Factors affecting milk production in the smallholder dairy sector of Zimbabwe

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Abstract

A baseline survey involving eight smallholder dairy schemes was conducted in the smallholder sector of Zimbabwe. The objective was to identify major constraints and opportunities facing the smallholder dairy farmers in Zimbabwe. Structured questionnaires through interviews were used for data collection. Eight households were randomly selected from stratified eight dairy schemes using a table of random numbers.

The performance of cows in terms of low milk yields, low calving rates, late age at first calving and long calving intervals were observed and attributed to low levels of nutrition and management. Quantitative and qualitative feeds were limiting in the smallholder sector. Natural pastures and crop residues were the primary feed resources. The high cost and unavailability of protein-rich commercial concentrates resulted in inconsistent and inadequate concentrate supplementation for increased milk yield. However, the major crops grown by most of the dairy farmers included maize, groundnut, sunflower, pearl millet, sorghum and cowpea with surplus for market. The surplus provided the opportunity to formulate least-cost local dairy concentrates, which could lead to year round feeding systems for dairy cattle.

Key words: constraints, dairy, feed, smallholder, supplementation

Introduction

The dairy industry of Zimbabwe consists of two sectors, the large-scale and the smallholder dairy sector that vary with scale of production. The large-scale dairy sector that originated in 1910 has large farms with high producing (> 5000 kg/lactation) pure exotic cows and their crosses, and produces then 98 % of marketed milk for the nation. The smallholder dairy sector, initiated in 1983, has limited resources to justify large-scale commercial milk production. Milk is produced for home consumption with surplus sold locally through milk collection centers. This sector contributes only 1-2 % of marketed national milk production (Dairy Marketing Board (DMB) 1992).
Smallholder dairy is a farming system that promotes regular monetary earnings to people who normally access cash once a season after the sole harvested crops. The regular monthly monetary earnings from the sale of milk and milk products have favorable effects on the cash flow charts of rural households and improve the lifestyles of the rural people. It helps African people to get involved into the mainstream of cash economy and poverty alleviation ventures of their countries. Smallholder dairy increases milk production base of the country, improves household nutrition, empowers women and youth in income generation ventures and agricultural development. It assists farmers to diversify, spread farming risks and creates opportunity to make some idling resources like crop residues enter the human food chain utilizing marginal form resources (Topps and Ngongoni 1998: personal communication). The demands for capital, production management and marketing to meet all requirements for dairy production lead to rural development, improved livelihoods and poverty alleviation on African rural societies (DMB 1992).

The dairy industry was facing viability problems when the smallholder dairy sector was introduced. Due to pre-independence government policies of separate development, improved technologies on dairy production were targeted for large-scale commercial dairy sector. The essential skills for dairying were lacking among the smallholder farmers when the market-oriented smallholder dairy programme was set up (National Association of Dairy Farmers (NADF)1993).

There is dearth of empirical information on constraints and opportunities that affect dairying in the smallholder dairy sector. This study was therefore, carried-out to identify major constraints and opportunities facing the smallholder dairy farmers in Zimbabwe.

**Materials and methods**

**Survey area**

The dairy schemes were located in agro-ecological zones I, II and III (Table 1); and these areas have ideal climate for mixed crop and livestock production.

<table>
<thead>
<tr>
<th>Dairy Development Scheme</th>
<th>Membership</th>
<th>Milk producers</th>
<th>Farming System</th>
<th>AEZ</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chikwaka</td>
<td>189</td>
<td>28</td>
<td>CA</td>
<td>II</td>
</tr>
<tr>
<td>Guruve</td>
<td>190</td>
<td>26</td>
<td>CA</td>
<td>II</td>
</tr>
<tr>
<td>Hondo Valley</td>
<td>189</td>
<td>26</td>
<td>CA</td>
<td>I</td>
</tr>
<tr>
<td>Lancashire</td>
<td>43</td>
<td>23</td>
<td>SSC</td>
<td>III</td>
</tr>
<tr>
<td>Marirangwe</td>
<td>33</td>
<td>13</td>
<td>SSC</td>
<td>IIb</td>
</tr>
<tr>
<td>Nharira</td>
<td>186</td>
<td>16</td>
<td>CA</td>
<td>III</td>
</tr>
<tr>
<td>Tsonzo</td>
<td>224</td>
<td>30</td>
<td>SSC</td>
<td>IIa</td>
</tr>
<tr>
<td>Rusitu</td>
<td>345</td>
<td>251</td>
<td>Res</td>
<td>I</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>1399</strong></td>
<td><strong>411</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 1. Smallholder dairy schemes studied in the base-line study
Sampling procedure

Eight households were randomly selected from stratified eight dairy schemes using a table of random numbers (Table 1).

