Effect of Trypanosomosis and tick borne diseases on productivity of Orma/Zebu cattle in an Arid and Semi-Arid Land (ASAL) area of South Western Kenya.

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Abstract.

Trypanosomosis and tick-borne diseases (TBD's) have a profound impact on the livelihoods of agro-pastoralists in the ASAL areas of Kenya whose transhumance nature exposes livestock to tsetse-infested areas and also new ground may be sources of parasites. Both diseases are endemic and cause suboptimal production, which is enhanced in presence of endoparasites and nutritional stress. Trypanosomosis infected animals have pronounced immunosuppression and easily succumb to TBD's even in presence of endemic stability and perhaps trypanotolerant animals will show minimal loss in production. A trial was conducted in trypanosomosis endemic foci to assess productivity of three hundred Orma zebu (OZ) (trypanotolerant Orma boran x Maasai zebu) and Sahiwal zebu (SZ) (susceptible Sahiwal x Maasai zebu) crosses, which were monitored monthly from birth to 18 months for prevalence of trypanosomosis and TBDs, and body weight changes. Diagnosis was based on parasitology and serology. Growth rate and disease prevalence were used as outcome measures of productivity. Factors associated with these outcome variables were assessed using multiple regression [Proc Reg, SAS version 9.1, SAS Institute Inc., Cary, NC, USA] and logistic regression [Proc Logistic] fitted at 95% confidence level. Daily weight gain for the O/Z and S/Z were 0.209 g/d and 0.212 g/d respectively and comparable. Prevalence of trypanosomosis, TBD and EPG counts were 1.9% and 2.5%; 59% and 62%; 48 and 42 in the O/Z and S/Z respectively. Factors significantly associated with disease distribution were season and age of calves. Enhanced trypanotolerance in O/Z crosses can be utilized for effective reclamation of tsetse-infested lands.

Introduction

The livestock sector (dairy in highlands and beef in rangelands or ASAL's) produces 30% of agricultural GDP which account for 10% national GDP (Ministry of Industrial Development, 1998). The sub sector employs over 50% of the agricultural labor force. Eighty (80%) percent of Kenya's landmass is Arid and Semi-arid lands (ASAL) inhabited by pastoralists and agro pastoralists who raise more than 60% of the cattle, 80% of sheep, 60% of goats and all the camels (MALDM, 1992; SARDEP, 2000; Kariuki, 1990). They hold 45% national livestock, particularly the Zebu and improved Boran that produce 3% milk and more than 70% of red meat consumed locally (Ministry of Industrial Development, 1998). Livestock keeping is the sole source of livelihood for these farmers but they rarely break even in their production enterprise due to high cost of treatment among other production constraints, especially associated with trypanosomosis and TBD's (Roderick, 1995; Warinda, 2001). Tsetse transmitted trypanosomosis is endemic in 60% of Kenya's rangelands and causes substantial loss in production associated with clinical, often chronic disease (KETRI, 1990). Of the most important TBD's are ECF, anaplasmosis, Babesiosis and Heart water (Wanjohi *et al*., 2001; Muraguri, 1999; Kariuki, 1990; Irvin *et al*, 1996; Gitau *et al*., 1997; Kanyari and Kagira, 2000; Maichomo et al., 2005). Theileriosis causes direct zebu calf mortalities of up to 10% (MALDM-1992) and costs over US$1 billion annually worldwide. Due to their endemic nature, trypaosomosis, TBD's and helminthosis are economically most important in the region due

to sub-optimal production they cause especially during periods of nutritional stress (Maichomo *et al*., 2004). At such times, the resulting incomplete relationship between host, vector and parasite causes endemic instability (Norval *et al*., 1992).

Episodes of prolonged drought are common in the ASAL's (SARDEP, 2000; Concern, 2006; IRIN, 2006) which compromises plane of nutrition and hence immune status. It is evident that these rangelands are also home to vast wildlife (Warinda, 2001; Wambwa, 2003; MALDM-1992) which are natural reservoirs of diseases hence act as focus of infection. Besides as a drought evasion mechanism, pastoralists move to new grazing grounds with different, often higher parasite challenges that perhaps, are a source of new infections (Macpherson, 1995).

