The comparative performance of primiparous Holstein Friesland and Jersey cows on complete diets during summer in a temperate climate

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The production performance of primiparous Holstein Friesland and Jersey cows was compared under local conditions during summer. A complete diet providing 15% crude protein (CP), 13% crude fiber (CF) and 10.8 MJ ME/kg dry matter (DM) was fed twice daily on an *ad libitum* basis in fence-line feeding troughs to a group of Holstein Friesland and Jersey cows each. Group feed intakes and individual milk production of cows were recorded daily. Milk samples collected once a week were analysed for fat, protein and lactose. Holstein Friesland cows produced more ($p < 0.01$) milk per day than Jerseys (23.94 vs 16.74 kg/day), while also having a higher ($p < 0.01$) feed (17.34 vs 14.10 kg DM/day) and water intake (88.2 vs 66.1 l/day). DM intake as a percentage of body weight was 3.38% for Holstein Friesland and 4.03% for Jersey cows. The milk composition of the two breeds differed ($p < 0.01$) with Holstein Friesland cows producing milk with 2.97% fat and 3.38% protein. Jersey cows produced milk with 3.96% fat and 3.90% protein. The efficiency of daily milk production for Holstein Friesland and Jersey cows was 1.38 and 1.18 kg milk/kg DM consumed, espectively. Higher ambient temperatures increased ($p < 0.05$) the water intake of Holstein Friesland and Jersey cows by 1.56 and 1.31 l/°C respectively. The higher feed efficiency of Holstein Friesland cows to produce milk supports the general trend for this breed to be used in a fresh milk market.

Die produksievermoë van eerstelaktasie Holstein Friesland- en Jerseykoeie is onder plaaslike toestande gedurende die somer vergelyk. 'n Volledige dieet wat 15% ruproteïen (RP), 13% ruvesel (RV) en 10.8 MJ ME/kg droë materiaal (DM) voorsien, is daagliks op 'n *ad libitum*-basis afsonderlik aan groepe van Holstein Friesland- en Jerseykoeie in voerkrippe langs die grensdraad voorsien. Die voerinnames van koeie is daagliks op 'n groepbasis bepaal, terwyl die melkproduksies van koeie op 'n individuele basis aangeteken is. Melkmonsters van koeie wat weekliks versamel is, is vir vet, proteïene en laktose ontleed. Holstein Frieslandkoeie het meer ($p < 0.01$) melk per dag as Jerseykoeie geproduseer (23.94 vs 16.74 kg/dag), terwyl die voer- en waterinname ook hoër ($p < 0.01$) was (17.34 vs 14.10 kg DM/dag en 88.2 vs 66.1 l / dag). DM-inname uitgedruk as 'n persentasie van liggaamsmassa was 3.38% vir Holstein Friesland- en 4.03% vir Jerseykoeie. Die melksamestelling van die twee rasse het ook verskil ($p < 0.01$) met Holstein Frieslandkoeie wat melk met 2.97% vet en 3.38% proteïene gelewer het. Jerseykoeie het melk met 3.96% vet en 3.90% proteïene gelewer. Die doeltreffendheid van daaglikse melkproduksie vir die Holstein Friesland- en Jerseykoeie was onderskeidelik 1.38 en 1.18 kg melk/kg DM ingeneem. Hoër omgewingstemperature het die waterinname van beide die Holstein Friesland- en Jerseykoeie met 1.56 en 1.31 l/°C onderskeidelik, laat toeneem ($p < 0.05$). Die hoër voeromsetting van Holstein Frieslandkoeie om melk te produseer ondersteun die algemene neiging om hierdie ras in die varsmelkbedryf aan te wend.

Keywords: dairy cows, milk yield, feed intake, feed conversion, efficiency

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The economic efficiency of various dairy breeds is regularly being compared in breed society journals showing the advantage of a particular breed. This is usually done by using simple calculations based on general guidelines. The efficiency of production of a given set of outputs is, however, dependent on which inputs are taken into account (Gibson, 1984). It is also important that the definition of efficiency takes into account the social framework within which the production is set. While feeding and management differ, it is accepted that under most dairy farming conditions feed costs amount to approximately 60% of total costs with about 90% of income being derived from milk sales. Comparing breeds in terms of economic efficiency as measured in terms of profit to the farmer has become a driving force for breed substitution and genetic selection within breeds. It has been shown (Gibson, 1986) that Friesian cows in Scotland produced 50% more liquid milk, 13% more milk fat and 29% more milk protein than Jersey cows, while consuming 22% more feed from calving to calving. Friesians were markedly more efficient (+23%) than Jerseys at producing liquid milk but not at producing milk energy (+2%). Oldenbroek (1988) found that Dutch-Friesians produced more ($p < 0.05$) liquid milk than Jerseys while fat yields were similar ($p > 0.05$). Protein yields were higher for Friesians. Jersey cows, however, had a higher biological efficiency on a roughage diet in comparison to Dutch type Friesian cows. In the USA Blake *et al.* (1986) demonstrated that the efficiency of DM digestibility was similar for Jerseys and Holsteins when fed *ad libitum* corn silage-based complete diets. Bryant *et al.* (1985) showed in New Zealand that the milk yield of Friesians was 30% higher than that of Jerseys at a stocking rate of 3.7 cows/ha. However, L'Huillier *et al.* (1988) found that Jerseys had higher food conversion efficiencies than Friesians on pasture in New Zealand. At a common live weight, they found that milk fat production per ha was higher for Jerseys than Friesians, particularly at high stocking rates.