Data collection

Structured questionnaires (pre-tested) through interviews were used for data collection. The data was collected from 1994 to 1996. The questionnaires were used to collect data on aspects like: socio-demographic characteristics (age, sex, marital status, household size, employment and educational background), landholding sizes (arable and fallow land, cropping patterns, yields of crops and forage production), and cattle breeds (cattle for milk, meat and draught power, reproductive performance of cows, types and number of bulls used, feeding systems during the wet season and during milking, availability of water, cattle management - all husbandry practices, animal health - disease problems and their incidences).

Data analysis

The data were stored as Dbase IV files and then subjected to analysis. Descriptive statistical analyses were carried out using SAS software (SAS 1998).

Results

Socio-demographic

Forty-two per cent of the households were above 55 years of age, with the highest frequency of that observed in Marirangwe (80 %), followed by Honde Valley (55 %), Lancashire (50%) and Nharira (44 %). About 50 % of the households in Rusitu were in the active age group (31-45 years). However, the overall mean age for all the dairy schemes was 50 (± 11.1) years. This was comparable to 51 years in households in Chinamhora communal area (Mutisi et al 1994). About 70 % of farmers were male and 30 % were female. Most of the female farmers were widows or their husbands worked and lived elsewhere. The frequency of females was highest in the communal areas especially in Nharira (66.7 %) and Honde Valley (60 %), while males out numbered females in small-scale commercial and in Rusitu (100 %). Most of the households (88 %) were married couples, while widows' accounted for 12 %.
The household size varied within and between dairy schemes. The majority (77%) of the households comprised of 8-12 members with a mean of 9 (± 0.6) members/family. Family size has been asserted as the most important determinant of labour investment for family farms (Bartlett 1980). In this study, household size was considered important because in addition to being a source of labour, the size of the family may also influence the need for increased milk production for home consumption as well as for the market. The frequency of labour hired ranged from 31% in Rusitu to 95% in Lancashire. Most of the farmers hired labour to perform dairy activities such as milking cows, feeding cows, milk delivery to MCC, herding cattle and also participated in crop production. Family members also assisted in performing the above duties, although family labour tended to concentrate on crop production. The number of hired labour varied from one in most communal areas to three in the small-scale commercial areas.

All the households were literate, with the majority (54%) having completed primary school education. Nyangito (1986) showed that the adoption of new and improved technologies in agriculture was positively related to education. The majority of dairy farmers were retired professionals who had some capital to invest in improved dairy cattle, hired labour and the construction of standard milk shed. Thus, most of the households viewed dairying as a more specialized enterprise than keeping ordinary multipurpose cattle or growing of crops. Although ordinary farmers and general workers represent the majority of the households residing in the rural areas, they accounted for 22.6% of the dairy farmers compared to 55.9% in the professional category.

Land size

There were differences in the size of land holding between the communal areas and the small-scale commercial areas. The mean land holding in the communal areas was 4.4 (± 0.62 ha). This was more than the average national communal land size of 3.0 ha. Rohrbach (1989) showed variation in land held in communal areas, Hurungwe (3.3-5.3 ha), Mangwende (2.1-3.8 ha), Bushu (1.3-2.4 ha) and Chibi (1.8-3.4). Hondje Valley had the smallest land units (3.1 ha/Household). However, a few households in Chikwaka, Guruve and Nharira owned 6-7 ha of land. The average land size in Tsonzo was 13.8 ha, in Marirangwe 72.5 ha and in Lancashire 95.8 ha. The households in the communal areas were unable to give details of the sizes of grazing land, indicating the complexity in the control and the management of the communal grazing land. Records of the grazing land obtained from the Agritex offices showed grazing land size of 11-16 ha/household. Over 79% of the households in the communal areas cultivated 2-3 ha, except in Guruve where 67% of the households cultivated 4-6 ha. Most of the households in the small-scale commercial sector cultivated more than 6 ha of land. The size of fallow land ranged from 0.5-2.5 ha.

