Calf Rearing Systems in Smallholder Dairy Farming Areas of Zimbabwe: A Diadnostic Study of the Nharira-Lancashire Area

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ABSTRACT : A formal survey was carried out in Nharira-Lancashire areas located in Chivhu to assess the calf rearing systems practised in smallholder dairy farming areas of Zimbabwe. A total of 47 farmers, collectively owning 305 cows and 194 calves of various breeds, participated in the survey. All the farmers allowed their calves to suckle their dams all day to obtain colostrum. The colostrum intake period was significantly ($p < 0.05$) shorter (5.2 vs 4.1 days) in the small scale commercial area (SSCA) compared to the communal area (CA). Milk was first sold to the Nharira-Lancashire Milk Centre a day after the colostrum intake period ended. Most of the CA (91.3%) and SSCA (77.8%) farmers penned their cows and calves together at night during the colostrum intake period. Thereafter the calves were penned separate from their dams. After colostrum intake, two types of calf suckling systems were practised; twice a day suckling and twice a day then changed to once a day suckling. In both systems, suckling was allowed for 30 minutes after the cows had been hand milked. There was no significant ($p > 0.05$) difference in the mean weaning age of calves between the CA and SSCA (5.8 vs 5.4 months). The most common weaning method was through separation of the calves from the dams. The limitations to calf production in Chivhu were the prohibitively high costs of calf meals, poor feed resources during the dry season, a general lack of knowledge on calf rearing, diseases and inappropriate calf housing.
(**Key Words** : Smallholder Dairying, Calf Rearing Systems, Restricted Suckling)

INTRODUCTION

In the mid-1980s the government of Zimbabwe set up farming schemes to promote smallholder milk production with the aims of broadening the milk production base, reducing the disparity in the supply of dairy products between the rural and urban people and at the same time using dairying as a "tool for accelerating rural development" (Dairy Development Programme-DDP, Norad Technical Review, 1992; Mupunga, 1994). To date, the Agricultural and Rural Development Authority which was tasked to promote smallholder dairy production through the DDP has established ten dairy projects in the country (DDP, 1992). The number of participating smallholder dairy farmers and the population of dairy cattle, and therefore milk production, have continued to increase since then (DDP, 1992; Dube, 1995). This trend indicates the willingness of CA and SSCA farmers to participate in commercial dairying in order to earn a regular income. However, since smallholder production systems are predominantly low input-low output ventures and are mainly for subsistence, efforts to fully develop smallholder farms into commercial dairy farms have met with many problems (DDP, Norad Technical Review, 1992).

Several technical and socio-economic constraints to smallholder dairying have been identified (FAO/DANIDA, 1988; Chiduza, 1994; Francis et al., 1996). Although a number of research programmes have been initiated to solve most of the technical constrains, none of these have focused on problems associated with calf rearing systems. Consequently, heifer calf rearing methods are based on individual farmer modifications based on combinations of their traditional system with the restricted suckling technique and the systems used on large-scale commercial dairy farms. This has resulted in poor calf survival and reduced growth rates thereby undermining the viability of smallholder enterprises. This paper reports on the study carried out to investigate the current dairy heifer calf rearing systems in Nharira-Lancashire smallholder dairying area in Zimbabwe. The paper also highlights the constraints experienced by the farmers in calf rearing.

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METHODOLOGY

Study area

Nharira-Lancashire smallholder dairy farms are situated about 170 km south east of Harare, the capital city of Zimbabwe. These farms are located in agro-ecological Region III which is characterised by infrequent heavy rainfalls totalling 570 to 750 mm during a normal season and poor sandy soils of granite origin (Chiduza, 1994). The farmers in this Region practise semi-intensive systems of farming (Chiduza, 1994).

The Nharira dairy project was initiated by 20 local farmers through the Department of Agricultural Technical and Extension Services (AGRITEX) in 1986. Currently, the number of participants has increased to 272 registered dairy farmers out of which 77 were producing and delivering milk to the local collection centre. The centre is responsible for buying, processing and marketing of the milk. The milk and its products are sold in areas around Nharira-Lancashire.

