PASTORALIST STRATEGIES FOR TICK-BORNE AND TSETSE-BORNE DISEASE CONTROL: STUDIES AMONG THE MAASAI IN MOROGORO, TANZANIA.

Silayo[1], R. S., Kimbita[1], E.N., Mutayoba[2], B.M. and Maselle[3], R.M.
[1] Dept of Veterinary Microbiology and Parasitology, P.O. Box 3019, Chuo Kikuu, Morogoro. [2] Dept. of Vet. Physiol., Biochem., Pharmac. & Toxicology, P.O. Box 3017, Morogoro. [3] Department of Veterinary Pathology, P.O. Box 3018, Chuo Kikuu, Morogoro.

ABSTRACT

A rapid rural appraisal (RRA) study among transhumant pastoralists in Morogoro region Tanzania has revealed strategies of tick-borne and tsetse-borne disease control which relate to the longstanding general lack of expert veterinary services in pastoral areas and the more recent (1984) change from government- to privately-delivered veterinary services. In this preliminary study, transhumant pastoralists in Morogoro and Kilosa districts who were predominantly Maasai, were interviewed to determine how they deal with the most important diseases of livestock namely tick-borne diseases and trypanosomosis. It was found out that, following the change from free/subsidised dipping to farmer's own-cost dipping, acaricides became more expensive and not readily available in the specified formulations. Interrupted supply often resulted in colossal losses of cattle in herds, which had been intensively dipped. This lead to general adaptation of non-dipping strategy to establish endemic stability, to tick-borne diseases. In the course of trying to establish endemic stability farmers lost as much as 80% of their calf crop through mainly East Coast Fever. There was indication of misuse of relatively cheaper agricultural pesticides for occasional spraying on cattle, sheep and goats to avoid flea and biting-fly nuisance. The strategy for trypanosomosis control was application of trypanocides curatively hand in hand with traditional tsetse avoidance. The route of administration of the trypanocides (as well as other animal drugs) was intravenous even in the case of those drugs for which the route of administration as recommended by the manufacturer, is other than intravenous. Often the intravenous dose administered appeared sub-curative and would therefore likely lead to development of drug resistance. At other times, the dose administered was lethal. Whereas parastatal ranches within the same region have successfully reduced the need for trypanocides through use of synthetic pyrethroids which control both tsetse and ticks, this method is unavailable to the Maasai pastoralists largely due to the nature of transhumant pastoralism itself but also partly due to the desire for endemic stability to tick-borne diseases. It was concluded that there was a clear need for extension efforts to enable farmers organise themselves to deal with the changed veterinary service delivery system particularly as it relates to control of tick-borne and tsetse-borne diseases. Additionally, if trypanocide application remains the mainstay trypanosomosis control strategy, there is a need to address the problem of Maasai applying every drug intravenously.

Key Words: Ticks; Tick-borne;Theileria parva; ECF; Acaricides;Tsetse;Trypanosomoses; Trypanocides.

INTRODUCTION

Tickborne diseases constitute an important hindrance to livestock development in East, Central and Southern Africa. East Coast Fever (ECF; *Theileria parva* infection), the most important of the tick-borne diseases, alone is responsible for economic losses estimated to be in the tune of US $ 170 million in its area of distribution (Mukhebi et al, 1992). Other tick-borne diseases also causing considerable economic losses are babesiosis, cowdriosis (heartwater) and anaplasmosis. Additional to their role in disease transmission, ticks cause severe economic loss through direct damages they inflict on their hosts.

Hand in hand with tick-borne diseases, tsetse-borne African animal trypanosomosis is a major factor hindering livestock development in Africa south of the Sahara. Thirty-seven countries of Africa are occupied by the vector *Glossina* spp (tsetse flies) transmitting four species of trypanosomes (*Trypanosoma congolense, T. simiae, T. vivax,* and *T.brucei*) to animals and two sub-species (*T. b. rhodesiense and T.b.gambiense*) to man. Estimates of losses attributable to trypanosomoses in terms of meat production, milk yield, draught power and added costs of control are put at US $ 500 million annually. The disease denies raising of high-producing livestock in affected prime rangeland areas and in addition mixed crop-livestock production systems with the bonus of organic fertilizer is precluded. This lost potential in animal production raises the cost of trypanosomosis to US $ 5 billion annually (ILRAD 1994).

