Pastoralism and milk production*

M.J.L. Nicholson
Ethiopian Rangelands Programme,
ILCA, P.O.Box 5689, Addis Ababa, Ethiopia

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Summary

THE SUCCESS *of the African pastoral family is determined by the amount of milk their animals yield. These animals, like their masters, are adapted to an often harsh environment, in which hardiness and the ability to survive are more important than high milk yields. However, the milk yield is still susceptible to seasonal influences and during the dry season there is often considerable competition between calf and man for the declining production. The calf usually suffers, with the result that the breeding rate and ultimate productivity of the herd is reduced, because a malnourished female calf is slow to reach reproductive age. Milk production in the pastoral system, and the few opportunities for its improvement, are discussed in this article.*

Introduction

Pastoralism has evolved in drier regions on land that is either unsuited to cultivation or where cropping is a marginal and precarious enterprise. In Africa pastoralists range across the climatic zones, being found in the subhumid zone of Nigeria (1300–1500 mm rainfall) right through to the arid zone of northern Kenya (150–400 mm rainfall). The mainstay of pastoralism is milk production from cattle, camels, goats and sheep; utilisation of milk from horses and donkeys is uncommon. Meat, a less efficiently produced commodity, is normally eaten only on festive occasions or during severe food shortages. Pastoralists may be nomadic, transhumant or quasisedentary; cultivation is a new but increasingly common enterprise.

Historically, the colonial powers paid little attention to pastoralists. The areas used were of low potential, their way of life inherently subsistent, and their contribution to development negligible. Contact was slight and sometimes centred on the removal of pastoralists from potential ranching land to even more marginal areas.

The first scientific group to take a positive interest in pastoralists were the social anthropologists. Only recently have animal scientists begun recording milk and animal performance. This interest in milk production is part of the broader objective of increasing animal production by improving either the utilisation of the rangelands or the animal husbandry practices.

Pastoralism has certain unique characteristics. First, milk and milk products are the mainstay of the human diet and at times the very survival of the household hinges on their continued production. Second, since supplementation of cows is uncommon, milk production is a function of season rather than stage of lactation. Third, since nutritional levels are low and water may be restricted, the ability to produce milk under nutritional stress and to survive adverse climatic conditions may be more important than high yields. Finally, owing to the crucial role of milk in the pastoralist diet and society, a delicate balance must be struck between milk offtake for

human needs and milk intake by the calf since the calf has no access to either milk substitutes or supplements. While camels and smallstock play an important role in certain societies the following general description of pastoralist milk production will concentrate on cattle.

Milk yield and milk offtake

In high-yielding *Bos taurus* animals milk offtake (i.e. milk not consumed by the calf) is a reliable indicator of total milk yield since let-down and retention problems are rare. In contrast, the pastoralists' cattle are usually *B. indicus* and will not readily let down their milk without the stimulus of their calf, and it is difficult to strip out all the milk by hand. Milk offtake in pastoral cattle is only about 30% of the yield during the first 4 months of the lactation, increasing in proportion as the calf develops a functional rumen. This total yield must be estimated by adding measured milk offtake by humans to estimated milk intake by calves, this latter term introducing a significant source of error into the final estimate.

Estimated total milk yields vary between 430 kg over 6 months in White Fulani to 300 kg in Maasai cattle over 10 months (Table 1), equivalent to 2.4 and 2.7 $kg.day^{1}$ respectively. Ethiopian Boran cows give a mean yield of 680 kg over a lactation of 7 months although the long lactations in the Borana system of southern Ethiopia yield an estimated 750 kg. The lower estimate of 518 kg over 7 months for Boran in Kenya (McKay, 1957) may be due to the drier environment.

Table 1. *Estimated lactation yield (kg) of Zebu cattle under pastoral conditions*.

Breed	Yield per cow (kg)	Recording period (months)	Source
White Fulani (Nigeria)	535	6	Otchere (unpubl.)
Maasai (Kenya)	800	10	Semenye and de Leeuw (in press)
Delta Fulani (Mali)	430	6	Diallo et al (1981)
Boran (Ethiopia)	680	7	Nicholson (unpubl.)
Boran (Kenya)	518	7	McKay (1957)

The most objective method of determining milk yield would be the weekly administration of oxytocin to allow complete milking out. Unfortunately pastoralists generally reject any experimental method that interferes with the normal milking procedure. An alternative is 'before and after' weighing of calves; this technique using dial scales with calf slings has produced disappointing results because intake is so low that the change in weight cannot be measured accurately enough. Working with more sensitive beam scales, intake can be measured to ±50 g but the process is laborious and the equipment expensive. Other workers have relied on the conversion factors of Drewry et al (1959) and Montsma (1960). More elaborate estimates may be obtained from the mathematical models of Konandreas and Anderson (1982) and equations based on calf growth and metabolizable energy content of the milk (Nicholson, 1984), but no great improvement has yet been demonstrated.

