CHARACTERISATION OF THE DAIRY PRODUCTION SYSTEMS PRACTISED BY LIVESTOCK KEEPERS IN SELECTED CONSTITUENCIES OF NAMIBIA: A CASE OF OMUTHIYA-GUINAS AND OVITOTO

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ABSTRACT

Dairying has been envisaged as a means to improve the nutritional status and income generation of poor African families. The study was conducted to characterise the dairy production systems practised by livestock keepers in selected areas of Namibia. 183 households were selected randomly to complete a structured questionnaire. Purposive sampling was used to select the households, and the data was analysed using SPSS version 16.0. A mixed crop-livestock system is found to be the dominant farming system in Omuthiya-Guinas, whilst livestock farming alone is the main form of agriculture in the Ovitoto constituency. About 55 % of farmers in Omuthiya-Guinas and 46 % in Ovitoto, had a total milk production per herd ranging between 16 to 20 litres per day during the wet season (January to May), and 1 to 5 litres per day during the dry season. In this survey, a high proportion of farmers in Ovitoto (78,2 %) and Omuthiya-Guinas (44,7%) indicated that their best performing milkers produce between 3,5 to 4 litres or more per cow per day during the wet season. The protein content, calcium, total milk solids, and percentage ash did not vary by location. However, the quantities of main milk constituents can vary considerably depending on the individual animal, its breed, stage of lactation, age and health status. Herd management practices and environmental conditions also influence milk composition. The constraints associated with marketing were the long distances that farmers had to travel to market centres, lack of transport, unreliable markets, weak bargaining power and low product prices, lack of cooling facilities, milk losses and spoilage, and inappropriate packaging materials. Both hygiene and handling practices at farm level, and marketing infrastructure are a big challenge as far as improving quality in the dairy chain is concerned. Smallholder dairy farmers can also make a further reasonable income if feeding resources are improved.

INTRODUCTION

In Namibia, agriculture's contribution to the gross domestic product (GDP) varies between 12 % to 15 %, depending on the amount of rainfall received in that particular year. Beef production is the main activity in Namibia's agricultural sector, constituting approximately 85 % of agricultural income and on average 10 % of the gross national product (Kruger & Lammerts-Imbuwa, 2008). Much has been said about beef and mutton production, and their contribution towards the country's gross agricultural income, yet milk and dairy products form part of the Namibian diet in many areas.

Currently Namibia has one dairy producer and processor, Namibia Dairies, which has 17 producers in Windhoek, Gobabis, Mariental and Grootfontein with a total of about 900 cows, that deliver milk. The annual production in Namibia is over 24 million litres of milk. About 65 000 litres of milk are further imported from South Africa every week. Namibia Dairies has a majority market share of over 50 % of all dairy product categories, which include a range of pasteurised, flavoured, UHT and fermented dairy products. They also produce traditional dairy products such as *Oshikadela*, *Oshitaka*, *Omayere* (sour milk) and others. The other 50 % of the market is met through imports from South Africa and other countries. Analysis of the trade data indicated that there is a distinct upward trend in imports, specifically of UHT milk and cheese products from South Africa, and this is adversely affecting the dairy industry of Namibia. However, an important feature of the Namibian dairy industry is the development of large scale commercial production enterprises (such as the proposed Vhunguvhungu amongst others for example) and small scale enterprises (such as Kilo 40, Klawerjas and others).

In the rural areas the demand for milk is being met by the informal sector. The bulk of milk is retailed as fresh or fermented milk in recycled one or two litre plastic containers. In the informal sector, which is purely small and medium enterprise-based (SME-based), milk is retailed mainly on the roadside following supply directly from the farm, or through intermediaries. Milk and dairy products are also available at practically every open air market and women dominate these sales (personal communication with SME women). They sell raw milk, fermented milk products (sour milk) and butter oil. Milk processing is based on rural technology. This involves accumulating milk in a gourd (or other containers), and then allowing it to ferment naturally for three to four days in the presence of *Omunkunzi* roots (*Boscia albitrunca*). Agitation of two to three hours finally churns it into butter. Butter is produced for household cooking and to sell in the rural open markets. Sour buttermilk (*Omashikwa*) is the main product produced to feed the family and to sell for an income (Bille *et al*., 2002).

Besides its beneficial effects on nutrition, milk also serves as a good medium for the growth of many organisms, especially pathogenic bacteria (Tasci, 2011). Traditionally, raw or unpasteurised milk has been a major vehicle for the transmission of pathogens. Most countries in the world have set their own legal total bacterial limits for raw and other milk products. The minimum accepted bacterial limit for raw

milk in Namibia and South Africa is 5 x 105 colony forming units/ml [International Organization Standardization (ISO 7208), 2008]. It is well established that consumers want clean, wholesome and nutritious food that is produced and processed in a sound, sanitary manner and is free from pathogens.

General objective

The general objective is to establish milk collection centres to improve the income and livelihood of smallholder dairy farmers in the selected communal areas.

Specific objectives

The specific objectives are to:

- characterise the dairy production systems practised by the livestock keepers;
- examine aspects of processing, handling and marketing of dairy products, and the associated challenges;
- assess the chemical composition and microbiological quality of raw, traditionally fermented butter milk and butter oil samples; and to
- identify constraints faced by livestock producers.

Justification of the study

The Ministry of Agriculture, Water and Forestry (MAWF) has (in its Strategic Plan for 2008/9 to 2012/13) prioritised value adding for the agriculture sector, and is actively promoting agro-industrial development projects and investments, both for income generation and employment creation. In this regard, there are concerted efforts to construct fresh produce hubs to prevent post-harvest losses through the establishment of cold storage facilities in communal areas linked to marketing and distribution. Consumers are reported to have a preference for locally produced dairy products. Since the communities in the northern and Ovaherero regions have a tradition of consuming naturally fermented milk, it is important to view the need to upgrade the production of preferred cultured milk for local markets. Developing better ways of producing *Omashikwa*/*Omaere* would be a way of preserving traditional foods and cultural heritage. Little is known about the existing dairy production system, constraints and opportunities associated with dairy production and processing in the area. There is an information gap on the milk production quantities and consumption in the communal areas.

