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ORIGINAL PAPER

# Milk production and calf rearing practices in the smallholder areas in the Eastern Cape Province of South Africa

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**Abstract** Farmer perceptions on milk production and calf rearing practices on communal rangelands in the smallholder areas of the Eastern Cape Province, South Africa were evaluated on a total of 218 cattle farmers using structured questionnaires, semi-structured interviews with key informants and personal observations. Nearly 70% of the households in the small-scale areas milked twice a day compared to 60% in the communal areas. About 62% of the interviewees weaned calves between 6 and 12 months of age. Milk yield/cow/day (7.5±0.5 litres), fresh milk consumption/household/day (3.2±0.5 litres) and sales/household/day (3.1±1.1 litres) were highest in the sour-veld, small-scale farms ($P<0.05$). Sour milk consumption/household/day (2.6±0.2 litres) and sales/household/day (0.8±0.2 litres) were significantly high in communal farms with a sour-veld. It was concluded that, calf rearing practices were poor and milk yield, consumption and sales were generally low and varied with production system and rangeland type. Further research is required to improve calf management practices, cow nutrition, milk yield and quality and how milk production can be used as a toll for rural development in the smallholder areas of South Africa.

**Keywords** Communal areas · Indigenous cattle · Milk yield · Veld type · Suckling

## Introduction

Generally, demand for animal products such as beef and milk in South Africa is rising (Delali et al. 2006). For example, milk imports costs increased from US$ 92 859 000 in 2003 to US$ 132 411 000 in 2006 (NDA 2008). In South Africa, the dairy sector produces about 2.7 million litres of fresh milk per annum from 0.79 million cows (NDA 2008). These statistics however, exclude milk off-take from the smallholder sector. Prinsloo and Keller (2000) reported that milk produced in the smallholder areas is mainly for home consumption and sales to neighbours. There are no records, however, for the amount of milk produced in the smallholder sector, and its contribution to the household and national economies is largely unknown. Improvement of the smallholder dairy production is a possibility to increase food security and income for resource-poor farmers (Kabirizi et al. 2004; Somda et al. 2005; Ngongoni et al. 2007a).

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In the smallholder sector, milk is largely obtained from indigenous cattle and their crosses with the exotic beef breeds (Moyo 1996; Mapiye et al. 2007a). These cattle breeds also have numerous functions in the smallholder areas which include meat, cash through sales, draught power, manure, social security and ceremonies (Delali et al. 2006; Nqeno 2008). Utilisation of recognised dairy breeds, such as Holstein, Jersey, Guernsey and Ayrshire under the smallholder sector is not common. These breeds do not produce to their full genetic potential and have high mortality rates under low management conditions (Ngongoni et al. 2006; Muchenje et al. 2007). Imported breeds lack adaptation to harsh environments, such as high prevalence of gastro-intestinal parasites, ticks and tick-borne diseases and low plane of nutrition (Moyo 1996; Bester et al. 2003; Ngongoni et al. 2007a. Selection and improvement of a moderate yielding dairy animal that is adapted to the harsh local environment of the smallholder farmer is, thus imperative.

The indigenous Nguni breed's adaptation to local agro-ecological conditions makes it attractive to smallholder farmers in South Africa. Nguni cattle are resistant to nematodes (Ndlovu et al. 2007), ticks, tick-borne diseases (Norval et al. 1996; Muchenje et al. 2008), have high feed utilisation efficiency at low feeding levels and the ability to select high quality diets when grazing course forages on rangelands (Collins-Luswet 2000). Such adaption traits could assist to reduce costs of inputs, such as drugs and feed supplements for the smallholder dairy farmers. Information on Nguni cattle's milk production and calf performance in the smallholder areas is limited, making it difficult to evaluate the role of dairying in improving the welfare of the poor in communal areas of South Africa.

Calf performance and productivity is crucial for efficient milk production and in increasing income levels among the resource-poor through cattle sales. Development of strategies to reduce calf mortality and increase weaning weights is pertinent. There are little, if any efforts that have been made to select and improve Nguni cattle herds for milk production in the smallholder areas. To design sustainable improvement programmes, it is crucial to evaluate the current production levels, milk consumption patterns, constraints to milk production and the value of the milk to smallholder farmers. The evaluation of the potential for milk production and calf performance on communal rangelands is of equal importance. The objective of study was to determine farmer perceptions on milk production and calf rearing practices on communal rangelands in the smallholder areas of the Eastern Cape Province of South Africa.