Characteristics of cattle productivity and constraints encountered by farmers in Magadi division of Kajiado District have been discussed by Roderick (1985). Upgrading of Maasai zebu with Sahiwal and improved Kenyan boran in the District has been done since 1985 in an effort to increase livestock productivity, aided by Maasai Rural Training Centre. The resulting upgraded indigenous stock though productive in terms of breed size hence market value and milk production, is, however far much susceptible to trypanosomosis and TBD's compared with the Maasai zebu. To trade off between productivity and susceptibility to diseases, the Orma boran (OB), an equally large size animal and relatively trypanotolerant (Njogu *et al*., 1985; Dolan *et al*., 1985; Maichomo *et al*., 2005; Mwangi *et al*., 1998) was acquired by the farmers and crossed with Maasai zebu for comparison with the Sahiwal zebu crosses. The objective of this study was to evaluate the effect of trypanosomosis, TBD's and helminthosis on productivity of Orma zebu crosses, the information that will aid adoption of the trypanotolerant breed in trypanosomosis endemic areas of Kenya and the East African region.

Materials and methods

Study area

Thirteen farmers who acquired the trypanotolerant OB bulls of interest in this study were purposively selected in a framework of 2 group ranches in Magadi division of Kajiado District, South west Kenya. The group ranches only serve for administrative purposes but in essence there are no physical barriers and livestock has free movement and is communally grazed. TBD are considered to be the main disease constraints to improved productivity in the area where livestock composition is largely crosses of the local Maasai zebu (MZ) with either improved Kenyan boran or Sahiwal. Fourteen farmers in the area adopted the OB from Kenyan coast) in an attempt to lower production cost associated with high prevalence of mainly trypanosomosis, and, hopefully TBD.

Study design

Observational, cohort study design was employed with a longitudinal follow-up of 200 OZ purposively selected due to limited numbers and 150 SZ calves from January 2004 to July 2005. The calves were sampled monthly for trypanosomosis using buffy coat technique and TBD's using dry smears fixed with alcohol and stained with Giemsa, as well as ELISA, and every three months for helminthosis using fecal egg count (FEC) procedure to determine their egg per gram (EPG). Blood drawn from the ear vein was collected in heparinised capillary tubes and Packed Cell Volume (PCV) determined. Near birth weights of each calf were taken using a spring balance and a suspending sling. Also during each sampling they were weighed using electronic weigh scale (Griffith Welder, UK) and body condition scored using the method of Nicholson and Butterworth (1986) whose scale ranges from 1 (very poor)-9(very good).

Data management and analysis

Data on body weight, body condition, disease status and calve off take were entered in Access® and analyzed in SAS® (SAS version 9.1, SAS Institute Inc., Cary, NC, USA) programs. For purposes of analysis; (i)Age of study animals was categorized as either pre-weaned calves (less than or equal to

9 months) or post-weaned young animals (10-20 months) or adults (>20 months), (ii) Season was categorized as either long rains (March to June), short rains (October to December), dry1 (July to September) and dry2 (January and February). Actual body weight and daily weight gain (DWG) were summarized using descriptive statistics (in Excel® program) while factors influencing disease prevalence were analyzed using logistic regression (Proc Logistic SAS version 9.1). Growth rate was assessed using multiple linear regression with stepwise selection (Proc Reg, SAS Institute Inc., Cary, NC, USA), to have the best fit model (Table 2).

Results

The growth curve (Figure 1) shows similar body weight changes between the OZ and SZ with minimal and insignificant variation related to season, farmer hence herd management aspect, TBD and trypanosomosis infection status.