There is no information available in South Africa regarding the comparative performance of Holstein Friesland and Jersey cows under similar feeding conditions. These breeds are the most important dairy breeds in the Western Cape. In three subregions of the Winter Rainfall Region, namely the Swartland, Boland and South Coast, these breeds constitute 90 and 6%, 63 and 29% and 24 and 46% respectively of all cows (Baard, 1989). Cows in the Swartland subregion in the Western Cape are kept mainly in open camps (dry lots) where feed is provided on a daily basis. A study was conducted with primiparous Holstein Friesland and Jersey cows to compare the two breeds, using this feeding regime. The effect of heat stress on some production parameters of the two breeds was also determined. The effect of summer climatic conditions on different heat tolerance indicators in Holstein Friesland and Jersey cows was described in a previous article (Muller & Botha, 1993).

The study was conducted at the Elsenburg Experimental Station of the Department of Agriculture of the Western Cape during the summer of 1988/89. Elsenburg is situated approximately 50 km east of Cape Town at an altitude of 177 m, longitude 18°50' and latitude 33° 51'. The experimental period started on November 30, 1988 and lasted for 100 days. Primiparous cows from both the Elsenburg Holstein Friesland ($n = 7$) and Jersey ($n = 6$) herds were used in the experiment. Average daily milk production of cows during the pre-trial period was 23.9 ± 4.1 kg/day for the Holstein Friesland and 19.5 ± 2.5 kg/day for the Jersey cows. The average number of days in lactation at the start of the trail for the two groups was 116 ± 59 and 97 ± 23 days while the average body weight of cows was 502 ± 51 and 347 ± 32 kg respectively. During the pre-trial period cows of both breeds received the same treatment in terms of housing, feeding and management.

Cows were kept under zero-grazing conditions in two open camps adjacent to each other. A surface area of approximately 100 m^2/cow was provided in each camp. Feeding space of 700 mm/cow was provided at fence-line feeding troughs. A 3-m concrete floor served as a feeding apron inside each camp along the feed manger. No protection against direct solar radiation was provided. A complete diet consisting of oat hay, wheat, maize, fish-meal, prime gluten, providing 150 g CP, 130 g CF and 10.8 MJ ME/kg DM, was provided *ad libitum* twice a day in the feed troughs of both groups. Fresh feed was provided after refusals of the previous feeding were removed. Samples of total fresh feed and total refusals in feed troughs in both camps were taken at each feeding and the DM content determined. By dividing the number of cows in each group into the total feed consumed the daily DM intake of both groups of cows was determined for day and night feeding periods separately. Water troughs, 2.0 × 0.5 × 0.4 m were provided in each camp. Water troughs were not shaded although water supply lines were buried 0.5 m underground to ensure cool drinking water. Standard water-flow meters were installed in the water supply lines to measure daily water intake. The water readings were taken at morning and afternoon milking to determine night- and day-time water consumption.

Cows were machine-milked twice daily at 05:00 and 15:30 in a milking parlour approximately 150 m from the open camps. The production of each cow was recorded at each milking. Daily milk production was regarded as the total of the afternoon and next morning's milking. Individual milk samples were analysed for fat, protein and lactose content with a Milko-Scan Infrared Analyzer. The somatic cell count (SCC) of the milk of each cow was determined with a Fossomatic cell counter.

Differences between the milk production and milk composition parameters of the two breeds were compared by analysis of variance using the Statgraphics statistical package. Body weight as well as feed and water intakes were compared by analysis of variance. Efficiencies of production were calculated, using group data. Linear regressions were fitted for various production parameters within breeds against ambient maximum temperature (Snedecor & Cochran, 1980).