## Materials and methods

### Study areas and selection of farmers

Data were collected from 18 communities located in the five district municipalities of the Eastern Cape namely; Alfred Nzo, Amatole, Cacadu, Chris Hani and Ukhahlamba. The communities were selected using stratified random sampling based on the production system (Table 1). There were, thus, small-scale farms and communal areas. Small-scale farms that were owned by communities that benefited from land restitution were chosen from each district municipality. Land restitution is a government-initiated programme of redistributing commercial agricultural land to benefit previously disadvantaged local black farmers. Farmers from both the sweet- and sour-veld were interviewed. In the sour rangelands, forages have low nutritive value and are largely unpalatable during the dry season compared to the sweet rangelands, where forages remain palatable and nutritious throughout the year (Ellery et al. 1995; Botsime 2006). Table 1 shows the rainfall, temperature, altitudinal, edaphic attributes and sample size for the surveyed communities. Selection of farmers was based on cattle ownership and willingness to participate in the study.

### Data collection

A total of 218 smallholder cattle farmers were interviewed using pre-tested structured questionnaires written in local language (Xhosa) between June and July 2007. The interviews were conducted in the Xhosa vernacular by trained enumerators for 25 to 30 minutes. The questionnaire captured household demography, cattle herd sizes, composition and management, calf rearing practices and milk production aspects. Personal observations and interviews with key informants (Department of Agriculture officials, commodity group chairpersons, local politicians, traditional leaders and livestock-related non-governmental organisations) were also made on milk production issues and calf rearing methods.

**Table 1** Mean annual rainfall and temperature, altitudinal and edaphic attributes for the surveyed communities

| Farm type | Community | Veld type | Respondents | Rainfall (mm) | Temperature (°C) | Altitude (m) | Soil type |
|---|---|---|---|---|---|---|---|
| Communal | Dyamala | Sweet | 6 | 300–500 | 16 | 500–550 | Loam |
| | Dyamdyam | Sweet | 11 | 800–1000 | 20 | 200–300 | Sandy |
| | Ityali | Sweet | 12 | 450–600 | 16 | 500–550 | Loam |
| | Kwamasele | Sweet | 26 | 450–600 | 16 | 400–600 | Loam |
| | Kwezana | Sweet | 6 | 450–600 | 16 | 500–550 | Loam |
| | Mahobe | Sour | 9 | 650–1000 | 14 | 600–1400 | Sandy |
| | Magwiji | Sweet | 15 | 400–600 | 10 | 1400–2000 | Sandy |
| | Melani | Sweet | 14 | 450–600 | 16 | 500–550 | Loam |
| | Msobubvu | Sweet | 6 | 450–600 | 16 | 500–550 | Loam |
| | Ncera | Sweet | 13 | 450–600 | 16 | 500–550 | Loam |
| | Ntselamanzi | Sweet | 16 | 450–600 | 16 | 500–550 | Loam |
| | Saphanduku | Sour | 10 | 650–1000 | 14 | 600–1400 | Sandy |
| | Tiwane | Sour | 13 | 650–1000 | 12 | 600–1400 | Sandy |
| | Upper Mnxe | Sour | 18 | 650–1000 | 12 | 600–1400 | Sandy |
| Small-scale | Caba-mdeni | Sour | 13 | 600–800 | 12 | 1250–2000 | Sandy-Loam |
| | Hex river | Sour | 11 | 450–700 | 14 | 1350–s | Sandy |
| | Masizame | Sweet | 12 | 450–600 | 16 | 400–600 | Loam |
| | Perkshoek | Sweet | 7 | 300–450 | 20 | 100–200 | Sandy-Loam |

### Statistical analyses

Associations between farm type (small-scale and communal) and veld type (sweet-veld and sour-veld) with milk production parameters and calf rearing practices measures were computed using chi-square tests (SAS 2003). Correlations among milk yield, herd size, household size, land size, number of lactating cows, milk consumption and milk sales were determined using PROC CORR of SAS (2003). The Generalized Linear Model procedure of SAS (2003) was used to analyse the effect of household characteristics, veld type, farm type and their interactions on herd size and composition, milk yield and milk consumption and sales. Pair-wise comparisons of the least square means were performed using the PDIFF procedure (SAS 2003).