Cropping sub-system

Cropping pattern

Maize, groundnuts and sunflower were the major crops grown. About 70% of the land was devoted to maize, while other crops occupied 20-30% of the cultivated land. Groundnuts were grown for cash and home consumption, while sunflower was grown specifically as a cash crop. Other crops grown by 7% of the households included cotton, cowpeas, watermelons, bambara
nuts, sorghum and pearl millet. The households showed less interests in growing the minor crops except cotton because they considered the yields and the market values of these crops to be less than that of major crops. Millets were grown mainly to supply ingredients for inclusion in brewing local beer and other social functions.

Households were asked to state their opinions on the adequacy of land to meet the farming objectives. Between 60 and 90 % of the households in the communal areas stated that the amount of land was inadequate. Honde Valley had the smallest land units compared to all the dairy schemes. This reflects the potential and intensity of land use associated with farming systems in agro-ecological zone I. Despite the larger size among the SSCAs, 25 % of the farmers expressed inadequate land for dairy production. However, there is higher potential for increased dairy production in the SSCAs due to availability of cropping and grazing land.

About 71 % of the households harvested 3.5-4.0 t/ha of maize, mostly (58 %) in Guruve. Only 20 % of the households in Chikwaka and Tsonzo and 5 % in Lancashire, Nharira and Rusitu reported maize of less than 2 t/ha. Thus, most of the dairy households achieved higher maize yields than the national communal area average of 1.2 t/ha. The household average retains about 150 kg of maize grain/capita per annum, implying that 1.5 t/annum for a family of ten people (Rohrbach 1989). Thus, most of the dairy households normally produced surplus maize, some of which could be considered for stock feed.

The yield of sunflower varied within and between the dairy schemes. Thirty-four per cent of the households in Guruve, Lancashire, Tsonzo and Chikwaka achieved 2.8 (± 0.09) t/ha. About 35 % of the households reported 1.5 t/ha, while 31 % reported a yield of less than 1.0 t/ha. Lower yields (< 1.0 t/ha) were consistent with most reports on sunflower in the smallholder farming sector. In Zimbabwe, smallholder farmers produce 90 % of the sunflower, but they do not use fertilizers to grow sunflower and often it is grown in soils with depleted fertility (Shumba 1984). Overall, 22 % of the households mostly in Tsonzo obtained groundnut yields of less than 0.50 t/ha. The majority of the households (55 %) in Honde Valley, Rusitu and Lancashire obtained yield of 0.6-1.0 t/ha. The highest yields (1.4 ± 0.25 t/ha) were obtained in Guruve.

**Fodder production**

Only 14 % of the households in the schemes grew more than one hectare of fodder, mostly in small-scale commercial and in Rusitu resettlement areas. Over 63 % of the households grew less than 0.4 ha of fodder with 43 % growing less than 0.2 ha, mainly in the communal areas such as Nharira (79 %), Chikwaka (60%) and Guruve (56 %). This shows that land to grow fodder for cattle is inadequate, since priority of available land was given to food crops.

The majority of the households grew fodder (93 %), but on small areas. Napier and Bana grass (*Pennisetum spp*) were preferred fodder grown by 55 % of the households, which were mainly in Rusitu and Honde Valley. Pasture legumes such as siratro (*Macroptilium atropurpureum*), fine stem stylo (*Stylosanthes guianensis*) and silverleaf desmodium (*Desmodium uncinatum*) were established by 27 % of the households, which were mainly in Tsonzo, Guruve, Marirangwe and Lancashire. Star grass (*Cynodon nlemfuensis*) and Rhodes grass (*Chloris gayana Kuth*) were grown by 12 % of the households. Five per cent of households in Chikwaka, Guruve and Lancashire established legume reinforced pastures. Most of the fodder plots grown were small
and used as seedbeds for bulking the fodder planting material. The households reported difficulties in the establishment of fodder. This was attributed to the drought, low soil fertility and overgrazing.

Livestock sub-system

Herd of cattle

Indigenous and dairy cattle were the dominant livestock in the smallholder sector, while small number of goats, donkeys and chickens were present. Indigenous cattle, which are essential beef animals constituted 71 % of the cattle herd owned in the smallholder dairy sector, while 29 % were dairy cattle. In Rusitu, dairy cattle (86 %) out numbered indigenous cattle (14 %).

