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WEBINAR SERIES

Heat Stress – Part 1

Presented by Shaun Balemi
AGVANCE NUTRITION

What is heat stress?

What are the sources of heat stress?

What does heat stress do in the cow?

Tools for predicting heat stress

Is our summer pasture affecting our cows?

Are our cows experiencing heat stress?

WHAT IS HEAT STRESS?

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Heat stress is when temperature/humidity or pasture toxins induce physical stress which causes reduction in cow appetite, production, or health

Heat stress can begin to affect cows at 20^{o}C with 50% humidity

Stress occurs when the cow cannot dissipate heat quickly enough

Cows are most comfortable at 4–16^{o}C – the thermo-neutral zone

Combination of heat/solar radiation, humidity, and wind speed

WHAT IS HEAT STRESS?

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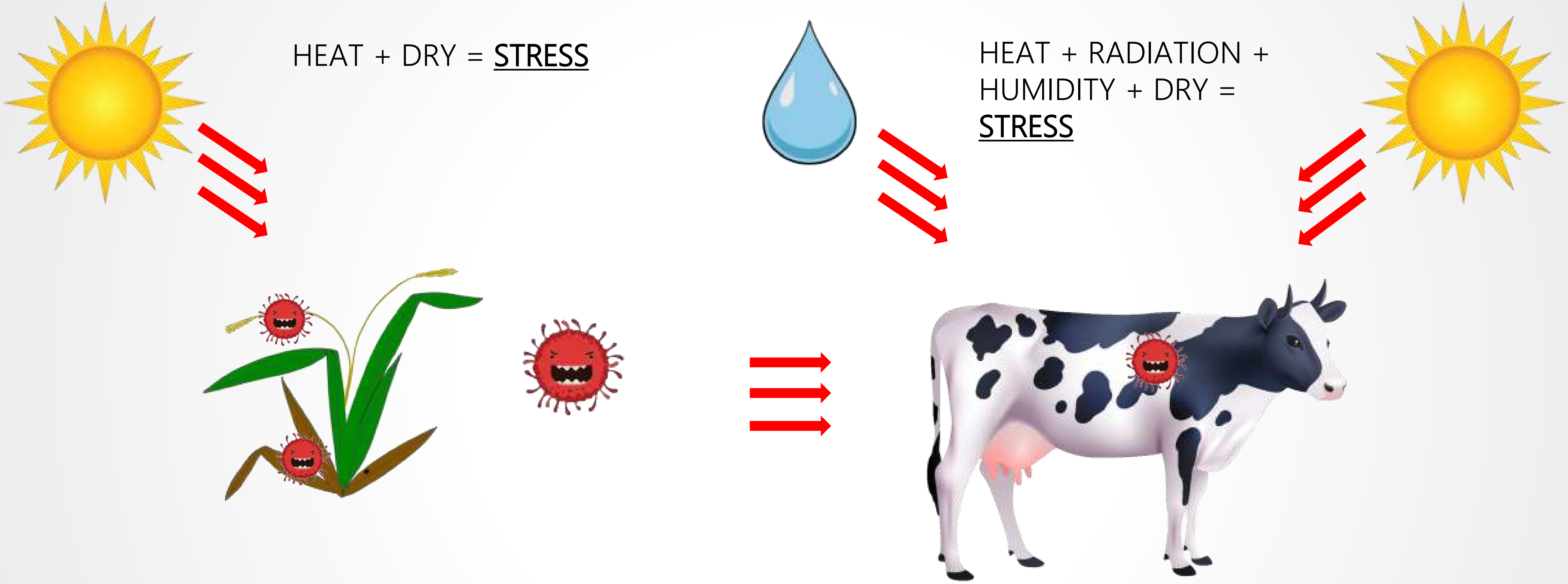
Causes cows to breathe heavily, graze less, drink more, move less, and rest less as standing helps to dissipate heat better

Cows produce a lot of heat in the rumen so are well equipped to handle lower temperatures but struggle with high temps

Heat stress costs vary based on region and climate. Owl Farm in the Waikato reported a loss of 6kg MS/cow over the summer months: $57/cow @ $9.50 payout – $34,200 for a 600cow farm

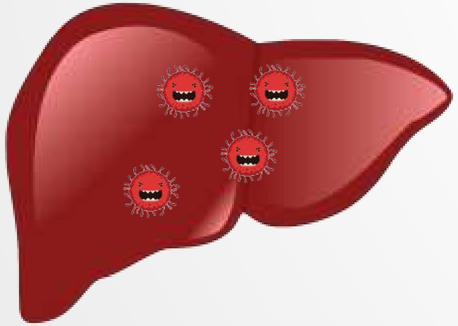
Other effects of heat stress are condition loss, reproductive dysfunction, and increased disease susceptibility

WHAT ARE THE DIFFERENT SOURCES OF HEAT STRESS?

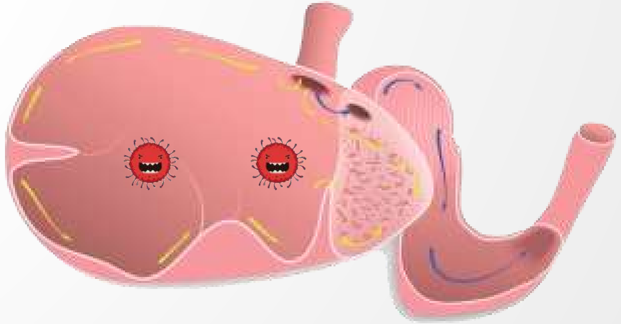


WHAT DOES HEAT STRESS DO IN THE COW?

Heat stress has direct effects on both the rumen and the liver



LIVER FUNCTION



RUMEN FUNCTION

WHAT DOES HEAT STRESS DO IN THE RUMEN?

