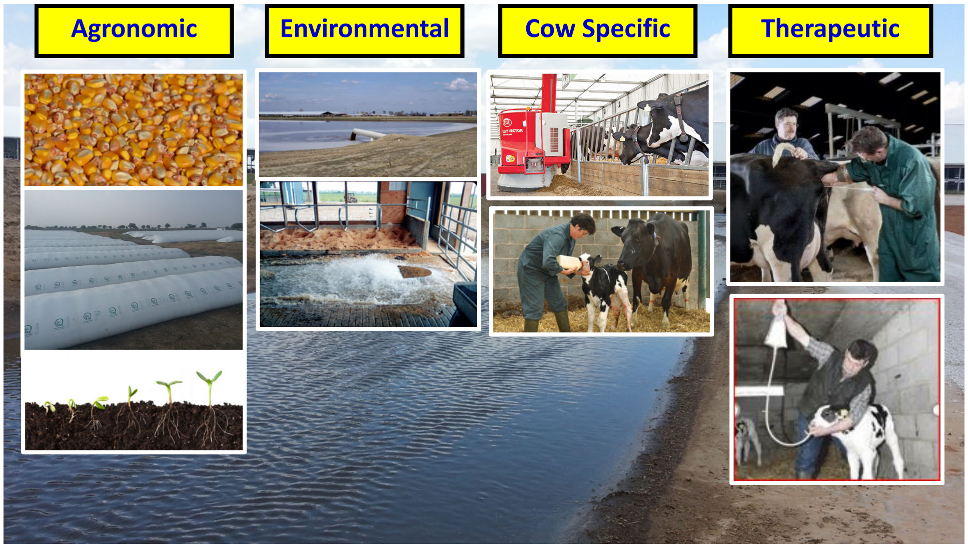
Practices for Managing the Epigenome

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

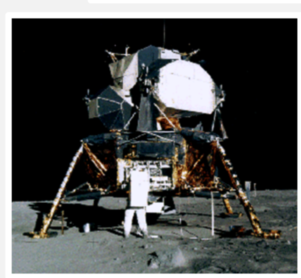


Microbiomics –relationships with genomically beneficial microbes that live within animals, plants, soils and in all environments

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.

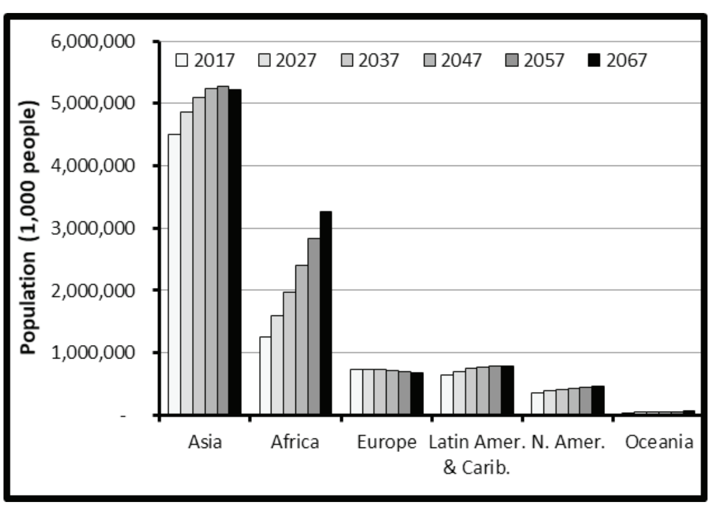


Figure 1. Estimated populations of major regions of the world by 2067. Estimates are from the United Nations. Adapted from Britt et al., 2018.

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.

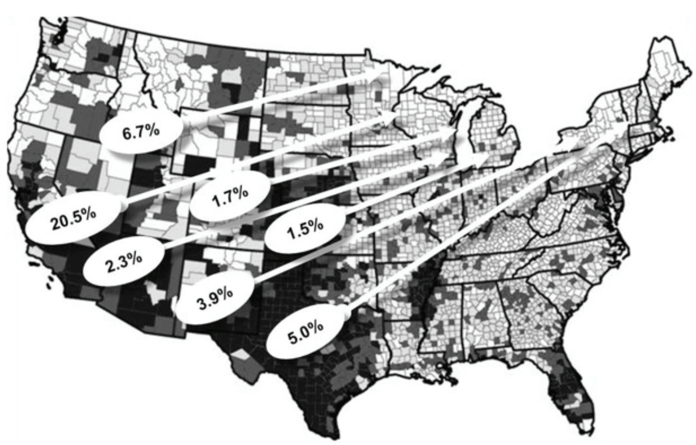


Figure 2. Projected shifts in dairy cattle in the USA associated with climate change. Dark-shaded areas will have limited water resources. Percentages represent the approximate proportion of USA milk produced by associated states in 2016. Source: Britt et al., 2018.

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

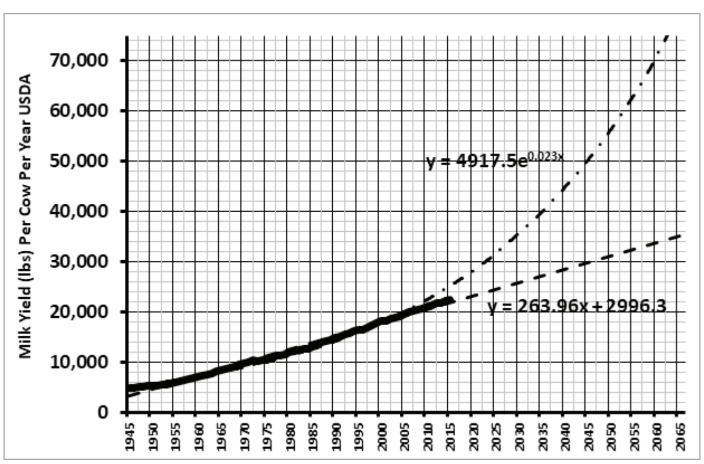


Figure 3. Extrapolation of milk yield using linear (straight line) or exponential (curved line) from existing yield data (heavy black line) in USA. Source: Britt et al., 2018.

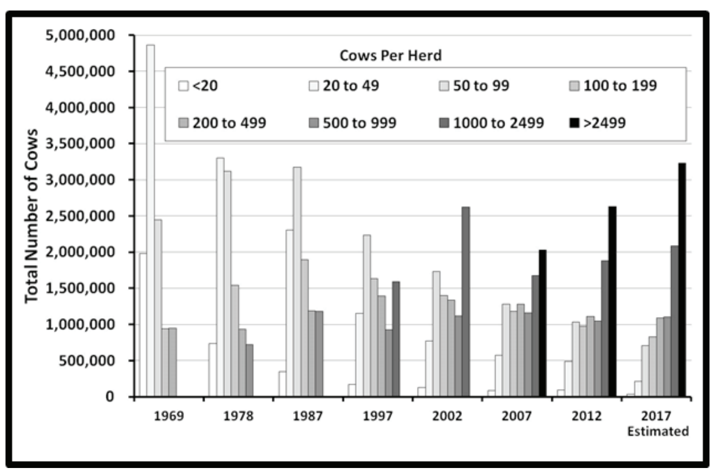


Figure 4. Change in dairy herd sizes in the USA from 1969 to 2017. Projections for the future are that dairy cows will continue to be milked in larger herds. Source: Stevenson and Britt, 2017.

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.

