Exploring Variation in Beef Cattle Water Intake and Utilization

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Introduction: Water

- Beef cattle consume approximately 760 billion liters of water per year (Beckett and Oltjen, 1993)
- Environmental factors, diet, breed, and body weight impact water intake (Arias and Mader, 2011)
- Interaction between these factors make it challenging to determine daily water intake requirements

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Introduction: Heat Stress

- Between 1.69 and 2.36 billion dollars loss in United States due to heat stress (St-Pierre et al., 2003)
  - Cattle trying to reduce heat load could be reason for increased water intake during the summer (Beede and Collier, 1986)
  - Primary way reduce heat load is through evaporative cooling
- 5-80% of United States land mass affected by drought past 7 years (NOAA, 2017)
  - 2012 worst drought since 1950's

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Introduction: Heat Stress

- Global warming effects soil infertility, water scarcity, grain yield and quality, and diffusion of pathogens which could impair animal production (Nardone et al., 2010)
  - Predict 25% loss in animal production in developed countries an may be more server in developing
- Cattle in hot environment drink 2-3 times more than cattle in cooler environments (Nardone et al., 2010)

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Introduction: Adaptability

- Arid land ruminants can graze far away from water sites and withstand prolonged periods of water deprivation
  - Drink a large amount quickly
  - Less frequent visits
  - Livestock that reduce water intake, tend to reduce feed intake, and have a slower metabolic rate
  - Minimize loss of water through urine and feces

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Introduction: Test Day length

- Currently no guidelines for water intake
- Shortened test day length 35 days feed intake Wang et al. (2006) and Archer et al. (1997)
- Collecting feed and water intake at the same time

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Objectives:

- To characterize daily water intake in individual beef cattle
  - Test day length
  - Individual daily intakes
  - Difference between groups
  - Water efficiency

- Develop water intake prediction equation
- Characterize adaptability

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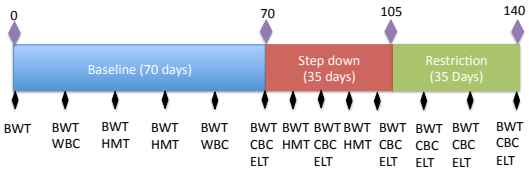
Material and Methods: Timeline



- Body Weight collected (BWT)
- White blood cells collected (WBC)
- Hematocrit collected (HMT)
- Electrolytes collected (ELT)

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Material and Methods: Data

- 579 crossbred steers
- Five groups
  - Group 1 (May 2014 to October 2014, Summer, n=117)
  - Group 2 (November 2014 to March 2015, Winter, n=116)
  - Group 3 (May 2015 to September 2015, Summer, n=118)
  - Group 4 (June 2016 to October 2016, Summer, n=105)
  - Group 5 (January 2017 to May 2017, Winter, n=123)

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Material and Methods: Data

- FI and WI collected using an Insentec System
  - 4 pens per group (~30 steers per pen)
  - 6 feed bunks and 1 water bunk per pen
  - Access to shade under barn
- All groups fed a growing diet
  - 15% corn, 51.36% sweet bran, 28.44% hay, 5.2% supplement
- Groups 1-3 managed using slick bunk feed call
- Groups 4-5 access to *ab-libtium* feed
- All groups access to *ab-libtium* water

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Environmental Factors

Trait[a]	Group 1	Group 2	Group 3	Group 4	Group 5
Temperature	25.03 (3.11)	4.21 (5.99)	23.17 (4.60)	27.85 (2.48)	9.45 (5.96)
Relative Humidity	71.33 (9.98)	70.98 (16.31)	76.24 (10.55)	69.10 (8.30)	63.33 (16.36)
Wind Speed	11.33 (3.43)	11.56 (4.59)	11.21 (3.16)	10.06 (2.92)	12.39 (5.14)
Solar Radiation	22.33 (6.68)	7.90 (4.52)	21.10 (8.48)	23.90 (5.38)	12.51 (5.74)

[a]Tempature measure in ºC, relative humidity measured as a percent, wind speed measured as kilometers per hour, and solar radiation measured as MJ/m²

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Water Intake:

Group	WI	WIbwt[b]	DMI	Mid Weight	ADG
1	40.50 (8.00)	10.75 (3.35)	9.93 (2.67)	401.45 (29.09)	1.39 (0.29)
2	28.23 (5.63)	6.94 (2.55)	10.18 (2.70)	426.64 (39.80)	1.74 (0.34)
3	36.37 (6.75)	8.61 (2.96)	10.27 (2.52)	445.49 (33.46)	1.46 (0.31)
4	49.46 (13.07)	10.89 (3.91)	10.57 (2.92)	457.18 (30.22)	1.27 (0.27)
5	34.92 (4.84)	8.41 (1.87)	11.66 (2.43)	416.72 (39.37)	1.84 (0.29)

