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Participatory investigations of bovine trypanosomiasis in Tana River District, Kenya

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Abstract. Participatory research on bovine trypanosomiasis was conducted with Orma pastoralists in Tana River District, Kenya. The use of participatory methods to understand local perceptions of disease signs, disease causes, disease incidence by cattle age group, seasonal patterns of disease and preferences for indigenous and modern control methods are described. Results indicated that local characterization of diseases called *gandi* and *buku* by Orma pastoralists was similar to modern veterinary knowledge on chronic trypanosomiasis and haemorrhagic trypanosomiasis (due to *Trypanosoma vivax*), respectively. The mean incidence of *gandi* varied from 10.2% in calves to 28.6% in adult cattle. The mean incidence of *buku* varied from 3.1% in calves to 9.6% in adults. Pearson correlation coefficients for disease incidence by age group were 0.498 ($P < 0.01$) and 0.396 ($P < 0.05$) for *gandi* and *buku*, respectively. Informants observed cases of trypanosomiasis in 24.1% of cattle (all age groups); these cases accounted for 41.8% of all sick cattle during the preceding 12-month period. Eight indigenous and three modern trypanosomiasis control methods were identified. Results indicated that an integrated approach to trypanosomiasis control based on private, individual action was well established in the assessment area. When presented with four different trypanosomiasis control methods, community representatives selected 'better use of trypanocides' as the most preferred intervention and 'community-based tsetse control' as the least preferred intervention. This finding prompted researchers to modify the original project activities. Constraints facing the sustainability of community-based tsetse control are discussed.

Key words. Bovine trypanosomiasis, community-based disease control, Orma pastoralists, participatory research, tsetse, Kenya.

Introduction

Participatory research

In recent years, institutions ranging from large international agencies to local non-governmental organizations have adopted participatory research as a means to improve the relevance of research findings and outputs to intended beneficiaries. Although a substantial literature on the principles and methods of participatory research is available, in summary, the approach aims to enable local people to take more control of research agendas, methods, analysis and outcomes. When comparing participatory and conventional research, Cornwall & Jewkes (1995) noted that in participatory research the research topic was identified by communities rather than researchers and that, crucially, the research was action-orientated. During participatory

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research, researchers acted as facilitators and technical advisers, and research methods were often based on the interviewing, visualization and scoring methods of participatory rural appraisal. As a measure of the scope of participatory research world-wide, Selener (1997) reviewed more than 1000 references describing applications in community development, research in organizations, research in schools and farmer participatory research. More recent accounts and discussion of participatory research include work in human health (Eisinger & Senturia, 2001; Lantz *et al.*, 2001; Quandt *et al.*, 2001; Riley *et al.*, 2001; Schmid *et al.*, 2001) and agriculture (Arriaga-Jordan *et al.* 2001; Bernet *et al.* 2001; Edward-Jones, 2001; Manyong *et al.*, 2001; Mulatu & Belete, 2001; Roothaert & Franzel, 2001) in rural and urban areas of developing and industrialized countries.

Participatory research in animal health

Workers involved in primary-level veterinary services in Africa have emphasized the importance of participatory analysis and identification of 'best-bet' solutions during the initial stages of community-based animal health projects (Leyland, 1996; Mariner, 1996; Catley & Leyland, 2001). However, in the case of trypanosomiasis control projects, accounts of local perceptions of the importance of trypanosomiasis relative to other livestock diseases (or more general problems at community level) are limited. For example, in the case of community-based tsetse control interventions, researchers seemed to overlook trypanosomiasis control methods that were already being used by livestock keepers, often on an individual basis, and assumed that traps or targets would automatically be preferable to other control options (Catley & Leyland, 2001). Similarly, it was often difficult to ascertain whether communities were likely to embark on prolonged collective action to control tsetse flies. There is little published information describing how the problem of trypanosomiasis was analysed at community level, or how decisions were made concerning the most appropriate interventions. This lack of information suggests that interventions were identified and planned by researchers prior to contact with target communities. Although some tsetse control workers have advocated greater local say in disease control decisions (Williams *et al.*, 1993), published reports describing this approach are lacking.

A further consideration regarding trypanosomiasis control projects is the ability of livestock keepers to diagnose the disease and to determine whether communities and researchers are talking about the same problem. The veterinary literature from pastoral areas makes frequent reference to pastoralists' diagnostic skills although systematic methods for validating local diagnoses vs. professional diagnoses are rarely used. By enabling livestock keepers to describe and compare signs, causes and seasonality of different diseases, participatory research methods can assist veterinarians to understand and validate local disease names in pastoral areas (Catley *et al.*, 2001).

Tana River District

Tana River District in the Coastal Province of Kenya comprises approximately 39 000 km^2 of semi-arid bush land and flood plains. Like most of Kenya's arid and semi-arid lands, the district is characterized by limited development, poor infrastructure and a livestock-centred economy based on pastoral production systems. The human population is approximately 180 000 and the two main ethnic groups are the Orma and the Pokomo. The Orma are predominantly cattle-keeping pastoralists who undergo seasonal movements to and from the flood plain grazing areas adjacent to the Tana River. The Pokomo are sedentary farmers who are permanent inhabitants of the flood plains and river delta areas. The cattle population of Tana River District has been estimated at 200 000 animals.