The OZ and SZ calves showed similar trend of daily weight gain (Figure 2). The entire study period was however marked by unusual dry spell that covered the entire East African region, hence the growth rate may be lower compared to studies done in wet seasons. The mean weight gain for the OZ was 0.209g/d and 0.212g/d for the SZ, this being statistically insignificant. The weaning period (8-9 months) shows a marked drop in DWG to less than 100g/day. DWG was significantly influenced by dry1, dry2 and long rainy seasons (p=<0.0001), and age category (0.0218) (Table 3).

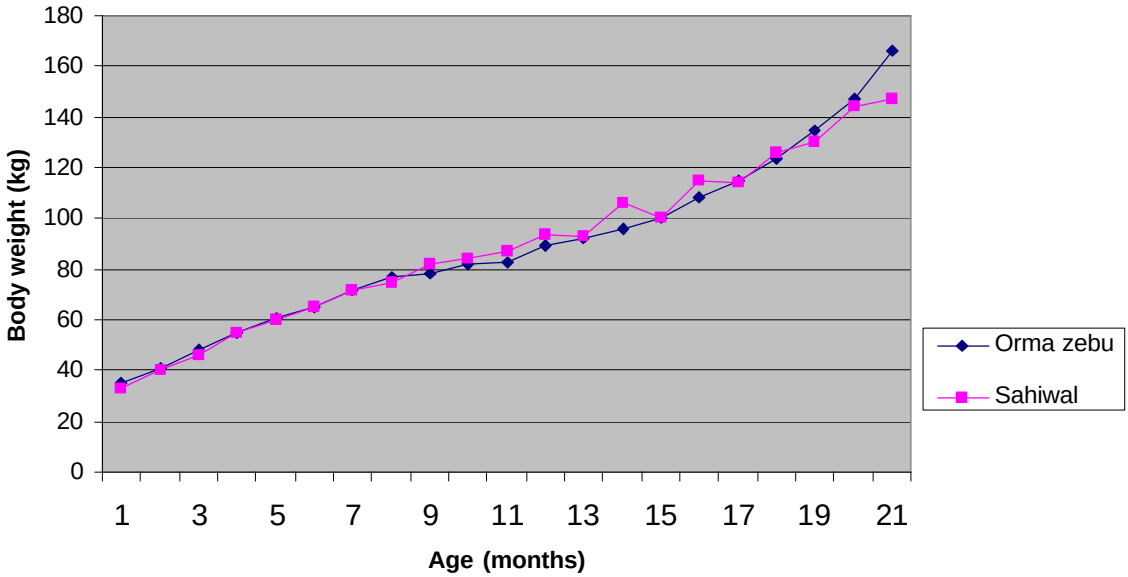

Figure 1: Comparative body weight changes between Orma zebu and Sahiwal zebu from birth to 20 months

