Camel calf losses and calf care measures in pastoral herds of Northern Kenya. A system view

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Key words

Camelidae - Young animal - Pastoral system - Productivity - Mortality - Livestock management - Innovation adoption - Knowledge-based system - Kenya.

Summary

A comparative analysis of management, production and productivity of three pastoral camel husbandry systems (Rendille, Gabra and Somali) in Northern Kenya was conducted using the life history technique, management questionnaires and a bioeconomic modelling approach. Based on life history data for 1506 Rendille (RE), 789 Gabra (GA) and 1206 Somali (SO) camel calves born between 1980 and 1995, this study presents quantitative information on losses and underlying causes. The effect of calf losses on overall herd productivity was assessed for the three systems using a bioeconomic herd-driven model. Average calf mortality up to one year of age was 27% in RE, 22% in GA and 31% in SO calves, with a wide variation between the years (5-87% RE, 12-67% GA, 11-42% SO). Mortality in SO calves was significantly higher in males than in females (35 vs. 28%). Diseases accounted for most of the losses: 59, 71 and 82% in RE, GA and SO calves, respectively. Mortality caused by drought (22, 21 and 1%), predation (9, 6 and 7%) and accident (2, 5 and 3%) was of lower importance. Unknown causes accounted for 7-10% of overall losses in the three systems. Few major disease groups, namely enteritic conditions, skin conditions, septicemia and tick intoxication were responsible for 66, 83 and 65% of losses in RE, GA and SO calves, respectively. Analyzing mortality causes and related management suggested that a change in colostrum management could reduce mortality considerably. However, pastoralists do not adopt management changes on the sole advice of an outsider, even if a beneficial impact is promised. They will first evaluate such proposed changes in the context of their own view and knowledge of cause and effect relationships within their production system. Understanding the pastoralists' rationale is a prerequisite for identifying appropriate research and development activities in pastoral production systems.

■ INTRODUCTION

High camel calf mortality rates are generally considered an important bottleneck in pastoral camel husbandry systems. Figures of 30-50% are estimated for East Africa (7, 10, 23, 26). Competition of man and calf for milk is said to be the main underlying reason (4, 21, 25). However, sources providing long-term data from the pastoral areas are scarce in literature. Furthermore, little is known about the importance of calf mortality for the productivity of the husbandry system. This knowledge in combination with knowledge on pastoral calf rearing management is essential to assess effective and feasible interventions to profitably reduce calf mortality. The present paper comparatively assesses calf mortality, its causes, importance and possible improvement measures in three pastoral camel husbandry systems in Northern Kenya.

■ MATERIALS AND METHODS

Study location, production conditions and pastoral communities

A comparative analysis of camel husbandry systems of the Rendille, Gabra and Somali pastoral communities was carried out in Marsabit District in Northern Kenya (figure 1).

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Figure 1: *Marsabit District.*

All three pastoral communities are classified as Hamitic peoples (19). The Rendille are said to have their ancestral origins among the Somali, but are considered an own ethnic group with their own language, Kirendille. They inhabit the southwest of the district. The Gabra originate from the Galla people of Ethiopia. At the beginning of the century, they became resident in the northwest of the district (18). The Somali of this study belong mainly to the Garre clan, one of the most important and numerous clans of the Somali pastoral community in Northern Kenya. They inhabit the northeast of the district (17).

All three communities lead a nomadic life, whereby several households form a camp (*manyatta*). Camel husbandry is the cornerstone of their production system, but all of them also keep small ruminants. Cattle are kept to a lesser degree where forage conditions are more favorable (15).

In Northern Kenya, rainfall follows a bimodal pattern. The long rainy season from March to May brings the majority of rainfall, whereas the short rainy season from October to November brings only little rain and often does not bring any.

A brief characterization of the natural resources in the Rendille, Gabra and Somali areas is given in table I. It becomes obvious that the production environment is most favorable in the Somali area.

Data collection

Production data

Animal records were obtained using the Life History Techniques whereby herders recall the complete life history for individual breeding females from birth to the present date chronologically and event by event (24). Herders knew their breeding females individually and identified them by names. For every calf of a breeding female the following information was collected: date of birth, sex, survival until weaning, age and reason for death if applicable, offtake reason and time if applicable, present destination.

The existence of a calendar system for the Rendille, Gabra and Somali permitted the collection of life history data as “dates” (year and season). Following the approach of Swift (24), members from the pastoral communities were chosen and trained as enumerators. They were well-respected elders of the community, who possessed their own herd of camels, and were literate in either English or Kiswahili. They were familiar with the topics, because the notion of animal life histories is part of their everyday life.