CLIMATIC CONDITIONS

1. Rumination decreases, reducing saliva production and buffering capacity

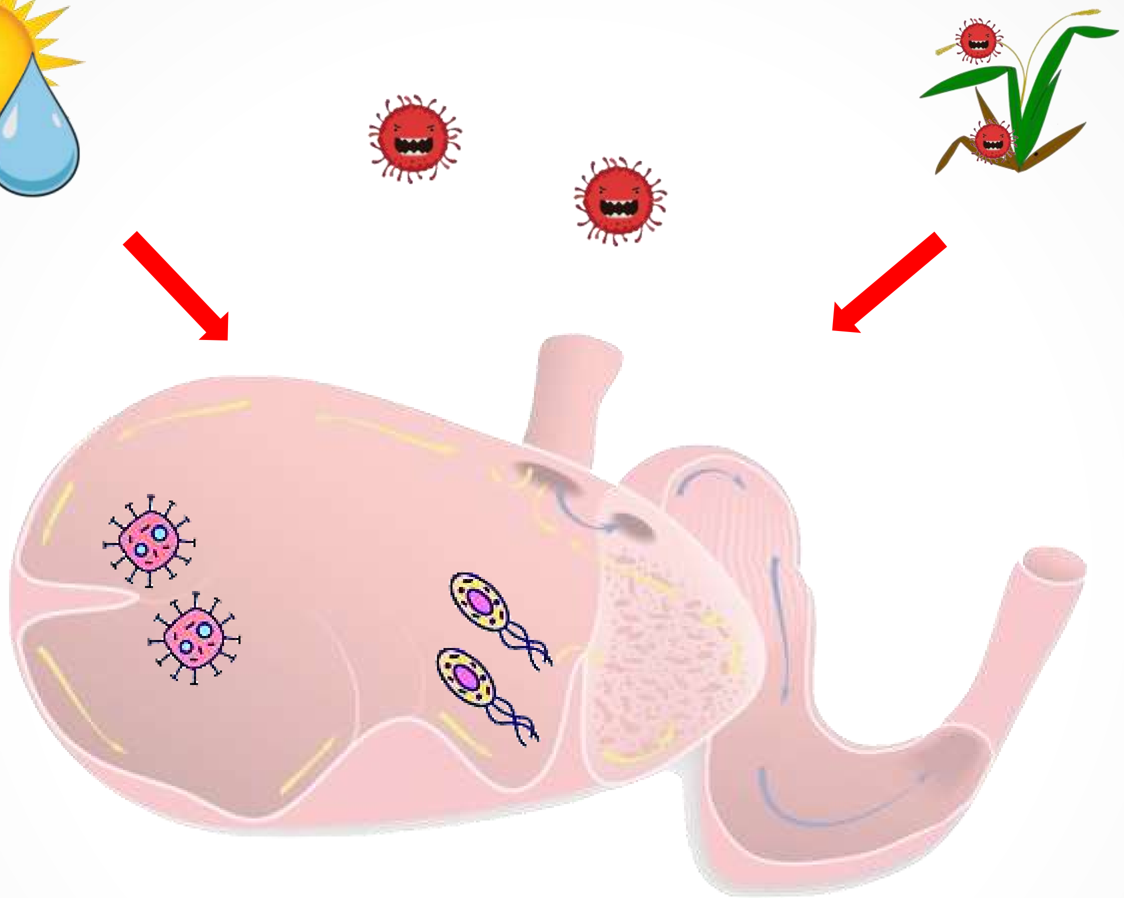
2. Volatile rumen pH

3. Increased pathogenic bacteria and less beneficial bacteria due to increased rumen temp and decreased pH[17]

4. Change in fatty acid metabolism, leading to changes in milk components

5. Decreased rumination, rumen activity, and rumen motility affect rumen passage rates[16]

6. Increased methane production[17]



PASTURE TOXINS

Pasture toxins pass through rumen and head to the liver

<u>ERGOT TOXINS</u>

<u>>1ug/g DM Ergovaline</u>

- Causes vasoconstriction upsetting **heat dissipation**
- Disrupts reproductive hormones
- Can inhibit prolactin release reducing milk production
- Can contribute to lameness

WHAT DOES HEAT STRESS DO IN THE LIVER?

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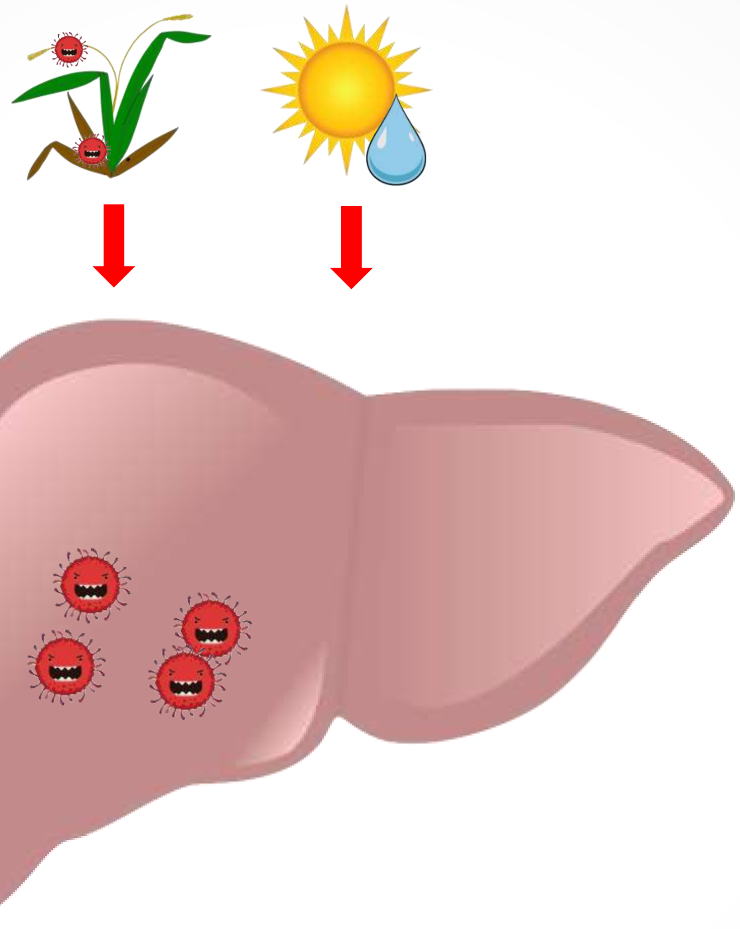
1. Toxin inflicted damage to hepatocytes and mitochondria[1]
2. Decreased oxygen availability, increasing anaerobic glycolysis[1]
3. Inflammation and bilirubin
4. Fatty Liver/Ketosis/NEFA BHBA
5. Reduced glucogenesis/insulin/appetite[1]
6. Reduced enzyme production
7. Interrupt hormone production
8. Protein metabolic dysfunction
9. Urea production up-regulated[1]
10. Reduced amino acid metabolism[1]



WHAT DOES HEAT STRESS DO IN THE COW?

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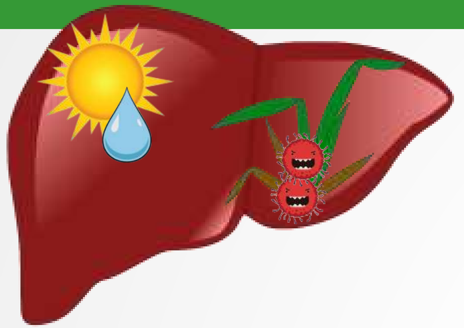
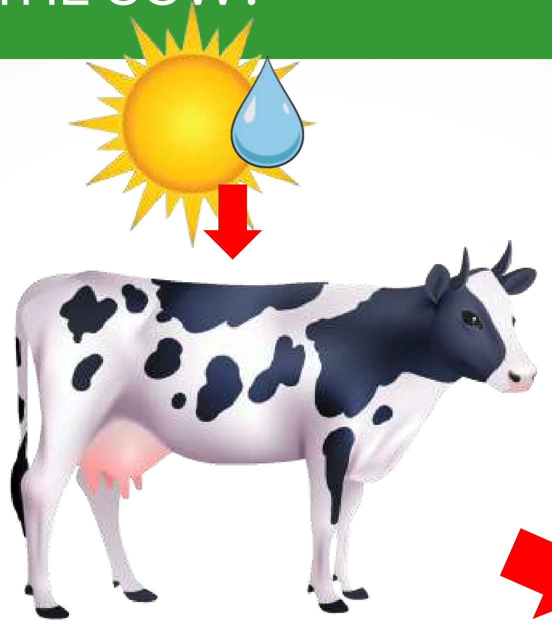
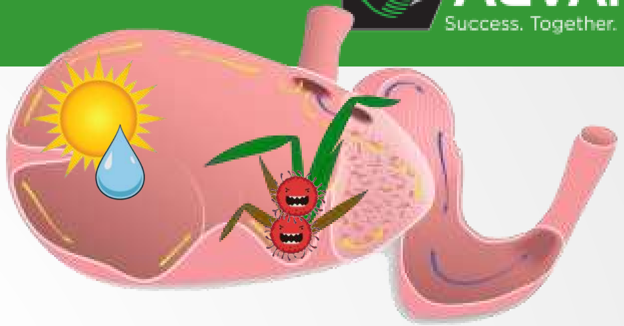






BEHAVIOURAL CHANGES
- Increased respiration/breathing
- Increased water intake
- Increased standing idle/less resting
- Looking for shade/grouping together
- Stressed/irritated/easily startled
- Drowsy, slow walking, lacking energy
- Drooling

