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CASE STUDY: Performance of Lactating Jersey and Jersey-Holstein Crossbred Versus Holstein Cows in a Wisconsin Confinement Dairy Herd

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ABSTRACT

The objective of this trial was to measure performance of paired pens of lactating Jersey and Jersey-Holstein crossbred (JX) vs. Holstein (H) cows over a year in a Wisconsin confinement dairy herd. Average daily milk yield of JX was 5.5 kg/cow less than H, whereas average milk fat and true protein percentages were 0.61 (4.26 vs. 3.65%) and 0.19 (3.05 vs. 2.86%) percentage units, respectively, greater for JX than H. Average daily DMI was 2.2 kg/cow less for JX than H. Services per conception and days open were 0.8 times and 22 d less, respectively, for JX than H. The incidence of lameness was 13.0 percentage units less for JX than H. The percentage of cows culled was 5.1 percentage units less for JX than H. Using actual monthly farm pay prices for milk, the average milk income over feed cost (IOFC) was $0.42/cow per day less for JX than H. However, after adjusting for differences between pens for days open, all health disorders, and culling, IOFC was $0.05/cow per day greater for JX than H. After the farm's add-on milk price premiums were attached to the value of milk components, IOFC was $0.21/cow per day greater for JX than H. The JX pen showed benefits over the H pen for milk composition, reproductive performance, some health disorders, and cull rate, which offset the observed milk yield reduction for the JX pen when the overall economic performance of the JX vs. H pens was calculated for this confinement dairy.

Key words: milk yield, Jersey, Holstein, crossbred

INTRODUCTION

There has been considerable interest over the past several years by both researchers and dairy producers in the crossbreeding of dairy cows (Weigel, 2007). Reasons for this interest include a change to multiple component pricing of milk and desire by some processors to move to cheese-yield pricing of milk (ALTO Dairy, 2007), potential for improving herd fertility and health through heterosis or hybrid vigor effects of crossbreeding (Weigel, 2007), and an emphasis on improving feed efficiency (Hutjens, 2005). The Holstein (high milk volume) and Jersey (high milk solids content) breeds are established as the predominant breeds in the United States, and thus have been included in many of the early crossbreeding programs on dairies. The objectives of this trial were to measure milk yield and components, feed efficiency, reproduction, health, and economic performance of paired pens of lactating Jersey and Jersey-Holstein crossbred and of Holstein cows over a year in a Wisconsin confinement dairy herd.

MATERIALS AND METHODS

The trial was conducted at Tauchen Harmony Valley (**THV**; Bonduel, WI) Dairy during January through December 2006. Cows were free-stall housed in a 6-row barn with a center drive-through feed alley and milked in a double-16 parlor. Prior to trial initiation, the THV herd was comprised of approximately 1,000 head (lactating and dry) of which 80% were Holstein and 20% were Jersey or Holstein-Jersey crossbred cows. To initiate the

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Table 1. Composition of trial pens over the 51 wk of data collection

Item	Holstein pen	Jersey and Holstein-Jersey crossbred pen[1]
Cows in pen	139 ± 7	137 ± 8
DIM	188 ± 15	182 ± 16
First lactation	34%	32%
Second lactation	38%	40%
≥ Third lactation	28%	28%

[1]The crossbred pen contained 62% half-Jersey and half-Holstein crossbred cows, 30% full-Jersey cows, and 8% crossbred cows that were either one-fourth or three-fourths Jersey.

trial, a pen of approximately 140 cows was filled from the population of lactating Jersey and Holstein-Jersey (**JX**) crossbred cows. There were not enough lactating crossbred cows to fill the JX pen. Therefore, Jersey cows were included in the JX pen because maintaining under-stocked trial pens would have meant over-stocking the nontrial pens for a year, which was unacceptable to herd management. The JX pen contained 62% half-Jersey, half-Holstein crossbred cows, 30% full-Jersey cows, and 8% crossbred cows that were either one-fourth or three-fourths Jersey. Another pen of approximately 140 cows was filled from the population of lactating Holstein (**H**) cows by pairing with JX cows to equalize parity and DIM of the pens. As cows were dried off from the pens, fresh H and JX cows were added to the pens to maintain similar parity and DIM composition of the pens throughout the trial. Parity, DIM, and breed composition of the trial pens are presented in Table 1. Both H and JX cows were comingled with other herd mates (both trial and nontrial cows) in a dry cow pen and a fresh cow pen from calving to 21 DIM before entering their respective trial pen.