Management data

Information on management areas, which are under the control of the pastoralists and which were anticipated to affect production parameters, was collected through management questionnaires.

Table I

Characterization of natural resources*

	Rendille	Gabra	Somali
Surface (km^2)	11,000	27,000	9,000
Altitude (m a.s.l)	350	400 to 600	400 to 700
Median rainfall** (mm)	163	123	503
Duration of drought (months)	4-11	4-11	4-11
Average total biomass availability (kg DM/ha/year)	1659	1835	2592
Herbal layer (kg DM/ha/year)	1190	1301	1778
Shrub layer (kg DM/ha)	469	534	814

* Based on data published in the Range Management Handbook (Schwartz *et al.*, 1991)
** Data from the Kenya Meteorological Department (1996) for the period 1980 to 1994

Among others, information on calf care, important calf diseases and respective treatment possibilities were recorded.

The number of both life history and management questionnaires completed in the three communities is compiled in table II.

Table II

Number of life histories and management questionnaires completed

	Rendille	Gabra	Somali
Life history			
Adult females	471	287	416
Calves	1506	789	1206
Management questionnaire	56	50	55

Data analysis

The data recorded with the life history questionnaires refer to the time period 1980-1995. For each community data from all herds were combined and thus represent the camel populations of the Rendille, Gabra and Somali. Inherent fitness traits for the respective populations (survival rates by sex and age, culling rates by age, age at first calving, calving interval and litter size) and produce-related input parameters for the production systems (yields, prices) were calculated and used as input parameters for a herd model.

The bioeconomic computer model PRY (2) was used to determine productivity of the respective camel populations. Outputs of the camel production system were aggregated into a total output value (TOV). A productivity index (PI) was calculated as total output value/dry matter intake for an average herd animal (AHA). An average herd animal is a "theoretical animal" composed of the different animal categories, breeding female, surplus female and fattening male, according to their proportions in a steady state herd (3). A steady state herd does neither increase nor decrease in size. Assuming a steady state herd is necessary when productivity indices for different husbandry systems or management alternatives are to be compared.

Sensitivity analyses were conducted using the bioeconomic model in order to determine the impact of change of single production parameters on the productivity of the camel husbandry system. These analyses permit the ex-ante evaluation of the effects of change in management, which are assumed to affect the production parameters.

Seminars

After the analyses, the results obtained and the management propositions derived from them were discussed in seminars with pastoralists for each of the three communities. Each topic was presented and discussed as follows:

- An introductory summary of the present management practices and production level was given to improve transparency for the pastoralists;

- The problems associated with this management were presented as seen by the scientist;

- The scientist proposed possible improvement measures;

- The pros and cons of the present and proposed management were discussed with the pastoralists.

■ RESULTS AND DISCUSSION

Calf losses

Average preweaning mortality (birth to 12 months of age) was found to be 27.3, 22.3 and 31.4% in Rendille, Gabra and Somali calves, respectively, over the 16 years from 1980 to 1995. Calf mortality for single years shows a wide variation especially in the Rendille and Gabra systems. It ranged from 5 to 87% in Rendille, 12 to 67% in Gabra and 11 to 42% in Somali calves.

The often quoted calf mortality rates of 30 to 50% for Northern Kenya (7, 10, 23, 26) can well represent values of single years, but seem to be exaggerated if used as long-term averages.

Only in the Somali system, mortality of male calves was significantly higher than that of female calves and of male calves in the other two systems (table III). In a milk oriented system, higher male calf mortality rates would not be surprising especially when males cannot be sold or fattened and slaughtered (9). Further analysis of the production systems (15) showed that the Somali production system is predominantly geared towards milk production and male calves are of secondary importance. In the Rendille and Gabra systems, however, males are of higher value because of their transport function and as savings (15).