Tanzania with a total area of 945,087 square kilometers and a human population now in excess of 30 million is one of the poorest countries in the world. Its economy is dominantly agricultural and this in essence means crop agriculture as animal agriculture is estimated to contribute only 10% of the gross national product (Mwakatundu 1992). This is despite the fact that the national herd is in excess of 13 million. This low productivity of national herd is contributed to, among other factors, the low genetic potential, high disease incidence, poor management and feeding practices, poor marketing and a number of socio-anthropological factors pertaining to the traditional sector to which 99% of the national herd belongs (Sempeho and Rushalaza 1985). If much improvement in the contribution of the national herd to the gross national product is to be made, the problems facing the traditional sector and in particular transhumant pastoralism under which at least 20% (Maeda-Machang'u et al, this conference) of the national herd is raised, must be addressed.

Transhumant pastoralism is characterised by lack of readily available expert veterinary services and quite often the owners have evolved their own solutions to their veterinary problems. We were therefore interested in determining the perceived importance as well as strategies to deal with two important groups of diseases namely tsetse and tick-borne diseases among pastoralists in Morogoro region of Tanzania. In this paper we report on our preliminary findings.

MATERIALS AND METHODS

Research Areas

Morogoro Region where the studies were carried out, is situated 60S -10^0S and 35^0 30'E - 38^0 30'E and is one of the 25 administrative regions of Tanzania. It covers a total area of 73,039 km^2 making up 8% of land area of Tanzania and ranking as the 4th largest region in the country. It has a human population approximating 1.5 million (current estimate based on 1988 census). Estimated cattle, goat and sheep populations are in excess of 330,000, 40,000 and 25,000, respectively (Table 1). The studies were carried out in two of the region's four districts namely Morogoro and Kilosa, which account for the vast majority of the regional livestock numbers

(77.5% of cattle, 92.1% of goats and 87.4% of sheep). Kilosa district alone had slightly over 50% of the cattle population and more than two thirds of the goat population. More specifically the studies were carried out in four divisions namely Kingolwira, Ngerengere, Mvomero and Mlali in Morogoro District and Magole and Kimamba in Kilosa District.

Table 1: Domestic ruminant populations in Morogoro Region: (1996 estimates)

District	Cattle	Goats	Sheep
Morogoro	80,693 (26.1%)	9,277 (22.3%)	10,187 (36.4%)
Kilosa	158,774 (51.4%)	28,995 (69.8%)	14,278 (51.0%)
Kilombero	47,155 (15.3%)	2,620 (6.3%)	2,322 (8.3%)
Ulanga	22,400 (7.2%)	676 (1.6%)	1,188 (4.2%)
Total	309,022 (100%)	41,568 (100%)	27,975 (100%)

Source: Regional Agricultural and Livestock Development Office, Morogoro.

Site and interviewee selection:

The selection of the actual sites in the two districts, where the studies would be carried out was based on estimated livestock numbers as provided by the Regional Livestock Development Office, the accessibility of the area throughout the year and the anticipated cooperation from the livestock owners. The divisional extension officers facilitated the farmer selection process. There was a bias for farmers who were easily approached and could spare time for the interviews at short notice. Maasai were the most cooperative group of pastoralists and therefore they easily constituted the majority of the interviewees (Table 2). Other tribal groups keeping livestock in the study area were the Barbeig, Sukuma, Luguru, Kwere, Kamba and Zigua. Cultural constraints dictated that we interview only males in this study.

Table 2: Summary of findings from interviews with livestock keepers in Morogoro and Kilosa Districts

Farmers/Managers interviewed in Morogoro District	28 out of 38
Maasai interviewed	20 out of 38
Maasai not applying acaricides at all or only rarely	19 out of 20
Non-Maasai using acaricides regularly on their cattle	18 out of 18
Maasai using Thiodan or "Sodan" for *Stomoxys* control	20 out of 20
Maasai admitting IV injection of trypanocides	20 out of 20
Non-Maasai admitting IV injection of trypanocides	0 out of 18

NB: The one Maasai regularly spraying his cattle with acaricides was from Ngerengere ward where it appeared (from interview with the Divisional Extension Officer) the Maasai there, in general, control ticks by regular acaricide application and they do not go for endemic stability opted for the Maasai in the other areas.