## Results

### Livestock species and cattle herd composition

There was a significant interaction between veld type and farm type for cattle, goat, sheep, chickens and pigs herd/flock sizes (Table 2). Cattle herd sizes in the small-scale farms in the sour-veld were significantly high (Table 2). Goat flocks were large ($P<0.05$) in the small-scale farms in the sweet-veld. Sheep flocks sizes were significantly high in the communal areas in the sweet-veld. Chicken flocks and pig herds were large ($P<0.05$) in the communal and small-scale farms in the sour-veld (Table 2).

Crossbreds between Nguni and exotic beef breeds (70% of the respondents) and Nguni (50%) breeds were the most common cattle breeds in the surveyed areas. Generally, small-scale farms in the sour-veld had the highest ($P<0.05$) number of calves, steers, heifers, cows and bulls (Table 2). The number of lactating cows was also high in the small-scale farms in the sour-veld ($P<0.05$). Ratio of lactating cows to reproductively active cows in the herd was 1: 4 across production systems and veld types. Cattle herd size was not affected by gender, religion, age and marital status of the head of the household. The level of education and occupation had a significant influence on cattle herd sizes. Farmers with tertiary qualifications and those with informal employment had large cattle herd sizes ($P<0.05$; Table 3).

**Table 2** Least square means (± standard error of means) of herd/flock sizes and cattle herd composition based on veld type and farm type

| **Livestock species** (numbers/household) | **Sweet-veld** | | **Sour-veld** | |
|---|---|---|---|---|
| | Communal (n=125) | Small-scale (n=19) | Communal (n=50) | Small-scale (n=24) |
| Cattle | 8.7±3.44[a] | 12.6±4.23[ab] | 13.1±3.73[ab] | 15.5±3.90[b] |
| Goats | 5.4±7.32[a] | 25.0±9.10[c] | 16.7±7.93[b] | 15.3±8.42[b] |
| Sheep | 4.7±13.61[a] | 3.3±17.00[a] | 24.2±14.83[c] | 11.5±15.62[b] |
| Chickens | 1.7±4.12[a] | 3.0±5.13[ab] | 7.7±4.50[b] | 8.3±4.73[b] |
| Pigs | 0.9±1.13 [ab] | 0.3±1.40 [a] | 1.8±1.22 [b] | 1.1±1.33 [ab] |
| **Herd composition** (numbers/household) | | | | |
| Calves | 0.1±0.21[a] | 0.2±0.10[a] | 0.2±0.11[a] | 0.8±0.21[b] |
| Heifers | 2.51±0.80[a] | 3.0±0.90[b] | 2.4±0.64[a] | 3.3±0.92 [b] |
| Steers | 1.7±1.14[a] | 3.4±1.30[b] | 2.0±1.13[a] | 3.5±1.22[b] |
| Bulls | 1.0±0.92[a] | 1.9±1.12[a] | 1.6±1.03 [a] | 2.9±1.03[b] |
| Reproductive cows | 3.6±1.42[a] | 4.9±1.73[a] | 4.7±1.52[a] | 6.9±1.22[b] |
| Lactating cows | 0.2±0.57[a] | 0.6±0.71 [a] | 0.8±0.63[a] | 1.2±0.73[b] |

[a,b,c] Values with different superscripts within a row are significantly different (P<0.05)

## Cow productivity and management

Age at puberty, age at first calving, calving interval and length of productive life were not associated with veld type and farm type (P>0.05). About 44 and 38% of the respondents reported that heifers reached puberty at 24 and 36 months, respectively. The majority (68%) of the interviewees reported that the age at first calving for their cows was between 36 and 49 months. Out of the 218 farmers enumerated, 70% reported that calving intervals were between 12 and 24 months. Generally, poor nutrition (66% of the respondents), diseases and parasites (24%) and breed (10%) were the major causes of delayed sexual maturity and long calving intervals in the study areas. Most cows had productive life of between 10 and 15 years (77% of the respondents) and produced between 6 and 10 calves (82%). Lactation period and calving season were significantly associated with veld type. Sour-veld areas had more respondents who reported lactation periods of between 151 and 300 days for their cows compared to sweet-veld (P< 0.05; Table 4). Most cows calved in the hot-wet season in the sweet-veld compared to sour-veld (P< 0.05; Table 4). Lactation period and calving season were not significantly associated with farm type.

