Precision Dairy Farming: What Have We Learned?

UK UNIVERSITY OF KENTUCKY College of Agriculture

PRECISION DAIRY & COW ENVIRONMENT CONSORTIUM

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The Future
NEXT EXIT

Technological Transformation

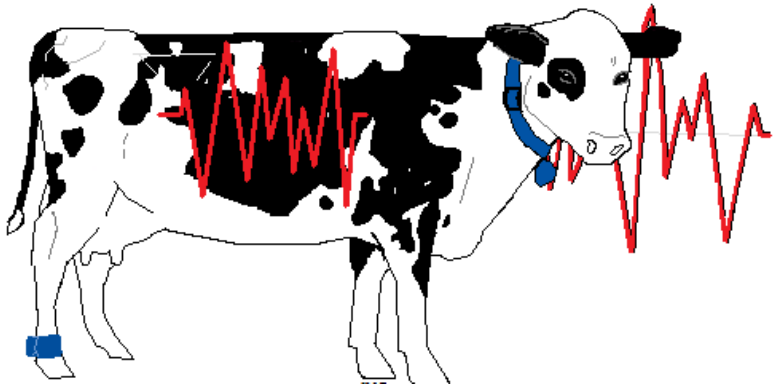
- Extension of other industries
- New dairy industry demands
  - Animal well-being
  - Consumer demands
  - Environmental pressure
  - Labor challenges
  - Economic competition

Cow Challenge Solutions

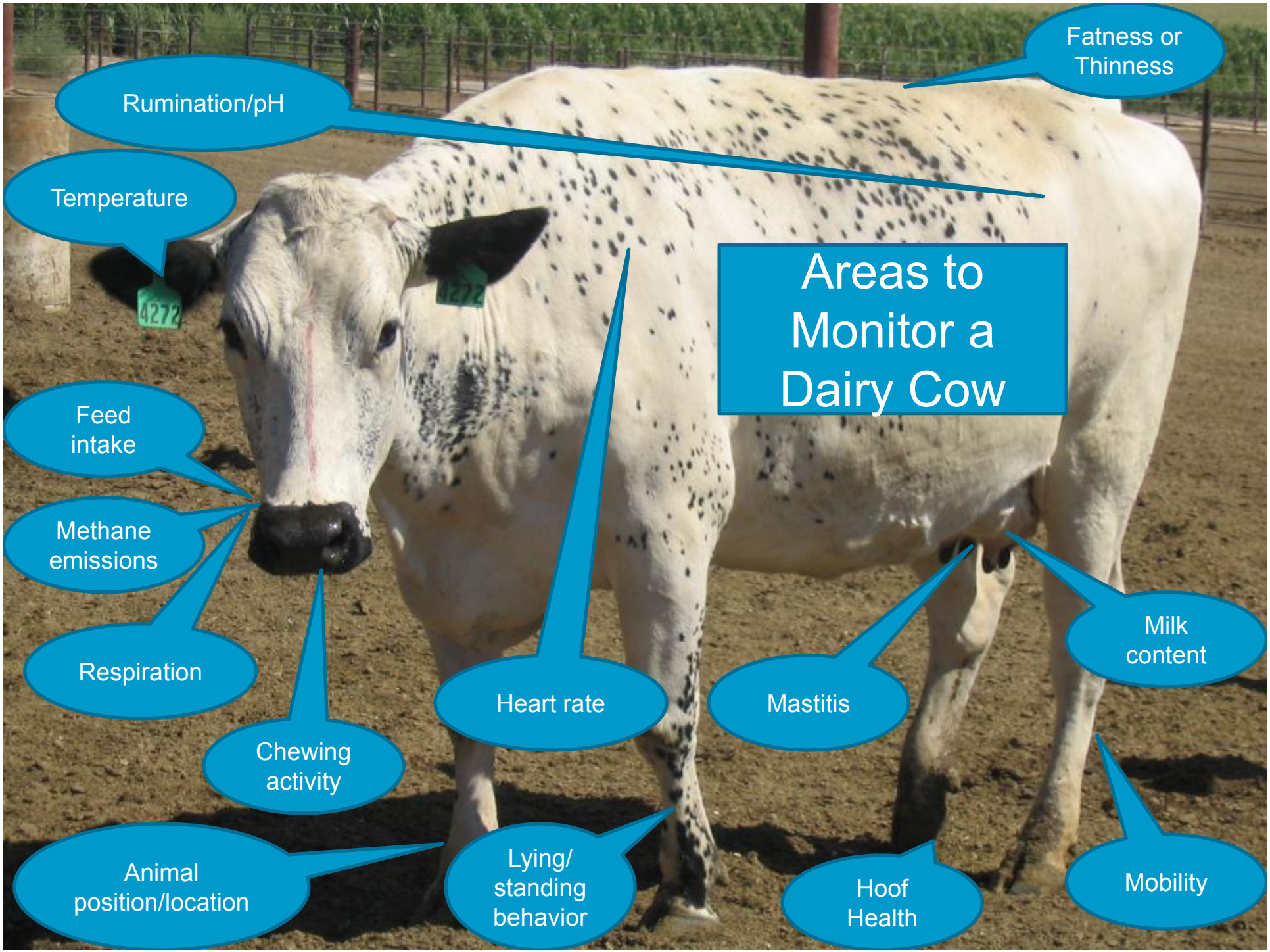
1. Finding cows in heat
2. Finding and treating lame cows
3. Finding and treating cows with mastitis
4. Catching sick cows in early lactation
5. Understanding nutritional status of cows
    a. Feed intake
    b. Body condition (fat or thin)
    c. Rumen health (pH/rumination time)

Happy Cows via Technology?

Precision Dairy Management



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


Areas to Monitor a Dairy Cow
Fatness or Thinness
Rumination/pH
Temperature
Feed intake
Methane emissions
Respiration
Chewing activity
Heart rate
Mastitis
Milk content
Animal position/location
Lying/ standing behavior
Hoof Health
Mobility

UK Coldstream Dairy Monitoring Capabilities

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Technology	Parameter(s) Measured
SmartBow	Position, Movement
VelPhone	Calving Time, Vaginal Temperature
Alanya	Temperature, Lying Time, Activity, Locomotion, Behavior
AfiLab	Fat, Protein, Lactose
Pedometer Plus	Lying Time, Steps
HR Tag	Rumination Time, Neck Activity
Track-a-Cow	Lying Time, Time at Feedbunk
Mastiline	Somatic Cell Count
CowManager Sensoor	Rumination Time, Feeding Time, Ear Skin Temperature, Activity
IceQube	Lying Time, Steps, Locomotion
Anemon	Vaginal Temperature, Estrus
TempTrack	Reticulorumen Temperature
FeverTag	Tympanic Temperature
AccuBreed	Mounting Activity
CowScout	Leg Activity

Precision Dairy Farming Benefits

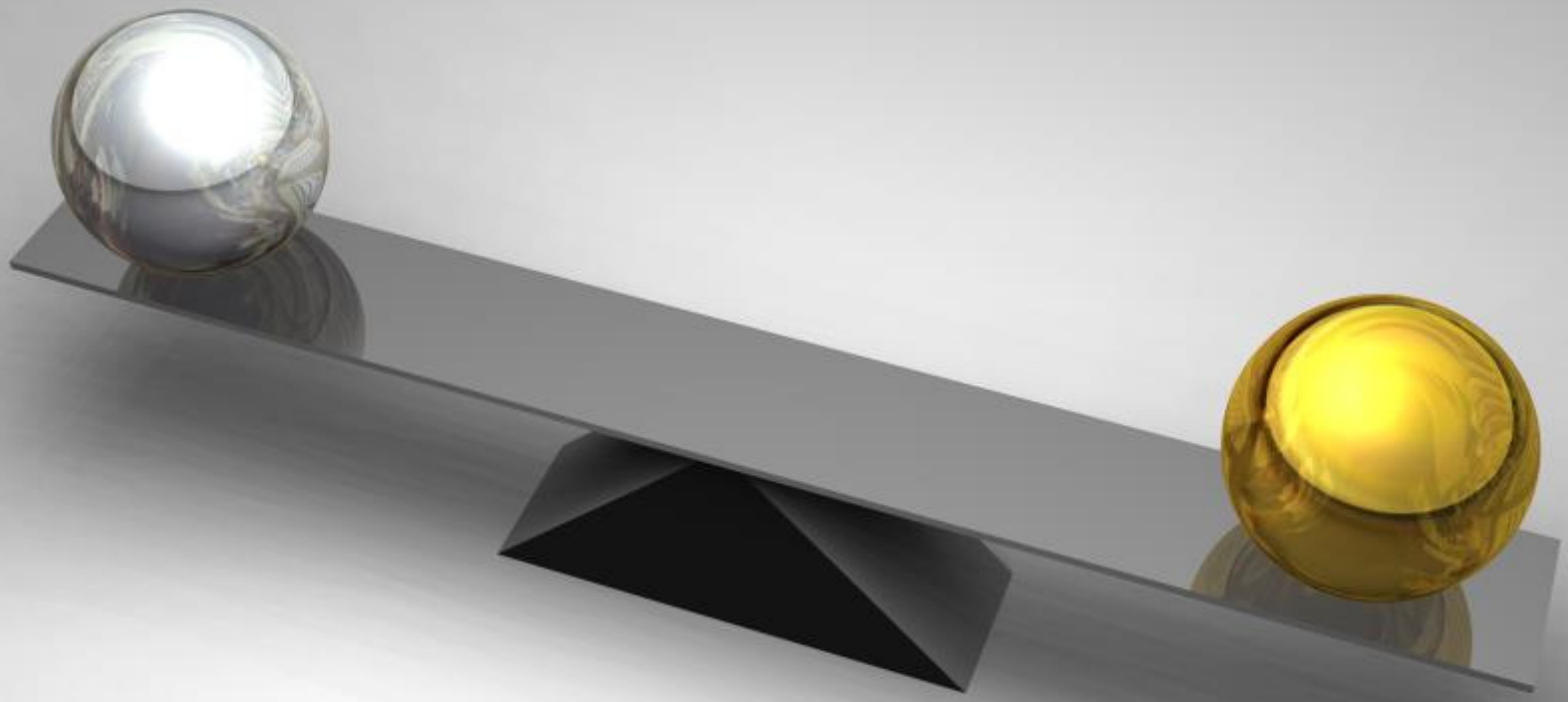
- Improved animal health and well-being
- Increased efficiency
- Reduced costs
- Improved product quality
- Minimized adverse environmental impacts
- More objective