There are some concerns regarding safety and quality issues, particularly regarding the containers used for milk transportation and storage. Traders and retailers travel distances of more than 150 km to source milk and milk products. There is also the possible use of adding non-milk ingredients during the dry season when milk supplies may be scarce. Farmers in the communal areas have little knowledge of proper milk handling procedures, and consumers also perceive local dairy products to be unhygienic and unsafe. Even if an area has the potential for successful production of milk and milk products, it is essential that researchers and dairy development agents understand the existing situations in order to design a relevant development strategy to suit that area.

MATERIALS AND METHOD

Study area

Ovitoto constituency

Ovitoto constituency is located more or less 40 km outside Okahandja in the Otjozondjupa region. The constituency is divided into 25 villages with a total of about 450 farming households. The mean annual rainfall ranges between 266 mm to 505 mm. The mean temperature ranges between 3,9 ^{o}C to 36,8 ^{o}C. The vegetation represents a transition between thorn bush savanna and the Namibian highland savanna characterised by thorny shrubs, trees and a grassy matrix mainly consisting of the annual grass species *Schmidtia kalahariensis* (Jürgens *et al*., 2010).

Livestock production is the main agricultural activity in Ovitoto. The main types/breeds of cattle are the Afrikaner breed, or crossbreds between Brahman and Afrikaner cattle. Cattle, goats and fewer sheep, donkeys and horses utilise about 58 km^2 of communal rangeland. An extensive small-scale pastoral system, with a focus on large stock, dominates in the Ovaherero community, which consists of traditional cattle farmers. Cow's milk is used daily, and sometimes a goat is slaughtered. Ovaherero people traditionally make sour milk from cow's milk and store this in calabashes (Jürgens *et al*., 2010). Sour milk is consumed with maize meal and is the main staple food. Small-scale gardening is very limited, due to the low and variable precipitation in the area. In good rainfall years, some maize and vegetables can be harvested and used to supplement the food supply of the community. However, people usually have to buy maize or wheat flour (and other items for daily consumption) from shops or hawkers who visit the villages (Jürgens *et al*., 2010).

Omuthiya-Guinas constituency

Omuthiya-Guinas constituency is located in the Oshikoto Region which straddles the Veterinary Cordon Fence (VCF) that divides the region into a southern part (consisting of the town Tsumeb and commercial farms), while the northern part consist mainly of communal farming areas. Omuthinya constituency is just north of Etosha Park, and is divided in numerous villages and has a total of about 4 362 households. Guinas constituency has 778 farming households, including the Mangetti Farming Block east of the main highway and five kilometres north of the veterinary cordon fence. The farmers in this block have long term leases giving them a sense of security. Their allotments are also fenced, allowing them a greater degree of control in managing their herds. The Mangetti Block accommodates 100 livestock farms on the State fenced-off farms (Fuller, 2006). The average annual rainfall varies between 550 mm to 660 mm per year in the wettest areas (northeast and around Tsumeb) to below 500 mm in the central and western parts of the region. The mean temperature ranges between 3 ^{o}C to 40 ^{o}C. Oshikoto region has a soil variety ranging from deep Kalahari sands in the northeastern part (Mangetti and Okankolo areas) to loams, clays and dolomite sands in the far southeastern part (Tsumeb) of the region. Small areas of salty soils are also found in the western part of the region. However, a high degree of soil salinity is found around the Etosha Pan, which is due to

constant flooding and evaporation of pans in that area. The ground cover is primarily dominated by annual grass species such as *Melinis repens*, *Urocloa brachyuran*, *Aristida stipitata* and P*ogonathria fleckii*. Perennial grasses such as *Eragrostis palens*, *Schmidtia pappophoroides* and *Stipagrostis uniplumis* are also found in undisturbed soil.

In addition, there are individual farms raising cattle, donkeys, horses, goats, sheep, as well as chicken and a few pigs. The main cattle breeds in Oshikoto region are the indigenous Sanga (Nguni) and their crosses with Brahman, Bonsmara, Afrikaner and Simmentaler. Many farmers to the north of the VCF grow pearl millet and sorghum. Those to the south of the VCF mainly produce maize on large scale. These crops are grown on dry land fields where they depend on rainfall for moisture. Most farmers only have one field (of at least two hectare), but wealthy farmers (who have oxen to plough with) have larger crop fields (four hectare). The differences, however, do not indicate any commercial gain through crop farming.

Sampling procedure

The target population of the study was defined as consisting primarily of all livestock keepers in villages which are within a 30 km radius of an existing open market and which are already active in dairy marketing. Ninety two of these target households in the Omuthiya and Guinas (the Mangetti farms and Oshivelo area) constituencies were interviewed, and in the case of the Ovitoto constituency, 91 households (the selected reference point here was Okandjira village). A total of 183 households, which were willing to participate and owned cattle in the Omuthiya, Guinas and Ovitoto constituencies, were selected for interviews using a purposive sampling strategy.

Data collection

Survey

A structured questionnaire (pre-tested) was used through interviews for data collection. The data was collected between June and July 2011. The data collected included socio-demographic characteristics (age, gender, income and educational background), herd characteristics (all livestock species, numbers, breeds, composition and uses), dairy management practices (milk quantity, calving and milking period), health management (diseases, vaccination frequency, source of medicines and drugs), management of feed (type of feed resources available and supplements), dairy processing and marketing (dairy products, marketing channels, prices and income) and milk handling and hygiene measures.