Stall stocking density and linear feet of bunk and water space per cow were similar for the 2 trial pens. Trial pens were located within the same free-stall barn. The stall size (122 cm width), base, and bedding (Pasture Mat mattress with kiln-dried sawdust) were similar for the 2 pens. Use of fans and water sprinklers for summer heat abatement was similar for the 2 pens. All cows were milked 3 times daily and fed a TMR once daily with frequent TMR push-up throughout the day. No cows in either pen were injected with bovine somatotropin. The same diet was fed to both pens, and the diet was formulated by the herd nutritionist. Diet ingredient and nutrient composition are presented in Table 2.

Milk yield measured daily on individual cows was used to determine weekly pen averages for milk yield. Milk samples from each pen were collected on the same day each week using an in-line drip sampler (QMI, St. Paul, MN) to determine weekly pen milk composition. Samples were analyzed (DQCI Services, Mounds View, MN) for fat, true protein (**TP**), lactose, other solids, and milk urea nitrogen. Weekly pen average yields of 4% fat-corrected milk (**FCM**), solids-corrected milk (**SCM**), and energy-corrected milk (**ECM**) were calculated using the following equations: FCM = (0.4 × milk yield) + (15 × fat yield); SCM = milk yield × [(0.1224 × fat%) + (0.071 × TP%) + (0.0625 × lactose%) − 0.0345]; and ECM = (milk yield × 0.3246) + (fat yield × 12.86) + (protein yield × 7.04). Weekly pen average cheese yields were calculated using a modified Van Slyke Cheddar formula as presented by US Jersey (2007).

Table 2. Diet ingredient and nutrient composition over the 12 mo of data collection

Item	Diet composition
Ingredient, % of DM	
Hay	2.4 to 4.4
Haylage	15.0 to 22.2
Corn silage	27.5 to 30.6
High-moisture shelled corn	0 to 14.0
Whole cottonseed	5.4 to 7.2
Dry shelled corn	11.4 to 24.0
48% soybean meal	4.4 to 6.7
Beet pulp	5.5 to 6.0
Soy Plus	3.0 to 5.5
Non-ruminant meat and bone meal	0 to 2.3
Blood meal	1.0 to 1.1
Minerals, vitamins, and additives	4.3 to 5.7
Nutrient	
DM, % of as-fed	52.2 ± 3.7
CP, % of DM	17.0 ± 1.3
NDF, % of DM	28.7 ± 3.0
In vitro NDF digestibility, % of NDF	59 ± 4
Non-fiber carbohydrate, % of DM	42.5 ± 3.4
Fat, % of DM	4.8 ± 0.6
Ca, % of DM	1.02 ± 0.13
P, % of DM	0.42 ± 0.06

Scale (XR3000; Tru-Test, Auckland, NZ) body weights were recorded for individual cows in the milking parlor return lane once a month. Cows were body condition scored (1 to 5 scale) monthly. Amounts fed and refused were recorded daily for each pen. The TMR was sampled monthly; samples were sent to the Soil and Forage Analysis Laboratory (Marshfield, WI) for TMR quality control assay. The monthly DM content of the TMR was used to calculate the average weekly DMI for the pens for that month. Average weekly pen feed efficiencies (FCM/DMI, SCM/DMI, and ECM/DMI) were calculated. Health and reproductive performance for the trial pens was determined from the herd's Dairy Comp 305 (Valley Agricultural Software, Tulare, CA) records. Health performance data of trial cows included events from the calving pen and the fresh cow pen prior to entry into the trial pens. The reproductive management program was similar for both pens and the overall herd. There was a 40-d voluntary waiting period with an Ovsynch (Pursley et al., 1997) protocol commencing at 56 DIM.

Weekly average gross milk income and milk income over feed cost for the pens were calculated using the actual monthly farm pay prices for milk and a constant TMR price of $0.154/kg of DM. The farm's milk component pay prices across the year were as follows: fat = $2.91 ± 0.18/kg, TP = $4.69 ± 0.42/kg, and other solids = $0.42 ± 0.09/kg. Additionally, the farm received a net add-on milk premium across the year of $0.03 ± 0.003/kg milk. Because this add-on premium favors milk volume over solids, a scenario was evaluated where the farm's add-on premium was attached to the value of milk components by apportioning the add-on premium to milk fat and TP pay prices according to the average milk composition. The economic costs of various diseases were calculated using a spreadsheet developed by Guard (1998). Assumed economic losses provided in the spreadsheet related to days open, death, or culling were not included in the calculated cost per case for the various diseases because days open, deaths, and culls and the economic losses were recorded and analyzed separately. The resulting costs per case were as follows: milk fever = $70, retained placenta or metritis = $136, displaced abomasum = $222, ketosis = $95, mastitis = $105, and lameness = $85. The cost of the difference in days open between the 2 pens was set at $4.50/d (DeVries, 2006). The cost of a cull was set at $900 per cow. There was no difference in death loss between the 2 pens (1.9%), so an economic cost was not calculated.

