



Evaluation of a Commercial Rumen Bolus to Monitor Cattle Behavior and Well-being on Rangelands



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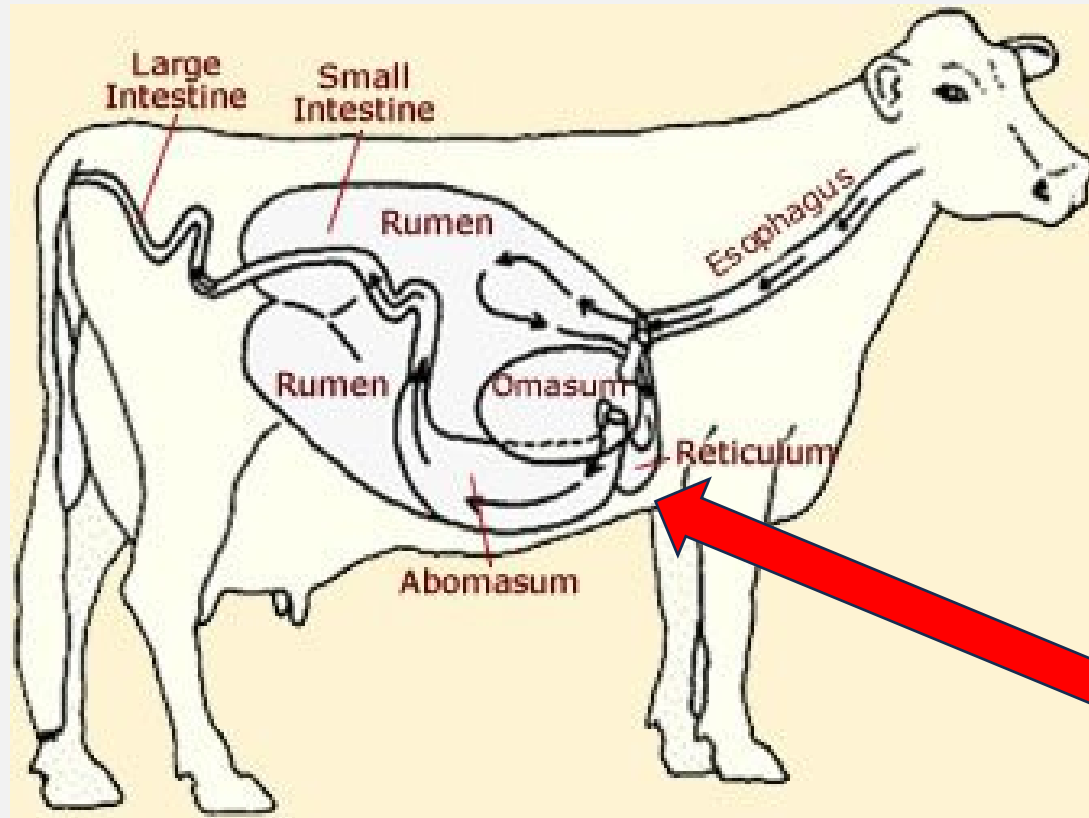
Corriente heifers Grazing at Deep Well Ranch, Prescott AZ

Why Study Precision Livestock Management (PLM)

"The goal of precision livestock management is to provide a real-time monitoring and management system that can improve livestock productivity and welfare." - Bailey et al. 2021

- Increase animal welfare
- Increase ranch productivity and efficiency

New Technology: Rumen Temperature Bolus



- Proxy for core body temperature
- Monitor animal well-being



credit: <https://extension.umn.edu/dairy-nutrition/ruminant-digestive-system>

Common Smart Rumen Bolus Use: Dairy Industry



- Easy to monitor animals
- Easy excess to AC power
- Internet capabilities
- Centralized location

Cows in a dairy credit: <https://blowerfab.medium.com/3-important-benefits-of-industrial-exhaust-fans-in-dairy-farms-34b772454143>

PLM Research Challenges on Rangelands



Cattle in Rangeland Deep Well Ranch, Prescott AZ

- Vast and rugged terrain
- Time consuming to observe and check
- Limited to no infrastructure
- Often limited Cellular Coverage

HOWEVER,...

These are the same challenges producers face and the reason why this type of research is necessary!

The Question: Animals Response to Weather



Cattle at Deep Well Ranch, Prescott AZ

Can a commercial rumen bolus predict changes in cattle activity and well-being resulting from variation in summer weather?

Potential Indicator of Heat Stress?

Animals and Location



Animals: 10 of 28, 2-year Registered Corriente heifers

- Given SmaXtec rumen temperature boluses
– April 7th, 2023

Site: Deep Well Ranch, Prescott Arizona

- North Ditch Pasture 312 ha
- Dominated by black grama (*Bouteloua eriopoda*)
- Rolling terrain - elevation range, 1434 to 1675 meters
- One water source



Top: Corriente cattle DW Ranch, Bottom: landscape DW Ranch

The Device: Rumen Temperature Bolus

SmaXtec Classic Boluses (Graz, Australia) <https://smaxtec.com/en/smaxtec-system-in-detail/#boli>



