Making Research Work: Translating Dairy Science into Practical Farm Implementation

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TELUS Agriculture & Consumer Goods

DAIRY HEALTH & Management Services

Outline

- Relative strengths of evidence for decision making
  - High quality evidence
  - Low quality evidence
    - Common problems with on-farm trials
- Steps to test new ideas, products or strategies
  - Example of large-scale commercial field trial
- Evaluation of available trial & “trial” results

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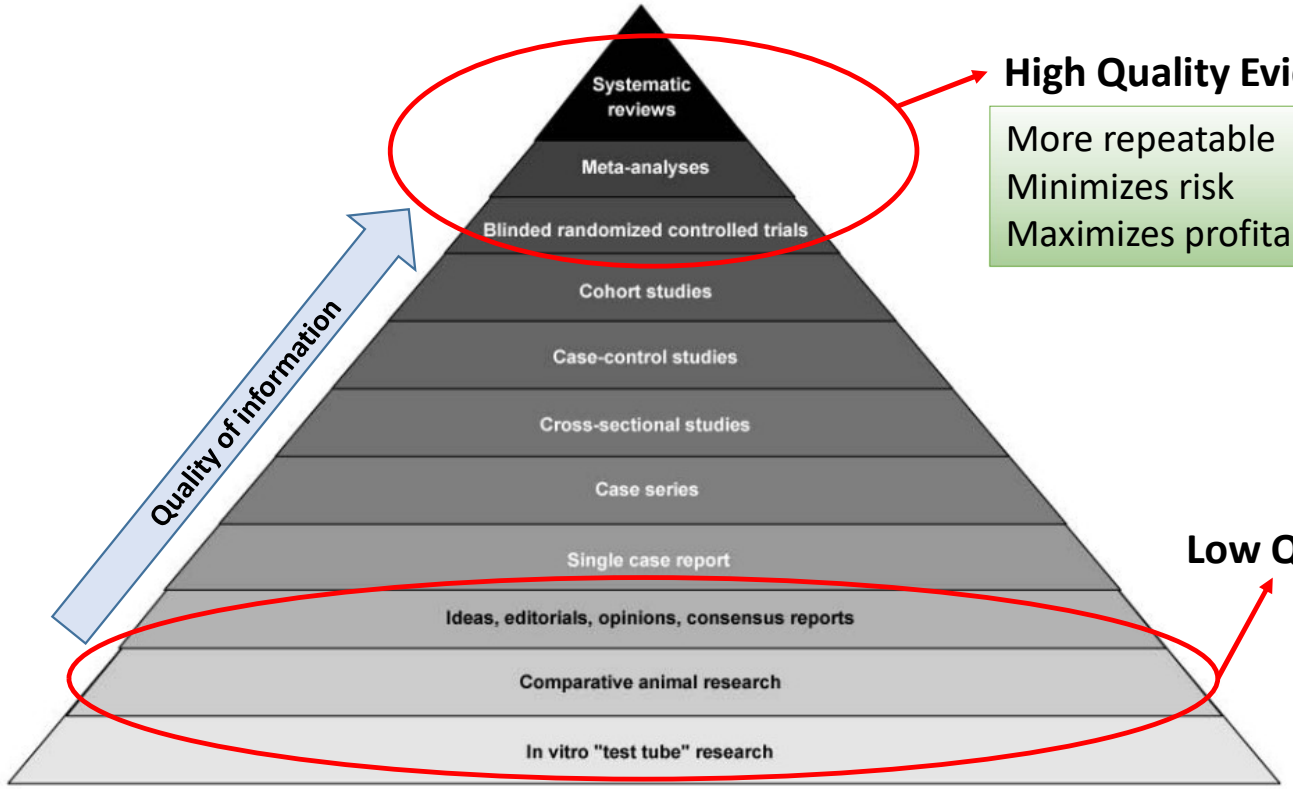
Relative strengths of evidence for decision making



Holmes, 2009. JAVMA, Vol 235, No. 9

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Beneficial effects of *Saccharomyces cerevisiae* fermentation postbiotic products on calf and cow health and plausible mechanisms of action

Jeong-Byoung Chae, Amy D. Schoofs and Jodi L. McGill*

Department of Veterinary Microbiology and Preventive Medicine, Iowa State University, Ames, IA, United States

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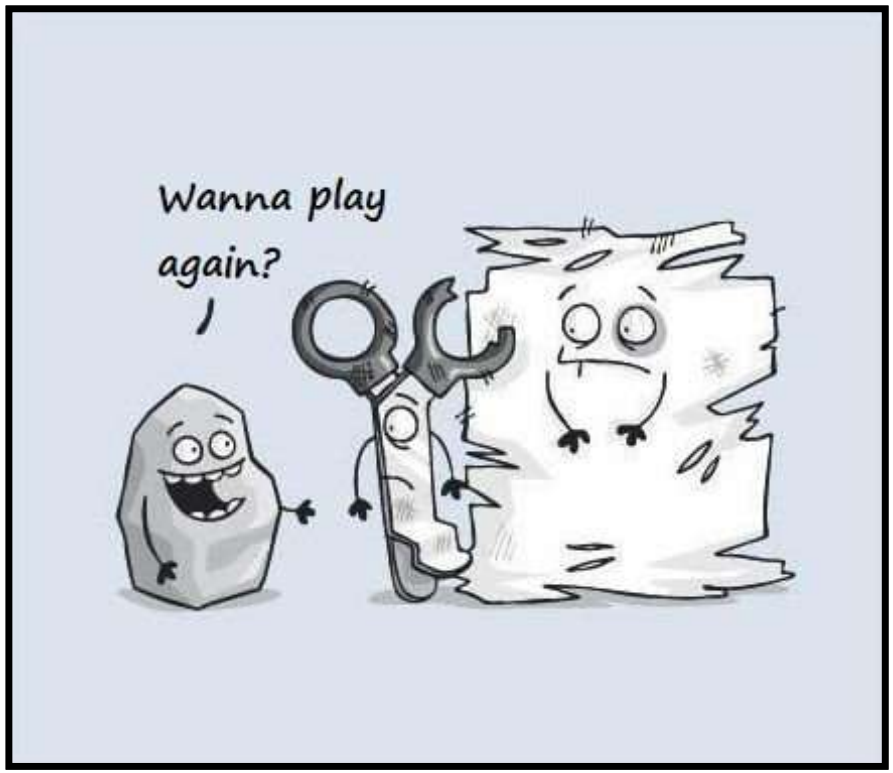
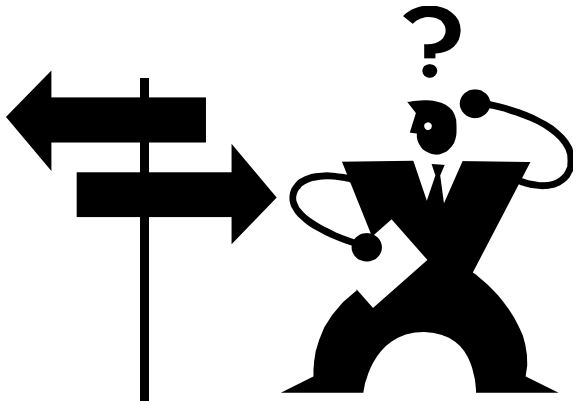
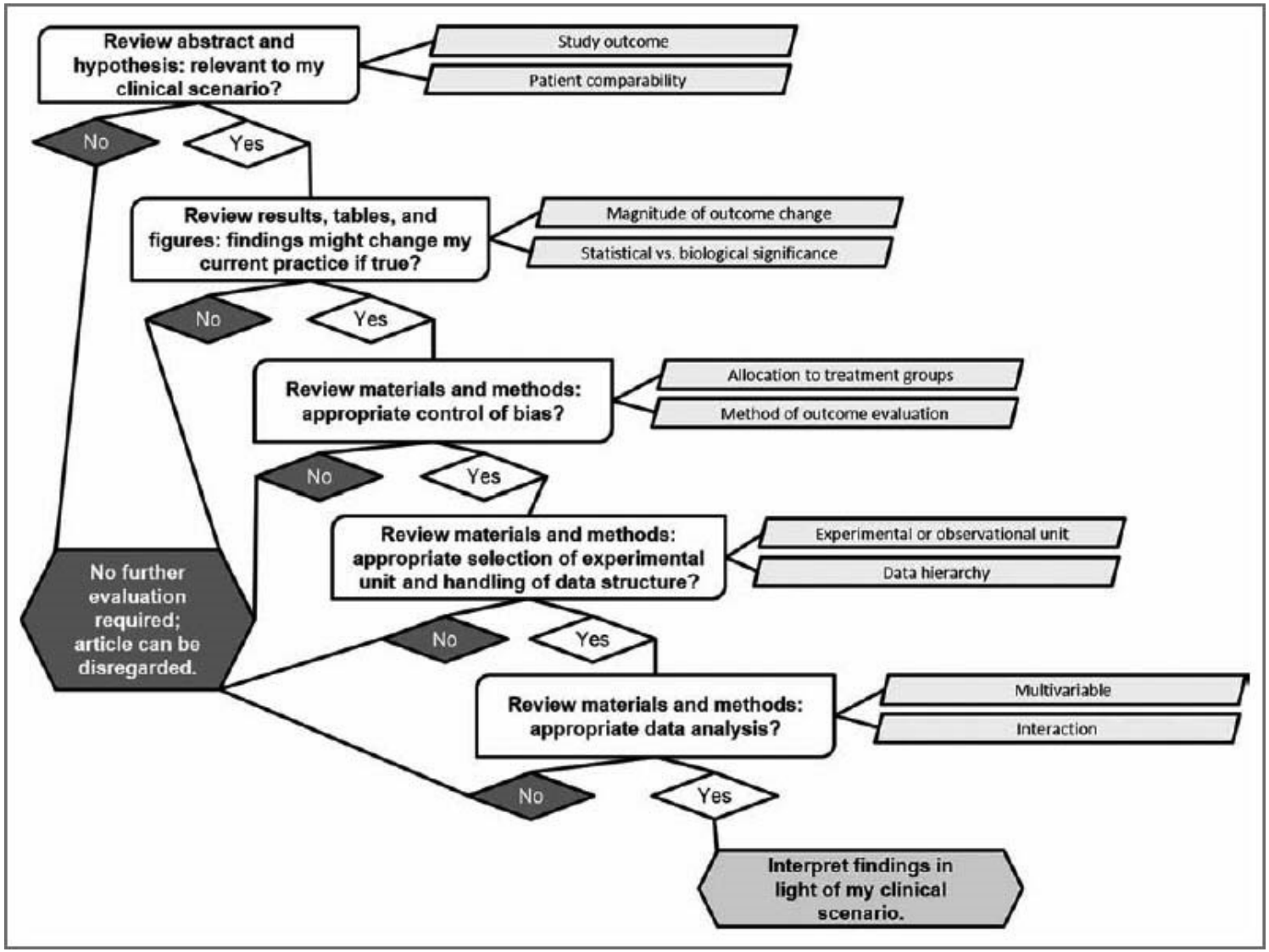
Low Quality Evidence: Rock vs. Paper vs. Scissors