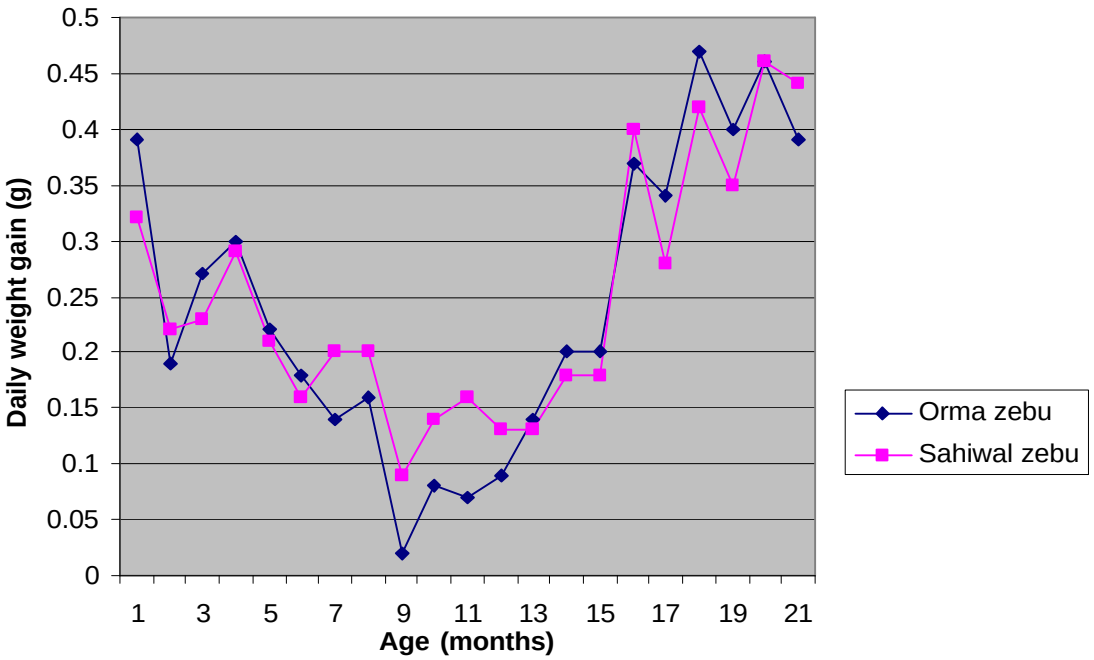

Figure 2: Comparative daily weight gains between the Orma zebu and Sahiwal zebu from birth to 20 months

There was no breed variation in helminth infestation (Table 3). However there seems to be a farmer variation with animals grazing along rivers and swampy areas having higher EPG's. In particular Olkiramatian group ranch had higher EPG's (53) compared to Shompole (36) (p=0.0075). Other important factors in helminth infestation include season (p=0.0008) with the long rainy season showing highest EPG counts (65). Though trypanosomosis was not an important predictor of helminthosis in the overall model, trypanosomosis positive calves had higher EPG counts (63, se=20) than uninfected ones (45, se=2). TBD's infection also enhanced helminth infestation (p=0.0648). Digestion of abomasal membrane did not reveal the presence of hypobiosis and the following species were identified by larval culture technique: Haemonchus, Trichostrongylus,Trichuris, Cooperia, Oesophagostomum and Nematodirus.

There was no difference in trypanosomosis infection between breed (1.9% for OZ and 2.5% for SZ; p=0.2170) but variation between group ranch (Olkiramatian, 1.4%, and Shompole, 3%, X^2 = 11.7, p= 0.0006, OR=2), season (dry1 2.9% and long rains 2.4%, X^2 = 5, p= 0.0240) and age category (post weaning 3.3% and pre weaning 1.3%, X^2 = 20, p= 0.0001) was significant (Table 4). The disease significantly lowered PCV values from 30% to 25 % p<.0001). Indeed PCV was the single most important factor negatively affected by trypanosomosis infection status, surpassing DWG. Such calves also had significantly higher EPG's of 86 versus 65 particularly during long rains though statistically insignificant (p=0.5547). It is also observed that PCV declined significantly in calves after weaning from 32% to 29% (p<.0001)

TBD was not an important factor in daily weight gain (Table 4). Sixty percent of all calves sampled had TBD. However, it was a more important health constraint in Sahiwal zebu (62%) than in Orma zebu (59%) (X^2 = 2.9, p= 0.0267). Pre weaned calves were 1.5 times less likely to acquire TBD (51%) than the weaned calves (74%) (X^2 = 232, p= 0.0001). Regression analysis showed that males (p=0.0026) and season (p=<0.0001) were significant predictors of TBD.

Table1: Prevalence(%) of trypanosomosis, TBD and helminthosis in Orma Zebu and Sahiwal Zebu calves from January 2004 to July 2005 categorized by age groups.