SmaXtec Bolus

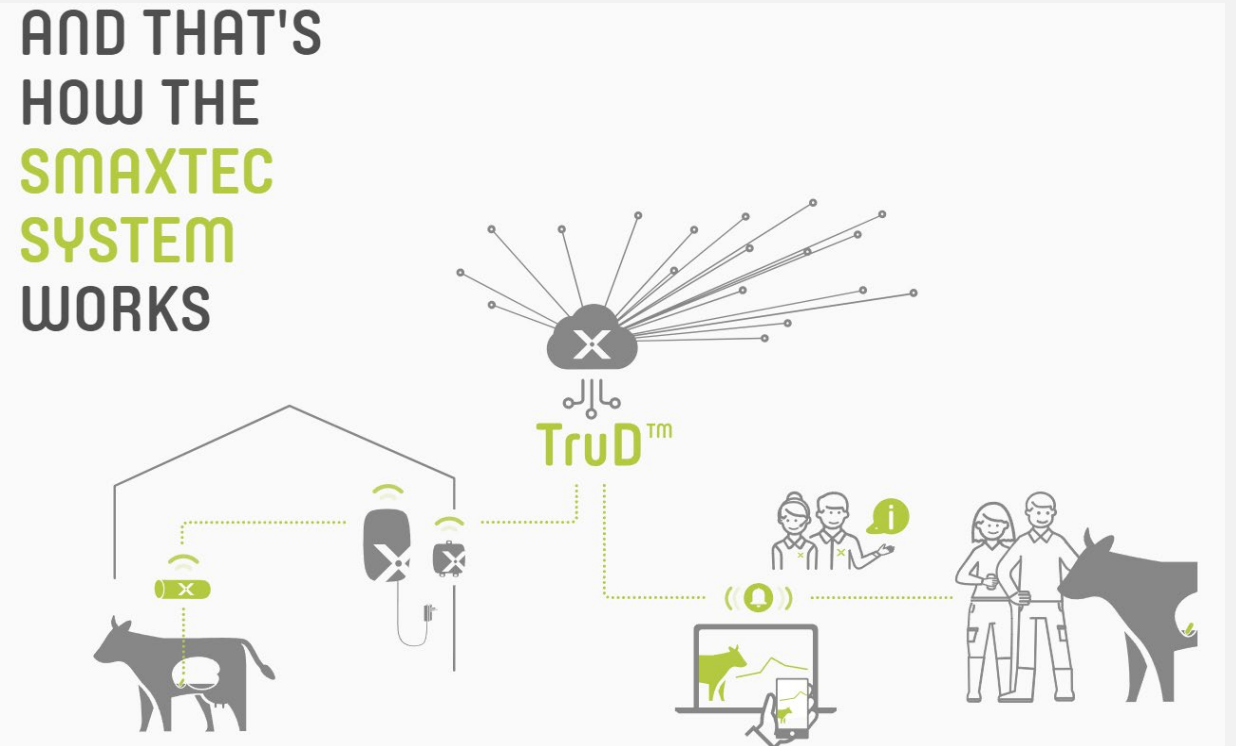


Illustration of SmaXtec system

More About SmaXtec



- Records values every 10 seconds averaged over 10 minutes
- Accelerometer
- Stores 6 days of data
- Communicates to base station using long range Bluetooth
- 3-5 year life expectancy of bolus

Solar powered base station Deep Well Ranch

Base Station Location

-
- Base station located ~40 meters from water

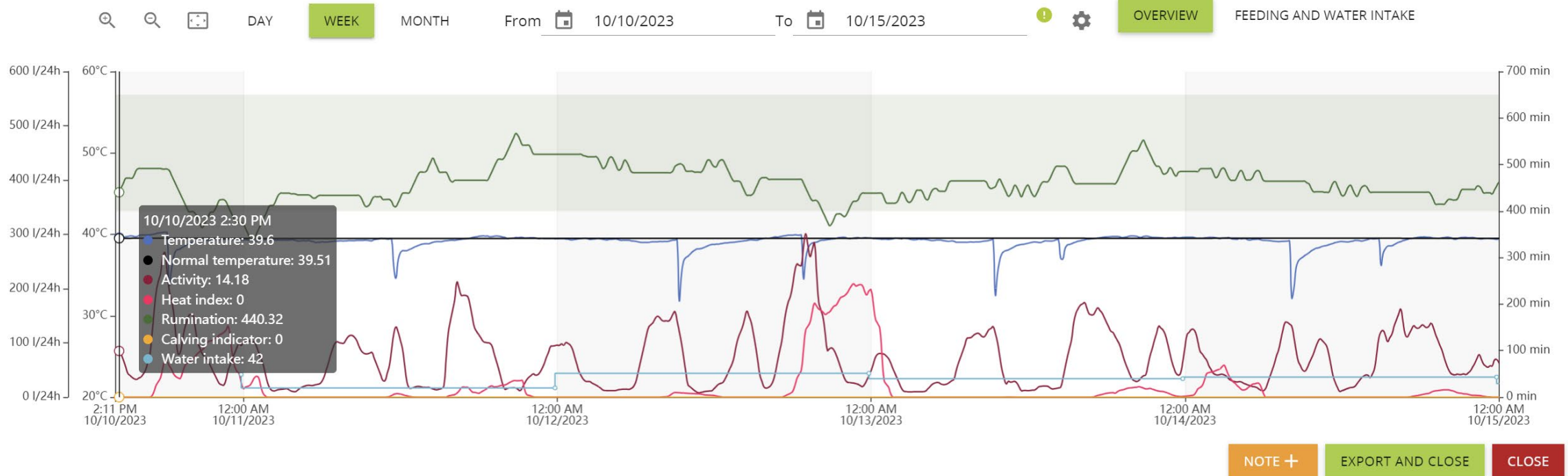
Base Station

- Study Period: 6/1 – 8/31/2023



Cattle loafing at water, Deep Well Ranch Prescott, AZ

SmaXtec Metrics



SmaXtec Dashboard Graphing of indices:

- Rumen Temperature
- Activity Index
- Estrus Index
- Ruminations Index
- Water Intake Index

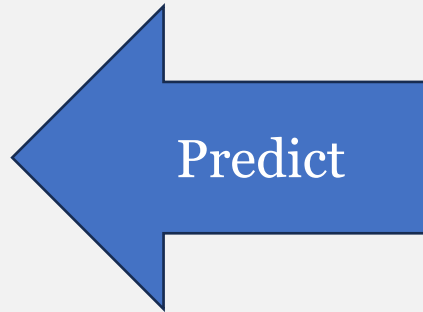
*6 days of data presented

Statistical Analysis (Repeated Measures)

Dependent Variables:

SmaXtec Metrics

- Activity
- Rumination
- Rumen Temperature, C°
- Water Intake (24-hour period)



Independent Variables:

Weather Metrics

- Relative Humidity
- Ambient Temperature, C°
- Wind Speed
- Linear and Quadratic Effects
- Interactions
- Time of Day (3-hour periods)