Milk samples

A total of twenty samples of raw milk, fermented buttermilk (*Omashikwa*) and butter oil were collected from the Omuthiya-Guinas and Ovitoto constituencies in 500 ml screw cap sterile bottles and were transported in an ice-cooler box to the laboratory for analysis. Nine samples of sour milk and one sample of butter oil was obtained from the women at Omuthiya, Casablanca and Oshivelo open markets. Six samples of raw milk, two soured (*Omaere* and *Omashikwa*) and two butter oils were collected from individual households in Ovitoto during the survey. The chemical analyses were carried out at the nutritional laboratory of the Ministry of Agriculture, Water and Forestry, whilst the microbiological quality assessment was done at the Central Veterinary laboratory, both in Windhoek.

Chemical quality assessment

Milk samples that have been kept cool in a refrigerator were first warmed in a water bath at 40 °C, cooled to 20 °C, mixed and a sample was then taken for determination. Milk samples were analysed for moisture content, butterfat, total solids (ash), protein and calcium. Moisture was measured as a mass difference after dehydration, and total solids or ash recorded as the material remaining after the removal of all vaporisable material by high temperature combustion in a furnace at 500 °C. Butter fat content was determined by the method described by the Gerber technique (Martin, 1979) and total nitrogen by the Kjeldahl procedure. Crude protein was calculated by multiplying the total nitrogen content by a factor of 6,25.

Microbiological quality assessment

Microbiological quality assessment was done by determining the standard aerobic plate count, total coliform count and presence of S*taphylococcus aureus*. One millilitre of milk sample was serially placed in Ringer's solution and appropriate dilutions were plated using the pour-plate method, as described by AOAC (1990). Different types of media were used for the microbiological quality assessment. Coliform counts were carried out on Violet Red Bile Agar incubated at 37 °C for 48 hours. Total aerobic plate counts were obtained on poured Plate Count Agar incubated at 30 °C for 72 hours. *Staphylococcus aureus* was obtained on Baird Parker Agar at 37 °C for 48 hours.

Statistical analysis

Descriptive statistics such as means, frequency distribution and percentages were used to analyse the data using SPSS software version 16.0.

RESULTS AND DISCUSSION

Socio-economic characteristics

The household size, age, gender, educational status and major source of income per household head in the study area are shown in Table 1. In Ovitoto 69,2 % of the household respondents were headed by men, whilst in Omuthiya-Guinas, 58,7 % respondents were herders. This implies that most livestock farms in Omuthiya-Guinas were managed by herders. In Omuthiya-Guinas 85,9 % of the household heads were found to be male and in Ovitoto 75,6 %. In Omuthiya-Guinas the age of 27 % of the household heads ranged between 41 to 50 years and in Ovitoto 34,1% ranged between 51 to 60 years. This may be the most important active group to undertake agricultural activities, having the better knowledge on livestock rearing in the area. Of the farmers in Omuthinya-Guinas, 53,3 % had only primary education and in Ovitoto 56 %. The literacy rate in all study locations, though, was above 80 % which implies that there is a mass of people that are trainable on issues to

do with the technicalities of running a dairy processing plant. Most of the income, in the study locations, is derived from agricultural practices (30,4 % Omuthiya-Guinas and 40,7 % in Ovitoto). Only 26,1 % and 20,9 % respectively, received a pension. This income could be potentially used to purchase future milk cans and feed supplements for the dairy herd.

Table 1. Socio-economic characteristics of livestock keepers in the study area

Parameter	Frequency		Percentage (%)	
	Omuthiya-Guinas	Ovitoto	Omuthiya-Guinas	Ovitoto
Respondents	n = 92		n = 91	
Household head	25	63	27,2	69,2
Wife	9	6	9,8	6,6
Son	4	6	4,3	6,6
Herder	54	16	58,7	17,6
Gender of farmer				
Male	79	68	85,9	75,8
Female	13	23	14,1	24,2
Age of farmer				
< 30	4	–	4,3	–
31–40	7	8	7,6	8,8
41–50	25	12	27,2	13,2
51–60	21	31	22,8	34,1
61–70	14	15	15,2	16,5
71–80	7	16	7,6	17,6
80+	3	9	3,3	9,9
Age known	11	1	12,0	1,1
Educational status				
Primary	49	51	53,3	56,04
Secondary	27	18	29,3	19,78
Tertiary	10	10	10,9	10,99
Others	6	12	6,5	13,19
Major source of income				
Agriculture	28	37	30,4	40,7
Non-agriculture	10	6	10,9	6,6
Formal employment	16	14	17,4	15,4
Pension	24	19	26,1	20,9
Others	14	15	15,2	16,5

Source: survey data 2011.

Livestock production

Cattle appeared to be the major livestock species kept in the study areas followed by goats (Table 2). The majority of farmers in the study owned 14,6 ± 3,6 cows per herd in Omuthiya-Guinas and in Ovitoto 30,5 ± 5,7 cows (Table 3). Households milked indigenous, crossbred and exotic cows. On average, each household owned a bull in both study areas. The overall mean number of heifers and dry cows were at 9,0 ± 1,8 and 4,0 ± 0,8 in Omuthiya-Guinas, and 8,0 ± 1,6 and 8,3 ± 1,7 in Ovitoto respectively. Farmers raised their own heifers for replacement in the herds. Poor quality feed or inadequate grazing during the dry period, had an effect on the number of cows milked as some farmers were not milking at the time of the data collection period (June to July). Steers were also noted to be less because farmers had already sold them by the time data was collected.