OTHER FACTORS
- Increased laminitis
- Increased blood urea nitrogen
- Increased blood BHBA/ketones
- Increased blood lactate[15]
- Decreased blood glucose
- Reduced saliva production
- Condition loss
- Increased pregnancy loss
- Reduced immune response

PRODUCTION
- Reduced production
- Drop in fat% in milk
- Drop in protein% in milk
- Increased milk urea

COW MONITORING
- Decreased rumination
- Decreased or increased activity?
- Heavy breathing minutes
- Increased cow temp
- Increased water intakes
- Decreased rumen pH

THI = Temperature Humidity Index

- The THI can be calculated a few different ways so check as DairyNZ also has THI figures available

- Wind can lower the THI risk level dramatically due to cows increased cooling ability

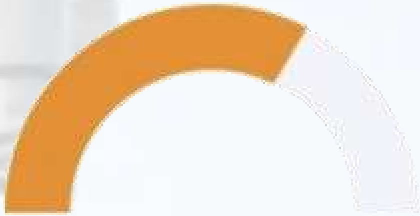
THI = 0.8*Temp + Humidity*(Temp-14.4) + 46.4

THI = (0.8 x 31) + ("0.29" x (31 – 14.4)) + 46.4

THI = 24.8 + 4.814 + 46.4

= 76.014

THI VALUES



Feb 5, 2024

THI: 76 - High stress

Temperature: 31 °C

Humidity: 29 %

THERMAL HEAT INDEX - THI

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Temperature		% Relative Humidity																		
°F	°C	0	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90
72	22.0	64	65	65	65	66	66	67	67	67	68	68	69	69	69	70	70	70	71	71
73	23.0	65	65	66	66	66	67	67	68	68	68	69	69	70	70	71	71	71	72	72
74	23.5	65	66	66	67	67	67	68	68	69	69	70	70	70	71	71	72	72	73	73
75	24.0	66	66	67	67	68	68	68	69	69	70	70	71	71	72	72	73	73	74	74
76	24.5	66	67	67	68	68	69	69	70	70	71	71	72	72	73	73	74	74	75	75
77	25.0	67	67	68	68	69	69	70	70	71	71	72	72	73	73	74	74	75	75	76
78	25.5	67	68	68	69	69	70	70	71	71	72	73	73	74	74	75	75	76	76	77
79	26.0	67	68	69	69	70	70	71	71	72	73	73	74	74	75	76	76	77	77	78
80	26.5	68	69	69	70	70	71	72	72	73	73	74	75	75	76	76	77	78	78	79
81	27.0	68	69	70	70	71	72	72	73	73	74	75	75	76	77	77	78	78	79	80
82	28.0	69	69	70	71	71	72	73	73	74	75	75	76	77	77	78	79	79	80	81
83	28.5	69	70	71	71	72	73	73	74	75	75	76	77	78	78	79	80	80	81	82
84	29.0	70	70	71	72	73	73	74	75	75	76	77	78	78	79	80	80	81	82	83
85	29.5	70	71	72	72	73	74	75	75	76	77	78	78	79	80	81	81	82	83	84
86	30.0	71	71	72	73	74	74	75	76	77	78	78	79	80	81	81	82	83	84	84
87	30.5	71	72	73	73	74	75	76	77	77	78	79	80	81	81	82	83	84	85	85
88	31.0	72	72	73	74	75	76	76	77	78	79	80	81	81	82	83	84	85	86	86
89	31.5	72	73	74	75	75	76	77	78	79	80	80	81	82	83	84	85	86	86	87
90	32.0	72	73	74	75	76	77	78	79	79	80	81	82	83	84	85	86	86	87	88
91	33.0	73	74	75	76	76	77	78	79	80	81	82	83	84	85	86	86	87	88	89
92	33.5	73	74	75	76	77	78	79	80	81	82	83	84	85	85	86	87	88	89	90
93	34.0	74	75	76	77	78	79	80	80	81	82	83	85	85	86	87	88	89	90	91
94	34.5	74	75	76	77	78	79	80	81	82	83	84	86	86	87	88	89	90	91	92
95	35.0	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93
96	35.5	75	76	77	78	79	80	81	82	83	85	86	87	88	89	90	91	92	93	94
97	36.0	76	77	78	79	80	81	82	83	84	85	86	87	88	89	91	92	93	94	95
98	36.5	76	77	78	80	80	82	83	83	85	86	87	88	89	90	91	92	93	94	95
99	37.0	76	78	79	80	81	82	83	84	85	87	88	89	90	91	92	93	94	95	96
100	38.0	77	78	79	81	82	83	84	85	86	87	88	90	91	92	93	94	95	96	98
101	38.5	77	79	80	81	82	83	84	86	87	88	89	90	92	93	94	95	96	98	99
102	39.0	78	79	80	82	83	84	85	86	87	89	90	91	92	94	95	96	97	98	100
103	39.5	78	79	81	82	83	84	86	87	88	89	91	92	93	94	96	97	98	99	101
104	40.0	79	80	81	83	84	85	86	88	89	90	91	93	94	95	96	98	99	100	101
105	40.5		80	82	83	84	86	87	88	89	91	92	93	95	96	97	99	100	101	102
106	41.0	80	81	82	84	85	87	88	89	90	91	93	94	95	97	98	99	101	102	103
107	41.5	80	81	83	84	85	87	88	89	91	92	94	95	96	98	99	100	102	103	104

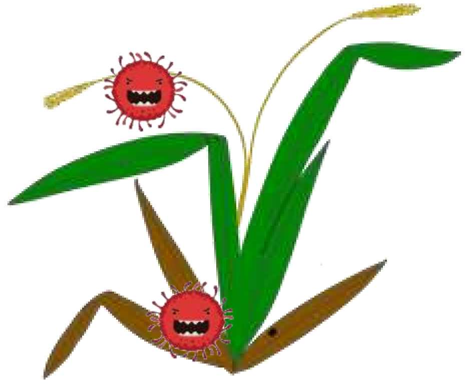
- https://www.thermo-heatstress.com/thermotool-measure-thermal-comfort/

CCPA GROUP

ThermoTool, the expert app dedicated to managing heat stress, developed by CCPA for livestock farmers

IS OUR SUMMER PASTURE AFFECTING MY COWS?

- It's hard to distinguish if heat stress is being triggered by environment conditions or pasture ergot toxins



- Your pastures are NOT low endophyte producing
- Higher proportion of seed head and dead matter
- Cow showing physical or production HS effects
- Herbage testing for ergots
- Blood testing for liver function: GGT, ALT, ALB & GLU

IS OUR SUMMER PASTURE AFFECTING MY COWS?