White BJ, Larson RL. *Journal of the American Veterinary Medical Association. 2015;247(5):496-500. doi:10.2460/javma.247.5.496*

Common problems with on-farm trials

- Free product: “put it in and you will see the difference”
- Comparing “before and after”
- Comparing unbalanced groups
- Incorrect implementation: no oversight
- Data issues:
  - Data losses (e.g., software down, missing RFID or tags)
  - Data overwritten (e.g., items vs. events in DC305, lack of track of pen moves)
  - Results evaluated directly in management software (e.g., inclusion vs. exclusion criteria)
- Numerical differences: random chance or significant?
- No sample size

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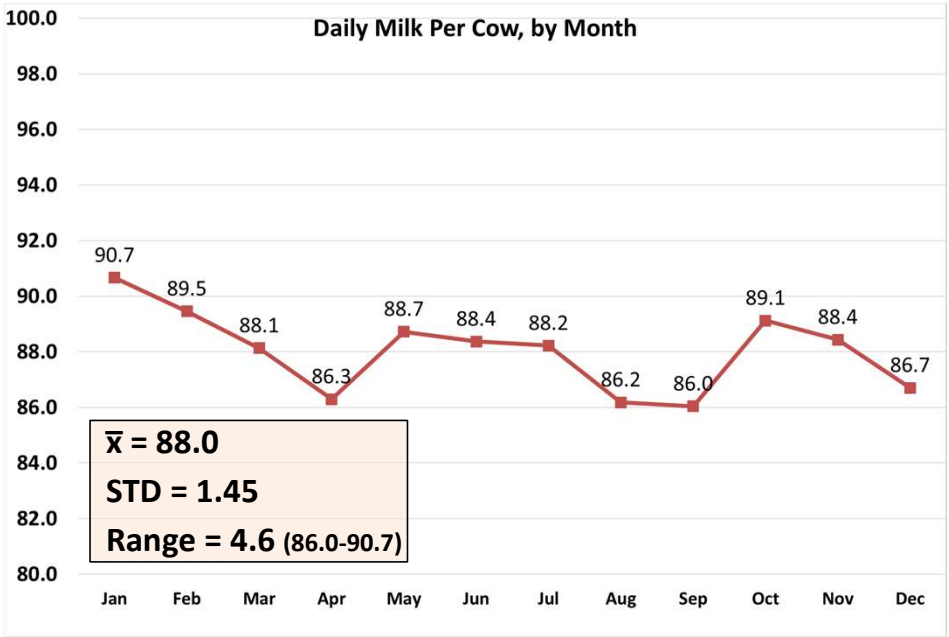
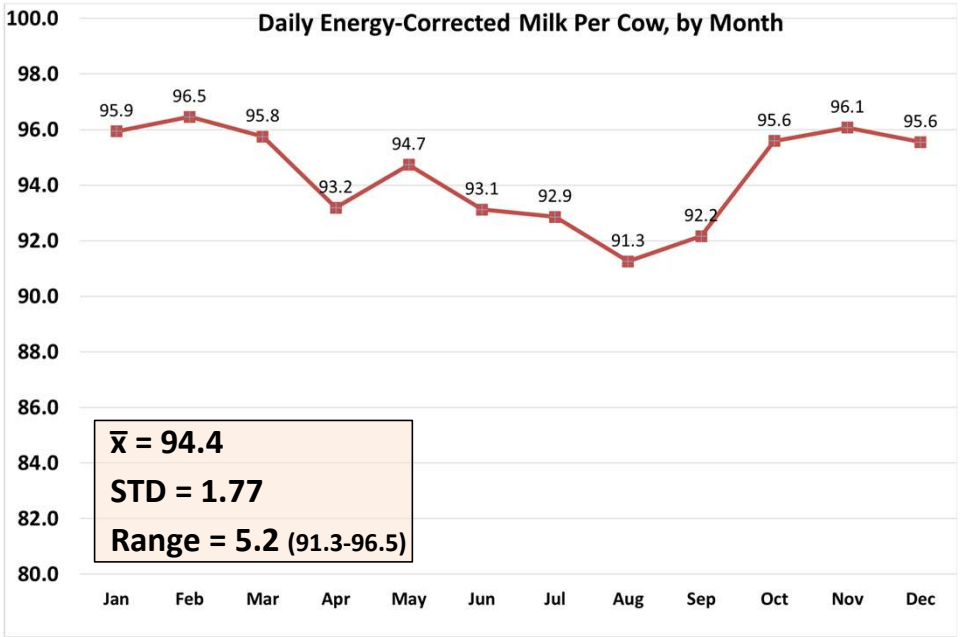
Comparing before and after

Usual variation might be greater than the expected response of a product or strategy





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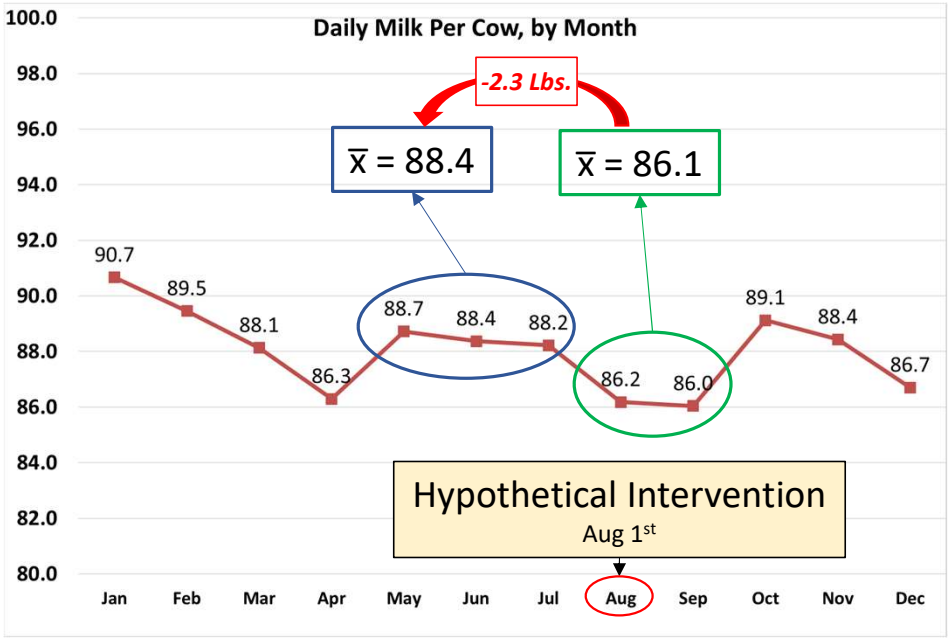

