J. Dairy Sci. 94:2581–2586
doi:10.3168/jds.2010-3688

Short communication: Effect of stocking rate on the economics of pasture-based dairy farms

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ABSTRACT

Data from a multiyear farm systems study evaluating the effect of stocking rate (SR) on pasture production and utilization, milk production per cow and per hectare, reproduction, and cow health were used to determine the economic implications of altering SR. The effect of SR was also evaluated relative to cow size and total feed available (comparative stocking rate; CSR), to account for differences in cow size and feed supplement availability. Milk production, gross revenue, operating expenses, and operating profit per cow all declined with increasing SR and CSR. In comparison, milk production, gross revenue, and operating expenses per hectare increased with increasing SR and CSR. These effects were irrespective of milk price. The effect of SR on operating profit and return on assets, however, was dependent on milk payment system. When payment was based on the economic value of milk fat and protein, operating profit and return on assets were quadratically associated with both SR and CSR, declining at an SR greater or less than 3.3 cows/ha and a CSR greater or less than 77 kg of body weight/t of feed dry matter available. In comparison, when milk payment was based on a fluid milk pricing system, profit per hectare increased linearly with increasing SR and CSR, but return on assets was not affected by SR or CSR.
Key words: comparative stocking rate, operating profit, operating expense, return on assets

Short Communication

There has been a rejuvenated interest in pasture-based dairy production systems internationally, primarily because of reductions in inflation-adjusted milk prices globally (Dillon et al., 2005). Pasture-based systems present an opportunity for lower operating expenses compared with TMR-based confinement operations, but milk production per cow is less (White et al., 2002; Dillon et al., 2005). Hanson et al. (1998) and Kriegl (2001) acknowledged the potential profitability of grazing dairy systems in the United States when systems are managed appropriately. Appropriate management involves assigning the correct stocking rate (**SR**; Macdonald et al., 2008) to match the seasonal supply of pasture with the herd intake demand as closely as possible (Dillon et al., 1995). This facilitates very high utilization of feed grown.

Stocking rate is generally defined as the number of animals allocated to an area of land (i.e., cows/ha). However, Macdonald et al. (2008) identified limitations to using SR in comparisons across dairy businesses. Differences between farms in land class, soil fertility, climate, climate variability, and the availability and price of supplements influence the amount of feed available per hectare. Additionally, differences in cow breed and genetic merit alter cow requirements. Together, these variables make it difficult to extrapolate and compare results from different SR experiments. To overcome this, Macdonald et al. (2008) introduced the concept of comparative SR (**CSR**), which was defined as kilograms of cow BW (at a standard BCS) per tonne of feed DM available, using BW as a proxy for the cows' genetic merit for milk production, and making the assumption that most feeds offered to dairy cattle were similar in ME content (between 10.5 and 12 MJ of ME/kg of DM).

Although SR has been evaluated many times over the last half century (McMeekan, 1956; Castle et al., 1972; Gordon, 1973; Baker and Leaver, 1986; Dillon et al., 1995; Fales et al., 1995; Kennedy et al., 2006), the foci were primarily on milk production changes from altering SR, with very few studies (Fales et al., 1995) providing economic analyses. In addition, apart from Macdonald et al. (2008), previous SR studies undertaken in temperate climatic zones investigated a maximum of 3 SR treatments, making it impossible to define an optimum SR or CSR, even if economic analyses were undertaken. The profitability of pasture-based dairy systems depends on the efficiency of pasture use coupled with reasonable production per cow (Dillon et

Received August 5, 2010.
Accepted December 13, 2010.
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Table 1. Effect of stocking rate on pasture growth and utilization, silage consumed, the proportion of the farm mechanically cut to maintain pasture quality (topped), milk production, and lactation length (adapted from Macdonald et al., 2008)