So Many Options!!!!

Ideal Technology

- Explains an underlying biological process
- Can be translated to a meaningful action
- Cost-effective
- Flexible, robust, reliable
- Simple and solution focused
- Information readily available to farmer
- Commercial demonstrations

Technological Transformation



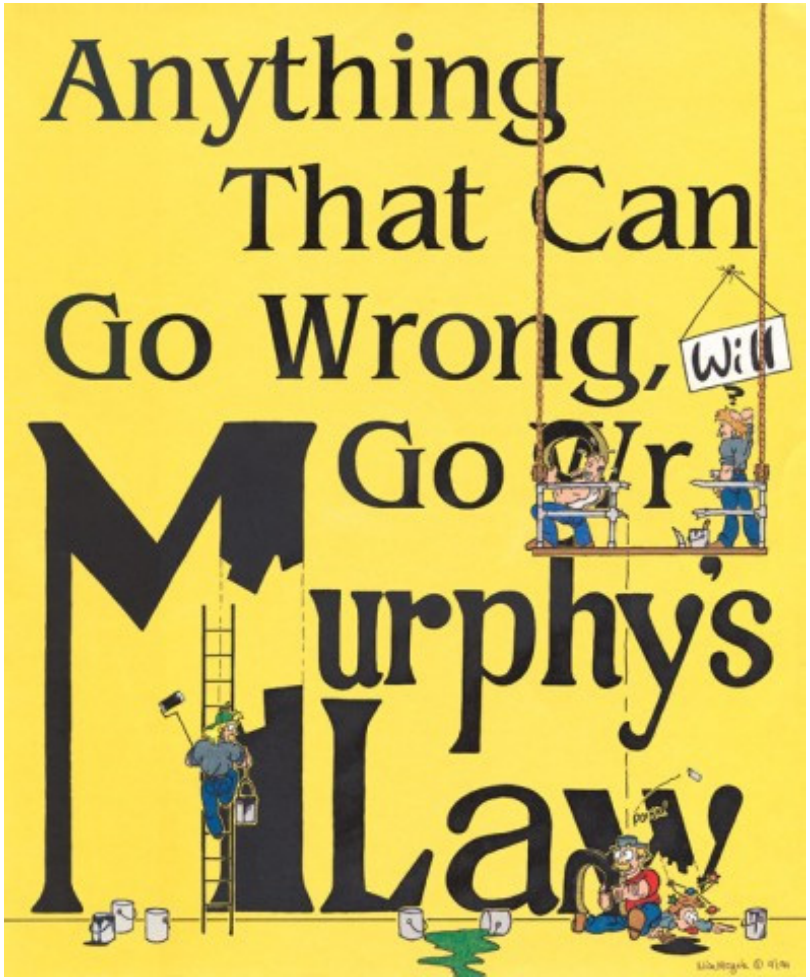
Associated Challenges

What Are the Limitations of Precision Dairy Farming?

PDF Reality Check

- Maybe not be #1 priority for commercial dairy producers (yet)
- Many technologies are in infancy stage
- Not all technologies are good investments
- Economics must be examined
- People factors must be considered

Murphy's Law



Sheldon's Friendship Flowchart
(as Modified by Wolowitz)

Place Phone Call

Home

No

Leave Message

Wait for Callback

Would You Like to Share a Meal

What Is the Response?

No

Yes

Dine Together?

Do You Enjoy a Hot Beverage?

What Is the Response?

No

Yes

Case:
Tea
Coffee
Cocoa

Have Tea
Have Coffee
Have Cocoa

Begin Friendship

n = No

Recreational Activities! Tell Me One of Your Interests?

No

ESC

Yes

LOA

n = 3

Do I Share That Interest?

Yes

Why Don't We Do That Together?

Partake in Interest

Technology Pitfalls

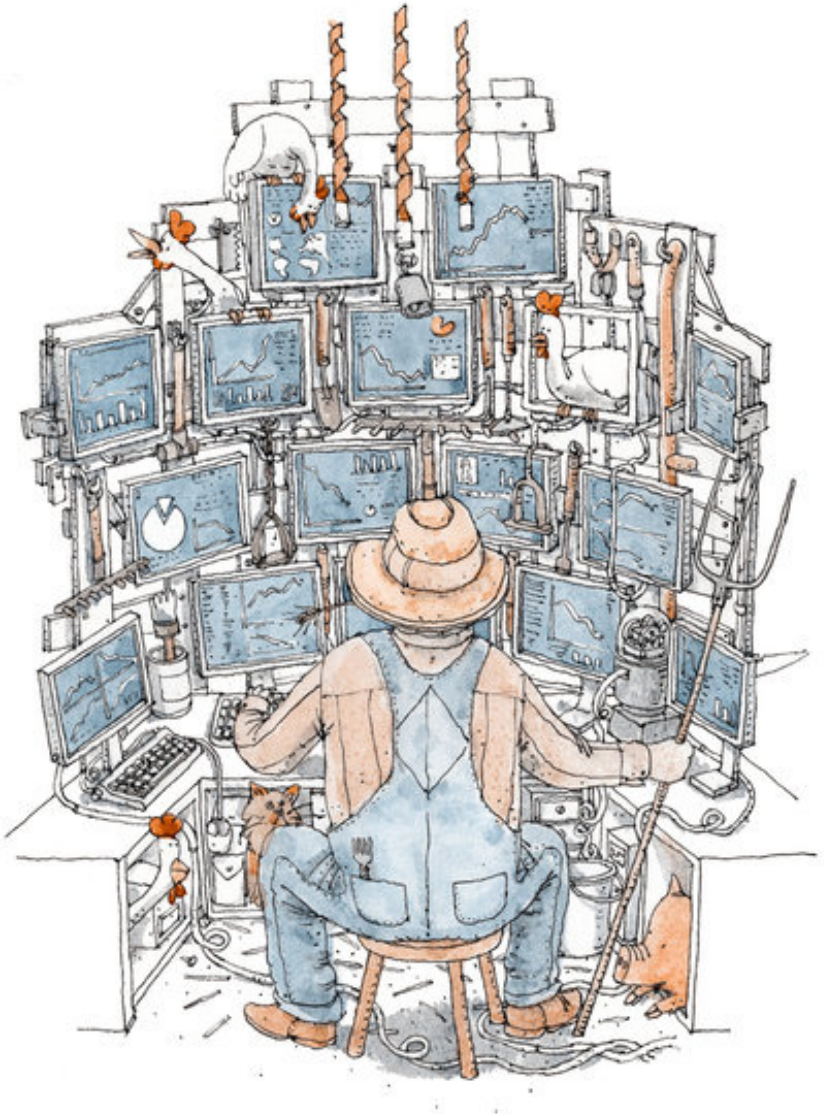
- “Plug and play,” “Plug and pray,” or “Plug and pay”
- Technologies go to market too quickly
- Not fully-developed
- Software not user-friendly
- Developed independently without consideration of integration with other technologies and farmer work patterns