Cow abortion problems were significantly associated with veld type, with more respondents in the sweet-veld experiencing higher incidences of abortions compared to sour-veld (45 versus 27%; P<0.05). Cow abortion problems were not associated with farm type (P>0.05). Cow abortions were attributed to diseases (48% of the respondents), poor nutrition (34%) and old age (18%). Cows experienced problems of retained placenta (27% responses), dystocia (17%), mastitis (15%), agalactia (6%) and metritis (3%) soon after calving and 32% did not experience any calving problems. The proportions of farmers who observed and assisted their cows during

**Table 3** Least square means (± standard error of means) of cattle herd size based on education levels and occupation status of the communal farmers (n=218)

| | **Cattle herd size** (numbers/household) |
|---|---|
| **Education levels** | |
| No formal education | 8.7±7.21[a] |
| Informal education | 7.7±3.42[a] |
| Grade 1–7 | 7.4±3.10[a] |
| Grade 8–12 | 9.7±3.53[a] |
| Tertiary | 24.5±4.74[b] |
| **Principal occupation** | |
| Unemployed | 12.4±3.63[b] |
| Formal | 6.2±2.32[a] |
| Informal | 17.6±3.43 [c] |

[a,b,c] Values with different superscripts within the column are significantly different (P<0.05)

**Table 4** Calving seasons and lactation period of cows as reported by the farmers (%) in the sweet-veld and sour-veld areas

| | **Sweet-veld** (n=144) | **Sour-veld** (n=74) |
|---|---|---|
| **Lactation period (days)** | | |
| <150 | 35 | 11 |
| 151–300 | 52 | 72 |
| 301–540 | 8 | 14 |
| >540 | 5 | 3 |
| **Season** | | |
| Hot-dry | 8 | 42 |
| Hot-wet | 80 | 50 |
| Cool-dry | 6 | 5 |
| All year round | 6 | 3 |

calving were not significantly associated with farm type. However, there was an association between veld type and the proportion of farmers who observed and assisted their cows during calving ($P<0.05$). Sixty-six percent of the respondents in the sour-veld assisted their cows during calving compared to 40% in the sweet-veld. Out of those farmers who did not observe their animals during calving, 55 and 80% in the sweet-veld and sour-veld, respectively, attended to their cows within 24 hours of calving.

All the respondents reported feed shortages and loss of animal condition, especially during cool-dry and hot-dry seasons. Veld type and farm type was significantly associated with the proportion of the farmers who provided supplementary feeding to their cattle. Seventy percent of the interviewees in the sour-veld, small-scale farmers provided supplements to their cattle compared to 22% in the sweet-veld, communal farmers ($P<0.05$). Crop residues (75% of the respondents) and hay (20%) were the main supplements used by farmers. Over 75% of the respondents supplemented animals once a day during the cool-dry and hot dry seasons, across production systems and vegetation types. Famers preferred giving extra feed to cows first, then calves, heifers, steers, oxen and bulls, in that order, across farm types and veld types. Farmers reported that they supplemented cows to improve milk yield and calves to improve growth.

## Calf rearing practices

Most of the farmers (73%) preferred to have female calves. Over 90% of the respondents reported that their calves were born healthy and 75% did not report calf mortality as a major constraint. Nearly 90% of the respondents were aware of the importance of colostrum for the calves. Farmers reported that colostrum is highly nutritious to calves (39%), boost calf immunity (34%) and both highly nutritious and boost calf immunity (27%). About 18 and 22% of the households did not milk colostrum and kept the calf with its dam, respectively, to ensure that the calf gets enough milk from its dam and 60% did nothing. When the calf lose its dam soon after birth, 55% of the farmers bought milk for it, 32% gave it milk from other cows in-milk within the herd and 13% did nothing.