Indigenous cattle

The cattle in the smallholder dairy sector were the indigenous cattle dominated by the characteristics of Mashona breed. The numbers of the indigenous cattle were highest in Lancashire and Marirangwe because of the large farm sizes. However, some of the households in Honde Valley (20 %), Rusitu (70 %) and Tsonzo (10 %) did not have indigenous cattle. The number of cattle kept tended to increase with farm size. As large farms produced more feed they were able to support more livestock than smaller farms. Large farms required more oxen for ploughing and more cows for breeding.

Dairy cattle

Between 60 and 80 % of the households in the communal areas owned 1-3 cows, while 4-5 cows were common in the SSCAs such as Marirangwe (35 %) and Tsonzo (50 %), with 43 % of the households in Lancashire keeping 6 or more cows. The households milked indigenous, crossbred and exotic cows. The exotic cows consisted of Jersey, Red Dane and Friesian. The farmers purchased exotic cows from large-scale farms through loans and participating in Pass-On the Gift program (POG), whereby a household is given a gift heifer and in turn passes the female offspring to another household. However, most of the farmers experienced difficulties in acquiring dairy stock, since large-scale farmers preferred to keep heifers as their own replacement. Most of the households (60 %) with Jersey cows were found in Chikwaka with mean 3.8 (± 1.86) cows followed by Marirangwe where 40 % of the households milked 3.5 (± 2.06) cows. Most of the Friesian cows were found in Rusitu where 80 % of the households milked 3.5 (± 1.50) cows. There were many crossbred cows in the SSCAs such as Lancashire and Marirangwe (2.8 ± 1.77 cows) than in the communal areas such as Chikwaka (1.5± 0.50), Nharira (1.9 ± 1.12 cows) and Honde Valley (1.6 ± 0.86 cows).

Cattle breeding

There were more bulls in the small-scale commercial areas. Most of the households in the communal areas did not own bulls; they relied on bulls that belonged to the Farmers Association. The households mated indigenous (Bos indicus) bulls with exotic cows, such as Nharira (81 %), Chikwaka (79 %) and Honde Valley (77 %). Households showed that exotic bulls were not readily available and when available, the price was high (US $ 750-1000/bull). Only 10 % of the households in Guruve and 90 % in Rusitu used artificial insemination (AI) services from
Agricultural Rural Development Authority (ARDA). When facilities for liquid nitrogen were available, prices paid were also high between US$ 6-13/insemination. Fifty-six per cent of the bulls were indigenous, 44 % were exotic with 8 % belonging to Farmer Associations. Only 27 % of the households mainly in Marirangwe (70 %) and Tsonzo (60 %), preferred to upgrade the indigenous cows through crossbreeding with the exotic bulls. Although, the households in Lancashire owned both exotic and indigenous bulls, 56 % preferred to mate exotic bulls with exotic cows, while 44 % mated indigenous bulls with exotic cows.

Oestrus and mating

Eighty-two per cent of the farmers observed the cows for the oestrus and tended to do so 60 days post partum. Sixty to ninety days post partum is recommended for mating exotic dairy cows (Trail and Gregory 1981). After observing oestrus, 57 % of the households brought cows for mating at the MCC since most of the households particularly in the communal areas had no bulls. Such a practice may impose stress on cows/heifers, resulting in low conception rates. This was a common practice with indigenous bulls. Fifteen per cent of the households did not follow a breeding system. They relied on random mating of cows during grazing in the pasture or at dip tanks.

The system of mating depended on the availability of bulls. Forty-nine per cent of the households exposed the cows to the bull at 3 months post partum. The period that the bull was allowed to stay with cows varied from one-week (16 %) to indefinite (15 %). Overall, 48 % exposed the cows to the bull for a period of 3 months while 21 % exposed the cows for 2 months. Although 30 % of the households introduced the bull to the cows after calving, only 15 % of them reported oestrus at 60 days post partum. In 32 % of the households all the cows failed to show oestrus at 60 days after calving. This was the same in 24 % of the households at 90 days post partum. Only 26 % of the households indicated oestrus in all their cows at 90 days post partum. Post partum anoestrus is a prevalent problem in the smallholder dairy sector.

