Effects of stocking rate and breed on milk production and reproduction in a pasture-based dairy system

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Introduction

Previous work has demonstrated that pasture-based dairying can be economically viable with minimal effects on the environment. However, dairy graziers are interested in answers to questions about specific production practices in order to optimize the economics of pasture-based systems. Optimal grazing strategies require an appropriate balance between stocking rate and per cow performance in pasture-based dairy systems. This work was initiated to examine issues that limit current grazing systems such as: forage species and quality, stocking rates, nutrient supplementation strategies, and use of crossbreeding.

The objective of the study presented here was to compare milk production levels and milk components as well as reproductive measures between the two stocking rates and among Jersey, Holstein, and crossbred cows within those stocking rates.

Materials and Methods

This was part of a three-year research project initiated in the fall of 2003. A primary objective was to compare 2 pasture-based systems with cows at 2 different stocking rates. Also, performance of Jersey, Holstein, and crossbred cows would be examined within the two systems.

The project consisted of two groups of 40 cows for each of 3 years at different stocking rates. One was a Low stocking rate of 2.5 cows/ha or 1 cow/acre receiving 1x supplementation at 8 to 16 pounds of concentrate per head per day. The High stocking rate was 3.7 cows/ha or 1.5 cows/acre with 1.5x supplementation of 12 to 24 pounds of concentrate per head per day.. Amounts of concentrate varied depending on quantities and quality of pasture or round bale haylage and consisted of ground corn, whole cottonseed, soybean meal, and mineral. Although the amounts of supplemented concentrate varied throughout the lactation, the relative proportions were kept at 1.5:1 for High vs. Low stocking rates, respectively. Round bale grass haylage was used during winter or in periods of drought when pasture was limited or unavailable. When lush pasture was available the relative proportion of soybean meal in the supplement was reduced as were total amounts of concentrate.

Each group of 40 cows was planned to include 13 Holstein, 13 Jersey, and 14 various Holstein x Jersey crossbred cows. However, because of limited numbers of cows available, there were < 40 cows per group in the 3rd year of the study. The High stocking group had 34 cows and the Low stocking group had 35 cows. Among the crossbred cows there were crosses varying from ¾ Holstein to ¾ Jersey and the average percentage Holstein was 53, 49.5, and 51.4 for 2003, 2004, and 2005 calving seasons, respectively.

Pastures were set up proportionately based on soil types and forages species on either 40 acres for the Low group or 27 acres for the High stocking rate group. Pasture species by percentage of the acreages included 20% improved fescue (MaxQ) plus ladino clover; 30 % winter annual ryegrass alternated with sorghum-sudan summer annual; and 50% Tifton-44

hybrid Bermudagrass overseeded with annual ryegrass each fall. Each group of cows also had access to two 3-acre sacrifice areas where haylage was fed as needed and two small areas of woods for summer shade when temperatures exceeded 90 degrees F. With calving in the fall, cows started on cool season pastures of either fescue-clover or ryegrass and moved to sacrifice areas as needed in the winter.

Breeding via detection of estrus and artificial insemination began in January and continued through March. Although nearly all cows were inseminated at a natural estrus, a few cows each year that were not observed in estrus by late February were treated with an appropriate hormonal sequence so that all could be inseminated at least once during the breeding season.

Results

Table 1.Reproductive measures and SCC Scores by breed pooled over 3 years.

	H	J	X	Std. Error
Conception Rate at 1st Service	43.5	51.3	66.1	±8.3
Conception Rate at All Services	40.5	56.5	64.2	±6.7
Pregnancy Rate	76.6	91.1	91.8	±3.0
SCC Score	3.2	3.3	3.5	±0.17

Reproductively, there were no significant differences between the two stocking rate groups. However, there were breed differences in measures of reproduction. Various reproductive measures for the different breeds averaged across stocking rates and all three years of the study are included in Table 1. Jerseys and Crossbreds had higher conception rates at 1st service and over all services as well as having higher pregnancy rate over the entire breeding season than Holsteins. However, the values for conception rates among the Jerseys were lower than expected in the first year of the study, likely because they were moved from a TMR-feeding system at another location in early lactation and had to adapt to the pasture-based system just before the breeding season. That year resulted in perhaps a lower average conception for the 3 years and may not precisely reflect long-term reproductive success of Jersey cows. In fact, in a related paper in these proceedings Jerseys had numerically the highest first service conception rates at 61.4% among all cows calving in 2005.