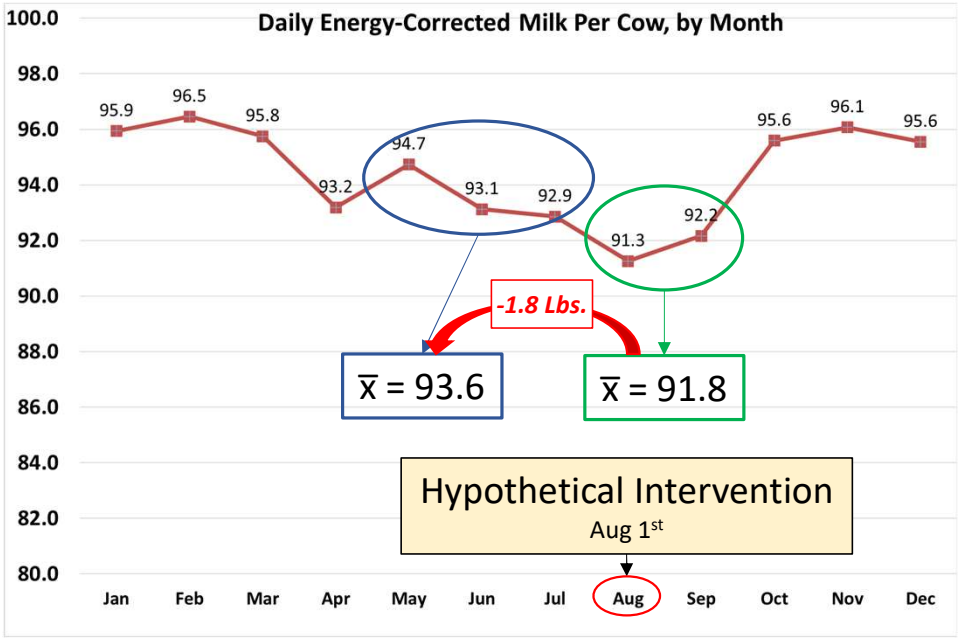

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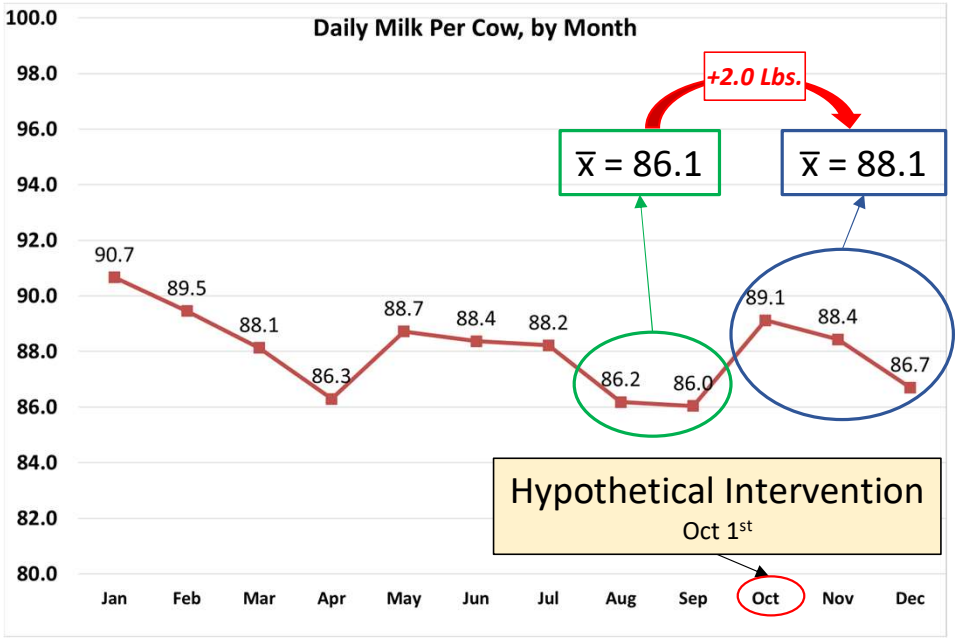

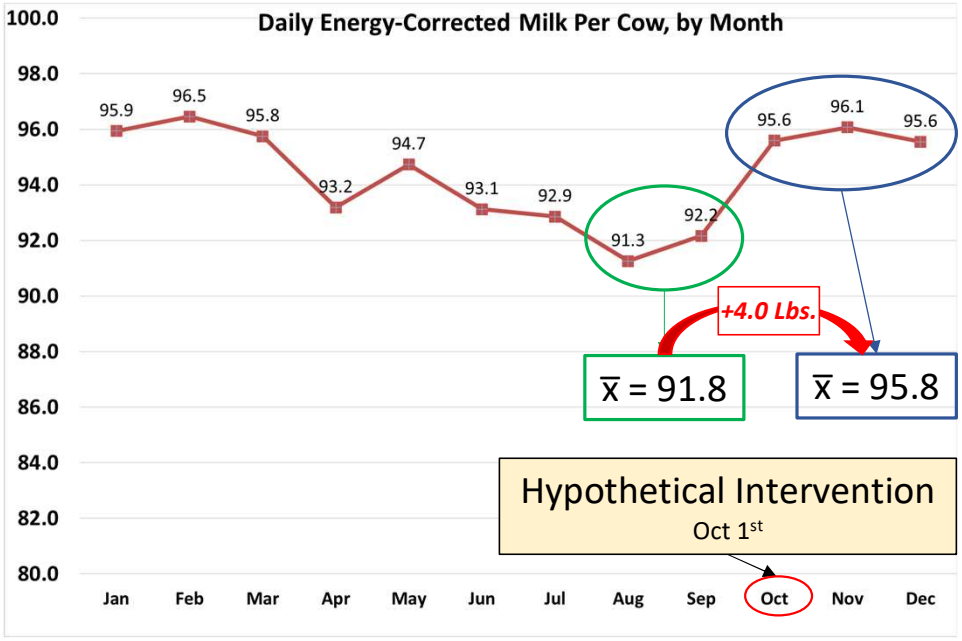

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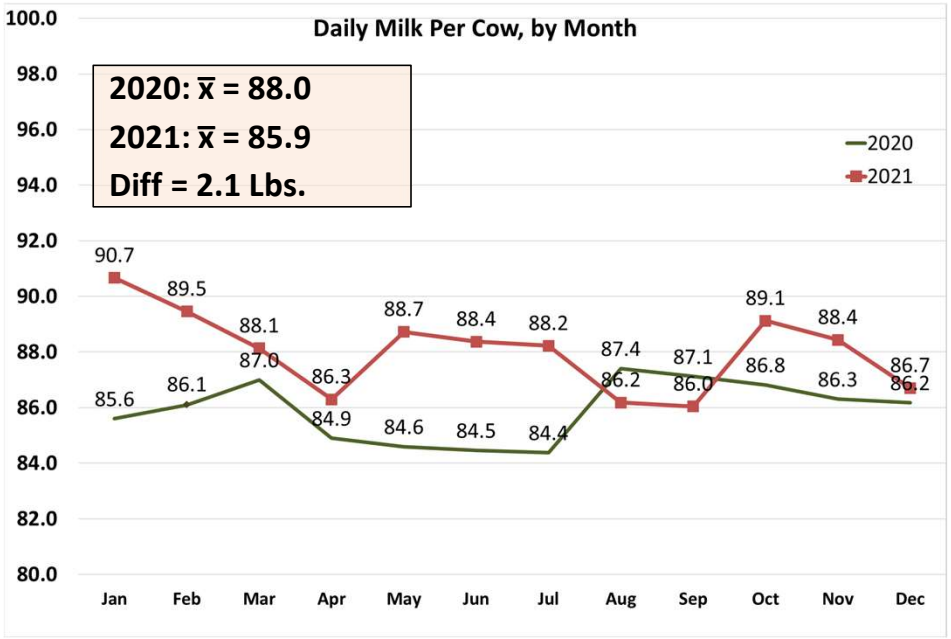