[a]WI, DMI, Mid Weight, and ADG are measured in kilograms

[b]WIbwt Water intake as a percent of body weight

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Water Intake:

- Milking dairy cows
  - 81.5 kg (Meyer et al., 2004)
- Growing Steers (GrowSafe System)
  - 29.98 kg (Brew et al., 2011)
  - *Bos indicus* crosses used
- Feedlot Steers (pen data)
  - 37.85 kg (Mader and Davis, 2004)

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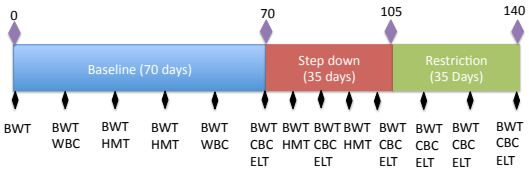
Material and Methods: Timeline



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Material and Methods: Water Intake Differences

- Model 1

WIbwt=Group

- Model 2

WIbwt=Group + Temperature

- Model 3

WIbwt=Group + Temperature + Humidity

- Model 4

WIbwt=Group + Temperature + Humidity + Wind

- Model 5

WIbwt=Group + Temperature + Humidity + Wind + Solar radiation

- For each of the 5 models comparison were made:
  - Slick bunk vs Ab-lib
  - Summer vs Winter
  - Slick bunk summer vs Slick bunk winter
  - Ab-lib summer vs Ab-lib winter

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Water Intake Differences:

Group[a]	WI Percent[b]	Temperature[c]	Humidity[d]	Wind Speed[e]	Solar[f]
1	10.75[g]	9.89[g]	10.07[g]	10.07[g]	9.89[g]
2	6.94[h]	8.52[h]	8.30[h]	8.36[h]	8.63[h]
3	8.61[i]	7.98[i]	8.29[h]	8.31[h]	8.05[i]
4	10.89[j]	9.70[j]	9.85[i]	9.83[j]	9.63[j]
5	8.41[k]	9.40[k]	8.99[j]	8.99[j]	9.25[k]

[a]Sum equals summer season which includes intakes that were collected during the summer, Win equals winter season which includes intakes that were collected during the winter, Slk equals groups that were under slick bunk management, ab-lib equals groups that had ab-libitum access to feed intake.
[b]Water intakes as a percent of body weight when no weather factors were accounted for
[c]Water intakes as a percent of body weight when average temperature was accounted for
[d]Water intakes as a percent of body weight when temperature and relative humidity were accounted for
[e]Water intakes as a percent of body weight when temperature, relative humidity, and wind speed were accounted for
[f]Water intakes as a percent of body weight when temperature, relative humidity, wind speed, and solar radiation were accounted for
[g-k]Significant difference between groups for each analysis

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Water Prediction: Cross Validation

	1	2	3	4	5
1	0.53				
2		0.38			
3			0.61		
4				0.44	
5					0.64

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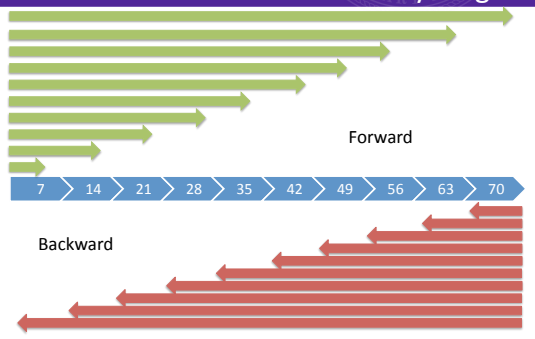
Material and Methods: Test day length



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Results: Test Day Length

	7	14	21	28	35	42	49	56	63	70
Forward[a]										
Pearson	0.830	0.892	0.921	0.941	0.966	0.977	0.988	0.992	0.997	1.0
Spearman	0.793	0.858	0.876	0.903	0.947	0.966	0.983	0.989	0.997	1.0
Backward[b]										
Pearson	0.712	0.822	0.920	0.933	0.950	0.970	0.985	0.994	0.999	1.0
Spearman	0.639	0.792	0.899	0.923	0.943	0.963	0.982	0.993	0.998	1.0

[a]Windows were formed starting at the beginning of the 70-day trial period

[b]Windows were formed starting at the end of the 70-day trial period

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Material and Methods: Water intake Prediction

- Prediction model

$$WI = b0 + b1 * dMWTS + b2 * DMI + b3 * TAVG + b3 * HAVG + b4 * WSPD + b5 * ATOT$$