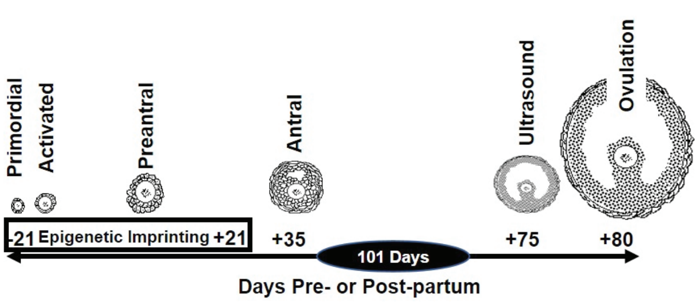


Figure 5. Illustration of how an oocyte exposed to negative energy balance during the transition period is altered by epigenetic mechanisms to be less fertile at breeding about 90 days later. Modified from Britt (1992).

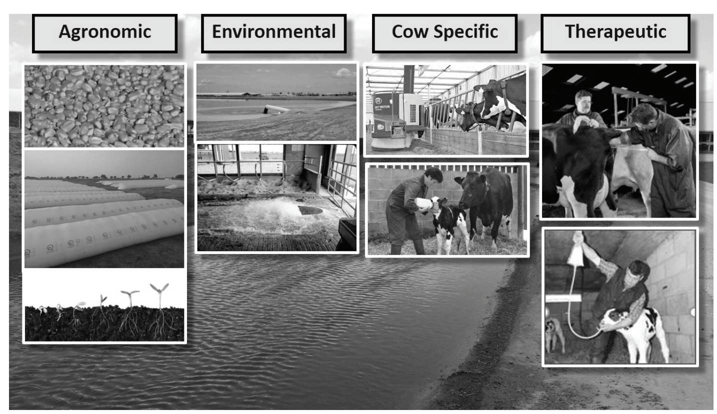


Figure 6. Examples of use of microbiome products for crops, wastewater, calves and cows, and disease treatments.

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.

REFERENCES

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.

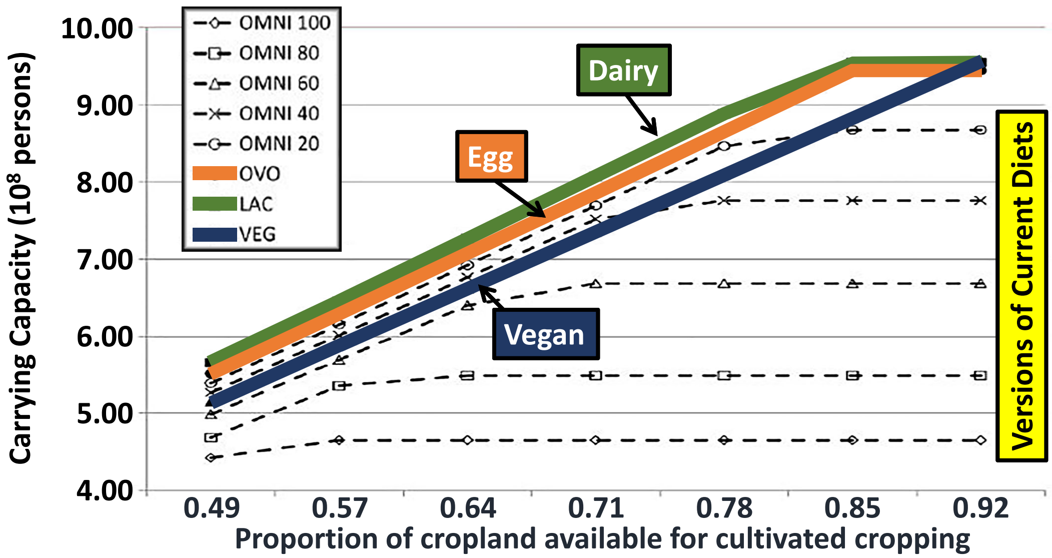
56 billion lbs.

23% vs 77%

Milk vs Other dairy

159 billion lbs.

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



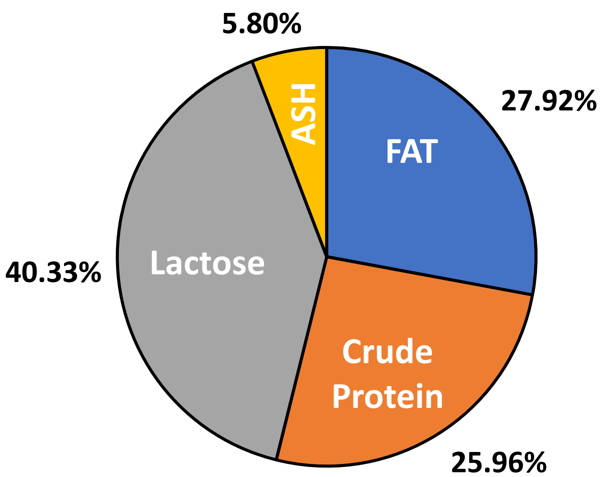
Peters, Christian J., Jamie Picardy, Amelia F. Darrouzet-Nardi, Jennifer L. Wilkins, Timothy S. Griffin, Gary W. Fick. 2016.
Carrying capacity of U.S. agricultural land: Ten diet scenarios. Elementa: Science of the Anthropocene • 4: 000116 • doi: 10.12952/journal.elementa.000116

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

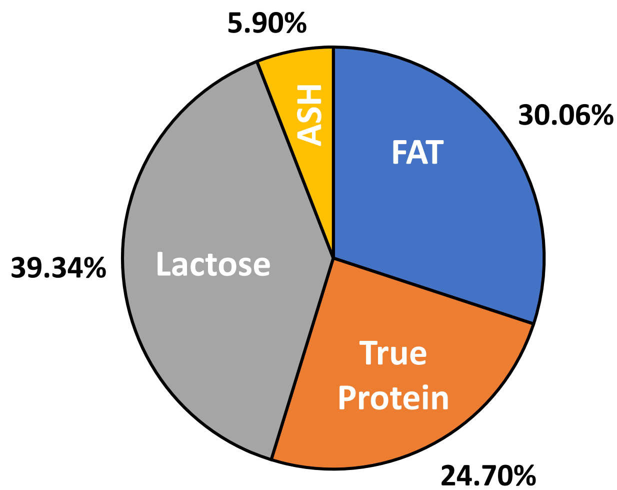
Component	**Average**	**Range**
Total solids	12.2%	10.46% - 15.6%
Solids-not-fat	8.8%	7.82% - 10.52%
Milk fat	3.4%	1.60% - 6.40%
Crude protein	3.2%	2.52% - 5.40%
Lactose	4.9%	3.76% - 5.72%
Ash	0.7%	0.54% - 1.00%
Energy, kcal/lb.	314	250 - 445