Bovine trypanosomiasis in Orma cattle

The southern parts of Tana River District are heavily infested with tsetse and, consequently, Orma pastoralists have a long history of both avoiding tsetse-infested areas and using trypanocidal drugs (Dolan, 1998). In addition, research on trypanotolerance conducted on Galana Ranch in Kilifi and Tana River Districts in Kenya from 1980 to date showed that Orma Boran cattle were less susceptible to trypanosomiasis than other breeds. However, the Galana Ranch studies used Orma cattle maintained under ranched rather than traditional herding systems. Preliminary work by the Kenya Trypanosomiasis Research Institute (KETRI) in Tana River District has collected background information on cattle-keeping practices of Orma communities and indicated that trypanosomiasis was a major concern among Orma communities (Irungu, 2000a). This study also outlined some of the trypanosomiasis control methods currently in use.

This paper describes the use of participatory research for describing and analysing the problem of bovine trypanosomiasis in traditional Orma herds in Tana River District, Kenya. The research aimed to understand how livestock keepers characterized bovine trypanosomiasis by comparing their perceptions with modern veterinary knowledge. The assessment also investigated existing control methods for bovine trypanosomiasis and local preferences for different methods. A stakeholder workshop was conducted to enable researchers and community representatives to analyse different control methods against sustainability indicators and identify a 'best-bet' intervention.

Methods

The research was conducted in four Orma villages called Gadeni, Danissa, Oda and Kipao in Garsen Division, Tana River District between 18 and 28 November 2000. These villages were easily accessible by road except Kipao, which was reached by a river crossing by canoe and walk of approximately 1.5 km.

Secondary data and interviews

Secondary data and interviews with key informants comp rised the main background information for the research. Secondary data included published and grey literature on bovine trypanosomiasis, community-based livestock disease control and other topics. Interviews were conducted with veterinary and public health personnel in Garsen Division and Witu Veterinary Investigation Laboratory.

Matrix scoring

Matrix scoring was used to understand local perceptions of the main clinical signs and causes of trypanosomiasis, and preferences for different control methods. The matrix scoring was adapted from the method described by Catley *et al.* (2001). In summary, interviews with local veterinary staff and a review of secondary literature indicated that Orma herders used the disease names *gandi* and *buku* to describe bovine trypanosomiasis. Therefore, these two disease names became the main topics of investigation in the matrix scoring. However, in order to avoid exaggeration of responses to *gandi* and *buku*, and check that informants understood the matrix scoring method, other diseases were added to the matrix as controls. These diseases were *hoyale* (foot and mouth disease, FMD), *somba* (contagious bovine pleuropneumonia, CBPP) and *madobesa* (rinderpest). The control diseases had already been characterized in the ethnoveterinary literature from Tana River District (Mahdi, 1999).

The five diseases named above were represented using everyday objects and placed along the top '*x*-axis' of a matrix drawn on the ground. Each of the five diseases was then scored against a list of clinical signs and causes of disease. The clinical signs and causes were represented using simple line drawings that were placed along the left '*y*-axis' of the matrix. The causes of disease were limited to items that livestock keepers could observe such as biting flies or contact with sick animals, rather than microscopic disease agents. When available, specimens of biting flies were used in preference to line drawings, and the local name for each specimen was checked prior to scoring. For each clinical sign or cause, informants were asked to score each disease by dividing piles of 20 stones against the five diseases. The more important a particular sign or cause, the greater the pile of stones assigned to it. After the scoring procedure was completed, the researchers prompted the informants to check their scoring and confirm that as a group, they agreed that the scores were correct. The scores were then recorded and the researchers asked additional questions to cross-check and probe the responses. The questions asked were open questions designed to elicit additional information and follow up interesting scores.

Matrix scoring was repeated with three informant groups in each of the four villages (total 12 informant groups). Group sizes varied from five to 12 individuals. The level of agreement between informant groups was assessed using Kendall's Coefficient of Concordance (W) (SPSS, 1999). Confidence interval software (Gardner *et al.*, 1992) was used to calculate 95% confidence limits.

In order to understand local preferences for different control methods for trypanosomiasis, a second matrix scoring method was used. This matrix comprised different control methods (both indigenous and modern methods) placed along the *x*-axis of the matrix and various features of these methods (e.g. cost, effectiveness) placed along the *y*-axis of the matrix. Each feature of the control methods was scored using piles of stones. The numbers of stones used were selected by the informants. This method was conducted with 1 large group of informants (15–24 people) in each of the four villages.

Proportional piling of livestock diseases

Proportional piling was used to estimate the relative incidence of livestock diseases in different age groups of cattle during the preceding 12-month period. Interviews with Orma informants indicated that their cattle were categorized by age group as *jabie* (calves to weaning age; 0–2 years of age), *waela* (weaner group, 2–3 years old), *goromsa* (young adult stock, including heifers and young bulls; age group 3–4 years) and *hawicha* (adult stock, particularly the milking cows kept around the permanent villages; $>$ 4 years of age).

Using a pile of 100 stones to depict each age group, the stones were divided by informants into 'sick cattle during the last year' and 'healthy cattle during the last year'. The pile of stones representing sick cattle was then subdivided by informants to show the relative numbers of cattle suffering from *gandi*, *hoyale*, *buku*, *somba*, *madobesa* and 'other diseases'. The method was repeated with six informants in Gadeni, 15 informants in Danissa, 19 informants in Oda and 10 informants in Kipao (total 50 informants). Mean incidence and 95% confidence limits were calculated for each disease by age group. Correlation between age and disease incidence was assessed using Pearson's correlation coefficient (SPSS, 1999).