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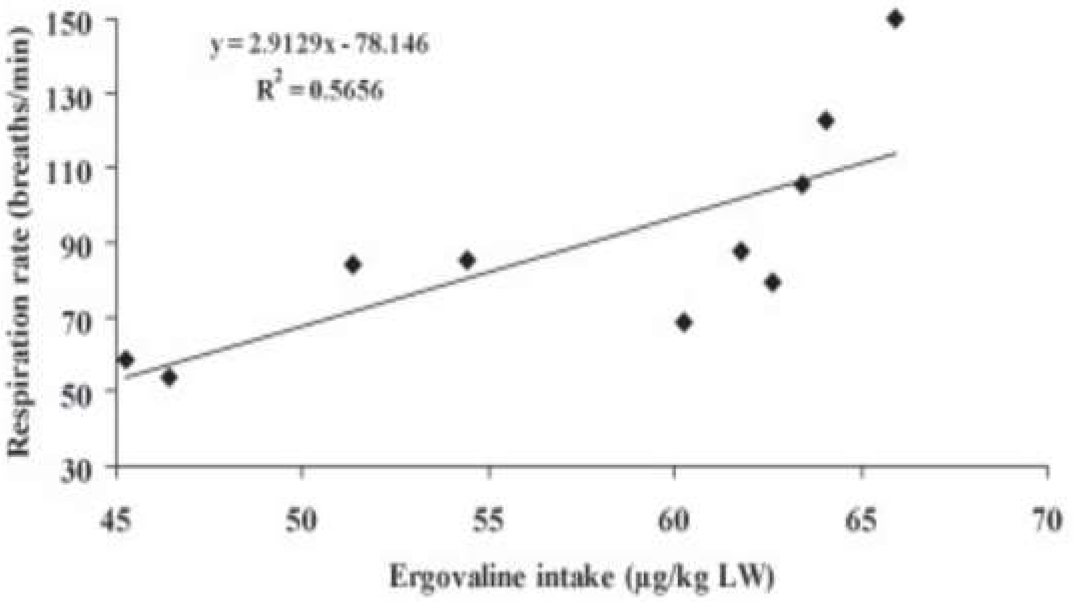
Figure 1 Levels of ergovaline (2-weekly mean and range) in 48 samples of endophyte-infected perennial ryegrass herbage from throughout New Zealand, September–May 1992-93. Points without a range bar indicate a single sample in a fortnight.

Figure 2 Relationship between respiration rate and ergovaline intake for T group in week 1 of the experiment.



Sowing low endophyte-producing pasture in areas prone to heat stress is important!

Pastures containing AR1 & AR37 endophyte will have significantly less Ergovaline and Lolitrem B

BUT endophytes travel between paddocks

>1ug/g DM of Ergovaline will induce heat stress symptoms[6,8]

ARE OUR COWS EXPERIENCING HEAT STRESS?

1. Changes in cow behaviour
2. Changes in cow performance
3. Changes in milk components
4. Changes in cow wearables
5. Changes in blood analytes
6. Influence of time

HEAT STRESS: CHANGES IN COW BEHAVIOUR

1. Increased respiration/breathing/drooling

2. Increased water intake

3. Increased standing idle/less resting

4. Looking for shade/grouping together

5. Stressed/irritated/easily startled

6. Drowsy, slow walking, lacking energy

HEAT STRESS: CHANGES IN COW PERFORMANCE

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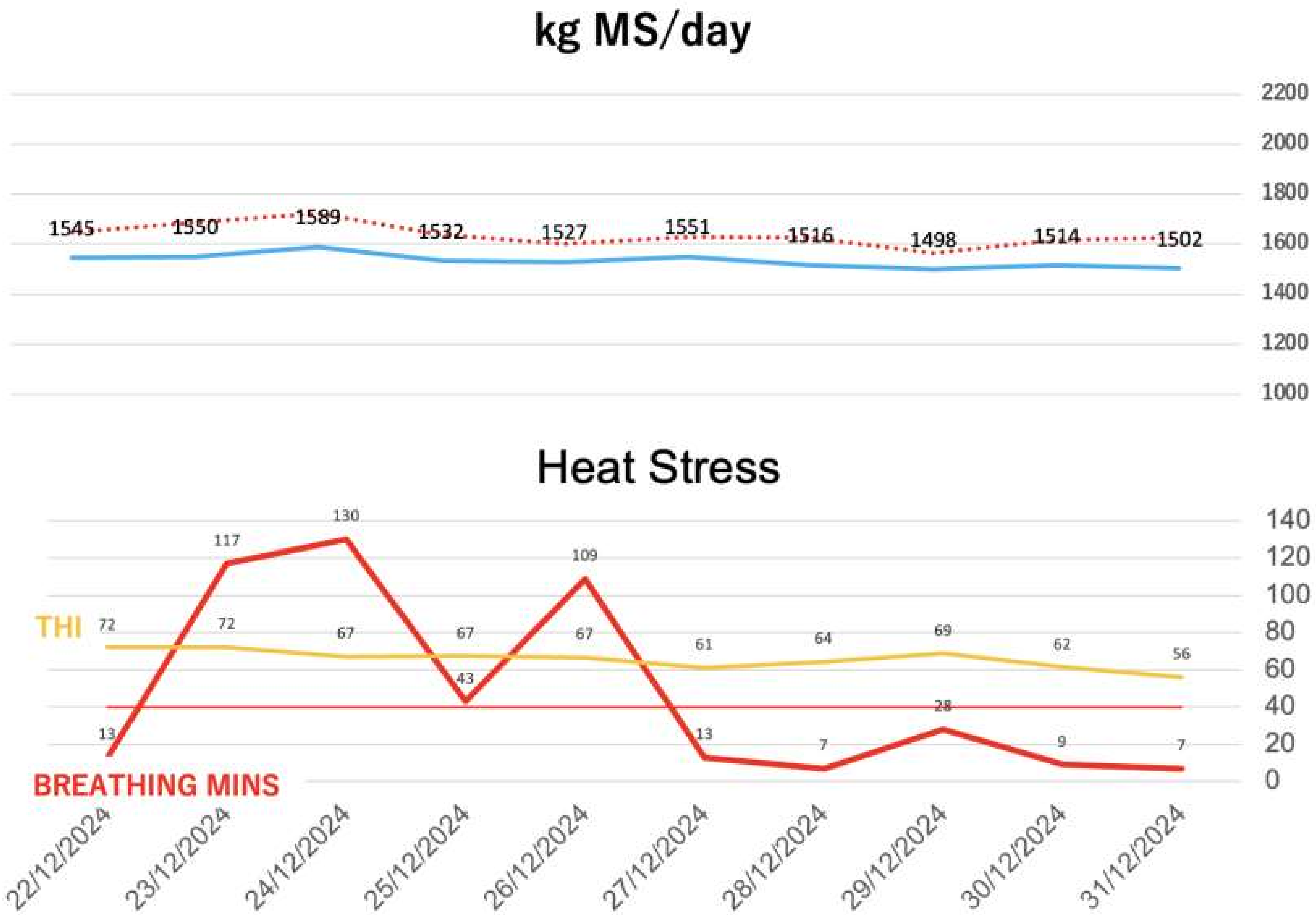
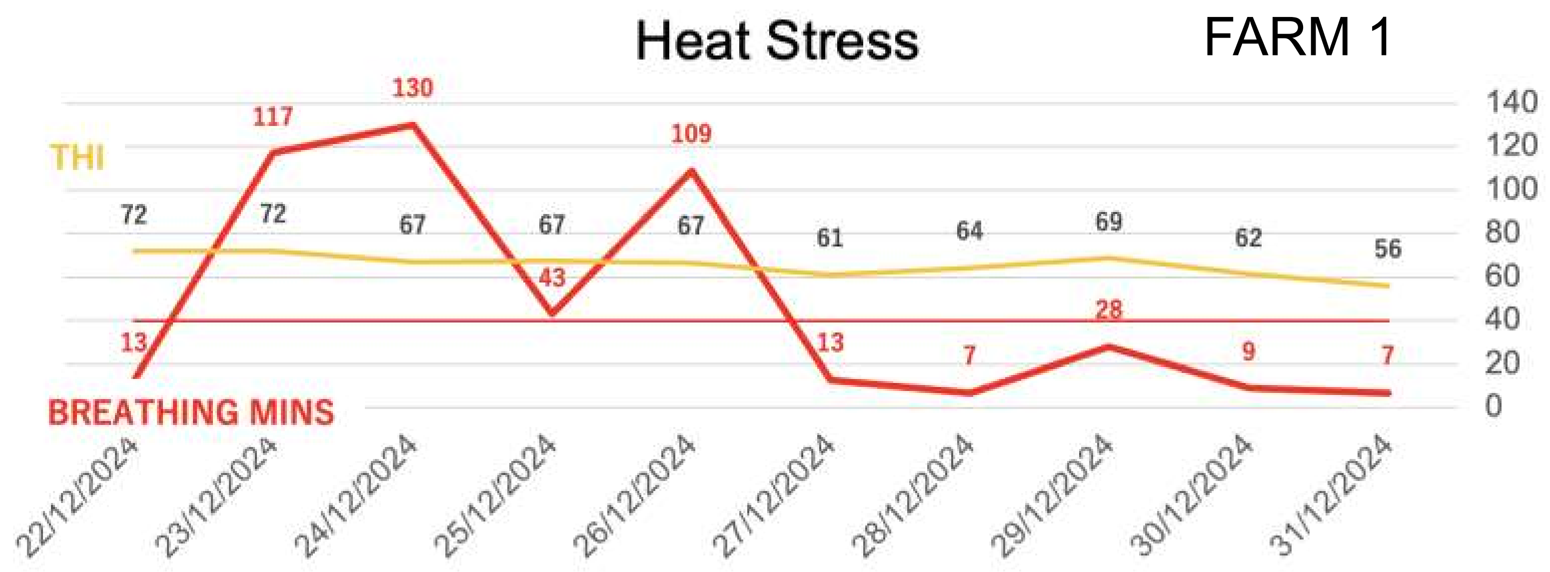
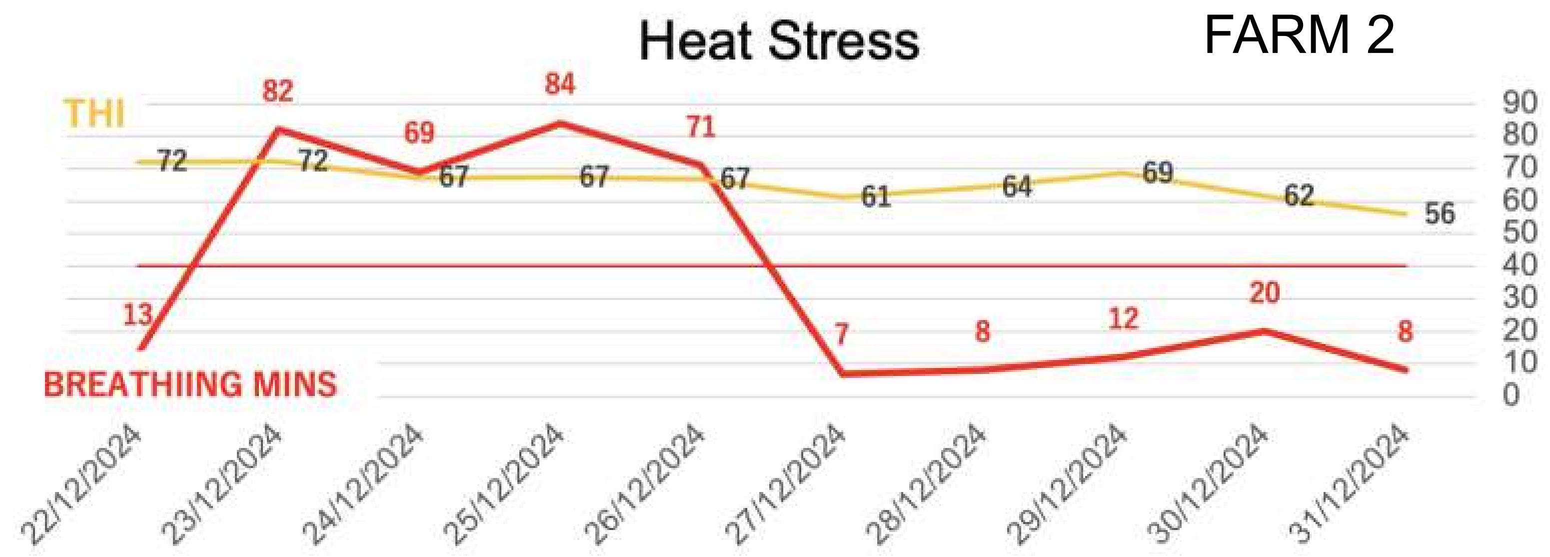