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**

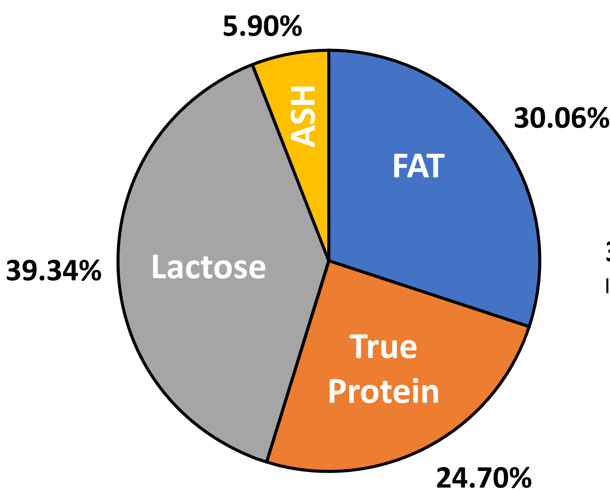


Original Holstein Data from Tyrrell and Reid, 1965

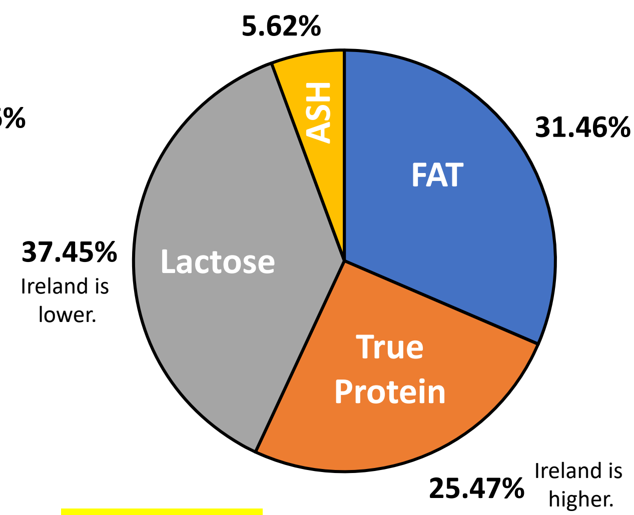


2017 Federal Order Data

Milk solids: **Comparisons USA and NZ**

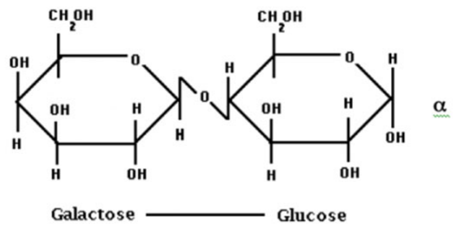


USA 2017 Federal Order Data



New Zealand Fonterra Target for 2018

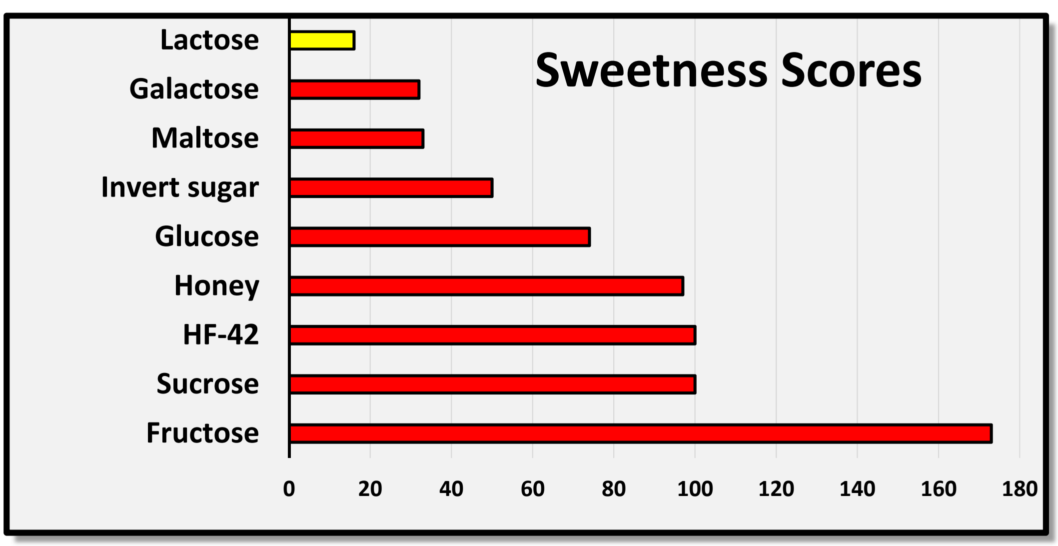
Lactose: **Controls volume, but has least value**



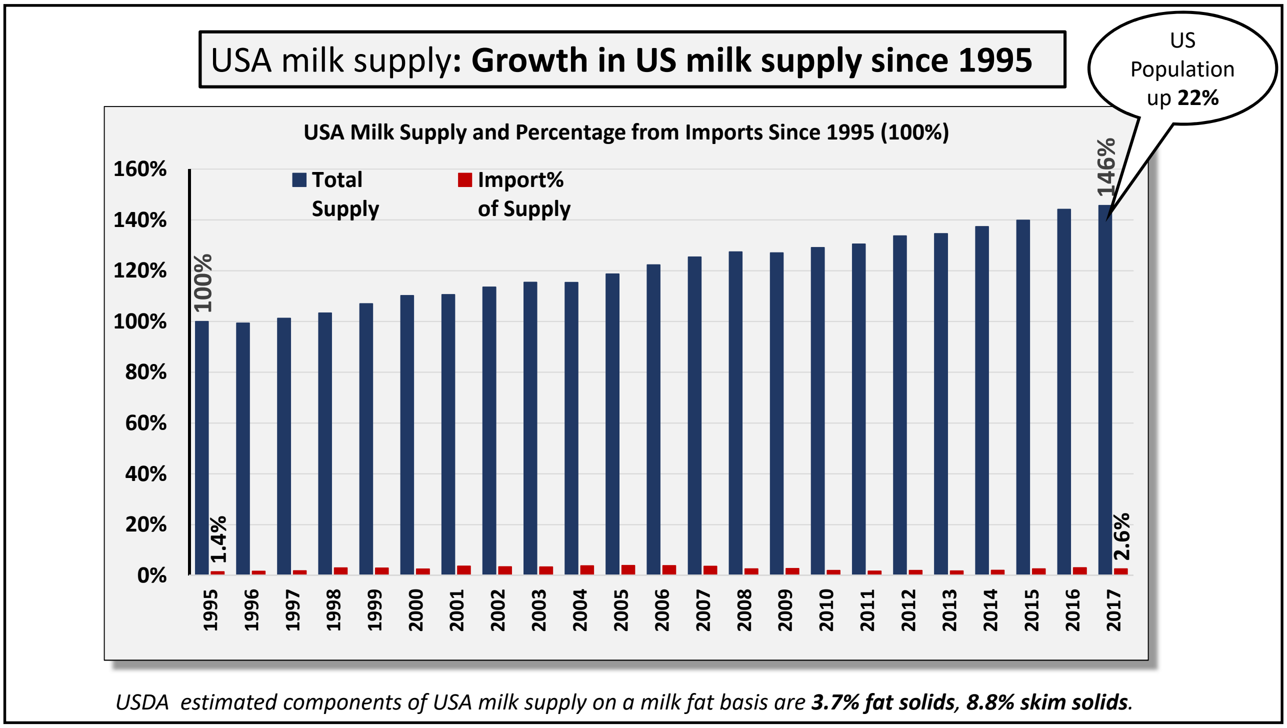
"Milk yield *greatly depends on mammary* **lactose** *synthesis due to its osmoregulation of milk, one that induces mammary uptake of water. Therefore, the* **rate of lactose synthesis** *in the epithelial cells of the mammary gland serves as a* **major factor influencing milk volume** *production."*