Seasonal calendars

Seasonal calendars were used to describe the seasonal incidence of the diseases used in the matrix scoring and seasonal populations of ticks, biting flies and cattle–buffalo interactions. Rainfall was also depicted. The methodology for constructing the seasonal calendars was similar to the matrix scoring. Local names for seasons were used and each season was represented using an object placed along the top '*x*-axis' of the diagram. Simple line illustrations of diseases and parasites, and actual specimens of parasites, flies and ticks were placed along the '*y*-axis' of the diagram.

The seasonal calendar method was used with one group of informants from each village.

Stakeholder analysis of bovine trypanosomiasis control methods

A workshop was organized to analyse bovine trypanosomiasis control methods and identify a best-bet option for further research to be supported by KETRI in the four pilot villages. The workshop was held in Minjila, Tana River District from 29 to 30 November 2000. Workshop participants were community representatives ($n = 24$), KETRI researchers ($n = 3$), project staff from the Catholic Diocese of Malindi ($n = 2$), local government veterinary officers ($n = 2$), one representative from a private 'Agrovet' store and one veterinarian from the International Institute for Environment and Development.

During the first stage of the workshop, KETRI researchers presented information on different trypanosomiasis control options, i.e. 'community-based tsetse control using targets and traps', 'use of trypanocidal drugs', 'use of pour-ons' and 'rehabilitation (or construction) of dips and community-based dip management'. These presentations focused on the advantages and disadvantages of the methods, and assisted different stakeholders to judge the feasibility and sustainability of each of method.

The second stage of the workshop required each group of community representatives to rank the four trypanosomiasis control methods mentioned above against sustainability indicators. The selection of sustainability indicators was based on increasing knowledge of the technical and social features of the project area as the fieldwork progressed and knowledge of some important sustainability issues affecting community-based animal health initiatives generally (Catley & Leyland, 2001). The sustainability indicators are described in detail in Table 1. The indicators did not include 'effectiveness' because the researchers considered all of the selected control methods to be effective if properly used. Finally, each stakeholder group ranked their commitment to contribute finance, labour and management inputs to the different control methods. Following the ranking exercises, results were collated and presented to the workshop participants in order to verify the findings. This process was followed by elaboration of activities to support the most preferred intervention and the formulation of a provisional work plan.

Results

Local perceptions of disease signs

The results of matrix scoring for disease signs showed moderate to high levels of agreement ($W = 0.26–0.86$) between the 12 informant groups for the disease signs (Fig. 1). The scores allocated to the three control diseases indicated that informants understood the scoring method. For example, *somba* (CBPP) received high scores for weight loss and coughing. The disease called *gandi* was associated with weight loss, abortion, reduced appetite, diarrhoea, coughing and loss of tail hair. After death, these animals had a 'watery' carcass. Further questioning about the signs of *gandi* showed that informants also noted swollen lymph nodes and poor coat condition. The disease called *buku* was characterized by rapid onset and short duration, diarrhoea, abortion and death. After death, a 'bloody carcass' was observed. After the scoring of *buku*, the researchers suspected that this disease could be a form of acute, haemorrhagic trypanosomiasis caused by *T. vivax*. However, as other diseases such as anthrax (Orma: *bashash*) might cause similar disease signs, further questions were used to probe if and how *buku* was distinguished from *bashash*. This line of questioning indicated that in cases of *bashash*, the spleen was swollen and people became sick if the carcass was

Table 1. Sustainability indicators used to assess trypanosomiasis control interventions during the stakeholder workshop.

Indicator	Notes
'Community commitment to contribute finance, labour and management'	This indicator was a measure of collective commitment to invest in an intervention.
'Low financial cost to end-users'	It was assumed that the lower the cost of a disease control method, the greater the willingness and capacity to pay at community-level.
'Builds on existing knowledge and practices'	More successful community-based animal health projects have utilized indigenous veterinary skills and knowledge, particularly in pastoralist communities (such as the Orma).
'Individuals can benefit by acting alone'	This indicator was used to highlight disease control methods that did not require collective action or group contributions to use the method. It was assumed that group action was less sustainable than individual action because it required prolonged community organization and management inputs.
'Resistant to crises'	Pastoral areas of Kenya and other countries are prone to drought, conflict and other crises. It was assumed that a sustainable disease control method should withstand these crises and continue to be available and accessible during crises.
'Avoids conflict with neighbours'	Competition for natural resources between pastoral communities and sedentary farming communities was an important issue in the Tana River delta. It was assumed that a sustainable disease control method should not contribute to conflict by, for example, enabling pastoral herds to encroach further into tsetse-infested, farmed areas.

Signs	Diseases: *Gandi* Trypanosomiasis	*Hoyale* Foot-and-mouth disease	*Buku* Haemorrhagic trypanosomiasis	*Somba* Contagious bovine pleuropneumonia	*Madobesa* Rinderpest
Chronic weight loss (W=0.59***)	4.5 (3.5-6.0)	1.5 (0-3.0)	0 (0-0.5)	11.5 (7.5-14.5)	0 (0-3.0)
Animal seeks shade (W=0.59***)	1.0 (0-3.5)	15.8 (10.0-20.0)	1.5 (0-4.0)	1.0 (0-4.0)	0 (0-0)
Diarrhoea (W=0.78***)	3.0 (1.0-5.5)	0 (0-0)	5.5 (3.0-8.5)	0 (0-0)	12.5 (8.5-15.5)
Haemorrhagic carcass (W=0.83***)	3.0 (0-5.0)	0 (0-0)	17.0 (15.0-20.0)	0 (0-0)	0 (0-0)
Coughing (W=0.86***)	4.25 (2.5-6.5)	0 (0-0)	1.0 (0-2.0)	14.5 (12.5-16.5)	0 (0-0)
Reduced appetite (W=0.26*)	5.25 (3.0-7.5)	6.0 (3.0-9.0)	2.5 (0-4.5)	3.0 (0.5-8.5)	1.5 (0-2.5)
Loss of tail hair (W=0.65***)	14.2 (10.0-19.0)	0 (0-0)	0 (0-2.5)	0 (0-0)	3.5 (0-7.0)
'Death is sudden' (W=0.78***)	0 (0-3.5)	0 (0-0)	17.5 (13.5-20.0)	0 (0-0.5)	0 (0-1.5)
Oedematous carcass (W=0.46***)	11.0 (5.5-17.5)	0 (0-0)	0 (0-5.0)	4.0 (0-10.0)	0 (0-0)