Age at weaning was not significantly associated with farm type and veld type. About 18% of the respondents weaned calves between 0 and 5 months of age, 62% between 6 and 12 months and 20% over 12 months. There was no association between weaning methods and veld type. Weaning method was significantly associated with farm type. The majority of farmers in the communal areas used the natural method to wean calves whilst those in the small-scale used the separation ($P<0.05$; Table 5). To separate the calves from the dams, farmers move the cows temporarily (for 7–21 days) to distant grazing areas whilst calves are grazed near to homesteads and kraaled at night. Alternatively, home-made metal nose plates are fitted to calves for up to 21 days at the age

**Table 5** Times of first milking after calving, milking frequency and weaning methods as reported by respondents (%) in the communal and small-scale areas

| | **Communal** (n=175) | **Small-scale** (n=43) |
|---|---|---|
| **Time of first milking after calving (weeks)** | | |
| <1 | 30 | 20 |
| 1–2 | 35 | 60 |
| >3 | 8 | 2 |
| Do not milk | 27 | 18 |
| **Milking frequency** | | |
| Once | 15 | 20 |
| Twice | 60 | 70 |
| Do not milk | 25 | 10 |
| **Weaning method** | | |
| Natural | 45 | 35 |
| Separation | 15 | 43 |
| Metal plate | 40 | 22 |

of 6–12 months. More than 90% of the respondents did not dehorn their calves. Sixty percent of the farmers had no reasons for not dehorning, 20% wanted to the calves to protect themselves during fighting, 15% did not know how to dehorn and 5% did not have the appropriate equipment. Over 85% of the households kraaled calves at night for about 12 to 15 hours. Most of the kraals (65%) were built of untreated wood and fence, without roofs.

## Milk production

Milk was ranked as the third most important reason for keeping cattle, after cash and ceremonies. The type of cattle breeds kept by farmers was not associated with farm type and veld type (P>0.05). About 30 and 50% of the farmers milked Nguni and crossbred cows and 20% used both breeds. Most of the households (72%) milked during the hot-wet season (November to February). Times of first milking after calving and milking frequency were significantly associated with farm type. There were more farmers in the small-scale who started to milk their cows between the first and second week of calving than those in the communal areas (P<0.05; Table 5). Most of the farmers in the small-scale milked their cows twice a day (between 0800 and 0900 hours and 1430 and 1500 hours) compared to those in the communal areas (Table 5). Over 65% of the households allowed calves to suckle for ½ to 1 ½ minutes to induce milk let down before milking the cow manually. Thereafter the calf was released together with its dam and enclosed separately at sunset. In cases where the calf was not allowed to suckle, it was fed with milk from its dam or other cows, and feed supplements.

Milk off-take was shared between family consumption and sales to neighbours. It was consumed as fresh in tea (64% of the respondents), as sour in a relish with a semi-solid boiled mealie-meal (55%), and whey was used as food for pets (8%). Only 10 and 6% of the households sold milk as fresh and sour, respectively. Average prices for fresh and sour milk were US$ 2.0 and US$ 1.60 per litre, respectively. Milk prices were not associated with farm type and veld type (P>0.05).

On average, the farmers milked 4.2 litres/cow/day. Over half of the respondents cited small herd sizes and low milk yield (35%) as reasons for low milk sales. There was a significant interaction between veld type and farm type for milk yield, fresh and sour milk consumption and fresh and sour milk sales (Table 6). Daily milk yield/cow and fresh milk consumption/day and sales/day were significantly high in the sour-veld, small-scale farms (Table 6). Daily sour milk consumption and sales were high in the communal farms in the sour-veld (P<0.05). Milk yield was highly correlated with number of lactating cows, milk consumption and milk sales (P<0.01; Table 7). Herd size, land size and household size were positively correlated with milk yield (P<0.05; Table 7). Respondents used the following criteria to evaluate milk quality; colour (60%), smell (18%), water content (12%) and taste (10%). Most of the respondents (94%) reported that the milk produced by their animals was of good quality. All the respondents reported a serious lack of milking facilities and infrastructure.

