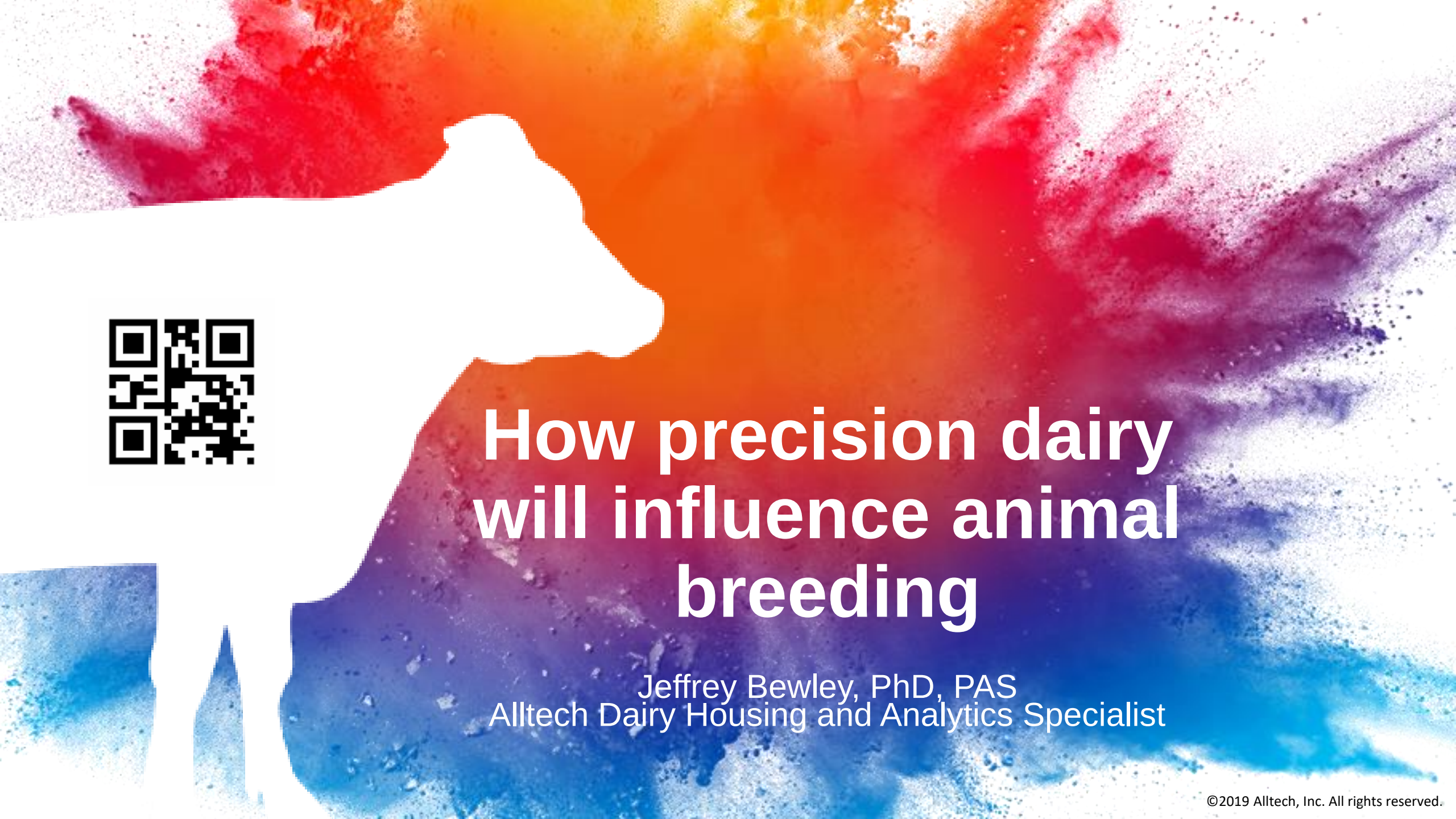
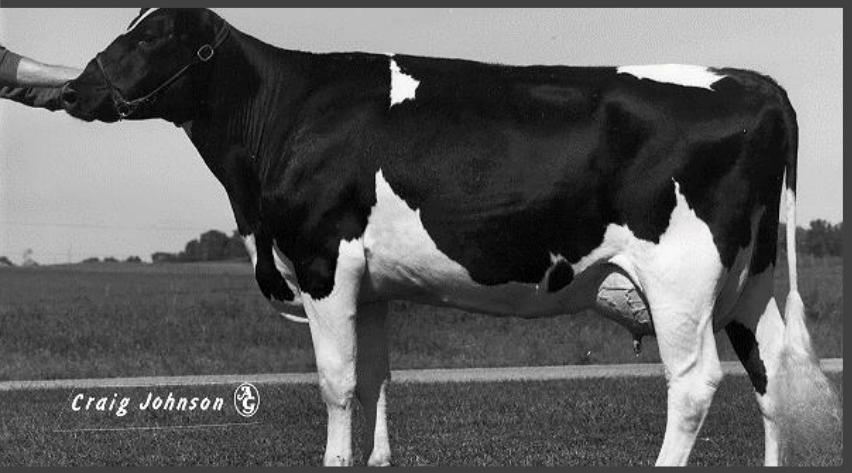


How precision dairy will influence animal breeding

Jeffrey Bewley, PhD, PAS
Alltech Dairy Housing and Analytics Specialist



Genetic Interest

- The first sire book that I studied cover to cover was as an 8-year-old
- Internship with AI company (NOBA) during college
- Mentors told me I’d never find a job in genetics
- Involved in breeding with partners in Kentucky

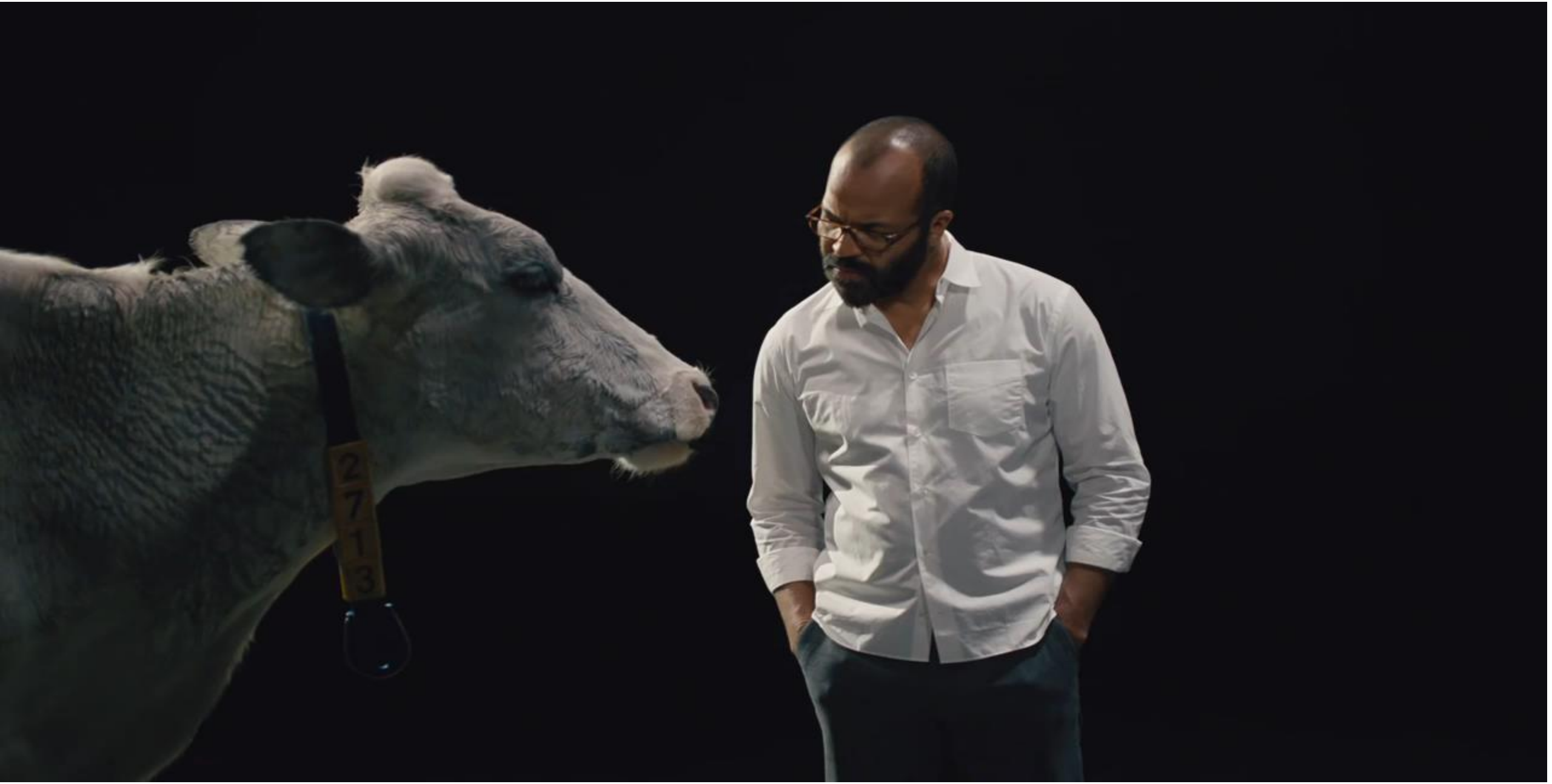
ICE BLUE

BLUE COW

Genetics + **Environment** = **Phenotype**

The Opportunity

- Considerable opportunities for measuring novel phenotypes
- Previously unavailable, consistent, objective measures for traits that have been difficult to measure in the past
- Traits may be incorporated into robustness assessments focused on measuring animal health, reproduction, behavior, and longevity (Hocquette et al., 2012)


2713

Analytics is The Next Scientific Breakthrough

LIVESTOCK **TECH LANDSCAPE** 2018

The Mixing Bowl — CONNECTING INNOVATORS IN FOOD, AG & IT

INNOVATION CENTER FOR U.S. DAIRY — HEALTHY PEOPLE • HEALTHY PRODUCTS • HEALTHY PLANET

LIVESTOCK HEALTH

Fertility / Breeding

ENGENDER · FUJITSU FUJITSU KYUSHU SYSTEMS · TL Biolabs · AgBoost

Activity Tracking / Wearable

QUANTIFIEDAG · smaXtec · Farmnote · FEVERTAGS · SCR by Allflex Make every cow count · nedap technology that matters · Afimilk Silent Herdsman · EmbediVet · FRESH COW MANAGER · GALLAGHER · iCEROBOTICS · Connecterra · Moocall connecting you to your animals · COWLAR · HerdDogg · CowManager · SMARTBOW

Disease Detection / Prevention

AAD Advanced Animal Diagnostics · EPIBIOME · automea · REX · WellCow · SmartVet Work Smarter, Not Harder · EIO DIAGNOSTICS · VitalHerd · MASTILINE

Cattle Herd Management

FARMIQ · SCR by Allflex Make every cow count · DairyCOMP 305 · AGVOICE · stellapps Smart Systems, Stellar Applications. · bovcontrol · DRMS DAIRY RECORDS MANAGEMENT SYSTEMS · HEALTHSUM · DHI-PROVO · VETIDENT · DeLaval · JETBOV · farmwizard magic herd management · milker · afimilk Vital know-how in every drop · PRODAP · herdwatch · CALF BOOK · AKOL · My Dairy DASHBOARD · agrigate · tambero.com · Cow Sense Herd Management Software · Cargill · DairyLive · Cattlesoft

LIVESTOCK MANAGEMENT

Nutrition / Feed

Hi-Plains Systems · DairyCOMP 305 · DRMS DAIRY RECORDS MANAGEMENT SYSTEMS · Hokofarm Group · VETIDENT · GrowSafe · SCIO by Consumer Physics · Agrimatics · adifo software · DALEX · AgBoost · DHI-PROVO · AgroVision Smart farming · Alltech · BioGen AG SYSTEMS · Cargill · PERFORMANCE LIVESTOCK ANALYTICS · PRODAP · FEEDMNGR · FEEDLOGIC CORPORATION · DIGI★STAR TOPCON POSITIONING GROUP

Barn / Stall / Pasture Tech

GALLAGHER · AGERSENS · cainthus · VENCE · maia TECHNOLOGY · Greengage Enlightened Farming · HALTER · PastureMap · iotag · farmGRAZE

Automation/Robotics

DIGI★STAR TOPCON POSITIONING GROUP · LIC · CALFSMART · miRobot · SAC · LELY · GEA · SCR by Allflex Make every cow count · INSENTEC · Metabolic Robots Prevailing on the Wings of Technology™ · DeLaval · afimilk Vital know-how in every drop

Livestock Management

intelia · CRITTERWORKS · ISAGRI L'informatique à portée de main · easy keeper · AgriWebb · Allflex · Porphyrio · SWINETECH · FARMIQ · CLOUDFARMS

LIVESTOCK OPERATIONS

Operations Management

AGRITEC · farmbrite · iCow · PROGRESSIVE SOFTWARE INC. ProSoftXP · FAIRPORT Farm Software · Dairy.com · DAIRY COACH · DairyQuest · Qbil software · CULTURA technologies

Livestock Trading

PrimeXConnect · ARI.FARM · SellMyLivestock · Farmia · AuctionsPlus

What Can We Learn From Basketball?