Conception and calving pattern

Conception was low in exotic cows (41 %) compared to crossbred (62 %) and indigenous cows (47 %). Dairy cows received priority access to feed than indigenous cattle during the dry season. This may partly account for the observed lower pregnancy in indigenous cows compared to crossbred cows. Calving rate was estimated to be 49 %. The highest calving percentage was for cows in Chikwaka (78 %) and the lowest in Tsonzo (30 %), while it ranged form 42-61 % in other schemes. There were no differences in the pattern of calving between genotypes. The majority of cows (70 %) calved between October and December, suggesting conception occurred between January to March. The months January through March coincided with the wet season when there is ample and nutritious feed in the natural pasture as a result of seasonality of rainfall. May-November is a dry period when the grass is low in nitrogen. The reproductive pattern of cows followed the seasonal pattern of rainfall, which tended to influence nutrition.

Milk production

Milk yield from exotic cows in the smallholder sector were below potential breed averages of those found in the large-scale dairy sector (Table 2). The breed average on the large-scale farms
were 6231 kg/lactation for the Friesian/Holstein, 4397 kg/ lactation for the Jersey and 6000 kg/lactation for the Red Dane cows (Mostageer et al 1987).

Table 2. Mean and standard deviation of reproductive performance parameters of dairy cattle in the smallholder dairy sector

<table>
<thead>
<tr>
<th>Red Dane</th>
<th>Jersey</th>
<th>Friesian</th>
<th>Crossbred</th>
<th>Indigenous</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lactation yield, kg</td>
<td>1967±183&lt;sup&gt;b&lt;/sup&gt;</td>
<td>1745&lt;sup&gt;b&lt;/sup&gt;±206</td>
<td>2015±238</td>
<td>1870±127</td>
</tr>
<tr>
<td>Lactation length, d</td>
<td>272±30</td>
<td>252±38</td>
<td>286±34</td>
<td>269±24.8</td>
</tr>
<tr>
<td>Calving interval, d</td>
<td>480&lt;sup&gt;b&lt;/sup&gt;±40</td>
<td>498&lt;sup&gt;b&lt;/sup&gt;±43</td>
<td>530±54</td>
<td>436±33.8</td>
</tr>
<tr>
<td>Age at first calving, months</td>
<td>38±2</td>
<td>35.7±1.9</td>
<td>37.9±3</td>
<td>36.3±1.97</td>
</tr>
</tbody>
</table>

<sup>a,b,c,d</sup> Means in the same row with different superscripts differ significantly P<0.05

Comparison among the Red Dane, Jersey and crossbred in this study showed no significant differences (P> 0.05) in lactation milk yield between exotic cows (1745-2015 kg) and crossbred cows (1870 kg) (Table 2). This is consistent with reports in literature which support that, in low-resource and low-input production systems such as those available in the smallholder sector, exotic cows will perform below their genetic potential (Walshe et al 1991). Milk yield of the indigenous cows was consistent with low producing *Bos indicus* breeds in some Sub-Saharan African cattle (Okantah 1992).

Lactation length and calving interval

The lactation length ranged from 201 (±21) in indigenous and 286 (±34) in Friesian (Table 2). Lactation length of 240 days was reported for agro-pastoral Fulani herds in Mali and Ghana (Okantah 1992), while Trail and Gregory (1981) reported 270 days for Sahiwal. Long lactation lengths increase calving intervals and thereby leading to reduced cow productivity. Indigenous cows showed shorter calving interval (405 days) than Crossbred (436 days) and exotic (480-530 days) cows (P < 0.05) (Table 2). Friesian cows showed the longest calving interval (530 days), suggesting 250 days open compared to standard 60-90 days open post partum. Trail and Gregory (1981) reported the mean calving interval of 420 days in Sahiwal cattle and their crosses. Long post partum anoestrous result in late pregnancy and long calving intervals.

Age at first calving and heifer replacement

The overall mean age at first calving was 37.4 (± 1.67) months (Table 2). This ranged from 35.7 months in Jersey cows to 39.2 months in indigenous cows (Table 2). The farmers expressed lack of adequate money to buy supplementary feed for calves. Age at first calving of 24-27 months has been reported in exotic heifers on large-scale dairy farms in Zimbabwe when adequate nutrition and good management were supplied (NADF 1993). Twenty-eight per cent of the dairy households attempted to raise replacement heifers on farm. The households complained of slow
growth rates in heifers raised on the farm. This was attributed to inadequate nutrition and poor management. Consequently, the households preferred to purchase replacement cows from the large-scale farms.