What becomes apparent is that individual and seasonal variations give rise to large standard errors of estimated mean yields. Most workers have found that year of calving and season of birth significantly affect both total milk offtake and total yield, while daily offtake and yield are a

function of season, stage of lactation, lactation number and location (probably due to the human demand for milk varying with population). Total yield is also higher when calving occurs around the start of the main rainy season, indicating that better nutrition is elevating the normal yield peak in the first 2 or 3 months of lactation.

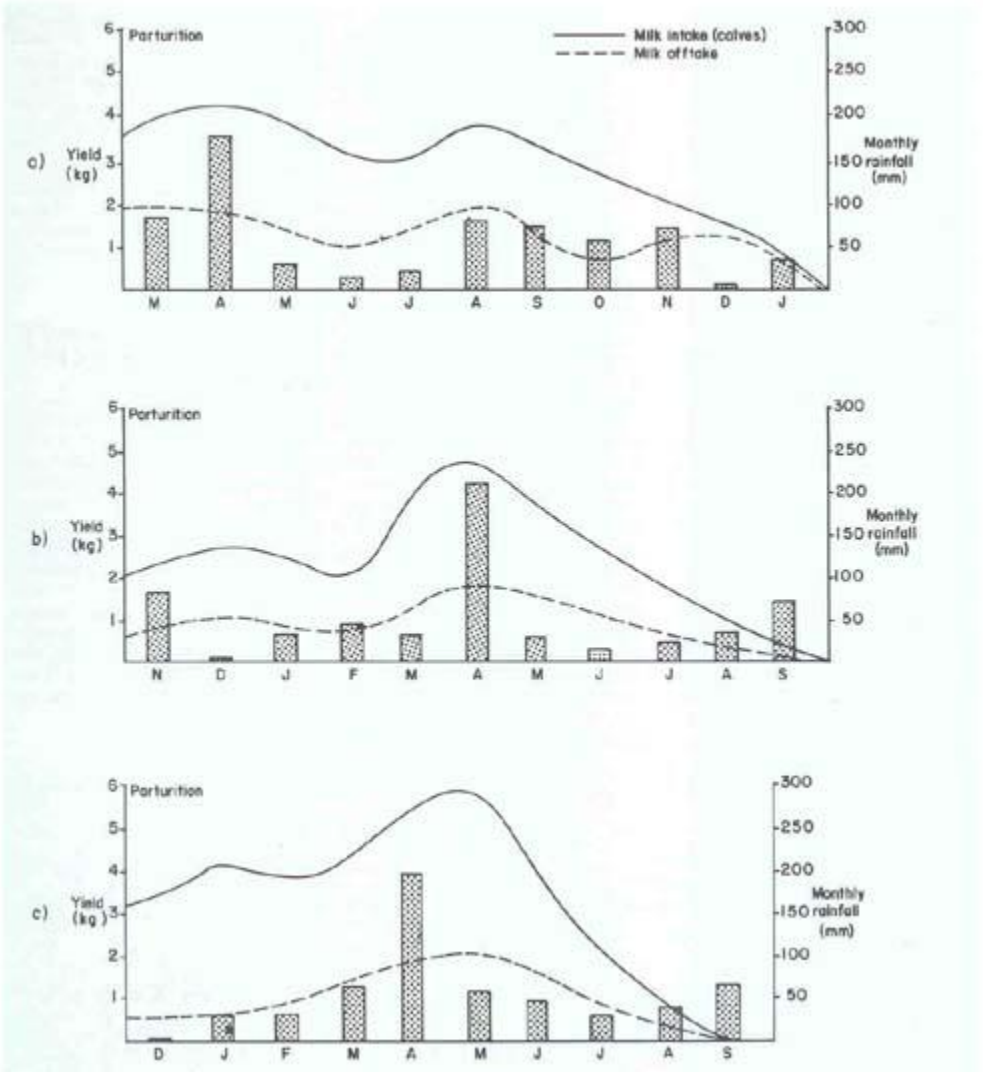
Hand-milking can be done before cattle leave their night enclosures and again on their return in the evening. This system is followed by the Borana and the Maasai pastoralists while the White Fulani cattle in Nigeria are milked only in the morning (Otchere, 1982). The Fulani tribe in Mali milk their animals in the evening and the calves remain with their dams through the night (Diallo et al,1981), whereas the Borana keep calves in their houses for a year or more and allow suckling twice a day and access to grazing during the daytime. Camels are milked several times a day by the Gabbra of southern Ethiopia, and apparently the camel calf is not essential to initiate letdown. Let-down in the absence of the calf is very difficult to induce in *B. indicus* cows, but the Borana have been observed to skin a dead calf and allow the dam to sniff the skin during milking, and by these means achieve a degree of let-down for several weeks.

