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IMPACT OF APPROPRIATE TECHNOLOGIES ON CALF AND HEIFER PERFORMANCE ON-FARM IN BAHATI DIVISION, NAKURU DISTRICT

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SUMMARY

A calf rearing package (individual housing and high quality forage) was introduced to smallholder farmers in Bahati Division, Nakuru District. The purpose was to investigate its effect on high morbidity, mortality and low weight gain which characterise calf production at smallholder farm level. The fifty participating farmers were categorized into two groups (Test and Control) with 25 farmers each. Animal performance data were collected up to 1170 days. SPSS and Dbstat statistical packages were used in analysing data using appropriate models. During the calf rearing period (24 wks), growth rates of the first 40 calves varied between test and control farms (370 and 307 g/d, respectively), female and male calves (376 and 310 g/d, respectively). Calves supplemented with a mixture of high quality forage gained 417 g/d. Mortality rate averaged 24% with marked differences between livestock production systems (13.3, 33.3 and 21.1% for zero, semi-zero and free grazing, respectively), sex of the calf (5.9 and 31.4% for female and male, respectively) and agro-ecological zone (29.4 and 11.1% in zone II and III, respectively). Up to 810 days of recording 123 calves participated and the mortality remained high in the free grazing system (32%), compared to zero (8%) and semi-zero (11%); differences between sexes persisted, but at different levels (12.5 and 20% for female and male, respectively). Production system and sex of the calf with age and the average weight of the dam over the lactation explained 67 to 85% of the variation in calf weight. Up to 1170 days mortality stood at 14.3% out of 140 calves born, 8 dams were culled/sold and 7 dams had died, while 18 heifers (14 from test farms) calved down (replacing the culled/died and sold dams) and another 18 heifers (12 from test farms) had been sold to others for breeding. The first 18 lactating heifers had a lower age at first calving, a higher body weight and milk yield, and breeding heifers sold at higher prices on test farms than on control farms. Over time, differences between mortality in test and control farms and even between male and female calves became smaller, suggesting increasingly more interest in raising young stock. Improved growth rate, survival rates and raising standards of calves in smallholder farms implied that, the interventions had a positive impact and therefore holds a considerable potential for improving production of dairy replacement stock at resource-poor farmer level.

Keywords: ***Smallholder dairy, calf, heifer, growth rate, morbidity, mortality, forage legumes, replacement stock***

INTRODUCTION

In Kenya, agriculture accounts for about 25% of the gross domestic product (GDP) directly, and indirectly, another 30% through linkages with manufacturing, distribution and other services related to economic activities. In addition, the sector accounts for almost 80% of the national employment and contributes about 60% of the total export earnings (Tanui, 1993; CBS,1995;). Dairy farming, which is an important component of the livestock sub-sector has, before and soon after independence, been in the hands of the European settlers, who were typically large-scale farmers. Smallholder farmers are now the major milk producers in the country. They contribute over 75% of the total milk produced in Kenya (CBS, 1995). Though the national dairy herd has increased (0.8 million in 1960 to 3 million in 1998), the average herd size per farm household has declined over the same period as a result of diminishing land resources per household. Until recently, large scale farms have continued to dominate production and supply of breeding stock for the dairy industry. This scenario is however changing rapidly. Due to the dwindling number of large-scale dairy farms, exacerbated by the high price tag for a quality dairy heifer (Kshs 40,000-75,000) smallholder resource-poor farmers are facing a major challenge. Following the liberalization of the dairy industry in 1992 and later the privatization of the artificial insemination services in 1994 smallholder dairy farmers are expected to devise strategies to improve milk production to take advantage of the liberalised milk market and more importantly seek sustainable ways of ensuring availability of high quality dairy replacement stock. This paper examines the impact of simple calf rearing technology on the performance of calves at smallholder farm level.