Surveys

A formal survey was conducted in February 1996. The survey was carried out using a structured questionnaire which focused on dairy animal production systems. The questionnaire was developed after carrying out an informal survey in the area between September and October 1995 (Francis et al., 1996). Heads of households from 29 CA (8 males and 21 females) and 18 SSCA (14 males and 4 females) farms were randomly selected for interviewing from a total of 77 farmers delivering milk to the centre in February 1996. In addition, the local DDP officer, AGRITEX extension officers and veterinary officers were interviewed. Each selected farming household was interviewed once.

During the interviews, the dairy facilities (which included calf pens and milking sheds) and feeds available for calves and cows were recorded. The information gathered included household structure data, livestock data (cattle populations and breeds, general cattle feeding, rearing and health management), cattle performance data, constraints to livestock production, and marketing of milk and its products.

Analysis of data

Descriptive statistical analyses were conducted using the Statistical Analysis Systems (SAS; 1988) programme. A χ^2 test for association between the CA and SSCA was carried out.

RESULTS

Farmer characteristics

Table 1 shows the gender of the farmers delivering milk to the centre and those interviewed who were actively participating in dairying during the study. There were more female than male farmers involved in dairying in the CA. Even in some households registered under the names of the husbands at the collection centre, women still played an important role in dairy activities at the homestead. However, in the SSCA men were more active in dairying than women. The differences between the two areas in the proportions of each gender on the dairying activities were significant ($p < 0.05$).

Table 1. Percentage (%) of male and female farmers involved in dairying activities

Farmers	Total number of farmers	Gender	Percentage farmers	
			CA	SSCA
[1] Delivering milk to the centre in February 1996	77	Male	37.50	78.57
		Female	62.50	21.43
[2] Most active in running the dairy activities	47	Male	20.69	83.33
		Female	79.31	16.67

[1,2] Differences between the two areas in gender of farmers for each dairying activity were significant ($p < 0.05$).

Cattle breeds

The common breeds of cows and dairy bulls kept and their distribution in the CA and SSCA are shown in table 2. In the CA, the average number of cows per household was 3.4 ± 0.47 while in the SSCA, it was 11.4 ± 1.30 cows. The commonest breeds in the CA were Mashona (indigenous breed), Friesian and Red Dane, whereas in the SSCA, Red Dane, Brahman and Mashona were popular. Significant differences ($p < 0.05$) were noted between the two farming areas in the numbers of cattle in

Table 2. Common breeds (%) of cows and bulls kept for dairy use

Breed	Percentage of cows		Percentage of bulls	
	CA	SSCA	CA	SSCA
Total number of animals with known breed types	95	191	5	22
Mashona and Mashona crosses	36.7	19.9	–	–
Red Dane and Red Dane crosses	23.3	22.2	60.0	22.7
Friesian and Friesian croses	24.4	13.1	–	13.6
Jersey and Jersey crosses	11.6	10.8	–	22.7
Brahman and Brahman crosses	2.3	19.9	40.0	31.8
Temperate beef and other breed types	4.7	14.2	–	9.1

Differences between the areas in the number of cattle in each breed class were significant ($p < 0.05$).

each breed class.

Crossbreeding was common in the CA and SSCA and Brahman, Red Dane and Jersey bulls were mostly used in this crossbreeding. In the CA the average number of bulls per household was 0.2 ± 0.07 while in the SSCA it was 1.2 ± 0.15 fulls. Usually the bulls were exchanged, sold or slaughtered after their daughters had reached mating age. This was done to avoid inbreeding since the farmers retained their heifers.

Calf birth weights

During the October 1995 to February 1996 calving period, only 13% of the farmers interviewed kept records of birth weights. Most of these records (83%) were kept by SSCA households and very few CA farmers kept records. Table 3, therefore, shows the birth weight of calves from the SSCA only. The Friesian breed produced the heaviest calves ($p < 0.05$) at birth followed by the crossbreds and the Red Dane, Jersey and Mashona breeds. The breed type of the dam significantly ($p < 0.001$) affected the birth weight of the calves and accounted for 30% ($p < 0.001$) of the variation in birth weight.