Offtake is reported as 20–25% (Semenye and de Leeuw, in press), 25% (Otchere, unpubl.), 25–38% (Nicholson, unpubl.) and 31% (Diallo et al, 1981) of total milk yield. The offtake/intake ratio appears to be fairly constant for the first 4 months irrespective of yield. Actual offtake varies enormously from 150 ml per day in the dry season to 3 1 or more per day from highyielding cows during the rains. Mean offtake in Borana villages is 312 kg, with a standard deviation of ±108 kg reflecting the wide variation (Nicholson, unpubl.). This figure is similar to the 235 kg recorded in Mali (Diallo et al, 1981) and 286 kg over 416 days in Nigerian Fulani (Otchere, unpubl.).

The lactation curve

The classic lactation curve of well nourished commercial dairy cattle is not seen in pastoralist cows because the major influence on production is the season. New grass following the onset of the rains causes a rapid rise in milk production at almost any stage of lactation while the dry season severely depresses milk yield. Figure 1a depicts a typical bimodal lactation curve for Boran cows calving just before the start of the 'main' (April/May) rains in southern Ethiopia. Figure 1b demonstrates that when these 'main' rains occur in the middle of the lactation, the second peak can surpass the first, while a cow calving in the dry season can reach peak yield as late as the sixth month of lactation (Figure 1c). Calf suckling during this period is vigorous and prolonged and 'before and after' weighing shows large intakes of up to 3.5 kg. The peak of the curve may not necessarily indicate final yield since the length of the rainy season, the severity of the dry season and the highly variable lactation length will thwart any such prediction. A lactation curve with three distinct peaks has been noted by the author in a 13-month lactation.

Figure 1. *Lactation curves of Boran cows under pastoralist conditions.*



Milk composition

The reluctance of pastoralists to allow complete hand-milking-out of their animals means that data on composition relate only to that fraction of the milk which is taken for human consumption. Borana milk showed large variations which were not consistently related to stage of lactation, to individual cows or to season (Dessalegne, pers. comm.). Total solids averaged 14.5% and fat 5.4%, giving an approximate energy content of 3.47 $MJ.kg^{1}$ (Tyrell and Reid, 1965). These data are. comparable with those of Orr and Gilks (1931), working with Maasai cattle, who reported solids as 14.8% and fat as 5.5%.

Seasonal variations in composition exist but authors do not agree. Dahl and Hjort (1976) cite Bartha who reported that fat percentage decreased in the dry season; Maliki (1981) states that wet-season milk is not considered to yield much butter. The Gurma Imrad and Delta Tuareg in Mali and the Borana consider the late rains and early dry season to give the richest milk (Wagenaar and Winter, pers. comm.; Nicholson, unpubl.). Composition affects the quality of

milk products such as butter, soured milk and cheese, all of which may be prepared by pastoralists although cheese is less common.

Lactation length

Deliberate weaning is practised by some tribes. Wagenaar and Winter (pers. comm.) report that the Delta Fulani wean their calves at 11–12 months for the purpose of inducing oestrus in the cows. In contrast, Otchere (unpubl.) found that deliberate weaning was resorted to only when the dam was in an advanced state of pregnancy. Fulani herders smear dung on the teats to discourage the calf, while the pastoralists of the Accra plains tie a piece of rope to the calf's nose (Otchere, unpubl.) and the Somali tie a strip of thorn to the nose to inhibit suckling (Cossins, pers. comm.). In East Africa, natural weaning is normal in both Maasai (Semenye and de Leeuw, 1983) and Boran cattle. As a result lactation length is extremely variable (Table 2). Authors cited by Dahl and Hjort (1976) reported lactation lengths varying from 139 days in Kenya Boran to 12 months in Dinka cattle in Sudan. However, 7–9 months appears to be the average.