Hou et al., 2021 showed a 17% drop in milk production and 13% drop in DM intake when cows where subjected to HS

Milk production shifts are dependent on the degree of heat stress. This is controlled by:

- Temperature and humidity (THI)
- Amount of time THI is high
- Cow's ability to dissipate the heat





Daily heavy breathing mins

- Measuring panting or heavy breathing
- Research so far indicates heavy breathing minutes per day of >40-50 are potentially having an impact on the cow

HEAT STRESS: CHANGES IN MILK COMPONENTS

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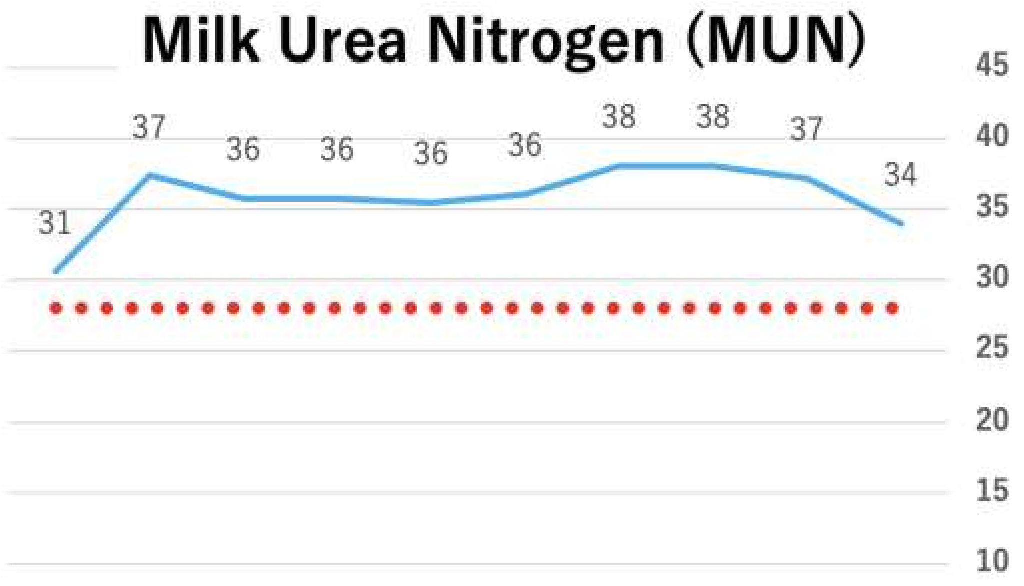
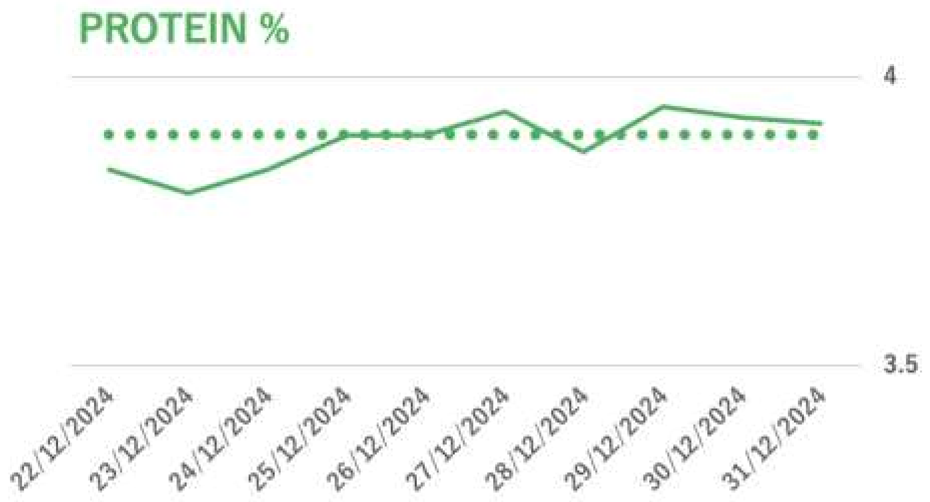
Hou et al., 2021