There were no significant differences in linear SCC scores by either stocking rate or breed group across the 3-year study (Table 1).

Group and breed differences in milk production levels and composition can be seen in Table 2. Typically, the Holsteins produced the most pounds of mature-equivalent milk, fat, and protein whereas Jerseys produced the least, and the crossbred cows were intermediate to both pure breeds. However, there was an exception in the 2005-2006 High stocking group. Holsteins

had poor production, lower than even the Jerseys. In contrast, the crossbreds had unusually high milk production compared to other years, surpassing the other breeds. More thorough analyses of what happened in the third year needs to be done. Because the total numbers of animals included in year 3 was fewer than the desired 40, a few animals with disproportionately high or low milk yields may have skewed the results.

Differences between the 2 stocking rates were seen in that the High stocking group produced significantly more milk, fat and protein than the Low stocking group each year and cumulatively. The advantage for the High stocking rate group in yield measures was about 11 to 12 percent across the 3-year study.

Conclusions

All 3 breeds produced at greater levels at the high stocking rate, receiving less pasture and more supplement per cow. Although amounts of concentrate supplement fed to cows on the High stocking rate was more, higher milk yields per cow and increased productivity per unit of land because of more cows per acre would favor High stocking rates economically as proposed by Clifton King in work on economic modeling of pasture-based systems in his M.S. thesis in 1997.

Table 2. Measures of milk production by breed and stocking rate over 3 years.

	Low Stocking Rate				High Stocking Rate				Difference: LowSR-HighSR			% Difference: (Low-High)/Low		
	H	J	X		H	J	X		H	J	X	H	J	X
2003-2004	lb/cow	lb/cow	lb/cow		lb/cow	lb/cow	lb/cow		lb/cow	lb/cow	lb/cow	%	%	%
ECM	13,714	11,517	13,177		14,545	12,669	14,017		-831	-1,152	-840	-6.1%	-10.0%	-6.4%
ME Milk	15,002	10,775	13,260		15,240	12,147	14,091		-238	-1,372	-831	-1.6%	-12.7%	-6.3%
ME Fat	457	412	456		494	460	488		-37	-48	-32	-8.1%	-11.7%	-7.0%
ME Protein	422	387	428		461	399	450		-39	-12	-22	-9.2%	-3.1%	-5.1%
2004-2005														
ECM	15,854	10,479	12,863		16,161	12,545	14,023		-307	-2,066	-1,160	-1.9%	-19.7%	-9.0%
ME Milk	16,895	10,404	12,861		16,811	11,628	14,239		84	-1,224	-1,378	0.5%	-11.8%	-10.7%
ME Fat	533	366	449		555	470	483		-22	-104	-34	-4.1%	-28.4%	-7.6%
ME Protein	499	340	414		506	388	453		-7	-48	-39	-1.4%	-14.1%	-9.4%
2005-2006														
ECM	14,667	12,122	12,516		13,619	13,896	15,365		1,048	-1,774	-2,849	7.1%	-14.6%	-22.8%
ME Milk	15,301	12,098	12,636		13,938	13,903	15,556		1,363	-1,805	-2,920	8.9%	-14.9%	-23.1%
ME Fat	486	427	438		477	488	536		9	-61	-98	1.9%	-14.3%	-22.4%
ME Protein	491	383	395		421	441	486		70	-58	-91	14.3%	-15.1%	-23.0%
All Years				SE				SE						
ECM	14,661	11,369	12,925	± 469	14,800	13,075	14,456	± 465	-139	-1,706	-1,531	-0.9%	-15.0%	-11.8%
ME Milk	15,681	11,178	12,986	± 486	15,401	12,578	14,622	± 482	280	-1,400	-1,636	1.8%	-12.5%	-12.6%
ME Fat	489	401	450	± 18	508	475	502	± 18	-19	-74	-52	-3.9%	-18.5%	-11.6%
ME Protein	466	368	416	± 15	465	410	463	± 15	1	-42	-47	0.2%	-11.4%	-11.3%