Because pens were not replicated, a statistical analysis to evaluate the differences between the pens or breeds could not be performed. Therefore, only calculations of descriptive statistics (mean and SD) over the 51 wk of data collection were performed and are presented in the tables. No attempt was made to separate data for Jersey cows from that of crossbred cows because intake and milk composition data were collected on a pen basis.

RESULTS AND DISCUSSION

Production data are presented in Table 3. Average milk yield was 5.5 kg/cow per day less whereas average

Table 3. Production data over the 51 wk of data collection[1]

Item	Holstein pen	Jersey and Holstein-Jersey crossbred pen
Milk		
kg/cow per day	37.2 ± 1.8	31.7 ± 1.9
Fat %	3.65 ± 0.13	4.26 ± 0.20
TP %	2.86 ± 0.09	3.05 ± 0.10
FCM, kg/cow per day	35.2 ± 1.7	33.0 ± 2.0
SCM, kg/cow per day	34.1 ± 1.4	31.8 ± 1.8
ECM, kg/cow per day	37.0 ± 1.6	34.5 ± 1.9
Cheese yield, kg/cow per day	3.7 ± 0.1	3.3 ± 0.1

[1]TP = true protein; FCM = fat-corrected milk; SCM = solids-corrected milk; ECM = energy-corrected milk.

Table 4. Intake and feed efficiency data over the 51 wk of data collection and BW and BCS data over the 12 mo of data collection[1]

Item	Holstein pen	Jersey and Holstein-Jersey crossbred pen
DMI		
kg/cow per day	23.1 ± 1.0	20.9 ± 1.0
% of BW	3.96 ± 0.21	4.26 ± 0.18
Feed efficiency		
FCM/DMI	1.53 ± 0.10	1.58 ± 0.12
SCM/DMI	1.48 ± 0.09	1.53 ± 0.11
ECM/DMI	1.61 ± 0.10	1.65 ± 0.12
BW, kg	587 ± 16	494 ± 12
BCS	2.90 ± 0.05	2.86 ± 0.06

[1]FCM = fat-corrected milk; SCM = solids-corrected milk; ECM = energy-corrected milk.

milk fat and TP percentages were 0.61 and 0.19 percentage units, respectively, greater for JX than H. Average yields of FCM, SCM, and ECM were 2.2, 2.3, and 2.5 kg/cow per day, respectively, less for JX than H. The average calculated cheese yield was 0.5 kg/cow per day less for JX than H. It is unknown whether the performance of JX relative to H could have been altered by dietary manipulation, because the same diet was fed to both pens throughout the study. The r^2-value for the regression of weekly milk yields for JX vs. H was high (0.82; $P < 0.001$) and this relationship did not vary by season, suggesting similar effects of summer heat and humidity on the 2 pens. The herd's heat abatement program (i.e., fans and water sprinklers) may have masked any differences in tolerance of heat stress that might exist between the breeds (Jordan, 2003).

Intake, feed efficiency, BW, and BCS data are presented in Table 4. Average DMI was 2.2 kg/cow per day less for JX than H, whereas DMI as a percent of body weight was greater for JX than H. The average BW were 93 kg less for JX than H, and average BCS were numerically similar for the 2 pens. All feed efficiency measures were numerically similar for the 2 pens.

Calculated gross milk income and milk income over feed cost are presented in Table 5. Using the actual monthly farm pay prices for milk, the average gross milk income and milk income over feed cost were $0.76 and $0.42/cow per day, respectively, less for JX than H. After the farm's add-on premiums were attached to the value of milk components, the average gross milk income and milk income over feed cost were $0.59 and $0.26/cow per day, respectively, less for JX than H. Clearly, this add-on premium program based on milk volume and not components favors H.