Table 2. Herd structure and composition per household in the study areas

Types of livestock	No.	Sum.	Mean ± Std. error	Min.	Max.
Omuthiya-Guinas (n = 92)					
Cattle	92	8 026	87,2 ± 10,3	2	500
Sheep	7	53	0,6 ± 0,3	1	28
Goat	66	3 217	35,0 ± 5,8	3	400
Donkey	42	199	2,2 ± 0,4	1	23
Pig	14	45	0,5 ± 0,2	1	14
Chicken	65	1 215	13,2 ± 1,6	2	80
Horse	6	54	0,6 ± 0,3	2	28
Pigeon	1	10	0,1 ± 0,1	10	10
Duck	1	20	0,2 ± 0,2	20	20
Total	292	12 839			
Ovitoto (n = 91)					
Cattle	85	5 185	57,0 ± 7,7	3	450
Sheep	28	836	9,2 ± 2,7	2	140
Goat	70	1 689	18,6 ± 2,2	2	110
Donkey	18	64	0,7 ± 0,2	1	7
Pig	0	0	0	0	0
Chicken	44	421	4,6 ± 0,7	2	35
Horse	22	70	0,8 ± 0,2	1	10
Pigeon	1	10	± 0,1	10	10
Duck	4	24	0,3 ± 0,2	1	10
Total	272	8 299			

No. = number of farmers
Std. error = Standard error

Table 3. Cattle herd composition per household in the study areas

Cattle class	No.	Sum.	Mean ± Std. error	Min.	Max.
Omuthiya-Guinas (n = 92)					
Total cows	60	1 341	14,6 ± 3,6	1	300
Cows calved in 2011	78	1 269	13,8 ± 1,9	1	100
Milkers	75	893	9,7 ± 1,1	1	67
Heifers	60	826	9,0 ± 1,8	1	130
Dry cows	37	371	4,0 ± 0,8	1	46
Steers	59	653	7,1 ± 1,4	1	80
Male calves	65	1 732	6,5 ± 1,4	1	100
Female calves	70	596	7,7 ± 1,4	1	100
Totals calves	85	706	18,8 ± 2,9	1	200
Bulls	75	248	2,7 ± 0,3	1	20
Total	664	8 635			
Ovitoto (n = 91)					
Total cows	71	2 774	30,5 ± 5,7	1	380
Cows calved in 2011	80	1 311	14,4 ± 2,2	1	120
Milkers	64	777	8,5 ± 1,6	1	120
Heifers	56	731	8,0 ± 1,6	1	120
Dry cows	39	756	8,3 ± 1,7	1	80
Steers	31	187	2,1 ± 0,5	1	20
Male calves	71	533	5,9 ± 1,1	1	60
Female calves	74	650	7,1 ± 1,2	1	80
Total calves	79	1 235	13,6 ± 2,0	1	120
Bulls	57	109	1,2 ± 0,2	1	15
Total	622	9 063			

No. = number of farmers
Sum. = summary
Std. error = Standard error

Milk production

In total, 95 % of farmers in this study were milking, while 5 % were not milking at all. A high proportion of farmers (55 % in Omuthiya-Guinas and 46 % in Ovitoto) indicated a farm production per day ranging between 16 to 20 litre during the wet season (Figure 1 and 2). This could be attributed to the availability of sufficient grazing in the communal areas during the wet season, which allowed farmers to milk their animals. Results indicated 41 % of farmers in Omuthiya-Guinas and 23 % in Ovitoto do not milk during the dry season (Figure 1 and 2). During the dry period, grazing becomes poor. Most farmers therefore stop milking around July to December, hence the decline in milk yields. A further factor is the tradition of the Ovaherero community where milk is used daily to make sour milk, which is the main second staple food to meat. In Omuthiya-Guinas, since most farms are managed by herders (58,7 % as shown in Table 1), the owners do not permit milking when there is no sufficient grazing.

In this survey, a high proportion of farmers in Ovitoto (78,2 %) and Omuthiya-Guinas (44,7%) had their best performing milkers ranging between 3,5 to 4 or more litres per cow per day during the wet season. Whilst during the dry season, farmers in Ovitoto (52,9 %) and Omuthiya-Guinas (48,2 %) had their milkers falling between 1 to 0,5 litres per cow per day (Figure 3 and 4). Since milk production is closely related to adequate feeding, the situation can be well explained by the availability of fodder, which follows the rainfall pattern with relatively adequate feed being reported during the wet season.

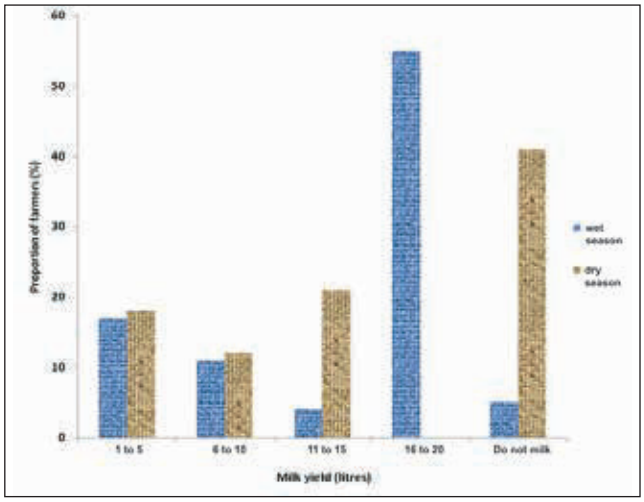

Figure 1. Average milk production per herd per day in Omuthiya-Guinas constituency.

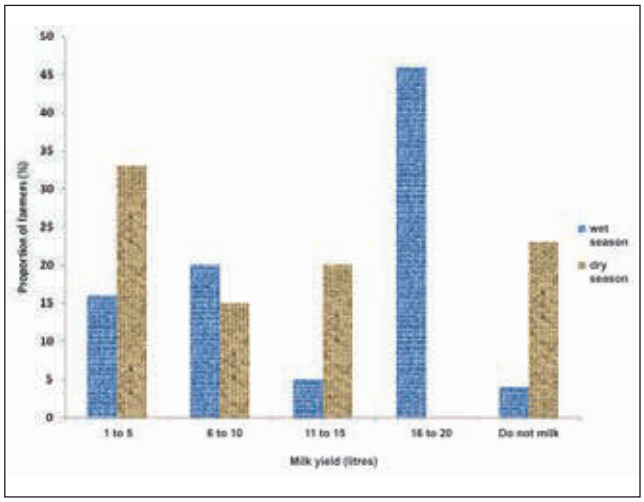

Figure 2. Average milk production per herd per day in Ovitoto constituency.