From Basketball to Cows

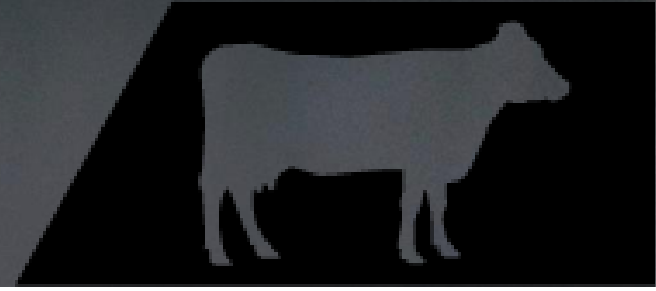
Efficient Players

- Nothing flashy
- No one knows her name
- High production
- Feed efficient
- Doesn’t get sick
- Breeds back quickly

- Nothing flashy
- No one knows his name
- Moderate points
- Scores when needed
- Top notch defense
- Wins games

Alltech®

Basketball Analytics



- ***Effective field goal percentage***: takes into account that 3 pointers are worth more than 2 pointers
- ***Value added***: what a player adds to a team above what a replacement player would
- ***Player efficiency rating***: Overall rating of a player's per minute statistical production

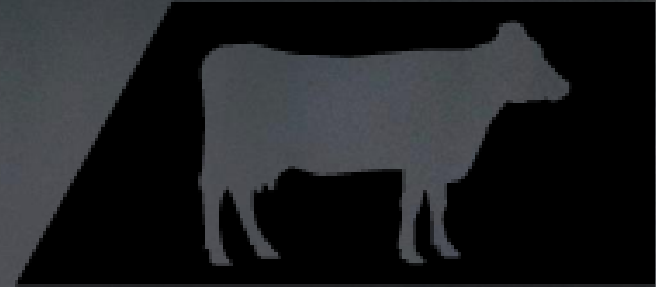
$$\text{uPER} \times \text{MP} = 3\text{PM} + \frac{2}{3}\text{AST} + \left(2 - f\frac{\text{TeamAST}}{\text{TeamFGM}}\right)\text{FGM} + \frac{1}{2}\text{FTM}\left(2 - \frac{1}{3}\frac{\text{TeamAST}}{\text{TeamFGM}}\right) - \nu\,\text{TO}$$

$$- \nu d\,(\text{FGA} - \text{FGM}) - 0.44\nu\,(0.44 + 0.56d)\,(\text{FTA} - \text{FTM}) + \nu\,(1-d)\,(\text{REB} - \text{OREB})$$

$$+ \nu d\,\text{OREB} + \nu\,\text{STL} + \nu d\,\text{BLK} - \text{PF}\left(\frac{\text{LeagueFTM}}{\text{LeaguePF}} - 0.44\frac{\text{LeagueFTA}}{\text{LeaguePF}}\nu\right)$$

Alltech®

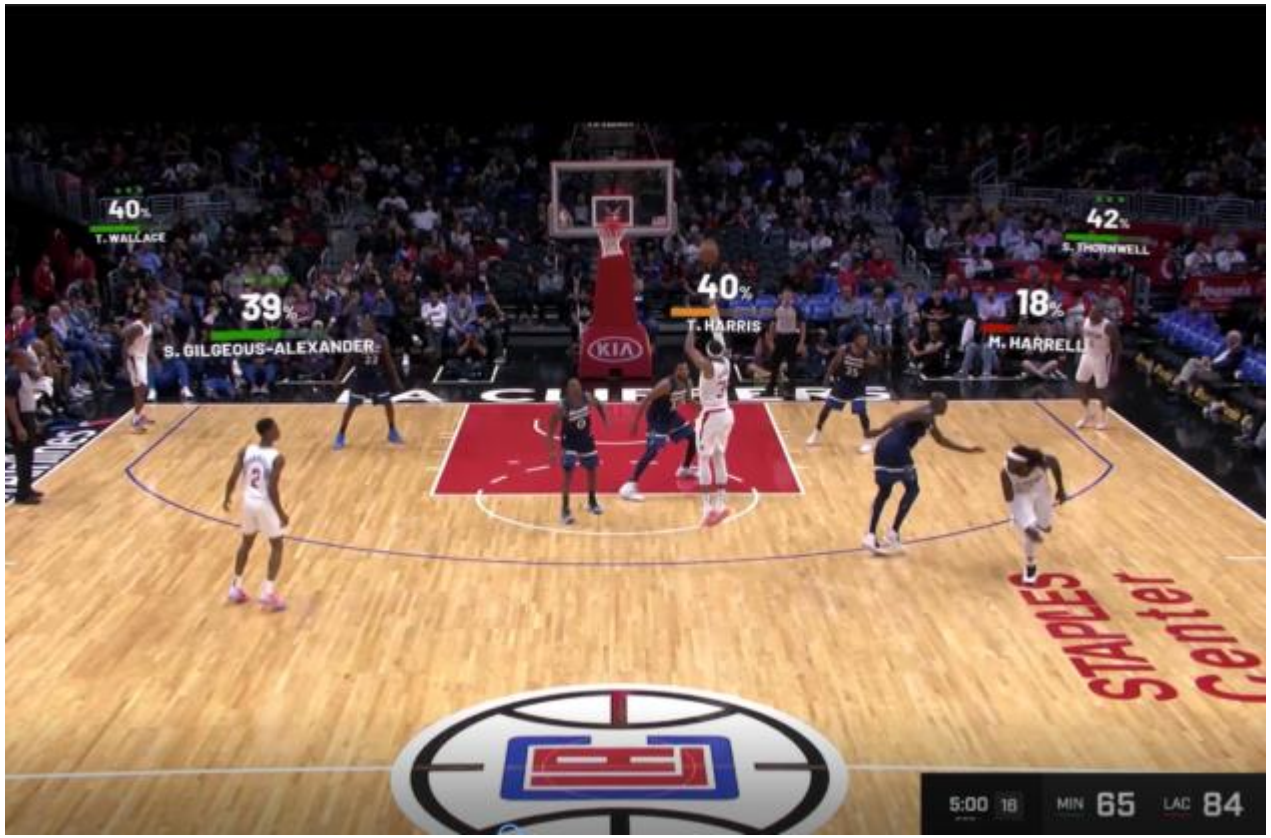
Dairy Cow Analytics

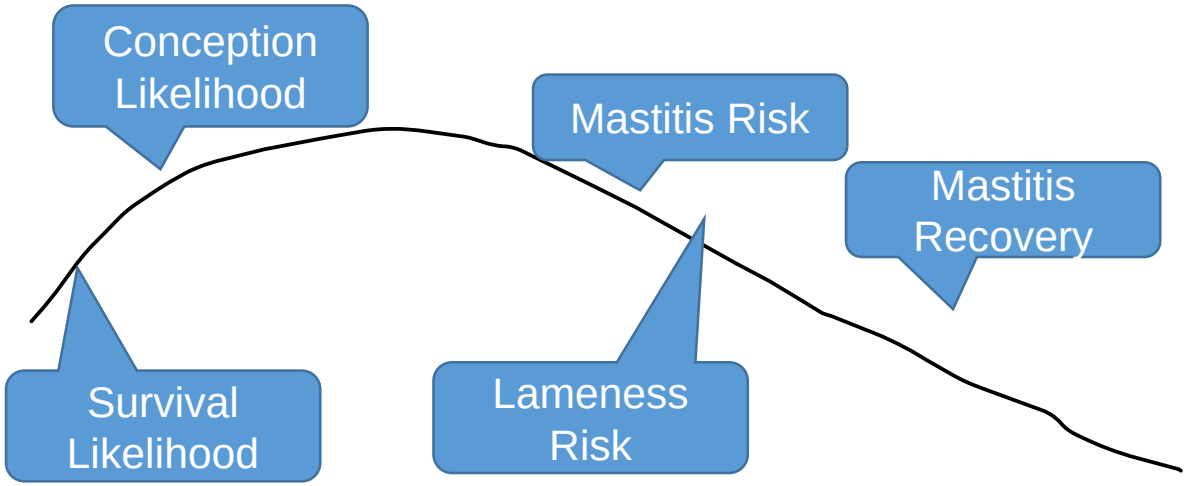


- ***Money corrected milk:*** revenue-based metric, considers value of components
- **Longevity corrected milk:** adjust milk yield to herd distribution of 30% 1st lactation, 20% 2nd lactation, 50% 3rd + lactation
- ***Retention pay-off:*** the value of a cow's future net revenues compared to her replacement
- ***Summer:winter ratios:*** compare milk, SCC, conception, etc. by season to monitor heat stress management

Alltech®

Dynamic Comparison





Basketball dynamically calculates shot percentages

Dairy can do the same within a lactation

Alltech®

Precision Dairy Monitoring

- Milk
- Behavior
- Physiology
- Conformation

Precision Dairy Monitoring Applications

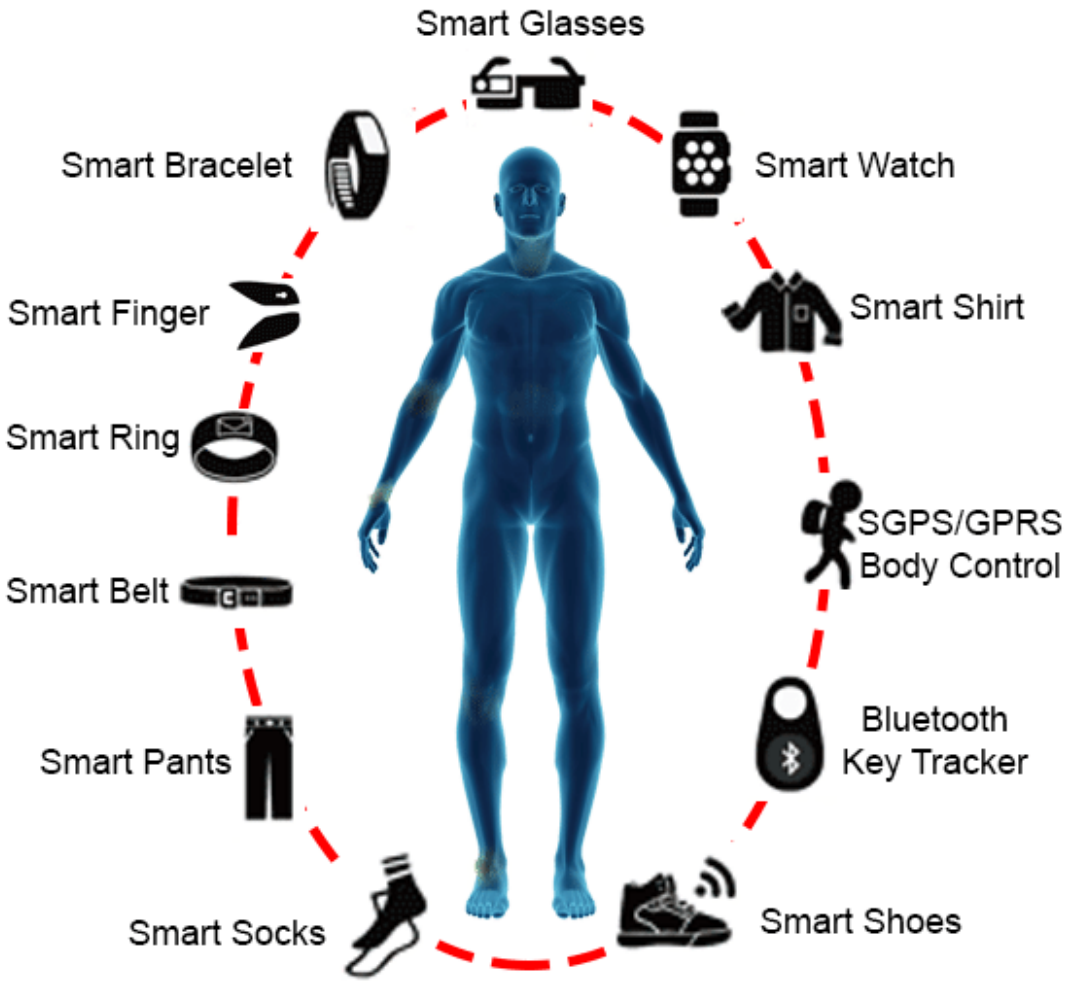
- Estrus Detection
- Mastitis Detection
- Fresh Cow Disease Detection
- Lameness Detection
- Calving Detection
- Management Monitoring

