Milk yield of Jersey × Nguni and Jersey × Tuli F₁ and F₂ cows reared under smallholder farming conditions

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Abstract
The objective of this study was to determine the best genotype between F₁ (Jersey × Nguni and Jersey × Tuli) and F₂ (Jersey × Jersey × Nguni and Jersey × Jersey × Tuli) cows for semi-arid smallholder farming areas. Effects of genotype, silage supplementation and month on milk yield of F₁ and F₂ dairy cows three months post calving were evaluated. Records from 24 cows at Matopos Research Station were used. Each of the four genotype groups had six cows. In each genotype three cows were randomly selected and were either supplemented or non-supplemented. The supplemented cows were given 10 kg mixed crop silage produced from a mixture of 70% sorghum and 30% Dolichos beans (Lablab purpureus) daily. There were significant variations in the monthly milk yield due to breed, treatment and month. Milk yield was higher in supplemented (133 ± 12.7 kg) cows than in non-supplemented ones (113 ± 8.33 kg). The Jersey × Tuli F₂ cows had the highest milk yield (156 ± 16.4 kg) while the Jersey × Nguni F₂ cows had the lowest yield (102 ± 8.66). This indicates that smallholder milk production can be improved by using Jersey × Tuli F₂ cows.

Keywords: Genotype, milk production, smallholder dairying, dietary supplementation

Introduction
Dairy farming is traditionally concentrated in the high rainfall areas of Zimbabwe. Besides receiving low and unreliable rainfall, farmers based in dry areas rely on beef cattle as a major source of livelihood. The harsh environment minimizes viability of dairy enterprises, as dairy cows cannot cope with the scarcity of food. Milk yields from indigenous cows are low (Tawonezvi et al., 1986; Smith et al., 1996). There is need to identify appropriate dairy genotypes for the smallholder farming conditions to increase milk production. It is imperative that research work should also focus on developing feeding strategies for smallholder farmers. Crossbreeding has been shown to improve milk yield in the indigenous cows (Gandiya, 1999), although the optimum crossbred genotype has not yet been established. The objective of the study was, therefore, to determine the appropriate exotic blood level between F₁ crossbred (Jersey × Indigenous) and F₂ backcross (Jersey × Jersey × Indigenous) cows which should be supported by adequate feed resource in the form of farm-grown mixed crop silage in order to increase levels of milk production in semi-arid areas.

Materials and Methods
The study was carried out at the Mhlonyane farm of the Matopos Research Station, from January to March 2002. The area is characterized by red soils and thorny trees. The area is situated at ca. 20° 24’S and 28° 29’ E. The altitude is ca. 1340 m above sea level. The hottest month is October with a mean temperature of 21 °C. The rainfall pattern is erratic ranging from 250 to 1400 mm per year (mean 570 mm) and the area is also prone to frost in winter. The surface is covered by well-drained red soils of moderate fertility and with good physical properties. Acacias are the dominant tree species in the area while Rhus and Grewia species are the most prevalent bushes. The common grasses are Hyperhenia filipendula, Themeda triandra, Heteropogon contortus and Cymbopogon plurinodis. This is a mixed veld. The pasture quality and quantity are good and abundant in the wet season, but less nutritious and scarce in the dry season.

Twenty four multiparous cows that had calved in December 2001 were randomly selected within each of the four genotypes. The three factors that were considered were diet, genotype and month of milking. The
genotypes had two combinations, namely $F_1$ Jersey × Indigenous crosses (six Jersey × Tuli and six Jersey × Nguni) and $F_2$ backcross (six Jersey × Jersey × Tuli and six Jersey × Jersey × Nguni) cows, resulting in four levels. The $F_1$ and $F_2$ Jersey × Nguni crosses were from the same sire that was bought from a commercial farm. The same applied to the $F_1$ and $F_2$ Jersey × Tuli crosses. Diet had two levels, the basal diet comprised of natural grazing pasture (grass) and browse alone, and the basal diet supplemented with 10 kg fresh silage per day. For each genotype there were three cows per diet level.