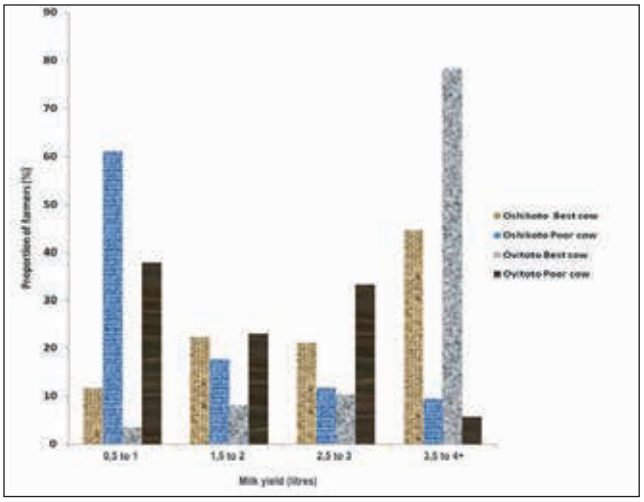

Figure 3. Average milk yield per cow per day during the wet season.

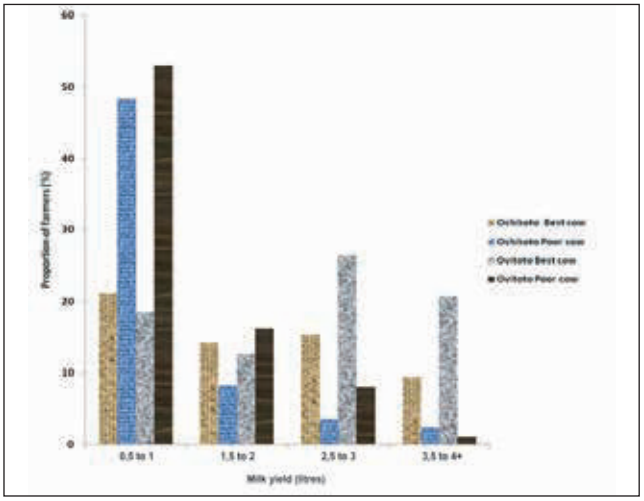

Figure 4. Average milk yield per cow per day during the dry season.

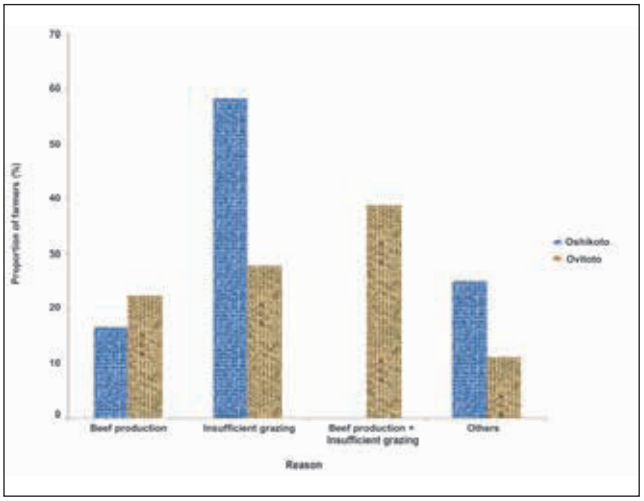

Figure 5. Reasons why farmers do not milk during the dry season.

Milking period

Milking period in this study was defined as the time taken when the farmer starts milking to the end of the milking period or when cows are dry. The information obtained from the respondents was classified into months of winter or summer, or either throughout the year. The majority of farmers in Omuthiya-Guinas (66,3 %) and Ovitoto (47,3 %) indicated that milking is mostly common in summer months. Surprisingly, 31,9 % of farmers in Ovitoto milked throughout the year, as compared to 10,9 % in Omuthiya-Guinas constituencies (Figure 6). This could be attributed to the differences in the two cultures as the use of sour milk in the Ovaherero community as a main staple food, is more common throughout the year, as compared to the Oshiwambo culture where it is sometimes substituted with dry vegetables or fish.

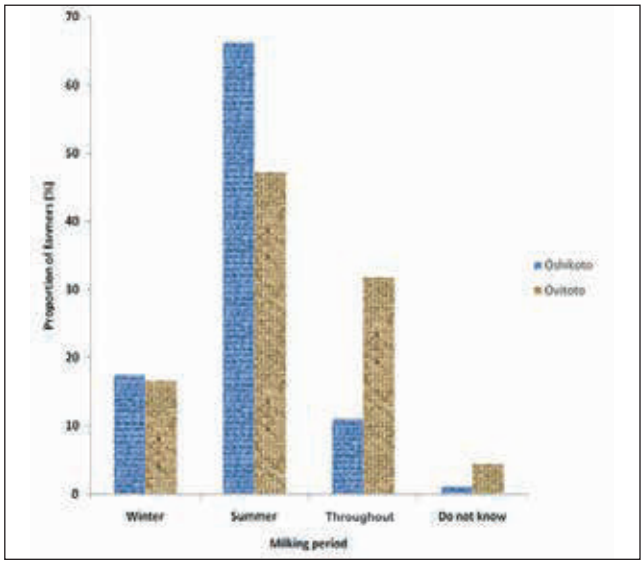

Figure 6. Milking period.

About 36,8 % of farmers in Ovitoto indicated that they milk according to family size demand and they could not milk all their lactating cows, because there was not enough storage (Figure 7). Farmers in Omuthiya-Guinas (31,9 %) indicated that the main reason why they could not milk all lactating animals immediately after calving, was that the calves are still young and the dam may not have enough milk to sustain the calf and the household family. The main reasons as to why farmers could not milk all their lactating cows during the milking period, are illustrated in Figure 7. Milking commences two to three months after calving to allow the calves to grow. Farmers also indicated that milking activities coincide with the time of crop field work. Labour then becomes limited, especially when the young boys are at school. Moreover, about 25,5 % of farmers in Omuthiya-Guinas (who were mostly herders) indicated that it was difficult to locate the cows in the camps and bring them to the homestead to be milked (Figure 7).