Ambient conditions during the experimental period were typical for this area during summer. Days were characterized by high day-time temperatures (mean maximum temperatures ± SD were 29.3 ± 4.1°C) and cool conditions at night (mean minimum temperatures were 14.4 ± 2.8°C). Intense heat periods of varying duration occurred every day. Ambient temperatures higher than 24°C were recorded between 09:00 ± 3:4 and 18:48 ± 2:0 h. As reported earlier (Muller *et al.*, 1994) relative humidity levels were inversely related ($p < 0.01$) to maximum temperatures resulting in relatively low temperature-humidity index (THI) values during summer. Cool conditions at night (< 24°C) usually help animals to restore thermal equilibrium after being subjected to high day-time temperatures.

Holstein Friesland cows were heavier ($p < 0.001$) and had higher feed and water intakes ($p < 0.001$) than Jersey cows (Table 1). Jerseys, however, consumed more feed and water per 100 kg live weight. The feed intake at night (post-afternoon milking) for both breeds was approximately 60% of the total daily feed intake. Gibson (1986) found that Friesians consumed 17% more feed from calving to calving during first lactation in comparison to Jerseys. L'Huillier *et al.* (1988) also found that Friesians on pasture had a higher (13%) feed intake than Jerseys. These higher intakes were mainly due to the larger frame sizes of Friesian cows.

Comparisons between the two breeds for milk production, milk composition and feed conversion efficiency are presented in Table 2. Holstein Friesland cows produced more ($p < 0.001$) liquid milk and more ($p < 0.05$) protein than Jersey cows. Owing to a lower ($p < 0.001$) fat concentration in the milk of Holstein Friesland cows, the fat and 4% fat corrected milk (FCM) yields were similar ($p > 0.05$) for both breeds. This accords with other results showing that Holstein Friesland cows produced more milk (L'Huillier *et al.*, 1988; Bitman *et al.*, 1996) with lower fat and protein percentages (Gibson, 1986; Bitman *et al.*, 1996). The uncharacteristically low fat content of the milk of both breeds (2.97% for Holstein Friesland and 3.96% for Jersey cows) could possibly be attributed to the experimental diet that was fed not containing sufficient scratch and buffering capabilities. Inclusion of an appropriate buffer or additional roughage (approximately 2 kg/cow/day) would

Table 1 The comparison of mean ± SE bodyweight and daily feed and water intake of Holstein Friesland (F) and Jersey (J) cows on a complete diet during summer

Parameters	Friesland	Jersey	F/J	Significance level (p)
Body weight (kg)	513 ± 16	352 ± 16	1.46	0.0001
Feed intake (kg DM/day)				
Day	7.11 ± 0.08	5.74 ± 0.10	1.24	0.001
Night	10.23 ± 0.08	8.44 ± 0.08	1.21	0.001
Total	17.34 ± 0.12	14.18 ± 0.14	1.22	0.001
% of body weight	3.38	4.03	0.84	–
Water intake (l/day)				
Day	43.1 ± 0.8	37.4 ± 0.6	1.15	0.0001
Night	45.0 ± 0.7	28.8 ± 0.7	1.56	0.0001
Total	88.1 ± 1.0	66.2 ± 1.0	1.33	0.001
% of body weight	17.2	18.8	0.91	–

Table 2 The comparison of mean ± SE production performance of primiparous Holstein Friesland (F) and Jersey (J) cows on a complete diet during summer in a temperate climate

Production parameters (kg/day)	Friesland	Jersey	F/J	Significance level (p)
Milk	23.94 ± 1.84	16.74 ± 1.02	1.43	0.008
Fat (%)	2.97 ± 0.11	3.96 ± 0.19	0.75	0.001
Fat	0.663 ± 0.038	0.635 ± 0.049	1.04	0.664
Protein (%)	3.38 ± 0.10	3.90 ± 0.05	0.87	0.001
Protein	0.750 ± 0.042	0.623 ± 0.037	1.20	0.048
Lactose (%)	5.18 ± 0.03	5.21 ± 0.04	0.99	0.534
4% FCM	18.99 ± 1.26	15.89 ± 1.06	1.20	0.092
Feed conversion efficiency (kg/kg DM consumed)				
Liquid milk	1.38	1.18	1.17	–
4% FCM	1.095	1.121	0.98	–
Fat yield	0.038	0.045	0.84	–
Protein yield	0.043	0.044	0.98	–

FCM: 4% fat corrected milk

probably have increased the fat content of the milk. The ratio between fat and protein concentrations of the milk of Holstein Friesland and Jersey cows was 0.75 and 0.86 respectively. Gibson (1986) found that although the fat and protein concentrations of the milk of Holstein Friesland and Jersey cows in their experiment were higher (3.94 vs 5.24% for fat and 3.17 vs 3.69% for protein respectively), the ratios between the fat and protein concentrations of the two breeds were similar, e.g. 0.75 and 0.86. Holstein Friesland and Jersey cows showed different ($p < 0.05$) persistencies in milk yield during the trial. Daily milk yield dropped by 0.40 and 0.27 kg every 10 days for Holstein Friesland and Jersey cows respectively.