The Analyses

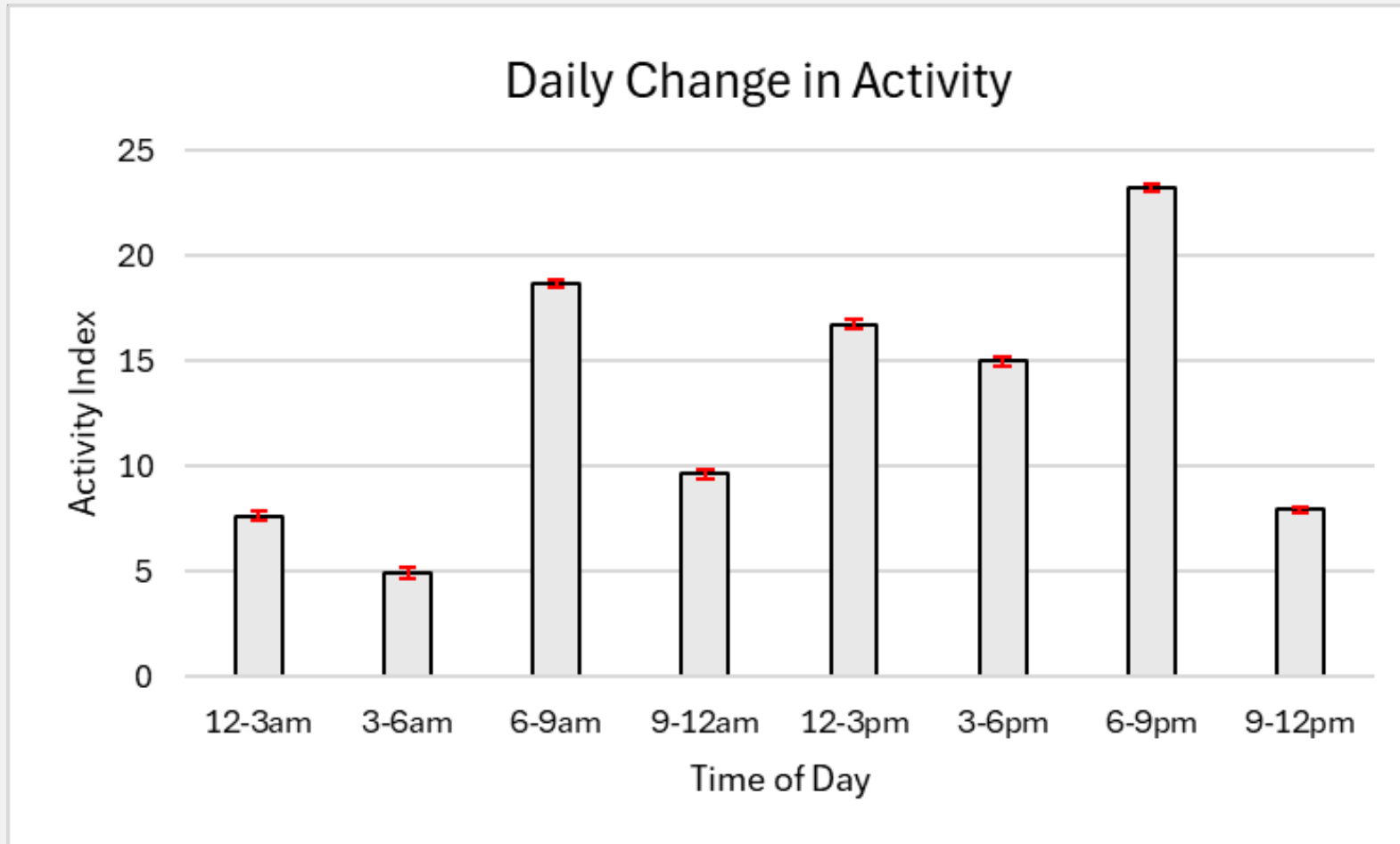
Analysis 1

- Data: Smaxtec and weather data averaged into one 24-hour period per day
- Dates 6/1/2023 to 8/31/2023
- SAS PROC MIXED

Analysis 2

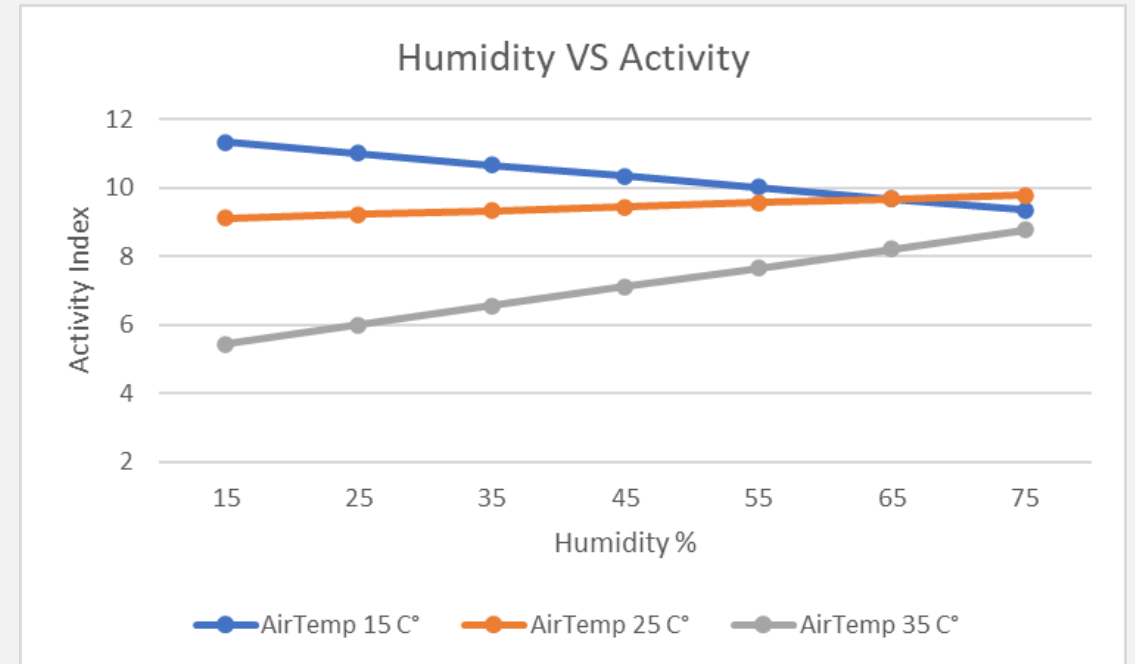
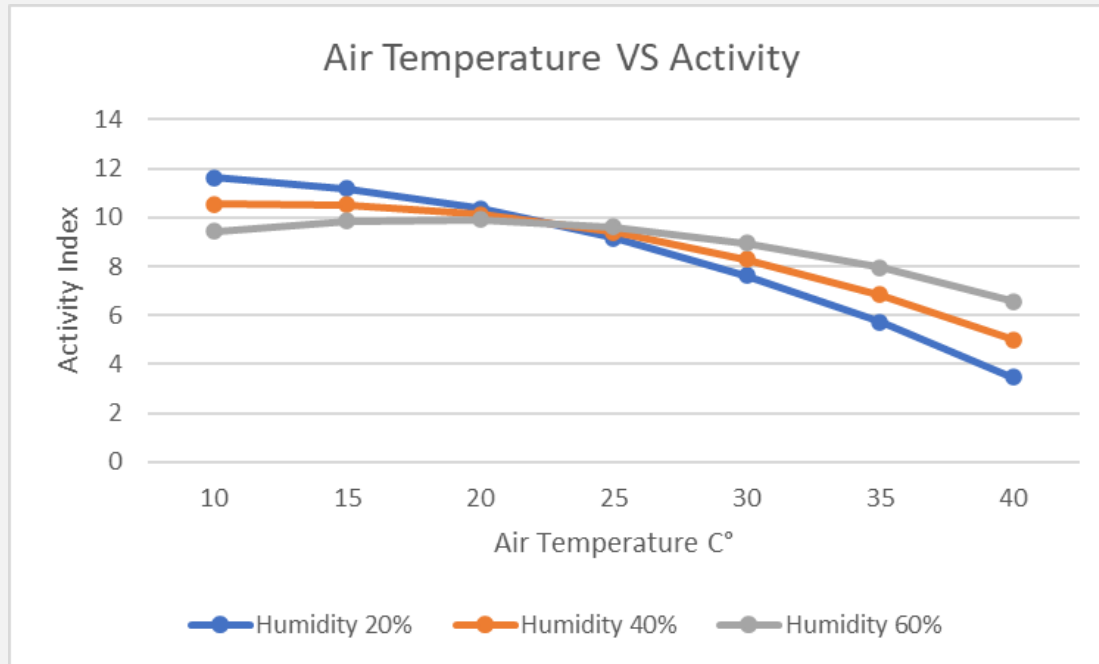
- Data: Smaxtec and weather data averaged into 8, 3-hour periods per day
- Dates 6/1/2023 to 8/31/2023
- SAS PROC MIXED
- Excluded water intake index