Major factors limiting production of replacement stock at smallholder level

Lack of credit facilities and increasingly high input prices, have limited resource-poor farmers' access to inputs necessary for dairy production (MoALDM, 1994). It is also asserted by authors (Gitau *et al.*, 1994a-c; Mulei *et al.*, 1995) that the other major underlying factors limiting calf survival and performance in smallholder farms include: poor housing and management, inadequate feed and feeding and poor disease control strategies. Loss of calves due to disease is acknowledged as one of those cited setbacks to calf rearing by smallholder resource-poor farmers. Due to livestock diseases, heavy calf losses have been reported in smallholder farms (Payne, 1990; Gitau *et al.*, 1994 a,b,c; De Jong, 1996) particularly at early weeks after birth. This was in agreement with research findings by Jagun (1982) in parts of Nigeria, which revealed that over 29% of losses in calves occur during the first 30 days post-partum. Diseases such as gastro-enteritis (due to colibacillosis, salmonellosis, coccidiosis and helminthiasis), tick-borne diseases (East Coast fever, babesiosis, anaplasmosis and heartwater), gastro-intestinal parasites (*Cooperia spp; Haemonchus placei; Oesophagostomum radiatum; Trichostrongylus colubriformis; Bunostomum phlebotomum* and others) and pneumonia are the most prevalent. They are reported to be the major killers of calves, in most parts of Kenya (Jagun, 1982; 1985; Radostit and Blood, 1985; Gitau *et al.*, 1994 a,b,c; Negesse, 1994; Latif *et al.*, 1995; Mulei *et al.*, 1995; Nyangito *et al.*, 1996). The problem is worsened by the small herd sizes (1 to 3 cows). Inadequate feed and feeding exacerbates the effect of diseases in the majority of smallholder resource-poor dairy farms (de Jong, 1996). Good feeding and care of calves is essential in dairy production, if they are to be used as future replacements. Better eventual weights and milk yields are achieved by very careful attention to feeding (Payne, 1990; Ologun and Egbunike, 1991; Gitau *et al.*, 1994a). In most smallholder farms, majority of calves rely on natural pastures (grasses mainly) for a major part of the year (Lanyasunya *et al.*, 1998). Tropical pastures are reportedly known for their rapid decline in quality (CP; 2 - 6%). Larbi *et al.* (1992) reported crude protein concentrations of 53g/kg DM which is lower than the 80 g/kg DM known to limit intake of tropical forages. The fast physiological change, coupled with scarce and/or frequent overstocking of grazing lands in the tropics, makes it unlikely that calves have satisfactory grazing conditions for long enough in one season (Payne, 1990). In most smallholder farms, calves frequently show a poor body condition of which rough (hair) coat, enlarged bellies (pot bellies) and unthriftiness are the most marked manifestations of malnutrition. The other aspect which also has been incriminated for the poor performance of calves at smallholder dairy farms, is lack of appropriate housing. It was observed that about 90% of smallholder farmers do not have appropriate calf housing structures (Lanyasunya, *et al.*, 1998). This further exacerbates the effects of disease and under nutrition leading to low calf survival.

MATERIALS AND METHODS

A combination of methods was used to delimit the problems limiting heifer production by smallholder farmers in Bahati Division, Nakuru District which was identified as the appropriate study site. These consisted of Participatory Rural Appraisal (PRA), Cluster (Research -Extension - Farmer linkage) field visits, Rapid Rural Appraisal (RRA), Reconnaissance surveys, Objective Oriented Project Planning (OOPP), Workshops/seminars and review of district's annual reports and development plans. Between 100 - 120 smallholder farms (average 2.0 acres or 0.8 ha), mixed farming: crops/livestock) were randomly visited and interviewed by the team and about 50 of them were selected to participate in the trial. The actual participating farms were purposively (non - random) selected taking into account their aspirations, existing livestock production systems (zero, semi-zero, and free grazing) and agro - ecological zonation (II - III). Availability of at least 1 calf ($\leq$ 2 weeks of age preferably) or in-calf cow(s), some of the targeted legume forages and farmers' willingness to participate, were considered in the selection process.

