FACTORS ASSOCIATED WITH DAILY WEIGHT GAIN OF CALVES IN MAASAI PASTORAL SYSTEMS IN KAJIADO DISTRICT, KENYA

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Abstract
An on-farm observational study was conducted between November 2000 and February 2002 to identify the factors associated with average daily weight gain (ADWG) of calves in Maasai pastoral systems of Kenya. The study involved a two-stage random sampling of 23 herds from 2 former Group Ranches. A total of 1,694 observations were made on 292 calves aged less than 13 months. Univariate and multivariate mixed model analysis were used to determine the association between growth rate and potential explanatory factors for ADWG. The overall ADWG was 0.26 kg (-0.57- 0.81 kg). There were significant differences in ADWG associated with age, breed, initial calf body weight, occurrence of clinical anaplasmosis and helminthiasis, frequency of water intake and seroconversion for *Theilaria parva* and *T. mutans*. Thus, selective breeding for higher weights and increased water intake during the dry period, coupled with improved delivery of animal health packages to control theileriosis and internal parasites would go a long way in increasing daily weight gains of calves in Maasai pastoral systems.

Introduction

In Kajiado District of Kenya, Maasai pastoral community keep indigenous cattle mainly for subsistence (de Leeuw *et al.,* 1984). However, calf health and production is low due to the interaction of poor nutrition and high incidence of diseases (Mwangi, 2000). Calves that survived up to one year were characterised by stunted growth, low body weight and delayed sexual maturity (Bekure *et al.,* 1991). For example, the body weights of Maasai zebu calves at birth, 1, 2 , 3, 4, 7, and 8 months of age were 19.2, 28.4, 35.2, 41.4, 47.5, 64.4, and 132.8 kg, respectively (Semenye, 1987). In the semi arid District of Trans Mara, Maasai Zebu calves that had been raised in an area that was endemic for theileriosis had a mean birth weight of 17.5 kgs and an average six-month weight of 53.4 kgs (Moll *et al.,* 1984). Low weight gains were associated with patent *T. mutans* and acute *T. parva* infections.

One of the strategies being used to improve calf growth rates in pastoral systems is the introduction of exotic breeds of cattle to upgrade local indigenous cattle (Karimi *et al.,* 2005; Ouda *et al.,* 2001). However, the impact of upgrading Maasai Zebu cattle with exotic cattle has not been measured due to scarcity of data. Similarly, factors affecting growth rate of calves have not been adequately analysed so that appropriate recommendations on how to improve calf growth can be made. The objective of this study was to identify causes of slow growth rate of indigenous calves in Maasai pastoral systems.

Materials and methods

Study area and selection of study herds

Study area and methods used to select the study herds are described in (Karimi *et al*., 2003)

Calf management

In the study by Bekure *et al*., (1991), Maasai calf raising practices were described. Calves were penned in well protected enclosures until they were one month old. Between 1-3 months, they were tethered in the shade and occasionally taken out to graze. During the dry season, women sometimes cut grass for calves. At 3-4 months old, calves were allowed to graze in the reserve grazing paddocks *(olopololis),* which had better quality herbage than the unprotected areas. Usually, the reserve grazing paddocks were located close to the homestead and along the pathway to the watering point so that the trekking distance was minimized. Calves from homesteads that were located in close proximity to the watering points were watered at an earlier age and were subsequently watered more frequently than calves from homesteads further from watering point. Calf suckling could continue even after milking had stopped while weaning was naturally done by the dam.

Data collection

Body weights were measured by the method described in Karimi *et al.,* (2005). The outcome variable of interest was ADWG calculated as the difference between body weights of 2 consecutive visits divided by the number of days between the visits. The period between visits for each calf varied from 30 - 76 days. The potential explanatory variables associated with ADWG that were investigated were season, pasture condition, calf herd size, nutrition, housing, distant grazing and watering, sex, age, breed, initial body weight, clinical diagnosis of theileriosis, anaplasmosis, babesiosis, helminthiasis and ringworms, seroconversion status for *T. parva, T. mutans, A. marginale* and *B. bigemina.*

Data analysis
Estimates of body weight (mean and standard deviation) were assessed at birth, 3, 6, 9 and 12 months for all the calves while the patterns of calf growth were explored in multiple-plot trellis of graphs and line graphs plotted for body weight and ADWG against calf age in S-Plus for all calves stratified by farm.