Measures of reproductive and health performance are presented in Table 6. Services per conception and days open were 0.8 times and 22 d less, respectively, and 21-d pregnancy rate was 6 percentage units greater for JX than H. Better reproductive performance for the JX pen was not unexpected (Weigel, 2007). The incidence of milk fever was numerically greater for JX than H, which was not unexpected (Horst et al., 1997). The incidence of ketosis was over 2-fold greater for JX than H, which may have been related to the greater incidence of clinical milk fever observed for this pen and possibly a greater incidence of subclinical milk fever for this pen that went undetected (Horst et al., 1997). The incidence of mastitis was 3.2 percentage units less for JX than H. Lameness incidence was 13.0 percentage units less for JX than H. The percentage of cows culled or sold for nondairy purposes was 5.1 percentage units less for JX than H. Although reductions in calf mortalities for crossbreds have been reported (Weigel, 2007), the percentage of calves born dead was similar for H and JX.

Table 5. Calculated gross milk income and milk income over feed cost over the 51 wk of data collection

Item	Holstein pen	Jersey and Holstein-Jersey crossbred pen
Using actual monthly farm pay prices[1,2]		
Gross milk income, $/cow per day	10.73 ± 0.52	9.97 ± 0.56
Income minus feed cost, $/cow per day[3]	7.17 ± 0.61	6.75 ± 0.65
Farms add-on premiums placed on components[2]		
Gross milk income, $/cow per day	10.54 ± 0.55	9.95 ± 0.58
Income minus feed cost, $/cow per day[3]	6.99 ± 0.64	6.73 ± 0.66

[1]Fat = $2.91 ± 0.18/kg; true protein = $4.69 ± 0.42/kg; other solids = $0.42 ± 0.09/kg.

[2]Add-on premiums = $0.03 ± 0.003/kg milk.

[3]Constant TMR price of $0.154/kg DM used for all calculations.

Table 6. Reproductive and health performance data over the 12 mo of data collection

Item	Holstein pen	Jersey and Holstein-Jersey crossbred pen
Days to first breeding	60	59
Services per conception	3.5	2.7
Days open	145	123
	%	
21-d pregnancy rate	20	26
Retained placenta	3.7	4.3
Metritis	12.4	10.9
Milk fever	0.4	3.8
Ketosis	5.1	12.3
Displaced abomasum	5.1	6.2
Mastitis	25.9	22.7
Lameness	28.9	15.9
Cows culled or sold non-dairy	12.8	7.7
Cows died	1.9	1.9
Calves born dead	6.1	6.5

Table 7. Milk income over feed cost measures adjusted for reproductive and health performance data over the 12 mo of data collection[1,2,3]

Holstein pen minus Jersey and Jersey-Holstein crossbred pen	Actual farm milk pricing	Adjusted milk pricing[4]
$/cow per day		
Income over feed cost (IOFC)	0.42	0.26
IOFC adjusted for days open	0.11	–0.05
IOFC adjusted for days open, all health disorders, and culling	–0.05	–0.21
$/100 cows per year		
IOFC	15,330	9,490
IOFC adjusted for days open	4,015	–1,825
IOFC adjusted for days open, all health disorders, and culling	–1,825	–7,665

[1]Fat = \$2.91 ± 0.18/kg; true protein = \$4.69 ± 0.42/kg; other solids = \$0.42 ± 0.09/kg.

[2]Add-on premiums = \$0.03 ± 0.003/kg milk.

[3]Constant TMR price of \$0.154/kg DM used for all calculations.

[4]Farms add-on premiums placed on components.

Milk income over feed cost measures adjusted for reproductive and health performance data are presented in Table 7. Using the actual monthly farm pay prices for milk, milk income over feed cost after adjusting for the less days open for JX was \$0.11/cow per day less for JX than H. After adjusting for differences between the pens for days open, all health disorders, and culling, however, milk income over feed cost was \$0.05/cow per day or \$1,825/100 cows per year greater for JX than H. After the farm's add-on premiums were attached to the value of milk components, milk income over feed cost was \$0.21/cow per day or \$7,665/100 cows per year greater for JX than H.

IMPLICATIONS

Evaluation of the economic performance of crossbred vs. purebred dairy cattle requires data on the differences between crossbreds and purebreds for milk yield, milk composition, feed intake, reproductive performance, health disorders, and cull rate, along with the associated economic values for those parameters. The JX pen showed benefits over the H pen for milk composition, reproductive performance, some health disorders, and cull rate, which offset the observed milk yield reduction for the JX pen when the overall economic performance of the JX vs. H pens was calculated for this confinement dairy. For this dairy, the economic performance of the JX pen was more favorable relative to the H pen when milk price was tied directly to component yields. This suggests that milk pricing programs, i.e., cheese-yield pricing, may impact the economic feasibility of crossbreeding programs for dairy farmers and should be evaluated.

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