The efficiency of daily liquid milk production of Holstein Friesland and Jersey cows was 1.38 and 1.18 kg milk/kg DM consumed, respectively (Table 2). While the efficiency of the fat yield of Holstein Friesland was 0.84 that of Jersey cows, the efficiency of 4% FCM and protein yields of Holstein Friesland and Jersey cows was similar. Gibson (1986) found that Friesians produced liquid milk with a food conversion efficiency that was 0.23 ($p < 0.01$) higher than that of Jerseys. The efficiency of producing milk fat, protein and milk energy did not differ between breeds. However, according to L'Huillier *et al.* (1988) Friesians had a lower ($p < 0.05$) efficiency of food conversion than Jerseys for fat production (61.2 vs 67.0 g milk fat/kg DM consumed). When production characteristics of the two breeds were calculated on a per ha basis, Friesians produced less milk fat and total solids than Jerseys particularly at high stocking rates (L'Huillier *et al.* (1988). The greater efficiency of Jerseys may reflect differences in energy metabolism. Partitioning of gross energy into digestible and metabolisable energy was similar between breeds. Efficiency of utilisation of metabolisable energy for milk and tissue was, however, higher for Jerseys (L'Huillier *et al.*, 1988). In the present trial efficiency of milk fat production was 38 vs 45 g milk fat/kg DM consumed for Holstein Friesland and Jersey cows respectively.

The higher feed efficiency of Holstein Friesland cows to produce liquid milk seems to indicate a greater use for this breed in a fresh-milk market. However, even under milk payment schemes where fat and protein yields are used to determine milk price, Holstein Friesland cows seem to have a higher income for milk on a per cow basis. According to Evans (1996; personal communication, E-mail: pevan@opennet.net.au) milk prices in New Zealand are based on fat and protein production (NZ$1.96/kg fat and NZ$4.64/kg protein) with a negative price on volume (–2.7c/l). Using this payment scheme, Holstein Friesland cows in this experiment had a 12% higher income per cow than Jersey cows albeit at lower fat and protein concentrations of milk. Only at a high negative price on volume (> –9 NZ c/l) would Jerseys be favoured on a per cow basis. This is in accordance with results obtained by Gibson (1984) that different payment schemes may either favour Friesians or Jerseys. In South Africa most milk-pricing systems do not yet include a negative price on volume therefore favouring the higher milk production of Holstein Friesland cows in comparison to Jerseys.

In the Western Cape high ambient temperatures occur on a regular basis during summer and would have a negative influence on the production performance of dairy cows. Humidity levels, however, decrease with increasing ambient temperatures, therefore not compounding the effect of high ambient temperatures (Muller *et al.* 1994). Regressions of day-time feed and water intake as well as daily milk yields of cows from both breeds on daily ambient maximum temperatures showed that only water intake was affected ($p < 0.05$) at higher maximum temperatures, the effects being 1.56 and 1.31 l/°C for Holstein Friesland and Jersey cows respectively. The higher water intake of Holstein Friesland cows corresponded with results obtained in a previous study (Muller & Botha, 1993) that indicated that the rectal (body) temperature and respiration rate of Holstein Friesland cows were more affected by increasing ambient temperatures than those of Jerseys. The lack of response in feed intake and milk yield to high environmental temperatures at Elsenburg could be attributed to the fact that cows were only subjected to short heat stress periods (9.8 h) per day with cool conditions at night. They could therefore recover from the heat load encountered during the day. The cool conditions at night also enabled cows to maintain a normal feed intake, while providing feed to cows during morning milking ensured that cows could eat before the onset of hot conditions at approximately 09:30. Holter *et al.* (1996) found that the feed intake of Jerseys in Georgia, USA was reduced ($p < 0.05$) with increasing THI values ($r^2 = -0.62$). It was concluded that day-time heat stress had less effect on daily dry matter intake when there was a temporary night-time respite.

While only a small number of animals over a relatively short experimental period was used in this trial, differences in production and efficiency parameters between cows of the two breeds were shown in this study. Holstein Friesland cows had higher feed intakes, milk and protein yields than Jerseys. Jersey cows on the other hand had higher fat and protein concentrations in their milk. From simple calculations it seems that the efficiency of liquid milk production was higher for Holstein Friesland cows. The efficiency of 4% FCM and protein yield was similar for both breeds. Results confirm that Holstein Friesland cows are well suited for the liquid milk market. Different payment schemes would favour either breed. A high negative price on volume could favour Jersey cows in comparison to Holstein Friesland cows.

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