Sources and distance to water

The main sources of water were rivers, dams and wells and bore holes. The majority (53 %) of the households obtained water from the river or dam while 28 % had wells and 19 % used boreholes. Most of the households expressed unreliability of river water as rivers tended to dry during the dry season. The wells were dug at homesteads, mostly within distance of 500 m, while boreholes were communal assets usually drilled in grazing areas. The distance to water tended to affect the frequency of watering cattle, as 40 % of the households lived 1-2 km away from the source of water, while 20 % lived between 2-3 km away. The households who lived far from the source of water reported that they drove the animals to drink water once/day, or the water was carried home using water carts.

Animal health

Table 3 shows the animal health problems that were prevalent in the areas of study.

<table>
<thead>
<tr>
<th></th>
<th>Retained placenta</th>
<th>Mastitis</th>
<th>Contagious abortion</th>
<th>Quarter Evil</th>
<th>Tick-borne diseases</th>
<th>Internal parasites</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chikwaka</td>
<td>20.0</td>
<td>15.0</td>
<td>25.0</td>
<td>10.0</td>
<td>60.0</td>
<td>60.0</td>
</tr>
<tr>
<td>Guruve</td>
<td>25.0</td>
<td>25.0</td>
<td>20.0</td>
<td>15.0</td>
<td>70.0</td>
<td>75.0</td>
</tr>
<tr>
<td>Honde Valley</td>
<td>15.0</td>
<td>20.0</td>
<td>10.0</td>
<td>10.0</td>
<td>65.0</td>
<td>88.7</td>
</tr>
<tr>
<td>Lancashire</td>
<td>25.5</td>
<td>20.0</td>
<td>15.0</td>
<td>25.0</td>
<td>60.0</td>
<td>66.7</td>
</tr>
<tr>
<td>Marirangwe</td>
<td>20.0</td>
<td>25.0</td>
<td>20.0</td>
<td>20.0</td>
<td>50.3</td>
<td>66.7</td>
</tr>
<tr>
<td>Nharira</td>
<td>33.3</td>
<td>25.0</td>
<td>30.0</td>
<td>10.0</td>
<td>60.0</td>
<td>78.2</td>
</tr>
<tr>
<td>Rusitu</td>
<td>20.0</td>
<td>10.0</td>
<td>15.0</td>
<td>-</td>
<td>50.0</td>
<td>88.7</td>
</tr>
<tr>
<td>Tsonzo</td>
<td>15.0</td>
<td>25.0</td>
<td>15.0</td>
<td>10.0</td>
<td>50.0</td>
<td>75.0</td>
</tr>
</tbody>
</table>

Helminthiasis (for example round worms) and ticks were the prevalent health problems in the study area, while mainly exotic cows experienced mastitis. Reproductive problems such as retained placenta and long post partum anoestrus periods were attributed to inadequate nutrition. Other diseases of importance included Quarter Evil (QE) and brucellosis, associated with stillbirth, abortions and embryonic mortality, leading to irregular oestrus cycles terminating in permanent infertility. Medicines were available to the households through local veterinary extension assistants, but most of the households did not vaccinate cattle due to lack of money. Diamide acaricide was applied routinely at weekly intervals during summer and fortnightly during the dry season to control ticks.
Cattle travelled long distances to the dip tanks (± 2 km) that imposed stress on lactating cows especially the exotic breeds. However, a few households controlled ticks on the farm using knapsack sprayers. Only 12% of the households followed a systematic de-worming program and inoculated cattle against QE and Contagious Abortion (CA) only when a cow had aborted. The majority (81%) of the households indicated haphazard and unsystematic de-worming, no vaccination against QE and CA and showed no idea on the common causes of death of their cattle.