Item	Stocking rate[1]					*P*-value	
	2.2	2.7	3.1	3.7	4.3	Linear	Quadratic
Pasture grown, kg of DM/ha per year	18,048	18,050	19,484	18,538	20,394	0.11	0.74
Pasture consumed, kg of DM/ha per year	12,098	13,785	14,322	15,609	16,597	<0.01	0.22
ME, MJ/kg of DM	11.0	11.2	11.3	11.4	11.4	<0.05	<0.001
Conserved pasture, kg of DM/ha per year	1,257	1,078	806	306	65	<0.01	<0.01
Silage consumed, kg of DM/ha per year	354	543	562	812	876	<0.01	<0.05
Purchased supplements, kg of DM/ha per year	0	0	0	506	812	<0.05	0.07
Proportion of farm topped, %/yr	90	75	65	0	0	<0.01	0.92
Annual milk yield, kg/cow per year	5,032	4,351	4,128	3,616	3,448	<0.01	0.07
Milk composition, %							
Fat	4.59	4.75	4.67	4.69	4.37	0.12	0.08
Protein	3.51	3.54	3.53	3.49	3.33	<0.05	<0.05
Lactose	4.85	4.86	4.91	4.89	4.88	0.34	0.23
Annual milk yield, kg/ha	11,071	11,747	12,796	13,380	14,828	<0.01	0.69
Annual fat yield, kg/ha	507	557	595	625	647	<0.01	<0.05
Annual protein yield, kg/ha	388	415	452	467	494	<0.01	0.31
Annual lactose yield, kg/ha	537	570	626	653	723	<0.001	0.83
Lactation length, d	291	274	258	234	221	<0.001	0.74

[1]These stocking rates are equivalent to comparative stocking rates (kg of BW/t of feed DM) of 60, 70, 76, 89, and 91, respectively.

al., 2005). Macdonald et al. (2008) reported decreasing milk yield per cow but increasing milk production per hectare with increasing SR, implying that there is likely an SR and CSR that maximizes profitability. Production data from Macdonald et al. (2008) and associated operating expenses were used to evaluate the economic implications of altering SR and CSR.

The experiment was undertaken at No. 2 Dairy Farm, DairyNZ, Hamilton, New Zealand (latitude 37°47′ S, longitude 175°19′ E, 40 m above sea level) over 3 years, and methods were reported in detail by Macdonald et al. (2008). Briefly, 94 Holstein-Friesian cows were randomly allocated to 1 of 5 SR farmlets (2.2, 2.7, 3.1, 3.7, and 4.3 cows/ha) in a completely randomized design; the CSR equivalent to the SR imposed was expected to be 62, 76, 90, 103, and 120 kg of BW/t of DM per year, respectively, assuming pasture production per hectare was the same on all treatments (18.0 t of DM pasture was grown/ha per year; McGrath et al., 1998), and no feeds were acquired externally to the grazing platform. This would have been equivalent to an annual feed allowance of 8.1, 6.8, 5.8, 4.9, and 4.2 t of DM/cow per year for 2.2, 2.7, 3.1, 3.7, and 4.3 cows/ha SR treatments, respectively. As outlined by Macdonald et al. (2008), however, and presented in Table 1, pasture grown tended ($P = 0.11$) to increase, pasture consumed increased linearly ($P < 0.01$), and cow BW decreased with SR. As a result, actual CSR was 60, 70, 76, 89, and 91 kg of BW/t of DM for 2.2, 2.7, 3.1, 3.7, and 4.3 cows/ha, respectively, using the BW of the cows in mo 6. This is equivalent to an annual allowance of 8.2, 6.7, 6.3, 5.1, and 4.9 t of DM/cow, respectively.

The farms were managed as seasonal calving systems, with cows calving over an 8-wk period in spring. Approximately 20% of cows from each farmlet were culled each lactation, on the basis of reproductive failure, health, age, and genetic merit, and were replaced with primiparous cows 1 mo before the planned start of calving. Age structure did not differ across treatments.

Grazing management decision rules were the same across treatments, with the exception of intergrazing interval (rotation length), which was managed to optimize each individual treatment (see Macdonald et al., 2008). Defined grazing areas (paddocks) were grazed in rotational order, with cows only returning to the same area when more than 2 leaves had appeared on more than 66% of perennial ryegrass tillers.

Individual cow milk yields were recorded weekly (Tru-Test milk meter system, Palmerston North, New Zealand). Milk fat, CP, and lactose concentrations were determined on composite afternoon and morning aliquots by Fossomatic FT120 (Foss Electric, Hillerød, Denmark). Body weight and BCS were determined every second week following the morning milking or at approximately 0900 h during the nonlactating period. Body condition score was assessed pre- and postcalving on a 10-point scale, where 1 is emaciated and 10 is obese (Roche et al., 2004). Mastitis and other health problems and reproductive data were recorded.

Annual milk yield and milk component yield were calculated for each treatment. Milk was valued in 2 ways to reflect a milk component market price, representative of the globally traded value of fat and protein products (hereafter, milksolids price) and a fluid mar-