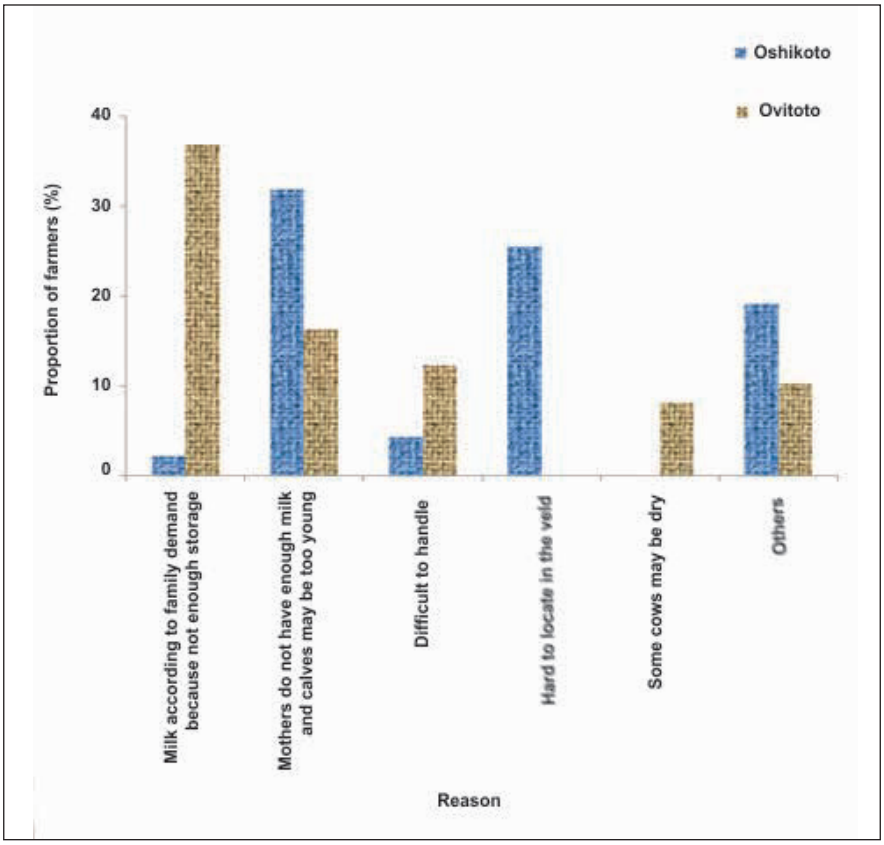

Figure 7. Reasons why farmers do not milk all their lactating cows.

Milk composition

The protein content of the milk from the two locations tested in this work, fall within an acceptable range (3,07 % to 3,9 %), which is in agreement with the regulated minimum standards of 3,2 % and those of Bille *et al*. (2002). The result indicated a higher milk fat of 5,8 % in raw milk as compared to fermented *Omashikwa* and *Omaere*. The low milk fat in the fermented products could be attributed to the removal of butter fat during processing. The total milk solids, percentage ash and protein content did not vary by location (Table 4). O'Connor (1995), states that quantities of main milk constituents can vary considerably depending on the individual animal, its breed, stage of lactation, age and health status. Herd management practices and environmental conditions also influence milk composition.

Table 4. Chemical properties of local dairy products

Source	Milk product	% Moisture	% Total solids	% Ash	% Fat	% Ca	% Protein
Oshivelo	*Omashikwa*	89,08	10,92	0,66	3,11	0,09	3,07
Omuthiya	*Omashikwa*	89,89	10,11	0,64	2,07	0,09	3,20
Casablanca	*Omashikwa*	86,30	13,70	0,70	2,75	0,11	3,60
Omuthiya	Butter oil	0,90	99,10	0	99,10	0	0,01
Ovitoto	Butter oil	0,34	99,66	0	99,66	0	0,01
Ovitoto	Raw milk	80,58	19,42	0,73	5,08	0,11	3,83
Ovitoto	*Omaere*	88,50	11,50	0,77	1,06	0,12	3,90
Ovitoto	*Omashikwa*	89,47	10,53	0,80	0,97	0,13	3,70

Feed resources and feeding management

Natural grazing, in the form of standing hay, is the main source of feed for livestock regardless of the land size per household, which ranges between two to six hectare, and includes crop and grazing areas (Table 5). Although crop residues and grass hay are important sources of roughage, they are low in nutritive values and do not provide the required adequate nutrients for animal production. Major storage structures for hay and crop residues are the top of trees or on house roofs. These poor storage methods practised by farmers expose the hay to rain and sunlight, resulting in further deterioration of quality. About 26,2 % of the farmers (Table 5) use purchased concentrates locally known as *Ofura* (concentrates) to supplement the feed of mostly lactating cows, calves and sick animals during the dry season (August to December). Mineral blocks are, however, available to all the animals most of the time. None of the farmers (in this study) practised silage making, probably due to a lack of technical skills and the high investment requirement. Farmers who are resettled on the Mangetti farms practise rotational grazing, because their farms are demarcated and fenced since the late 1970s to 1980s. Feed availability follow the rainfall pattern closely with relatively adequate feed being reported during the wet season (January to May). A high proportion of farmers (60 %) reported severe shortage of feed at peak mainly in September to December. This implies that, during these months, animals do not receive adequate feed to meet their full production potential, which results in low milk

productivity and most farmers stop milking as a result. During the period of feed scarcity, farmers adopt a range of coping strategies. Some move their cattle to other grazing lands, 16,3 % of farmers purchase concentrates from Agra shops and 12 % reduce their livestock numbers. Farmers also collect tree pods and local tree leaves such as *Omupanda* (*Philenoptera* spp.) and *Omubuti* (*Combretum apiculatum*), *Oviraura* bush (in Ovitoto) and *Omunghama* to feed their livestock during the dry season.