Table 3. Birth weights (kg) of calves owned by the small scale commercial area farmers

Breed	n	Mean weight ± SE (kg)	Range (kg)
Friesian	3	37.0 (2.82)^{a}	35.0-38.0
Red dane	14	25.3 (1.31)^{bc}	19.0-30.5
Jersey	5	24.7 (2.19)^{bc}	20.0-28.9
Mashona	10	21.8 (1.55)^{b}	16.0-30.0
Crosses[1]	26	26.1 (0.96)^{c}	15.0-39.0
All breeds (mean)	58	25.6	15.0-39.0

^{abc} LSmeans with different superscripts show significant differenees ($p < 0.05$).

[1] Refers to crosses between the above breeds and other breeds.

Colostrum intake

All respondents allowed their calves to suckle their dams all day to obtain colostrum during the early natal period (table 4). The colostrum intake period ranged from three to six days in the SSCA and four to seven days in the CA. There was a tendency by farmers in the CA to feed colostrum for a longer period compared to those in the SSCA ($p < 0.05$). Farmers only commenced selling their milk to the centre a day after the colostrum intake period had ended.

Table 4. The number of days calves were allowed to suckle colostrum

Days	Percentage of farmers	
	CA	SSCA
3	0.0	37.5
4	20.0	25.0
5	56.0	25.0
6	12.0	12.5
7	12.0	0.0
mean day (SE)	5.2 (0.20)^{a}	4.1 (0.24)^{b}

^{ab} LSmeans with different superscripts show significant differences ($p < 0.05$).

Calf housing

In the CA and SSCA, the majority of farmers penned the cow and the calf together during the colostrum intake period (table 5). Thereafter, the animals were housed separately and various structures were used for housing the calves. These included mud and pole walls or brick with mortar walls both under a roof, stone walls with or

Table 5. Housing of dam and calf at night during the colostrum intake period

Night housing	Percentage of farmers practicing	
	CA	SSCA
Separate penning throughout the colostrum intake period	8.7	22.2
Pen calf with dam throughout the colostrum intake period	91.3	61.1
Pen calf with dam for one night only	0.0	11.1
Pen calf with dam for two nights only	0.0	5.6

There were significant differences between the areas in the numbers of farmers for practising each penning criteria ($p < 0.05$).

without roofing and the traditional wooden and roofless open type pens. The roofing materials included thatch grass (*Hyparrhenia* species), asbestos, metal corrugated sheets, polythene sheets and sometimes sacks. The type of material used on the structures depended on the financial resources available to the farmer.

Calf suckling systems

All the farmers practised restricted suckling (table 6) whereby the calf was allowed to suckle a small quantity of milk before or after hand milking of the dam. Within the restricted suckling practise, there were two calf suckling systems observed. In one system, calves were allowed to suckle twice a day after hand milking. This system, which lasted until weaning, was practised by 64% and 40% of the CA and SSCA farmers, respectively. The second system which was practised by the remaining farmers involved the calves being changed from an initial twice a day suckling to once a day suckling.

During the twice per day suckling system, a large group (40%) of the SSCA farmers let their calves suckle for not more than one month. The rest of the farmers allowed their calves to suckle for periods ranging from less than two months to more than six months before weaning. In the CA, most farmers (32%) appeared to prefer a suckling period varying from two to three months and very few farmers allowed calves to suckle for less than one month. In addition, very few CA farmers allowed calves to suckle twice per day beyond six months. In the twice per day followed by once per day suckling system, the change over to once a day suckling began after the calves were one and two months old in the SSCA and CA, respectively.

Time allocated for suckling

In the twice a day suckling system in the CA, calves were allowed to suckle for 30 minutes in the morning while one to two hours was commonly allowed in the afternoon (table 7). However, in the SSCA 30 minutes was the common nursing duration both during the morning and afternoon. In the twice a day changed to once a day suckling system, the most popular nursing duration varied between 30 minutes to one hour in the CA, while in the SSCA 30 minutes was practiced by 67% of the farmers.