Trial design

The fifty participating farmers were categorized into two groups (Test and Control) with 25 farmers each. Calves in control farms remained under ordinary type of management, i.e. communal/roadside grazing, tethering, no supplementation (protein, minerals), common or no housing, communal watering and poor disease control strategies i.e. little use of acaricides and/or dewormers. Test farmers were assisted to construct the simple movable calf pen and develop feeding regimes based on the available forages. Except for short periods per day, calves were confined. All calves were fed with milk, though the amount of milk offered depended on the production of the dam and demand for milk within the household. Treatment and de-worming was carried out when necessary and according to the economic ability of the farmer. Data on; growth rate, calf mortality, morbidity, milk production and liveweight of dams was collected regularly.

Materials

The movable calf pens compartmentalised with feed and water troughs, were constructed using cheaply available materials. Commonly grown forages focused included: Napier grass (NAP) - *Pennisetum purpureum* cv. **Bana** as the basal feed; Sweet potato vines (SPV) - *Ipomea batatus* cv. **Musinya** or Musinyamu; Desmodium (DES) - *Desmodium intortum* cv. **Green leaf**; Fodder shrubs (FOD) - *Leucaena leucocephala* and *Sesbania sesban* and other assortment of forages available in small quantities (Lucerne, Calliandra spp., Stylosanthes spp. Banana stems/leaves and forage Sorghum). All these forages, already existed in variable quantities at the farms but many farmers were not using them as calf supplements. Farmers willing to plant more of these fodders, were provided with planting materials. Feeding regimes (for test farms only) were regularly reviewed to keep abreast with emerging farm circumstances. Growth charts indicating the expected performance of different categories as large (Friesian, Ayrshire), medium (crosses) and small (Jersey, Zebu cattle) were distributed to farmers. Stationery, small spring balances (max. 25 kg), and plastic buckets (10 litre capacity), were also provided to test farmers.

Statistical analysis

The data were stored in dBASE IV. SPSS and Dbstat statistical packages were applied. Analysis of variance (ANOVA) was used to investigate the differences in growth performance of calves between the two groups, as affected by agro-ecological zones, livestock production system and fodder type used as supplement. Analytical models were developed for specific study periods. Model (170 days study period):

$$G_{ijklm} = m + F_i + Z_j + LPS_k + S_l + E_{ijklm}$$

Where: G_{ijklm} = Body weight change in g/d.

m = Average mean

F_i = Farm category (i = 1,2: Control or Test)

Z_j = Agro-ecological zone (j = II,III)

LPS_k = Livestock production system(k= 1,2,3: Zero, Semi-zero or Free grazing)

S_l= Calf sex (l = 1, 2: Female or Male)

E_{ijklm} = Error

The analysis was classified according to: calf sex (within and between groups), livestock production system (zero-, semi-zero and extensive grazing), agro - ecological zones (II - III) and type of supplement(s) utilized. Farm type or zones (II and III) were used as class factors and the effect of livestock production system and protein supplements on body weight gain were determined. Average body weights of individual calves and dams were presented as scatter plots using the programmes Dbstat version 3 and SPSS to illustrate the dispersion of the observations as function of increasing age. Other statistical models were also developed to investigate individual calf body weight development according to livestock production systems. Cases of morbidity were considered as any calf having had an attack of one or more diseases. Such cases were counted once, due to difficulty in getting confirmative diagnoses of cause-specific disease events. Cases of mortality were counted as they occurred.

RESULTS

Historical background on calf rearing in Bahati Division

Farmers' recall revealed that, the number of male calves born was about 11% less than female calves (N=59 and 67, respectively)(Table 1.) The number of calves born in both farm categories did not differ significantly (control: N=67 and test: N=59). Farmers were also asked to recall the calf exit trend for the period under review (1992-95). The calf population dynamics is shown in Table 2..