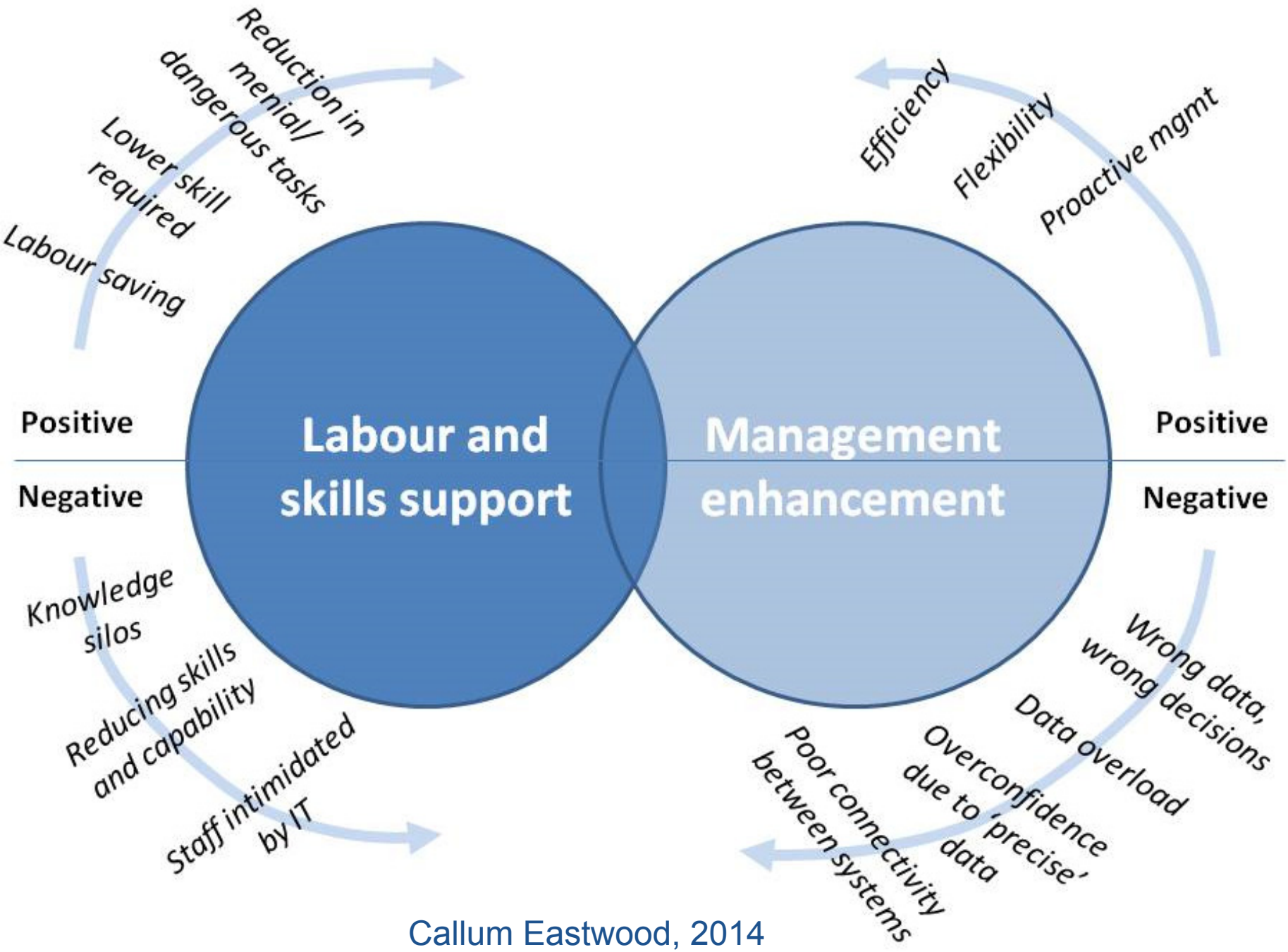
Technology Pitfalls

- Too many single measurement systems
- Lack of large-scale commercial field trials and demonstrations
- Technology marketed without adequate interpretation of biological significance of data
- Information provided with no clear action plan

- Be prepared for little things to go wrong
- Be careful with early stage technologies
- Need a few months to learn how to use data
- Data integration is challenging