Table 6. Percentages (%) of farmers practicing each suckling system and the duration of the suckling system

Suckling system	Duration (months)	Percentage of farmers	
		CA	SSCA
[1] Twice per day	n	22	15
	<1	9.09	39.97
	1-2	18.18	13.13
	2-3	31.82	6.67
	3-5	9.09	6.67
	5-6	22.73	13.33
	>6	9.09	20.00
[2] Twice per day then changed to once a day	n	8	9
	<2	0.00	33.33
	2-3	12.50	0.00
	3-5	0.00	22.22
	5-6	37.50	11.11
	>6	50.00	33.33

[1,2] There were significant differences ($p < 0.05$) between the CA and the SSCA in the proportion of farmers in each suckling duration for both suckling systems.
n = number of farmers.

Weaning age and methods

The farmers weaned the calves according to their age (table 8). In the CA 24% of the farmers had an early weaning age of three months while in the SSCA 25% of the respondents weaned between one and two months. Fifty eight percent of CA farmers had a late weaning age

Table 7. Percentages (%) of farmers letting calves suckle in the morning (am), at mid-day and afternoon (pm) for the two suckling systems

Suckling system	Nursing duration	Percentage of farmers					
		CA			SSCA		
		am	mid-day	pm	am	mid-day	pm
[1]Twice per day	no suckling	3.6	78.6	39.3	0.0	64.7	18.8
	less than 30 mins	25.0	3.6	7.1	68.8	25.5	62.5
	30 mins to 1 hour	10.7	0.0	10.7	12.5	0.0	0.0
	1 to 2 hours	14.3	3.6	35.7	6.3	5.9	0.0
	2 to 3 hours	17.9	0.0	0.0	0.0	0.0	0.0
	3 to 5 hours	28.6	14.3	7.1	12.5	5.9	18.8
[2]Twice changed to once a day	no suckling	0.0			22.2		
	less than 30 mins	25.0			66.7		
	30 mins to 1 hour	37.5			0.0		
	1 to 2 hours	12.5			11.1		
	2 to 3 hours	12.5			0.0		
	3 to 5 hours	12.5			0.0		

[1,2] There were significant ($p < 0.05$) differences between the CA and the SSCA in the proprtion of farmers in each nursing duration for corresponding day-times in both systems.

Table 8. Weaning ages of calves

Weaning age (months)	Percentage of farmers		
	CA	SSCA	Average
number of farmers	29	16	45
<2	3.85	25.0	11.90
3	23.8	6.25	16.67
5	7.69	0.0	4.76
6-7	34.61	50.5	40.48
8	23.08	0.0	14.29
≥9	7.69	18.75	11.90
mean age (SE)	5.77(0.445)[a]	5.38(0.568)[a]	5.62

[a] LSmeans with similar superscripts show non significant differences ($p > 0.05$).

of between six and eight months whereas in SSCA the late weaning age of six to seven months was practised by 51% of the farmers. However, there was no significant ($p > 0.05$) difference between the mean weaning ages in the two areas. Weaning was done either by separating (88% SSCA and 76% CA) the calves from their dams or by using weaner plates. About 20% of the respondents experienced problems with weaned calves returning to suckle their dams.

Solid feeding and provision of drinking water

Calves were introduced to solid feeding at various ages ranging from three days to six months in both the CA and SSCA. About 21% of the SSCA farmers first offered solid feeds to calves when the calves were one week old while in the CA 39% of the farmers introduced solid feed when the calves were three to four weeks old. The solid feed was offered in troughs of various designs which included old cut-out tyres, tins, drums, dishes and concrete troughs. The most popular feed was a commercial calf grower meal (145.5 g CP/kg DM and 10.67 MJ ME/kg DM; Agrifoods Pvt., Ltd.). Only 26% of the farmers started by feeding a calf starter meal (160 g CP/kg DM and 11.07 MJ ME/kg DM; Agrifoods Pvt., Ltd.) before offering the calf grower meal.

Limited amounts of home-made feeds were offered to calves. These feeds consisted of crushed sunflower seed, sunflower heads or sunflower cake mixed with maize grain, maize stover, groundnut tops and shells. Sometimes pumpkin seeds and *Piliostigma thonningii* (Monkey bread) pods were added to the maize grain:sunflower seed mixture and milled together. Water was either provided freely in several types of home-made troughs or the calves were allowed access to streams, weirs or dams. However, during the dry season provision of adequate clean water was limited.