- Factors included in regression model
  - Daily metabolic weights (dMWTS), DMI, temperature (TAVG), relative humidity (HAVG), wind speed (WSPD) and solar radiation (ATOT)
- Calculate individual daily weights using regression

$$dWTS = Intercept + ADG * day$$

- 3 different prediction equations
  - All groups, Summer, and Winter

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Water Prediction:

	All	Summer	Winter	All	Summer	Winter
Intercept	-4.10	-9.68	-4.25			
DMI	2.00	2.32	1.77	0.124	0.155	0.291
MWTS	0.22	0.11	0.22	0.055	0.039	0.032
TAVG	0.56	1.31	0.26	0.194	0.138	0.032
HAVG	-0.14	-0.17	-0.09	0.025	0.006	0.032
WSPD	-0.16	-0.27	-0.06	0.002	0.002	0.0
ATOT	0.14	-0.03	0.13	0.001	0.0	0.002
R^2				0.40	0.34	0.39

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Material and Methods: Water Efficiency

- Each group was divided into low, medium, and high intake
- Residual water intake (RWI)

$$RWI = WI - eWI$$

$$eWI = b0 + b1\ DMI + b2\ MMWT$$

- Water to gain (W/G)

$$W/G = WI(kg)/ADG(kg)$$

- Difference between low, medium, and high for RWI and W/G

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Results: Water Efficiencies

Trait[b]	Low	Medium	High
Group 1			
Wlbwt	8.39[a]	9.90[b]	11.96[c]
RWI	-5.06[a]	-0.68[b]	5.74[c]
W/G	27.46[a]	29.25[a]	32.77[b]
Group 2			
Wlbwt	5.66[a]	6.50[b]	7.65[c]
RWI	-2.48[a]	-0.56[b]	3.06[c]
W/G	16.03[a]	16.29[a]	18.29[a]
Group 3			
Wlbwt	6.85[a]	8.16[b]	9.39[c]
RWI	-4.15[a]	-0.64[b]	4.54[c]
W/G	23.32[a]	26.16[b]	27.77[b]
Group 4			
Wlbwt	8.50[a]	10.06[b]	13.94[c]
RWI	-7.88[a]	-2.36[b]	10.24[c]
W/G	32.32[a]	40.53[b]	49.69[c]
Group 5			
Wlbwt	7.66[a]	8.56[b]	8.98[c]
RWI	-1.51[a]	0.05[b]	1.53[c]
W/G	18.11[a]	19.83[b]	20.05[b]

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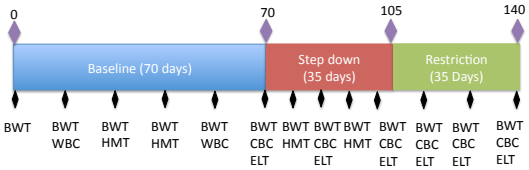
Material and Methods: Timeline



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Material and Methods: Adaptation

- Splines were used to illustrate pattern for groups 1-5 between different periods
- ADG was calculated for each animal for baseline, step down, restriction using regression

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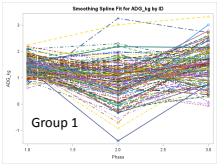
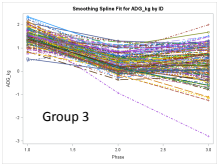
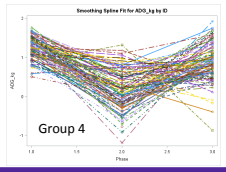
Results: ADG Splines Summer







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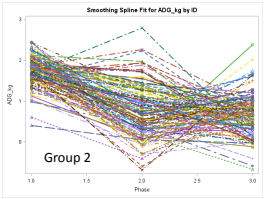
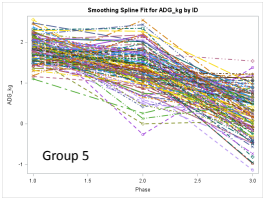
Results: ADG Splines Winter





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Conclusion:

- Water intake test day duration can be shortened to 35 to 42 days
- Differences in water intake between groups when weather factors are not accounted for
- Water intakes are similar between groups when weather factors are accounted for
- Water intake is predictable
  - R^2 range from 0.34 to 0.40 correlation

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Conclusion:

- There are differences between low, medium and high water intake in their water efficiency measures
- Majority of animals have a drop in ADG from baseline to step down, then a recovery from step down to restriction

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Future Work:

- Heritability estimates of water intake
- Estimate breed composition using genotypes
  - Breed effects for water intake
  - Breed effects for adaptability
- Further adaptability analysis

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TEXAS CATTLE FEEDERS ASSOCIATION

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Questions?

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