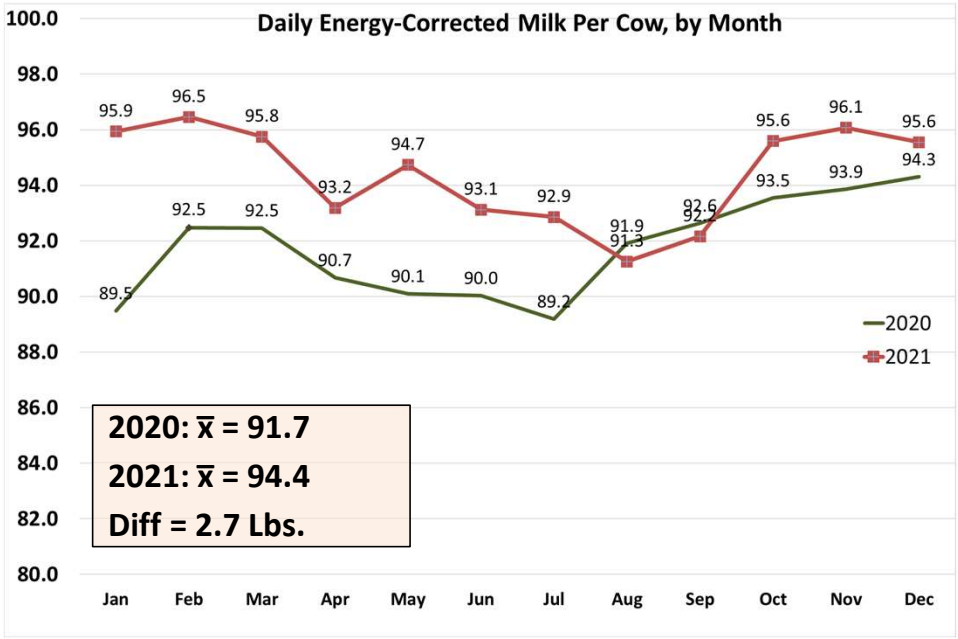

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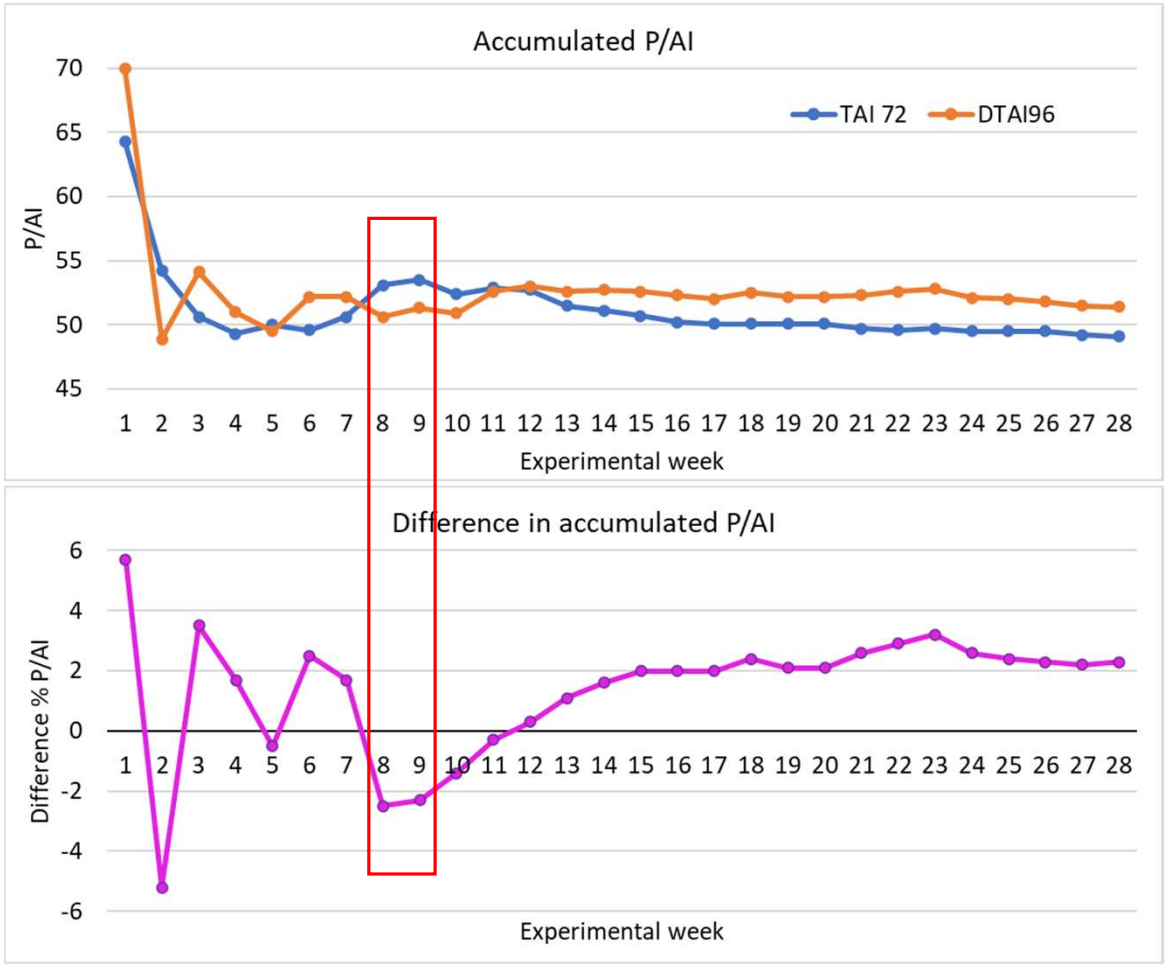
No sample size calculation



DATE	WEEK	ACCUMULATED CR		DIFF POINTS	n
		TAI 72	DTAI96		
11/15/2021	1	64.3	70.0	5.7	24
11/22/2021	2	54.2	48.9	-5.2	95
11/29/2021	3	50.6	54.1	3.5	166
12/6/2021	4	49.3	51.0	1.7	287
12/13/2021	5	50.0	49.5	-0.5	430
12/20/2021	6	49.6	52.2	2.5	560
12/27/2021	7	50.6	52.2	1.7	720
1/3/2022	8	53.1	50.6	-2.5	856
1/10/2022	9	53.5	51.3	-2.3	952
1/17/2022	10	52.4	50.9	-1.4	1080
1/24/2022	11	52.9	52.6	-0.3	1200
1/31/2022	12	52.7	53.0	0.3	1307
2/7/2022	13	51.5	52.6	1.1	1423
2/14/2022	14	51.1	52.7	1.6	1536
2/21/2022	15	50.7	52.6	2.0	1644
2/28/2022	16	50.2	52.3	2.0	1745
3/7/2022	17	50.1	52.0	2.0	1862
3/14/2022	18	50.1	52.5	2.4	1971
3/21/2022	19	50.1	52.2	2.1	2091
3/28/2022	20	50.1	52.2	2.1	2230
4/4/2022	21	49.7	52.3	2.6	2373
4/11/2022	22	49.6	52.6	2.9	2503
4/18/2022	23	49.7	52.8	3.2	2624
4/25/2022	24	49.5	52.1	2.6	2732
5/2/2022	25	49.5	52.0	2.4	2847
5/9/2022	26	49.5	51.8	2.3	2951
5/16/2022	27	49.2	51.5	2.2	3041
5/23/2022	28	49.1	51.4	2.3	3103

Laplacette et al., 2022. Unpublished

Outline

- Relative strengths of evidence for decision making
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  - Low quality evidence
    - Common problems with on-farm trials
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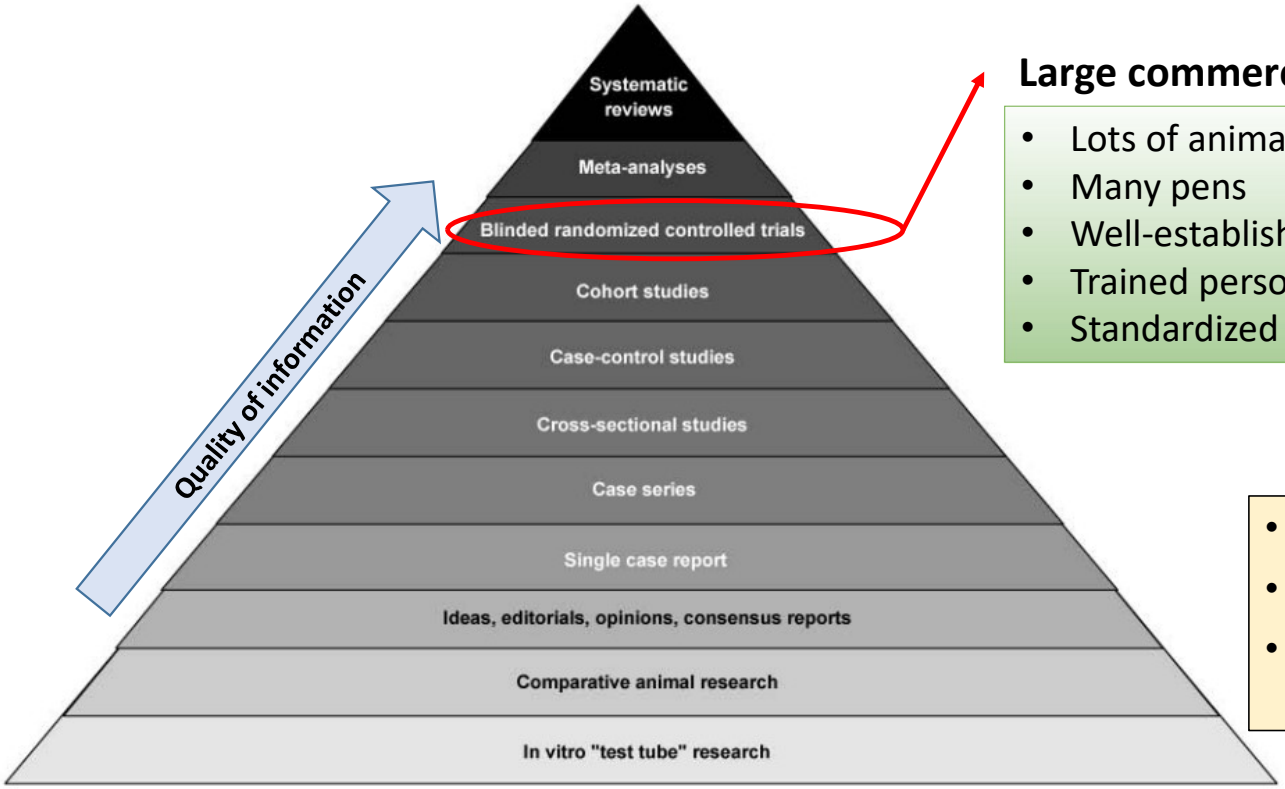
Relative strengths of evidence for decision making



Large commercial farms

- Lots of animals
- Many pens
- Well-established protocols and procedures
- Trained personnel
- Standardized data collection

Randomized controlled trials

- Generate new data
- Validate previous research
- Test if a product/protocol works under their own farm conditions

Holmes, 2009. JAVMA, Vol 235, No. 9

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Steps to test new ideas, products or strategies

1. Ask the right question	▪ Formulate the hypothesis ▪ Define the objectives
2. Develop a proper study design	▪ Number of groups ▪ Outcomes of interest ▪ Sample size calculation ▪ Time needed to see an effect
3. Execute the trial and collect data	▪ Groups should be equal except for the factor to test: Randomization! ▪ Define data collection method to guarantee reliability and integrity ▪ Ensure is being applied correctly
4. Analyze the data and interpret results	▪ Appropriate stat analysis: numerical vs. statistical differences ▪ Relate the results with the hypothesis and objectives
5. Conduct an economics analysis	▪ Biological vs. economic differences ▪ Return on investment

✓ **Biological response**
✓ **Economic benefit**

→ **RECOMMENDATION**

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1. Ask the right question

WHAT DO WE KNOW ABOUT HEAT STRESS?