Post-weaning treatment

At weaning, about 68% of the farmers kept the calves in separate paddocks from the rest of the herd or let them roam around the homestead where they grazed in isolation. Eleven per cent of the farmers let their calves join the non-dairy herd while 5% allowed them to graze with older calves. The remaining 16% of the farmers allowed their calves to graze together with the dairy herd. Natural grazing formed the only basal diet after weaning. Supplements were provided only when they were available.

Health of calves

The prevalence of calf diseases in Nharira-Lancashire area was said to be generally low. About 23.4% of the respondents reported scouring to be a problem with their calves. And most of them cited overfeeding (with milk) as the main cause. However, these scours soon disappeared or responded to treatment. Other farmers cited tick-borne diseases (10.6%), ringworm (8.5%) and eye infections (4.3 %) as problems. Tick-borne diseases could have been high because during the period when the survey was conducted, the cattle had not been dipped for over two months due to a shortage of water. However, according to the local veterinary department, diphtheria and sweating sickness were the most prevalent diseases in the rainy season. It was difficult to quantify the mortality rate of calves in Nharira-Lancashire area because of a general lack of records. However, most of the farmers interviewed indicated that calf survival was very poor. This was also supported by the fact that farmers bought their replacement stock from other areas.

DISCUSSION

Farmer characteristic

In the CA, women played a more active role in dairying than men. This was because the majority of the women population live in the rural areas (CSO, 1989) and as a result they contributed more to the peasant farm labour than men who are normally engaged in off-farm employment (Chiduza, 1994). The women were responsible for the planning and production of food requirements for the family and the selling of the extra farm produce to augment family income. This type of scenario has been reported (ILCA, 1990; Kabirizi and Drania, 1996) in other developing countries such as Ethiopia and Uganda which have adopted dairying as a rural development tool. In the SSCA, men usually reside on the farms unlike in the CA. Consequently the men were more active in dairying than women. Per capita farm holdings in the SSCAs are larger (125 ha) than in CAs where the average holding is 0.4-0.7 ha (Chiduza, 1994). Therefore, there is increased capital and management requirements which makes it necessary for men to stay at their farms.

Cattle breeds

In this study, there was a high population of Mashona cows both in the CA (37%) and SSCA (20%) because the animals were the initial breed farmers had when dairying was introduced. The Mashona cattle were also common on resource-poor farms (mostly in the CA) where the farmers could not afford to acquire and/or maintain specialised dairy breeds. However, most farmers were shifting from Mashona and other beef breeds to specialised dairy animals for milk production as evidenced by the lower numbers of beef breeds such as Brahman, Hereford, Susse and their crosses. The farmers were doing this by acquiring dairy breeds and/or crossbreeding with dairy bulls. The high numbers of the Brahman breed in the SSCA demonstrates that these farmers were capitalising on the dual-purpose nature of this *Bos indicus* breed.

Most farmers in both the CA and SSCA perferred the Red Dane cows because of their high milk yield and hardiness. Although the Friesian cows and their crosses were also common in the CA than in the SSCA, they were not preferred by most of the CA farmers. This is because from the farmers' experiences, the Friesian cows required high levels of good quality feeding, had poor reproductive performance and were highly susceptible to diseases despite their high milk yield potential. Nevertheless, the Friesian cows were present in high numbers in the CA because they were easily available from commercial farms and donor agencies. The donor organisations did not give animals to SSCA farmers as they were considered to have the financial resources to acquire dairy animals.

Calf birth weights

The heaviest calves were obtained from the Friesian breed. This may be explained by the preferential treatment accorded to the Friesian cows by the farmers because they believed that these animals were lazy grazers with big appetites. They offered this breed better pastures and more concentrate. In addition the Friesian breed has a relatively large frame compared to the other breeds kept, therefore, bears heavier calves. The crossbred calves had heavier birth weights than the Red Dane, Jersey and Mashona breeds. This may be explained by heterosis in the crossbreds and the relative small frame of

the other three breeds.