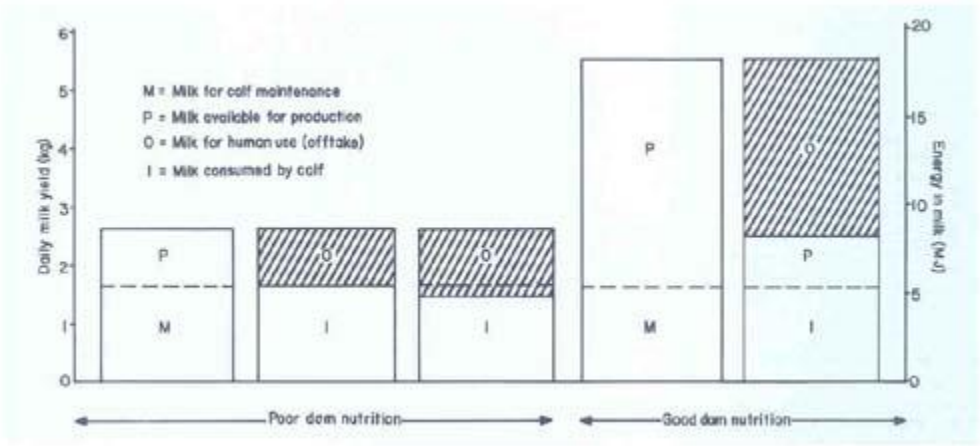
Table 2. *Variation in length of lactation (months)*.

Ethnic group	Typical lactation Length	Range	Source
Fulani (Nigeria)	13.9	–	Otchere (unpubl.)
Delta Fulani (Mali)	11.3	–	Diallo et al (1981)
Maasai (Kenya)	5	5–10	Semenye and de Leeuw (in press)
Borana (Ethiopia)	9.5	7–13.5	Nicholson (unpubl.)
Dinka (Sudan)	12	–	Dahl and Hjort (1976)
Somali (Somalia)	8	–	Mares (1954)
Borana (Kenya)	–	5.5–8	McKay (1957)

Calf growth

The relationship between calf growth and milk offtake is complex. If the offtake is high during periods of nutritional stress, the calf may even lose weight.

Figure 2. *Diagrammatic representation of the relationship between requirements for maintenance and production, and between intake and offtake.*



This is diagramatically represented in Figure 2 which shows how offtake can infringe upon the calf's maintenance needs. In the southern rangelands of Ethiopia, there are periods in the long dry season when calves lose weight and live off their body reserves. The owner, desperate for milk, tries to ensure that the calf does not die, which would terminate milk supply from the dam. Conversely, when the nutritional plane is high, offtake is also usually high but the calf still receives enough milk for reasonable weight gains. Diallo et al (1981) reported a positive correlation between milk offtake and calf growth, but any offtake means the calf will not realize its full potential. Typical weaning weights are shown in Table 3.

Table 3. *Calf weaning weights (kg) in various rangeland systems*.

Breed	Weight (kg)	Age (days)	System	Source
Boran (Kenya)	250	240	ranching	Nicholson (1984)
Boran(Ethiopia)	180	210	ranching	Abernossa ranch (Ethiopian Ministry of Agriculture)
Boran (Ethiopia)	47	210	pastoralist	Nicholson (1984)
Fulani (Nigeria)	55	180	pastoralist	Otchere (unpubl.)
Delta Fulani (Mali)	61	180	pastoralist	Diallo et al (1981)
Maasai (Kenya)	65	210	pastoralist	Semenye and de Leeuw (in press)

There is no doubt that milk offtake affects calf growth but it is difficult to assess by how much when there are other confounding factors such as water availability and frequency, disease, onset of rumen function and nutrition. The greatest difference is that between the Boran calves reared in the traditional way and Boran animals reared on an Ethiopian government ranch where all the milk goes to the calves. The 7-month weights average 47 and 180 kg respectively. The obvious superiority of the ranch animals is a reflection of their extra milk intake as well as the superior grazing and husbandry not usually encountered in pastoralist areas.