Age category	Breed	Trypanosomosis	TBD	Helminthosis
Calves (0-9 months)	OZ	1.19	49.8	14.8
	SZ	1.5	53	13.9
Young (10-20 months)	OZ	2.7	73.3	18.3
	SZ	3.8	75.5	20.2
Adults (>20 months)	OZ	8.6	88	34.5
	SZ	7.1	81	26

Table 2: Results of multiple regression on DWG and EPG's

Response variable	variable	Parameter estimate	SE	Type II SS	F value	Pr > F
Daily weight gain	Intercept	0.15066	0.06810	1.41204	4.89	0.0270
	Dry 1	0.17389	0.04039	5.34666	18.53	<0.0001
	Dry 2	0.49707	0.06192	18.58894	64.44	<0.0001
	Long rains	0.28010	0.03880	15.03504	52.12	<0.0001
	Calf, Young or Adult	-0.13556	0.05904	1.52075	5.27	0.0218
	Calf, Young or Adult, pre or post weaned	0.08520	0.05904	0.60070	2.08	0.1491
EPG' counts	Intercept	58.02386	16.68743	251996	12.09	0.0005
	Group ranch1	14.59498	5.45897	148986	7.15	0.0075
	Dry 1	28.21176	8.39851	235188	11.28	0.0008
	Long rains	53.51608	7.80213	980623	47.05	<.0001
	Age class	-9.11857	5.85171	50611	2.43	0.1193
	TBD	-10.65937	5.77018	71164	3.41	0.0648
	PCV	-1.50500	0.44892	234256	11.24	0.0008

Table 3: Results of logistic regression on trypanosomosis and TBD's

Trypanosomosis	Variable	DF	Wald Chi square	Pr >chisq
	DWG	1	1.1069	0.2927
	Age category	2	6.8413	0.0327
	PCV	1	55.5898	<.0001
	Worms	1	0.3489	0.5547
	Breed	1	6.9953	0.0082
	Sex	1	0.2993	0.5843
	GR	1	7.4180	0.0065
	Season	3	0.4639	0.9267
	TBD	1	0.0440	0.8339
TBD	DWG	1	1.4250	0.2326
	Age category	2	71.6834	<.0001
	PCV	1	0.0551	0.8144
	Worms	1	1.6414	0.2001
	Breed	1	4.9133	0.0267
	Sex	1	9.0900	0.0026
	GR	1	0.0418	0.8380
	Season	3	109.6874	<.0001
	Trypanosomosis	1	0.0202	0.8870

Discussion and conclusion

Studies on trypanotolerance and productivity of OB and their crosses with local zebu (OZ) (Njogu, 1985; Dolan, 1985; Mwangi *et al*., 1998; Maichomo *et al*., 2005) have yielded significant positive results that can be utilized in dissemination and adoption of the breed in trypanosomosis endemic areas of Kenya and the region. Since the OB has been raised locally it takes less time to adapt in different AEZ other than area of origin and its utilization will enhance conservation of indigenous genetic resources (Maichomo *et al*., 2003). Trials done at Galana (Dolan, 1985) ranch in Tana river District and at Nguruman in Kajiado District (Maichomo *et al*., 2005) showed that the OB and their Zebu crosses has higher growth rate than the local zebu during rainy season when tsetse challenge and trypanosomosis prevalence is high. However their evaluation in different Agro Ecological Zones depicts threat to TBD that compromised their productivity, hence tick and TBD control should not be relaxed.

These results show that performance of OZ and SZ are comparable in terms of body weight changes, daily weight gains and prevalence of trypanosomosis, TBD and helminthosis. Drop in DWG post weaning correlated with drop in PCV suggests that farmers should pay special attention to this category of young stock to minimize lag in productivity, perhaps by giving feed supplements. The ability of these local animals to withstand adverse conditions (feed and water shortage, heat stress) is remarkable given that body weight changes were still fare in January and February. However, trend for the SZ is more erratic hence unreliable. It implies that this breed is susceptible to climatic extremes and for an economic oriented livestock keeper, the OZ is more reliable within the prevailing conditions. Lack of expected significant difference in growth rate and disease prevalence between breed could be due to unusual dry spell that covered the entire East African region (IRIN, 2006; Concern, 2006) that corresponds with low vector population.