The calf birth weights in this study were similar to the weights that have been reported in literature from other smallholder enterprises in tropical countries (Agyemang and Nhkonjera, 1986; Matthewman, 1993; Osuji et al., 1995). However, the calf birth weights of the Friesian breed and their crosses were smaller than those from pure Friesian calves in Cuba (Ugarte et al., 1974; Ugarte, 1978). This can be explained by the better feeding regimes in that country compared to the poor nutritional planes in Chivhu.

Colostrum intake

The importance of colostrum in providing immunity to calves was well known by all the respondents such that they allowed the calves to suckle their dams (all day and at night during the colostrum intake period) in order to obtain colostrum. However, it appeared that the CA farmers preferred to feed colostrum for longer periods compared to the SSCA farmers. This was probably because the CA farmers had limited quantities of calf feeds. In addition, the high percentage of indigenous breeds in the CA may have necessitated longer colostrum feeding periods because these breeds tend to have a stronger calf-dam relationship compared to exotic breeds (Hermann and Stenum, 1981). Therefore, it was easier for the farmers to separate exotic calves from their dams earlier than in the case of indigenous calves. The degree of protection conferred to the calves from colostrum intake appeared to be adequate since the intake lasted for at least three days after birth and calves suckling dams instead of being bucket fed colostrum have been shown to have higher serum immunoglobulin concentrations and, therefore, higher chances of survival (MAFF Reference Book 10, 1984).

Calf housing

A considerable number (22%) of SSCA farmers separated their calves from the dams at night during the period of colostrum intake. This practice was carried out in order to prevent the development of strong calf-dam relationship, to reduce the possibilities of calf injuries from trampling and to limit the spread of infections which can occur when young and older animals are mixed together. The remainder of farmers in SSCA allowed cows to suckle their calves for one or two nights before separating them. This practice was not done in the CA where some of the farmers believed that a new-born calf was difficult to rear and penning the calf together with the dam reduced the risks of early ill-health or deaths.

The main purposes of the calf pens were to house calves at night and keept them away from suckling the dams after the colostrum intake period. Normally the pens were located close to the homestead in order to discourage rustling. The pens also served to protect the calves from adverse climatic conditions. But for some farmers, especially those with roofless open type pens, protection of the calves against bad weather was not adequate such that young animals were sometimes allowed to sleep indoors i.e., in kitchens or granaries. Mortalities from such stressful climatic conditions were common. Some completely covered pens were not well ventilated and in addition litter was not removed regularly. This could have resulted in the build up of sources of infection. In some cases, the calves were penned together with goats or sheep. After weaning, the calves were penned together with older animals during the night.

Calf suckling systems

In both the CA and SSCA there was a wide variation in the time when twice a day suckling was changed to once a day suckling. Even with calves of the same age, breed and feeding regimes under one household, the time of change differed. This shows that there was no pre-determined calf-age for the change over. The reasons for changing over to once a day suckling included making more milk available to the household, preparing the calves for weaning and lessening the nutritional burden on dams.

There were farmers who allowed their cows to nurse their calves for more than three hours. This happened more in the CA than the SSCA. Farmers practising such long nursing durations had some calves that spent the whole day (after morning milking) with their dams. As a result the farmers usually omitted the afternoon milking. This practice was common because of long distances to the milk collection centre, labour limitations, low milk yields or poor feed resources. The CA farmers showed reluctance to wean their calves or change over to once a day suckling when they were still young. This was because the CA farmers had inadequate feed resources which were often of poor quality. Where supplementary feed was available it was introduced late and fed inadequately and inconsistently. Thus farmers had to rely more on suckling to supply most of the nutrients required by the growing calves.

Time allocated for suckling

In general, the restricted suckling after the morning and afternoon milking lasted for about 30 minutes across all the breeds for all the CA and SSCA farmers. It was not influenced by milk yield of the dams or weight and

age of the calves or the season of the year and stage of lactation. It is not clear whether suckling the calves for 30 minutes after hand milking was adequate for calves of various weights or ages, and dams of different breeds and milk yield potential. The restricted suckling durations did not take into account the different feeding regimes practised by the different farmers in the CA and SSCA. Therefore, it is difficult to analyse critically the effects of the suckling methods. However, nursing duration of 30 minutes or less have been reported in Cuba, Malawi, The Gambia and Ethiopia (Agyemang and Nhkonjera, 1986; Preston 1989).