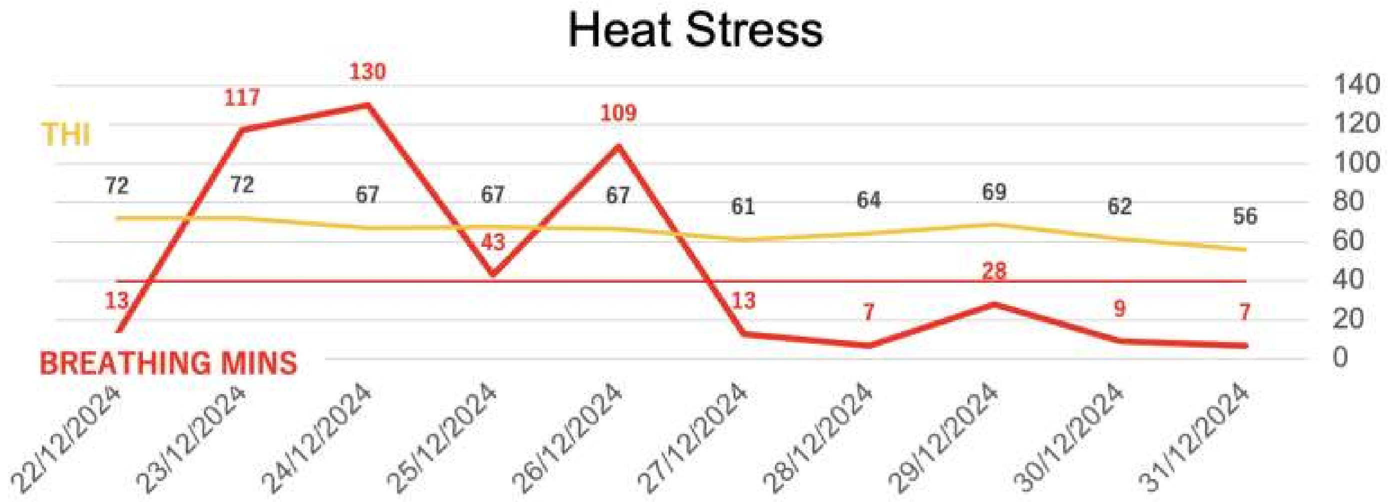
Table 3. Effect of short- and long-term heat stress on milk yield and milk composition

	Treatment[2]				
Item	P_0[1]	STHS	LTHS	SEM	Trt[3]
Milk yield (kg/d)	24.30[a]	21.50[b]	17.80[c]	0.42	0.003
4% FCM (kg/d)[4]	22.86[a]	21.35[b]	17.76[c]	0.42	0.003
Protein (%)	3.23[a]	3.22[a]	3.00[b]	0.05	0.041
Fat (%)	3.84	4.07	4.01	0.12	0.627
Casein (%)	2.43[b]	2.51[a]	2.34[c]	0.02	0.010
Lactose (%)	4.78	4.78	4.82	0.03	0.302
Solid matter (%)	12.54	12.62	12.38	0.13	0.208
MUN (mg/L)	364.72[c]	442.41[b]	509.00[a]	2.92	0.002
Protein yield (g/d)	768.84[a]	687.86[b]	533.48[c]	6.01	0.000
Fat yield (g/d)	910.54[a]	865.81[a]	708.91[b]	32.37	0.017
Lactose yield (g/d)	1,161.19[a]	1,019.55[b]	857.51[c]	19.07	0.003

