In Year 1 there was on average 3298 kg hay (corrected for DM) harvested from each replicate of OWB in the grass-only treatment. Hand-clipped forage samples from the same area were analyzed for forage quality and averaged 6% crude protein (CP) and 64% neutral detergent fiber (NDF).

Total digestible nutrient (TDN) was estimated with NRC (2016) equation:

$$\text{TDN} = (1.0787 \times \text{CP}) + (1.327 \times \text{Fat}) + (0.4208 \times \text{NDF}) + (0.9689 \times \text{NFC}) = 47.8\%$$

where, CP = crude protein calculated by multiplying plant N concentration determined by dry combustion using a LECO analyzer by 6.25; Fat = fat from NRC (2016; bluestem hay = 1.4%); NDF = neutral detergent fiber from the filter bag technique in an ANKOM 200 Fiber Analyzer); NFC = nonfibrous carbohydrates from NRC (2016; bluestem hay = 12.7%).

This TDN value was input into Table T1.2 in the Beef Cattle Nutrient Requirements Model (v. 1.0.37; NRC, 2017) (advanced > tables > T1.2). Mean LW for the grass-only treatment for Year 1 was used for the SBW (starting body weight). Solving Table T1.2 resulted in estimates of NE$_M$ (0.93 Mcal kg$^{-1}$) and NE$_G$ (0.38 Mcal kg$^{-1}$) for the OWB hay and predicted ADG (0.092 kg d$^{-1}$) from this feed source.

Parameters in Table T1.1 were updated to reflect the SBW and predicted ADG from Table T1.2. Required NE$_M$ (5.0 Mcal d$^{-1}$) and NE$_G$ (0.2 Mcal d$^{-1}$) values were found by solving Table T1.1.
The remaining calculations were completed in a Microsoft® Excel worksheet (Microsoft, Redmond, WA).

Total NE\textsubscript{M} supply from the OWB hay was determined by:

\[
\text{Total NE}\textsubscript{M} = 3298 \text{ kg hay} \times 0.93 \text{ Mcal NE}_{\text{M}} \text{ kg}^{-1} = 3067 \text{ Mcal available for NE}\text{M}
\]

Nutrient supply and demand were balanced concurrently to maximize the number of animals the hay could support per season (86 days in Year 1). For instance,

\[
6 \text{ hd} \times 5.0 \text{ Mcal d}^{-1} \text{ required for NE}\text{M} \times 86 \text{ d} = 2580 \text{ Mcal required to meet NE}\text{M}
\]

\[
3067 \text{ Mcal available for NE}\text{M} - 2580 \text{ Mcal required to meet NE}\text{M} = 487 \text{ Mcal remaining for NE}\text{M}
\]

\[
487 \text{ Mcal remaining for NE}\text{M} / 0.93 \text{ Mcal kg}^{-1} = 524 \text{ kg OWB remaining}
\]

\[
524 \text{ kg OWB remaining} \times 0.38 \text{ Mcal NE}_{\text{M}} \text{ kg}^{-1} = 199 \text{ Mcal available for NE}_{\text{G}}
\]

\[
6 \text{ hd} \times 0.2 \text{ Mcal d}^{-1} \text{ required for NE}_{\text{G}} \times 86 \text{ d} = 103 \text{ Mcal required to meet NE}_{\text{G}}
\]

\[
199 \text{ Mcal available for NE}_{\text{G}} - 103 \text{ Mcal required to meet NE}_{\text{G}} = 96 \text{ Mcal remaining for NE}_{\text{G}}
\]

Finally, predicted liveweight gain (LWG) was calculated.

\[
6 \text{ hd} \times 0.092 \text{ kg hd}^{-1} \text{ d}^{-1} \times 86 \text{ d} = 47 \text{ kg predicted LWG}
\]
APPENDIX B. EXAMPLE CALCULATION FOR WATER FOOTPRINT.

Assumptions for one replicate: 854 kg observed liveweight gain (LWG), 402 mm total rainfall per ha (8.34 ha per replicate), 45,662 L of drinking water directly consumed by the cattle, 2,334,357 L of corrected irrigation.

First, convert all water inputs into cubic meters.

\[
\begin{align*}
402 \text{ mm rainfall} & \cdot 8.34 \text{ ha} \cdot \frac{1 \text{ m}}{1000 \text{ mm}} \cdot \frac{10,000 \text{ m}^2}{1 \text{ ha}} = 33,527 \text{ m}^3 \text{ total rainfall} \\
2,334,357 \text{ L corrected irrigation} & \cdot \frac{1000 \text{ L}}{1 \text{ m}^3} = 2,334 \text{ m}^3 \text{ corrected irrigation} \\
45,662 \text{ L drinking water} & \cdot \frac{1000 \text{ L}}{1 \text{ m}^3} = 46 \text{ m}^3 \text{ drinking water}
\end{align*}
\]

Second, total all water inputs then convert to.

\[
33,527 \text{ m}^3 \text{ total rainfall} + 2,334 \text{ m}^3 \text{ corrected irrigation} + 46 \text{ m}^3 \text{ drinking water} = 35,914 \text{ m}^3 \text{ total water input}
\]

Third, divide the observed LWG by the total water input. This is the water use efficiency of stock LWG in the example beef production system.

\[
\frac{854 \text{ kg observed LWG}}{35,914 \text{ m}^3 \text{ total water input}} = \frac{0.024 \text{ kg LWG}}{\text{m}^3 \text{ water}}
\]

Finally, take the reciprocal of the water use efficiency to find the water footprint.

\[
\frac{1}{\frac{0.024 \text{ kg LWG}}{\text{m}^3 \text{ water}}} = \frac{42.1 \text{ m}^3 \text{ water}}{\text{kg LWG}}
\]
Based on these assumptions it would take 42.1 cubic meters of water (from all inputs) to achieve 1 kg of LWG in this grazing system.