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Case Study: Irrigation and stocking rate influences on northern Michigan beef cow-calf and forage production

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ABSTRACT

Although the Great Lakes Region has abundant fresh water, the area can be dry, especially during the summer growing season. Beef producers are considering use of irrigation because of this combined with diminished access to grazing land. Our objective was to investigate the combination of irrigation, genotype, and stocking rate on northern Michigan cow-calf production systems. Treatments were a combination of 2 irrigation levels, 2 breeds of cattle of contrasting body size, and 3 stocking rates expressed in animal unit equivalents (AU/ha). Sixty-four Red cow-calf pairs in total were assigned to 1 of 4 treatments: (1) 3 small Angus cow-calf pairs without irrigation (3SWO; 2.1 AU/ha); (2) 3 small Angus cow-calf pairs with irrigation (3SW; 2.1 AU/ha); (3) 5 small Angus cow-calf pairs with irrigation (5SW; 3.5 AU/ha); and (4) 5 large Simmental cow-calf pairs with irrigation (5LW; 4.4 AU/ha). Both animal and forage performance were monitored from May to August 2011. Irrigation aided forage growth with 17.8 and 16.0% greater pregrazing forage biomass in August compared with May in the 5SW and 5LW treatments, respectively. The greater stocked treatments returned more performance per hectare; 5SW had twice the overall cow and calf BW gain/ha in July to August when compared with 3SW. Overall, irrigation may sustain greater stocking rates and herbage production later in the grazing season and may be a viable tool for Midwest beef producers. This study was limited to 1 yr, so more long-term studies are needed to address the effect of variable precipitation and climatic conditions in Midwest beef systems.

Key words: beef cow-calf, forage production, grazing, irrigation, stocking rate

INTRODUCTION

The combination of increased land rent, drought, and cropland conversion has decreased pasture availability in the upper Midwest region. Average pasture value has increased by 75% since 2005 (National Agricultural Statistics Service, 2015). Also, increased drought frequency increases the uncertainty of pasture availability (Chaplin-Kramer and George, 2013). Finally, historically high corn prices with increased corn-based ethanol production have increased farmland demand (Hart, 2015). To manage these challenges, optimizing grazing practices is necessary. Although there are no one-size-fits-all solutions, available local resources and regionally appropriate management must be considered.

The Great Lakes Region occupies 84% of North America's surface fresh water and approximately 21% of the world's supply (EPA, 2012). Although there is abundant freshwater in this area, Michigan is the driest state east of the Mississippi during summer (Michigan Department of Agriculture and Rural Development, 2012). A typical Michigan sandy soil has high evapotranspiration and low soil moisture retention that can lead to limited forage and animal productivity during the growing season. To address water-related challenges, a pasture irrigation system could be a regionally resource-appropriate management tool for increased production.

Stocking rate and cow size also influence production efficiency in grazing settings. Stocking rate is the relationship between the number of animals and the grazing management unit used over a specified time period (Allen et al., 1992). When forage is not limiting, greater stocking rates can lead to more beef performance per hectare (Newman et al., 2002) but should be balanced with the nutritional maintenance requirement of the cow. Aligning stocking rate with forage production can maximize production efficiency and economics (Lalman et al., 2013). There are no data in Michigan addressing cow-calf performance under the combination effects of irrigation and stocking rate.

Therefore, our case study objective was to determine the effect of irrigation and stocking rate on beef and forage production in northern Michigan.

MATERIALS AND METHODS

Study Site

This case study was conducted at the Michigan State University AgBioResearch Center, Lake City, Michigan

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Table 1. Monthly total precipitation (rain, mm) and average monthly high and low air temperatures (C°) at Lake City, Michigan, from May to October (2010 and 2011)

	2010			2011			History[1]		
Month	High (°C)	Low (°C)	Rain (mm)	High (°C)	Low (°C)	Rain (mm)	High (°C)	Low (°C)	Rain (mm)
May	20.8	6.8	88.1	19.1	6.4	61.9	24.1	10.3	106.7
Jun	23.8	12.0	143.5	24.4	10.9	104.3	26.5	12.6	67.1
Jul	28.0	14.6	145.2	29.3	14.8	54.6	25.2	11.7	91.0
Aug	27.1	13.7	52.8	26.6	12.5	91.7	20.8	7.1	68.6
Sep	19.7	7.6	115.8	21.7	7.3	66.3	13.4	1.7	82.3
Oct	16.1	1.2	49.3	15.3	1.9	97.8	18.7	4.9	85.3

[1]Historic averages reflect data collected from 1981 to 2010 in Lake City, Michigan.