Table 1. Calves born by sex in 38 of the Bahati study farms before the inntervention

Farm	N	Female				N_F	Male				N_M
		1992	1993	1994	1995		1992	1993	1994	1995	
Test	59	9	7	8	11	35	7	5	6	6	24
Control	67	10	8	10	4	32	5	7	9	14	35
Total	126	19	15	18	15	67	12	12	15	20	59

Table 2. Calf population dynamics in 38 of the Bahati study farms before the intervention

Farm	1992	1993	1994	1995	Total
Test:					
Total number	16	12	14	17	59
Number died	11 (69%)	6 (50%)	7 (50%)	6 (35%)	29 (49%)
Number given away/sold	4 (25%)	1 (8%)	1 (29%)	5 (29%)	11 (19%)
Control:					
Total number	15	15	19	18	67
Number died	10 (67%)	4 (27%)	9 (50%)	6 (33%)	29 (43%)
Number given away/sold	2 (13%)	9 (60%)	9 (50%)	7 (39%)	27 (39%)

As indicated in Table 2, there was no difference in mortality of calves in the period 1992-5 between the test and control farms before the introduction of the calf rearing package. The calf mortality however, tended to decline between 1992-5 (69 - 35%; test and 69 - 33%; control farms, respectively). The research team probed further to find out whether farmers were housing, supplementing or free grazing their calves during the period under review. Out of the 38 farmers interviewed 26 (68%) did not house their calves, 8 (21%) housed them only at night (commonly with sheep and goats) and the rest were not sure. This revealed that over 90% of farmers did not provide suitable housing. On the issue of supplementation, 17 (55%) claimed to have been supplementing their calves with assorted feeds such as calf pellets, Napier grass, stunted maize plants, farm weeds and harvested roadside grass. None mentioned use of fodder trees such as Calliandra, Sesbania and Leucaena or forages such as Sweet potato vines, Desmodium and Lucerne.

Calf rearing costs

Table 3 shows the means and coefficients of variation of inputs for calf rearing during the study period in the two categories of farms.

Table 3. Means and coefficients of variation (CV) in inputs and costs of calf rearing per calf in Control and Test farms during initial phase of the study (170 days)

	Control		Test	
Variable	Mean	CV	Mean	CV
Quantity of milk fed (kg)	181	32	198	23
Cost of milk fed (Kshs)	2,535	32	2,776	118
Quantity of conc. (kg)	36	180	41	232
Cost of conc. used (Kshs)	360	53.2	428	226
Cost of health mgt (Kshs)	760	107	309	72
Total per calf (Kshs)	3,655		3,513	

Amount of milk fed to calves in control farms was lower compared to test farms. Amount of concentrates, mainly calf pellets offered to calves also varied considerably from farm to farm as evidenced by large CVs. Some farmers in both categories did not supplement calves with concentrates, whereas others used up to 163 kg of concentrates (calf pellets) per calf in a period of 170 days. Though the majority of farmers (90%) practised some form of disease control, the cost of health management (treatments, de-wormers and acaricides) showed a wide variation between farms. Control farmers on average spent 146% more cash on health management of calves, compared to test farmers. Overall cost of rearing a calf up to 170 days was slightly higher in the control farms (4% higher), but not significant ($P>0.05$).

Calf performance

Growth

Body weight gains (on weekly basis) of calves in control and test farms were compared. The results of the first 40 calves are presented in Table 4. To illustrate the performance of individual calves, according to sex and farm category, during the study period in detail, all individual calf weights up to 170 days of age plotted (Figure 1 and 2) and analysed according to the developed statistical model in SPSS (Table 4). Calves in test farms performed better compared to calves in control farms (370 and 307 g/d). The growth rates between female and male calves was also significantly different ($P<0.05$). Female calves were gaining 58 g/d more than male calves. Performance of calves within test farms according to type of supplementation was compared with control farms (Table 5).

