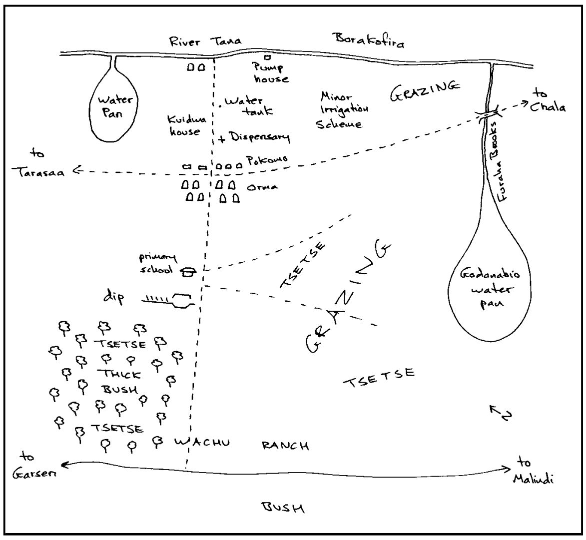
Participatory research on bovine trypanosomosis in Orma cattle, Tana River District, Kenya



Preliminary findings and identification of best-bet interventions

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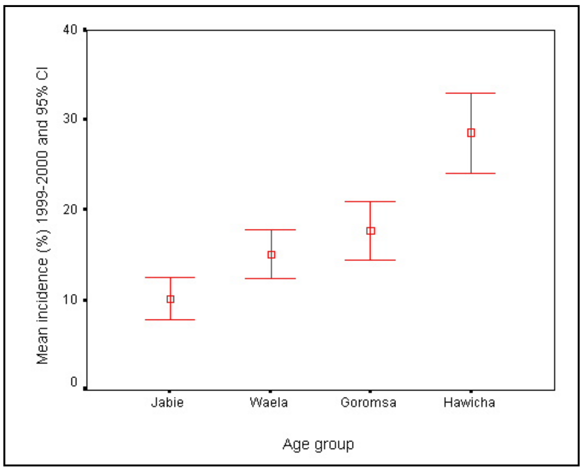
November 2000



International Institute for Environment and Development

KENYA TRYPANOSOMIASIS RESEARCH INSTITUTE
KETRI

This research depended on the contributions and ideas of 144 people from Gadeni, Danissa, Oda and Kipao villages, Garsen Division, Tana River District as follows:

Gadeni

Kulisa Godana	Ali Omar	Mohamed Godana	Omar Shure
Godana Gobale	Bocha Gobale	Banaya Kokabi	Omar Dokoto
Chai Doge	Omari Dambelo	Barako Bonaya	Mohamed Golo
Hamadi Jilo	Hanisi Galga	Dokota Shora	Idris Gobo
Omer Doge	Kuno Galano	Jillo Bocha	Mohamed Roka
Dokoto Doge	Ali Gobole	Dane Guyo	Ali Wario
Boneya Guyo	Kolomo Jilo	Guyo Jillo	Dido Bashare
Abdi Ware	Omar Boneo	Gorisa Shari	Ari Waticha
Mohamed Hindada	Roba Goba	Sido Bocha	Bakari Hindada

Danissa

Salim Kunyo	Dabelo Galgalo	Ismail Hokolo	Saida Gola
Ashako Kukuyo	Ijema Hachi	Abdi Gure	Gure Hashako
Waticho Shambaro	Roba Gobu	Bocha Abalaga	Omar Abaroba
Bocha Koticha	Bocha Dama	Hassan Bare	Guyole Gullo
Chanchala Oda	Wario Dada	Abdi Koticha	Shongolo Omar
Abdi Abadiba	Baru Ware	Abatuna Boru	Gobu Kokane
Omar Golo	Gure Gollo	Mohammed Dara	Serida Gola
Abdiraman Igiro	Rancho Hanti	Daudi Koticha	
Godana Abadiba	Boneto Hashako	Omer Mahmud	