Table 5. Dry season feed strategies practised by livestock keepers

Feed resource	Proportion of total respondents (%)
Natural rotational grazing	47,5
Crop residues	7,7
Grass hay	10,9
Mineral and winter supplement (*Ofura*)	26,2
Other methods	11,8

NB: Multiple responses

Breeding season

A high proportion of farmers in Omuthiya-Guinas (85,9 %) and Ovitoto (85,7 %) indicated clearly that the calving period takes place in summer months – September throughout to November (Figure 8). If the first effective rains in these study areas fall in October, this implies that the breeding season is from November to February. The advantage of a summer breeding season is that the cows are normally in a good condition, resulting in higher conception rates. The summer breeding season coincides with the peak production period of natural pastures, resulting in higher weaning weights and less supplementation needed. The main disadvantage of a summer breeding season is that the internal and external parasite load is high during the pre-weaning phase of calves. Summer droughts, though, may also occur, in which case it may result in lower conception rates due to the poor condition of cows in the breeding season. (Bergh, 2008).

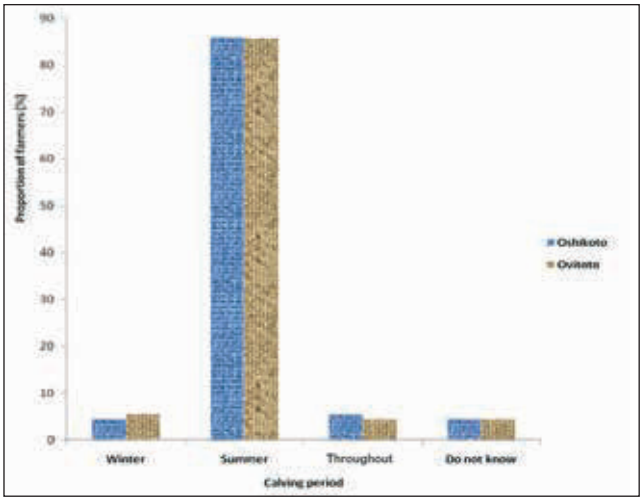

Figure 8. Calving periods.

Public health and milk quality

The most common diseases indicated by farmers were Blackquarter (also known as Q-evil or Black Leg) (18 %), Lumpy Skin Disease (16,9 %) and Anaplasmosis (15,3 %). About 14,2 % of farmers mentioned that Foot Rot problems were encountered and could be caused by the muddy conditions probably due to the amount of good rainfall received in 2011. Vaccinations in the regions are mostly carried out on notifiable diseases such as Anthrax, Foot and Mouth Disease, and Brucellosis. This is normally done by law or by government through the Directorate of Veterinary Services (DVS). Apart from those which are done by DVS, limited vaccinations were done privately by farmers themselves. Farmers did, however, indicate that, at times, they do administer specific drugs such as Ivomec and Supervax (obtainable at all Agra shops) to all cattle, sheep and goats as a preventative measure against most diseases. Table 6 shows the list of common diseases encountered in the study areas.

Table 6. Animal health problems that were prevalent in the areas of study

Disease	Proportion of farmers (%)
Anaplasmosis	15,3
Lung Sickness	13,7
Blackquarter (Q-evil/Black Leg)	18,6
Lumpy Skin Disease	16,9
Foot problems	14,2
Botulism	13,1
Others	27,3

NB: Multiple responses

Farmers were asked whether they consumed unpasteurised raw milk. The aim was to obtain information on farmers' knowledge and awareness of zoonoses with particular emphasis on milk-borne zoonoses and farmers' behavioural practices that may lead to an increased risk of milk-borne zoonoses transmission. The study indicated that 67,8 % of farmers were aware of zoonosis, while 32,2 % were not aware. General hygienic and disease control practices need to be integrated in the milk production process, and particularly at smallholder level to reduce the public health risk of milk-borne zoonoses.

In the Namibian and South African legislation, raw milk has to contain less than 5×10^4 cfu/ml coliform bacteria. The legal bacterial limit in raw milk intended for further processing is 2×10^4 cfu/ml. In this survey, the total bacterial count (TBC) of all sour milk (*Omashikwa*) samples did exceed the limit (Table 5) and a limited number of TBC was detected in raw milk samples from Ovitoto. This high contamination rate of TBC could be due to very poor hygienic conditions during milking, handling and transportation of milk, and the way it is offered for sale. Milking in all study areas is done by hand and cows are usually milked in the kraal where they are kept overnight. Udders of the animals consequently come in

contact with faeces and are usually not washed before milking. This corresponds well with Bille *et al*., 2002. About 76,5 % respondents in the study claimed that they wash hands, milking utensils and filter raw milk through a sieve or clean cloth. However, 23,5 % do not employ any hygienic measures. It is not common practice among milkers to wash their hands with soap or the udder with water, or use a towel to clean before milking (Bille *et al*., 2002). The person milking plays the most important part in maintaining proper hygiene during production. When handling the animals, like tying their hind legs prior to milking, milkers' hands and clothes become further contaminated. Surprisingly, many milkers even dip their fingers into the milk to moisten them, which adds dirt and bacteria to the milk. Before milking commences, the calf is also allowed to suckle its mother for stimulation of milk let-down, and the saliva of the calf left on the teats is also known to facilitate easier milking (personal communication with herders; Hempen *et al*., 2004 and Millongo *et al*., 2008). Other sources of infection to the milk are insects such as flies and cockroaches, as they can carry many bacteria and viruses.