HEAT STRESS: CHANGES IN MILK COMPONENTS





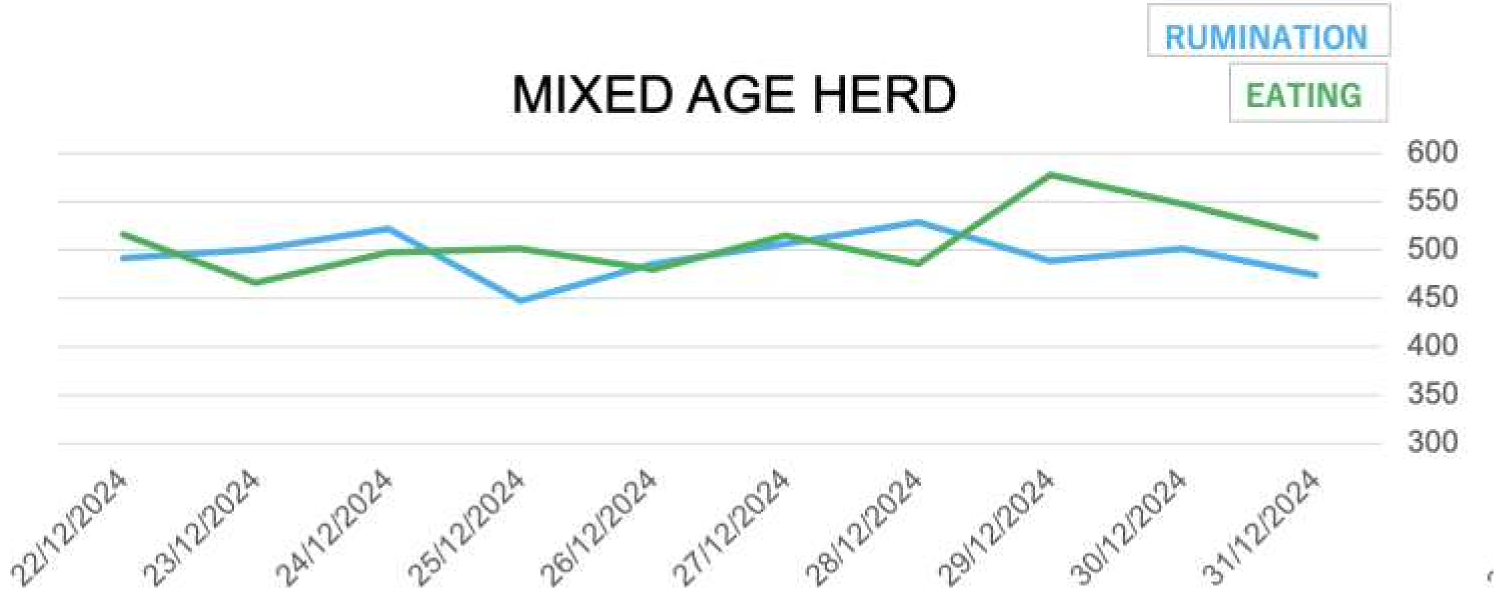


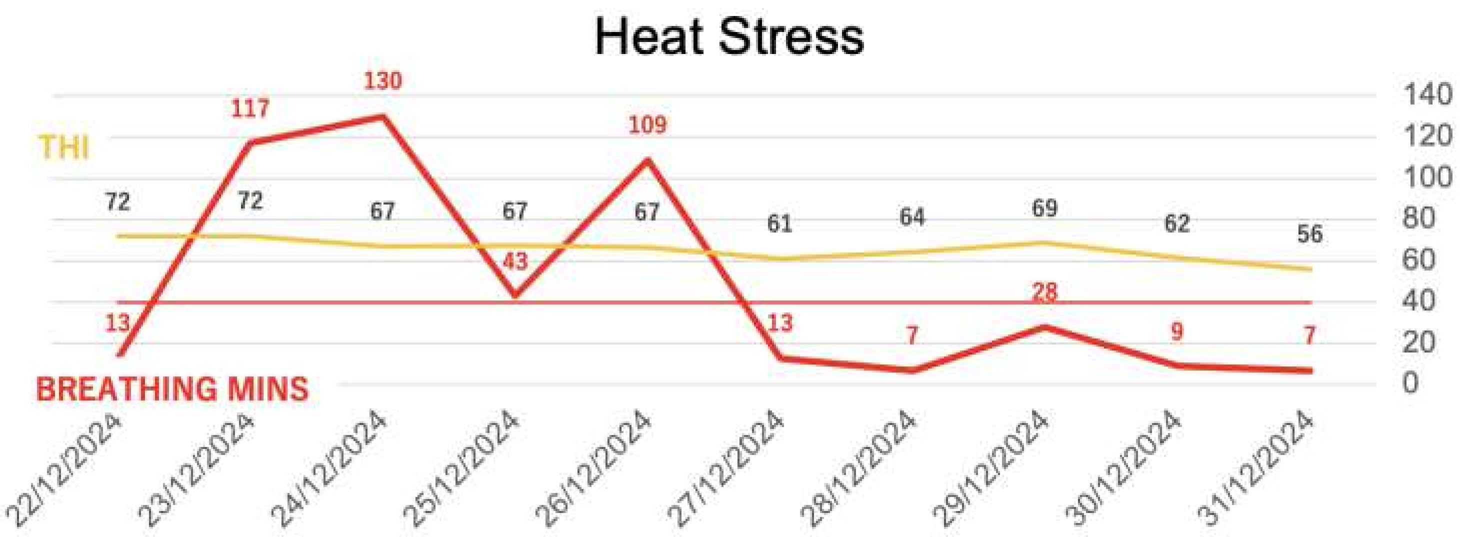
Various researchers have shown MUN to increase by 12-28% under heat stress [5,18,19]

MUN is heavily influenced by protein% and pasture digestibility

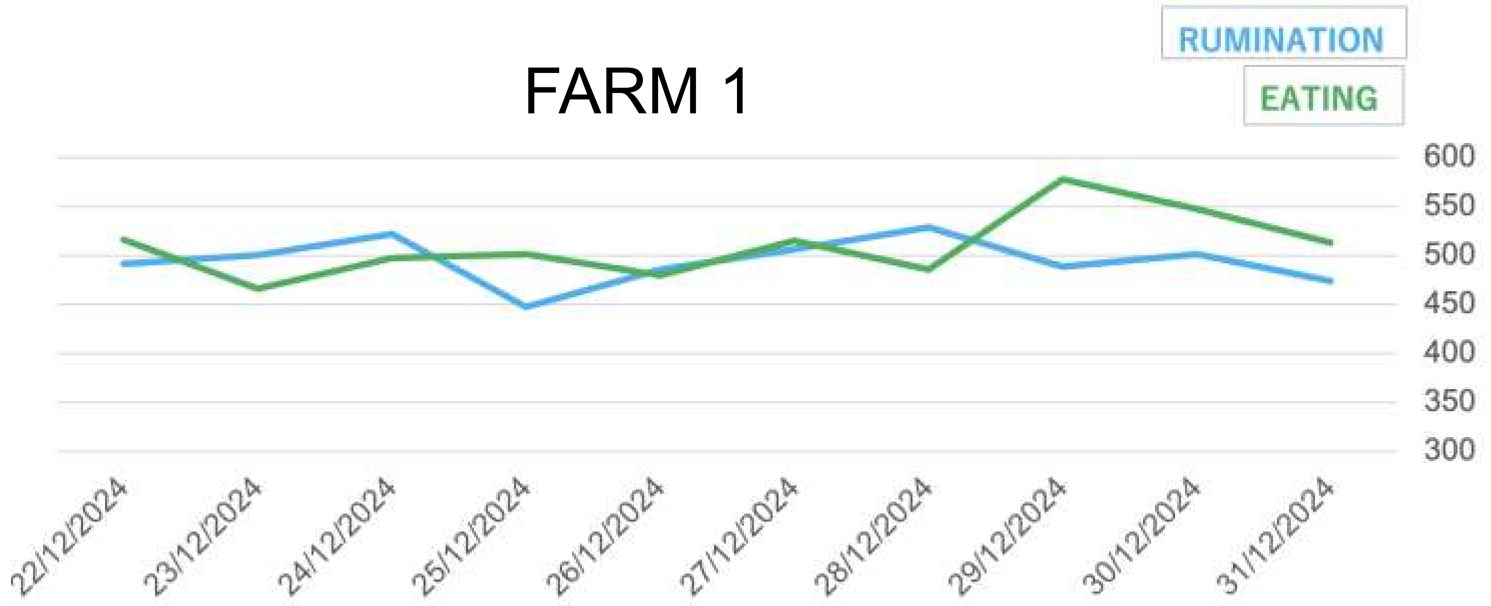
MUN must be used alongside other factors before diagnosing HS

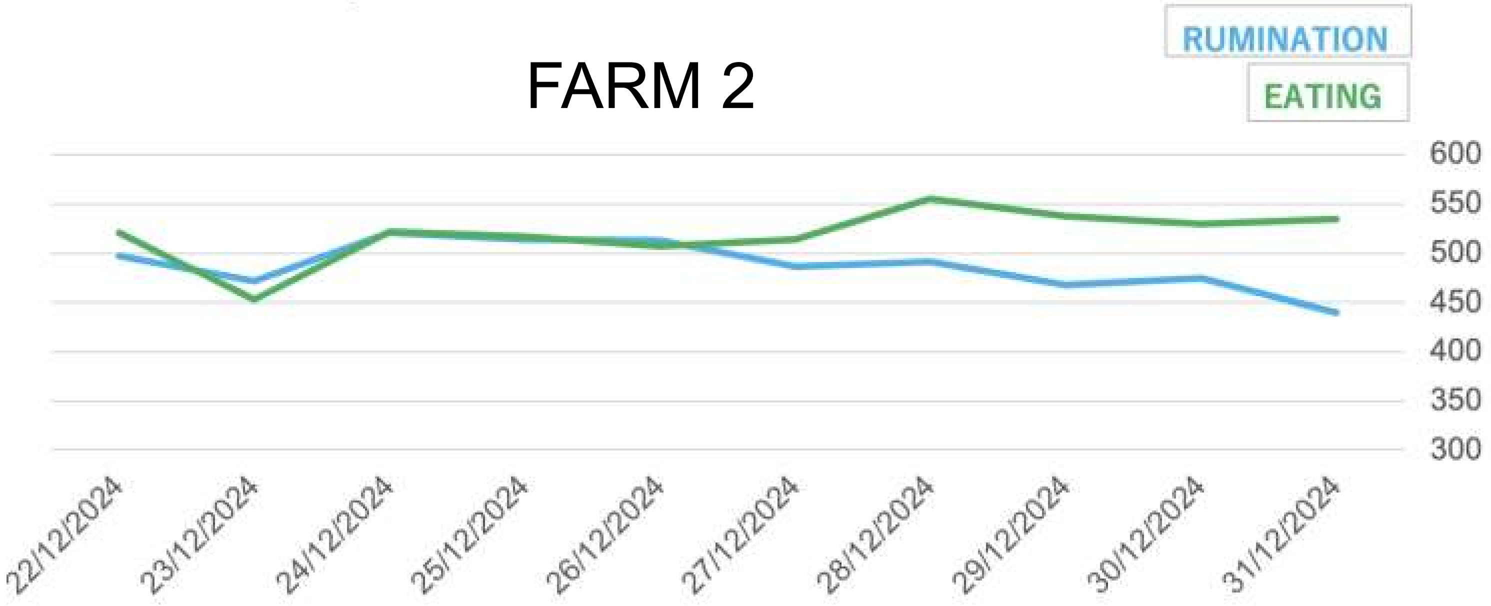
HEAT STRESS: CHANGES IN COW WEARABLES





HEAT STRESS: CHANGES IN COW WEARABLES





HEAT STRESS: CHANGES IN BLOOD ANALYTES

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Blood Urea Nitrogen – BUN

- Both BUN and MU increase as a result of changing rumen microbial metabolism
- Various researchers showed increases of 17% under the effects of heat stress
- Be careful though as diet also modifies both BUN and MU