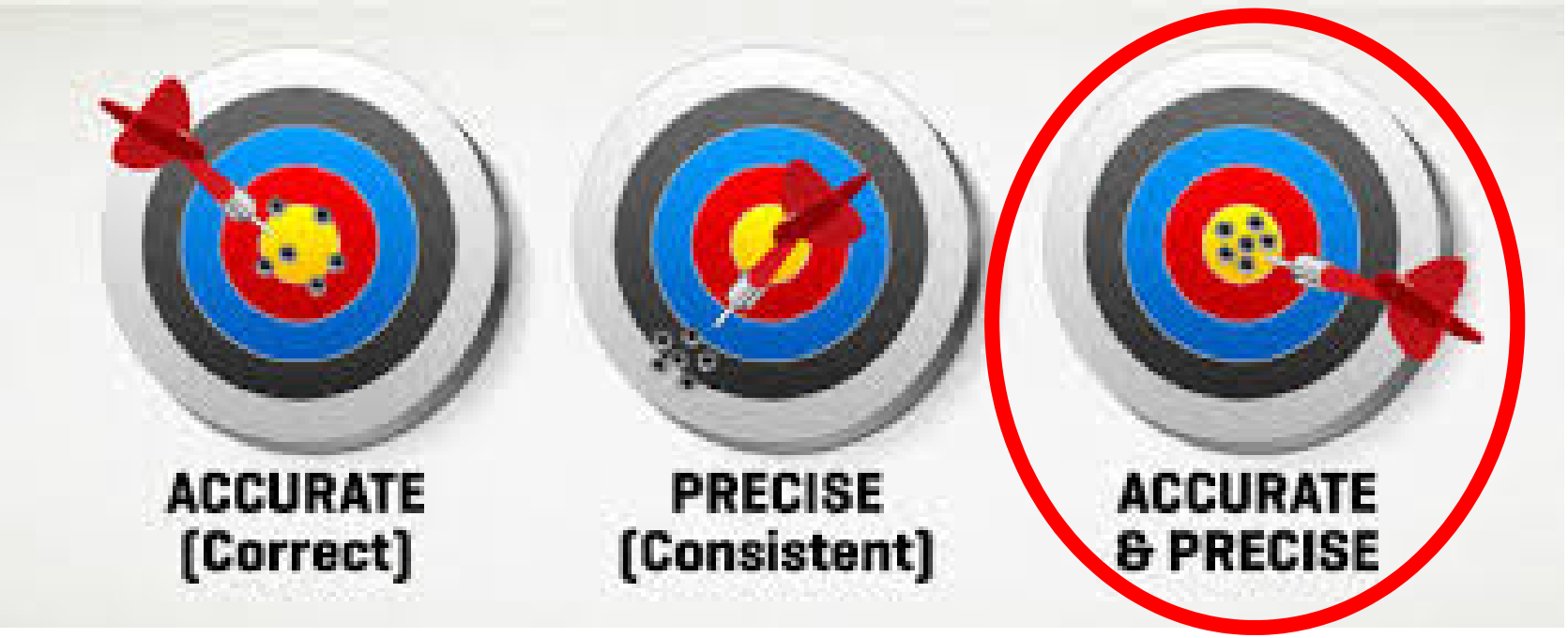
UK Herdsman Office





Callum Eastwood, 2014

Accuracy and Precision



Sensitivity and Specificity

Sensitivity (true positive rate): alert with an observed mastitis case

$$Sensitivity = \frac{true\ positives}{true\ positives + false\ negatives}$$

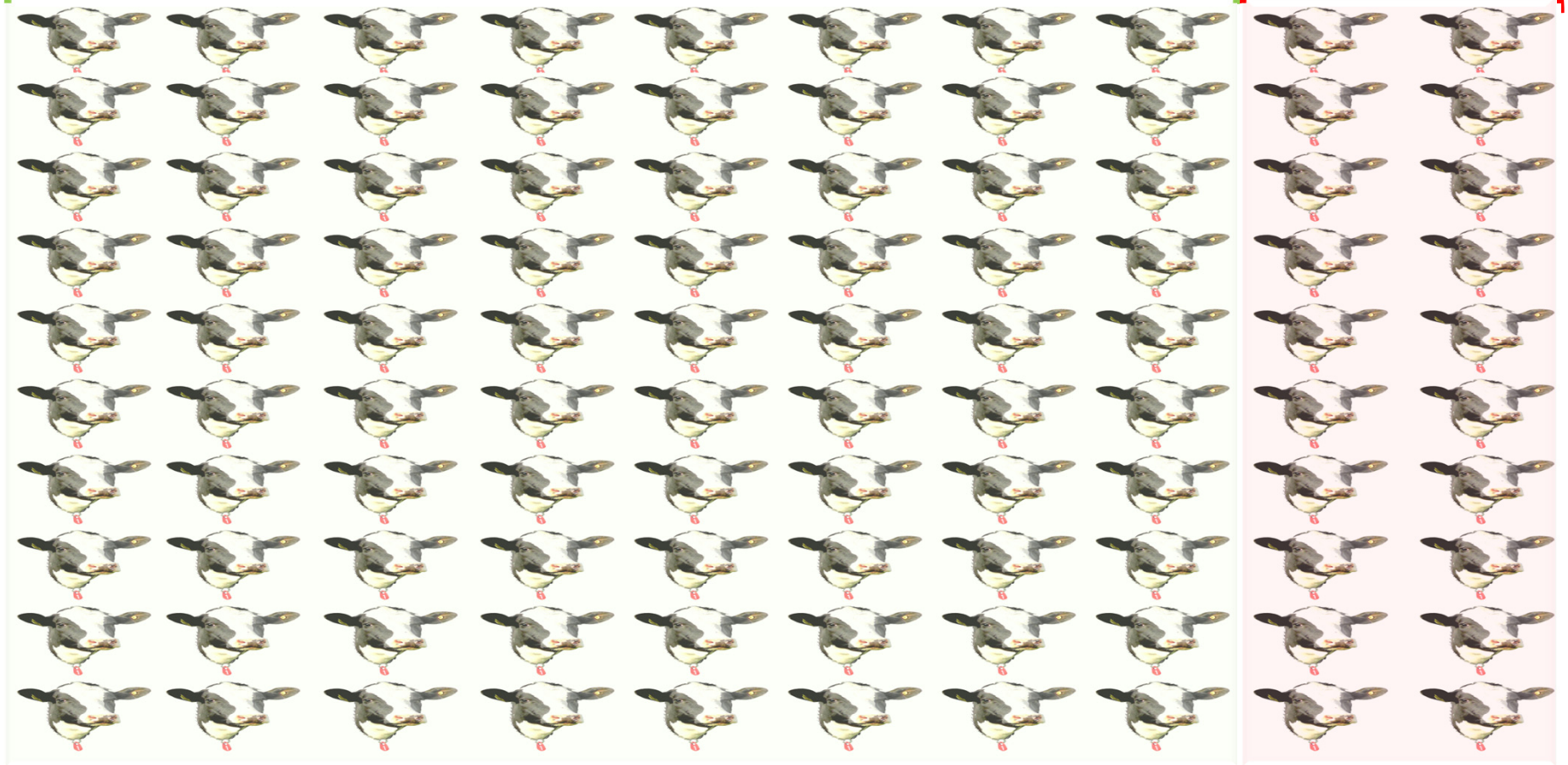
Specificity (true negative rate): no alert with no mastitis

$$Specificity = \frac{true\ negatives}{true\ negatives + false\ positives}$$

How Many Cows With Condition Do We Find?

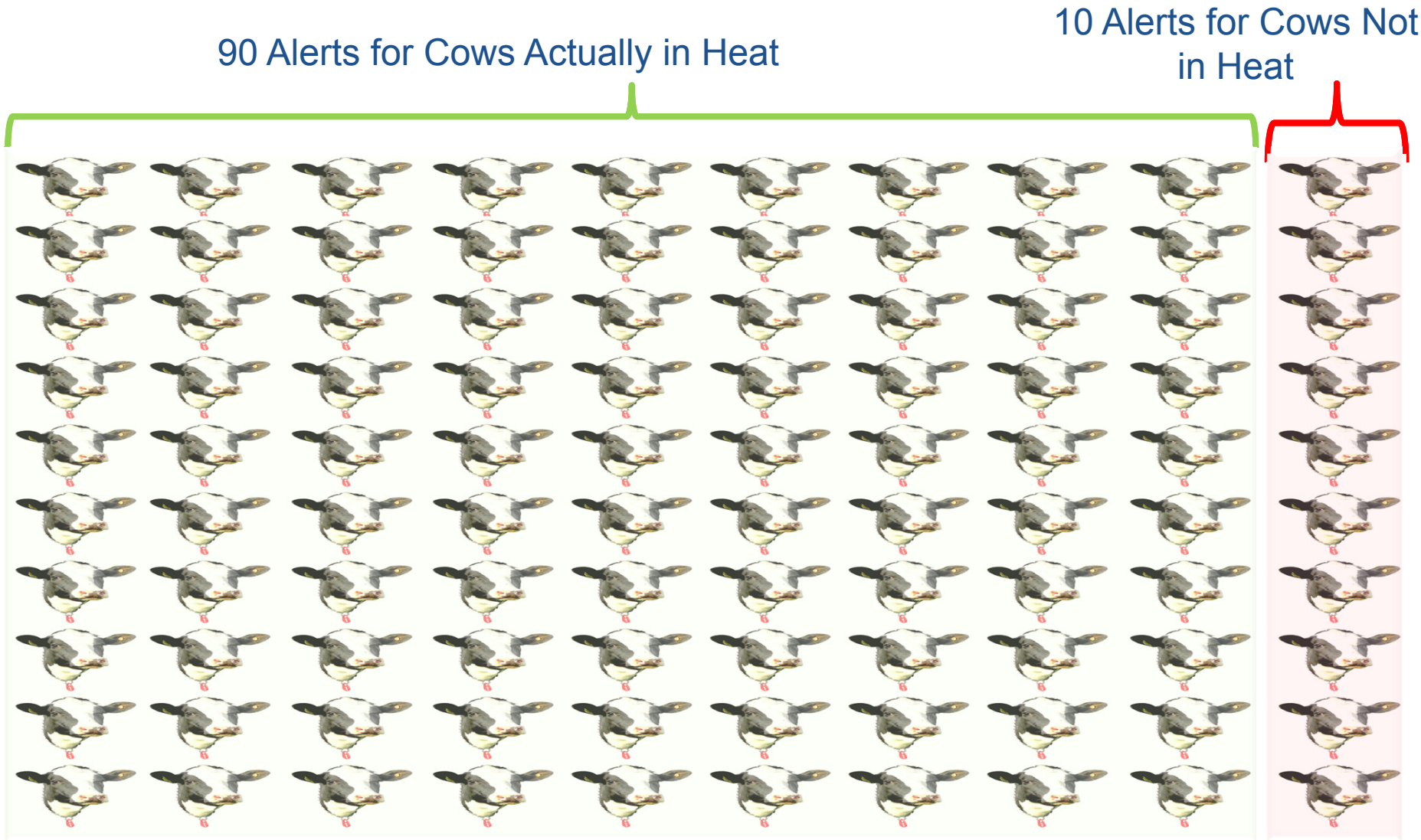
80 Estrus Events Identified by Technology

20 Estrus Events Missed by Technology



Example: 100 estrus events

How Many Alerts Coincide with an Actual Event?