Table 4. Means and standard errors for body weight gain (g/d) of the first 40 calves in the Bahati study farms

	Body weight gain		
	N	Mean	SE
Overall mean	40	338	13
Farm category: Control	19	307[a]	20
Test	21	370[b]	18
Livestock production system:			
Zero grazing	13	349[a]	22
Semi-zero grazing	16	325[a]	21
Free grazing	11	341[a]	24
Calf sex: Female	16	367[a]	21
Male	24	310[b]	17
Agro-ecological zone:			
II	24	334[a]	18
III	16	343[a]	20

Means with different superscripts [(a,b)] are significantly different, $P<0.05$.

Table 5. Growth rate of 21 calves supplemented with Desmodium, sweet potato vines and fodder shrubs in test farms compared to non-supplemented calves in control farms

	Body weight gain		
	N	Mean	SE
Type of supplement			
Sweet potato vines (SPV)	6	345[a]	66
Desmodium + SPV[+]	7	375[b]	30
SPV + Fodder shrubs[+]	8	417[b]	60
Control	19	307[a]	19

Means with different superscripts are significantly different, $P<0.05$.

\+ = Plus other assorted legume forages

Calves supplemented with combinations of forage legumes indicated better growth rates compared to control and those supplemented with sweet potato vines only. The mean daily live weight gains of calves supplemented with a combination of SPV and desmodium or fodder shrubs and other assorted leguminous farm forages, were higher than the non-supplemented control calves. Differences in daily weight gains of calves supplemented with SPV alone and non-supplemented were non-significant ($P>0.05$). It was however observed that, some farmers learnt from their test neighbours and voluntarily started to supplement their calves. The large variation and the first scatter plots of calf weights in the on-farm trial observed early 1996, prompted further investigation to look more into the breed type of cattle at the study farms. For this reason, the dam weights were measured to have a more objective indication of the breed type from mid 1996 onwards. Measurements of calf weights were plotted against target growth rate curves for small, medium and large breeds (assumed to weigh 300, 400 and 500 kg at maturity, respectively). Figure 1 and 2 present scatter plots of individual body weights of all male and female calves in control and test farms over time.

The scatter plots 1 and 2 indicate that, female calves performed better than male calves. Thus at the age of 170 days, some female calves attained between 150 – 200 kg body weight, whereas male calves remained below the 150 kg mark. A clear difference was also observed between production systems. In both sexes, calves in the semi-zero grazing system performed better than those in either zero or free grazing system.

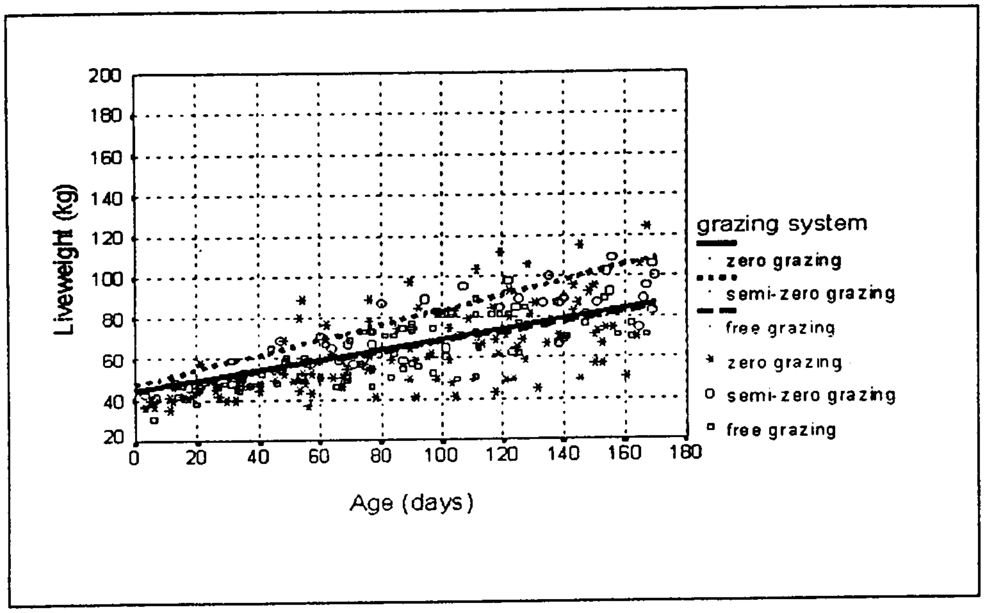

Figure 1. Individual live weights of female calves in different livestock production systems in Bahati Division