AFFECTIVE STATES & BEHAVIOR

PHYSIOLOGICAL & BIOCHEMICAL CHANGES

Al-Qaisi et al., 2020; Becker et al., 2022; Burhans et al., 2022

- Dry Matter Intake
- Energy requirements & metabolism
- Immune Response
- Systemic Inflammation

HEAT STRESS

DETRIMENTAL EFFECTS

- **MILK PRODUCTION** (Al-Qaisi et al., 2020)
- **HEALTH & REPRO** (Menta et al., 2022)
- **WELFARE** (Polsky & von Keyserlingk., 2017)
- **ECONOMICS** (St-Pierre et al., 2003)

PREVENTION & CONTROL

- Cooling strategies
- Genetic selection
- **NUTRITIONAL MANAGEMENT**
- (...)

Saccharomyces cerevisiae **fermentation product (SCFP)**

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1. Ask the right question

WHAT DO WE KNOW ABOUT SCFP?

SACCHAROMYCES CEREVISIAE FERMENTATION PRODUCT

YEAST CULTURE-BASED SUPPLEMENT

PROPERTIES

- Anti-inflammatory properties (Knoblock et al., 2019)
- Modulates immune responses (Mahmoud et al., 2020)
- Influence rumen pH (Thrune et al., 2009)
- Influences rumen microbiota (Tun et al., 2020).

MAIN OBJECTIVES

Evaluate the effect of feeding a SCFP to lactating Holstein cows exposed to Heat Stress on milk yield and feed efficiency (FE) in commercial dairy herds in Mexico.

STUDY HYPOTHESIS

We hypothesized that cows fed the supplement would have greater FE as a result of increased milk yield, decreased DMI, or both.

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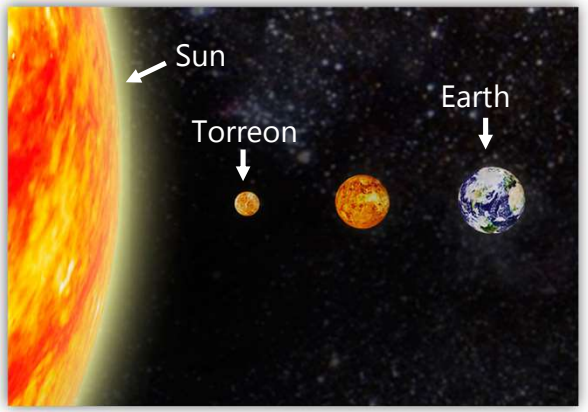
2. Develop a proper study design

WHAT DID WE DO?

A PEN-LEVEL RANDOMIZED CONTROLLED TRIAL

- **2 Commercial Dairy Farms | Torreón, Mexico | Jul – Oct 2020**
- **1,843 Lactating Holstein Cows** (21 – 180 DIM; < 100 DCC)
- **915 Primiparous cows | 928 Multiparous cows**
- **2 Treatment Groups: CTRL (n= 923) vs. SCFP (n=920)**



Outcomes of Interest

- Daily Milk yield | Energy Corrected Milk (cow)
- Bi-weekly Milk Components % (cow)
- Bi-weekly somatic cell counts (SCC; cow)
- Daily Dry Matter Intake (DMI; pen)
- Daily Feed Efficiency (FE; pen)
- Body Condition Score (BCS; cow)
- Individual Body Temperature (cow)

(Thermochron, Data Loggers; subset sample: ~160 cows)

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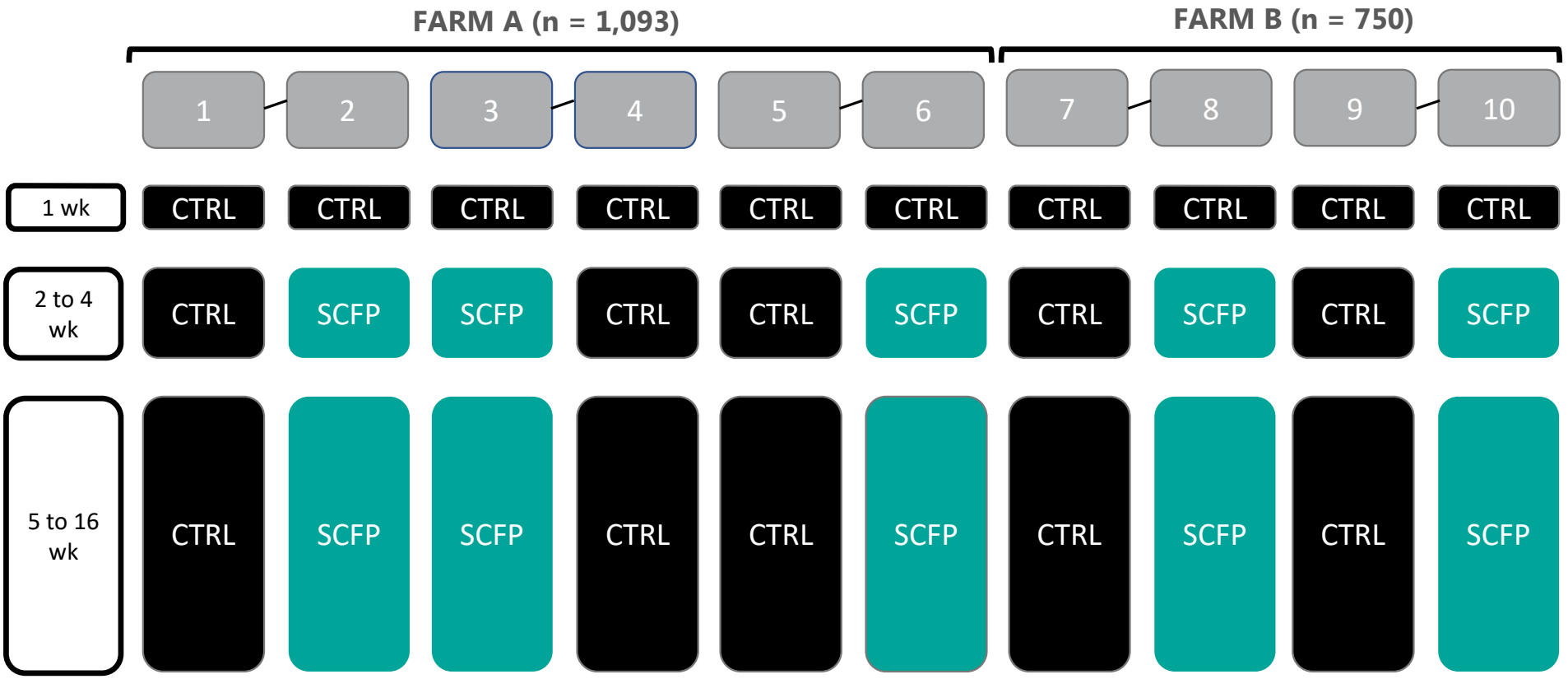
2. Develop a proper study design

STUDY DESIGN

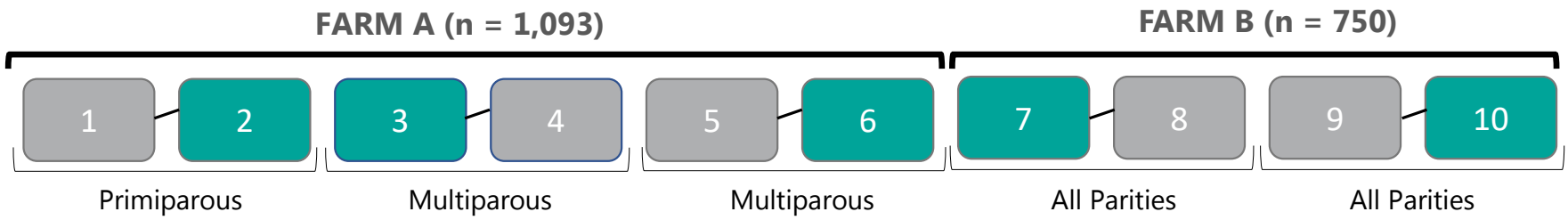
CTRL: Base ration without SCFP

SCFP: Base ration with SCFP (NutriTek Diamond V, 19 g/hd/d)



After initial randomization, no cows were moved in or out of the pen unless they need to be treated or they are culled.

STUDY POPULATION



PAIRS OF PENS RANDOMIZATION

- DIM
- LACT
- DCC
- Milk

WEEK 1 (COVARIATE)

- Milk yield
- Fat and Protein (kg, %)
- SCC
- ECM
- DMI
- FE

- $P > 0.25$

vs.