**Table 6** Least square means (± standard error of means) of milk yield (litres/day), milk consumption (litres/day/household) and milk sales (litres/day/household) based on veld type and farm type

| **Milk production** | **Sweet-veld** | | **Sour-veld** | |
|---|---|---|---|---|
| | Communal (n=125) | Small-scale (n=19) | Communal (n=50) | Small-scale (n=24) |
| Milk yield per cow | $3.0\pm0.52^{a}$ | $6.0\pm0.41^{c}$ | $4.5\pm0.21^{b}$ | $7.5\pm0.52^{d}$ |
| Fresh milk consumption | $0.8\pm0.22^{a}$ | $2.0\pm0.43^{a}$ | $1.2\pm0.43^{a}$ | $3.2\pm0.52^{b}$ |
| Sour milk consumption | $1.5\pm0.22^{a}$ | $1.7\pm0.63^{ab}$ | $2.6\pm0.24^{b}$ | $2.3\pm0.73^{ab}$ |
| Fresh milk sales | $0.2\pm0.12^{a}$ | $1.8\pm0.31^{c}$ | $1.2\pm0.23^{b}$ | $3.1\pm1.10^{d}$ |
| Sour milk sales | $0.2\pm0.10^{a}$ | $0.1\pm0.41^{a}$ | $0.8\pm0.20^{b}$ | $0.4\pm0.41^{ab}$ |

a,b,c,d Values with different superscripts within a row are significantly different (P<0.05)

**Table 7** Correlations between milk yield, consumption and sales with herd size, land size and household size

| | Milk yield | Lactating cows | Herd size | Milk consumption | Milk sales | Land size |
|---|---|---|---|---|---|---|
| Lactating cows | 0.80** | | | | | |
| Herd size | 0.25* | 0.50** | | | | |
| Milk consumption | 0.62** | 0.17 | 0.18 | | | |
| Milk sales | 0.76** | 0.22 | 0.28* | 0.31* | | |
| Land size | 0.40* | 0.29* | 0.30* | 0.11 | 0.12 | |
| Household size | 0.35* | 0.20 | 0.13 | 0.33* | 0.17 | 0.15 |

Significantly correlated at *P<0.05; **P<0.01

## Discussion

The observation that cattle herd sizes were high in the small-scale farms in the sour-veld could be attributed to feed availability and farmer resources ownership. Sour-veld areas receive moderate to high rainfall (600–800 mm per annum) that promote excess herbage growth during the hot-wet season (Ellery et al. 1995), which in turn, could be conserved as hay for dry season supplementary feeding by small-scale farmers (Simela et al. 2006). A strong relationship is expected to exist between feed availability, milk production and cattle populations (Ezanno 2005). Animals with higher levels of protein and/or energy are better able to produce more milk than under-nourished animals (Bebe et al. 2003; Ezanno 2005). Small-scale farmers' use of technology for feed conservation and purchase of external feed inputs is moderate compared to communal farmers who are resource-limited (Ainslie et al. 2002; Mapiye et al. 2007b). High cattle herd sizes observed for educated and informally employed respondents have implications for adoption of smallholder dairy production technologies. To increase adoption on smallholder dairy production technologies, research and development should target informally employed people who have time and resources, and educated people who have knowledge to manage dairy production.

Cattle herd structure has implications for milk production, because dairy cows make up part of the reproductive herd. The high number of cows and heifers might indicate that farmers prefer retaining female animals in the herd because they derive extra benefits such as milk, and calves, from them compared to castrated males which are often sold to meet immediate household cash needs (Musemwa et al. 2008). However, the observed ratio of lactating cows to reproductive cows can be attributed to low cow management and productivity levels, and low bull numbers and poor bull fertility and in the smallholder areas (Nqeno 2008). Cow productivity and bull fertility for the smallholder herds deserve investigation.

Cow productivity was low as reflected by delayed age at puberty (24 and 36 months) and at first calving (36–48 months). This is partly due environmental factors, including nutrition, and diseases and parasites (Abeygunawardena and Dematawatewa 2004; Nqeno 2008). Estimates of age at puberty in *Bos indicus* cattle in the tropics and subtropics range between 16 and 40 months compared to 12–24 months for *Bos taurus* x *Bos indicus* crossbreeds or purebred Taurine cattle (Galina and Arthur 1989; Mukasa-Mugerwa 1989). In agreement to findings of this study, Galina and Arthur (1989), Abeygunawardena and Dematawewa (2004) and Ngongoni et al. (2006), the age at first calving of *B. indicus* cattle ranges from 23 to 60 months with an average estimate of 44 months. Age at puberty and first calving marks the beginning of a cow's productive life and are closely related to generation interval and, therefore, influences response to selection (Mukasa-Mugerwa 1989). The calving intervals of 24–48 months reported by the farmers are long when compared to 12–36 months recorded by Ngongoni et al. (2006). Schoeman (1989) also observed shorter inter-calf intervals of 12–24 months for indigenous cattle in South Africa.