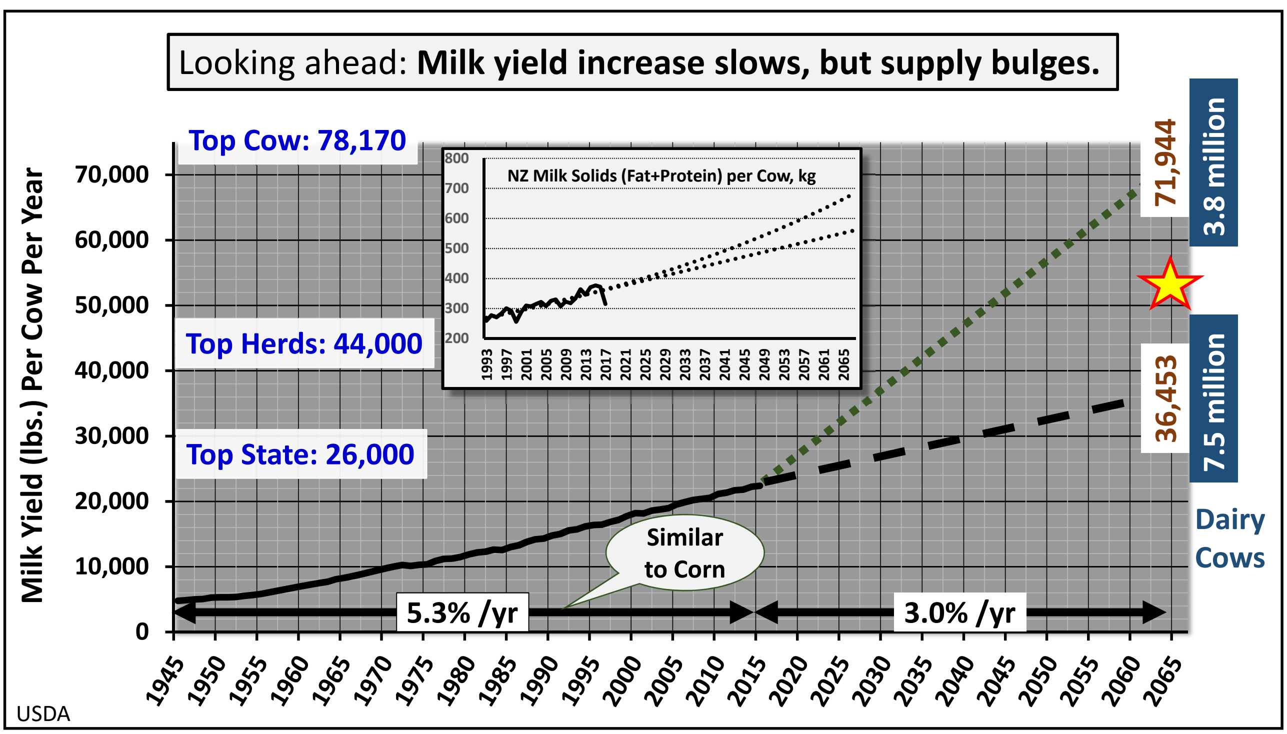
J. S. Osorio, J. Lohakare, and M. Bionaz. 2016. Biosynthesis of milk fat, protein, and lactose: roles of transcriptional and posttranscriptional regulation. Physiological Genomics https://doi.org/10.1152/physiolgenomics.00016.2015

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

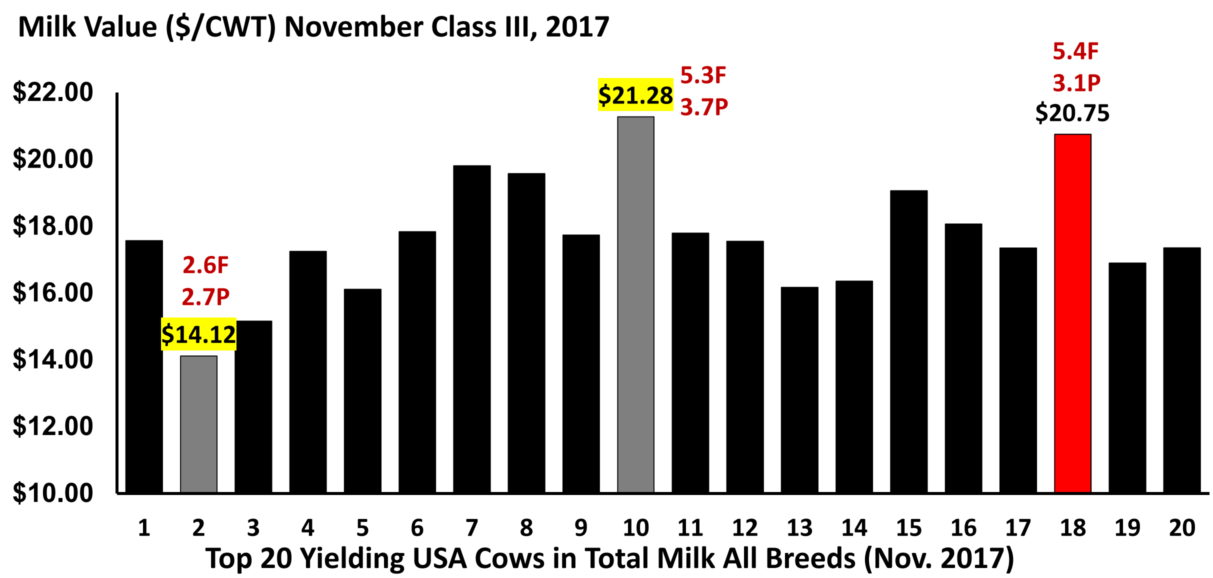


Source: https://en.wikipedia.org/wiki/Sweetness


USA milk supply: Growth in US milk supply since 1995
US Population up 22%
USA Milk Supply and Percentage from Imports Since 1995 (100%)
Total Supply
Import% of Supply
160%
140%
120%
100%
80%
60%
40%
20%
0%
100%
146%
1.4%
2.6%
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
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 Cow: 78,170
Top Herds: 44,000
Top State: 26,000
Milk Yield (lbs.) Per Cow Per Year
70,000
60,000
50,000
40,000
30,000
20,000
10,000
0
NZ Milk Solids (Fat+Protein) per Cow, kg
71,944
36,453
3.8 million
7.5 million
Dairy Cows
Similar to Corn
5.3% /yr
3.0% /yr
1945
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
2025
2030
2035
2040
2045
2050
2055
2060
2065
USDA

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



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

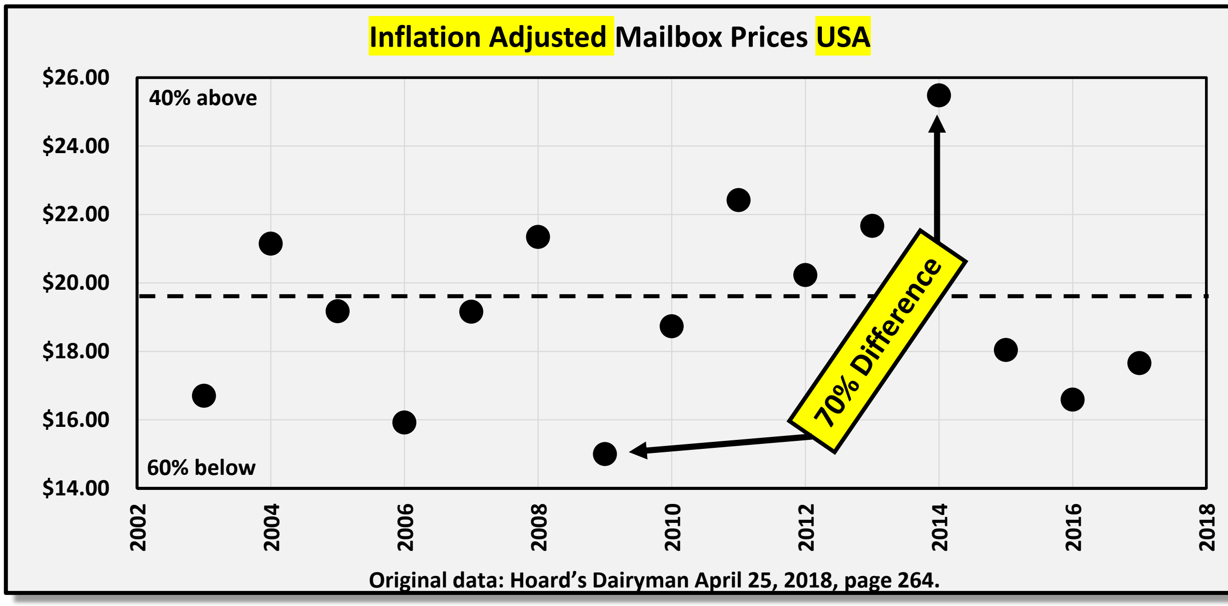
Value of USA milk supply 2017: **$ per CWT in today's market**

