COLLEGE OF AGRICULTURAL, CONSUMER AND ENVIRONMENTAL SCIENCES

Estimating Water Intake for Range Beef Cattle

Revised by Marcy A. Ward, Nicholas K. Ashcroft, Eric J. Scholljegerdes, and Samuel T. Smallidge[1]

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INTRODUCTION

There is considerable natural variability in water intake and limited research supporting current water use estimates for beef cattle grazing New Mexico rangelands. While there are numerous prediction equations available, most have been developed using young growing cattle (most data sets were developed using cattle in dry-lot situations) in environments outside of the desert Southwest. Therefore, extrapolating these data to cattle in the Southwest, and in particular grazing and lactating beef cows, is questionable. However, with careful consideration of the variables, assumptions, and model limitations, producers may use the models in this guide to estimate water use for their specific situation. Selection of a model should be based on the ease with which information for model variables can be acquired. It is important to use knowledge of your herd and rangelands in assessing estimates because many of these models have not been verified to be accurate for grazing animals on New Mexico rangelands.

WATER ACCESS

Water is the most important nutrient needed to sustain life. Therefore, water should be made available free-choice to grazing animals, with no attempts to

[1]Respectively, Extension Livestock Specialist, Department of Extension Animal Sciences and Natural Resources; Extension Range Management Specialist, Department of Extension Animal Sciences and Natural Resources; Associate Professor, Department of Animal and Range Sciences; and Associate Professor/Extension Wildlife Specialist, Department of Extension Animal Sciences and Natural Resources, New Mexico State University.

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limit water intake. Limiting water intake may be detrimental to physiological processes, including temperature regulation, milk production, metabolism, blood volume, and digestion (Squires, 1988). The overall health and well-being of cattle are negatively affected when they cannot fulfill their physiological water requirements. Because it is impossible to accurately account for all variables that contribute to overall water requirements, it is recommended to provide liberal amounts of water for cattle (Squires, 1988; Lardy et al., 2008). Squires (1988) suggested that livestock watering systems should be designed to supply enough water to meet the needs of cattle during times of greatest physiological needs (e.g., lactation and high temperatures).

FACTORS AFFECTING WATER CONSUMPTION

There are many variables that influence animals' water consumption, many of which cannot be accounted for directly when making estimates of water use. Factors that influence water consumption include species, breed, size, age, sex, forage quality and quantity, water accessibility (Wilson and Lucero, 1995), water temperature (Lofgreen et al., 1975), rate and composition of gain, reproductive status, lactation, physical activity, supplementation, feed intake, forage dry matter content, and ambient temperature (Winchester and Morris, 1956; National Academies of Sciences, Engineering, and Medicine [NASEM], 2016). Other potential factors may include water quality, humidity, precipitation, and elevation. Rouda et al. (1994) determined that supplementation, lactation, and temperature influenced water consumption. Supplementation can have an influence on water intake; Vallentine (1990) suggests that an additional 5 gallons of water consumption can be observed per pound of supplement, whereas Rouda et al. (1994) observed a decrease in water intake with supplementation. In addition, lactation increased water intake by 24% (Rouda et al., 1994).

ESTIMATION MODELS

Prediction models may provide useful water intake estimates for making herd management decisions. The primary challenge is their applicability to specific situations and having the data needed to estimate water intake.

The National Academy of Sciences, Engineering, and Medicine's (NASEM) *Nutrient Requirements of Beef Cattle* (2016) provides the most appropriate model to use for water intake estimates because it encompasses the largest data set and has been evaluated for accuracy (R^2 = 0.997; NASEM, 2016).

The NASEM (2016) model (Eq 19-105) is:

$$\textit{Water Intake (liters/day)} = 7.3 + 0.0805 \times SBW - 0.00008 \times SBW^2 - 1.225 \times CETI + 0.0411 \times CETI^2 + 0.0023268 \times SBW \times CETI$$

Where:

SBW = Shrunk body weight is body weight adjusted for 4% gut fill.

CETI (Current Effective Temperature Index; NASEM, 2016, Eq 19-103) = $27.88 - 0.456 \times Tc + 0.010754 \times Tc^2 - 0.4905 \times RHc + 0.00088 \times RHc^3 + 1.1507 \times (WS/3.6) - 0.126447 \times (WS/3.6)^2 + 0.019867 \times Tc \times RHc - 0.046313 \times Tc \times WS/3.6 + 0.41267 \times HRS$

Table 1 contains the full list of variables for the NASEM model.

Table 1. Inputs Used for Variables with Examples for Cow and Calf Water Use Estimates Using NASEM (2016) Model

Variable	Cow (1,100 lb; 498.9 kg)	Calf (250 lb; 113 kg, mid-season)
CETI[a] = Weather index	29.1	29.1
SBW[b]= Shrunk body weight (kg)	479	109
Water intake (liters/d)	59.1	21.6
Water intake (gallons/d)[c]	15.4	5.6
Tc (temperature, °C)	26.7	26.7
RHc (relative humidity)	30	30
WS (wind speed, mph)	10	10
HRS (hours of sunlight)	12	12

[a]CETI = Current Effective Temperature Index data gathered from http://weather.nmsu.edu/products/climate-new-mexico.