Glucose – GLU

- Indicates energy draw and liver glucogenesis
- Antanaitis et al., 2024 showed that glucose levels drop even with mild heat stress challenge

Non-Esterified Fatty Acids – NEFA

- Levels increase in response to a drop in available energy and appetite
- In mid/late-lactation cows putting on condition should be <0.2mmol
- Averages above 0.4-0.6mmol/L indicate heat stress

Gama-Glutamyl Transferase – GGT

- Indicates toxin damage to the liver
- This damage can occur from pasture toxins or rumen stress

Extra Parameters

- cHgb blood haemoglobin
- Base excess
- pH

HEAT STRESS: CHANGES IN BLOOD ANALYTES

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Antanaitis et al., 2024

Table 5. Descriptive statistics of the investigated blood parameters (mean ± standard error of mean).

Blood Parameters	**Risk of HS**			
	High (THI > 78) [a]	**Medium (THI 72–78) [b]**	**Low (THI < 72) [c]**	**RMSE**
pH	7.41 ± 0.017	7.46 ± 0.019	7.47 ± 0.013	0.23
pCO2	46.77 ± 1.850	41.17 ± 2.033	40.57 ± 1.773	2.67
pO2	191.93 ± 9.683	153.83 ± 16.603	202.35 ± 6.586	19.35
HCO3-	29.52 ± 0.551	28.67 ± 0.541	29.21 ± 0.679	0.84
BE (ecf)	4.88 ± 0.644	4.74 ± 0.623	5.50 ± 0.584	0.87
cSO2	99.59 ± 0.074	98.00 ± 0.851	99.75 ± 0.037	0.70
Na+	135.30 ± 0.539	135.90 ± 0.690	136.50 ± 0.500	0.82
K+	4.17 ± 0.086	4.02 ± 0.137	4.15 ± 0.069	0.14
Ca++	1.18 ± 0.020	1.17 ± 0.025	1.19 ± 0.014	0.03
Cl−	100.70 ± 0.539	101.40 ± 0.748	101.70 ± 0.539	0.87
TCO2	29.410 ± 0.546	28.450 ± 0.540	28.950 ± 0.688	0.84
Hct	25.30 ± 0.423	25.90 ± 0.657	26.40 ± 0.427	0.73
cHgb	8.66 ± 0.128	8.80 ± 0.230	8.98 ± 0.150	0.23
BE(b)	4.32 ± 0.591	4.350 ± 0.584	5.05 ± 0.504	0.79
Glu	3.01 ± 0.145 [c]	3.12 ± 0.081 [c]	3.45 ± 0.054 [a,b]	0.14
Lac	2.03 ± 0.150 [c]	1.45 ± 0.131	1.27 ± 0.086 [a]	0.17
BUN	14.80 ± 0.814 [b,c]	12.30 ± 0.700 [a]	12.60 ± 0.670 [a]	1.03
Urea	5.28 ± 0.287 [b,c]	4.36 ± 0.249 [a]	4.49 ± 0.230 [a]	0.36
Crea	81.90 ± 1.616	77.60 ± 2.798	70.40 ± 3.661	3.99
BUN/Crea	15.96 ± 0.729	14.27 ± 1.288	16.02 ± 0.841	1.39

The letters a, b, and c indicate statistically significant differences between HS groups; $p < 0.05$. pH—hydrogen potential; pCO2—partial carbon dioxide pressure; pO2—partial oxygen pressure; HCO3—bicarbonate; BE (ecf)—base excess in the extracellular fluid; sO2—oxygen saturation; Na+—sodium; K+—potassium; Ca++—ionized calcium; Cl-chlorides; TCO2—total carbon dioxide in the blood; Hct—hematocrit; cHgb—hemoglobin concentration; BE—base excess in the blood; Glu—glucose; Lac—lactate; BUN—blood urea nitrogen; Crea—creatinine; BUN/Crea—blood urea nitrogen and creatinine ratio. RMSE—root mean square error.

HEAT STRESS: INFLUENCE OF TIME

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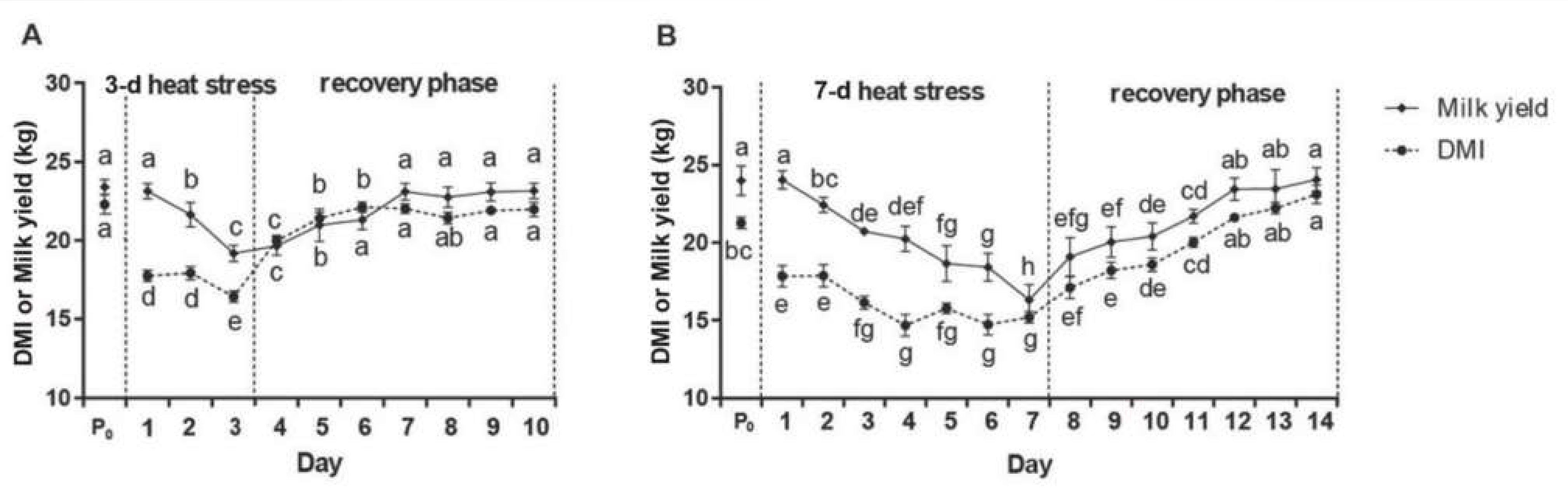

Hou et al., 2021

NEXT WEBINAR

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How we can use each of the wearable tech to help monitor and measure heat stress

- Allflex
- Cow Manager
- Halter
- Smaxtec

Deeper dive into NZ data on heat stress and the likely gains available

Solutions for helping prevent and mitigate heat stress, research review with industry experience insights

NEXT WEBINAR

1. Water
2. Shade
3. Cow management
4. Soaking and sprinklers
5. Feed: Energy and fibre
6. Rumen stabilizing: Buffers and yeast
7. Toxin binder and seaweed
8. By-pass fat and betaine
9. Future solutions? Niacin, technologies

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- Visit our website: www.agvance.co.nz
- Talk to your local Agvance Consultant
- Email me at shaunb@agvance.co.nz