The association between ADWG and each explanatory variable were evaluated by adding the variable to a linear model with ADWG as the outcome and the explanatory co-variables: group ranch, age, age square and age cubed in uni- or multivariable models using PROC GLM in SAS (SAS, 1985). The possible interactions of each explanatory variable with group ranch were also assessed in the same way.

For the multi-variate regression model, group ranch, plus the quadratic age structure and all univariate effects that were significant from the univariate model was constructed. The mean daily weight gain data were considered as clustered in time and space. Thus, PROC MIXED was employed to choose a variance-covariance structure that addressed the correlations between calves within farm and repeated measurements within calves. Farm was treated as a random effect and a variance component was estimated for farm. The backward elimination method was used to generate a final model through elimination of non-significant ($P>0.05$) variables from the full model.

Results
The mean body weight of calves at birth, 3, 6, 9 and 12 months was 25.9 ± 5.5, 46.2 ± 11.7, 67.7 ± 15.7, 89.8 ± 21.2 and 104.5 ± 23.1, respectively. Figure 1 shows there was wide variation in calf body weights for age within farms. Figure 2 shows that the ADWG by calf age varied between farms (Figure 2). The results indicate that calves that had low initial body weight were growing at lower rate than calves that had high initial body weight.

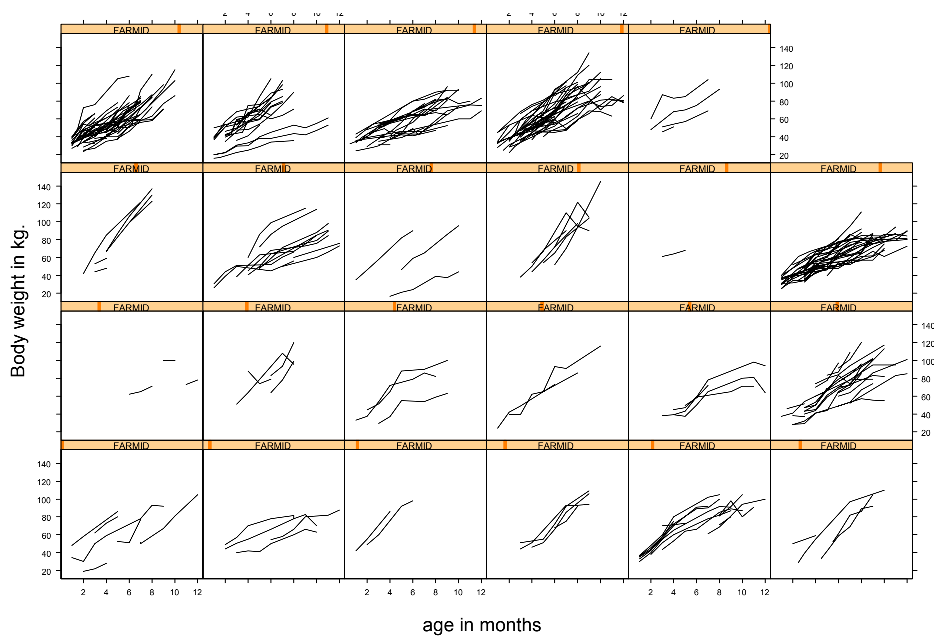
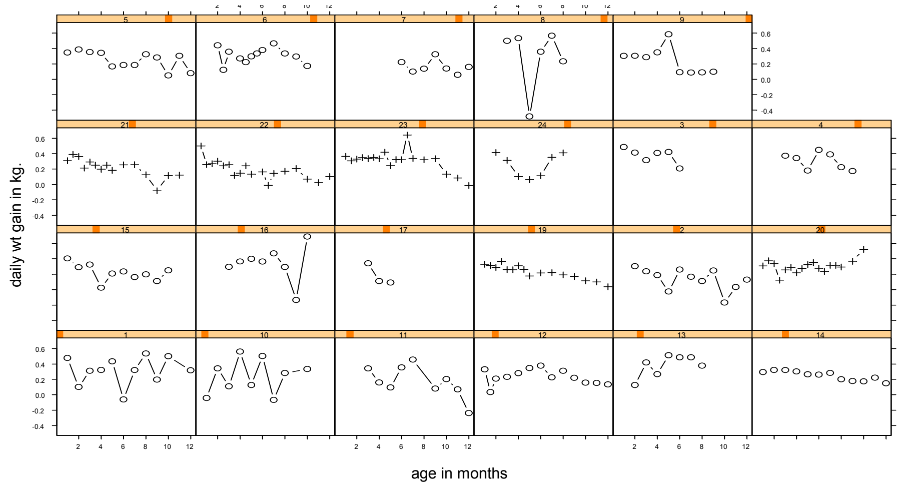