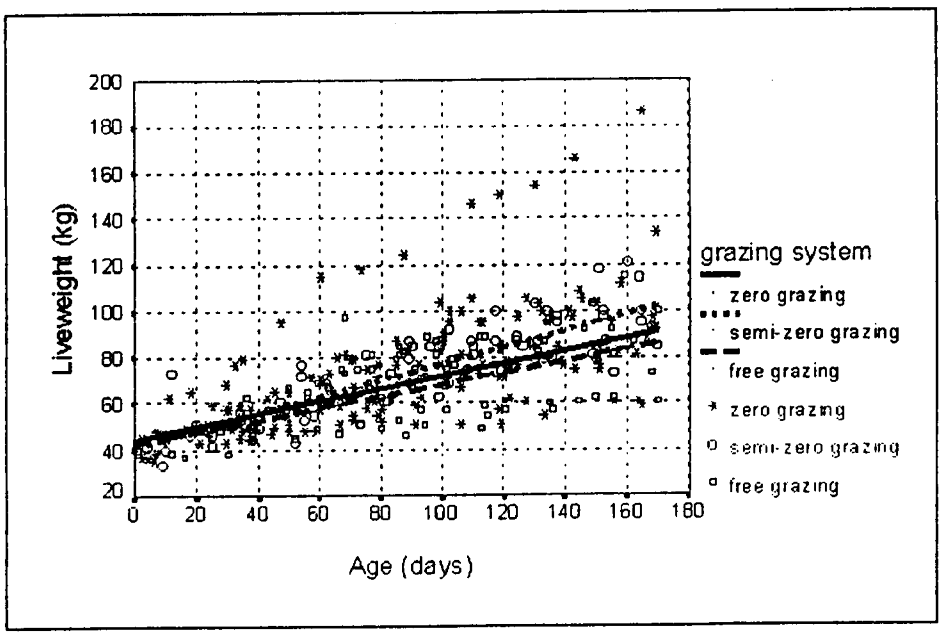

Figure 2. Live weight development of male calves in different livestock production systems in Bahati Division

Further statistical models were developed to compare body weight changes of male and female calves in different livestock production systems up to 170 days of age (Table 6).

Table 6 Live weight development models for 116 calves differentiated for grazing system and sex of calves in Bahati Division upto 170 days of age (1996-1998)

G/System	Sex	Model	N_m	R^2
Zero	Male	Wt = 0.074*DmWt + 0.250*Cage(d) +16.7	120	0.470
	Female	Wt = 0.085*DmWt + 0.339*Cage(d) + 12.0	151	0.455
Semi-zero	Male	Wt = 0.105*DmWt + 0.297*CAge(d) + 78.0	49	0.772
	Female	Wt = 0.036*DmWt + 0.339*CAge(d) + 51.8	68	0.704
Free	Male	Wt = 0.078*DmWt + 0.236*CAge(d) + 19.3	78	0.672
	Female	Wt = 0.137*DmWt + 0.258*CAge(d) - 2.05	77	0.602

N_m - No. of heart girth measurements

Both the age of the calf and the weight of the dams at the first measurement after calving, explained between 45-77% of the variation in calf weight by sex and grazing system.