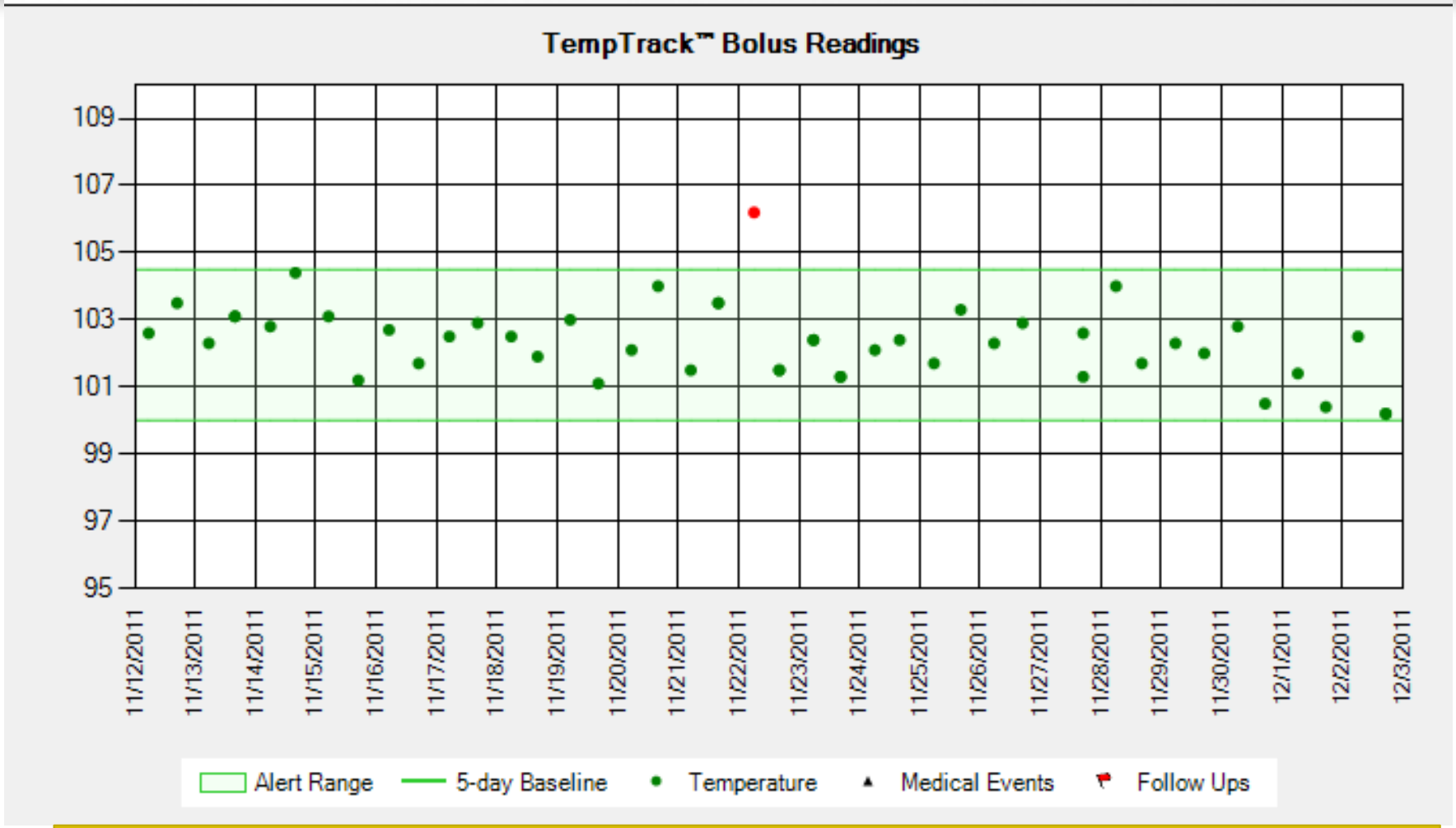
Example: 100 estrus events

What's the Sweet Spot?

- Cost of missed event
  - High for estrus
  - Lower for diseases?
- Cost of false positive
  - Low for estrus
  - High for mastitis
- Farm dependent


SMOKE
&
MIRRORS

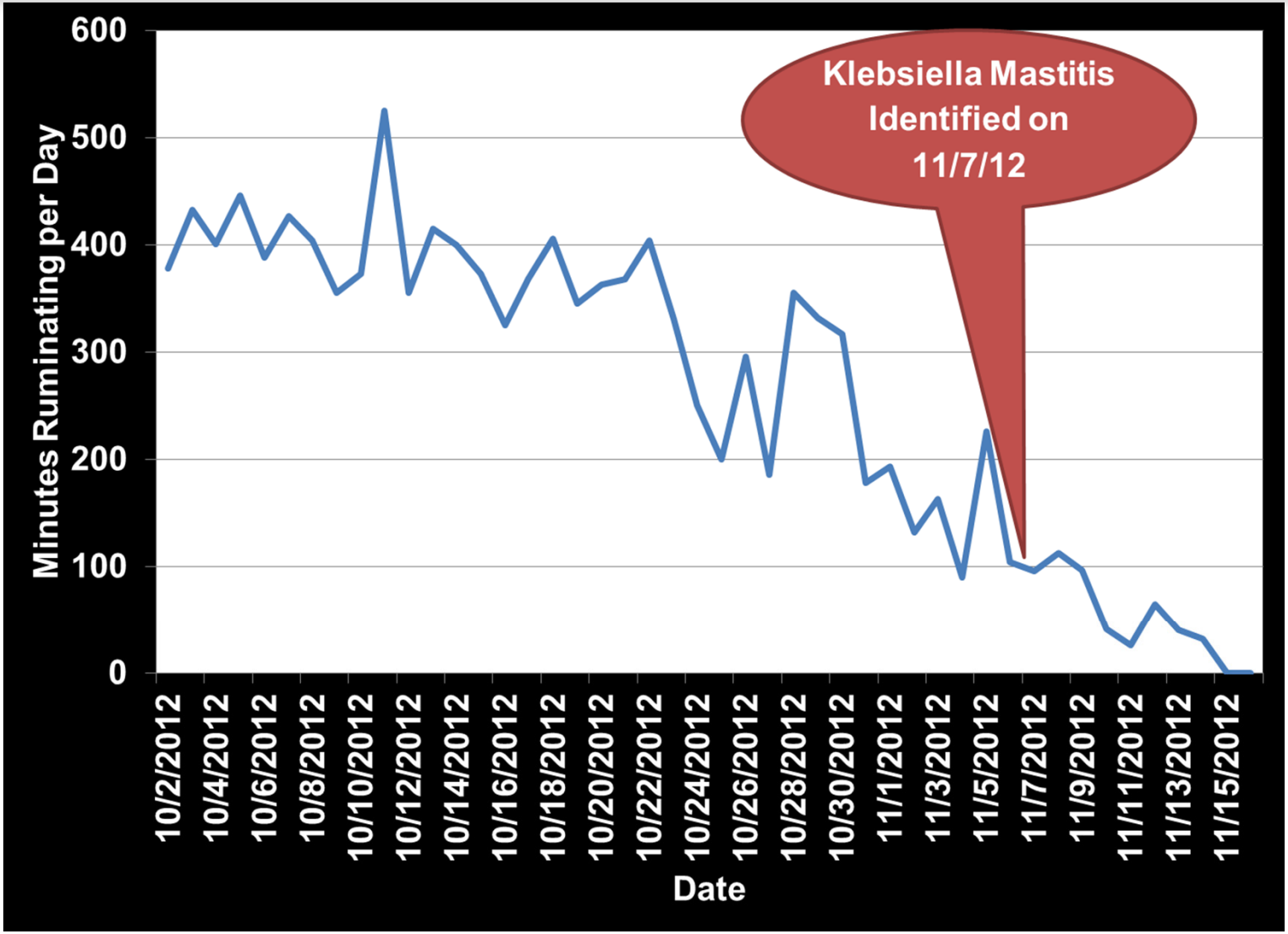
DVM TempTrack



1331 had *Strep uberis* isolated from her LF and RF quarters on 11/29/11

Amanda Sterrett et al. , Unpublished Data

SCR Rumination Time



Amanda Sterrett et al. , Unpublished Data

Percent of cows above and below Z-score thresholds and varying alert time windows from udder quarters from clinical, subclinical, and mastitis-free cows

			Subclinical mastitis		Clinical mastitis		No mastitis detected	
Z-score threshold	Observation window (d)	Variable monitored	% Below	% Above	% Below	% Above	% Below	% Above
-2	1	RU	45	55	49	51	54	46
-3	1	RU	45	55	49	51	54	46
-3	2	RU	46	54	49	51	54	46
-3	2	RU	46	54	49	51	54	46
-2	3	RU	48	52	46	53	56	44
-3	3	RU	47	53	48	52	55	45
-2	1	NA	45	55	49	51	54	46
-3	1	NA	45	55	49	51	54	46
-2	2	NA	46	54	49	51	54	46
-3	2	NA	46	54	49	51	54	46
-2	3	NA	48	52	48	52	56	44
-3	3	NA	47	53	48	52	55	45
-2	1	MY	4	96	22	78	35	65
-3	1	MY	4	96	21	79	35	65
-2	2	MY	7	93	25	75	35	65
-3	2	MY	7	93	25	75	35	65
-2	3	MY	15	85	29	71	38	62
-3	3	MY	15	85	29	71	37	63