CTRL SCFP

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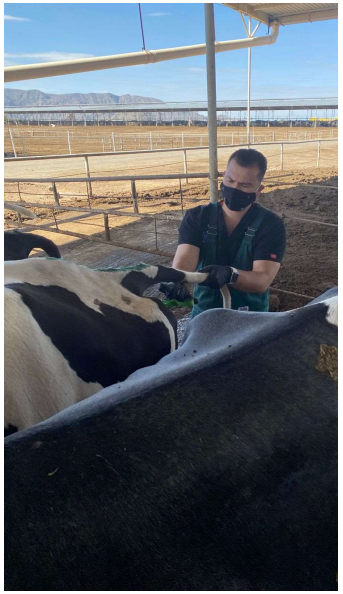
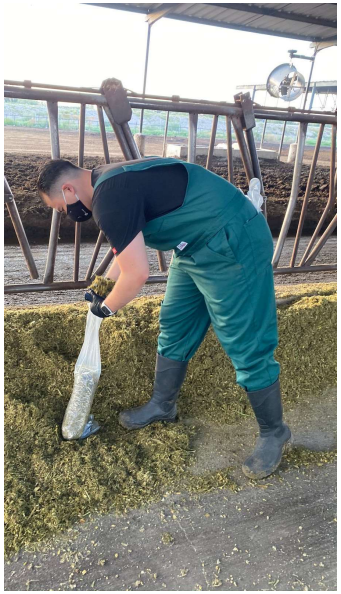
3. Execute the trial and collect data

Oversight and data collection



Intravaginal Thermochron



Mixer validation

DHMS-1927 Diamond-V mixer validation (PPM Cobalt)			
	Farm 1	Farm 2 (A)	Farm 2 (B)
Mean	9.84	21.76	25.39
SD	0.69	1.08	0.96
CV (%)	7.08	4.95	3.78

Microtracer F
(Micro-Tracers, Inc F, San Francisco, CA

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STATISTICAL ANALYSIS

STATISTICAL MODELS

Linear regression models of each outcome accounting for **repeated measures** (**PROC MIXED SAS 9.4**)

COW as observational & PEN as experimental unit

- Treatment (Trt)
- Time (Week of trial or Hour if the day)
- Parity (1st vs. 2nd)
- Baseline value (wk 1) of the outcome
- Interactions of Trt ×Time, Parity, and Trt × Time × Parity

PEN nested within farm and Trt as a **random effect**

COW nested within farm and Trt as subject of **repeated measures**

PEN as observational & experimental unit

- Treatment (Trt)
- Time (Week of trial or Hour if the day)
- Baseline value (wk 1) of the outcome
- Interactions of Trt with Time

FARM as a **random effect**

PEN within farm and Trt as subject of **repeated measures**

- Backward elimination of covariates when $P > 0.1$
- Statistical Significance: $P \leq 0.05$ (tendency: $0.05 < P \leq 0.1$)

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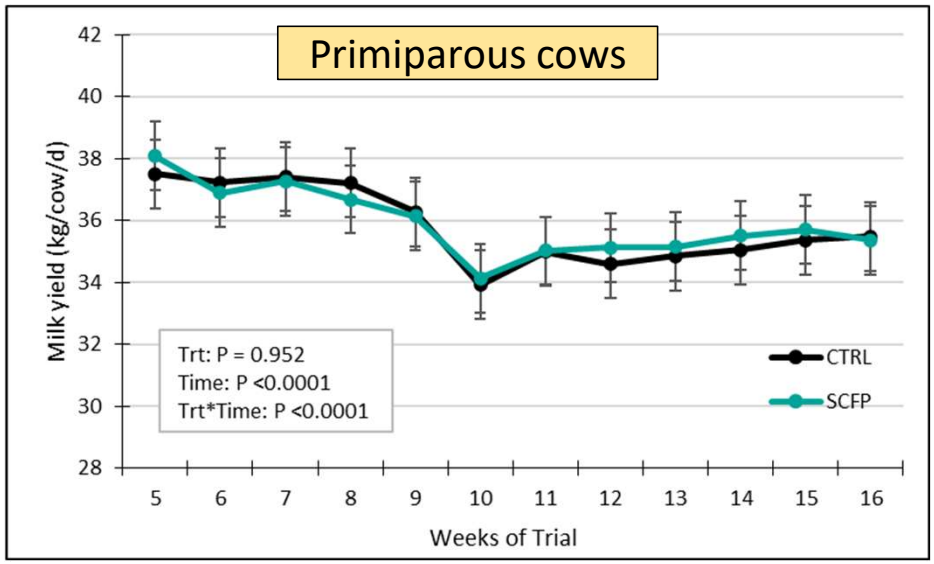
WHAT DID WE FIND?

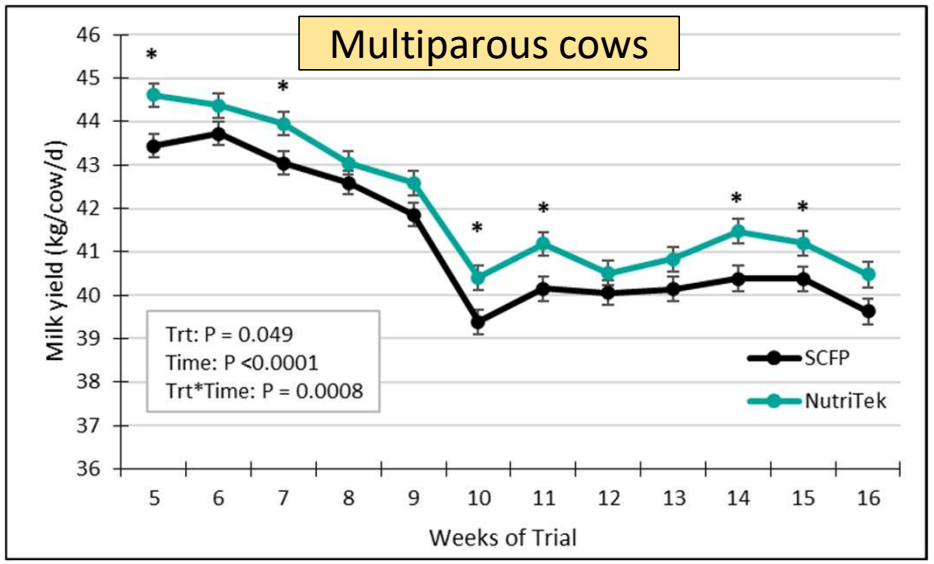
Milk Yield

Treatment had no effect on milk fat, milk protein (yield, %), SCC, and ECM

PRIMIPAROUS	Control	SCFP	*Diff.*
Milk production (kg/cow/d)	35.8 ± 1.1	35.9 ± 1.1	*+0.1*

MULTIPAROUS	Control	SCFP	*Diff.*
Milk production (kg/cow/d)	41.2 ± 0.2	42.1 ± 0.2	*+0.9*

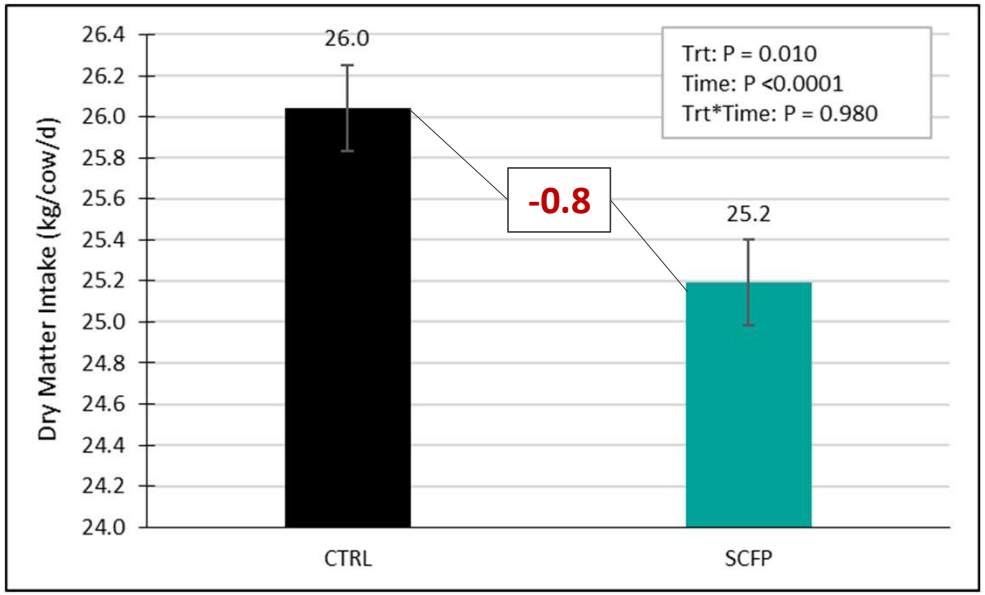


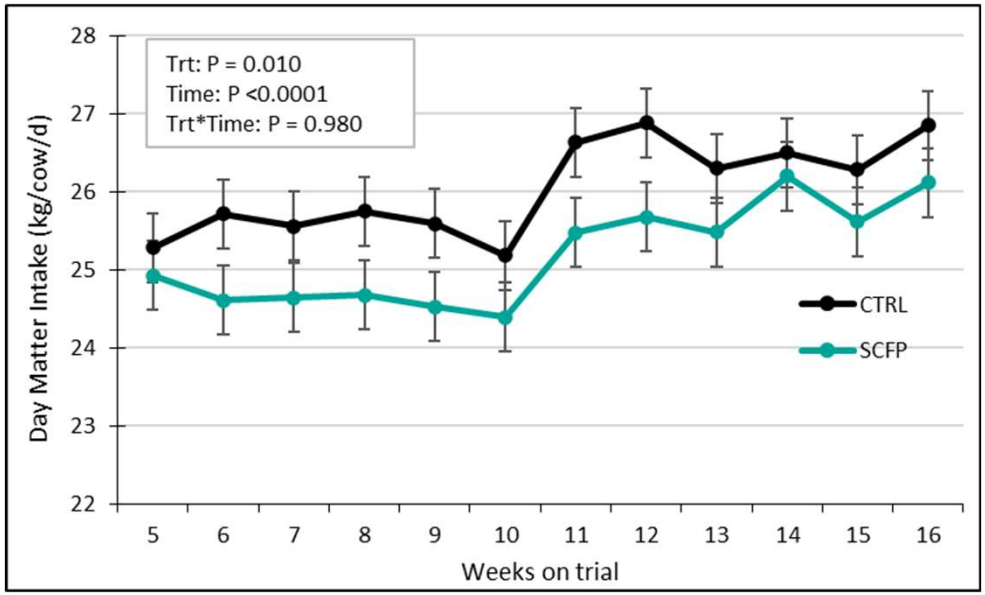


* $P < 0.05$

WHAT DID WE FIND?