US Federal Order 2017 Values

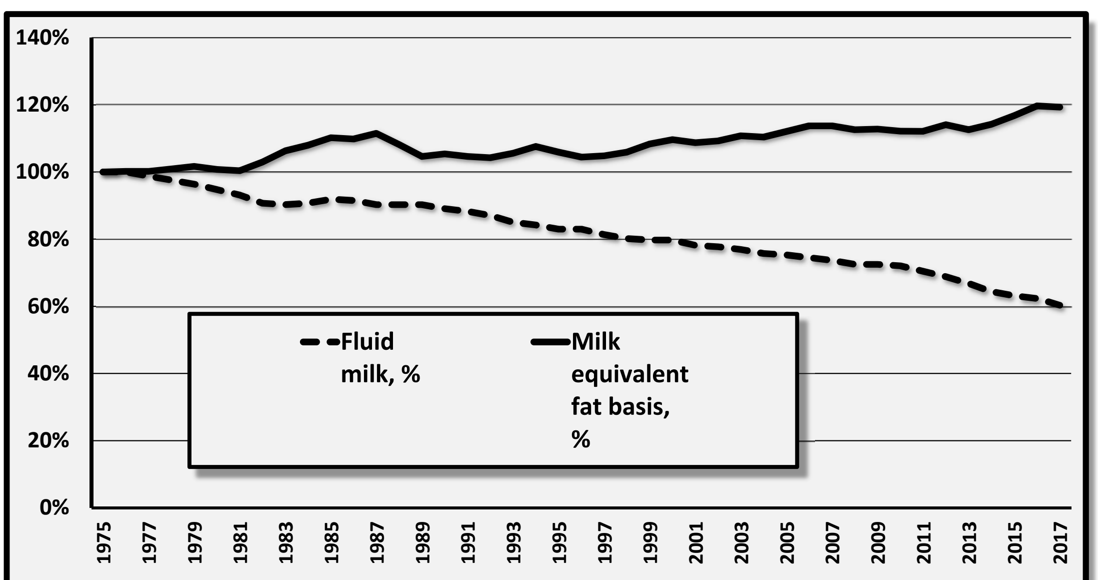
Component	Percentage	Value/Lb.	Value/CWT
Milk fat	3.82%	$2.54	$9.70
True Protein	3.14%	$2.00	$6.28
Lactose	5.00%	$0.35	$1.75
			$17.73

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

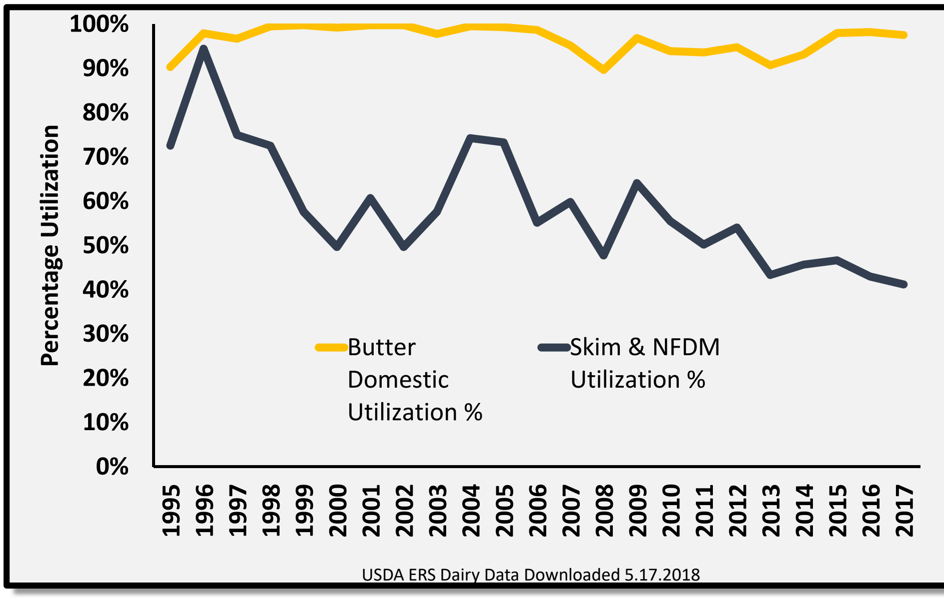
Forecasts: **Milk prices in USA will continue to be VOLATILE!**



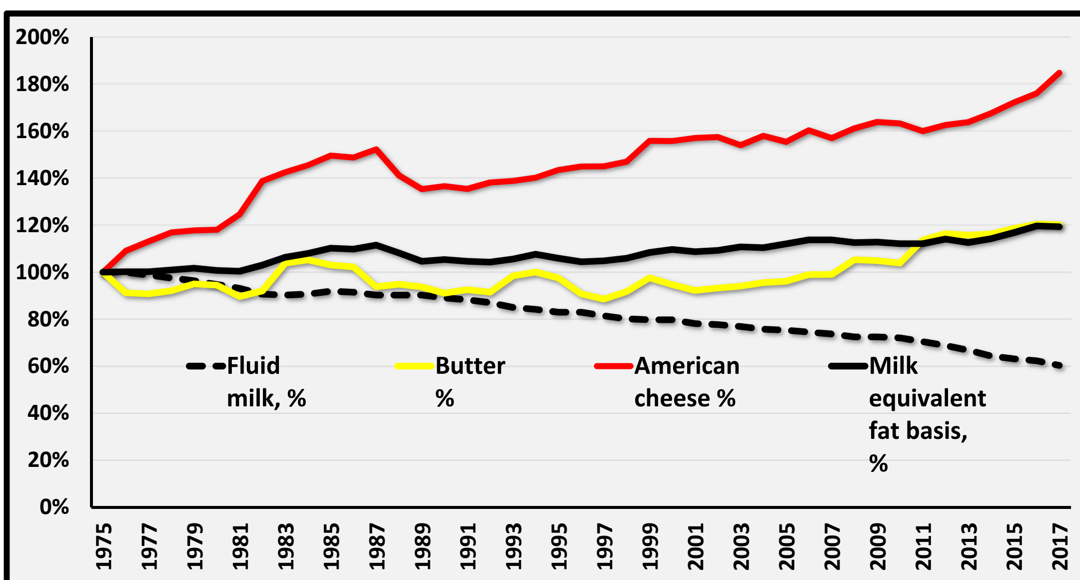
Consumption: **USA per capita dairy consumption (1975 = 100%)**