Calf morbidity and mortality

Table 7 presents morbidity and mortality stratified according to production systems, calf sex and agro-ecological zones over the 170 days study period. Incidences of calf morbidity and mortality were different between control and test farms. Results indicated that the morbidity (37%) and mortality (33%) cases in control farms, were significantly higher (P< 0.01) in control farms than in test farms (17 and 8%, respectively) during the 170 days rearing period.

Table 7. Calf morbidity and mortality structure as recorded in control and test farms during calf rearing period (170 days) for the first 54 calves born (1996)

		Livestock production system			Calf sex		Zone		Rate
		Zero	Semi-zero	Free	Female	Male	II	III	(%)
Control (30)									
	Morbidity	2(7)	4(13)	5(17)	2(7)	9(30)	8(27)	3 (10)	37
	Mortality	2(7)	4(13)	4(13)	1(3)	9(30)	8(27)	2 (7)	33
	Others[1]	0	0	1(3)	0	1(3)	0	1 (3)	3
Test (24)									
	Morbidity	1(4)	2(8)	1(4)	2(8)	2(8)	2(8)	2 (8)	17
	Mortality	0	2(8)	0	0	2(8)	2(8)	0	8
	Others[1]	1(4)	0	0	0	1(4)	1(4)	0	4
Overall	Mortality	2	6	4	2	11	10	3	
	Rate (%)	13.3	33.3	21.1	5.9	31.4	29.4	11.1	24

1: - refers to calves transferred out of the farm (i.e. sold)
(#) - No. in parenthesis refers to proportion(%)

Results in Table 2 and 7 show that while morbidity and mortality remained the same in control farms, mortality decreased to 8% in test farms over a period of 170 days. When stratified according to production systems, calf sex and agro-ecological zones, variations were observed. Morbidity and mortality were low in the zero grazing system in the control and test farms. Mortality was high among the male calves and especially in zone II (cold, wet climate) in control farms.

Results of 810 and 1170 days study period

Considerable variations in liveweight development, mortality and morbidity of calves in different livestock production systems were further observed during the 810 and 1170 study periods. Upto 810 days study period, the number of participating calves increased to 123 (N_{zero} =61; $N_{semi\text{-}zero}$ = 27 and N_{free} = 35). Table 7 presents calf structures during this period. By the end of the study (1170 days), the number of participating calves had increased to 140.

Table 8. Calf structure during 810 days period in the study farms

System	Farm type	calf sex	No. calves born	Mortality (%)	Sold (%)
Zero	Test	Female	33	6	6
	Test	Male	16	13	69
	Control	Female	3		33
	Control	Male	9	11	78
	N Total and average %		**61**	**8**	**34**
Semi-zero	Test	Female	7	15	29
	Test	Male	2	0	50
	Control	Female	9	22	22
	Control	Male	9	0	70
	N Total and average %		**27**	**11**	**40**
Free	Test	Female	10	20	20
	Test	Male	10	50	40
	Control	Female	9	22	11
	Control	Male	6	33	33
	N Total and average %		**35**	**32**	**26**

Table 9. Live weight development models for 140 calves differentiated for grazing system and sex of calves in Bahati Division over a 1170 days study period

Grazing system	Calf sex	Model
Zero	Male	CalfWt = -342.1 + 1.858*DmWt + 0.344*CAge(d) +2.158 $^{-3}$*DmWt^2
	Female	CalfWt = -70.21 + 0.588*DmWt + 0.355*CAge(d) +6.918 $^{-4}$*DmWt^2
Semi-zero	Male	CalfWt = 69.2 + 0.79*DmWt + 0.256*CAge(d) +2.158 $^{-3}$*DmWt^2
	Female	CalfWt = 178.76 + 0.847*DmWt + 0.315*CAge(d) + 1.287*DmWt^2
Free	Male	CalfWt = 2.62 + 0.129*DmWt + 0.238*CAge(d) + 1.351 $^{-4}$*DmWt^2
	Female	CalfWt = -108.32 + 0.92*DmWt + 0.278*CAge(d) + 1.38 $^{-3}$*DmWt^2

Calf live weight development over 1170 year study period

As observed during the 170 days, individual calves in different livestock production systems, demonstrated variations in liveweight development. Female calves seemed to perform better than male calves. At system level, variations were not significant between male calves in free and semi-zero and between female calves in zero and semi-zero grazing systems.