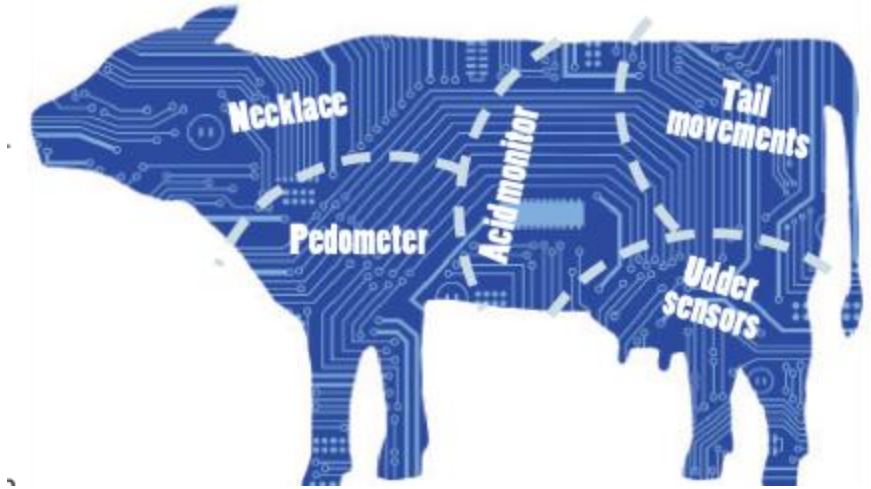
Wearables, Images, and Milk Analyses

Alltech®


Low Rumination
Cystic
High Resting
Non Cycling
Heat
Pregnant
Low Feeding
Embryonic Loss
Decreased Yield
DAIRYMASTER

Wearable Technologies






SMARTBOW
024F8D
BellaAg
Silent
Herdsman
afimilk
Beth Herges


806

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

Development of a noninvasive system for monitoring dairy cattle sleep

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

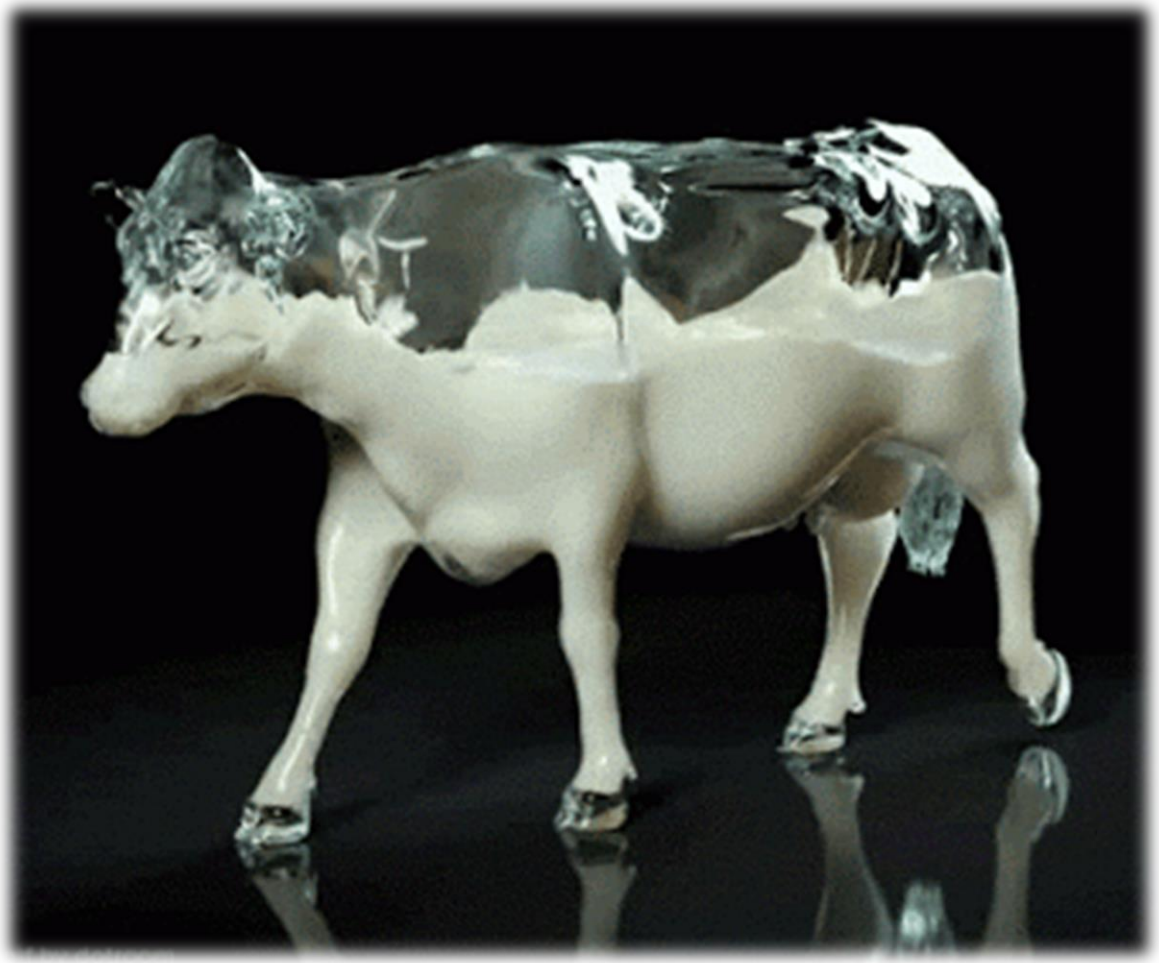
SMARTBOW®

YOUR COWS. YOUR BUSINESS.