Fig. 1: Body weights of calves for age by farm in Maasai pastoral systems in Kajiado District, Kenya. Longitudinal Study: November 2000 – February 2002



- +- +- +- Nentanai group ranch   -o-o-o-o- Olosho Oiborr group ranch

Fig. 2: Average daily weight gain for age by farm in Maasai pastoral systems in Kajiado District, Kenya. Longitudinal Study: November 2000 – February 2002

Table 1 shows variables that were associated with ADWG of calves from the multivariate model. The cubic term for age was significant (p=0.0002) in a linear model of ADWG vs. group ranch, age, age squared and age cubed. Interaction terms for age and group ranch were not significant (p=0.67, 0.18, 0.15 for the linear, quadratic and cubic terms, respectively). Calves in Olosho Oiborr group ranch had significantly higher (p=0.0291) ADWG compared to calves in Nentanai group ranch. Explanatory variables that were significantly associated with ADWG are listed in Table 1.

Table 1–Fixed and random effects for a mixed model analysis of variables associated with average daily weight gain from 647 calf observations in Maasai pastoral systems in Kajiado District, Kenya (Longitudinal study, November 2000 – February 2002)

Variable	Category	b	se	p-value
a) Fixed effects				
Intercept		0.06	0.06	0.30
Group Ranch	Olosho Oiborr ranch (1) vs. Nentanai(0)	0.05	0.02	0.029
Grazing	Restricted (1) vs. free (0)	0.28	0.11	0.013
	Restricted in Olosho Oiborr ranch (1)		0.14	0.024
	vs. restricted in Nentanai (0)	-0.36		
Pasture condition	Good (1) vs. poor (0	0.14	0.02	<0.0001
Season	Wet (1) vs. dry (0)	0.07	0.02	<0.0001
Distance to pastures	Near (<5km) (1) vs. far (>5km) (0)	0.15	0.05	0.005
(relative to boma)	Near (<5km) in Olosho Oiborr ranch (1)		0.07	<0.0001
	near (<5km) in Nentanai (0)	-0.36		
Watering frequency	*Ad libitum* (1) vs. once daily (0)	0.07	0.02	<0.0001
	Less than once (1) vs. once daily (0)	-0.04	0.02	0.010
	None vs. once daily (0)	0.08	0.04	0.040
Age		-0.06	0.03	0.248
Age^2		0.01	0.01	0.111
Age^3		<-0.01	<0.01	0.031
Initial body weight		<0.01	<0.01	<0.0001
Breed	Crosses (1) vs. Maasai Zebu (0)	0.05	0.01	0.0008
	Exotic (1) vs. Maasai Zebu (0)	0.03	0.02	0.085
Clinical Anaplasmosis	Yes (1) vs. no (0)	-0.09	0.02	<0.0001
Sero conversion status				
TpConvert	Yes (1) vs. no (0)	-0.06	0.02	0.0004
LagTmConvert	Yes (1) vs. no (0)	-0.06	0.02	0.011
LagAmConvert	Yes (1) vs. no (0)	-0.04	0.02	0.023
Random effects				
Farm		0.0003	0.0005	0.26
Residual error		0.024	0.001	<0.0001

Discussion

The mean calf birth weight of 25.9 kgs observed in this study was higher than 17.5 kgs reported by Moll *et al.,* (1984) and 19.2 kgs reported by Semenye (1987). The calf body weight of 46.2 kgs at 3 months that was observed in this study was also higher than the 35.2 kgs reported by Semenye (1987) indicating that calves in the latter study were growing at a lower rate than the ones observed in this study.

The ADWG of 0.26 kg/day observed in this study was slightly lower than 0.28 kg/day which was reported for calves on Olosentu ranch in Trans-Mara District (Muhuyi *et al.,* 2002). The ADWG of calves in Maasai pastoral systems varied between group ranches, farms and calves within the same farm. Calves in Olosho Oiborr group ranch had significantly higher ADWG than those in Nentanai group ranch. Similar observations were reported that group ranch was associated with ADWG (Semenye *et al.,* 1980). The higher growth rate of calves on Olosentu ranch was attributed to better feeding and management. The estimated variance within calves (same farms) was greater and significant (σ^2=0.024, p<0.0001) compared to the estimated variance between calves (different farms) which was insignificant (τ^2=0.0003, p=0.30). Out of the total variance observed in this study, the variance component attributed to calf-level variables was 98.8% while the variance component attributable to farm level variables was 1.2%. The correlation between consecutive repeated measures of ADWG on the same calf was negative and significant (correlation was - 0.174 and p=0.001).