Data collection

The method of data collection in our study can be described as a form of Rapid Rural Appraisal (RRA) which has been defined as any systematic activity designed to draw inferences, conclusions, hypotheses or assessments, including acquisition of new information in a limited time (Waters-Bayer and Bayer, 1994). We instituted semi-structured interviews in which a mental set of questions was asked by a team of four interviewers who were all veterinarians and Faculty of Veterinary Medicine academic staff. The team was first introduced to the interviewee(s) by the accompanying divisional extension officer and then any one of the members of the team would start the interview rolling by inquiring on the major livestock disease problems the farmer(s) was/were facing. The mental set of questions was added upon as farmers introduced interesting areas of discussion. In addition to the questions asked by the leading interviewer, any team member could ask supplementary questions, which helped us obtain additional useful information.

RESULTS

Farmers Interviewed

A total of 38 farmers were visited and interviewed (Table 2). The majority (20) were Maasai who were transhumant pastoralists. These had a fixed homestead from which they sent the whole or part of their herd for better pastures especially during the dry season.

Major livestock disease problems

From the interviews, East Coast Fever came out as the number one killer of cattle belonging to the pastoralists surveyed. We were informed that the problem increased particularly after stoppage of free dipping in 1984 (Mpelumbe, 1984).

To the livestock keepers in the study area, animal trypanosomosis came second to East Coast Fever in terms of hindering cattle production. The problem is particularly acute during the dry season when livestock have to be taken to grazing areas fringing bush heavily infested with tsetse. The availability of drugs effective against trypanosomoses meant the farmers had a measure of confidence in their battle against the disease.

In goats the major problem was fleas. Farmers were also very concerned about the problem of biting flies especially *Stomoxys* which were especially troublesome to cattle.

Strategy for tick and tick-borne disease control

The study showed that 19 out of the 20 Maasai interviewed were deliberately not applying acaricides to their cattle. This followed the observation that the cattle owners who had practised intensive dipping in the era of free/subsidised dipping (Mpelumbe 1984) had their herds almost wiped out by ECF whenever there was interrupted dipping as a result of unreliable supply of the right acaricides in the right formulations. It appeared these Maasai pastoralists were aiming to create a kind of endemic stability to tick-borne diseases. However, the interviews also revealed that farmers were losing as much as 80% of the calf crop (largely due to ECF) in this endeavour

to create endemic stability to tick-borne diseases. Animals, which survived to adulthood, resisted tick-borne diseases.

Farmers reported that acaricides were expensive, supply erratic and quality of some perceived as low compared to when they were being supplied from government centres. We were informed that some acaricides were being obtained from mobile drug salesmen at cattle auction markets. Indeed, there was a general expressed desire to return to the old system whereby acaricide supply was in the hands of the government.

Interestingly, it was found that livestock keepers, who opted for no dipping of cattle, would occasionally spray their goats and sheep with Thiodan (Endosulfan) or Sumicidin (which in any case they referred to as "Sodan"). This was necessary to control fleas, which sometimes caused considerable mortality in kids. These products were also occasionally dispensed as space aerosols in cattle sheds to deal with biting fly especially *Stomoxys*. These flies were reported to greatly annoy cattle particularly during the rainy season when they were most abundant. To give relief to the animals, livestock keepers would apply the insecticides using simple hand pumps such as those used for control of mosquitoes in households. These pesticide formulations reportedly used on livestock by farmers were really meant for use on crops only. From the interview we found out that the farmers were using them because of their low cost. However, sometimes their use resulted in animal deaths.

All the 18 non-Maasai farmers as well as one of the 20 Maasai interviewed indicated that they were dipping their animals regularly. Our interviews revealed that most of these farmers were applying the acaricides by knapsack handsprayers even for herd size greater than a hundred.