GEA

Real Time Location Systems

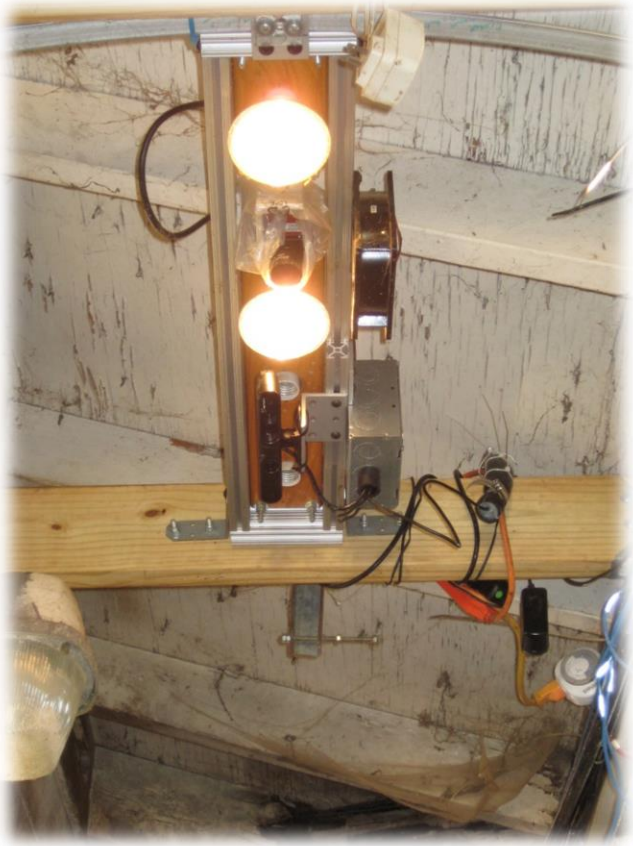
Future is Image and Milk Analysis

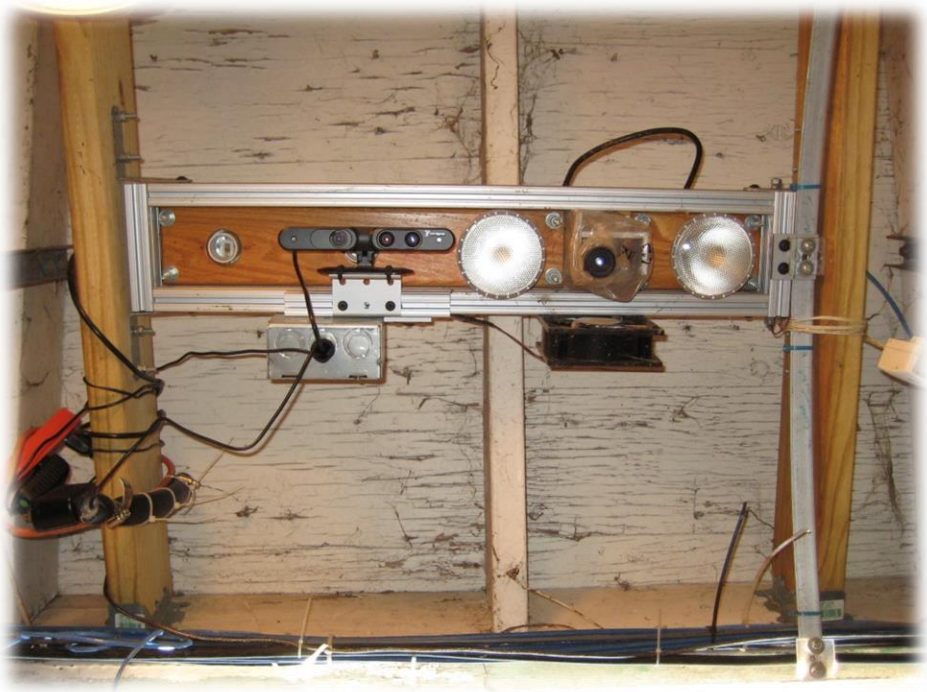


SomaDetect

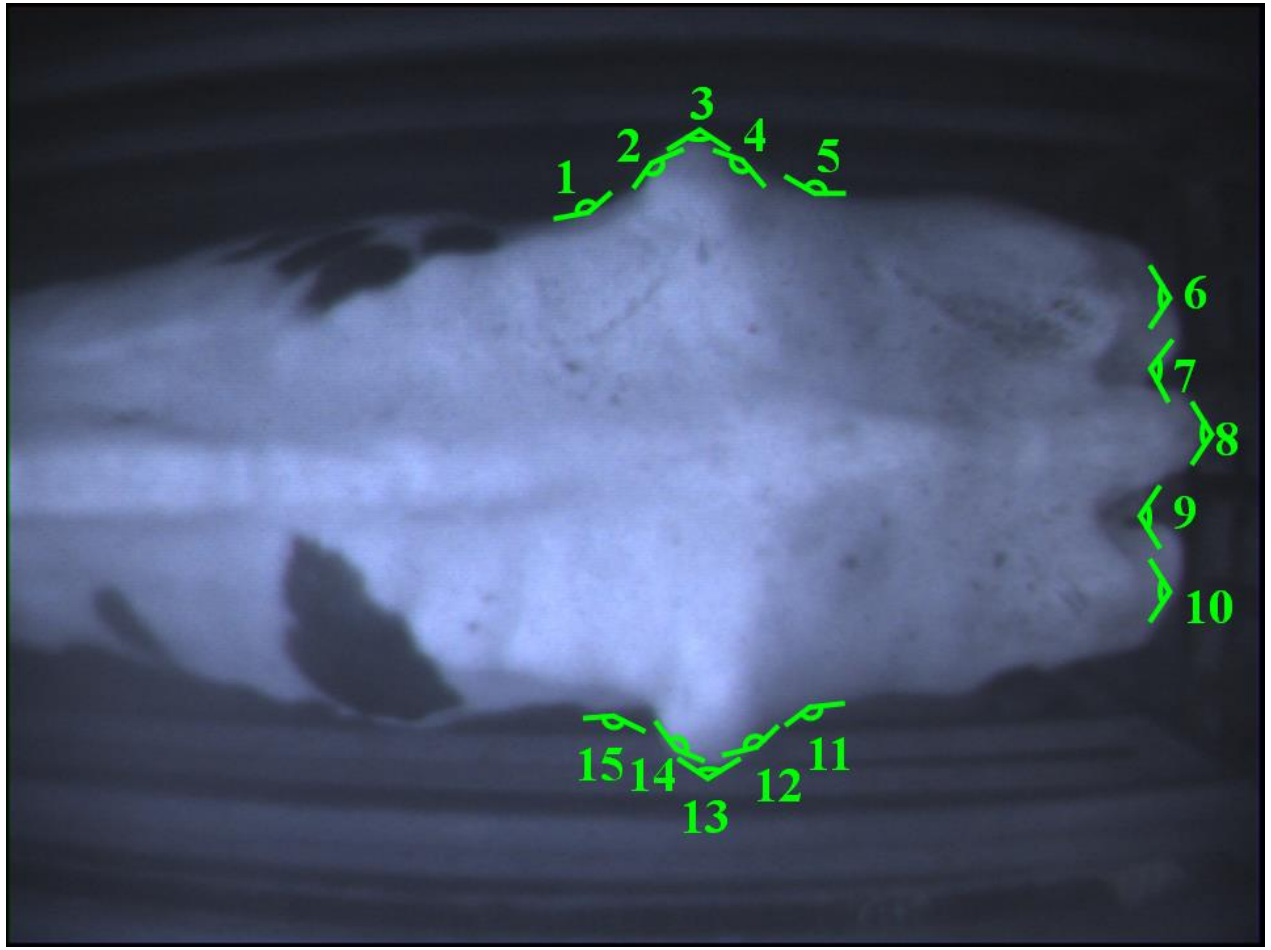
THE PEARSE LYONS ACCELERATOR

Body Condition Scoring



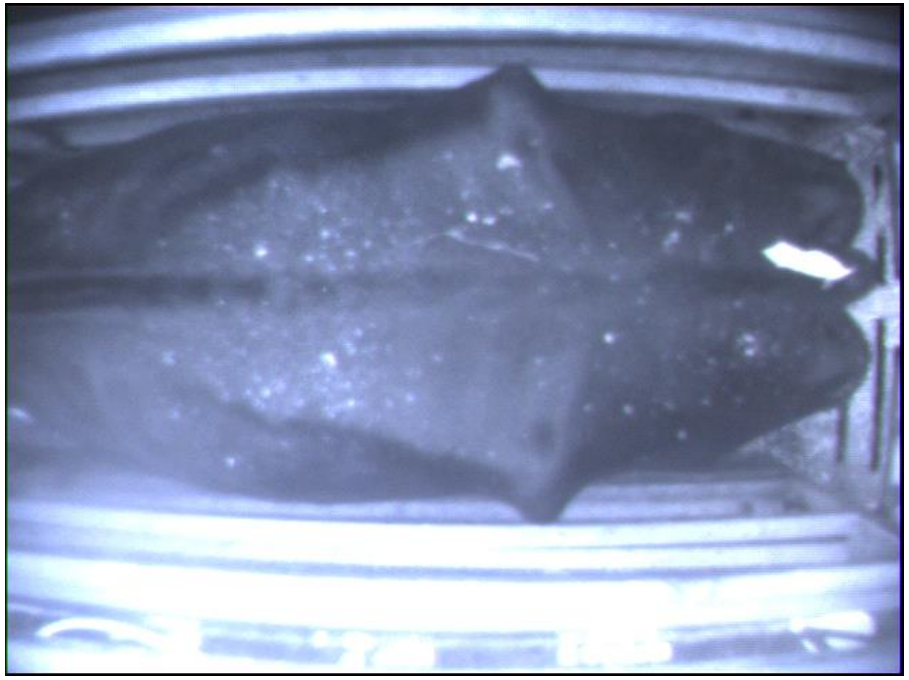


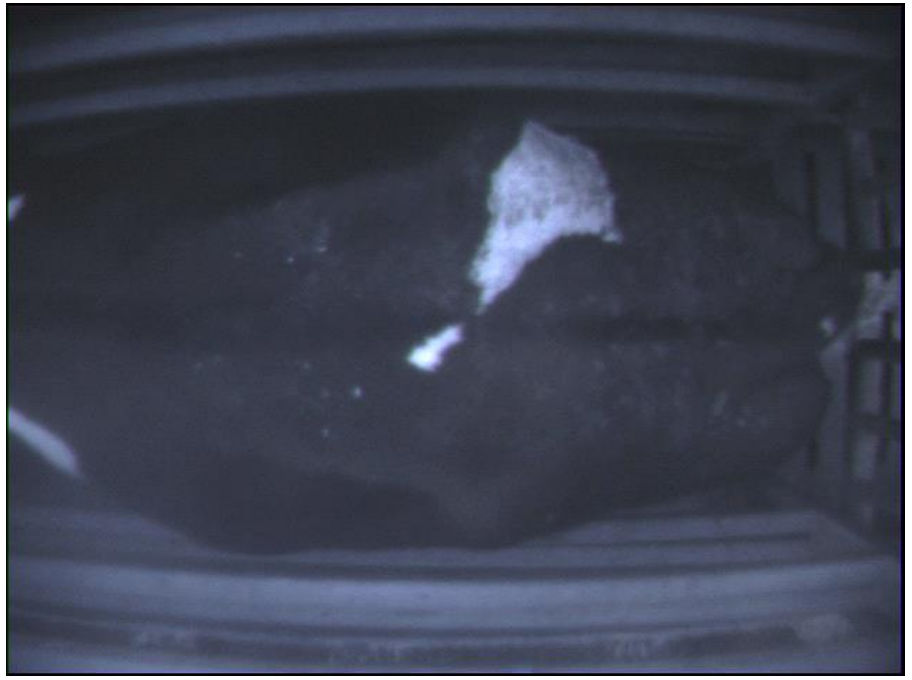
Calculated Angles



1 & 15	Hook Anterior Angles	5 & 11	Hook Posterior Angles
2 & 14	Hook Anterior Curvatures	6 & 10	Thurl to Pin Angles
3 & 13	Hook Angles	7 & 9	Tailhead Depressions
4 & 12	Hook Posterior Curvatures	8	Tailhead Angle