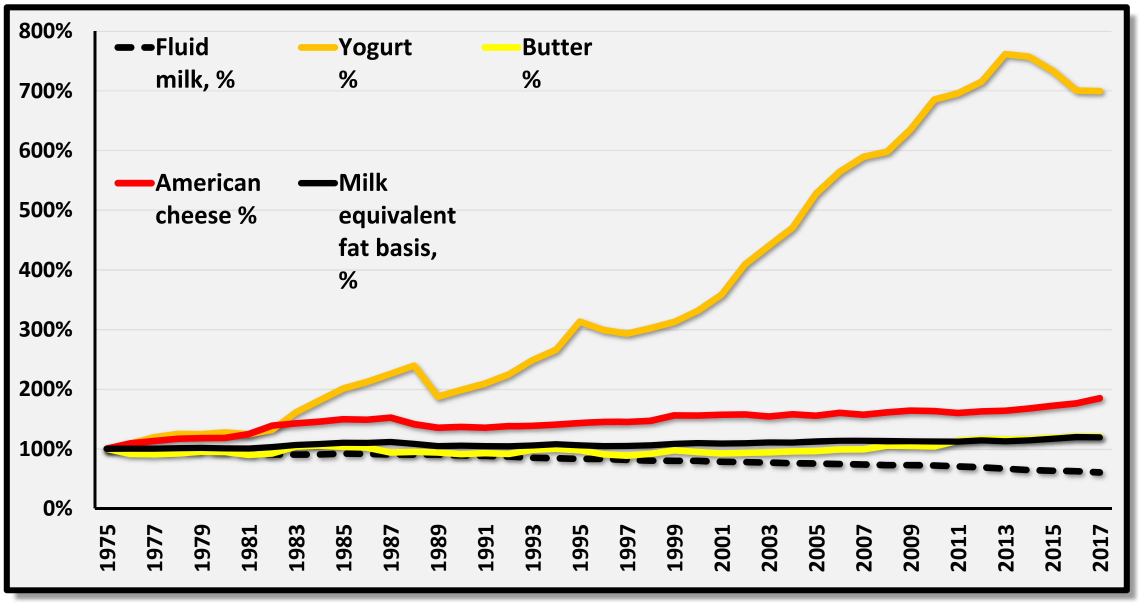
Skim and non-fat domestic utilization: **Declining for 20 years.**



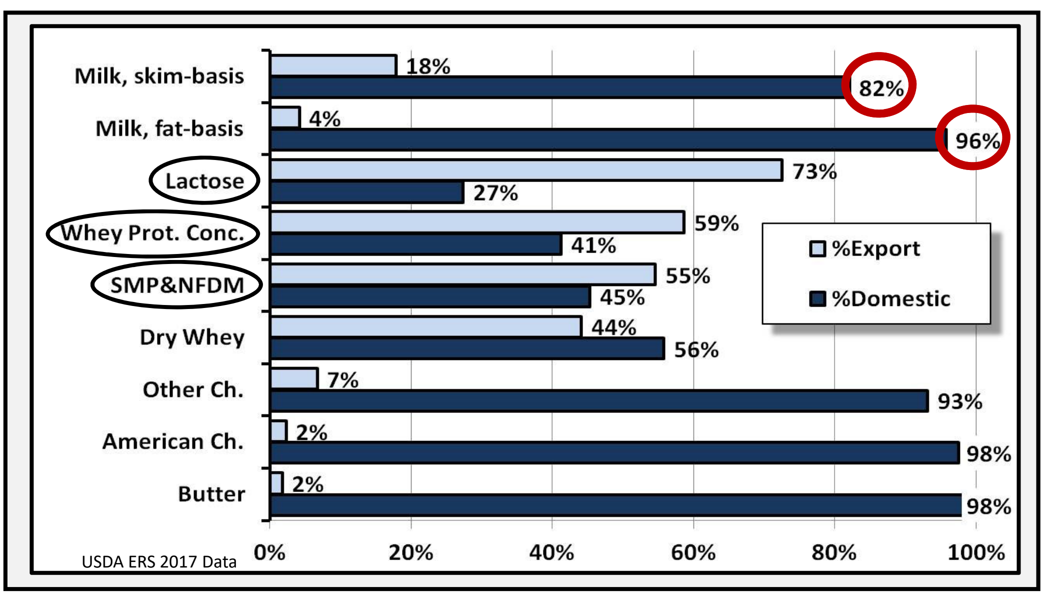
Consumption: **USA Per Capita Dairy Consumption (1975 = 100%)**



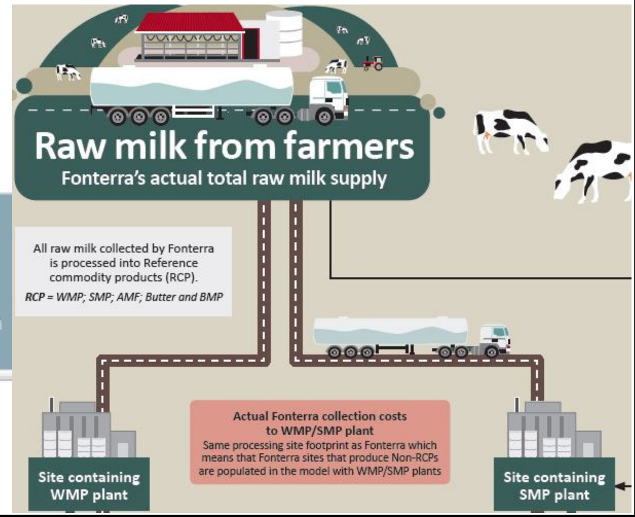
Consumption: **USA Per Capita Dairy Consumption (1975 = 100%)**



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**

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

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

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

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

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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

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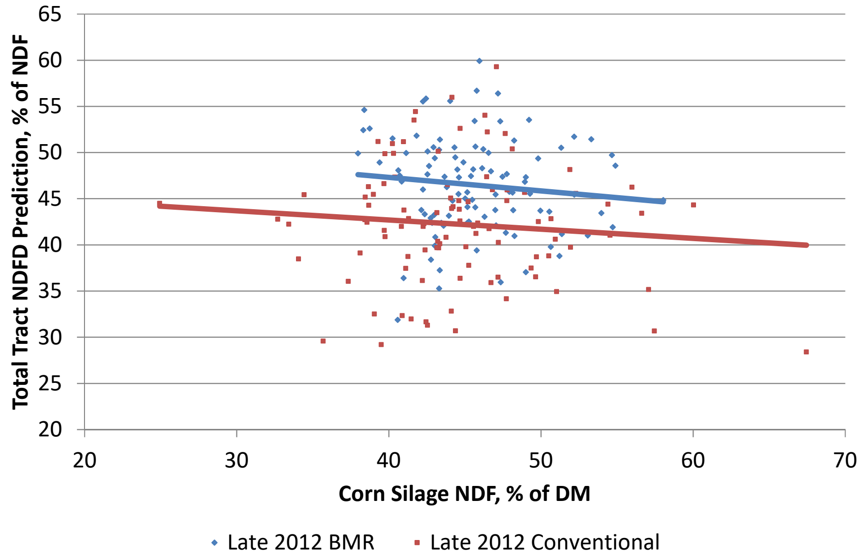
Fiber digestibility: BMR vs Conventional Corn Silage



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

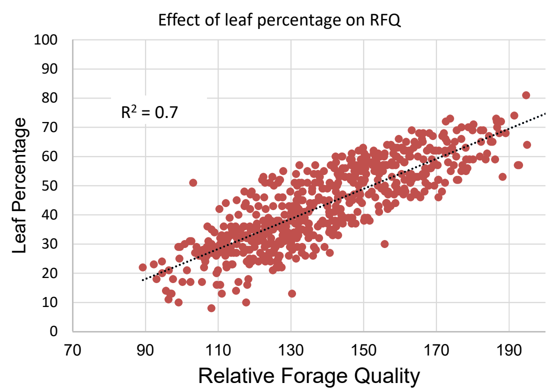
	NDF	Lignin	TTNDFD	DOM
	% of DM	% of DM	% of NDF	% of DM
Immature	33	5.4	54	71
Vegetative	37	6.2	50	67
Mid-maturity	43	7.3	47	63
Mature	50	8.4	46	60