Results-Activity



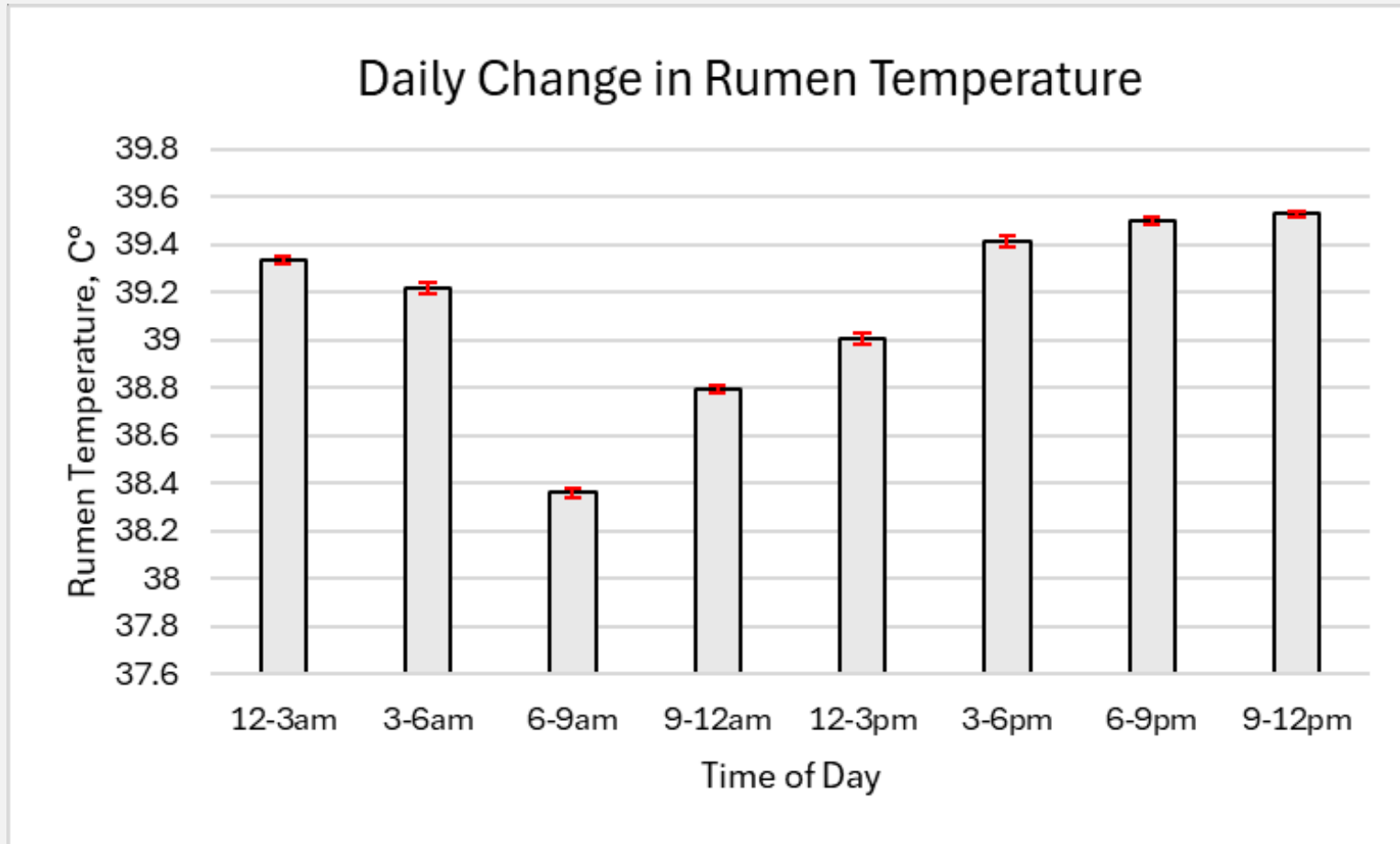
Note: All indices in these analyses are dimensionless (no units)