Table 7. Prevalence of microorganisms in milk samples obtained from open markets

Test	Oshivelo	Casablanca	Omuthiya	Ovitoto
	Log_{10} cfu/ml			
***Omashikwa*/sour-milk**				
Coliform	<1	<1	<1	5,46 x 10^{5}*
Total bacterial count	1,5 x 10^{7}*	1,8 x 10^{7}*	1,97 x 10^{7}*	1,99 x 10^{8}*
Staphylococcus aureus	<1	<1	<1	1,16 x 10^{4}
Raw milk				
Coliform	–	–	–	<1
Total bacterial count	–	–	–	2,3 x 10^{3}
Staphylococcus aureus	–	–	–	3,7 x 10^{2}
***Omaere*/sour-milk**				
Coliform	–	–	–	<1
Total bacterial count	–	–	–	5,0 x 10^{7}*
Staphylococcus aureus	–	–	–	<1
Butter oil				
Coliform	–	–	1,2 x 10^{7}*	<1
Total bacterial count	–	–	<1	<1
Staphylococcus aureus	–	–	<1	<1

Key: Colony forming units (cfu) above 5 x 10^{4} are denoted by *

Dairy marketing

Marketing is a very important aspect of the dairy chain. The most important constraints associated with marketing of local dairy products (as prioritised by farmers during the study) were the long distances they had to travel to market centres. Public transport is not always available and where it is, traders most likely have to wait long hours. Most local open markets are situated alongside the road and road travellers are the main customers. Customers have a tendency of using bargaining power, resulting in low product prices received by the farmer. It is further important to mention that, in the study area, the majority of farm owners are absentees (weekend farmers). They usually place their herders under the order of no milk sales. In the event where herders do manage to sell, it is cited that major marketing challenges are the already mentioned market distances and lack of transport which results in large quantities of milk going to waste. Lack of cooling facilities coupled with a lack of electric power supply at the open markets makes for further major losses due to spoilage. Inappropriate packaging materials currently also have a negative effect. Traders use recycled two litre plastic bottles and jerry cans. Table 8 shows the prices of local dairy products.

Table 8. Prices of dairy products at farm and open market levels

Types of dairy products	Quantity	Purchase price (N$)	Selling price (N$)	
			Wet season	Dry season
Raw milk	1 L	5	7.50	10
Omashikwa	2 L	10	20	25
Omashikwa	25 L	80	80–100	120–150
Butter oil	250 ml	15	25	25
Butter oil	5 L	100	200–250	300

Key note: L = litre; ml = millilitre; US$1 = N$7

Fermented buttermilk (*Omashikwa*) and butter oil were the most common commodities sold at local open markets. Fresh, raw milk and cream were rarely sold due to a lack of cooling facilities in Omuthiya-Guinas constituency. The average selling price of sour milk (*Omashikwa*) at a local open market during the wet season is N$20, which increases to N$25 in the dry season. The selling price of butter oil tended to remain unchanged (N$25 per 250 ml) regardless of the season (Table 8). This implies that the production of butter oil is limited and the demand high.

During the focus group discussion with traders at Omuthiya, it was observed that, traditionally, in the Oshiwambo culture, raw milk is not allowed to be sold or to leave the homestead or farm before it is processed (specific reasons were not well explained). In contrast, women traders in Ovitoto sell raw milk at N$10 per litre to the public – mostly in the nearby town, Okahandja. No traditional beliefs attached to raw milk sales were discovered in Ovitoto. Women traders at Omuthiya indicated that it takes about two to three days to sell a 100 litre container of milk, depending on the availability of customers. Fresh, sour milk is added to old, sour milk that could not be sold in time, and this is then sold at a discount. Although there were no formal group cooperatives among the women traders at the time of data collection, they operated

using the same principle of cooperatives such as selling together; watching over each other's business when one is away; and sourcing sour milk in groups from the villages.

CONCLUSION

The study showed that farmers in Omuthiya-Guinas practiced mixed livestock-crop production, whilst in Ovitoto livestock farming alone is the main agricultural practice. Both the study areas did, though, integrate their practices with dairy production. The main cattle breeds in both study areas are the indigenous Sanga (Nguni) and their crosses with Brahman, Afrikaner and Simmentaler. Natural grazing, crop residues and grass hay are the main sources of feed for livestock, but farmers also give supplements such as minerals and winter licks. During the wet season, a substantial amount of milk is produced in smallholder dairy setups, but this declines during the dry season (September through to December) due to poor grazing.

The hygiene and handling practices at farm level and the marketing infrastructure hold big challenges as far as improving quality in the dairy chain is concerned. High bacteria counts in raw and processed milk indicate low levels of milking hygiene practice, and high levels of post-processing contamination, which may present a public health hazard.

Marketing is a very important aspect of the dairy chain. There are, however, a number of constraints associated with the marketing of local dairy products. Milk losses occur due to a lack of cooling facilities, poor transportation, unreliable milk markets, labour or man power shortages, inappropriate packaging materials, and low product prices received by farmers. No form of any type of association exists; not for the milk producers, nor for the traders. Each farmer has to operate on his/her own and the marketing of milk is done by individual milk traders at open markets or simply locally.

RECOMMENDATIONS

- Feeding is a very important factor in a successful dairy industry. The study shows that there is a need to increase farmers' knowledge on techniques that enable year-round availability of feed resources. This includes feed conservation practices, such as the making of silage and hay, as well as improving the quality of crop residues, especially during the dry season. In addition, a need also exists to enhance farmers' knowledge on the use and benefits of alternative feeding sources and by-products.
- The current processing technology (such as the use of a starter culture) should be improved to add quality to the products sold.
- Milk producers, traders and all those involved in the distribution chain of milk, should be trained on the handling and hygienic aspects thereof.
- The importance of milk cooling or other systems, that prevent bacterial growth, should be promoted to ensure food safety.
- The legislative environment (policies, standards and regulations) is an integral part of a successful dairy sector and should be developed as such.
- Establishing dairy cooperative networks of smallholder dairy farmers will enhance accessibility to resources and markets regardless of other socio-economic environments.
- The development and use of genotypes such as crossbreds (*Bos taurus* x *Bos indicus*) has shown to increase production and tolerance to climatic and nutritional stresses.

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