Alfalfa Leaf Loss Effect on Forage Quality

- Leaves higher in quality than stems

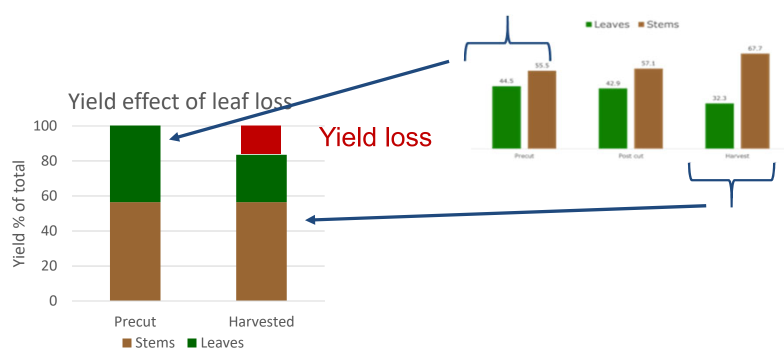
Leaves 15 to 20% NDF
~ 450 RFQ

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

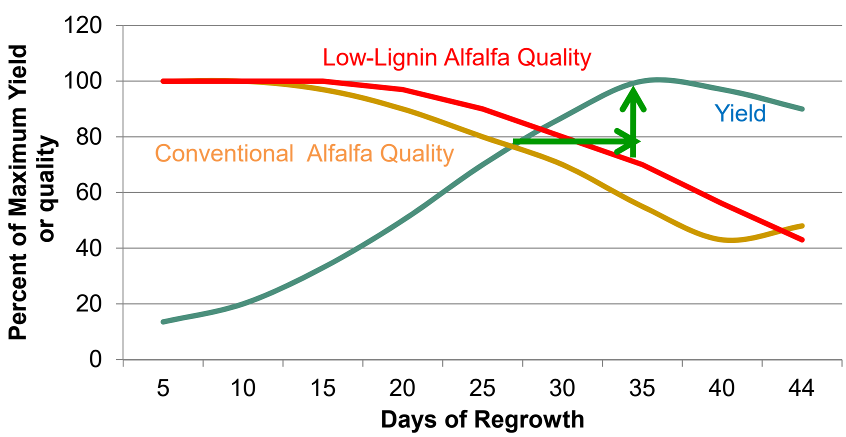
The proportion of iNDF and rate of fiber digestion (kd) vary in forages

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)

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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

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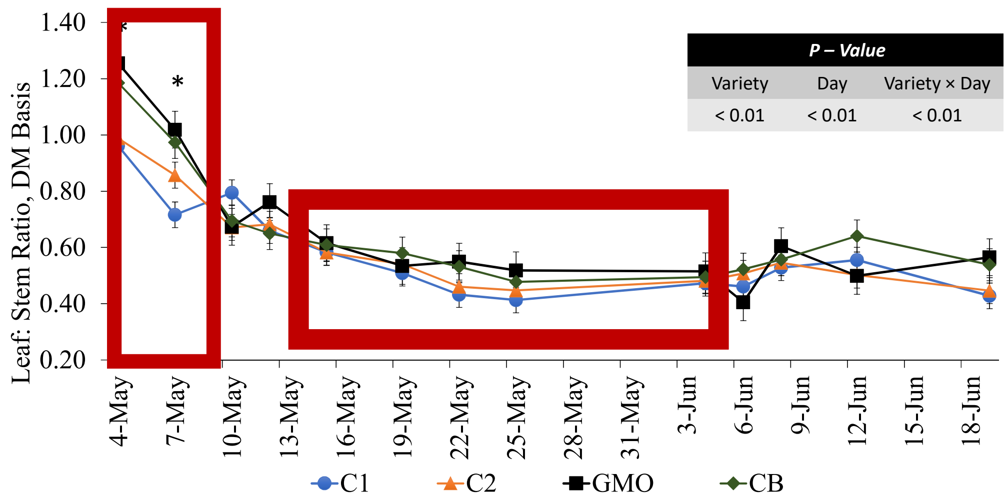
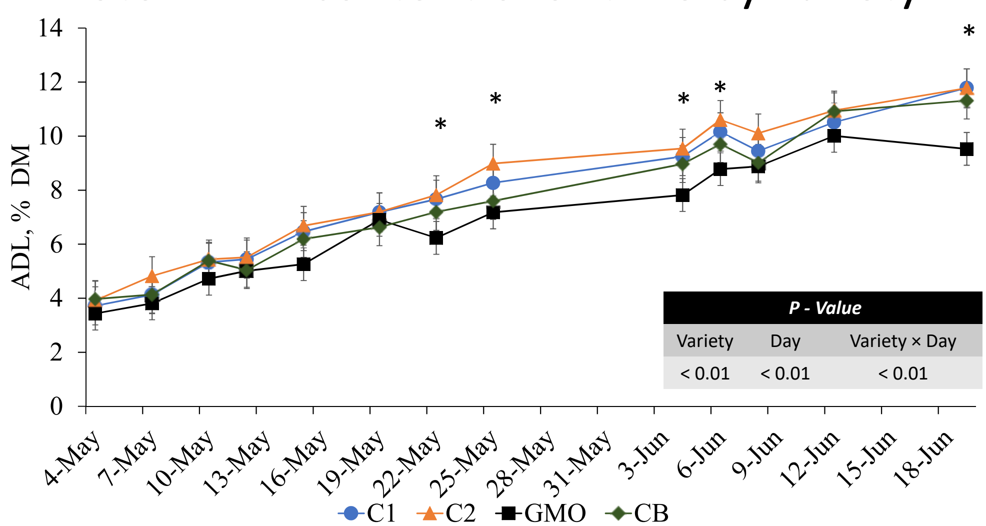
Leaf to Stem ratios over time by variety