Results-Activity

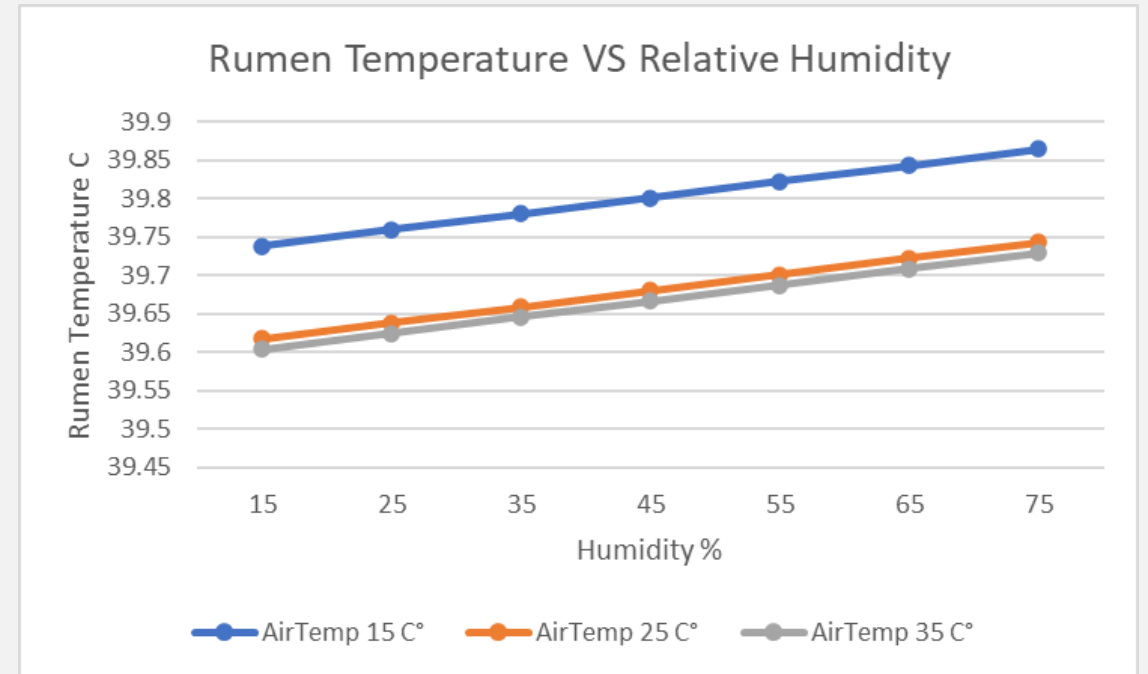
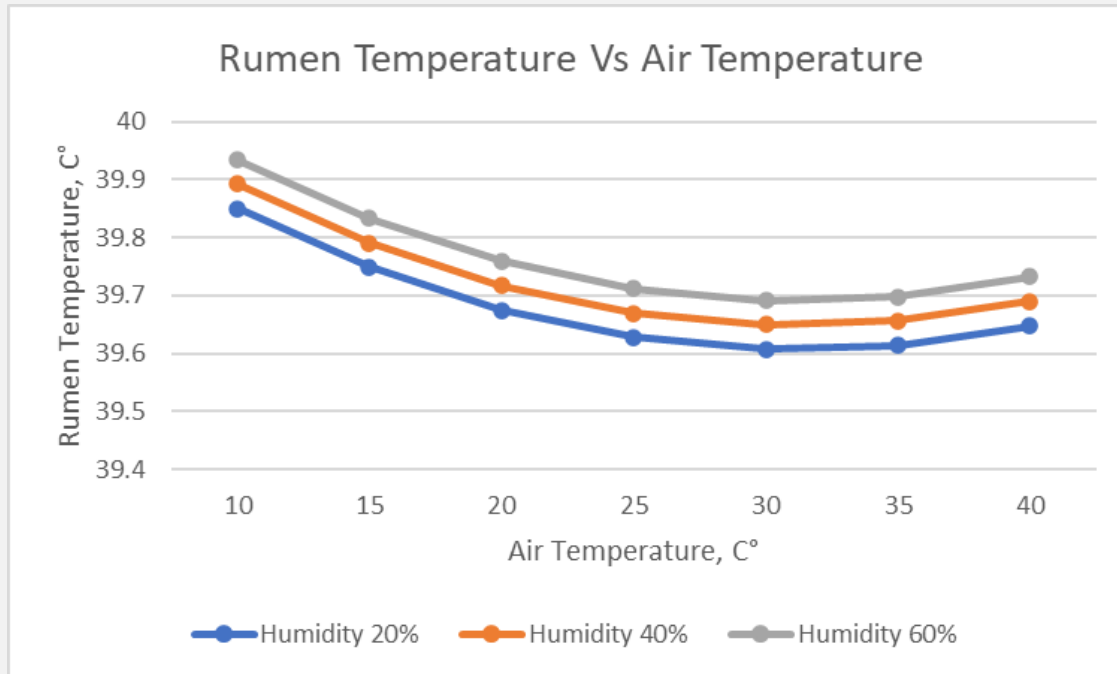


*Wind Speed was not significant for modeling activity and was excluded from the final model.