(latitude: 44°18′N, longitude: 85°11′W; elevation 377 m). This region, which developed over glaciated soils, was primarily deciduous and coniferous forest before farming entered the area in the 1860s (Frederick, 1985). In the study site, 64.7% of the area is dominated by the Nester soil series, which comprises well-drained sandy loams with 1 to 6% slopes. The remaining area is dominated by the Kawkawlin soil series, which is characterized by heavier soil texture and gentle slope. Weather data, including precipitation and maximum, minimum, and mean air temperature, were obtained from an on-site weather station (Table 1).

Animals and Management Treatments

The Michigan State University Animal Care and Use Committee approved all study procedures. Sixty-four Red Angus and Simmental crossbred cow-calf pairs (mean age: 4.5 ± 1.5 yr) were used. Simmental-based cows calved in January and February, and the Red Angus cows calved in March and April. This case study was initiated on May 17, 2011, and concluded August 25, 2011. On d 0, all cow-calf pairs were weighed and observed for initial BCS on a 1-to-9 scale by 2 qualified technicians (Wagner et al., 1988). All cows were in moderate to good body condition (Table 2). Animals were stratified by BW into 4 groups (Table 2; BW ranges are also supplied) with 4 replicates: (1) 3 small Angus cow-calf pairs without irrigation (**3SWO**); (2) 3 small Angus cow-calf pairs with irrigation (**3SW**); (3) 5 small Angus cow-calf pairs with irrigation (**5SW**); and (4) 5 large Simmental cow-calf pairs with irrigation (**5LW**). The mean cow BW for each treatment representing small Angus cows ranged from 510 to 514 kg, and the treatment group representing the large Simmental cow treatment was 653 kg. The resulting grazing treatment groups (n = 16) were randomly allotted to 1 of 16 grazing paddocks (1.62 ha, divided into 0.09-ha subpaddocks) where they remained until the end of the study. The equivalent stocking rates, calculated as one animal unit (AU) equals one mature, 454-kg dry cow in gestation (Vallentine, 1965), were 2.1 AU/ha, 3.5 AU/ha, and 4.4 AU/ha for each of 3SWO and 3SW, 5SW, and 5LW, respectively. One fertile 2-yr-old Angus-Simmental composite bull (685 ± 8.9 kg) per cow-calf group was randomly assigned and entered the study from July 18 to August 25. As the bulls were weighed on and off study, the addition of the bull was accounted for in the gain efficiency calculation. All cows and calves were weighed on d 0, 62 (study middle), and 102 (study conclusion). All groups had unlimited access to fresh water and a loose, free choice mineral and vitamin (minimum of 10% Ca, 8% P, 24% NaCl, 10% Mg, 1,200 mg/kg Cu, 40 mg/kg Se, 4,500 mg/kg Zn, 121,500 IU/kg vitamin A, 24,300 IU/kg vitamin D_3, and 585 IU/kg vitamin E) supplement (Michigan State University Custom Mix, McBain, MI). One cow-calf pair from 5SW was replaced with a similar pair after wk 1 due to chronic bloat of the cow.

Cow-calf grazing rotation through paddocks (0.09 ha) was conducted early afternoon from Monday to Saturday. On Saturdays, twice the space was allotted to all treatment groups, such that all cattle remained in the allotted paddock until Monday. Rotations lasted 18 d from d 0 to 18, 27 d from d 19 to 45, and 36 d from d 46 until study completion. On d 62 (July 1, 2011) paddocks in the low stocking rate treatments (3SWO and 3SW) were topped to an approximate height of 15.2 cm to remove standing plant material and facilitate new plant regrowth.

Pastures

Pastures (1.62 ha each, n = 16) were composed primarily of cool-season grasses, were leguminous, and had weedy forbs. Early in the grazing season (May and June), the botanical composition was primarily Kentucky bluegrass (*Poa pratensis* L.), with common bromegrass (*Bromus* sp.), white clover (*Trifolium repens* L.), and dandelions (*Taraxacum officinale* F.H. Wigg.). Later in the grazing season (July–August), the botanical composition shifted to orchardgrass (*Dactylis glomerata* L.), tall fescue (*Festuca arundinacea* Schreb.), and red clover (*Trifolium*