Strategy for tsetse and trypanosomosis control

The main strategies used by the Maasai pastoralist against tsetse and trypanosomosis were traditional tsetse avoidance and application of trypanocidal drugs. There was indication that the Maasai pastoralists knew areas of heavy tsetse challenge and they avoided these areas as much as possible. They took a calculated risk of taking their animals into heavy tsetse challenge areas when these were the only areas with feed for their cattle during the dry season. None of the Maasai interviewed protected their animals by application of prophylactic trypanocidal drugs. Instead they carried out close clinical monitoring of their animals and treated them with trypanocides immediately on suspecting them to be suffering from trypanosomosis.

An interesting finding was the use of the intravenous route as the route of administration of all trypanocides. Except for suramin, none of the trypanocides currently available or have been available for field application is recommended for intravenous application (Table 3). However, as shown in Table 2, 100% of Maasai interviewed admitted to applying them by intravenous injection and it was intimated that both men and women from very early age were conversant with the technique. The trypanocidal drugs used were Isometamidium chloride (SAMORIN;VERIDIUM), Homidium (NOVIDIUM), and Diminazene aceturate (BERENIL;VERIBEN) all of which, according to the manufacturers, are meant for deep intramuscular application (Table 3).

Table 3: Indications for trypanocidal drugs.

Compound	Trade name	Dosage (mg/kg)	Indication	Prophylaxis
Isometamidium chloride	Samorin (RMB)	0.25-1.0 (im)	Tv., Tc	2-6 months
	Veridium (Sanofi)			
Diminazene aceturate	Berenil (Hoechst)	3.5 (im)	Tv, Tc	(curative)
	Veriben (Sanofi)			
Homidium br Homidium cl	Ethidium(BDC) Novidium(RMB)	1.0 (im)	Tv, Tc	1 month
Pyrithidium br	Prothidium (Boots Drug)	2.0(im)	Tv,Tc	4 months
Quinapyramine sulphate	Trypacide(RMB)	5.0 (sc)	Te, Tb	(curative)
Suramin Na	Naganol (Bayer)	10 (iv)	Te, Tb	2 months
Quinapyramine-Suramin complex		40 (im)	Ts	3-6 months

(Key: Tb = *Trypanosoma brucei* ; Tc = *T. congolense*; Te= *T. evansi*; Ts=*T. simiae;* Tv= *T. vivax*; im= intramuscular*; iv*= intravenous; sc= subcutaneous*)*

This practice is often carried out at a considerable risk of death of animals injected. The strength of solutions made is estimated by a crude method of applying the solution on a fingernail and gauging its viscosity. On some occasions, an animal injected with Samorin intravenously would drop dead immediately after injection. Through long experimentation with intravenous application of these drugs, losses through acute toxicity have been minimised with only transient signs of toxicity including diarrhoea; urination and an immediate drop in milk yield being often seen. The major reason given by the Maasai for using drugs intravenously rather than intramuscularly as recommended by the manufacturer is that they expected the drug to spread faster to all parts of the body thus effecting cure more rapidly. They also stated that the local reactions resulting after intramuscular injection of some of the trypanocidal drugs such as isometamidium chloride, were unacceptable.

An interesting sanative application of Novidium and Berenil was narrated in the interviews. It was reported that Novidium was sometimes injected simultaneously with berenil. The two were mixed in a ratio of 1.05 g diminazene aceturate (one sachet) to 250 mg homidium chloride (one tablet), the mixture dissolved in 20 ml of water and the whole injected intravenously as single dose sufficient for one cow.

It was noted that the Maasai were also using some of the trypanocides for treatment of conditions other than trypanosomosis. For example Novidium was being used for expulsion of retained placenta.

DISCUSSION

Acaricide application has been the mainstay of control methods used against tick-borne diseases. However, there are a number of problems associated with the use of this method including development of acaricide resistance, shortage of acaricide and/or water and rising costs of the acaricides and labour (Kagaruki and Mbise, 1984). These problems were there even in the days of free/subsidised dipping. From our study, we noted that while liberalization of trade in Tanzania resulted in abundant supply of veterinary drugs, a major complaint in connection with acaricides was that there were many brands but the constant supply of any particular brand of acaricide at affordable prices was not assured. In many cases the prices of these acaricides and insecticides were many times higher than those paid at government veterinary clinics/stores. Nevertheless, it is to be noted that the prices are still affordable when compared with the colossal losses from ECF. The sale of a few animals would enable purchase of enough acaricide to save many more animals. This is where more extension efforts are needed particularly also in relation to the need for the pastoralists to form their own co-operatives.