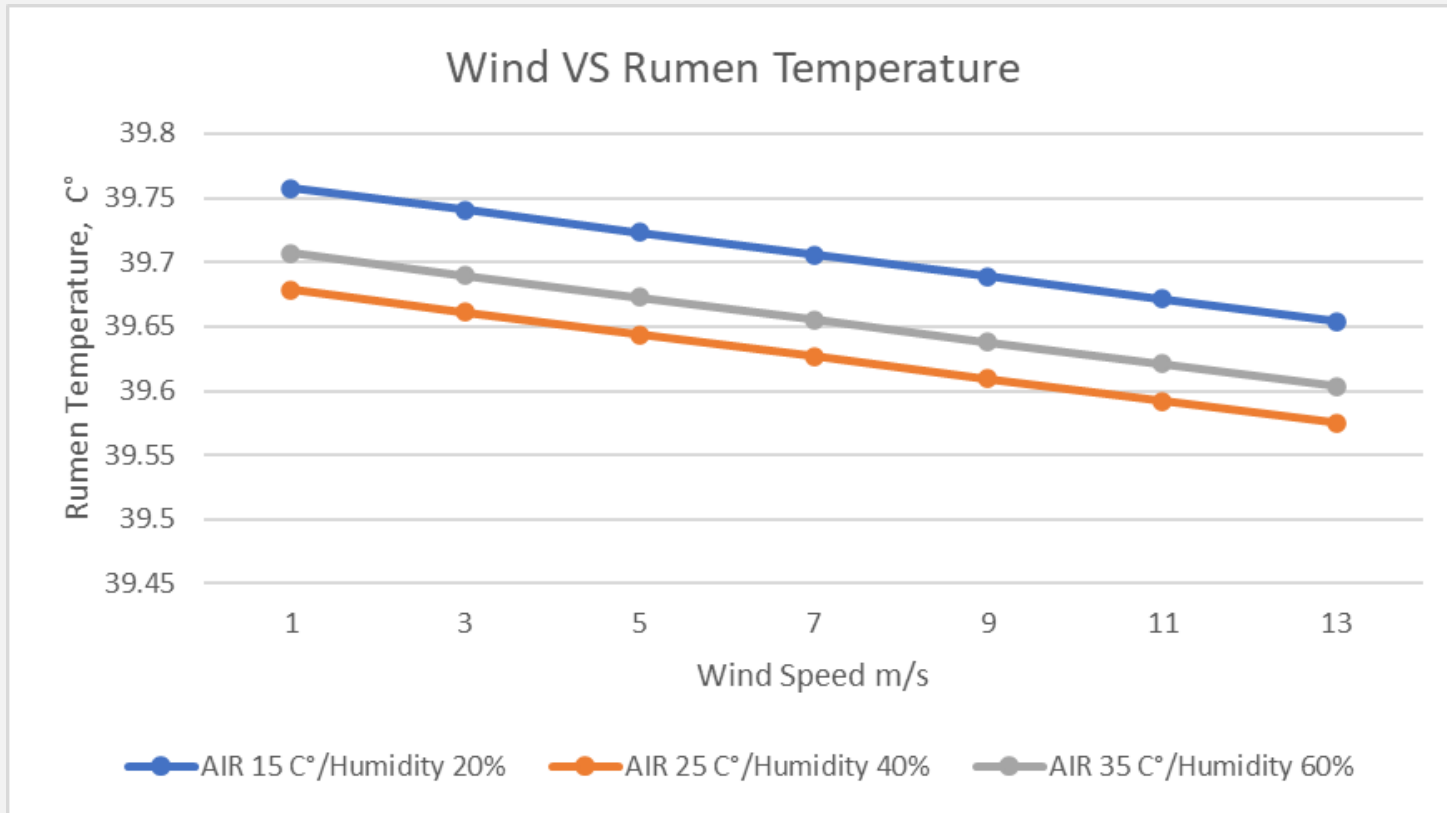
Results-Rumen Temperature



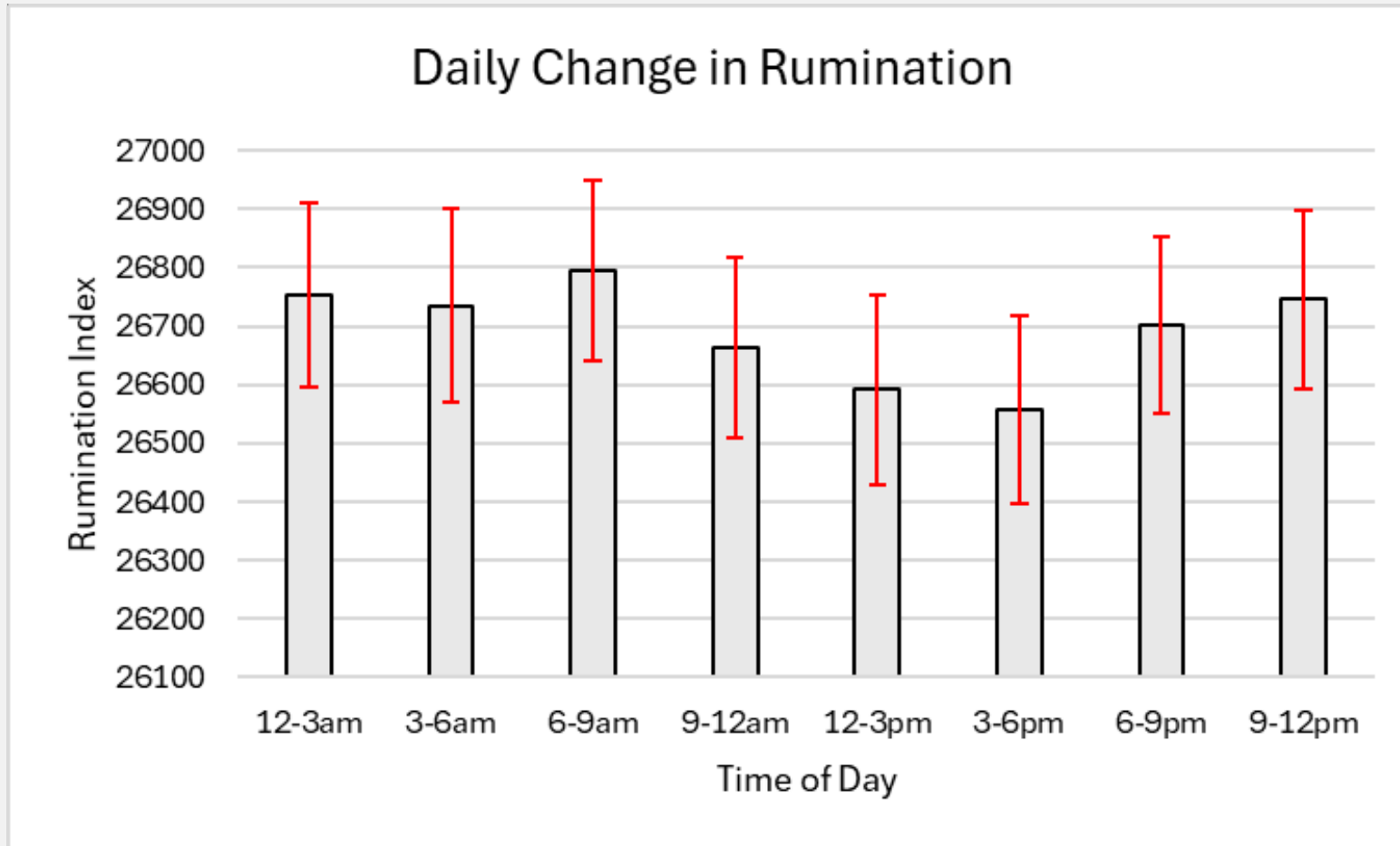
Results-Rumen Temperature



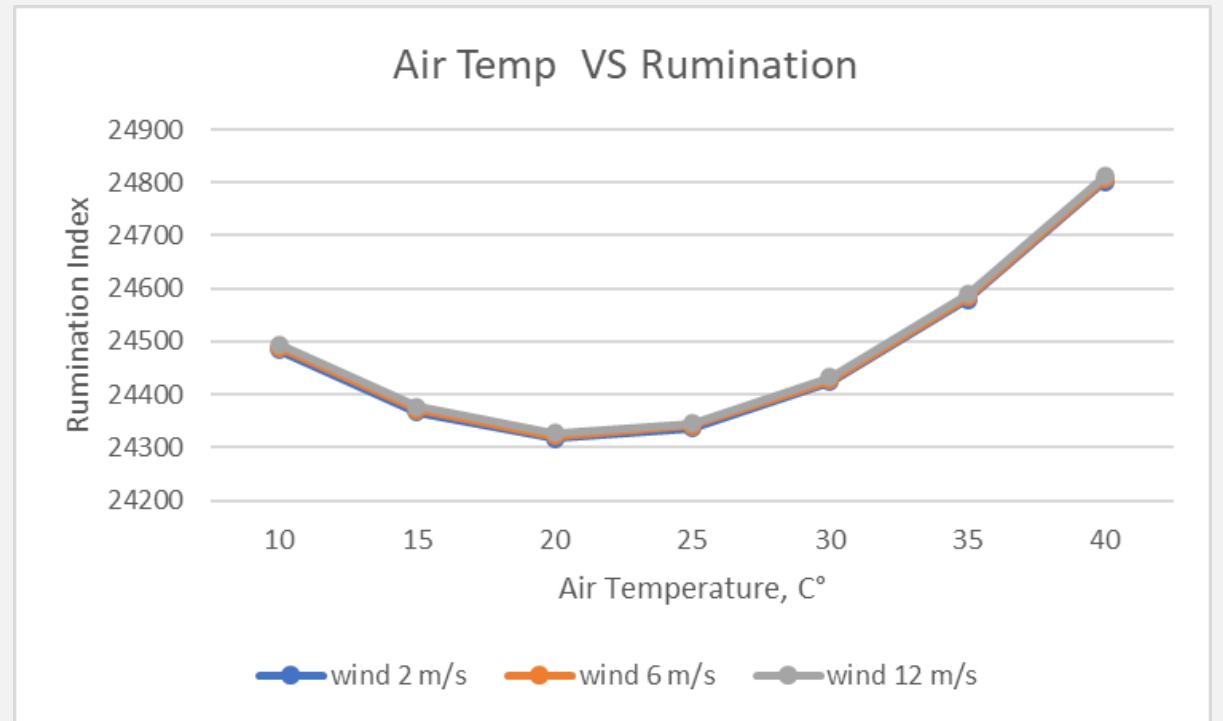
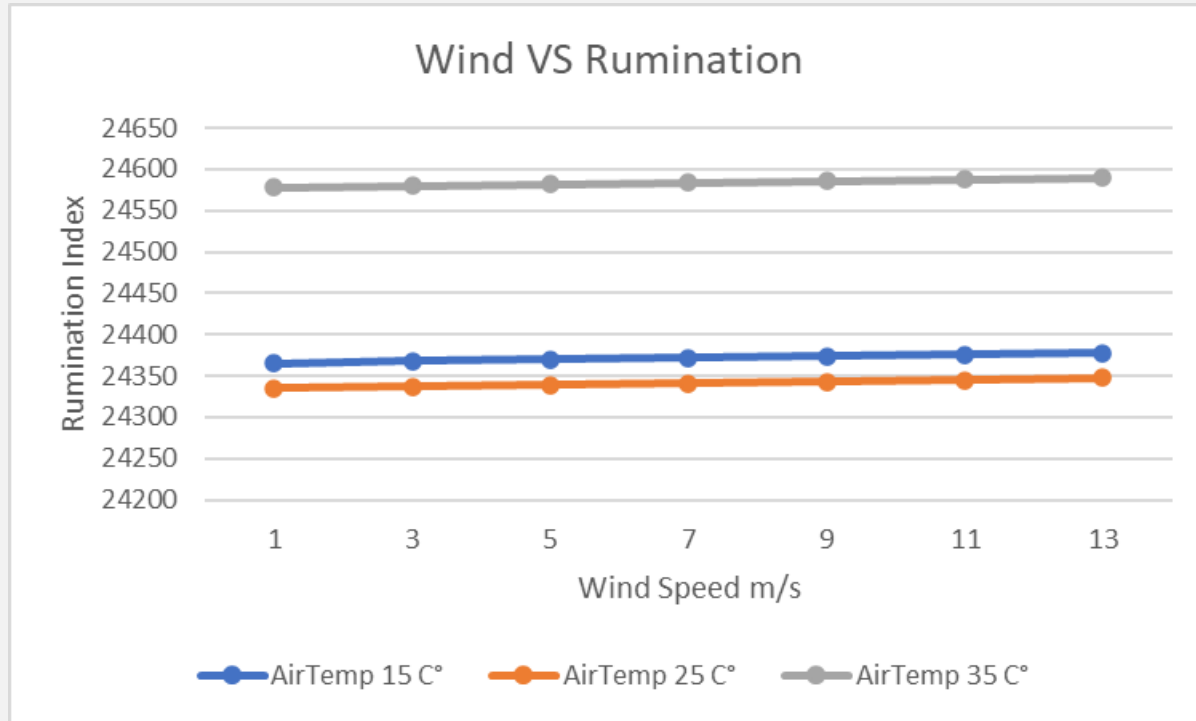