Fig. 1. Summarized matrix scoring of disease signs. Number of informant groups = 12; W = Kendall's Coefficient of Concordance (*$P < 0.05$; **$P < 0.01$; ***$P < 0.001$). The black dots represent the median scores (number of stones) that were used during the matrix scoring. 95% confidence limits are shown in parentheses. Orma words are shown in italics.

consumed. Also, in *bashash* cases, informants stated that the blood in the carcass did not clot.

Local perceptions of disease causes

The results of matrix scoring for disease causes showed moderate to high levels of agreement ($W = 0.38$–0.88) between the 12 informant groups for the disease causes (Fig. 2). The scores allocated to the three control diseases indicated that informants understood the scoring method. For example, *hoyale* (FMD), *somba* (CBPP) and *madobesa* (rinderpest) received high scores for 'sick cow entering herd' as a cause of disease. The disease *gandi* was associated with flies called *gandi* (tsetse) and *shilmi* (ticks). Further questioning about the role of ticks in transmitting *gandi*

Causes	Diseases: *Gandi* Trypanosomiasis	*Hoyale* Foot-and-mouth disease	*Buku* Haemorrhagic trypanosomiasis	*Somba* Contagious bovine pleuropneumonia	*Madobesa* Rinderpest
Sick cow entering herd (W=0.71***)	0 (0-3.0)	●●●●●●●●●● 10.0 (8.0-11.0)	0 (0)	●●●● 4.25 (2.5-6.0)	●●●●●● 6.0 (5.0-7.0)
Shilmi Ticks (W=0.67***)	●●●●●●●●●●●● 11.5 (6.0-16.0)	0 (0-0)	●●●●● 5.0 (0-8.5)	0 (0-0)	0 (0-0)
Kobabe Tabanids (W=0.38**)	●●●●●●●●●● 10.0 (0-13.0)	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-0)
Gandi 'kawaida' Tsetse (W=0.86***)	●●●●●●●●●●●●●●● 15.0 (11.5-17.5)	0 (0-0)	●●●●● 5.0 (2.5-8.5)	0 (0-0)	0 (0-0)
Gandi buku ?Tsetse (W=0.88***)			●●●●●●●● 7.5 (0-12.5)		
Gadarsi Contact with buffalo (W=0.75***)	0 (0-0)	●●●●●●●● 8.25 (7.0-10.0)	0 (0-0)	●● 1.5 (0-3.0)	●●●●●●●●●● 9.5 (7.0-12.0)

Fig. 2. Summarized matrix scoring of disease causes. Number of informant groups = 12; W = Kendall's Coefficient of Concordance (*$P < 0.05$; **$P < 0.01$; ***$P < 0.001$). The black dots represent the median scores (number of stones) that were used during the matrix scoring. 95% confidence limits are shown in parentheses. Orma words are shown in italics.

indicated that informants considered ticks to cause a similar disease to *gandi*. In contrast to *gandi*, informants identified this tick-borne disease by observing an enlarged liver at post mortem and no generalized oedema. Other informants described how large numbers of ticks caused animals to become debilitated, 'like they have *gandi*'. Informants also considered the disease *buku* to be caused by biting flies called *gandi* (tsetse). They stated that *buku* was most commonly observed in coastal areas. Six informant groups described two types of fly called *gandi* and *gandi buku* (or *gandi bola*).

Incidence of bovine trypanosomiasis

The estimated incidences of *gandi* (trypanosomiasis) and *buku* (haemorrhagic trypanosomiasis due to *T. vivax*) by Orma cattle age groups are illustrated in Figs 3 and 4, respectively. The incidence of *gandi* varied from 10.2% in *jabie* (calves <2 years of age) to 28.6% in *hawicha* (adult milking cattle). The incidence of *buku* varied from 3.1% in *jabie* to 9.6% in *hawicha*. Pearson correlation coefficients for disease incidence by age group were 0.498 ($P < 0.01$) and

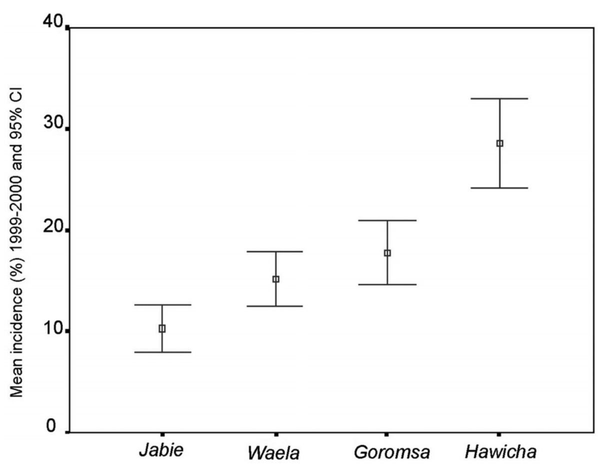

Fig. 3. Mean incidence of bovine trypanosomiasis by age group 1999–2000. Age groups: *Jabie* 0–2 years; *Waela* 2–3 years; *Goromsa* 3–4 years; *Hawicha* > 4 years.