Example

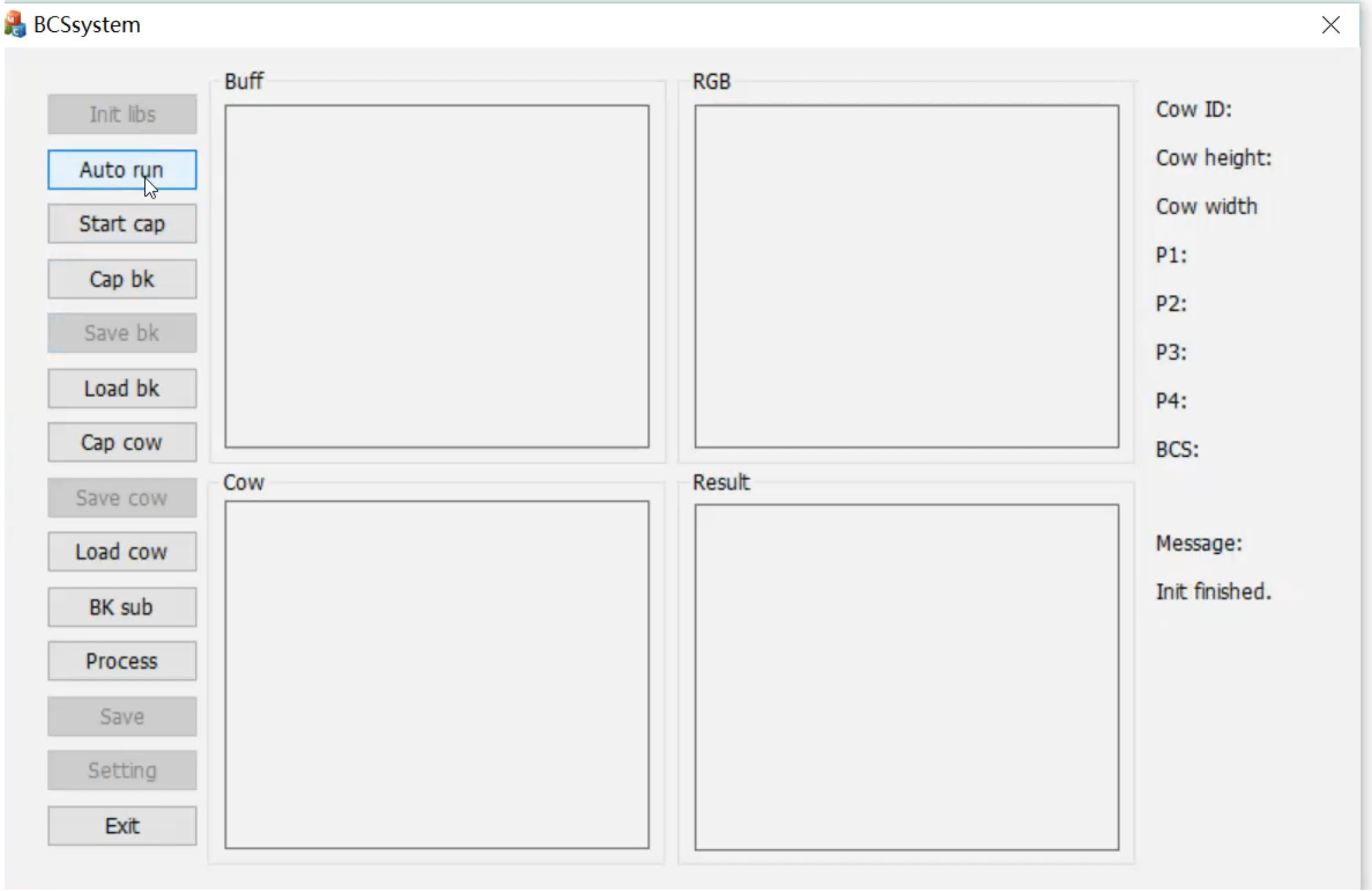




USBCS	2.50
Predicted BCS	2.63
Posterior Hook Angle	150.0°
Hook Angle	116.6°

USBCS	3.50
Predicted BCS	3.32
Posterior Hook Angle	172.1°
Hook Angle	153.5°

Alltech®

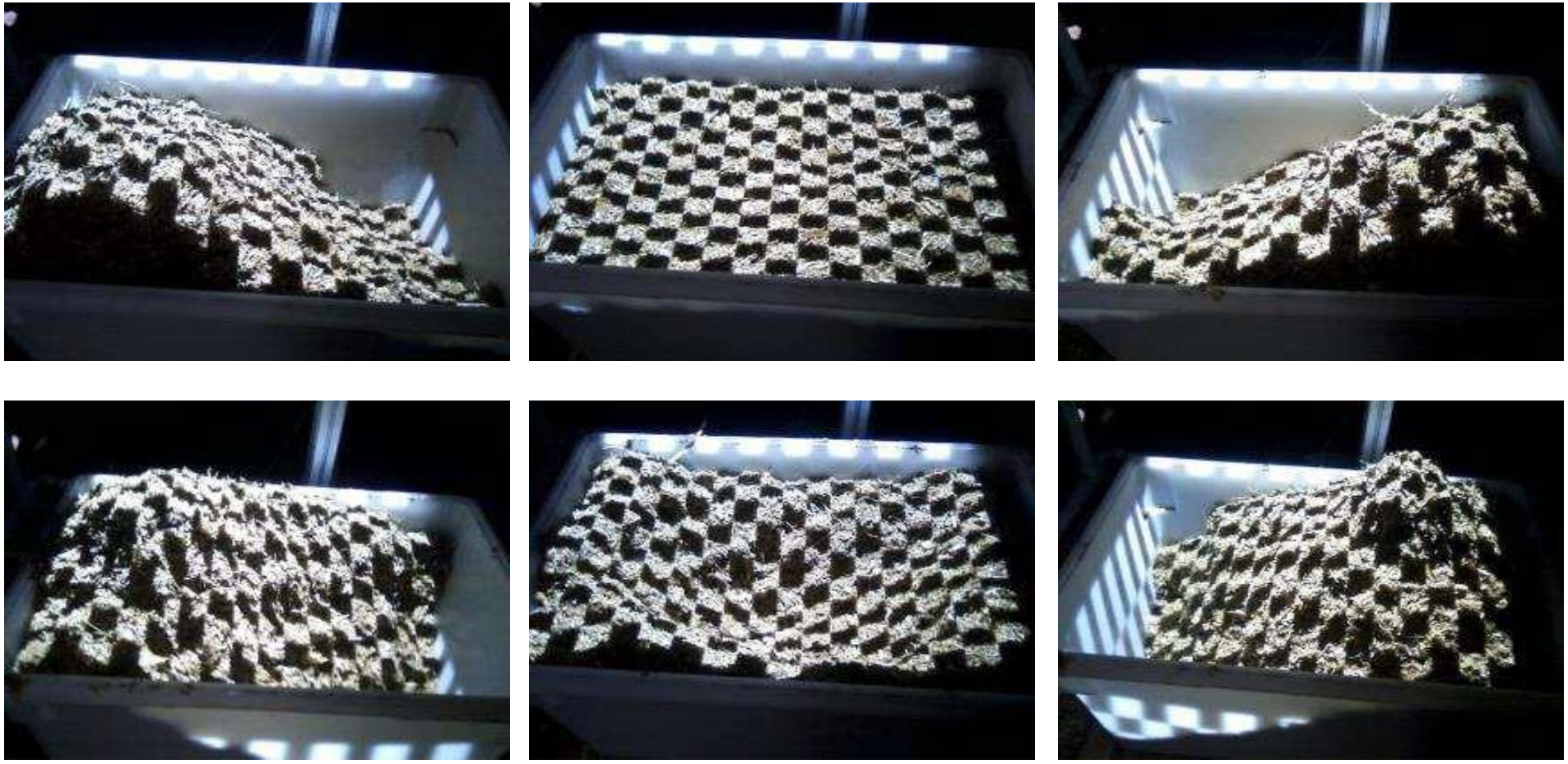


Lau, Zhao, Shelley, and Bewley, 2019

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

Short communication: Measuring feed volume and weight by machine vision

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



Video Behavior

Cattle Care

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

Contents lists available at ScienceDirect

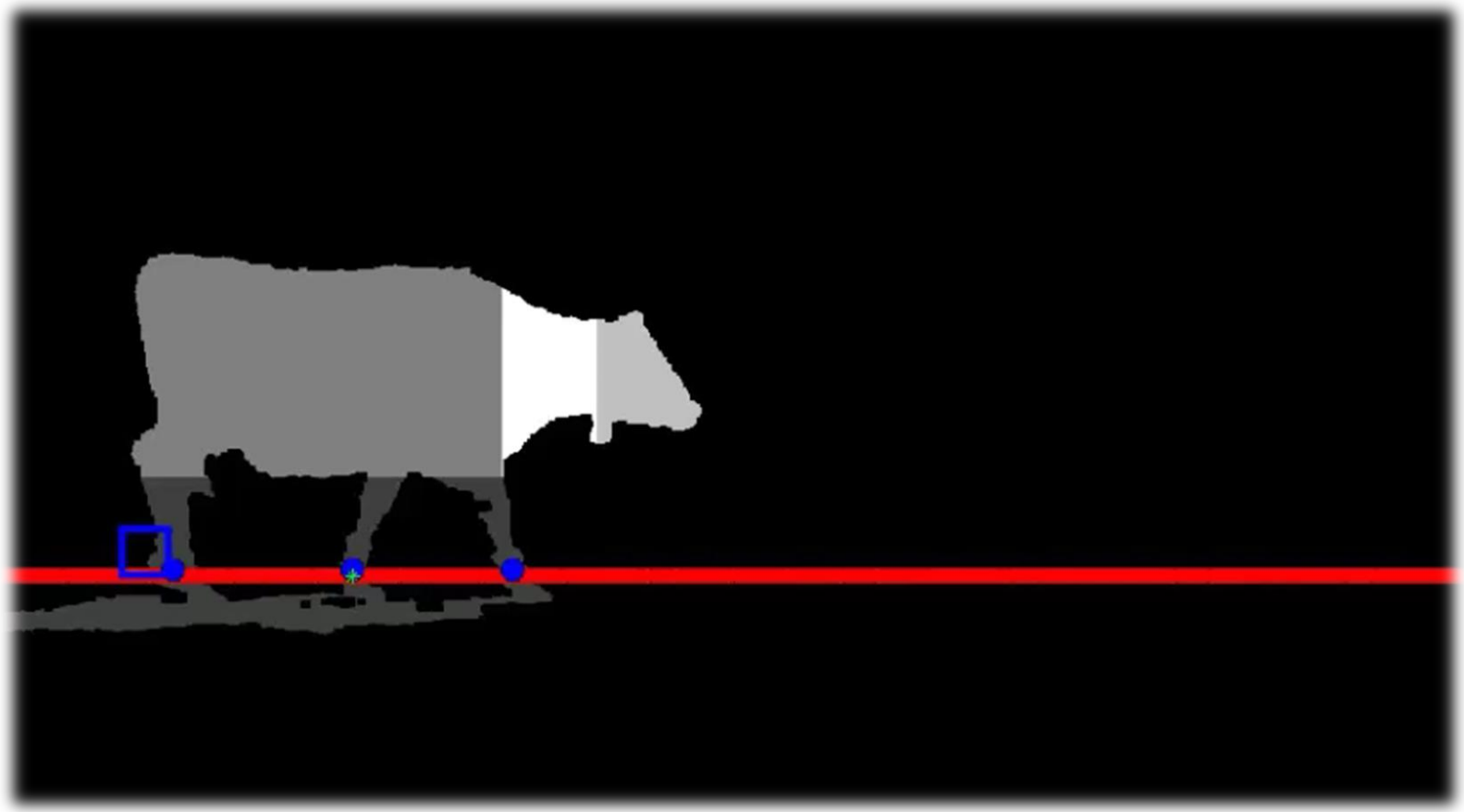
Computers and Electronics in Agriculture

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

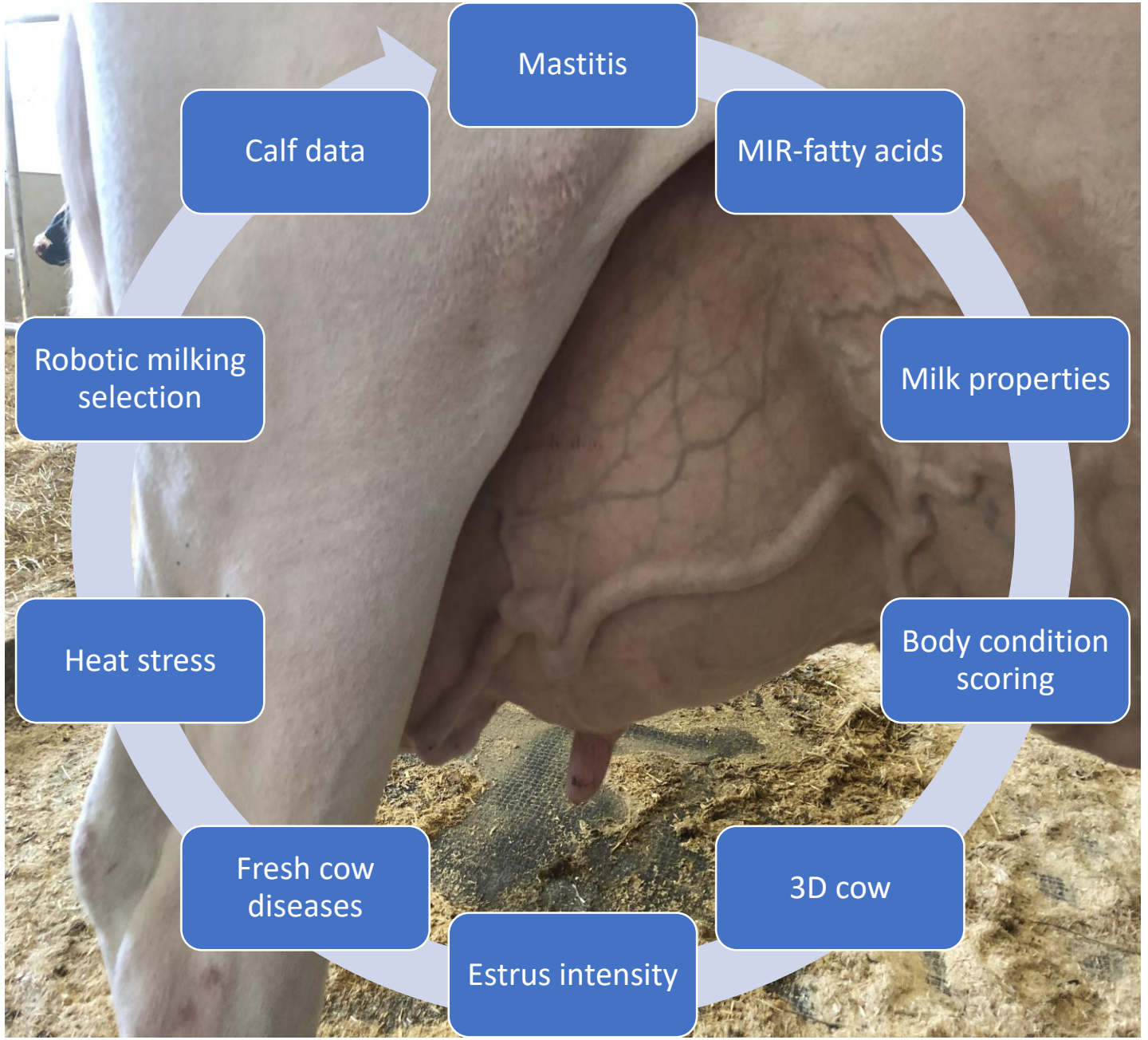
Original papers

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

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



New Phenotypes

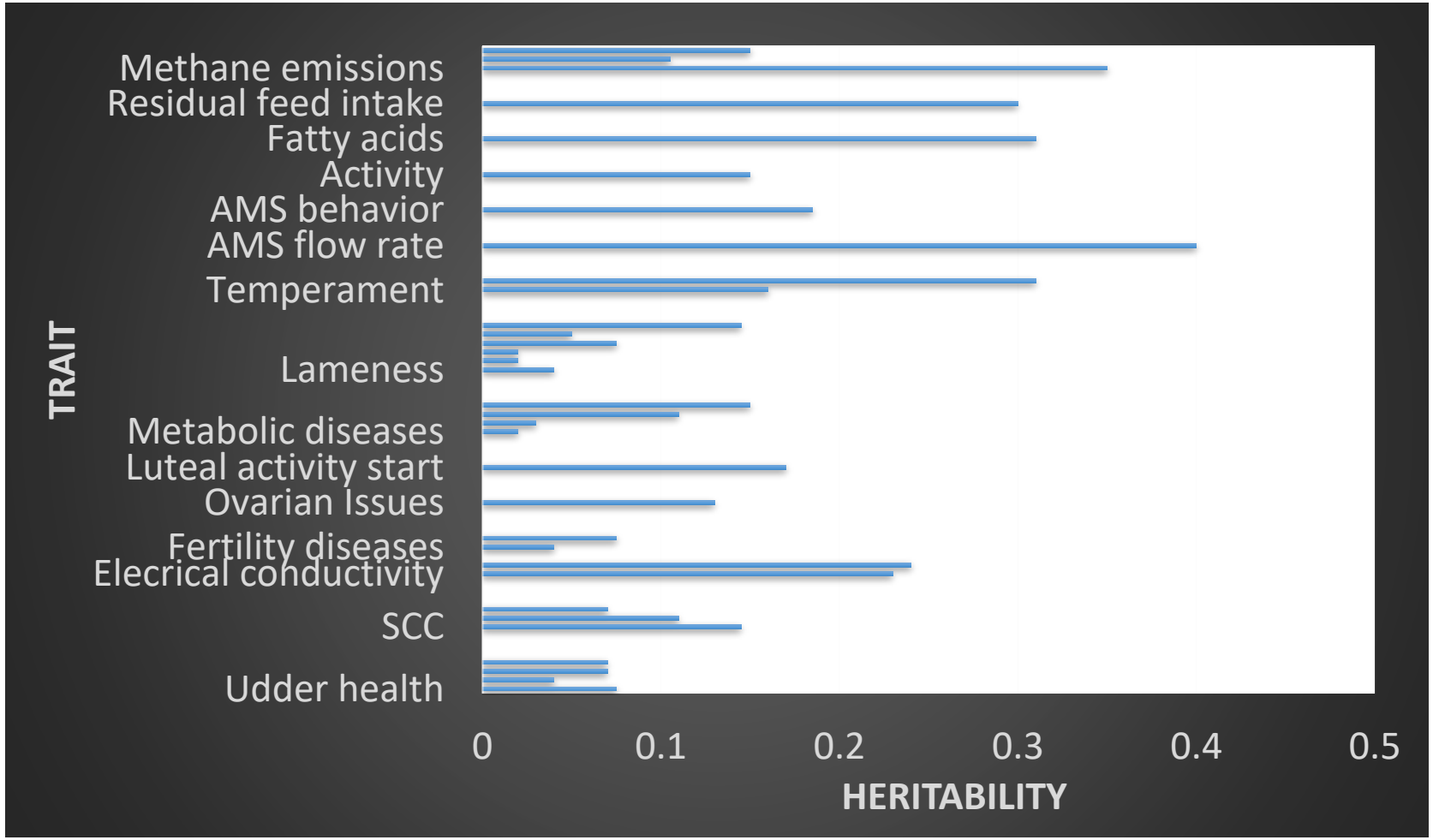


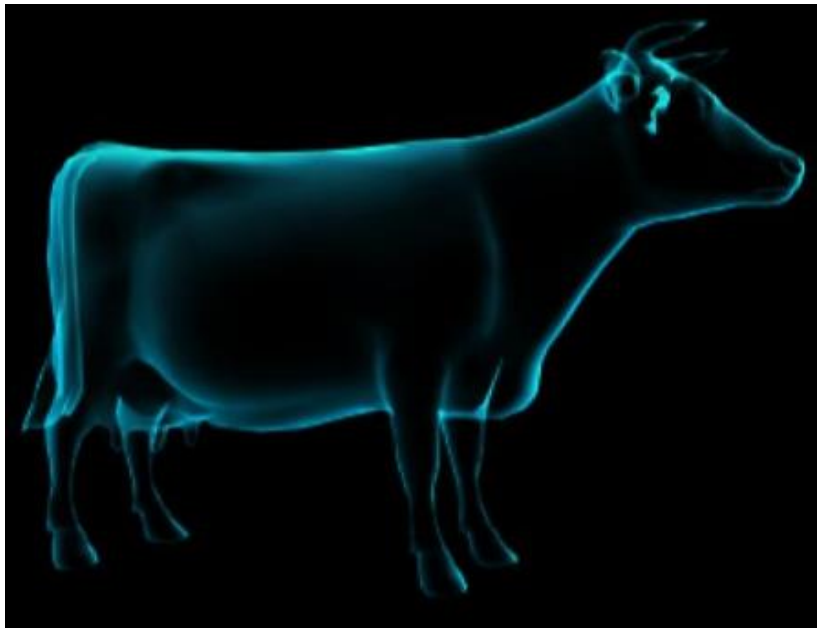
Animal (2015), **9:2**, pp 191–207
doi:10.1017/S1751731114002614

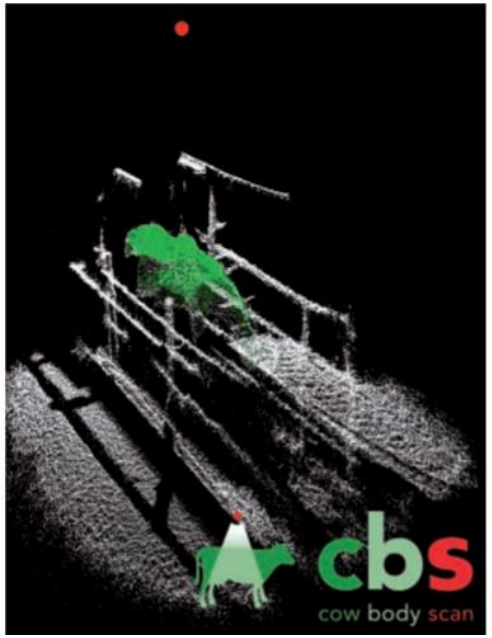
animal

Invited review: overview of new traits and phenotyping strategies in dairy cattle with a focus on functional traits