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

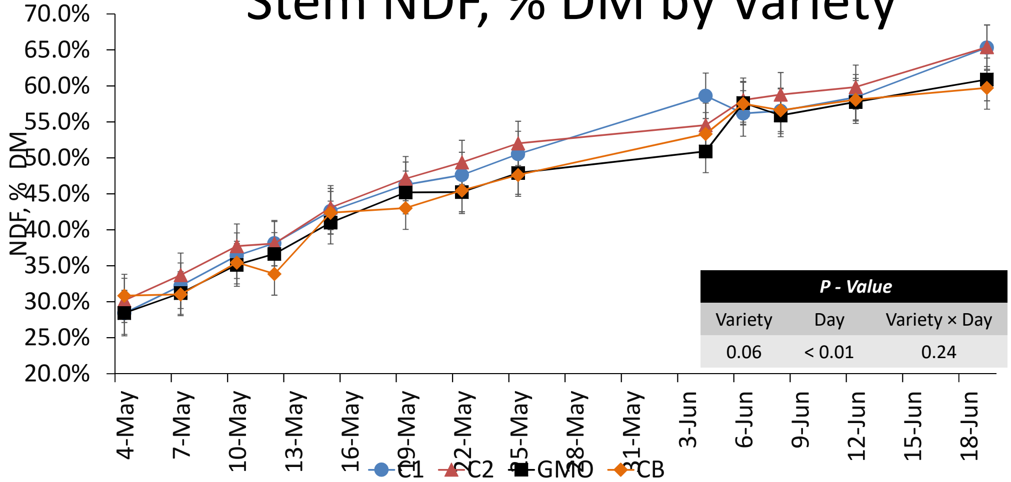
Donnelly et al. 2018

Stem ADL content over time by variety



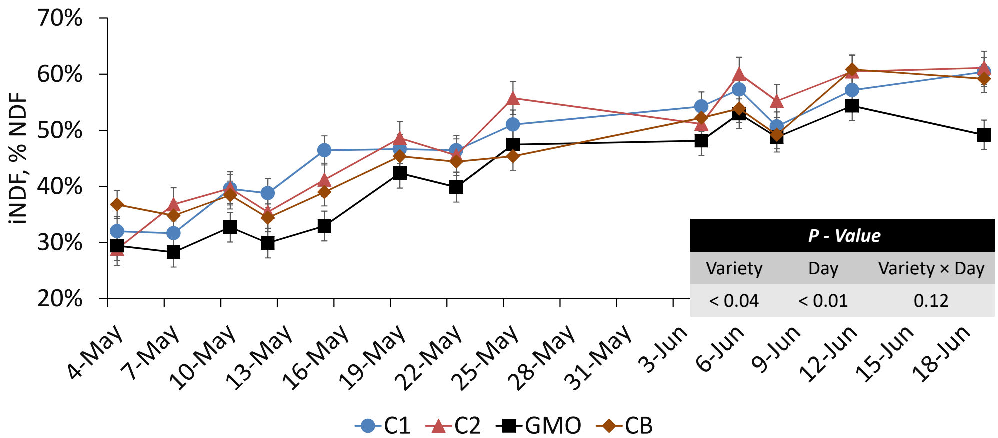
P - Value		
Variety	Day	Variety × Day
< 0.01	< 0.01	< 0.01

Stem NDF, % DM by Variety



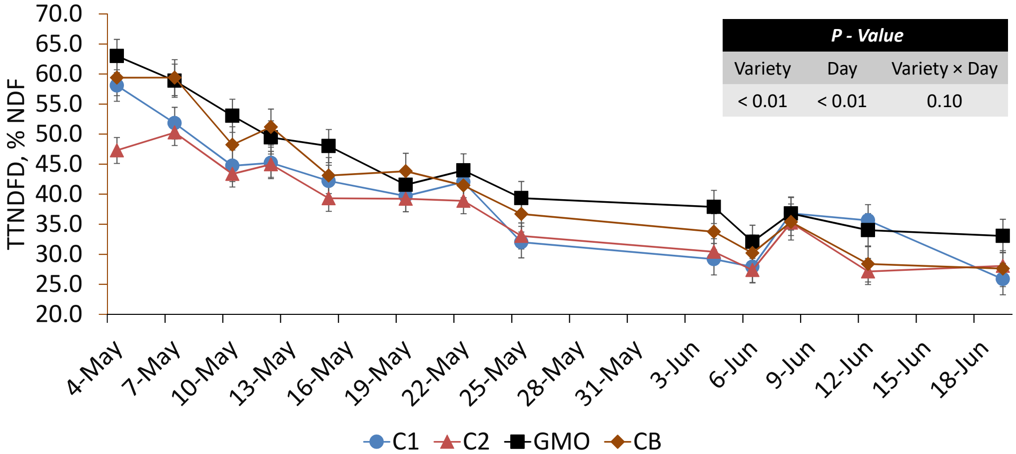
P - Value		
Variety	Day	Variety × Day
0.06	< 0.01	0.24

Stem iNDF, % NDF by Variety

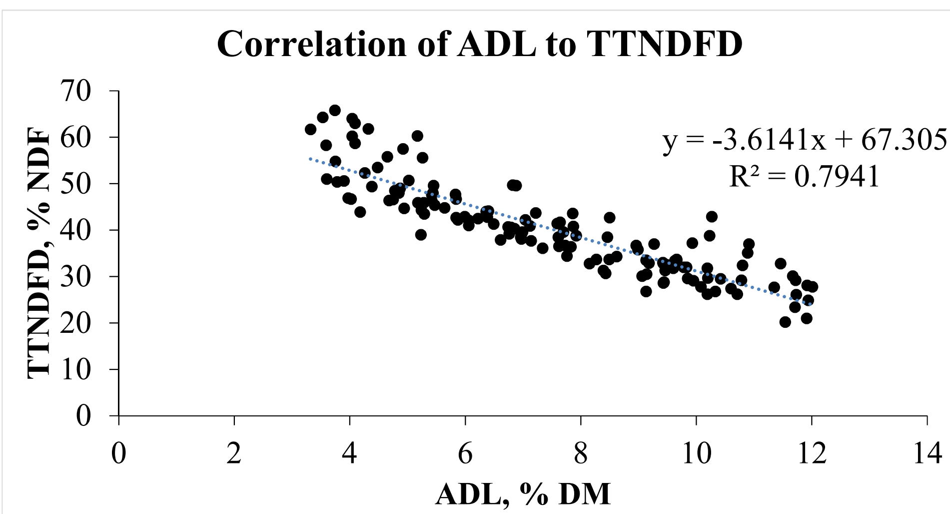


P - Value		
Variety	Day	Variety × Day
< 0.04	< 0.01	0.12

Alfalfa Stem TTNDFD, % NDF by Variety



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



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

*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

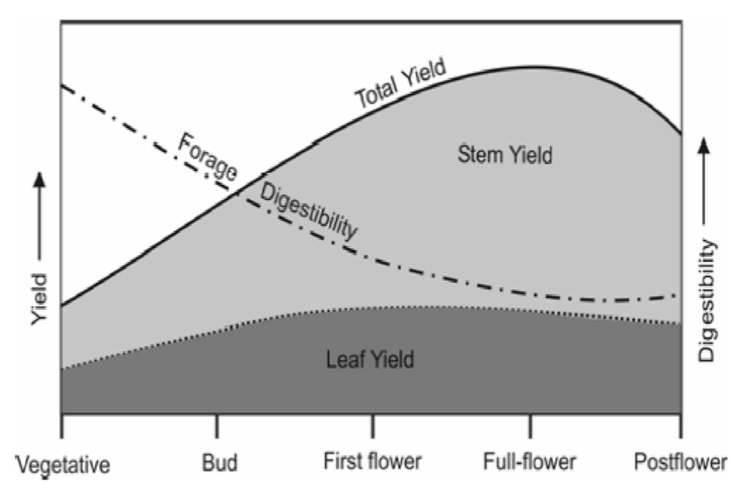
Talking points

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

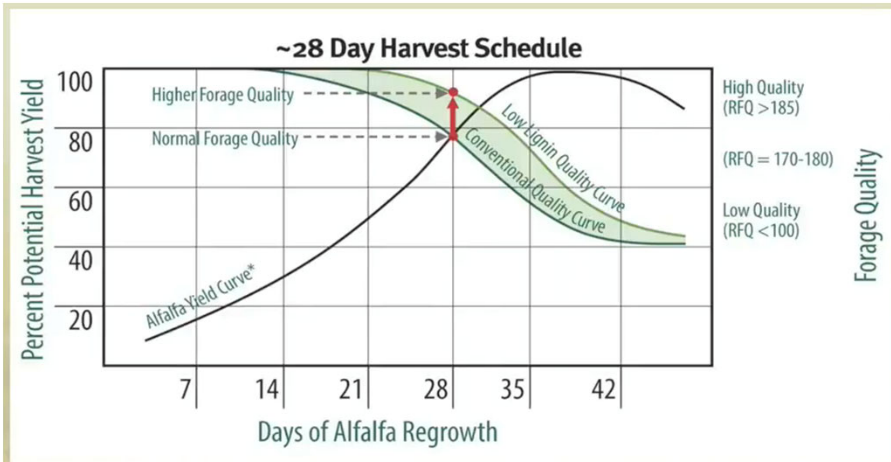
Why Lignin?

- 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