Results-Rumen Temperature



Results-Rumination



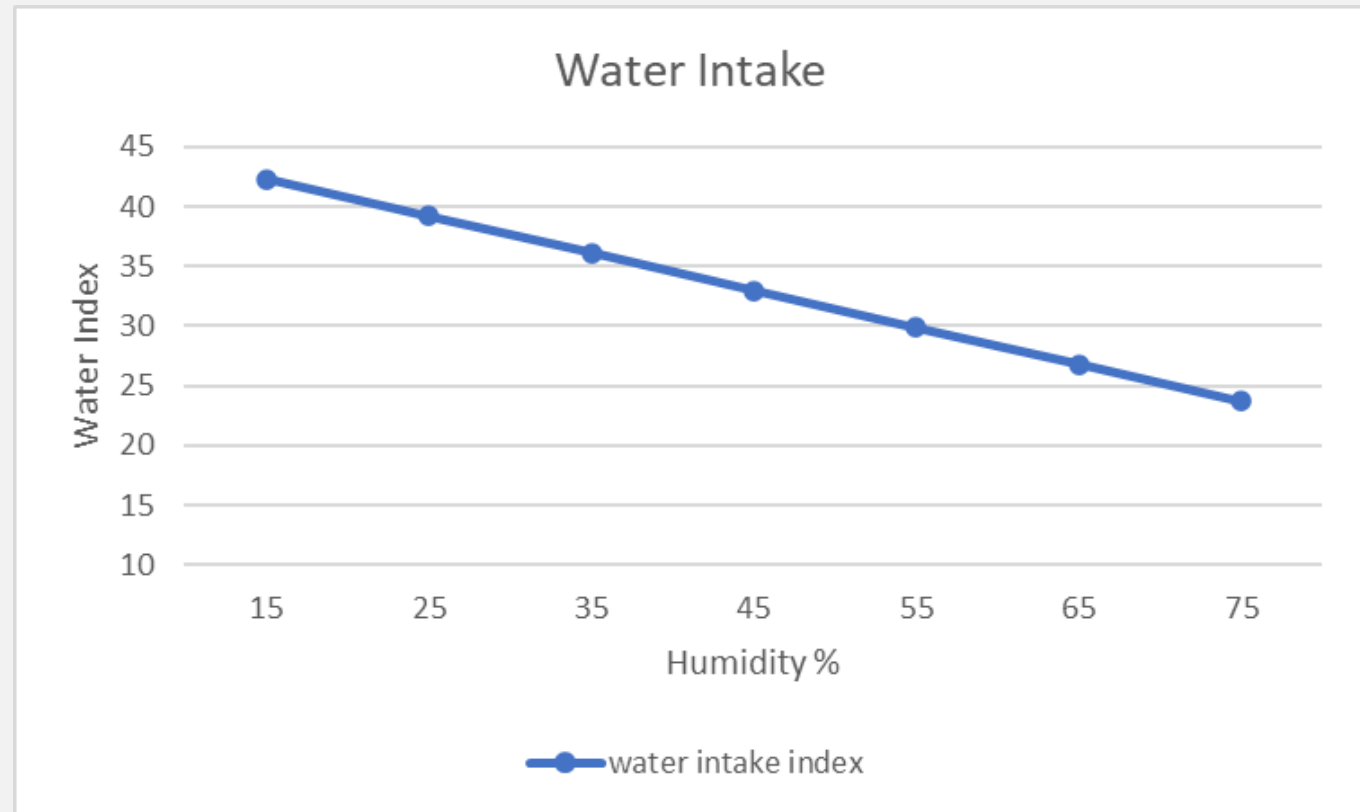
Results-Rumination



*Humidity was not significant for modeling Rumination and was excluded from the final model.