Table III

Calf mortality until weaning

	Rendille			Gabra			Somali		
Calves	**n***	**n_d****	**mortality (%)*****	**n***	**n_d****	**mortality (%)*****	**n***	**nd****	**mortality (%)*****
Females	719	183	$29.3^{a,\alpha}$	388	73	$20.8^{b,\alpha}$	606	147	$27.6^{a,\alpha}$
Males	787	178	$25.6^{a,\alpha}$	400	85	$23.8^{a,\alpha}$	600	180	$35.3^{b,\beta}$
All	1506	361	27.2^{a}	788	158	22.3^{b}	1206	327	31.4^{a}

* Number of animals at the beginning of the period
** Number of animals that died during the period
*** Calculated as n_d / n - 1/2 n_d
Within rows (a,b) and columns (α, β), respectively, values with different letters differ at $p < 0.05$

Causes for calf losses

Losses caused by disease accounted for 59, 71 and 82% of total losses in Rendille, Gabra and Somali calves, respectively. Rendille herders associated 22% of their calf losses with drought. Almost all of these occurred in calves born in 1991. Gabra herders associated 11%, and Somali herders only 1% of calf losses with drought. The difference in production conditions between the areas could explain it, because drought and feed shortage were more common in the Rendille and Gabra areas than in the Somali's. Predation was another important mortality cause responsible for 6 to 9% of preweaning calf losses. Hyenas accounted for most of these, usually attacking stray or lost animals. Hence, careful herding and preventing animals from straying were regarded as important herd management measures by the pastoralists.

Few major disease conditions, namely enteritic conditions, skin conditions, septicemia and tick intoxication were responsible for 76, 83 and 65% of losses caused by disease in Rendille, Gabra and Somali calves, respectively (table IV).

Diarrhea was a major cause of loss in all three systems, as well as in camel systems in Somalia and Niger (13, 20). Furthermore, pox was important in the Gabra and Somali systems, septicemia/navel ill and tick paralysis in the Rendille and Gabra's, and Ilgoff in the Somali's. These disease conditions have also been identified as the most important ones in Morocco (12). Orf and camel pox are of high importance in Tunisia (11) and severe tick infestation in the Pokot system in Kenya (5).

Calf care measures

Pastoralists reported to follow a combined milking and suckling regime, whereby calves usually get the milk of half their dam's udder, while the remaining half is milked for human consumption. If calves do not thrive well enough they might get the whole milk of their dam, be supplemented with more milk from other camels or even be fed sheep fat as energy rich supplement.

Other commonly reported calf care measures were:

- Removal of ticks, washing with acaricides, changing pasture;

- Improving fencing, protection from predators;

- Preventing diarrhea.

Herders say that one main measure to prevent diarrhea is to ensure that the calf does not get too much of the first milk (colostrum). Therefore, the udder is milked out once before the calf first sucks and the calf is left with only a restricted quantity (about half a liter) of colostrum on the first day of life. Pastoralists claim that if this practice is not followed, calves are likely to get diarrhea, especially if their mothers have high milk yields.

There was a special care for the so-called *lamadel* calves. A traditional belief is that the milk of a camel giving birth to her second calf (the *lamadel* calf) is harmful to the calf. This is either because the amount is too high or because the milk is too strong, as they say, meaning more concentrated. Therefore, the calf is likely to get diarrhea and may die as a consequence. To prevent this, the udder of high yielding camels is milked out completely, both in the morning and in the evening, from the first day of lactation onwards. The *lamadel* calf is only allowed to suck the remnant after milking. After the first month, *lamadel* calves are treated like the others.

Especially the last two calf care measures reported, i.e. preventing the calf from drinking "too much" colostrum and milk, seem contraproductive. Withholding the colostrum means depriving the calf of antibodies, essential to combat infections during the first weeks of life. Other pastoral communities also consider colostrum harmful to the calf and hence restrict its intake (5, 6, 13). Only Burgemeister (8) observed that Tunisian herdsmen actively feed with colostrum those calves which fail to stand up soon after birth, because they consider the early intake as important.

Physiologically, the observed digestive disorders might be related to the high protein content of colostrum, 14% versus 4% in milk (1). If large amounts of colostrum are ingested at once, the resulting high amounts of ingested proteins cannot be completely absorbed and/or digested in the small intestine of the newborn and is passed on into the colon. There, these proteins are osmotically active causing water influx, which might lead to the observed diarrhea (14).

Ex-ante analysis of possible measures to reduce calf mortality

Sensitivity analyses to compare the systems output and productivity for the actual mortality level (status quo) and with reduced calf mortality were done using the bioeconomic model PRY.

Analyses were run under the assumption that calf mortality up to six months of age could be halved. This would reduce overall preweaning mortality to about 20, 15 and 20% in the Rendille, Gabra and Somali populations, respectively.