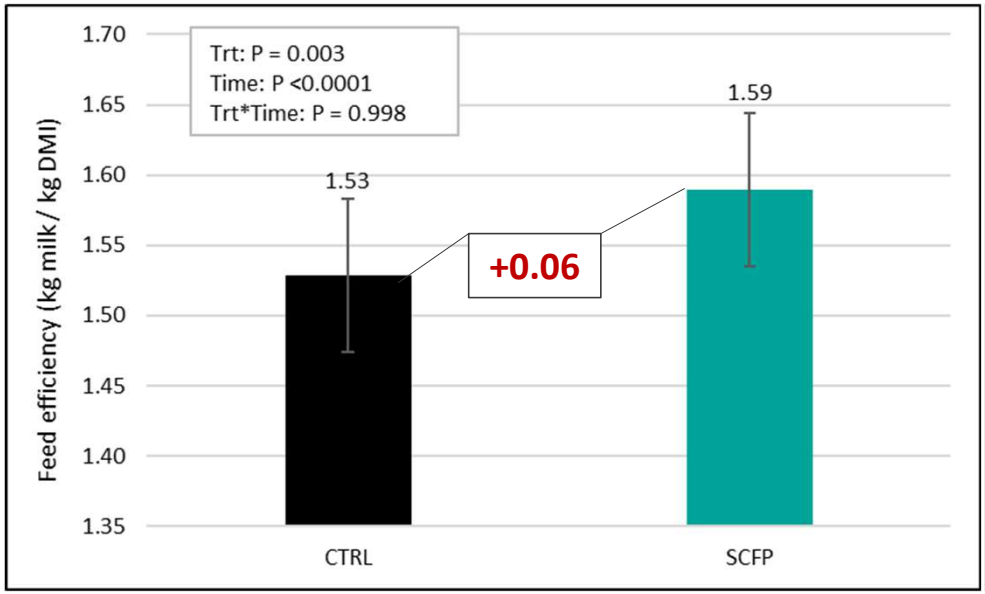
Dry Matter Intake (DMI)



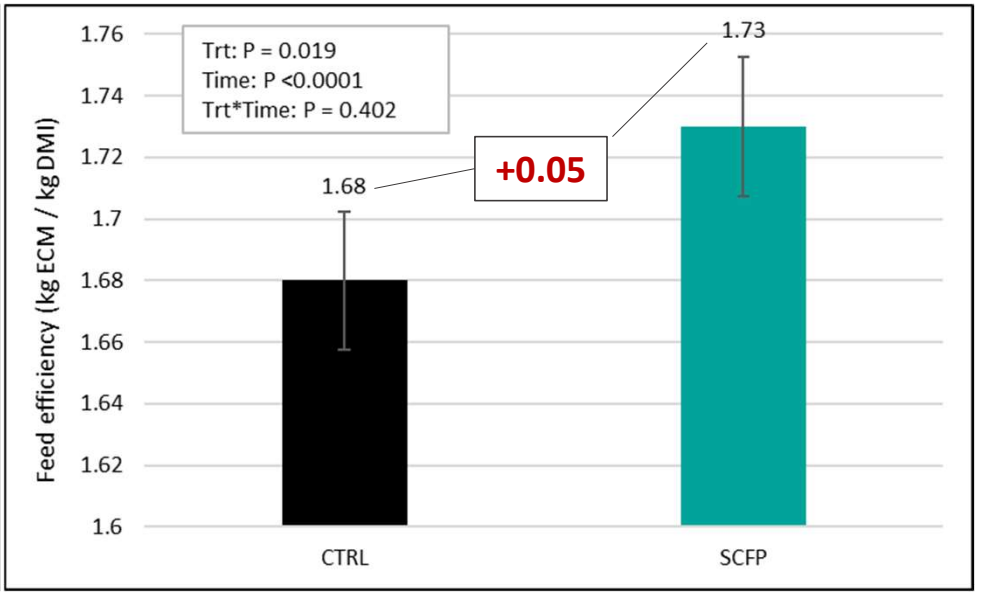


WHAT DID WE FIND?

Feed Efficiency (FE_{MY})



Feed Efficiency (FE_{ECM})



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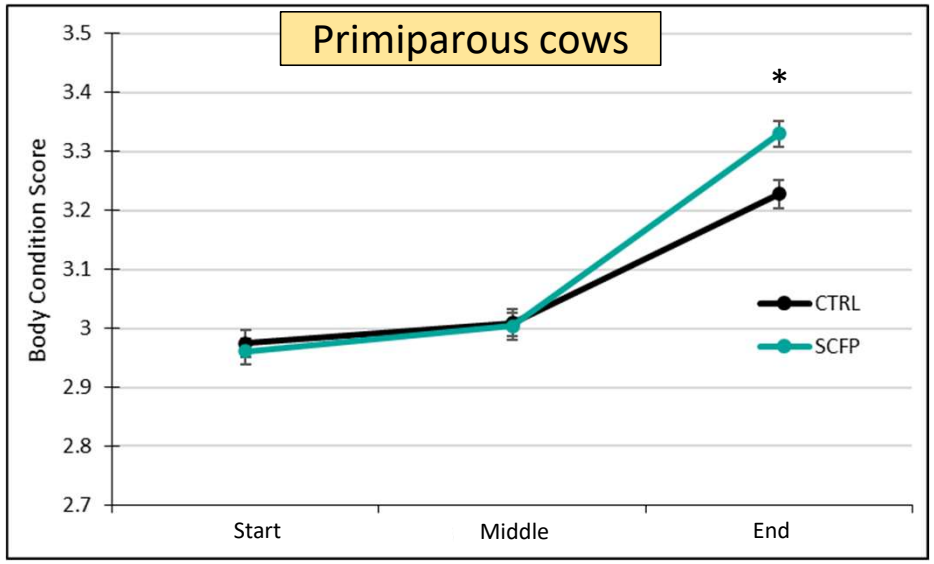
WHAT DID WE FIND?

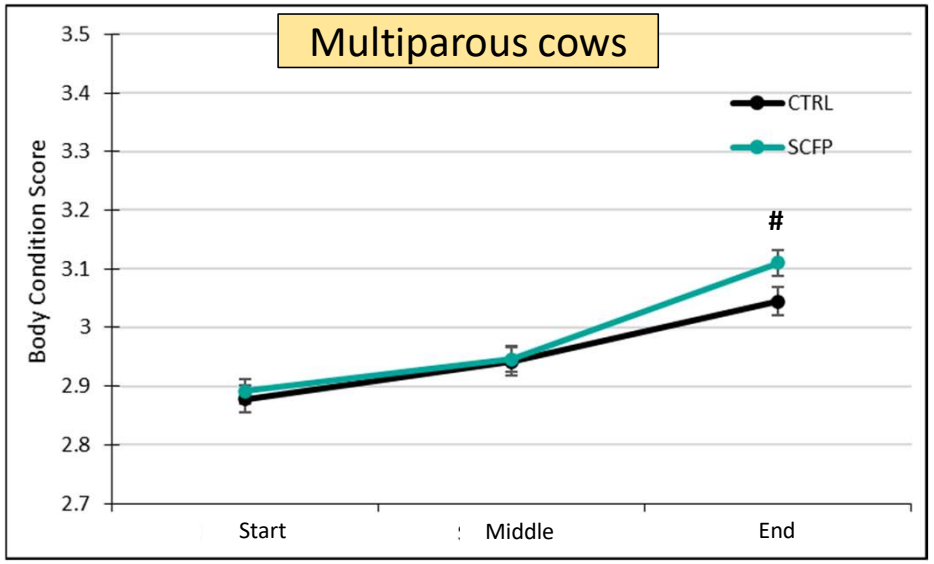
Body Condition Score (BCS)