Discussions and recommendations

The aspects which have been highly incriminated for the low performance of calves at smallholder farm level, is the lack of appropriate housing and management. Poor housing, usually results in unsatisfactory health status of calves (Hansen and Birkkjaer, 1986). Individual housing of calves resulted in a significantly lower incidence of respiratory diseases, enteritis, ecto-parasitic ailments and other diseases (Jagun 1982, Radostit and Blood, 1985). The results of the current study supports these findings.

The farm to farm differences in weight gain of calves observed in the current study, are likely indicative of variations in level of calf management and feed (quality and/or quantity) among farms. Results of this study indicated growth rates of 423 and 327 g/d for female and male calves in test farms and 345 and 286 g/d for female and male calves in control farms, respectively. Generally, these growth rates are higher than those reported by Gitau *et al.* (1994a and b.; 210 g/d) but comparable to those reported by de Jong, (1996; 270 - 481 g/d) and Larbi *et al.* (1992; 270 - 370 g/d). From the results it appeared that agro-ecological zonation and type of livestock production system, had no influence on the growth of calves. This therefore implies that the observed improvement of calves' growth rate in control and test farms were strongly attributed to the overall change in calf management at farm level.

The management of animal health is becoming increasingly important in modern livestock farming. The widespread occurrence of calf morbidity and mortality is likely indicative of the relatively low value placed on calves by smallholder farmers, rather than calf vulnerability. Mortality in test and control farms was 49% and 43%, respectively before the intervention (1992-1995). During the project period it changed to 8 and 33% (170 days); at 810 days it stood at 15.4 and 20% while at 1170 days it amounted to 12 and 15.7%, respectively. Chronic malnutrition however strongly exacerbated the severity of the infections and mortality rate, especially in control farms. The results also indicated that male calves showed a higher mortality rate than females in both control (30 and 3%) and test farms (8 and 0%). Though, it could probably be coincidental due to the limited number of animals involved in the current study, the high mortalities recorded for male calves was an indication of the general lack of attention given to them in the smallholders farms. The difference in calf mortality between control and test farms could possibly be due to differences in level of feeding and management. The results indicate that, majority of diseases or predisposing factors, can be avoided through application of proper management procedures.

CONCLUSIONS

From the results, the following conclusions were drawn:

1. High survival of calves in the test farms implied that the technology had a profound effect in controlling and/or reducing the severity of disease infections to calves. This further suggest that majority of the disease conditions could be avoided by the application of proper management procedures.
2. Improved growth rates of calves in test farms also indicate that use of the farm grown legume forages can alleviate calf nutritional problems faced by most smallholder farmers. In addition, improvement of fodder production, conservation and utilization of fodder and crop residues, holds considerable potential as a strategy to improve feed availability at farm level.
3. Land scarcity for growing forages, as evidenced in the results, will most probably continue to deter efforts to introduce forages i.e. sweet potato to farmers because such forages directly compete with food crops for the scarce land resource. On the other hand, forages such as Desmodiums, which can be grown in mixtures with grasses, and fodder shrubs i.e. Leucaena and Sesbania which can be grown as green hedge or crop alleys have comparative advantage and therefore, hold greater potential.

In addition it was observed that the package renewed farmers' interest in livestock production strengthened the research-extension-farmer linkage. This enhanced technology modification and eventual transfer to farmers. Compared to other systems of raising calves, the current calf rearing package is economically effective (not costly) in the context of resource-poor farmers and also easy to apply. In conclusion, the package holds considerable potential for increasing dairy production through increased availability of replacement stock, efficient use of available feed resources and improved farmers' dairy husbandry knowledge.

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