Table IV

Reported disease signs associated with calf losses

Rendille (n* = 213)	%	Gabra (n* = 112)	%	Somali (n* = 270)	%
Har (diarrhea)	33	Abthara (pox)	25	Ilgoff** (emaciation)	28
Gulor (navel ill)	18	Mita (septicemia)	24	Har (diarrhea)	23
Chilim ticks)	15	Albati (diarrhea)	21	Dulla (abscesses)	7
Lamadel (loss in second borns)	10	Chilim (ticks)	13	Bagga (pox)	7
Other diseases	24	Other diseases	17	Other diseases	35

* Number of preweaning calf losses due to disease
** Disease of unknown etiology, showing symptoms of eye infection, emaciation and weakness

In camels, lactation ceases in absence of the stimulus of the sucking calf, hence, early calf mortality leads to a reduction in milk offtake. A reduction of the lactation yield of about 50% was recorded by Simpkin (23). Using this estimate, it was assumed that reducing calf mortality would increase milk yield and consequently the offtake in the respective dams in the order of 50%. It was further calculated that reducing calf mortality to the above percentage would affect about 7, 7 and 11% of all the lactation in the Rendille, Gabra and Somali systems, respectively. Consequently, the average milk offtake per lactation would rise from 1097, 1400 and 1581 kg to 1180, 1499 and 1763 kg in the Rendille, Gabra and Somali systems, respectively (15).

Under these assumptions, the productivity index increases by 10 and 9% in the Rendille and Gabra systems, respectively, and even by 14% in the Somali system. Evaluated on a monetary basis, the total output value increases by 320, 329 and 709 Kenya shillings (KSh) per average herd animal per year for Rendille, Gabra and Somali camels, respectively (table V).

Seminars with pastoralists

The assessment of calf losses, loss causes, calf care measures and their impact on systems output and productivity suggests that:

- Only few disease conditions are of paramount importance for calf losses;

- Among these are diarrhea, navel ill and septicemia, i.e. infections with ubiquitous bacteria, which are likely to be due to a lack of passively acquired immunity;

- Herders' management of restricting colostrum intake in calves might foster these disease conditions;

- Reducing calf mortality is beneficial for the productivity of the husbandry system.

Therefore, possible changes in colostrum management as an improvement measure to the system were discussed with the pastoralists in seminars. A summary of the dialogue that took place in one of the seminars is given in annex 1.

The extract of the discussion in annex 1 shows that the Rendille pastoralists doubted the usefulness of the change in management, because they could not see that the recommendation would yield the same effect in their production environment as in the one the scientist had experience with.

Although the outcome of the seminar seemed at first unsatisfactory, some essentials could be learned about the pastoralists' perception of problems. It became clear that cause and effect relations were seen differently by scientists and pastoralists. In essence, the pastoralists observed that calves that consumed high amounts of colostrum suffered from diarrhea and therefore they reasoned that colostrum consumption promotes diarrhea. Scientists, on the other hand, followed the reasoning that colostrum contains antibodies and protects the animal from diseases like diarrhea. The proposed change in management, i.e. giving calves full access to colostrum, did not comprise a solution to the problem diarrhea, which pastoralists empirically related to colostrum feeding in their production system. The fact that the scientist did not encounter a diarrhea problem following free access to colostrums was not convincing in itself, and could in their view be due to the difference in vegetation. The nutritional base of the mother camels had to their knowledge an impact on milk properties.

Table V

Total output value and productivity index for status quo and reduced calf mortality (PRY model results)

	Rendille			Gabra			Somali		
	Sq[1]	Assumed change		Sq	Assumed change		Sq	Assumed change	
Calf mortality rate (%)	27,2	20		22,3	15		31,4	20	
Milk offtake (l/lactation)	1097	1180		1400	1499		1581	1763	
Output value in monetary units (KSh)[2] per year	**per AHA[3]**	**per AHA**	**Δ**	**per AHA**	**per AHA**	**Δ**	**per AHA**	**per AHA**	**Δ**
Liveweight (KSh)	894	932	+4%	857	897	+5%	1318	1467	+11%
Fallen meat (here hides) (KSh)	12	11	-8%	15	14	-7%	24	21	-13%
Milk offtake (KSh)	2574	2857	+11%	3192	3482	+9%	4149	4712	+14%
Total output value (TOV) (KSh)	3480	3800	+9%	4062	4393	+8%	5491	6200	+13%
Dry matter intake (DMI)(kg)	2051	2029	-1%	2094	2077	-1%	2903	2868	-1%
PI[4] = TOV/DMI (KSh/kg)	1.7	1.9	+10%	1.9	2.1	+9%	1.9	2.2	+14%

1. Status quo
2. 55 KSh (Kenya shillings) = 1 US$ in 1996
3. Average herd animal
4. Productivity index

Annex 1

Extract of a seminar with Rendille pastoralists

Introducing the topic, the scientist pointed out that:

1. Despite various calf care measures it was observed that on average about one third of the calves died before reaching weaning age, and that diseases probably due to a low immune status, such as diarrhea, were the major causes.