Cows in the surveyed areas had long productive lives of 10–15 years and produced high number of calves. Schoeman (1989) reported that indigenous cows in the smallholder areas of South Africa have long productive life (10–15 years) and produce more than 10 calves. Mukasa-Mugerwa (1989), reported that the useful life of Zebu cattle ranges from 4.5 to

8.5 years, during which they produce three to five calves. Even though Zebu cattle tend to reach sexual maturity rather late, their productive life and that of their crosses tends to be longer than that of Taurine cattle (Mukasa-Mugerwa 1989). If animals with long productive life are also highly productive, it can be advantageous to keep them in the herd as long as possible. This might, however, increase the generation interval and thus reduce the response to selection. The trade-off between immediate productivity and herd improvement must, therefore, be carefully considered.

Lactation periods of 151–300 days found in this study are similar to 150–240 days reported for Nguni and cows by Moyo (1996). These lactation periods are lower than the recommended lactation periods of 250–305 days for recognised dairy breeds (Ngongoni et al. 2006). Long lactation lengths increase calving intervals and thereby leading to reduced cow productivity. The higher proportion of farmers who reported lactation lengths of 151–300 days in the sour-veld than in the sweet-veld can be ascribed nutrition. Cows in the sour-veld have access to a higher plane of nutrition during lactation compared those in the sweet-veld (Botsime 2006).

The finding that most cows calved in the hot-wet and hot-dry seasons agree with Abayawansa et al. (1994) and Pedersen and Madsen (1998). This corresponds to improved nutritional conditions during the subsequent rainy season to meet their nutrient requirements for maintenance, growth, reproduction and lactation (Abayawansa et al. 1994; Abeygunawardena and Dematawatewa 2004). The disparity in calving season reports given by respondents in the sweet and the sour-veld can be ascribed to different rainfall patterns between the two veld types. In the sour-veld, effective rainfall is received earlier (in mid November) compared to the sweet-veld, where effective rainfall is received late (in mid December) (Ellery et al. 1995; Botsime 2006).

The higher percentage of respondents who experienced cow abortion problems in the sweet-veld compared to those in the sour-veld could be credited to poor rangeland management practices which reduces the feed resource base for the cattle. Undernourished animals have weak immunity and are more susceptible to diseases and parasites than well conditioned animals (Ezanno 2005). The problems of retained placenta and difficulty calving experienced in this study could be a reflection of inadequate prepartum nutrition (Ngongoni et al. 2007a).

The reported feed shortages and loss of animal condition, particularly during the dry season and the low cow productivity warrants research on alternative supplementary feeding strategies for cows. In the current study, the farmers gave more attention to cow supplementation compared to other classes of cattle. The potential for crop residues (such as stover straws and hulls) that is available should be fully exploited by offering them to cows together with salt urea-molasses blocks or treat them with ammonia before feeding. Utilisation of supplementation strategies which include use of crop by-products (that include milling by-products and oilseed cakes), and improved herbaceous and browse trees deserve investigation (Kabirizi et al. 2004; Mapiye et al. 2007b; Ngongoni et al. 2007b). Research on indigenous browse trees (leaves, pods and fruits), which are low-cost supplements that also provide fencing posts, fuel wood and shade for animals should be prioritised.

Farmers' preference for female calves can be attributed to their future reproductive and milk production roles. Weaning ages and methods in this study are similar to earlier reports by Pedersen and Madsen (1998). The natural weaning method practised by most of the communal delays postpartum ovarian activity and reduces reproductive efficiency (Ngongoni et al. 2006; Nqeno 2008). Farmers should practice early weaning using the home-made nose plate. This reduces calf weaning stress compared to the separation method, lowers the pressure on the cow and allows it to quickly regain lost weight, and shortens the calving interval (Pedersen and Madsen 1998).

Since the farmers' priority for cash through beef sales was higher than that for milk, it is important to develop smallholder dairy production to a level where farmers can easily derive benefits through milk sales. As long as farmers derive immediate and continuous supply on cash from milk, smallholder milk production can be sustainable source of livelihoods for the resource-poor farmers (Ngongoni et al. 2006). The fact that the majority of the farmers milked their cows in the hot wet season implies that the quantity of milk extracted for human consumption and sales varies between seasons. Thus, the seasonality of milk production can prevent farmers from earning a stable income throughout the year. Although the hot-wet season remains the best period for increased milk production, it is also the period of low prices (Somda et al. 2005; Musemwa et al. 2008).