Silage was produced from a mixture of forage sorghum and *Lablab purpureus* (Dolichos beans). The crops were harvested when the Dolichos beans were at the pre-flowering stage and the sweet forage sorghum at the heading stage. After harvesting the crops were mixed at a ratio of 70% forage sorghum to 30% Dolichos beans. The mixed crop silage was chopped into small pieces of 12 – 18 mm in length and then compressed into polythene bags and the bags tied at the open end to allow for anaerobic fermentation. Each bag was packed with fresh material weighing 10 kg. The quality of the mixed crop silages used for supplementing the cows is shown in Table 1.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value (g/kg DM)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Silage dry matter</td>
<td>370</td>
</tr>
<tr>
<td>Silage pH</td>
<td>4.0 – 4.2</td>
</tr>
<tr>
<td>NH$_4$-N, % of total N</td>
<td>7.3</td>
</tr>
<tr>
<td>Ash</td>
<td>110</td>
</tr>
<tr>
<td>Crude protein</td>
<td>93.3</td>
</tr>
<tr>
<td>Acid detergent fibre</td>
<td>350.3</td>
</tr>
<tr>
<td>Neutral detergent fibre</td>
<td>611.3</td>
</tr>
</tbody>
</table>

*Except units for pH and NH$_4$*

The six cows in each group were randomly and equally allocated to the two diet levels. The performance of the animals was assessed for three months, namely January, February and March 2002. The effects of each of the three months on milk production were evaluated. Milking and milk yield recording were done once a day in the morning. Animals’ body condition scores (score 0 = thin or emaciated and 5 = very fat) (Oliver, 1987) were recorded at fortnightly intervals from January to March 2000. Body condition scoring was done by the same person throughout the study.

General Linear models procedures for Minitab (Minitab, 1994) were used to evaluate variations on milk yield. The model used was:

\[
\bar{Y}_{ijkl} = \mu + \text{treatment}_i + \text{genotype}_j + \text{month}_k + \Sigma_{ijkl}
\]

where $\bar{Y}_{ijkl}$ = monthly milk yield, $\mu$ = overall mean (constant), treatment$_i$ = effects of supplementation/non supplementation, genotype$_j$ = genotype effects ($J \times T$; $J \times N$; $J \times J \times T$; and $J \times J \times N$), month$_k$ = effects of months (January, February and March), $\Sigma_{ijkl}$ = random or residual error.

Comparisons of means were done using the least significant difference (LSD) method.

**Results and Discussion**

There were differences ($P < 0.001$) in milk yield with respect to genotype and month. Furthermore, all supplemented cows proved their superiority over the non-supplemented ones ($P < 0.05$) as they produced an average of 133 ± 12.7 kg as compared to 113.7 ± 8.33 kg. This indicates that supplementation improves milk yield. Ferreira (1997) and White *et al.* (2001) also reported that supplementing high-yielding dairy cows is economical since they utilize the nutrients more efficiently for milk production than lower producers, mainly...
because a smaller proportion of the total nutrients is used to satisfy the maintenance requirements of the animal.

Table 2 shows that the Jersey × Tuli F_{2} backcross had the highest monthly milk yield whereas the Jersey × Nguni F_{1} crosses and the Jersey × Nguni F_{2} backcrosses had the lowest 3-month milk yields (P < 0.05). The superiority displayed by the Jersey × Tuli backcross over other genotypes suggests that the Tuli blood in the backcross provides a better match of the desired economical traits for higher milk yield than its indigenous counterpart, Nguni. This is in keeping with what was reported by Smith et al. (1996). When the two indigenous breeds were each crossed with the Jersey breed in a bid to come up with high yielding crossbreeds adapted to the tropics, the Jersey × Tuli crosses were found to be better milkers than the Jersey × Nguni crossbreeds and either of the indigenous breeds (Smith et al., 1996). It is therefore evident that the genetic merit of a cow for milk production is of paramount importance in dairy cattle breeding (Muchenje et al., 1998).