Potential calf growth in the absence of milk offtake can be predicted from actual growth and the metabolizable energy content of the milk provided milk offtake is known (Nicholson, 1984). Using such equations, it was predicted that, in a pastoralist system, Boran calves would be

120–140%a heavier at 8 months if they received all the available milk. While this is a somewhat academic consideration it does illustrate one of the most important constraints to animal productivity under pastoralist conditions.

Effect of milk production on reproductive rate

Milk offtake for human consumption and body adornment (several tribes adorn themselves with butter), combined with low milk yield, affects reproductive rate in two ways. First, milk offtake results in slower calf growth and late puberty and age at first calving, although this is probably exacerbated by post-weaning nutritional stress. Second, low reproduction rates, probably caused by lactational anoestrus, have been observed in Fulani cattle in Mali (Wagenaar and Winter, pers. comm.) and by Otchere (unpubl.) in the White Fulani breed in Nigeria. These observations may partly explain the long calving intervals of 15 months in the Borana system (Agrotec, 1974) and 27 months in the Fulani cattle of Nigeria (Otchere, unpubl.). Both estimates were based on only a short period of data collection and are probably underestimates. There are some suggestions that Zebu cattle are more prone to anoestrus than European cattle as a result of undernutrition during lactation and hormonal factors, but direct comparisons are not available.

Milk restriction may also contribute to calf mortality rates which vary from 9% in the Maasai (Semenye and de Leeuw, in press) to 49% in White Fulani in Nigeria (Otchere, unpubl.), and this further depresses annual cow productivity rates.

Milk from camels and smallstock

Pastoralists who rely on camels as a source of milk often live in harsher, drier environments than cattle pastoralists, but this is not always the case. The Gabbra of southern Ethiopia are mainly camel herders but share their habitat with the Borana, and the browsing habits of their camels seem to be complementary rather than competitive in terms of land use. Lactations vary between 12 and 18 months and offtake yields between 1000 and 2500 kg, although higher estimates have been reported (Dahl and Hjort, 1976). A feature of camel production is the high calf mortality, recorded as 65% in the Gabbra system and supported in the above review by Dahl and Hjort. Percentage of fat and total solids in milk is lower than in Zebu cattle and cattlemilk drinkers regard it as inferior. Average composition is 10.1% SNF and 2.9% fat (Williamson and Payne, 1978).

Both cattle and camel pastoralists complement their milk supply by keeping smallstock. Ethiopian Borana seldom drink sheep milk whereas goat milk is often used as a dry-season reserve, particularly for children. In Kenya the Turkana take milk from both sheep and goats while the Maasai, Samburu and Kenya Borana use only goat milk (Dahl and Hjort, 1976). These authors point out the difficulty of deciding whether quoted yields represent milk offtake for human use or total estimated yield. What is important to note is that milk from smallstock may be an important source of energy at certain times, and that goats and camels are able to exploit browse in the dry season better than cattle or sheep, and so continue to produce milk when cattle milk is scarce.

Conclusion

Milk production in pastoralist societies is marked by a strong seasonal influence on yield and composition. Because of poor nutrition milk production is correspondingly low and a significant part of the yield is taken for human use. As a result calf growth rates are poor and mortality is high. Poor nutritional status is therefore thought to be the main cause of delayed age at maturity and first calving. High-yielding cows are unsuited to such environments, and natural selection appears to have favoured the development of hardiness at the expense of high yields. Camels have higher yields and longer lactations than cows but the milk is of lower quality and not liked by all tribes. The milk of smallstock may be a crucial energy source in dry seasons, particularly for children, but is usually of secondary importance to that from cattle and camels.

It must be emphasised that pastoralists rely on milk as their staple food and that drought and seasonal stress are recurring facts of life. Pastoralists are efficient users of a difficult environment and opportunities for improvement are few. Three alternatives exist. The first is the introduction of a cropping enterprise which would allow diversification of the diet and provide stock with crop residues or forage as a source of feed during dry-season nutritional stress. The problem here is that in many pastoralist regions, cropping is not a viable option. Second, individual milk yields could be raised by a combination of supplementation and breeding, but the prospects for this are limited. Third, the ratio of people to milking cows could be lowered, but since the human population is increasing in Africa at present, and stock numbers are often at or beyond the carrying capacity of the ranges, this is unrealistic. Improvements in the system will be difficult to realize, and considerable thought must be given to the question of whether any change in pastoralism will not ultimately be for the worse.

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