An observation of significance in terms of the need to organise livestock keepers was the method of application of acaricides among those who opted to control ticks. Most of them would handspray their cattle even for herd size greater than hundred. Hand spraying is highly inefficient and is really meant for small holder farmers with less than 10 animals. Usually when carried out effectively to point of saturating the animal it is highly wasteful compared to dipping or use of spray races. However, the usual thing is to under-apply the acaricide and this can result in deaths from tick-borne diseases.

As in other livestock production systems in the tsetse infested areas, trypanocidal drug application was found to be the mainstay of control methods against trypanosomosis. However, unlike in some of the parastatal ranches in which there is already successful application of pyrethroids against tsetse to supplement drug application, the method is not readily applicable to this livestock production system. Such reliance on chemotherapy especially with the kind of misuse found in this study is bound to lead to problems as there are so few drugs of different chemical structure and there is development of drug resistance (Anon, 1979; Holmes and Scott, 1982; Holmes and Torr, 1988). Presently, diminazene aceturate and isometamidium chloride are the only two trypanocidal drugs against which drug resistance is not yet a major problem (Williamson, 1976; Finelle, 1973; Anon, 1979; Leach and Roberts, 1981; Holmes and Scott, 1982). However, even for these, there are increasing field reports of development of drug resistance in both West and East African strains of *Trypanosoma congolense* and *T. vivax* (Jones-Davies, 1967; 1968; Mwambu and Mayende, 1978; Njau et al, 1983; Pinder and Authie, 1984; Mbwambo et al, 1988).

The Maasai have opted for curative treatment of trypanosomosis and not prophylactic treatment. In a way this is better than prophylactic treatment as this often leads to some development of immunity. Whitelaw et al. (1986) have shown that when Isometamidium chloride is properly used for prophylaxis, it does not lead to antibody development against the challenge trypanosomes. Silayo and Mkoma (1988) recommended that where proper diagnosis can be made promptly, it is better to treat trypanosomosis curatively rather than prophylactically as the former conferred some immunity.

In common with many of the veterinary drugs, trypanocides are freely available to farmers who are increasingly applying them on their own. For pastoral people like the Maasai in East Africa, farmer's own administration of veterinary drugs has been the practice over a considerable length of time. However, their practice of applying every drug intravenously needs to be addressed. In the literature, there are reports of increased efficacy following intravenous as opposed to intramuscular application of Isometamidium chloride for eliminating drug resistant trypanosomes (Dowler et al, 1989). However, such findings have not been corroborated by other studies (Sutherland et al 1991).

The Maasai in this study admitted to causing some mortality in cattle through intravenous injection of trypanocides meant for intramuscular injection. Other signs of toxicity observed were immediate diarrhoea, urination and a drop in milk yield. This has also been reported from studies on use of Isometamidium chloride intravenously at a farm in Kenya (Dowler et al, 1985; 1989; Sutherland et al, 1991).

In many of the areas visited, the divisional extension officers admitted to failing to convince the Maasai to change the habit of intravenous application of the trypanocides. At one study site (Dumilla) the Maasai indicated they had attended a workshop in which this issue was discussed and they had agreed to change.

In the field, a well-established regime for application of trypanocidal drugs is the administration of drugs alternatingly if the two drugs are sanative to each other. This means the two do not lead to cross-resistance and therefore if the trypanosomes are resistant to one they are still susceptible to the other. Use of the sanative pair in a single injection was a surprise finding from this study. The use of trypanocides for conditions such as retention of placenta is interesting but has also some implications on development of drug resistance particularly if the dosages for placenta removal are subcurative for trypanosomoses.