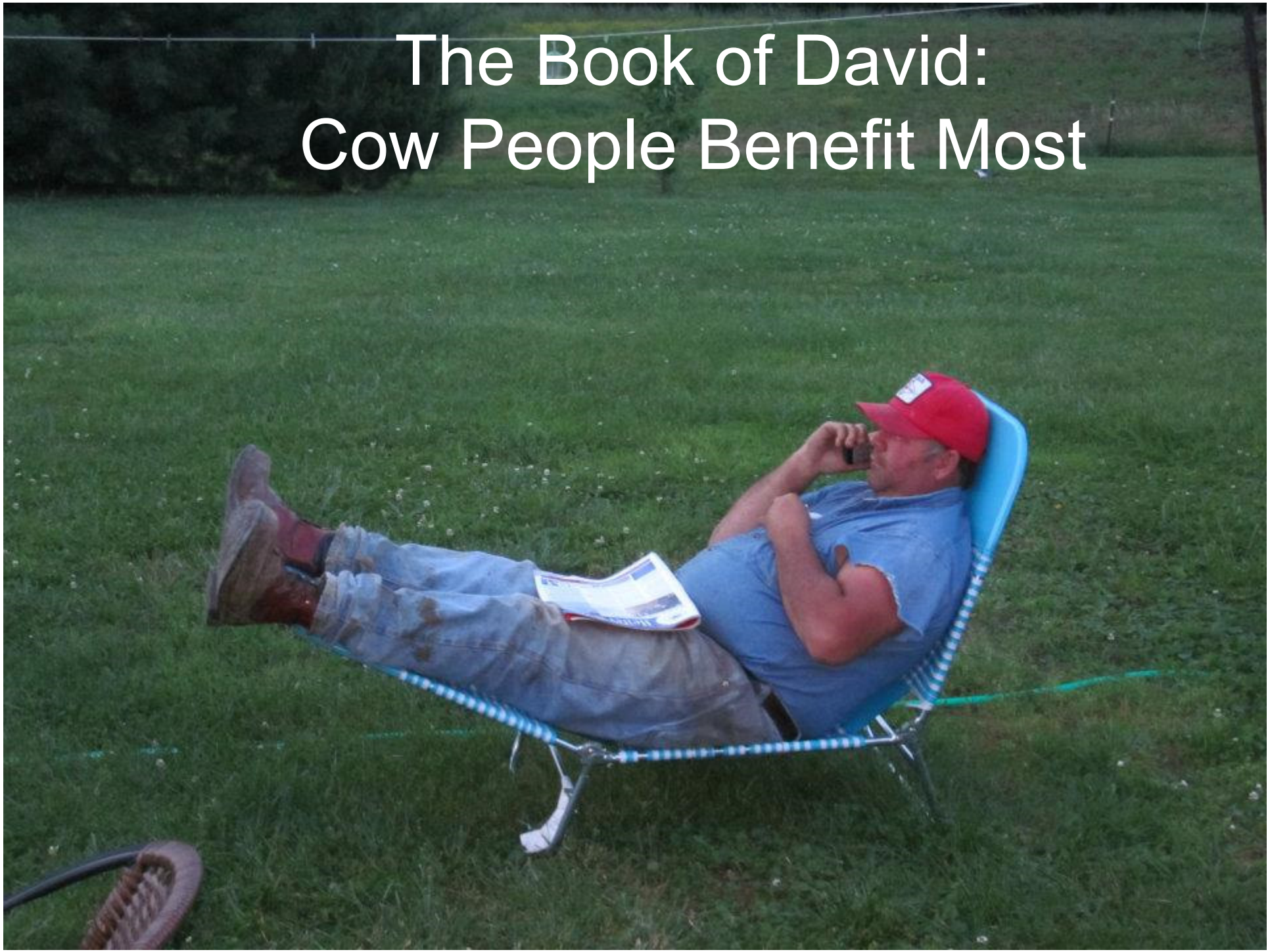
RU = rumination time, NA = neck activity, and MY = milk yield.

From Purdue to Poor Due

PURDUE
UNIVERSITY

Did I get the wrong PhD?

The Book of David:
Cow People Benefit Most



Why Have Adoption Rates Been Slow?

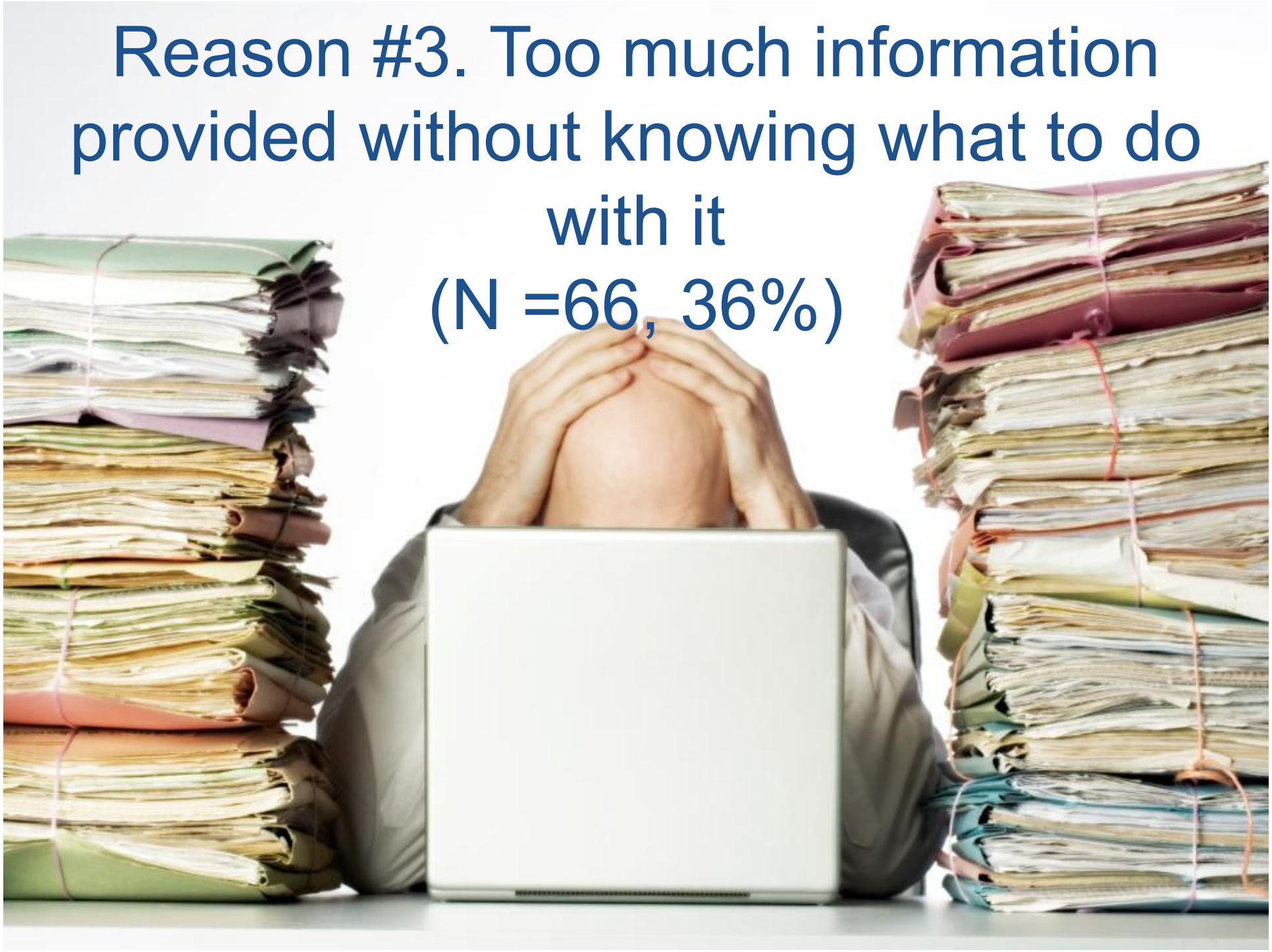
Rebecca Russell, 2013


Reason #1. Not familiar with technologies that are available (N =101, 55%)

Reason #2. Undesirable cost to benefit ratio

(N =77, 42%)