C. Egger-Danner[1†], J. B. Cole[2], J. E. Pryce[3], N. Gengler[4], B. Heringstad[5], A. Bradley[6,7] and K. F. Stock[8]

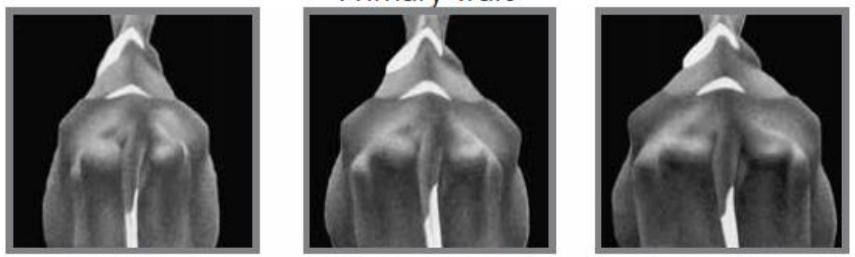






RUMP WIDTH - RW

Primary Trait



1 pt. = 2″
Extremely narrow

25 pts. = 4-1/2″
Intermediate width

50 pts. = 7″
Extremely open

UDDER DEPTH - UD

Primary Trait

1-5 pts.
Very deep udder floor well below hocks

25 pts.
Udder floor above hocks

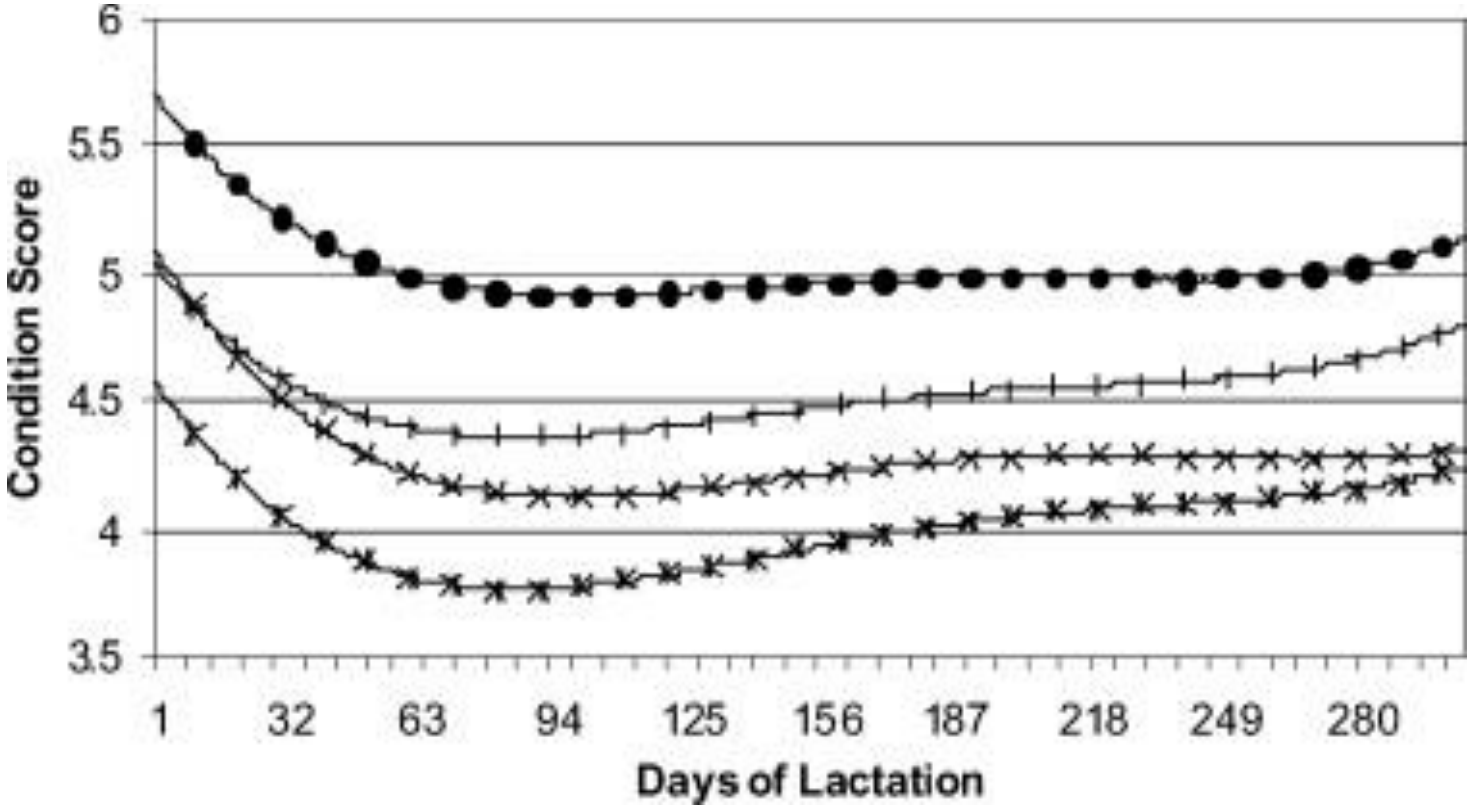
45-50 pts.
Extreme height of udder floor above hocks

Linear Evaluation for Genetic Evaluations

J. Dairy Sci. 86:2205–2212

Genetic Evaluations of Dairy Bulls for Daughter Energy Balance Profiles Using Linear Type Scores and Body Condition Score Analyzed Using Random Regression

M. P. Coffey,* G. Simm,* W. G. Hill,† and S. Brotherstone†
*Animal Biology Division, Scottish Agricultural College,
West Mains Road, Edinburgh EH9 3JG, UK
†Institute of Cell, Animal and Population Biology, University of Edinburgh,
West Mains Road, Edinburgh, EH9 3JT, UK

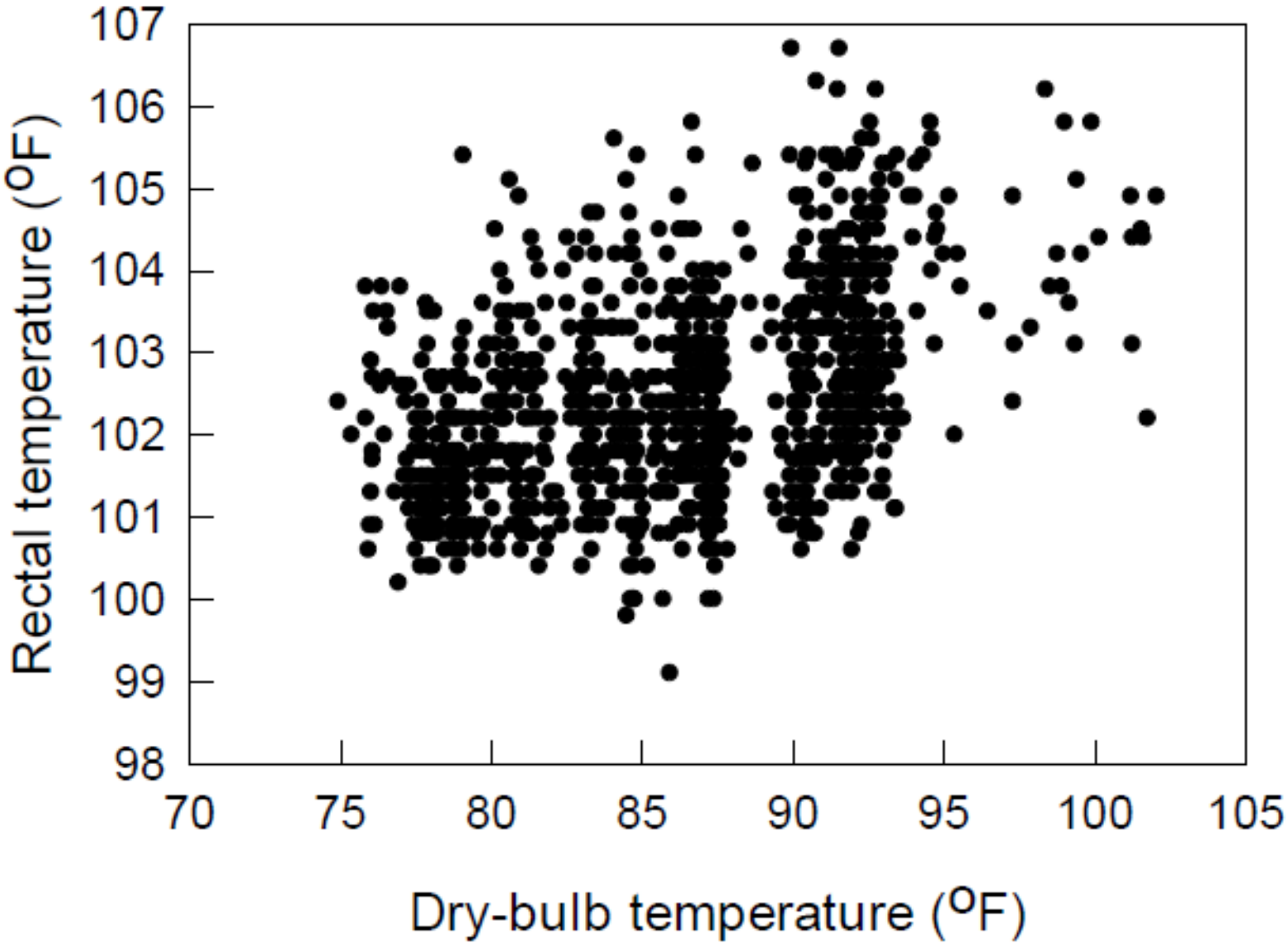


BCS Heritability ~ 0.20

Body condition score for the top (× and *) and bottom (+ and ●) two sires ranked on profit index (PIN)


Heat Stress
Genetics

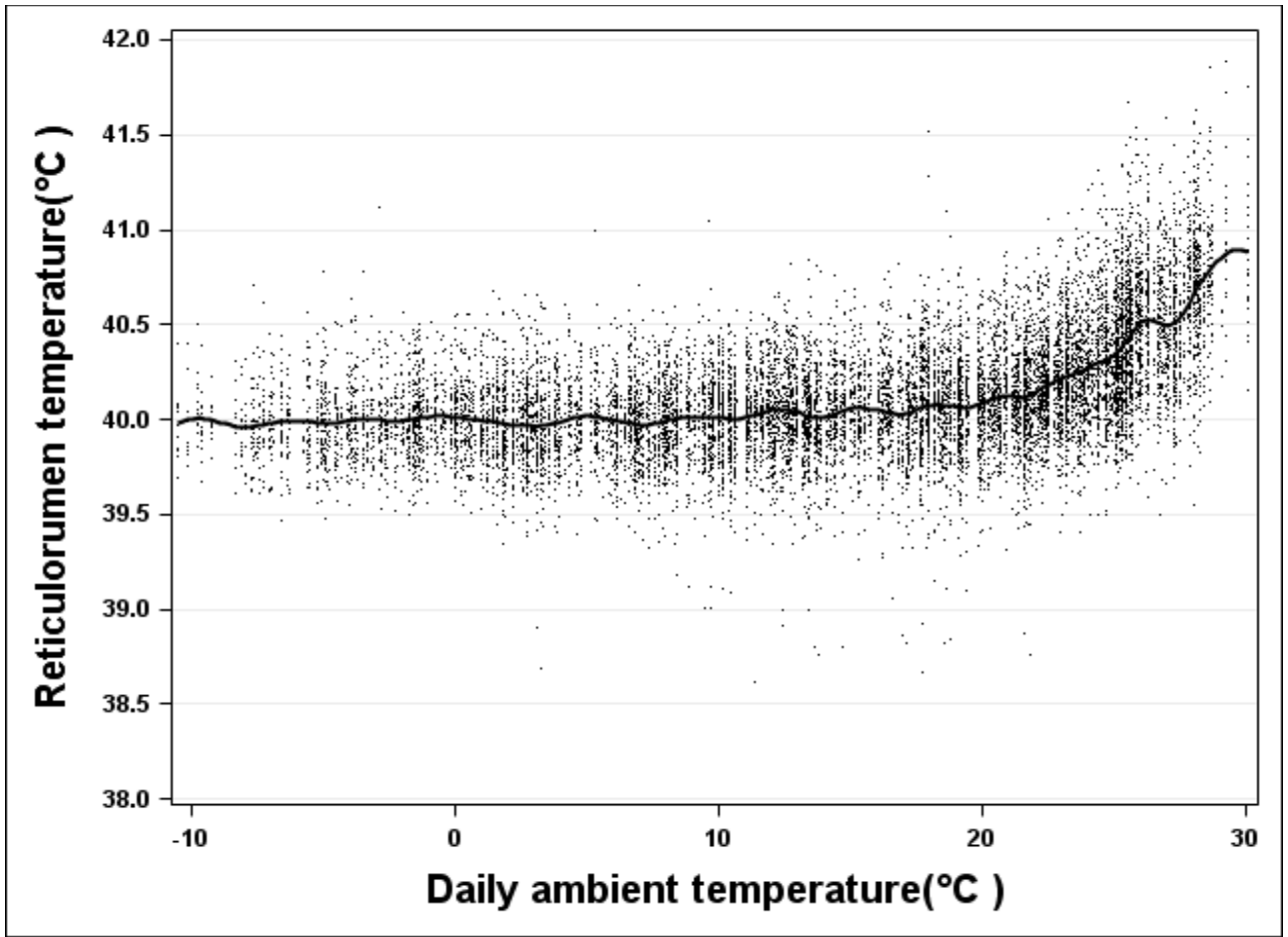
Rectal temperatures from Florida study (Dikmen and Hanse, 2009)