0.396 ($P < 0.05$) for *gandi* and *buku*, respectively. Mean incidences of cattle diseases for all age groups are summarized in Fig. 5. Cases of trypanosomiasis were observed by informants in 24.1% of cattle (all age groups) and accounted for 41.8% of all sick cattle.

Seasonal factors

A summarized seasonal calendar for livestock diseases, biting flies, ticks and cattle–wildlife contact is shown in Fig. 6. These results were discussed with informants and, in particular, findings were related to seasonal movements of cattle. Informants explained that more cattle were present in the delta and permanent villages during *hageiya* (October–December) and *bona hageiya* (January–March). As the delta was wet (during *hageiya*) and hot (in both *hageiya* and *bona hageiya*) during these seasons, exposure to biting flies and ticks was high. When the main rainy season *gana* (April–mid-June) started, cattle were moved out of the delta to avoid flooded areas, and into the hinterland grazing areas. As the hinterland was drier than the delta and had different vegetation, exposure to biting flies and ticks reduced. This pattern of seasonal movement into and out of tsetse- and tick-infested areas in the delta determined the level of contact between cattle and these disease vectors. Contact between cattle and buffalo peaked during the dry periods called *bona hageiya* and *bona adolesa* (August–September) because wild and domesticated animals congregated around dry season water points.

Use of bovine trypanosomiasis control methods

Table 2 shows that informants used various indigenous and modern methods for controlling bovine trypanosomiasis. Indigenous methods included movement of cattle away from tsetse-infested areas, bush clearance to reduce contact with tsetse, use of dung fires in kraals, blood-letting and use of herbal remedies. In general, these methods were ranked highly for low cost and ease of use, but some were considered to be less effective than modern methods. Modern methods included the use of trypanocides, pour-on and dips. Although termed 'modern', interviews indicated that Orma herders had been using trypanocides for many years and they could recall their parents or grandparents using drugs. Informants obtained trypanocides from three main sources, i.e. informal traders, community animal health workers (CAHWs), and an agrochemical shop in Garsen town. Ranking of these three sources of trypanocides indicated only minor differences in cost and effectiveness. Overall, the results showed that herders were already using an integrated trypanosomiasis control approach that included 10 or more control options, with varying degrees of cost, effectiveness and ease of use.

Stakeholder identification of appropriate intervention to improve control of bovine trypanosomiasis

Ranking of trypanosomiasis control methods against sustainability indicators by community representatives is shown in Table 3. Improved use of trypanocidal drugs was ranked first, whereas community-based tsetse control was the least preferred option. According to this finding, KETRI staff outlined a series of activities to improve the use of trypanocides as summarized below. These activities were based on a limited budget for the work of approximately Kenya Shilling 1.5 million (US$ 19 500.00) over 3 years.

Activity 1. Conduct participatory research to quantify trypanocidal drug use, including timing of treatments, use

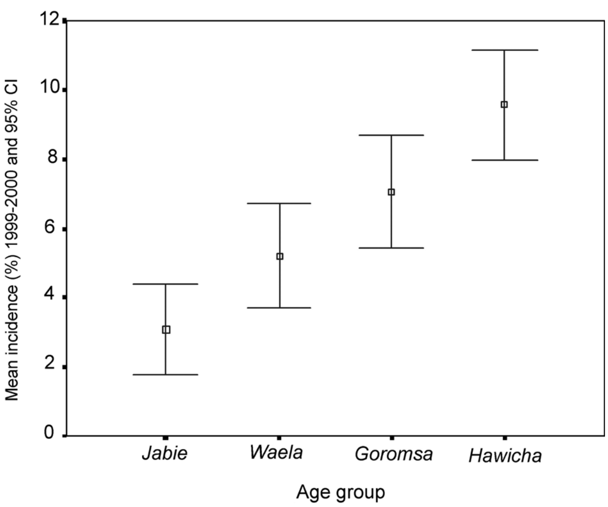

Fig. 4. Mean incidence of haemorrhagic trypanosomiasis due to *T. vivax*, 1999–2000. Age groups: *Jabie* 0–2 years; *Waela* 2–3 years; *Goromsa* 3–4 years; *Hawicha* > 4 years.

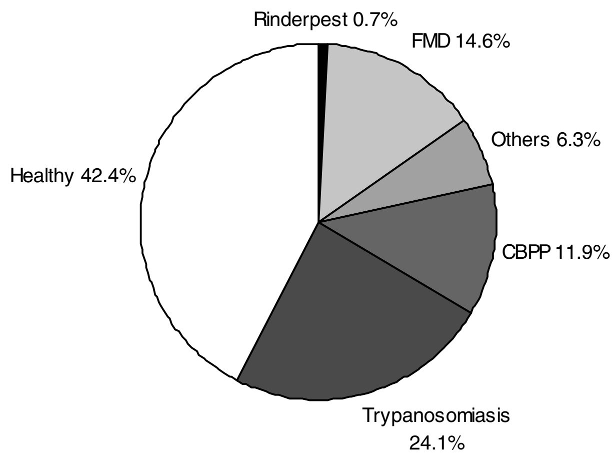

Fig. 5. Mean incidence of cattle diseases relative to healthy cattle, all age groups 1999–2000. The mean incidences of the Orma cattle diseases *gandi* (trypanosomiasis) and *buku* (haemorrhagic trypanosomiasis due to *T. vivax*) have been grouped as 'trypanosomiasis'.