Feed resources

Table 4 shows various feeds available to cattle in the smallholder sector. Natural pasture accounted for 90% of the feed that was available during the wet season, while green maize stover and fodder such as napier and bana grass contributed 10% of the overall feed resources. In addition to natural pasture, crop residues provide 36% of the feed during the dry season. The main crop residues include maize stover, groundnut tops and to a lesser extent sorghum and millet stover. Most of the households reported feeding groundnut tops as a protein supplement during the dry season. However, the quantities available to cattle are limited by low herbage yield.

| Table 4. Sources of feed available to cattle during the year according to household % ranking |
|-----------------------------------------------|-----------------------------------------------|
| Feed available during the wet season | Feed available during the dry season |
| Natural pasture | Green maize stover | Pasture, Napier or bana grass | Browse | Natural pasture | Silage | Crop residue |
| Chikwaka | 85.0 | 5.0 | 10. | - | 45.0 | 15.0 | 40.0 |
| Guruve | 77.8 | 22.2 | - | - | 55.6 | 8.6 | 33.3 |
| Honde Valley | 88.7 | 10.0 | 2.3 | - | 50.0 | - | 50.0 |
| Lancashire | 93.5 | - | 6.5 | 2.0 | 63.5 | 5.0 | 25.5 |
| Marirangwe | 97.5 | - | 2.5 | 1.5 | 55.0 | 7.5 | 35.0 |
| Nharira | 88.9 | - | 11.1 | - | 44.4 | 11.1 | 44.4 |
| Rusitu | 60.0 | - | 40.0 | - | 40.0 | 35.0 | 25.0 |
| Tsonzo | 90.0 | - | 10.0 | 2.0 | 45.0 | 20.0 | 35.0 |
| All schemes | 90.3 | 2.1 | 7.6 | 0.4 | 49.8 | 12.8 | 37.0 |

Fodder production was limited by size of land available. The exception to this was Rusitu where napier fodder was planted on 206 ha to feed the cows in a cut and carry feeding system. A yield of 30.0 t/ha DM of napier was reported in Rusitu and this could feed dairy cows for 750 days. Consequently, the households in Rusitu were able to make silage from Napier, although the methods to make good quality silage were lacking.

All the households fed concentrates during milking time, although 56% did not measure the quantities given, while 23% fed concentrate to calm the cow during milking and 20% indicated
feeding 2-3 kg/day. Both the frequency and the quality of concentrate feed depended on the farmer's ability to buy concentrate. Overall, 75% of the farmers fed irregular concentrate because it was expensive and was not readily available in the area. Most of the households were unable to purchase adequate quantities of concentrate because of high concentrate cost and distance from the supply center increased from 1-10 kilometers (Walshe et al 1991).

Discussion

The performance of cows in terms of low milk yields, low calving rates, late age at first calving and long calving intervals were observed and attributed to low levels of nutrition and management. Unless supplemented with a protein concentrate, cattle grazing natural pasture lose body weight (Topps and Oliver 1993) with cyclic ovarian activity ceasing when cows lost 20-30% of their mature weight due to under nutrition. Inadequate level of nutrition has been found to be the most important factor influencing length of post partum anoestrus in cows grazing tropical rangeland (Topps and Oliver 1993). Several factors including disease, genetics, climate and nutrition may influence oestrus, conception and calving rate; however, of these an inadequate level of nutrition is undoubtedly the most important cause in many cows grazing tropical rangeland. Under-nutrition through reduced energy intake affected oestrus, ovulation and fertilization in cows (Topps and Oliver 1993). Grazing systems offer only limited potential for intensification of dairy production.

Good quality forage and improved pasture may only provide sufficient nutrients for maintenance and production of approximately 5.0 kg/d of milk (Trail and Gregory 1981). Concentrates are fed to supply energy and protein for increased milk production. In addition to the limited availability, the high cost of concentrates and the declining milk to concentrate price ratio makes it difficult to feed adequate concentrates regularly resulting in low productivity. The declining milk price to concentrate price ratio from 1985 through 1993 caused the decline in viability of dairying. It has been shown that unless the milk to concentrate price ratio is greater than one, the economics of feeding concentrates may be doubtful (Walshe et al 1991). The declining milk price to concentrate price ratio may be used as a guide to choose feeds and the optimum quantity of concentrate to be fed in a given situation.

The development of dairying requires changes in management methods because husbandry standards for indigenous multipurpose cattle usually lead to failure, if applied to improved dairy cattle such as the crossbred and exotic cows. Appropriate technical packages for milk production are lacking. Most of the available technologies were extrapolated from those recommended for the capital-intensive large-scale dairying.