Solid feeding

In this study, the feeding of solids was introduced to calves when they were older compared to other calf rearing systems. In the Henderson early weaning system (where calves are weaned by 21 days of age) and on most large scale commercial farms, calf meals are fed from five days after birth (Oliver, 1987). The farmers in the SSCA introduced solid feed earlier than CA farmers (1 vs 4 weeks). This was probably due to the better financial and feed resources of the SSCA farmers and a more commercial orientation. By introducing solid feed earlier, the farmers reduced the nursing durations and weaned early thereby maximising milk available for home consumption and sale. The practice by most CA farmers of letting the calves suckle for longer durations may have contributed to the late introduction of solid feed. However, in both areas, farmers did not assist the calves to eat the solid feed offered. As a result, the calves took long to get used to the solid feed.

Feeding of calf meals was both inadequate and inconsistent since most farmers did not feed according to recommendations of the calf feed suppliers and feeding was erratic and depended on the availability of financial resources. Most farmers discontinued feeding of the calf meals soon after weaning or when calves exhibited sufficient grazing behaviour such that their herbage intake was adequate to sustain growth. The addition of sunflower seed to home-grown calf meals was done in order to augment the protein content of these rations. Although some of the home-grown rations may have had adequate protein (130-160 g CP/kg DM) and energy (9-12.6 MJ ME/kg DM), the percentage of fat might have been too high such that intake and fibre digestion in ruminant calves was depressed (ARC, 1980). The sunflower hulls also added considerable fibre that might have depressed digestibility of the ration. Addition of *P. thonninghii* provided more energy than protein (Mandibaya, 1994) contrary to the farmers' expectations.

Utilisation of natural grazing

There was a possibility that calves were not consuming sufficient DM to support adequate growth during grazing since little or no supplements were offered. However, the calves were allowed to graze freely from birth in both the CA and SSCA. This early exposure to pasture could be one reason why digestive scours were not common in Nharira-Lancashire area. Dry feed promotes the early development of the rumen and efficient use of the natural grazing. Although solid feeding regimes were poor, most calves benefited from the better herbage as they were born at the onset or during the rainy season (November to April).

Weaning

Due to limited grazing lands, separation of calves from dams at weaning was difficult in the CA and farmers had to use weaner plates. In addition, the weaner plates were also used by all farmers on calves which were found difficult to wean. The incidences of weaners returning to suckle could be related to the high percentage of indigenous breeds kept, longer periods of colostrum intake, longer nursing durations and penning of calves together with dams which allowed the development of close calf-dam relationships. Weaning around six months of age might have been necessitated by low milk yields due to poorly fed cows and indigenous breeds. Also, as the calving season was from October to January, weaning at six months of age coincided with the dry season and this helped in reducing the nutritional drain on dams. Farmers might have weaned late as a way of protecting calves from suffering nutritional deficiencies due to lack of good quality pastures in the grazing area. However, late weaning contributes to delayed conception and, therefore, causes long calving intervals (Matthewman, 1993).

CONCLUSION

Although this study revealed that all farmers practised restricted suckling, there were marked differences in the rearing systems practised. This clearly indicated the lack of knowledge on suitable calf rearing systems for the various breeds used. There is, therefore, a need to design suitable calf rearing programmes for such animals. The use of bought-in calf meals was both inadequate and inconsistent due to their high cost. Where farm-grown meals were offered, the quality was variable due to the array of ingredients used and their adequacy in meeting the nutrient requirements of growing calves could not be established.

The above constraints may have negatively affected calf growth rates and subsequent performance of the animals. The improvement of the restricted suckling regimes practised can confer marked benefits to the smallholder dairy systems in terms calf performance and enhancing milk offtake for home consumption and sale. While a lot is known about restricted suckling in other tropical and developing countries, the adoption of such technology without carrying out on-farm based evaluations under local conditions can result in unforeseen problems and waste of resources. Therefore, research work addressing these different practices under local conditions is needed to come up with improved and sustainable producer-implementable rearing systems.

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