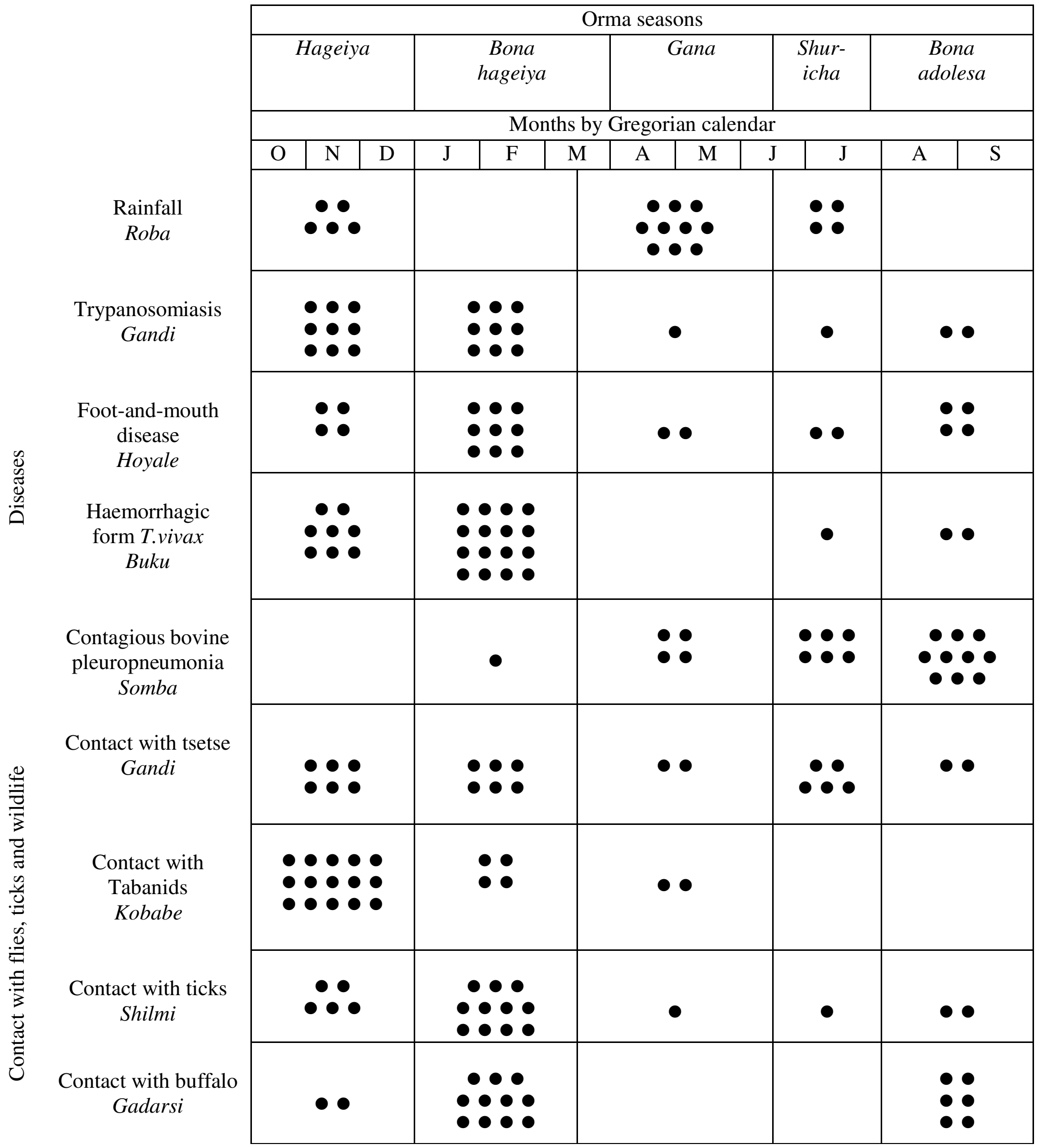

Fig. 6. Summarized seasonal calendar for livestock diseases, biting flies, ticks and cattle-wildlife contact. Number of informants groups = 4; statistical analysis was not conducted. Seasonal patterns for *madobesa* (rinderpest) were not included because informants claimed not to have seen this disease in the previous year. These informants differed from those conducting the proportional piling method (Fig. 5) in which 4/50 informants reported *madobesa* in 1999–2000.

of different products, local criteria for selecting animals to be treated and knowledge on correct doses, fake drugs and correct drug handling. This research would provide the baseline data against which the impact of future activities could be measured.

Activity 2. Identify herds in each village for assessment of trypanocidal resistance. Implement field research to assess levels of resistance.

Activity 3. Using the results from Activities 1 and 2, design and implement participative training courses on 'better use of trypanocides'; to include production and dissemination of illustrated booklets in the Orma language to all households in target villages. Conduct refresher training for community-based animal health workers; conduct training for Agrovet staff.

Activity 4. Conduct an impact assessment. Measure levels of knowledge and use of trypanocidal drugs relative to baseline data.

Discussion

Participatory research approach and methods

The research included the use of standardized participatory methods such as matrix scoring and proportional

Table 2. Preference ranking of control methods for *gandi* in Gadeni, Danissa, Oda and Kipao.