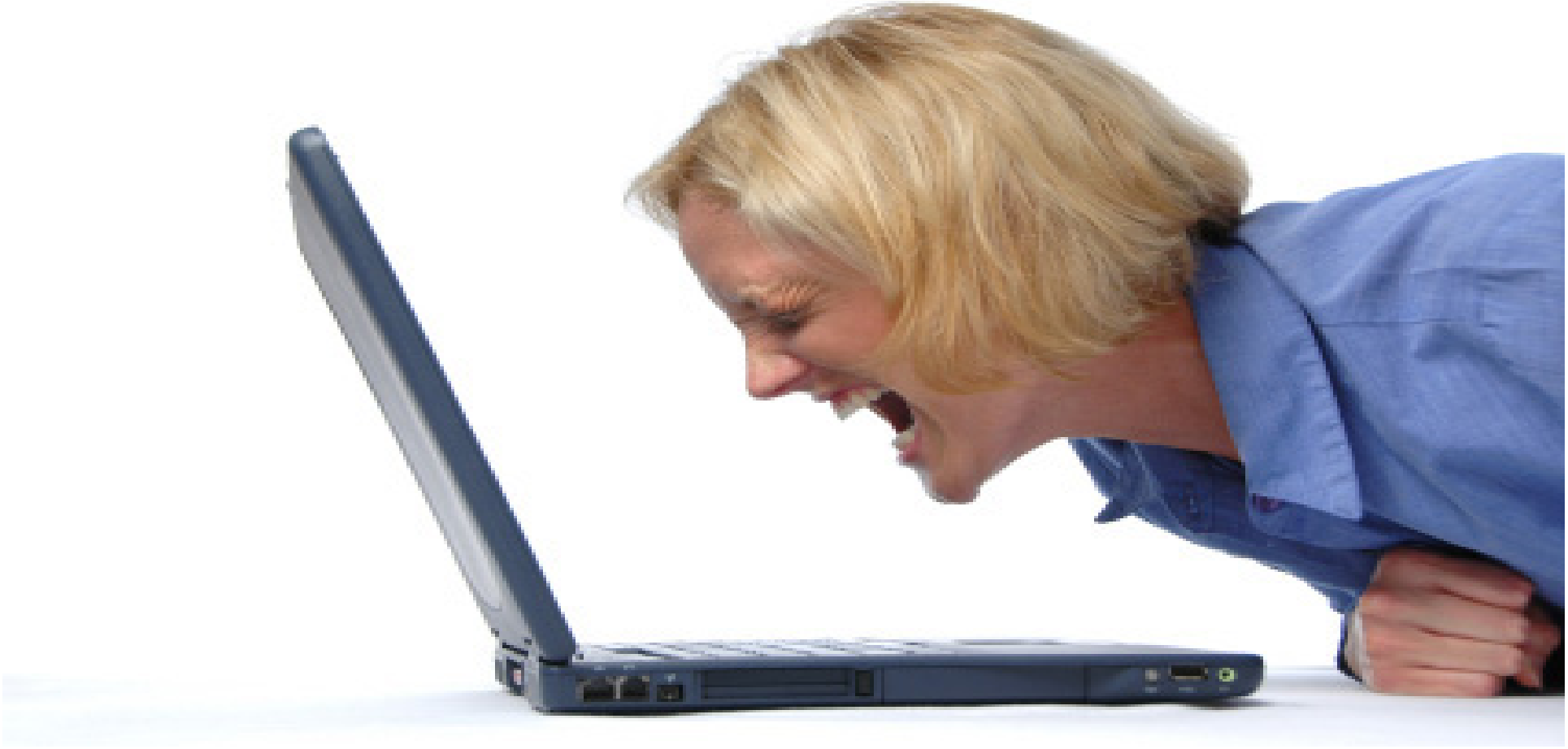
Reason #3. Too much information provided without knowing what to do with it (N =66, 36%)



Reason #4. Not enough time to spend on technology (N =56, 30%)

Reason #5. Lack of perceived economic value (N =55, 30%)

Reason #6. Too Difficult or Complex to Use (N =53, 29%)

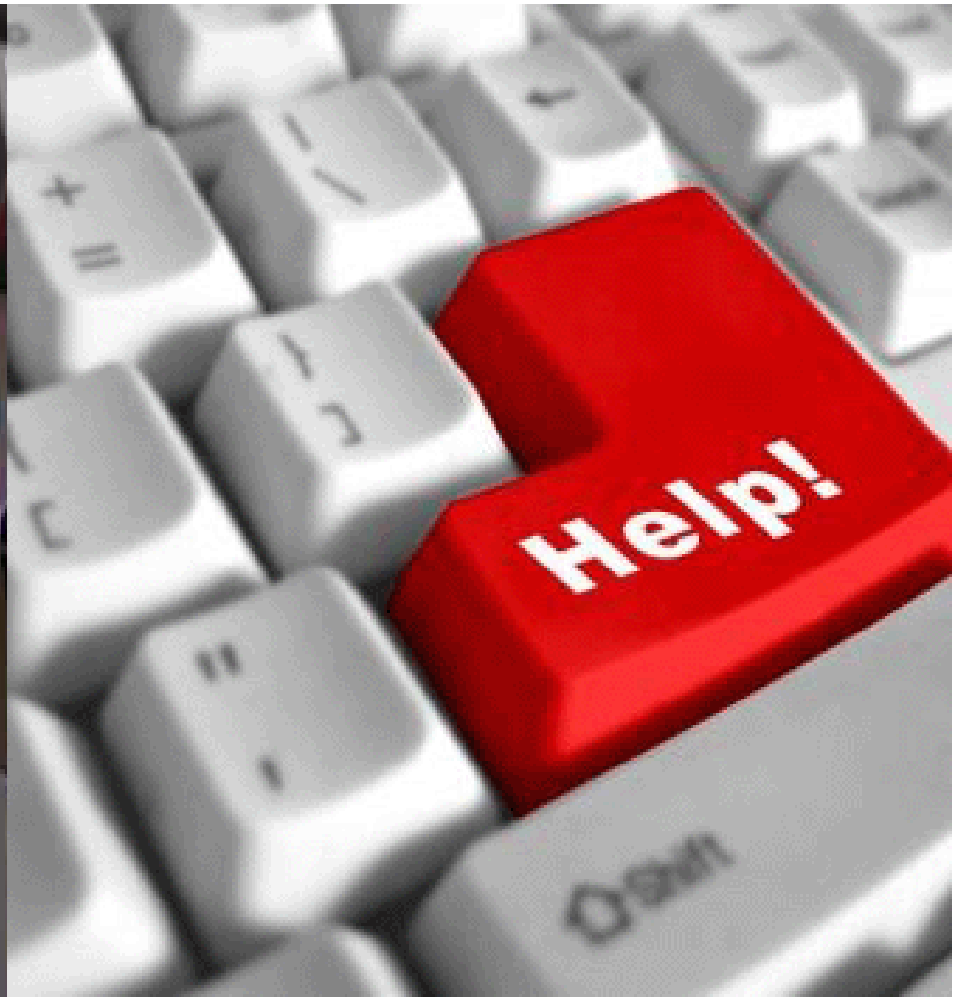


Reason #7. Poor technical support/training (N =52, 28%)

Reason #8. Better alternatives/easier to accomplish manually (N =43, 23%)

Reason #9. Failure in fitting with farmer patterns of work (N =40, 22%)

Reason #10. Fear of technology/computer illiteracy (N =39, 21%)



Reason #11. Not reliable or flexible enough (N =33, 18%)

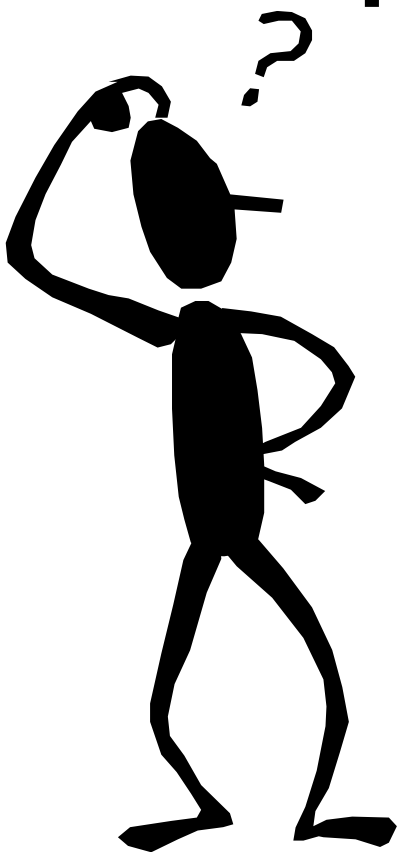
What do producers consider before purchasing one of these technologies?

Consideration #1.
Benefit: cost ratio
(4.57 ± 0.66)

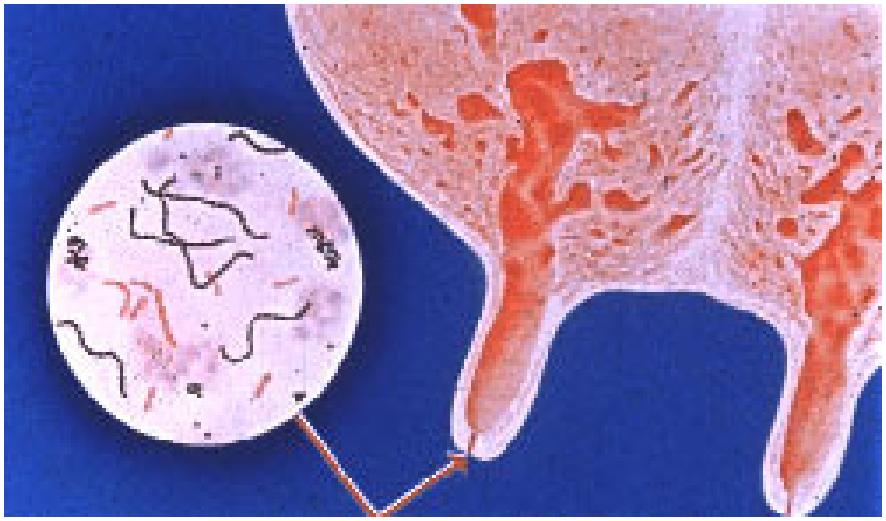
Consideration #2
Total investment cost
(4.28 ± 0.83)