First BCS	153 ± 54 DIM
Second BCS	189 ± 54 DIM
Third BCS	245 ± 54 DIM

PRIMIPAROUS	CTRL	SCFP	*Diff.*
Third BCS	3.23 ± 0.02	3.33 ± 0.02	*+0.10*

MULTIPAROUS	CTRL	SCFP	*Diff.*
Third BCS	3.04 ± 0.02	3.11 ± 0.02	*+0.07*





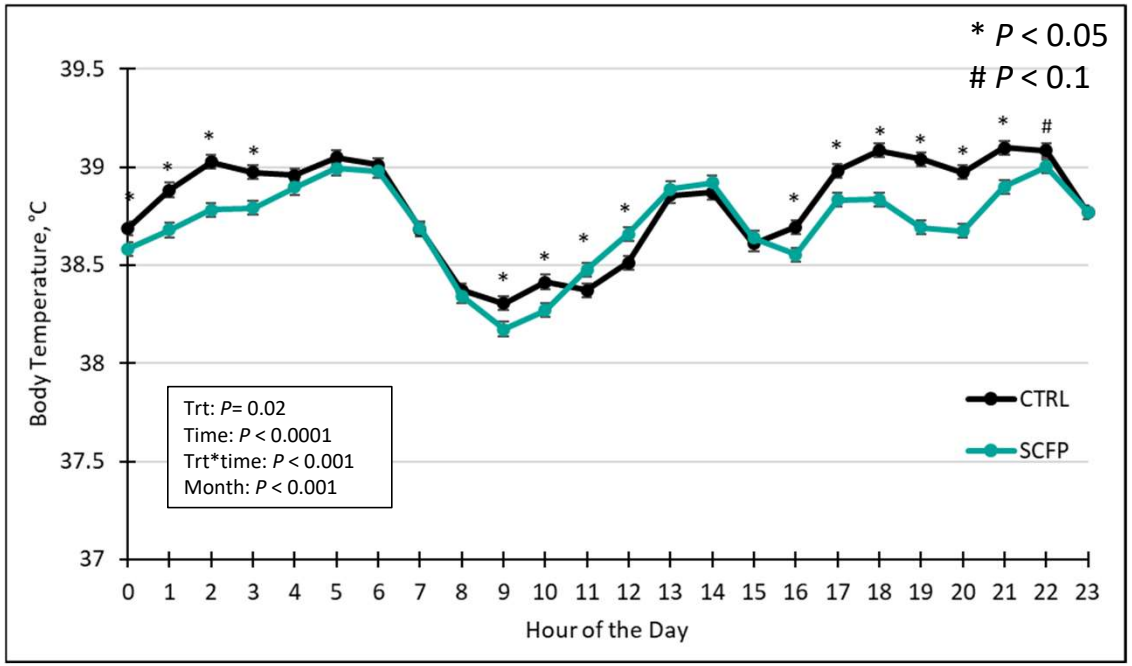
* $P < 0.05$ # $P < 0.1$

Min and max BCS in CTRL: 2.25 ; 3.75
Min and max BCS in SCFP: 2.50 ; 3.75

WHAT DID WE FIND?

Vaginal temperature

n = 162 cows (83 CTRL; 79 SCFP)



- Overall, vaginal temperature was lower for cows on Nutritek (P = 0.02)
- 50% (12h / 24h) of the day, SCFP cows had a lower temperature than CTRL cows (average difference: -0.19 ° C)
- 8% (2h / 24h) of the day, CTRL cows had a lower temperature than SCFP (average difference: -0.13C);
- 42% of the day there was no difference between the two groups.

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Conclusions: biological responses

COMPARED WITH THE CONTROL COWS, COWS SUPPLEMENTED WITH A SCFP DURING HEAT STRESS HAD:

- Greater milk yield in multiparous cows (+0.9 kg/cow/d)
- Reduced DMI (-0.8 kg/cow/d)
- Improved FE_{MY}(+0.06) and FE_{ECM}(+0.05)
- Greater body condition at the end of the study
- Lower body temperature

Is this enough information for recommending the product?

5. Conduct an economics analysis

Economical analysis

Model Inputs

PRODUCT:	NutriTek
Dose of NutriTek (g/cow/d)	19
Concentration of NutriTek (g/Lb)	453.6
Days on NutriTek	305
Days of expected response	305
Milk price ($/Lb)	$0.24
Price of NutriTek ($/Lb)	$3.30
Feed cost ($/LbDM)	$0.15
Number of cows	1000

Expected response when feeding NutriTek

	P-value	Control	NutriTek	Dif. NutriTek vs. Con
Dry Matter intake (Lbs/d)	0.01	57.20	55.45	-1.75
Milk (Lbs/d)	0.05	91.00	92.5	1.50
Fat (%)	0.56	3.99	4.06	0.0
Protein (%)	0.81	3.24	3.25	0.0

Model Outputs

NutriTek feeding cost

Cost of NutriTek ($/cow/d)	$0.14
Cost of NutriTek (Lbs of milk/cow/d)	0.74

Extra income from increased production

Extra milk per day (Lbs/cow)	1.50
Extra milk income per cow per day ($/cow/day)	$0.36

Extra savings due to decrease in DMI

Extra feed cost per cow per day ($/cow/d)	-$0.26

Profit margin and return on investment

Daily Margin per cow ($/cow/d)	$0.48
Extra income per dollar spent ($)	$3.70
ROI ($ gained for each $ invested)	$2.70

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Economic analysis

Type I and Type II Errors of Feeding NutriTek

- ✓ **Type I Error:** Implementing a procedure, product, or some management change when there is no positive effect from doing so.
- ✓ **Type II Error:** Failure to implement a procedure, product or some change in management when there is a positive effect in doing so.

Galligan et al., 1991. J Dairy Sci 74:902-910
Michael F. Hutjens

Type I and type II error for NutriTek

	Response	No Response
Feed NutriTek	**CORRECT**	**INCORRECT** ***Type I error*** **$0.14 per cow/day**
Do Not Feed NutriTek	**INCORRECT** ***Type II error*** **$0.48 por cow/day**	**CORRECT**

Outline

- Relative strengths of evidence for decision making
  - High quality evidence
  - Low quality evidence
    - Common problems with on-farm trials
- Steps to test new ideas, products or strategies
  - Example of large-scale commercial field trial
- Evaluation of available trial & “trial” results

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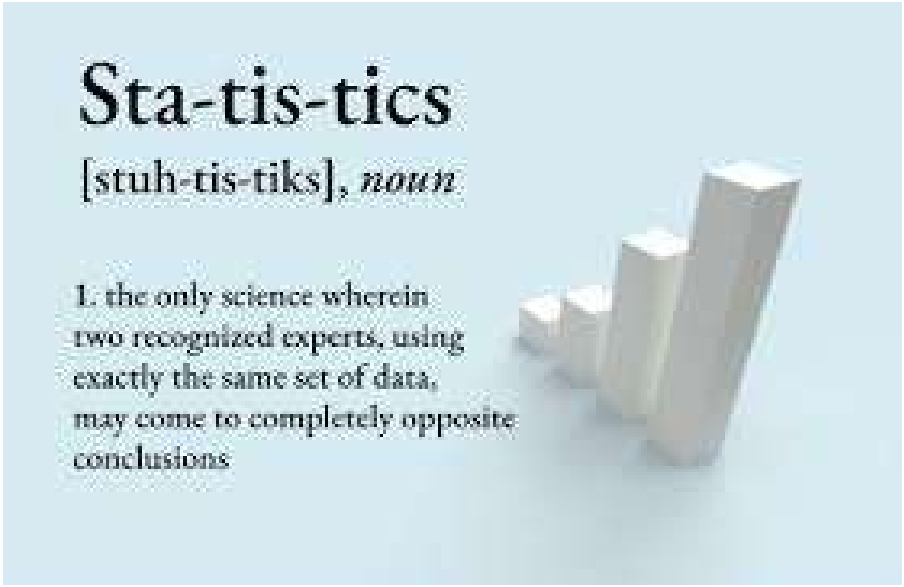
Can We Trust the Results?

- Randomization and balanced groups
- Defined inclusion and exclusion criteria
- Oversight of implementation and feeding accuracy
- Validated data collection methods
- Verification that cows actually consumed the treatment
- Appropriate statistical analysis and economic evaluation



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Biological vs. Statistical Significance

- Not every statistically significant result is biologically meaningful
- Not every non-significant trend should automatically be ignored
- Evaluate magnitude of response, repeatability, and economic relevance
- Example: +0.9 kg milk/cow/day may be economically important
- Interpret P-values together with confidence intervals and ROI

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Will This Work on My (or my client's) Dairy? Internal vs External Validity

RESPONSES DEPEND ON FARM MANAGEMENT AND ENVIRONMENTAL CONDITIONS

STOCKING DENSITY, HEAT STRESS SEVERITY AND RATION CONSISTENCY MATTER

COMPLIANCE AND IMPLEMENTATION ARE CRITICAL

RESEARCH GENERATES EVIDENCE; MANAGEMENT DETERMINES REPEATABILITY

SAME PRODUCT ≠ SAME RESPONSE ON EVERY DAIRY

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The Danger of Noise in Dairy Data

- Normal herd variation may exceed the expected treatment response
- Daily milk production naturally fluctuates
- Small differences can be due to random variation
- Large datasets and proper controls reduce risk of false conclusions
- Many commercial success stories are simply normal biological variation

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Common Reasons Commercial Trials Fail

- Poor study design: no randomization or inadequate sample size
- Implementation failures: inconsistent feeding or pen movements
- Data issues: missing tags, overwritten data, software problems
- Improper interpretation of tendencies and correlations
- Lack of economic evaluation
  - Significant biological outcomes but product is too expensive

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Experimental Unit: Cow vs. Pen

- If treatment is applied at the pen level, the pen is the experimental unit
- Analyzing pen-level treatments at the cow level can invalidate conclusions
- Nutrition studies commonly require pen-level randomization
- Proper statistical models must account for repeated measures and nesting

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What Would Change Our Recommendation?

- Lack of repeatability across farms or seasons
- No measurable improvement in profitability
- Inconsistent implementation of the protocol
- No biologically plausible mechanism of action
- High variability with minimal practical benefit

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Why Many Bad Recommendations Survive

- Confirmation bias and anecdotal experiences
- Pressure to solve problems quickly
- Testimonials and social media influence
- Free products and sales-driven recommendations
- Lack of controlled evaluation under commercial conditions

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TAKE HOME MESSAGE

- Recommending products/protocols based on high quality evidence minimizes risk and maximizes profitability
  - Stay away of opinions or anecdotal evidence
- Avoid common errors if you plan to generate your own data
  - Comparing before and after, unbalanced groups, underpower studies
- Large commercial dairies farms can generate/validate data under their own farm conditions
  - Lots of animals and many pens
  - Well-established protocols and procedures as well as trained personnel
  - Standardized data collection methods
- Develop a plan to test new ideas
  - Follow the steps and don't forget to run an economic analysis

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Questions?

Thank you!

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