J. Dairy Sci. 96:5072–5081
http://dx.doi.org/10.3168/jds.2012-6537

Influence of breed, milk production, season, and ambient temperature on dairy cow reticulorumen temperature

D. Liang,* C. L. Wood,† K. J. McQuerry,† D. L. Ray,* J. D. Clark,* and J. M. Bewley*[1]
*Department of Animal and Food Sciences, and
†Department of Statistics, University of Kentucky, Lexington 40546



Journal of
Animal Breeding and Genetics

J. Anim. Breed. Genet. ISSN 0931-2668

ORIGINAL ARTICLE

Single nucleotide polymorphisms associated with thermoregulation in lactating dairy cows exposed to heat stress

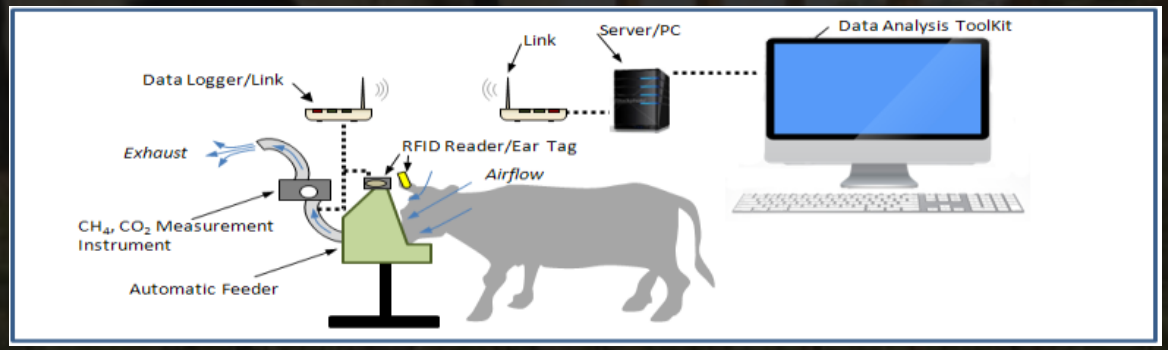
S. Dikmen[1], X.-z. Wang[2], M.S. Ortega[3], J.B. Cole[4], D.J. Null[4] & P.J. Hansen[3]

1 Department of Animal Science, Faculty of Veterinary Medicine, University of Uludag, Bursa, Turkey
2 College of Animal Science and Technology, Southwest University, Chongqing, China
3 Department of Animal Sciences, University of Florida, Gainesville, FL, USA
4 Animal Genomics and Improvement Laboratory, Agricultural Research Service, USDA, Beltsville, MD, USA

- SNPs identified
  - Rectal temperature
  - Respiration rate
  - Sweating rate

Methane Emissions

C-LOCK INC.



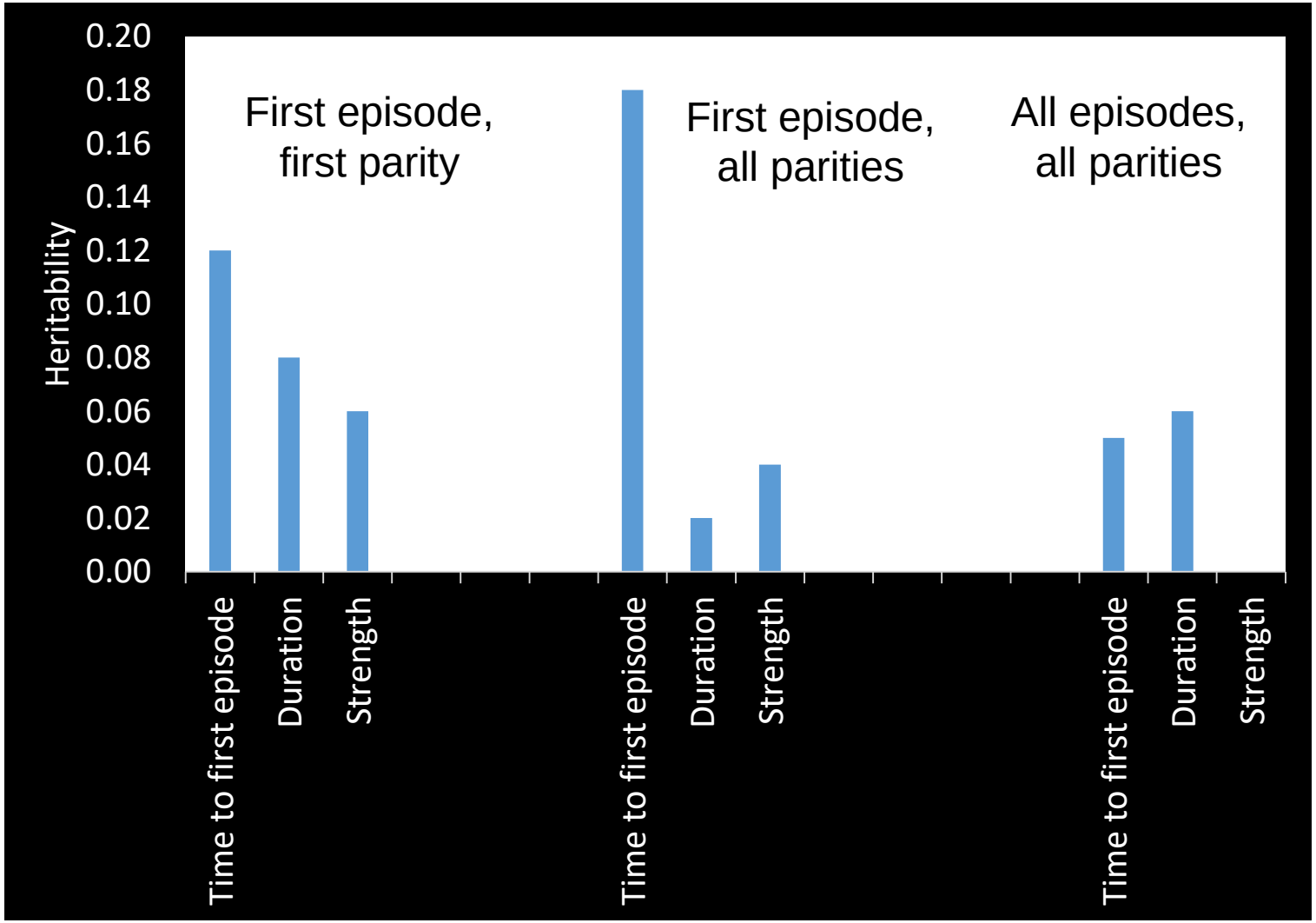
Estrus and Fertility

J. Dairy Sci. 92:4683–4688
doi:10.3168/jds.2008-1736

Short communication: **Genetic variation in estrus activity traits**

P. Løvendahl*[1] and M. G. G. Chagunda†
*Department of Genetics and Biotechnology, Faculty of Agricultural Sciences, Aarhus University, Tjele DK 8830, Denmark
†Sustainable Livestock Systems Group, Scottish Agricultural College, Dairy Research Centre, Midpark House, Bankend Road, Dumfries, DG1 4SZ, United Kingdom

High activity for cows and heifers



Robotic Milking

ROBOTIC

friendly sires

Alta

Sires suited for **ROBOTIC** Milking Systems

NAABCODE	NAME	CP	PEDIGREE	TPI	NM$	PTAM	PTAP	PTAF	CFP	PTAT	UDC	FLC	PL	DPR	SCS	SCE	DSB
11H11446	**AltaPITA**	CP	SUPERSIRE xMAN-O-MAN	2449	675	1170	53	68	121	1.18	1.05	1.35	4.6	0.9	2.94	5.1	5.7
11H11227	**AltaWISEMAN**	CP	SNOWMAN X WIZARD	2436	662	923	35	62	97	0.85	0.72	1.09	6.3	2.7	2.58	6.8	5.5
11H11438	**AltaEXCHANGE**	CP	MOGUL xMAN-O-MAN	2430	600	1523	46	53	99	1.28	1.33	1.27	4.2	2.6	2.94	5.8	5.9
11H11448	**AltaENTRY**	CP	SUPERSIRE xBOWSER	2416	629	862	37	46	83	0.48	0.51	0.50	6.7	4.3	2.91	5.9	6.1
11H11274	**AltaJACKMAN**	CP	SNOWMAN X MASSEY	2397	580	1195	49	49	98	1.55	1.43	1.77	4.1	0.2	2.50	8.1	8.1

These traits especially include Rear Teat Placement (RTP), Teat Length (TL), Udder Depth (UD), Rear Leg Rear View (RLRV) and Milking Speed (MSP)

BETTER COWS | BETTER LIFE

Based on data from six million robot milkings a week for 500,000 cows on over 4000 dairy farms

MILKING INTERVAL

Time between two milking sessions

HABITUATION

Speed of heifer adoption to robot

ROBOT EFFICIENCY

Amount of milk produced in kg per total robot time in minutes

Automated calf feeders

- Daily intake
- Drinking speed
- Average daily gain
- Meal size
- Disease

Genetic Evaluations

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

Branded Genetics

- Could bull studs supplement technology costs in large progeny test herds in exchange for data?
- Reduction in data collection costs
- May be a new form of product differentiation

Genomics

Precision Dairy Farming/genomic selection synergies may lead to improvement in health traits

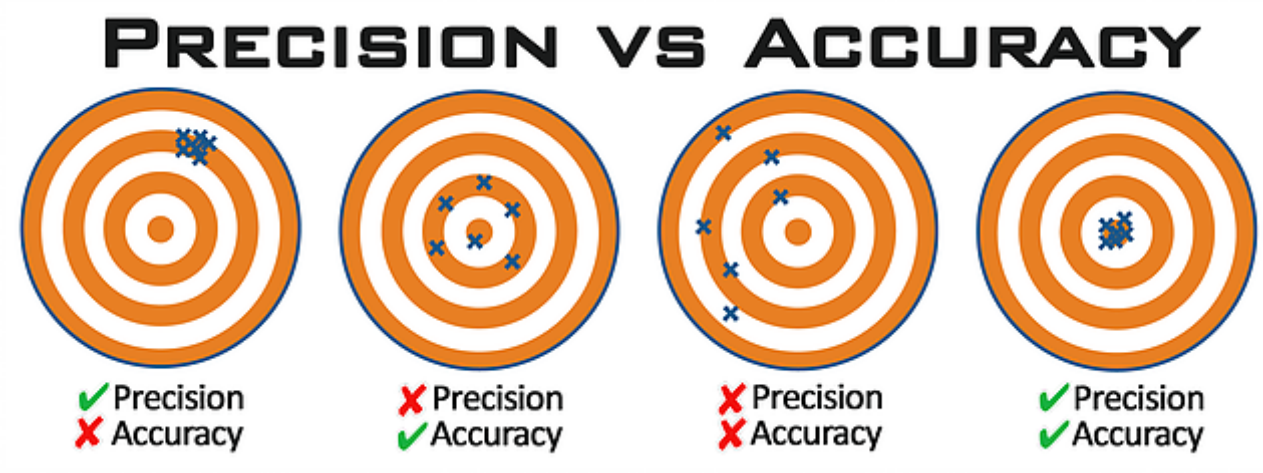
But, need enough high-quality phenotypic data to calculate the SNP effects