2. Mortality was especially high for calves of heifers and for *lamadel* calves. This high disease incidence and subsequent mortality was very likely caused by the common practice of withholding colostrum.

The scientist then explained the function of colostrum as passive immunization against diseases and proposed that the herders should feed the whole colostrum to the calves.

A discussion with elders followed (it must be kept in mind that the pastoralists knew the scientist as a camel expert from a livestock ranch keeping over 400 camels in semi-arid Laikipia District of Kenya).

During the discussion the elders were first receptive to the advice, but at the same time expressed their fears. From their experience, colostrum is dangerous for the calf; especially calves of high yielding mothers are likely to get diarrhea from consuming colostrum ("When pastures are good the milk is more nutritious hence during that period you must prevent the calf from drinking colostrum from birth up to three days"). Pastoralists were, however, also aware of beneficial effects of colostrum. It was mentioned that the young warriors themselves consume much colostrum "in order to get strong".

When asking the pastoralists whether they would try to let the calf have full access to the colostrum, they wanted to know what the scientist would recommend in order to prevent the diarrhea, a danger they anticipated from the proposed change in management.

First, they asked whether the scientist gave additional medicine to prevent diarrhea. The scientist replied that this was not necessary as no problems were experienced after giving the colostrum. Then, they asked several questions about the camel production system the scientist had experience with, e.g. whether the camel breeds were the same and how the vegetation in that area compared to their own. This revealed that there were differences in the vegetation the camels were feeding on, and led the pastoralists to conclude: "The risk of getting milk, which brings about the diarrhea to the calves, depends on the vegetation. Thus, the situation in your area might not be the same as here".

■ CONCLUSION

Field methods are available to collect long-term demographic and production parameters for pastoral camel husbandry systems. A ready to use bioeconomic herd model exists to further aggregate such parameters into productivity indices, and to perform sensitivity analyses for the ex-ante evaluation of intervention-induced parameters change.

Regarding calf mortality, only long-term data permit a meaningful assessment of its importance within a production system and there is evidence that its actual value and impact have often been overestimated in the past. Assessing a realistic impact of calf mortality requires a system's perspective and calf mortality cannot generally be considered a major production constraint for camel husbandry. In the present study, the predicted benefit of reducing calf mortality was moderate for the husbandry system as a whole. However, analyzing mortality causes and management practices revealed that a change in colostrum management could reduce mortality considerably, and because this is a cheap measure it would at first glance seem a sensible one to take.

This leads to the question of target group participation in research programs. Analyzing husbandry systems should be conducted in close cooperation with the pastoralists in order to include their system inherent knowledge. When finally deriving recommendations and proposing management changes in order to improve on certain aspects of the system, pastoralists must be closely involved in the evaluation of such recommendations. The present study made it clear that no experienced livestock keeper will adopt changes to his management on the pure advice of an outsider, even if a beneficial impact is promised. He will first evaluate such proposed changes in the context of his own view and knowledge of cause and effect relationships within his production system, and will not adopt it if he anticipates problems arising from it. He will take the lesser risk; the higher his degree of dependence on livestock husbandry is, the more critical to innovation he will be.

Understanding that non-adoption is not caused by pastoralists' ignorance, that it has a rationale behind it, is a prerequisite for appropriate research and development activities in pastoral production systems.

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Résumé

Kaufmann B.A. Mortalité du chamelon et mesures envisagées dans des troupeaux de systèmes pastoraux au Nord Kenya. Point de vue