Indicator	Median rank for control methods: Herbal remedy	Burning the bush[1]	Bleeding[2]	Movement[3]	Dung fires[4]	Pour on	Dips	Trypanocides obtaind from: Hawkers and shops	CAHW[5]	Agrochemist
Effectiveness	8.5	6.0	7.0	7.0	7.0	4.0	3.0	3.0	2.0	3.0
Low financial cost	1.0	1.0	1.0	2.0	1.0	10.0	9.0	6.0	7.0	9.0
Easily used[6]	4.0	2.0	6.0	3.0	1.0	8.0	9.0	5.0	5.0	6.0
Requires group action[7]	3.0	3.0	3.0	2.0	3.0	3.0	3.0	3.0	3.0	3.0
Individual acts alone[8]	5.0	7.0	6.0	8.0	1.0	6.0	8.0	1.0	1.0	1.0

Interpretation of ranks – 1 = most preferred; 10 = least preferred.
[1]Bush clearance by burning was against Kenya government environmental policy.
[2]Bleeding or blood-letting involved removal of blood from the jugular vein.
[3]Cattle movement to and from the river delta to avoid flooding and tsetse.
[4]Dung fires were lit among the cattle in the kraals every evening.
[5]Community animal health workers were unpaid workers trained by the local Catholic diocese.
[6]'Easily used' included availability of the materials required to use the method, time and labour inputs, and the level of specialist knowledge required by the users. This specialist knowledge could be either indigenous knowledge, e.g. about a specific herbal remedy, or technical knowledge about the use of a veterinary medicine.
[7]'Requires group action' referred to methods that could only be used when people organized themselves for collective action. This indicator was considered to be a negative indicator.
[8]'Individual acts alone' meant that a single livestock keeper could use the method independently of other community members, and any benefits would be received by that person alone.

piling, and repetition of methods with different informants. This approach enabled results from different informants to be compared and, when levels of agreement were moderate to high, data were summarized accordingly. Therefore, although the methods used were described as 'participatory', some quantification was also possible. We concluded that the methods were valuable for understanding local characterization of cattle diseases, including two forms of trypanosomiasis, estimating disease incidence and analysing seasonal disease patterns. There was considerable overlap between indigenous knowledge on bovine trypanosomiasis (and other cattle diseases) among Orma herders and modern veterinary knowledge.

In addition to the data that arise during participatory research, the process of sitting and listening to people has value in itself. This value takes the form of giving people an opportunity to express their views and helping to create open and constructive relationships between the researchers and local people. Also, rather than conducting the analysis of data at a location remote from the research sites, the researchers compiled data while in the field and left copies of results with community representatives. Relative to conventional research approaches, this helped to improve the community's ownership of information and reduce local frustration with researchers who fail to provide reports (written or verbal) to the people who provided the original data.

Table 3. Ranking of potential trypanosomiasis control interventions against sustainability indicators by community representatives.

Sustainability indicator	Median ranks for possible control intervention[1]: Community-based tsetse control project	Improved use of trypanocides	Use of pour-on	Community-based dips
Community commitment to contribute:				
Finance	3.5	1.0	1.5	3.5
Labour	3.5	1.0	1.5	2.0
Management	3.5	1.0	1.0	2.0
Low financial cost to individual end-users	2.0	1.0	3.0	4.0
Builds on existing knowledge systems and practices	3.5	1.0	2.5	2.5
An individual can benefit by acting alone	3.5	1.0	1.0	3.0
Resistance to crises (e.g. drought, conflict)	3.5	1.0	1.0	3.0
Avoids conflict with neighbours	4.0	1.0	1.0	3.0
Overall rank	4.0	1.0	2.0	3.0

[1]The lower the rank, the greater the preference. Number of groups (villages) conducting the ranking = 4. There was no significant difference between the ranks of the four groups (Friedmans test, $P = 1.000$).

There is no standard method for predicting the sustainability of disease control measures. The ranking methods used were developed spontaneously in the field. The identification of sustainability indicators was based on the previous experience of the researchers and knowledge of the literature on community-based tsetse control projects. We suggest that these methods should be developed further and used more widely when identifying sustainable, community-based trypanosomiasis control interventions.

Signs and causes of bovine trypanosomiasis

During participatory research on a specific disease, it is useful to assess how local characterization of the disease and the local disease name compare with the western perceptions of the disease and the scientific disease name. Findings demonstrated much overlap between the Orma disease *gandi* and bovine trypanosomiasis. For example, *gandi* was associated with chronic weight loss, mild diarrhoea, mild coughing, reduced appetite and loss of tail hair (Fig. 1). In carcasses, oedema and haemorrhage was observed by livestock keepers in cases of *gandi* and *buku*, respectively. Apart from coughing, these signs are indicative of trypanosomiasis and are well known by veterinarians working in pastoralist areas of Africa. In addition, the disease name *gandi* is similar to the synonyms *gendi* and *gundi* for trypanosomiasis noted by veterinarians working with Somali (Mares, 1954; Dirie, 1984; Catley & Mohammed, 1995) and Gabra (Lindquist & Adolph, 1992) herders.

Assessment of disease causes showed that the disease *gandi* was strongly associated with the fly called *gandi* (tsetse). Considering that the Orma name for the disease and the fly are the same, this association was anticipated. However, informants also linked the disease *gandi* to *kobabe* (Tabanids) and *shilmi* (ticks) (Fig. 2). Further questioning about *kobabe* and *shilmi* indicated that both these parasites were associated with thin cows and prevented cattle from grazing normally. In general, tick-borne diseases were not considered by local veterinary staff or herders to be a serious problem.