CONCLUDING REMARKS

East Coast Fever is recognised as the number one killer of cattle in the area of study and this is no doubt the same in the other areas of Tanzania where the disease is known to occur. Changed policy on supply and use of acaricides has meant unreliable supply of these essential inputs to the livestock industry at affordable costs. Their own experience has taught them that intensive dipping carries the risk of massive loss of adult cattle later on when dipping is interrupted as a result of lack of acaricides. They are prepared to accept a calfhood mortality of up to 80% from ECF as long as they know that the surviving adult cattle would be resistant to ECF. The question is whether Tanzania should continue to accept such collossal economic loss to the farmers and the country as a whole. The change from free/subsidised dipping to farmer's own-cost dipping came without necessary education of farmers on how they should organise themselves to approach tick and tick-borne disease control.

Application of animal drugs by the intravenous route even for drugs recommended for other routes, is likely to continue as a practice by the Maasai. To bring a change requires a lot of extension work. It remains to be seen whether the Maasai such as those of Dumilla will indeed change. Presuming they are unlikely to change in the near future and will continue to buy drugs for own administration to their animals, the question is whether drug formulations for intravenous use should be devised. This may be an alternative approach to the problem. For

trypanocides, the product sold need not be in liquid form, as powder packages for intravenous use after dissolving in a given volume of sterile water could be availed.

CONLUSION

There is a need for promotion of co-operative movement among pastoralists. Livestock co-operatives would facilitate sale of livestock and livestock products as well as supply of inputs such as acaricides and essential chemicals/drugs for their livestock. Such unions may also help them in planning for the future particularly as a pressure group for land tenure issues. Reported clashes between nomadic pastoralists and sedentary farmers though still few may increase in future as more and more land is acquired for crop farming (Mwakatundu, 1996). Ownership of the rangeland by the pastoralists is also an incentive for instituting improvements on pasture and control methods against the tsetse fly for example. In the course of the studies it was reported that there were attempts by the pastoralists to organise themselves into cooperative societies for the above purposes although success has so far not been recorded. There are indications that the Ministry of Agriculture and Cooperatives in Tanzania is intent on promotion of livestock farmers' cooperatives.

REFERENCES

Anon (1979). "The African Trypanosomiases"- *Report of a joint WHO Expert Committee and FAO Expert Consultation - Rome 8-12 November, 1976. FAO Animal Production and Health Paper No.14, FAO, Rome.*

Dowler, M., Mwenda, G. and Abdirahman, M. (1985). Trypanosomiasis treatment - a coast farmer's view (Paper presented at the Scientific Meeting of the Kenya Veterinary Association on Field Aspects of Trypanosomiasis in Kenya, Ukunda, Kenya, August 1984*). Kenya Veterinarian 9 (2), 19-20.*

Dowler, M.E., Schillinger, D. and Connor, R.J. (1989). Notes on the routine intravenous use of isometamidium in the control of bovine trypanosomiasis on the Kenya coast. *Tropical Animal Health and Production 21, 4-10*

Finelle, P. (1973). African animal trypanosomiasis. 1. Disease and chemotherapy. World *Animal Review, 7, 1-6*

Holmes, P.H. and Scott, J.M. (1982). Chemotherapy and animal trypanosomiasis. In: *"Perspectives in Trypanosomiasis Research", Ed. J.R. Baker, Chichester, Research Studies Press, pp. 59-69.*

Holmes, P.H. and Torr, S.J. (1988). The control of animal trypanosomiasis in Africa: Current methods and future trends. *Outlook in Agriculture 17, 54-60.*

Jones-Davies, W.S.(1967). A berenil-resistant strain of *T. vivax* in cattle. *Vet.Rec.18, 567-568.*

Jones-Davies, W.S. (1968). Berenil resistance in naturally occuring *T. congolense*. Bull. epiz. Dis. Afr. 16, 213-216.