The management of land under a traditional system with no title deed to land results in overstocking and overgrazing leading to limited herbage production throughout the year. This is exacerbated by the fact that grazing is communal, without proper management and control over livestock numbers. Farm sizes are generally small and used first and foremost for food crop production in order to ensure household food security. As a result, there is limited cultivation of fodder for animals. Land tenure is not conducive to long-term investments and improvements required to increase dairy production. Given the scarcity of communal grazing land and
difficulties with its access and management, it appears unlikely that the households can overcome their shortage of feed by greater reliance on communal feed supplies.

Since feed, feeding systems and management are real constraints to intensification, the development and use of genotypes such as crossbreds (Bos Taurus x Bos indicus) has been shown to give the benefits of both increased production and tolerance to climatic and nutritional stresses (McDowell 1989). Most of the crossbreeding studies in the tropics have recommended indigenous (Bos indicus) as maternal cows (Mostageer et al 1987). This is because indigenous cows are most readily available in greater numbers than the exotic cows, and they are well adapted to disease and nutritional constraints in their environment. There is evidence that indigenous cattle are more resistant than Bos Taurus to ticks and tick-borne diseases (Baker and Rege 1984). In addition, they probably use feed more efficiently at low feeding levels and have the ability to select high quality diets when grazing course tropical pastures (McDowell 1989). The use of improved animals (Friesian, Jersey, Guernsey and Ayrshire) requires high management, large amounts of concentrates/cow and low forage to concentrate ratio of the magnitude 40:60 (McDowell 1989). These requirements are lacking in the smallholder sector and therefore use of improved pure exotic dairy cows should not be encouraged. The problem of exotic cows in the environment with feed and management constraints was reported in Friesian cows, which produced 1736-2540 kg/lactation (Mostageer et al 1987).

Dry season feeding of cows is constrained by the quality of forage. Considerable quantities of stover are available in cereal crop growing areas. Treatment with urea and strategic supplementation with protein has been found to increase the quality of stover to the animal by increasing the level of voluntary intake. Both the economics and the technical aspects of these processes deserve detailed investigations.

Most of the households produce surplus crop yields in maize, sunflower and groundnuts. These may have value added through feeding to the dairy cows. Maize is generally used in feed manufacturing processes as a source of energy in livestock rations, while sunflower and groundnut tops and cakes are sources of protein supplements. With the advent of the ram press equipment, added value to sunflower may be realized by extracting oil from sunflower seed for local consumption. The sunflower cake may be mixed with maize grain, snap corn, corn and cob, sorghum or millet to produce dairy concentrates. Mupeta et al (1995) demonstrated sunflower oil extraction using the ram press equipment and obtained 250 litres of sunflower oil with 750 kg of sunflower cake/t of Panar seed variety. The cake was used to formulate a dairy ration for crossbred cows. This is likely to make concentrates feed readily available, ensuring regular feeding throughout the year. The millets and sorghum, which are drought resistant, could provide alternative sources of energy for home produced dairy rations.

Fifty-seven per cent of the households had access to fallow land ranging from 0.5 to 2.5 ha/household. The land may be used to produce fodder for livestock. In the arable land, the relative economics of inter-cropping maize with groundnuts and harvesting the groundnuts at the vegetative stage, before adversely affecting maize yield, may be exploited. The yield of groundnut tops depends on the vegetative growth, while the harvesting and curing procedures influence its quality. Where topography rules out cultivation, attempts to improve carrying capacity of the land by growing improved pastures may be worthwhile. In general, the limiting
nutrients to pasture improvement are phosphorus and nitrogen. Nitrogen fertilizer application in such areas is often not economical. This possibility needs investigation from area to area using manure, pasture legumes and combination of fertilizer and manure.

Conclusions

- The smallholder dairy farmers are mixed crop and livestock producers dominated by indigenous cattle.
- The cattle make a significant contribution to food production through draught power, manure, meat and social functions.
- Land is most limiting in the communal sub-sector with a mean arable area of 4.4 ha and approximately 11.0 to 16 ha/household for grazing.
- Grazing systems on the smallholder farms offer limited potential for intensification. Therefore, crop-based dairying becomes a feasible option with crop by-products such as sunflower cake as sources of protein in dairy rations.
- The study showed that dairy farmers produce crop yields with surplus, which may be used to formulate dairy rations on the farm.

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