The Orma disease *buku* appeared to be an acute, haemorrhagic form of trypanosomiasis that was most commonly seen in coastal areas. Orma herders differentiated the disease from other acute, fatal diseases such as *bashash* (anthrax). This haemorrhagic form of trypanosomiasis (due to *T. vivax*) was previously reported in coastal areas of Kenya (Mwongela *et al.*, 1981) and was diagnosed at the Witu Veterinary Investigation Laboratory, near the sites of the current research, between 1992 and 1995. A mild haemorrhagic syndrome in cattle due to *T. vivax* was also reported along the tsetse-infested Shabelle River in southern Somalia (Dirie *et al.*, 1988). These findings indicate that although there was good agreement on the main characteristics of *gandi*, as the research progresses the roles of *kobabe*, *shilmi* and *gandi buku* as causes of trypanosomiasis should be clarified. For example, local perceptions of the relationship between ticks and *gandi* might help to prevent misunderstanding concerning the use of acaricide for controlling the disease.

Estimates of disease incidence

In common with previous descriptions of trypanosomiasis in Tana River District by Mahdi (1999), Irungu (2000a) and the Veterinary Department, this assessment indicated that the disease was a priority for Orma herders (Fig. 5). It is possible that estimates of incidence are exaggerated because informants were aware that the researchers had a particular interest in *gandi*. Limited data were available for triangulating the results, although a preliminary cross-sectional survey was conducted by KETRI earlier in the year (Irungu, 2000b). Using the microhaematocrit centrifugation technique (MHCT), this survey estimated trypanosomiasis prevalence at 5.0% ($n = 456$). Prevalence varied from 1.6% in calves ($n = 188$) to 7.5% in adults ($n = 268$) and therefore followed a similar trend to the age-specific incidence for *gandi* illustrated in Fig. 3. When comparing the two sets of data, it should be noted that the sensitivity of the MHCT is usually 50% or less (M. Eisler, personal communication) and there was widespread use of trypanocides in Tana River District. Therefore, the MHCT results are probably an underestimate of the true trypanosome prevalence.

Seasonal factors

Seasonal variations in the incidence of *gandi* indicated that most cases were observed in the short rains *hageiya* (mid-October–December) and the main dry season *bona hageiya* (January–March) (Fig. 6). These trends vary from those described for Orma Boran cattle on Galana Ranch in Kenya. On the ranch, trypanosome prevalence followed a bimodal pattern in line with rainfall (Dolan, 1998). Prevalence peaked in December and January and was followed by a second, usually lower, peak in April to June. It was noted that under ranch conditions, trypanosome prevalence was associated with seasonal changes in tsetse challenge rather than seasonal grazing patterns. The incidence of *buku* peaked in the dry season *bona hageiya* when more cattle were present in the delta. A similar pattern of incidence was noted for haemorrhagic disease due to *T. vivax* along the Shabelle River in southern Somalia (Dirie *et al.*, 1988).

Existing control methods for bovine trypanosomiasis

The ranking of control methods in the four villages indicated that Orma herders used an integrated approach to control bovine trypanosomiasis involving up to 10 control methods, varying in effectiveness, cost and ease of use. The Orma have a long history of both moving their cattle to avoid tsetse and using trypanocides (Dolan, 1998). However, some of the other control methods noted in this assessment have not received much attention. For example, the control method 'herbal remedy' could be subdivided into at least four specific remedies, i.e. soups prepared from sheep head or tail fat, soups prepared from fish waste, use of roasted coffee beans and a drench prepared from *hargesa*, an Aloe species. A factor that was not reflected in the results or discussion on control methods was trypanotolerance. This feature of Orma Boran cattle has evolved over many years and is probably an important underlying influence on the types of control methods used, and when and how they are applied.

Stakeholder analysis of interventions

In the KETRI project, community-based tsetse control featured prominently in the original research proposal. Therefore, KETRI staff were expecting to implement a community-based tsetse control project, based on the assumption that targets or traps were appropriate technologies for long-term adoption by communities in the project area. However, local analysis of trypanosomiasis control methods with communities revealed the potential constraints facing community-based tsetse control relative to other control options. Despite the cost of trypanocides, people were more willing to continue to control trypanosomiasis according to individual, private action rather collective, group action. Based on earlier interviews with 25 Orma pastoralists, Irungu (2000a) estimated a mean cattle herd size of 124 head and annual expenditure on trypanocides per herd at Kenya Shilling 15 575 (US$ 200).

The research findings led the researchers to modify the original proposal and develop an action plan to conduct further research on trypanocide usage with local stakeholders. In general, participatory research approaches require prolonged interaction between researchers and communities during the initial stages of the project (Thomson, 1998). This interaction leads to elaboration of project objectives and activities that are mutually agreed. Our experience indicates that research organizations and donors should adopt more participatory approaches to developing control programmes for bovine trypanosomiasis, and be willing to adjust project activities according to local analysis of problems and opportunities. This approach is likely to be particularly valuable in pastoralist communities who possess well-developed knowledge on livestock diseases and already commonly use a variety of disease control methods.

Regarding community-based tsetse control, poor sustainability has been associated with management and financing issues at community level (Barrett & Okali, 1998; Budd, 1999). These problems were evident even though low-cost tsetse traps, costing only approximately US$ 8.5 per unit, were developed in Kenya (Brightwell *et al.*, 1991). Our research shows that despite the apparently low cost of traps, communities can predict problems with tsetse trapping projects if they are provided with sufficient information. Furthermore, local people can cite rational reasons for investing in alternative interventions or areas of research. In addition to the social and project management issues hindering community-based tsetse control, modelling studies indicate that small-scale community-based tsetse control activities are subject to rapid re-invasion of tsetse (Hargrove, 2000). Therefore, community-based tsetse projects are currently hindered by a combination of important social and technical constraints.

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