Kagaruki, L.K. and Mbise, S.R. (1984). Tick control constraints in Tanzania. In: *Proceedings of the Second Tanzania Veterinary Association Scientific Conference, Arusha, Tanzania, 4-6 December, 1984, TVA, Morogoro, Tanzania, pp.60-77.*

Leach, T.M. and Roberts, C.J. (1981). The present status of chemotherapy and chemoprophylaxis of animal trypanosomiasis in the Eastern hemisphere. *Pharmacology and Therapeutics, 13, 91-147.*

Mbwambo, H.A., Mella, P.N.P. and Lekaki, K.A. (1988). Berenil (diminazene aceturate)-resistant *Trypanosoma congolense* in cattle under natural tsetse challenge at Kibaha, Tanzania. *Acta Tropica 45, 239-244.*

Mpelumbe, I.S. (1984). Current animal disease situation in Tanzania. In: *Proceedings of the Second Tanzania Association Scientific Conference, 4-6 December, 1984. TVA, Morogoro, Tanzania, pp.1-11.*

Mukhebi, A.W., Perry, B.D. and Kruska, R. (1992). Estimated economics of Theileriosis control in Africa. *Preventive Veterinary Medicine 12, 73-85.*

Munstermann, S. Mbura, R.J., Moloo, S.H. and Lohr, K-K. (1992). Trypanosomiasis control in Boran cattle in Kenya: a comparison between chemoprophylaxis and parasite detection and intravenous treatment method using isometamidium chloride. *Tropical Animal Health and Production 24, 17-27.*

Mwakatundu, G.A.K. (1996). Nomadic pastoralism in Tanzania and its effect on the environment. In: Zessin, K.H. (ed.) (1996). Livestock Production and Diseases in the Tropics: Livestock Production and Human Welfare. *Proceedings of the VIII International Conference of Institutions of Tropical Veterinary Medicine Vol II, DSE, Felfing Germany, pp. 416-422.*

Mwambu, P.M. and Mayende, J.S. (1971). Occurrence of berenil resistant strain of *T. vivax*. *Trans. Roy. Soc. Trop. Med. Hyg. 65, 254-255.*

Njau, B.C., Mkonyi, P.M. and Kundy, D.J. (1983). Berenil resistant *Trypanosoma congolense* isolated from naturally infeced goats in Tanga Region, Tanzania. In: *ISCTRC 17th Meeting 1981, Arusha, Tanzania. OAU/STRC Publication No.112 pp.289-298.*

Njau, B.C., Mkonyi, P.A. and Lekaki, K. (1988). Susceptibility of *Trypanosoma congolense* isolate of water-buffalo origin to diminazene aceturate and Isometamidium chloride. *Insect Science and its Application 9 (4) 461-463.*

Peregrine, A.S. (1994). Chemotherapy and delivery systems: haemoparasites. *Veterinary Parasitology, 54 (1-3): 223-248.*

Pinder, M. and Authie,E.(1984). Appearance of isometamidium resistant *Trypanosoma congolense* in West Africa. *Acta Trop.(Basel) 41, 247-253.*

Sempeho,G. and Rushalaza, V.G. (1985). The impact of improved technologies in the traditional livestock sub-sector of Tanzania. In: *Proceedings of the 12th Scientific Conference of the Tanzania Society of Animal Production 12, 55-68.*

Silayo, R.S. and Mkoma, F.N. (l988). Diminazene aceturate versus Isometamidium chloride in the control of trypanosomiasis in a dairy herd within a low challenge area. *Proceedings of the Tanzania Veterinary Association Scientific Conferences, 6, 47-55.*

Sutherland, I.A., Codjia, V., Moloo, S.K., Holmes, P.H. and Peregrine A.S. (1992). Therapeutic activity of isometamidium chloride in Boran cattle against a tsetse transmitted clone of Trypanosoma congolense with a low level of drug resistance. *Tropical Animal Health and Production 24, 157-163.*

Sutherland, I.A., Moloo, S.K., Holmes, P.H. and Peregrine A.S. (1991). Therapeutic and prophylactic activity of isometamidium chloride against a tsetse-transmitted drug-resistant clone of Trypanosoma congolense in Boran cattle. Acta Tropica 49, 57-64.

Waters-Bayer, A. and Bayer, W. (1994): *Planning with pastoralists: PRA and more - a review of methods focused in Africa, German Agency for Technical Cooperation (GTZ) GmbH, Eschborn, Germany, 153 pp.*

Williamson, J. (1976). Chemotherapy of African trypanosomiasis. *Tropical Disease Bulletin 73, 531-542.*