Wet season which influenced pasture availability had positive effects on ADWG of calves. The positive effects of season were also reported by (de Leeuw *et al.,* 1991) who found that calves that entered the long dry season (July-November) at an early age were exposed to poor pastures for long resulting in growth retardation. In this study, calves that suffered from sickness (TBDs or any other clinical disease) had low ADWG. In particular, clinical anaplasmosis, seroconversion for *T. parva (*current visit), *T. mutans* (previous visit) and *A. marginale* (previous visit) were associated with significantly low ADWG. Moll *et al.,* (1984) also associated the low weight gains of calves in their study with patent *T. mutans* and acute *T. parva* infections. In the current study over 60 per cent of the calves were crossbreds that were observed to have higher ADWG than the Maasai Zebu that were observed by Moll *et al*., (1984).

Calf feeding practices that were associated with significant improvement in ADWG of calves included increased frequency of milk and water intake, mineral supplementation and grazing management. During the dry season calves spend more energy trekking to distant pastures and watering places but during the wet season there are ponds and plenty of feed including forbs and rush pasture around the homestead. This drastically reduced the walking distances, thus conserving energy that is made available for other essential body functions.

Increased watering frequency was associated with increased ADWG of calves, which agrees with other studies that have shown that increasing watering frequency improves feed intake by livestock (Bekure *et al.,* 1991; Coppock, 1994). Supplementation of calves with crop residues was associated with negative ADWG possibly because Maasai pastoralists allow sick and weak calves to graze on relatively low quality standing crop residues. Mineral supplementation increased the ADWG of calves. Possibly Maasai pastoralists start supplementing calves with minerals from as early as less than one month old.

The results of the multivariate analysis showed that trekking calves to distant grazing pastures had negative effects on calf growth rate in Olosho Oiborr ranch but positive effects in Nentanai. Compared to Nentanai, the area around Olosho Oiborr ranch was more densely populated causing overstocking and denudation of forage (Karimi, personal observation). Consequently, calves in Olosho Oiborr ranch had to trek further distances in search of pasture thus causing further decrease in ADWG. Among the Maasai pastoralists, pre-weaned calves (< 7 months old) usually graze in *olopololis* where there was more herbage but of inferior quality than the open pastures (de Leeuw *et al*., 1991). Weaned calves had access to a wider grazing orbit with greater chance of selecting quality forage. However, pre-weaned calves by virtue of their young age and increased frequency of milk intake had higher ADWG than weaned calves, which possibly explains why their ADWG was superior to that of weaned calves in spite of the latter's access to better forage quality.

Adequate milk intake by calves during the first 3 months of age was very important in ensuring better growth rates. Although majority of the Maasai pastoralists allow the calf to suckle at least twice a day during the pre-weaning period, quite often competition for milk is common especially where there was ready market for milk (de Leeuw *et al.,* 1984). Thus, there is need to educate the pastoralists on the importance of adequate milk intake by the calf for improved growth. Similarly, pastoral farmers need to be made aware of the importance of providing adequate and clean water to calves for improved calf growth rate.

A temporary solution to inadequate water for calves would be to harvest rain water from roofs. While the roof areas for water collection may be too small to obtain considerable amounts of water, for the calves, this source of clean water during the time of confinement could be of major significance.

Feed shortage especially during the dry season was as a major constraint for improved calf production in Maasai pastoral systems (de Leeuw *et al*., 1991). Feeding packages based on haymaking and collection of browse legumes are relatively cheaper options for extension to these semi-settled pastoralists. Improvement of pasture in the reserve grazing paddocks *(olopololis)* through selective introduction of leguminous plant species should be tested as a means of improving calf nutrition. Low quality crop residues could be offered along with urea-molasses blocks to improve efficiency of utilisation. Urea-molasses blocks are cheap and readily available in many commercial shops.

Maasai pastoralists have been upgrading the indigenous Maasai Zebu using improved bulls of Sahiwal and Boran breeds which, significantly improved growth rates of calves. However the crosses should be monitored for survival and adaptability in the harsh environment and the reality of high disease challenge especially in a situation where extension services are inadequate.

Conclusion

In conclusion, selective breeding for higher weights, provision of water during the dry period, coupled with improved delivery of animal health packages to control theileriosis and internal parasites would go a long way in increasing daily weight gains of calves in Maasai pastoral systems.

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