Trypanosomosis control in young and adult cattle herded in thick vegetation especially during and after long rains needs special attention. Consistent with other studies (Dolan, 1985) the disease significantly lowered PCV values and was the single most important factor negatively affected by trypanosomosis infection status, surpassing DWG. Such calves also had significantly higher EPG's of 86 versus 65 particularly during long rains though statistically insignificant. Significant variation of trypanosomosis observed between group ranches emphasizes risk of movement during drought to graze in thickets where tsetse and other disease vectors are abundant thereby acquiring dynamic infections (McPherson, 1995). The increasing prevalence of TBD in herds with age category is consistent with endemic stability (Gitau *et al*., 1997), perhaps the reason it doesn't seem to affect growth rate. However, TBD is a more important health constraint in Sahiwal zebu than in Orma zebu. Helminthosis infestation was light with mean EPG<100. Normally this is not significant to affect productivity in ASAL's except in young calves and small ruminants. But results here show that trypanosomosis and TBD infection can lead young cattle stock to succumb to helminthosis infestation, hence strategic herd worm control might reduce productivity losses.

Qualitative responses from farmers (Maichomo *et al*, 1999) indicate that they spend fewer drugs of all categories on OZ compared to the SZ. Other advantages cited with the OZ crosses are ease of management during drought, less feed intake, high libido and high herd turn over (Maichomo *et al*., 1999 & 2005). Any reduction in cost of production for these small scale beef producers that will result in higher profit margins definitely will lead to reclamation and effective utilization of tsetse-infested lands. The importance of this Agricultural sub-sector can not be denied according to report by Ministry of Industrial Development (1998) that beef production is based on the Zebu cattle production which is mainly found in Arid and Semi-Arid Lands, representing about 70% of local beef consumption, and has huge potential for export market. More convincing financial advantage of raising OZ may be realized during high trypanosomosis challenge.

References

Concern, 2006 (www.concern.net). Update on concerns emergency programme in Kenya. Tuesday 21st March 2006.

Dolan, R.B., Njogu, A.R., Sayer, P.D., Wilson, A.J and Alushula, H. (1985). Trypanotolerance in East African cattle. *18th ISCTRC, OAU/STRC* 113: 240-246.

Gitau, G.K, Perry, B.D, Katende, J.M, McDermott, J.J, Morzaria, S.P, Young, A.S. 1997. The prevalence of serum antibodies to tick-borne infections in cattle in smallholder dairy farms in Murang'a District, Kenya; a cross-sectional study. *Preventive Veterinary Medicine*, 30:95-107.

IRIN, 2006 (www.irinnews.org). KENYA: Drought could lead to humanitarian catastrophe, warns UN envoy. UN Office for the Coordination of Humanitarian affairs Wednesday 12 April 2006.

Irvin, A.D., McDermott J.J. and Perry B.D. (eds) 1996. Epidemiology of Ticks and Tick-borne Diseases in Easter, Central and Southern Africa. Proceedings of a workshop held in Harare, 12-13 March 1996. *ILRI (International Livestock Research Institute)*, Nairobi, Kenya. 174 pp

Kanyari, P.W and Kagira, J.The role of parasitic diseases as causes of mortality in cattle in a high potential area of central Kenya: a quantitative analysis. *Onderstepoort Journal of Veterinary Research*, Sep69(3):157-61.

Karanja, S.M. (2005). Epidemiology and importance of trypanosomosis, helminthosis and tick-borne diseases on the performance of cattle in Busia district, Kenya. *PhD Thesis, Institute for Parasitology and International Animal Health Faculty of Veterinary Medicine Freie Universitat Berlin.*

Kariuki, D.P. 1990. Current status of theileriosis in Kenya. Progress towards the control of East Coast fever (Theileriosis) in Kenya. *Proceedings of an East Coast fever planning workshop, KARI, Nairobi*, 1990:17-26.

KETRI, 1990. *Kenya Trypanosomosis Research Institute, Strategic Plan* 1990-2000. pp1-8

Macpherson, C.N.L. (1995). The effect of transhumance on the epidemiology of animal diseases. *Preventive Veterinary Medicine*, 25, 213-224.