Une analyse comparative des pratiques, de la production et de la productivité de trois systèmes pastoraux camelins (Rendille, Gabra et Somali) au Nord Kenya a été réalisée par la technique d'analyse généalogique, les questionnaires sur les pratiques et une approche de modélisation bioéconomique. Sur la base des données généalogiques provenant de 1 506 chamelons Rendilles (RE), 789 Gabra (GA) et 1 206 Somali (SO), nés entre 1980 et 1995, cette étude présente une information quantitative sur l'importance des pertes et leurs causes sous-jacentes. L'effet des pertes sur la productivité globale du troupeau a été évalué pour les trois systèmes par l'intermédiaire d'un modèle bioéconomique. Le taux de mortalité moyen des chamelons de 0-1 an a été de 27 p. 100 chez les RE, 22 p. 100 chez les GA et 31 p. 100 chez les SO avec une variabilité importante selon l'année (respectivement 5-87, 12-67 et 11-42 p. 100). La mortalité des chamelons SO a été significativement plus élevée chez les mâles que chez les femelles (35 vs 28 p. 100). Les maladies ont été à l'origine de la plupart des pertes (59, 71 et 82 p. 100 respectivement chez les RE, GA et SO). Les mortalités dues à la sécheresse (respectivement 22, 21 et 1 p. 100), aux prédateurs (9, 6 et 7 p. 100) et aux accidents (2, 5 et 3 p. 100) ont été d'importance mineure. Celles qui étaient liées à des causes inconnues ont représenté 7 à 10 p. 100 de l'ensemble des pertes des trois systèmes. Quelques maladies majeures, comme le syndrome entéritique, les maladies cutanées, la septicémie et les infections par les tiques, ont été responsables de 66, 83 et 65 p. 100 des pertes dans les trois systèmes respectifs. L'analyse des causes de mortalité et des modes de gestion associés a montré qu'en modifiant la gestion du colostrum on pouvait réduire la mortalité considérablement. Cependant, les pastoralistes n'appliquent pas à leurs méthodes les changements recommandés par les personnes de l'extérieur, même si des résultats prometteurs leur sont garantis. Ils évalueront d'abord ces propositions de changement à la lumière de leurs connaissances sur les relations de cause à effet à l'intérieur de leur système de production. C'est d'abord en comprenant le raisonnement de ces éleveurs que des activités de recherche et de développement pourront être identifiées pour les systèmes de production pastoraux.

Mots-clés : Camelidae - Jeune animal - Pastoralisme - Productivité - Mortalité - Conduite d'élevage - Adoption de l'innovation - Système basé sur la connaissance - Kenya.

Resumen

Kaufmann B.A. Pérdidas de camellos jóvenes y medidas para el cuidado del joven en hatos en pastoreo en el Norte de Kenia. Una visión del sistema

Se llevó a cabo un análisis comparativo del manejo, la producción y la productividad de tres sistemas de crianza de camellos en pastoreo (Rendille, Gabra y Somali) en el Norte de Kenia, esto mediante el uso de la técnica de historial de vida, cuestionarios de manejo y un enfoque de modelo bioeconómico. El presente estudio, basado en datos de registros de 1506 camellos jóvenes Rendille (RE), 789 Gabra (GA) y 1206 Somali (SO), nacidos entre 1980 y 1995, presenta una información cuantitativa de las pérdidas y las causas adyacentes. El efecto de las pérdidas de animales jóvenes en la productividad global del hato se midió en los tres sistemas, utilizando un modelo bio-económico, hato orientado. La mortalidad promedio hasta el primer año de edad fue de 27 % para RE, 22 % para GA y 31 % para SO, con una amplia variación entre años (5-87 % RE, 12-67 % GA, 11-42 % SO). La mortalidad en los jóvenes SO fue significativamente mayor en machos que en hembras (35 vs. 28 %). La mayor causa de las pérdidas fueron enfermedades: 59, 71 y 82 % en RE, GA y SO respectivamente. La mortalidad causada por la sequía (22, 21 y 1 %), predadores (9, 6 y 7 %) y accidentes (2, 5 y 3 %) fue de menor importancia. Causas desconocidas incurrieron en 7-10 % de las pérdidas totales en los tres sistemas. Una cantidad reducida de grupos de enfermedades mayores, como las enteritis, problemas de la piel, septicemia e intoxicación por garrapatas, fueron responsables de 66, 83 y 65 % de las pérdidas de jóvenes RE, GA y SO respectivamente. El análisis de las causas de mortalidad y el manejo relacionado sugirió que un cambio en el manejo del calostro podría reducir considerablemente la mortalidad. Sin embargo, los productores pastoriles no adoptan cambios de manejo únicamente bajo el consejo de un extraño, aún si se les promete un impacto benéfico. Primero evaluaran los cambios propuestos según el contexto del conocimiento y visión propios de la relación causa efecto dentro de cada sistema de producción. La comprensión del raciocinio de los pastores es un prerequisito para la identificación de las actividades de desarrollo y de investigación apropiadas en los sistemas de producción pastoriles.

Palabras clave: Camelidae - Animal joven - Pastoralism - Productividad - Mortalidad - Manejo del ganado - Adopción de innovación - Systema inteligente - Kenia.