Water Intake

- Only Humidity was significant
- 24 hour averaged



Implications

- SmaXtec Classic Bolus shows potential for detecting the onset of heat stress and other well-being concerns for cattle grazing rangelands.
- More research is needed.

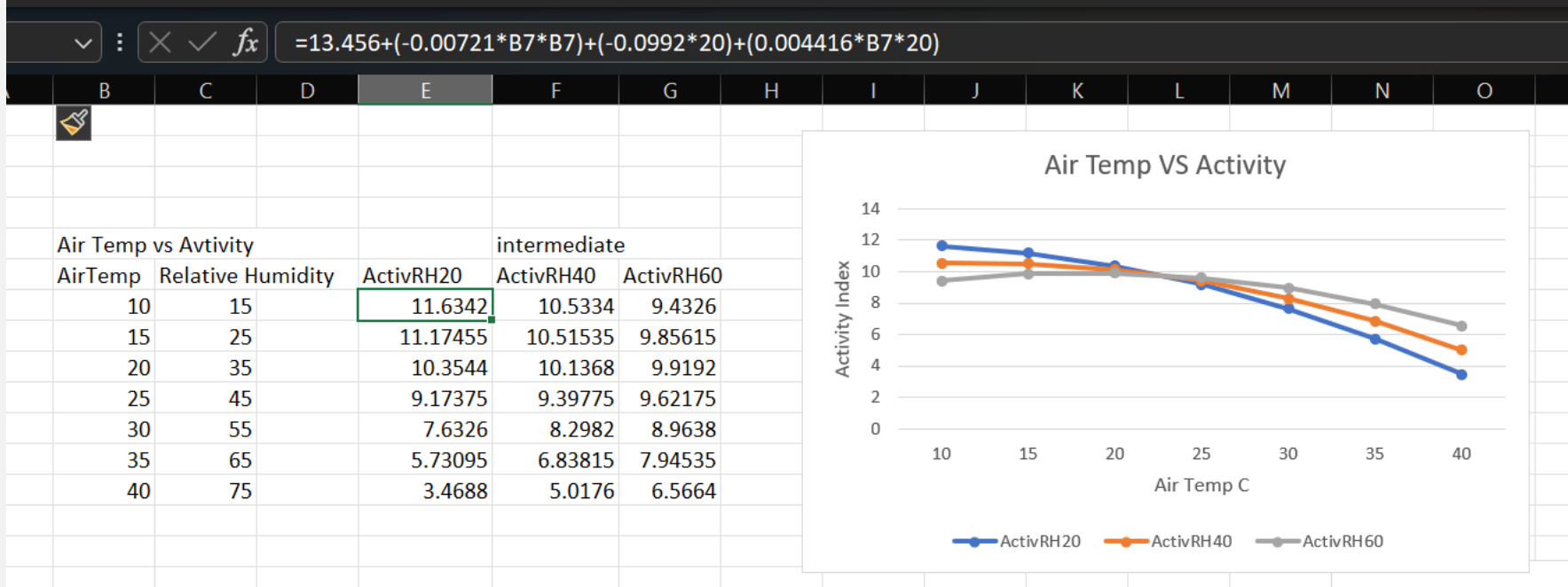


Questions...

The Process

Solution for Fixed Effects

Effect	Trunc	Date	Estimate	Standard Error	DF	t Value	Pr > t
Intercept			13.4560	0.7419	9	18.14	<.0001
AirTempC*AirTempC			-0.00721	0.000557	7012	-12.95	<.0001
Humidity			-0.09920	0.01336	7012	-7.43	<.0001
AirTempC*Humidity			0.004416	0.000859	7012	5.14	<.0001

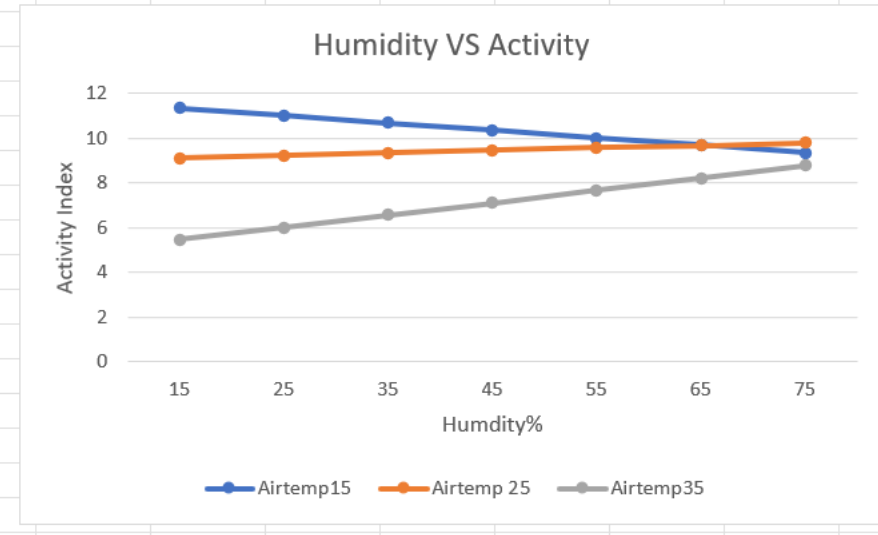


The Process

Clipboard	Font	Alignment	Number	Styles											
$=13.456+(-0.00721*15*15)+(-0.0992*X90)+(0.004416*15*X90)$															
W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH	AI	AJ	AK	AL
AirTemp	Relative Humidity			Airtemp15	Airtemp 25	Airtemp35									
10	15			11.33935	9.11775	5.45415									
15	25			11.00975	9.22975	6.00775									
20	35			10.68015	9.34175	6.56135									
25	45			10.35055	9.45375	7.11495									
30	55			10.02095	9.56575	7.66855									
35	65			9.69135	9.67775	8.22215									
40	75			9.36175	9.78975	8.77575									

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Check for Multicollinearity

	<i>AirTempC</i>	<i>Humidity</i>	<i>Wind</i>
<i>AirTempC</i>	1		
<i>Humidity</i>	-0.52055	1	
<i>Wind</i>	0.443785	-0.46543	1