More data needed for lowly heritable traits

Challenges and Limitations

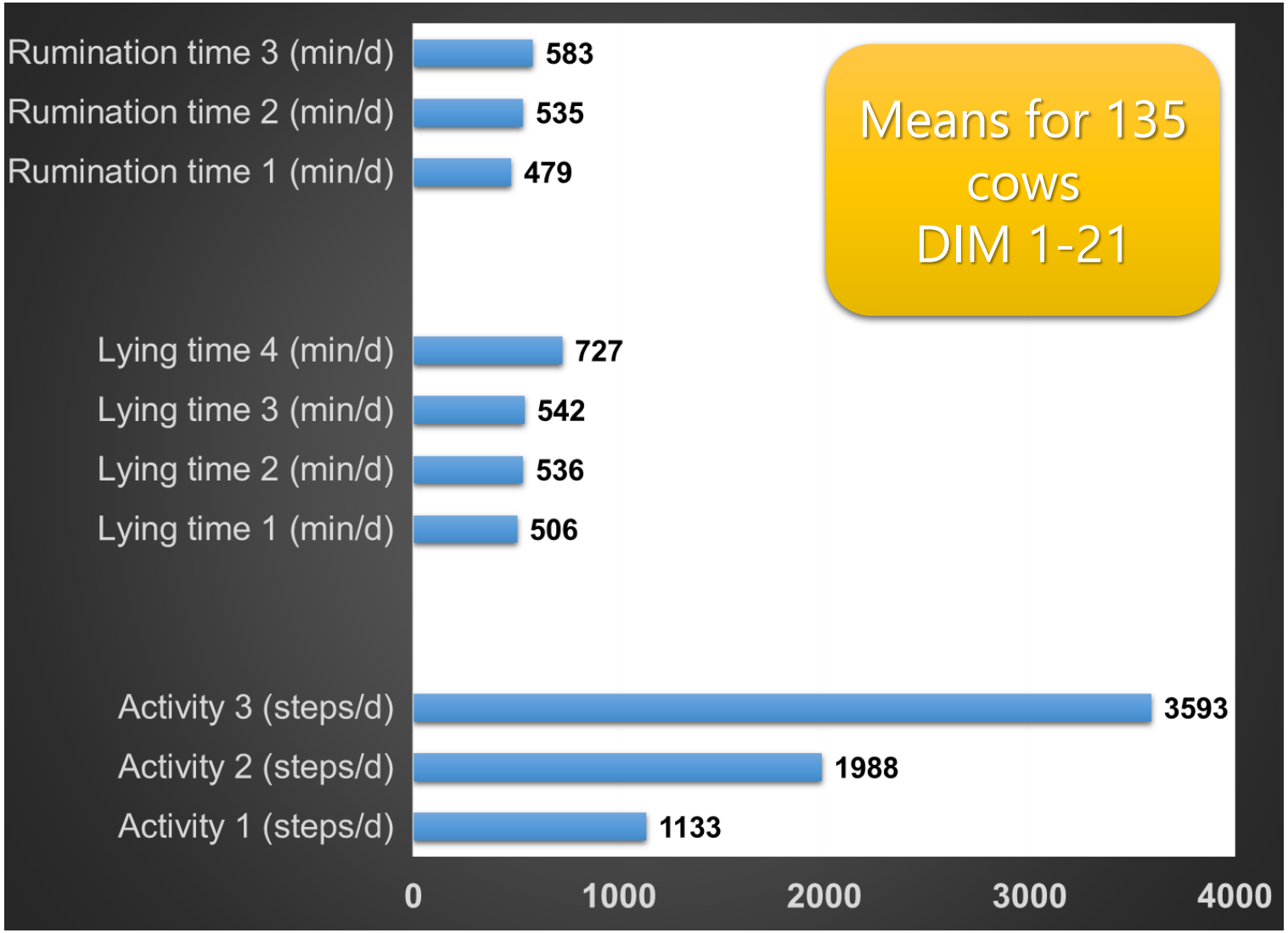
- Brand differences in measures
- Technology failures
- Standardization
- Calibration
- Data ownership
- Who pays for what?

Are we measuring the targets we intend to?



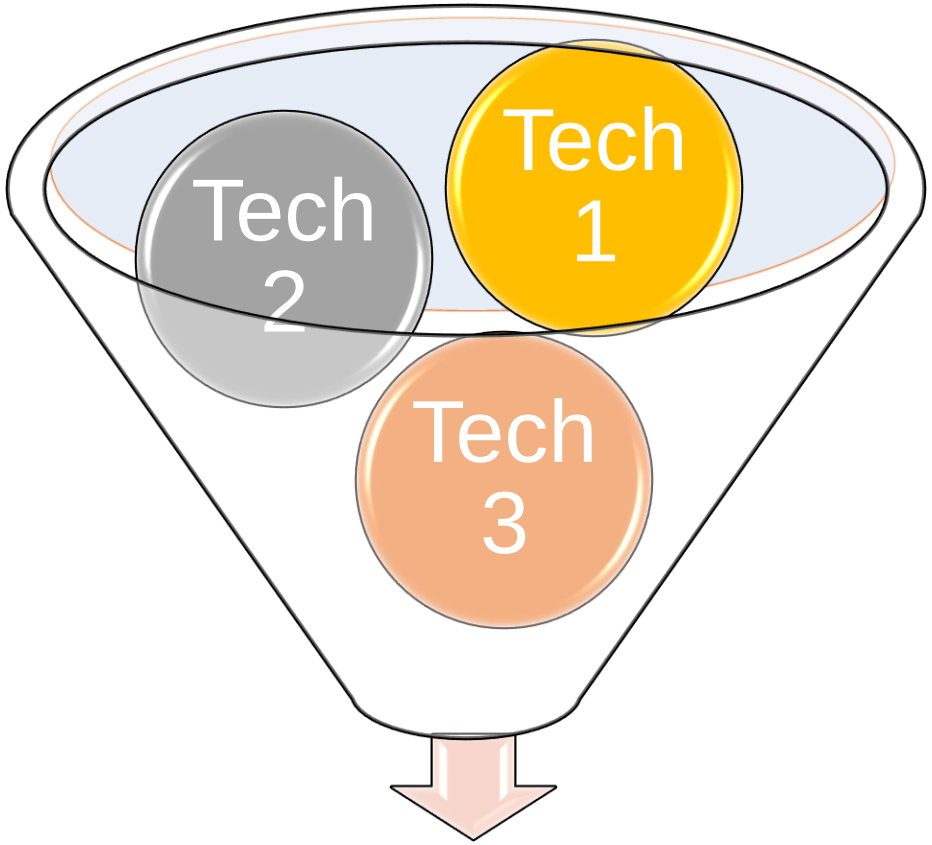
Can't forget the need for third party validations

X ≠ X and Y ≠ Y



Tsai et al., 2019

Disappearing Data

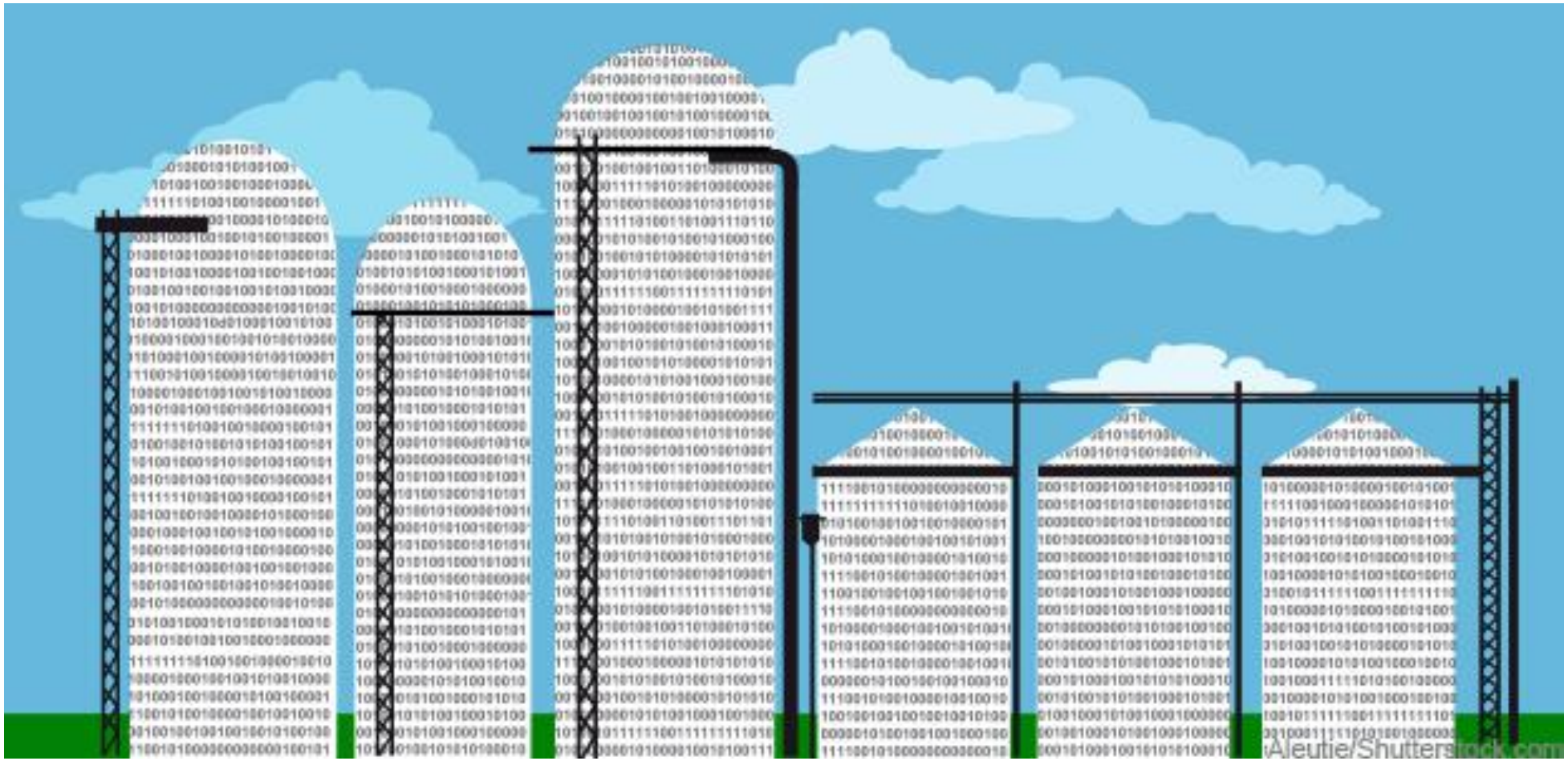


847 cow days (29%) out of possible 2898

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

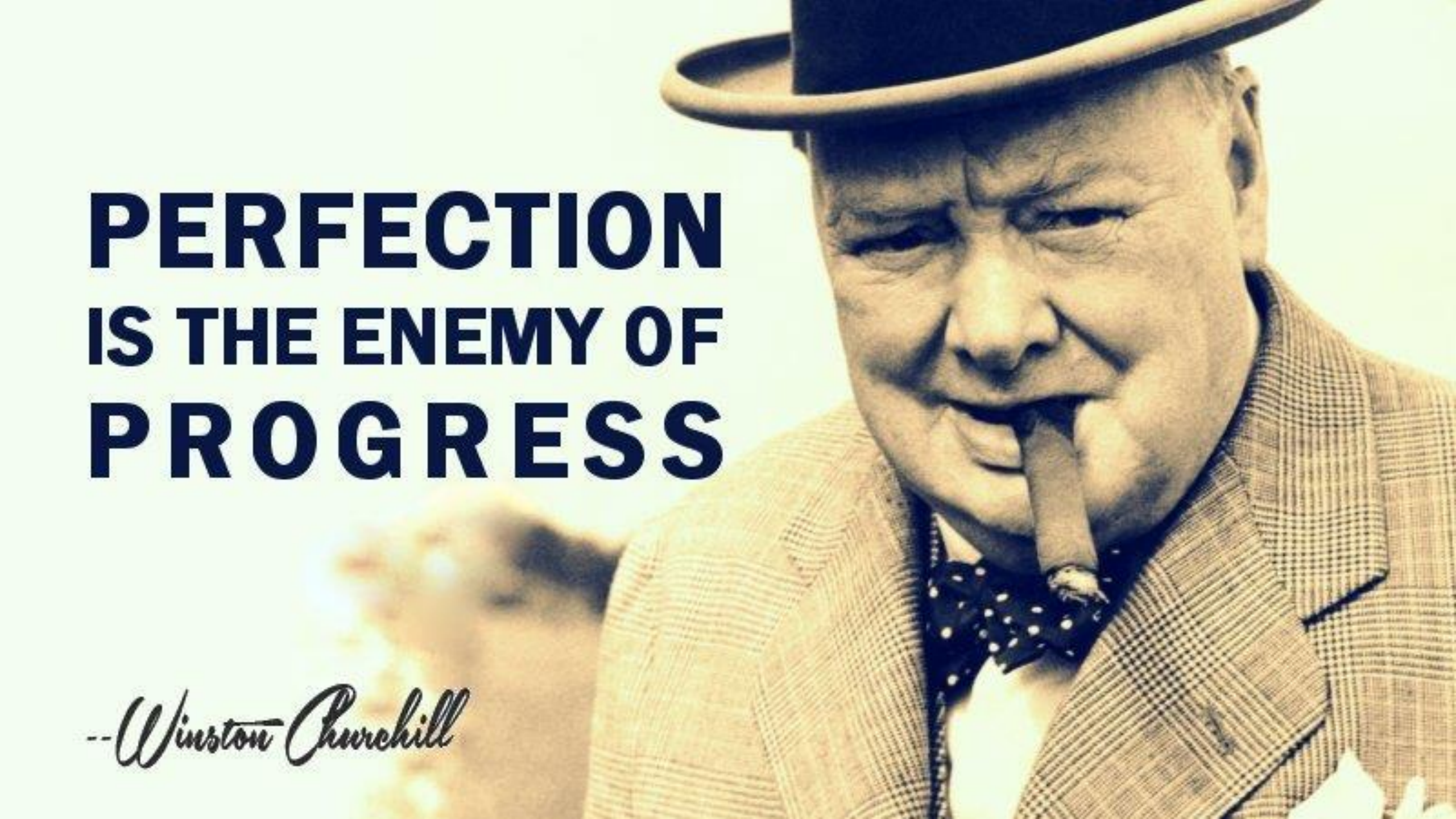
Tsai et al., 2019

Data Silos



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

Alltech®


PERFECTION
IS THE ENEMY OF
PROGRESS
--Winston Churchill

Jeffrey Bewley, PhD, PAS
jbewley@Alltech.com
@bewleydairy
www.linkedin.com/in/jeffreybewley