Maichomo, M.W; Olubai, W; Mwendia C.M.T. and Mapenay I.M. (1999). Farmer responses on acceptability of the Orma Boran, a trypanotolerant breed of cattle introduced into Nguruman, Kajiado district in Kenya. *25th ISCTRC Conference, Mombasa, Kenya.*

Maichomo, M.W; Orenge, C.O; Munga, L.K and Ndung'u, J.M. (2003). Conservation of trypanotolerant Orma-boran through utilization. *27th ISCTRC Conference, South Africa.*

Maichomo, M,W, Kagira, J.M, Walker, T.(2004)The point prevalence of gastro- intestinal parasites in calves, sheep and goats in Magadi division, south-western Kenya. *Onderstepoort Journal of Veterinary Research 71:257-261.*

Maichomo, M.W; Ndung'u, J.M; Ngare, P and Ole-Mapenay, I.M. (2005). The performance of Orma Boran and Maasai Zebu crossbreeds in a trypanosomosis endemic area of Nguruman, Southwestern Kenya. *Onderstepoort Journal of Veterinary Research 72:87-93.*

MALDM (1992). Annual Report. Ministry of Agriculture and Livestock Development, Animal Production division, *Ministry of Agriclture, Livestock Development and Marketting,* Hill Plaza, P.O Box 30028, Nairobi, Kenya.

Ministry of Industrial Development, 1998. A diagnostic study on animal based food industry. *Final report prepared for the Ministry of Industrial Development in collaboration with the Ministry of Planning and National Development*, by Fekagi Investment Consultants, P.O Box 58301, Nairobi, April, 1998.

Muraguri, G,R. Comparison of indirect fluorescent antibody test and enzyme linked immunosorbent assay in the detection of exposure of cattle Theileria parva in Kenya. *Onderstepoort Journal of Veterinary Research,* 66:119-122.

Mwangi, E.K; Stevenson, P; Gettinby, G; Reid, S.W.J; Max Murray (1998). Susceptibility to trypanosomosis of three *Bos indicus* cattle breeds in areas of differing tsetse fly challenge. *Veterinary Parasitology* 79, 1-17.

Nicholson, M.J. and Butterworth, M.H. (1986). A guide to condition scoring of zebu cattle. *International Livestock Centre for Africa (ILCA).*

Njogu, A.R.; Dolan, R.B.; Wilson, A.J.; Sayer, P.D. (1985). Trypanotolerance in East African Orma Boran cattle. *Veterinary Records*. 117, 632-636.

Norval, R.A.I., Perry, B.D. and Young, A.S. (1992). The epidemiology of Theireliosis in Africa. *Academic Press, London*.

Roderick, S. (1995). Pastoralist cattle productivity in a tsetse infested area of South West Kenya. *PhD Thesis, University of Reading.*

Semi-Arid and Rural Development Program, SARDEP. (2000)

Wambwa, E. 2003. Diseases of importance at the Wildlife/Livestock Interface in Kenya. Kenya Wildlife Service, Nairobi, Kenya. Occasional paper No. 30. *Proceedings of the Southern and East African Experts Panel on Designing Successful Conservation and Development Interventions at the Wildlife/Livestock Interface: Implications for Wildlife, Livestock and Human Health, AHEAD (Animal Health for the Environment and Development) Forum, IUCN Vth World Parks Congress, Durban, South Africa, 14th and 15th September, 2003.*

Wanjohi, J.M, Ngeranwa, J.N, Rumberia, R.M, Muraguri, G.R, Mbogo, S.K. Immunization of cattle against East Coast fever using Theileria parva (Marikebuni) and relaxation of tick control in North Rift, Kenya. *Onderstepoort Journal of Veterinary Research,* The Sep 2001.

Warinda, E. (2001). A socio-economic survey and economic analysis of land use options in Shompole and Olkiramatian group ranches – Magadi division. *African Conservation Centre,* P.O Box 15289, Nairobi

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