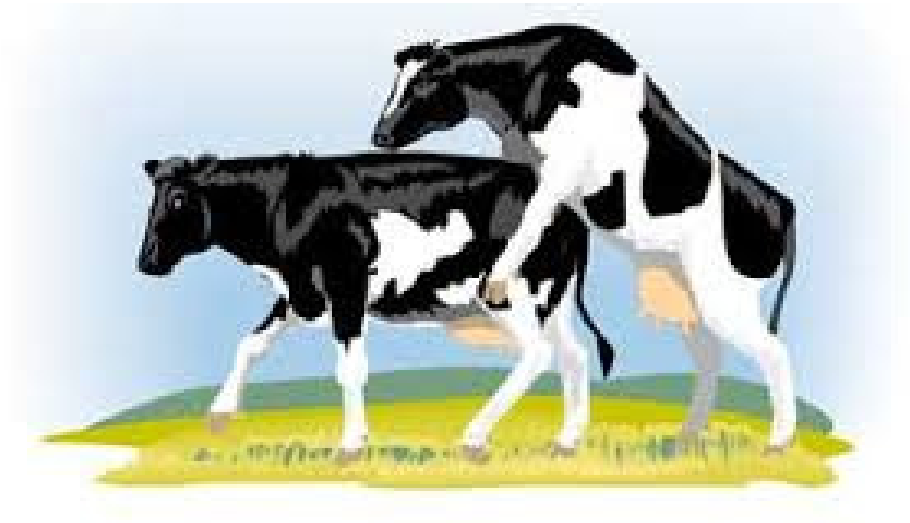
Consideration #3. Simplicity and ease of use (4.26 ± 0.75)

What parameters do producers find most useful in technologies?

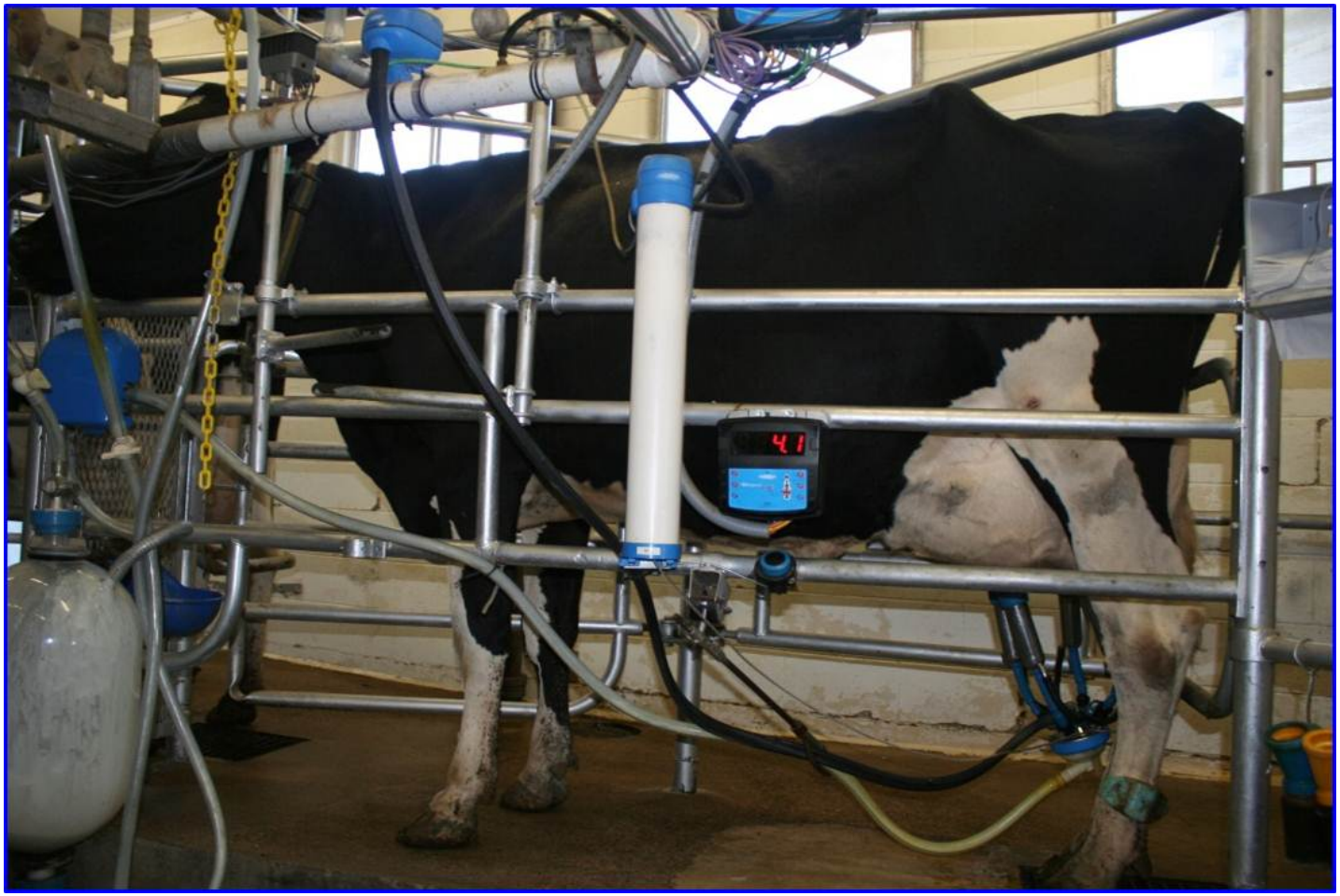


Important Parameter #1. Mastitis (4.77 ± 0.47)





Important Parameter #2
Standing heat
(4.75 ± 0.55)



Important Parameter #3 Daily milk yield

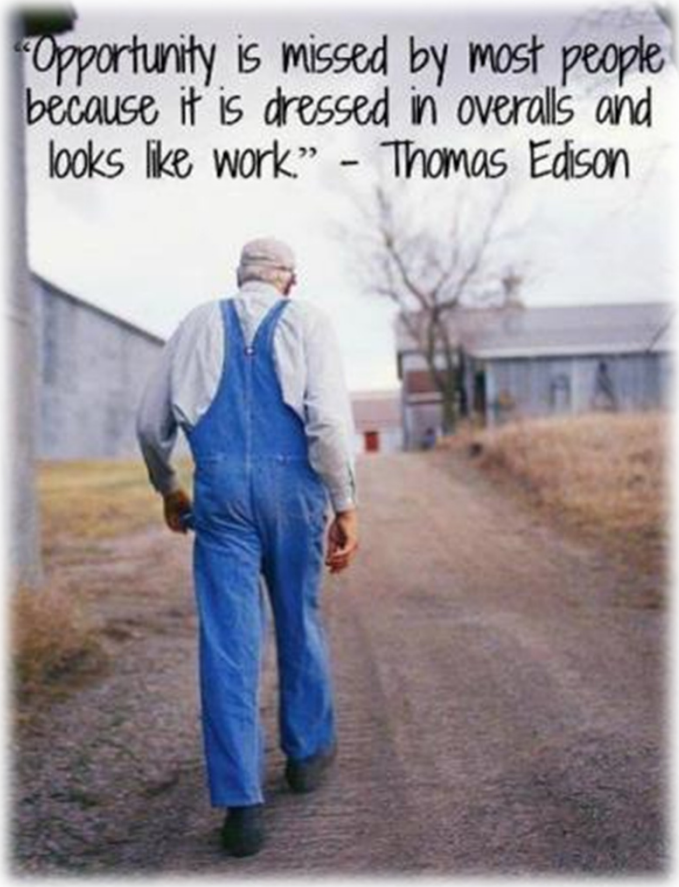
(4.72 ± 0.62)

Economic Considerations

- Need to do investment analysis
- Not one size fits all
- Economic benefits observed quickest for heat detection/reproduction
- If you don’t do anything with the information, it was useless
- Systems that measure multiple parameters make most sense
- Systems with low fixed costs work best for small farms

Cautious Optimism

- Critics say it is too technical or challenging
- We are just beginning
- Precision Dairy won't change cows or people
- Will change how they work together
- Improve farmer and cow well-being



Path to Success

- Continue this rapid innovation
- Maintain realistic expectations
- Respond to farmer questions and feedback
- Never lose sight of the cow
- Educate, communicate, and collaborate

Future Vision

- New era in dairy management
- Exciting technologies
- New ways of monitoring and improving animal health, well-being, and reproduction
- Analytics as competitive advantage
- Economics and human factors are key

Questions?

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