### Table 2 Least square means for milk yields of crossbreed and backcross cows

<table>
<thead>
<tr>
<th>Genotype</th>
<th>n</th>
<th>Mean monthly milk yield ± s.e. (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jersey × Tuli (F_{1} Crossbreed)</td>
<td>18</td>
<td>128 ± 11.3^{a}</td>
</tr>
<tr>
<td>Jersey × Jersey × Tuli (F_{2} backcross)</td>
<td>18</td>
<td>156 ± 16.4^{b}</td>
</tr>
<tr>
<td>Jersey × Nguni (F_{1} Crossbreed)</td>
<td>18</td>
<td>108 ± 8.65^{c}</td>
</tr>
<tr>
<td>Jersey × Jersey × Nguni (F_{2} backcross)</td>
<td>18</td>
<td>102 ± 8.66^{c}</td>
</tr>
</tbody>
</table>

^{a,b,c} Values with different superscripts differ (P < 0.05), s.e. - standard error

Besides the advantages of breed complementarity and heterosis from highly productive breeds to increase overall efficiency and economic merit, Mhlanga (2000) indicated that heterotic responses from crossbreeding favourably influenced economically important traits and furthermore tended to exhibit greater responses in stressful environments. This is similar to the findings in this study in which the Jersey × Tuli backcross produced the highest milk yield irrespective of treatment and the prevailing environmental conditions resulting from the 2001-2002 drought spell. Therefore, this suggests that the Jersey × Tuli backcross is the appropriate milking crossbred cow with the right level of exotic blood introduced into the indigenous cow for sustainable milk production without affecting the hardiness of the indigenous cow. Provided the environment is good and the genotype matches the levels of inputs that can be supplied economically, crossbred animals have afforded the low resource producer a more viable option for the stressful environments of the tropics (Mhlanga, 2000).

The mean monthly milk yield (133.4 ± 12.66 kg) for supplemented cows was higher (P < 0.05) than that of the non-supplemented cows (113.7 ± 8.33 kg). Out of the three months, January had the highest mean milk yield (172 ± 11.2 kg) and the lowest mean milk yield was recorded in March (89 ± 5.64 kg). The variation (P < 0.001) observed in monthly milk yield could have been a result of the scattered rainfall which occurred in December, thus leading to better veld conditions in January than in other months during which there was no rainfall at all. This strongly suggests that the poor veld conditions reduced the forage nutritive value and its palatability. In addition, the prevailing high temperatures could also have stressed the cows, thus reducing dry matter intake and consequently contributing to the observed declining trend in milk production. Milk yield was highest in January with an average of 172 ± 11.2 kg and declined to 110 ± 6.3 and 89 ± 5.6 kg in February and March, respectively. However, the expected trend would have been an increase in milk yield from January onwards, in line with the “normal” lactation curve to attain peak yield in mid-March. The failure to reach peak yield would reduce the total milk yield in the lactation period, since peak yield is a major determinant of the total milk yield (Titterton, 2000; White et al., 2001). This suggests that it was more economical to supplement the cows in January than in subsequent months.

According to Mutsvangwa & Hamudikawanda (1993), in most high yielding dairy cows the nutrient requirement for milk production during early lactation is greater than the intake from feed, thus creating a negative energy balance or a nutrient gap. This suggests that the reduced available nutrients and the resultant...
negative energy protein balance could have contributed to reduced milk yields in February and March. The negative energy protein balance could have been a result of the fact that at early lactation, the mammary energy demands were higher than the feed intake. In addition, all the animal breeds had a low body condition score which averaged to 3. According to Titterton (2000), cows with a low condition score of 3 do not show a high body condition loss, they will be in negative energy balance without body fat to mobilize for energy. Such animals therefore give priority to milk production by mobilizing muscle protein through gluconeogenesis to provide the milk they are genetically capable of.

Mobilisation of body protein is very limited. Therefore the dietary protein should be high during early lactation in order to maximise the efficiency of energy utilisation and to meet the requirements of protein for maximum milk production without any detrimental effects on the health and reproductive performance of the cow (Mutsvangwa & Hamudikuwanda, 1993; Titterton, 2000; Robinson et al., 2001). Feeding the dairy cows with good quality mixed crop silage such as a mixture of on farm grown Pennisetum and legume varieties will provide the required dietary protein which will enable the cow to produce nutritious good quality milk.

Conclusions
For sustainable milk production in the semi-arid areas of Zimbabwe, smallholder farmers are encouraged to use the high-yielding Jersey × Tuli backcrosses and supplement them with farm grown mixed crop silage. There is, however, a need for economic evaluation of supplementation of these backcrosses and assessing the effects of post calving gluconeogenesis in conception rates in the F₁ crossbred and F₂ backcross Jersey cows. This will enable smallholder farmers to make decisions on the appropriate breeds and feeding strategies.

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References