[b]Shrunk body weight (kg) = 96% of actual body weight, an adjustment for digestive fill. This estimate is based on a standard established by NRC (2000).

[c]Liters converted to gallons (e.g., 59.1 L × 0.26 = 15.4 gal).

THE CHALLENGES OF ESTIMATING WATER INTAKE

Current models are based on water intake by animals in feedlots or other confined areas and may not represent cattle water intake under rangeland grazing situations. Further, the number and range of natural variations possible with model variables makes universal application of one water intake estimate impractical. Different models yield different estimates for the same inputs; Table 2 reports the variation between models using the same input variables. Winchester and Morris (1956), Hicks et al. (1988), and the *Nutrient Requirements of Beef Cattle* publication (NASEM, 2016) are commonly referenced models in research publications. When evaluating all models, it appears dry matter intake, body weight, and

Table 2. Water Intake Estimates for Different Predictive Water Intake Models Using the Same Inputs for Each Model[a]

AUTHOR	%DM[b]	DMI[c]	Precip	Salt	Milk, kg	TEMP	Body Wt.	CETI[d]	Estimated Intake (gal/day)
Winchester and Morris, 1956[e]	%	lb		%					17.9
Hicks et al., 1988[f]		lb	inches	%		°F			19.2
NRC, 2000[g]		kg	cm	%		°F			10.6
NASEM, 2016[h]						°C	kg	X	15.4
Murphy et al., 1983[i]		kg		g/d	kg/d	°C			14.8

[a]Inputs were the same for each model: DMI = 24.8 lb or 11.02 kg; Precip = 13.9 inches of precipitation per year; Salt = 0.1%; TEMP = 80°F or 26.7°C; Body Wt. = 479 kg.

[b]%DM = the % dry matter of the diet.

[c]DMI = dry matter intake of the animal.

[d]CETI = Current Effective Temperature Index data gathered from http://weather.nmsu.edu/products/climate-new-mexico.

[e]Water intake (*Bos taurus*) = DMI × (3.413 + 0.01595 ($e^{0.17596T}$))

[f]Gal/d = -4.393 + 0.1040Tmax + 0.2923 DMI (lb/d) – 2.5971 Precip. (inch weekly) – 1.739 Salt(%).

[g]Adapted from Winchester and Morris, 1956.

[h]Water Intake (liters/day) = 7.3 + 0.0805 × SBW – 0.00008 × SBW^2 – 1.225 × CETI + 0.0411 × $CETI^2$ + 0.0023268 × CETI

[i]Lb water/d = 35.18 + (1.58 × DMI, lb) + (0.11 × Salt, g/d) + (2.64 × T °C).

air temperature have the most influence on water consumption. However, water intake is also influenced by the energy demands of milk production during lactation for lactating beef cows (Murphy et al., 1983; Rouda et al., 1994). Murphy et al.'s (1983) model is one of the few that accounted for lactation. Using the same inputs used in Table 1, the Murphy et al. (1983) model indicated that an additional 6.5 gallons of water are needed to adequately meet a lactating beef cow's water requirement. Rouda et al. (1994) generally agreed, indicating lactating cows drank 24% more water than their non-lactating counterparts.

CONSIDERATIONS

Distance to water and forage moisture content also impact water intake of grazing animals. In a rangeland environment, diet and water quality may also contribute to water intake. Though lactation and dry matter intake have been shown to be key drivers of water intake, they are difficult to measure or predict in a grazing scenario.

When using one of these models to estimate water intake, there are a few considerations that will help ensure predictions represent specific circumstances. Use the average weight of animals to estimate dry matter intake (an adult lactating cow and nursing calf eat approximately 2.5% of their body weight per day in dry matter intake [NASEM, 2016]). If unknown, use 1,100 lb (498.9 kg) as a reasonable estimate for average New Mexico cattle. Determining average high temperatures in your area will increase the accuracy of the model because as temperatures fluctuate, water use requirements will decrease or increase. Nutrient requirements, including water, change with stage of production (growing, lactating, dry). When estimating water consumption for optimal health, peak energy demand (i.e., lactating cow with calf in summer) is a good benchmark for determining water needs for your livestock year-round.

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Marcy Ward is the Extension Livestock Specialist at NMSU. She received her B.S. and M.S. in animal science from Colorado State University and NMSU, respectively, and her Ph.D. in ruminant nutrition from North Dakota State University. She was most recently the Beef Program Director at Colby Community College in Colby, KS.

Please contact Dr. Marcy Ward, Extension Livestock Specialist (575-646-5947, maward@nmsu.edu), or the Department of Extension Animal Sciences and Natural Resources (http://aces.nmsu.edu/ces/animal/) if you have questions or comments.

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