Similar to findings of this study, Das et al. (1999) reported that traditional milking of Zebu cows is based on twice a day suckling of calves, and later, when grazing with their dams, calves suckle their dams throughout the day. Suckling just before and during milking is known to be a major stimulus for lactation milk yield in Zebu and crossbred cows (Das et al. 1999; Yilma 2006). Suckling exploits the maximum milk potential of the cows through the consumption by the calf of the residual milk, achieves high milk yield at milking, good calf growth, low mastitis incidence and results in low calf mortality (Mejia et al. 1998; Yilma et al. 2006). The fact that there were more farmers milking twice in the small-scale areas could be also accredited to provision of supplementary feeds during the milking season compared to the communal areas.

The use of crossbred and indigenous cattle in the smallholder milk production areas was also reported by Moyo (1996), Ngongoni et al. (2006) and Yilma (2006). An average milk yield of about 4.0 litres/per day for indigenous cows and their crosses correspond to 2–4 litres/day obtained by Moyo (1996), Ngongoni et al. (2006), but is lower than 10–15 litres produced by exotic breeds in the same studies. Milk production traits of indigenous cattle can be improved through different methods which include selection within the existing population and cross-breeding with exotic breeds (Moyo 1996; Muchenje et al. 2007). Selection within the existing population has advantages of ensuring the development of animals which are able to adapt well to the existing feeding and management system (Cunningham and Syrstad 1987). Consequently, it is necessary to improve the genetic potential of indigenous cattle by selection within populations, but it takes a long time to attain adequate genetic progress. When carrying out breed improvement, it is important to note that indigenous cattle are multi-purpose cattle.

The higher milk yield in cows in the sour-veld than sweet-veld indicates that smallholder milk producers are heterogeneous in their resource ownership and utilisation. The positive correlations observed between milk yield, milk consumption and milk sales confirms earlier assertions by Kabirizi et al. (2004) and Ngongoni et al. (2007a) that increasing milk production improves household food security and income levels of the smallholder farmers. The observation that milk yield was positively correlated with land size and household size agrees with previous reports (Hanyani-Mlambo et al. 1998; Ngongoni et al. 2007b). Pedo-climatic factors (rainfall, temperature and soil fertility), land size, labour and capital indirectly determine feed availability, milk yield, milk consumption and milk sales (Hanyani-Mlambo et al. 1998; Somda et al. 2005; Ngongoni et al. 2007b). To invest in new technologies whose returns occur over a number of years, such as dairy production, resource-poor farmers located in low-medium rainfall areas need adequate labour force, access to land, improved animal genetic resources and more importantly capital to sustain these resources. Thus, resource-poor farmers should be financially supported and their access to credit and information improved. Since small-scale farmers have resources, they may need little technical support. Smallholder dairy production research and development should, therefore, be re-orientated toward producing appropriate technologies for farmers with diverse resource endowments and located in different agro-ecological zones.

High consumption and sales of sour milk in the sour-veld, communal farms can be attributed to high temperatures prevalent in the sour-veld during the hot-wet season (Ellery et al. 1995) and lack of proper milk preservation facilities in the communal areas. In the absence of adequate milk processing and handling facilities, the risk of losing part of the milk off-take is high, because dairy products are highly perishable. Improvement of processing and handling facilities and market access is therefore, crucial.

## Conclusions

Generally, calf rearing practices were poor in the surveyed smallholder areas. Milk yield/cow/day and fresh milk consumption/day and sales/day were high in the small-scale farms in the sour-veld. Sour milk consumption/day and sales/day were significantly high in communal farms with a sour-veld. It was concluded that, calf rearing practices were poor and milk yield, consumption and sales were generally low and varied with production system and rangeland type. It was suggested high milk production can be improved provision of supplementary feeds and selection of milk production traits within indigenous cattle populations. Further research is required to improve calf management practices, cow nutrition, milk yield and quality across seasons, breeds and agro-ecological zones in the smallholder areas of South Africa.

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