Oda

Omali Idado	Abdallah Boba	Dido Kofonda	Mohamed Barissa Shamaro
Gata Bodda	Ali Dido	Walo Dado	Dame Dado
Mohamed Dado	Abdul Dado	Galgalo Golo	Ismail Wachu
Mohamed Kuni	Ahmed Algi	Galgalo Shambaro	Hussein Guyo
Boru Godana	Abubakar Dara	Mohamed Bocha	Oddo Jillo
Ranchero Barisha	Dido Dado	Twalibo Dido	Mohamed Galgado
Barissa Shambaro	Kokane Dadi	Gobu Godana	Mohamed Goshi
Barissa Abaroba	Osman Gondana	Bodole Wachu	Hamed Halji
Hiridada Oda	Bosha Shanbaro	Mohamed Barisa	Mane Bocha
Dahir Gure	Abdi Kaso	Aboroba	Bada Hashako
Abdul Dado	Yakob Twahir	Elmi Yusufu	

Kipao

Tari Lale	Jari Ganyo	Said Golo	Mohamed Gayo
Abdi Ware	Kolde Shongolo	Lale Bado	Adim Abatana
Ijenta Koromi	Jomo Rufo	Kuno Elema	Hukicha Hidi
Dido Dara	Roba Algi	Mohamed Komoro	Kuno Shongollo
Adan Rufo	Omar Kuno	Gola Mabruk	Guyo Fangare
Jiba Tuna	Abdalla Ganyu	Maalim Duwe	Bakero Baba
Ilyas Biyole	Ali Tare	Salim Boneya	Shalado Wario
Kuna Shongolo	Shambaro Mule	Barisa Abashora	Kufo Fangare

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Summary

Recent experiences with community-based tsetse control in Africa have indicated that greater community involvement in project design might help to avoid inappropriate and non-sustainable interventions. Specifically, the high level of collective and sustained action that is often expected of communities in tsetse control projects needs to be compared with the methods that people are already using to control trypanosomosis. This comparison of options is particularly relevant when private, individual action to control the disease is well-established and widespread.

The original research proposal formulated by KETRI for Tana River District was prompted by the development of a Technology Transfer Fund by KETRI-DFID. The proposal aimed to reduce tsetse and trypanosomosis using community-based tsetse trapping. Activities included initial entomological and epidemiological surveys followed by 'community capacity-building' during which 'the community will be shown how to make traps using locally available materials and also how to set the traps and empty the cages'. It was expected that 'the community will adopt the control methods after the training and start using them'. Therefore, the proposal reflected a predetermined solution to the problem of bovine trypanosomosis in the study areas.

This report describes small-scale participatory research on bovine trypanosomosis with Orma pastoralist communities in Tana River District. The research aimed to combine the perspectives of researchers and livestock keepers to identify 'best bet' interventions to improve disease control. Rather than collecting large quantities of technical data on tsetse and trypanosomosis, the participatory research methodology was intended to initiate a partnership between researchers and communities that would lead to action, and in turn, further learning and refinement of project activities. The research was also an opportunity for KETRI to learn more about participatory approaches and methods.

The participatory research approach proved to be a useful way of reassessing best bet interventions for trypanosomosis control. For example, as the work progressed a number of resource and sustainability issues emerged which indicated that community-based traps or targets were unlikely to be sustained in the four study villages. This prompted the researchers to rethink their own assessment of the control options available. As a result of this process, 'Improved use of trypanocides' was considered by the researchers to be the most appropriate control intervention – an opinion that was verified by community representatives. Therefore, the work described in this report is a good example of how research activities identified by scientists were modified according to the findings of participatory assessment.

In order to improve the use of trypanocides, the following four activities were proposed:

Activity 1 Participatory research to quantify trypanocidal drug use, including timing of treatments, use 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 a herd(s) 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 CAHVs; conduct training for Agrovet staff.

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

Closer contact with communities during these activities might also provide opening to investigate other issues, such as:

a) the epidemiology of *buku* and the role of biting flies other than tsetse in the transmission of the disease;

b) local perceptions on the role of ticks, and biting flies such as Tabanids and Stomoxys in the transmission of *gandi*;

c) local perceptions of economic losses due to chronic and acute trypanosomosis.

CONTENTS

1 Introduction

Within Kenyan research institutes there is increasing interest in ways to involve rural communities in the definition of research problems and identification of solutions. Commonly, more people-centred approaches to research have involved the use of participatory methods such as Participatory Rural Appraisal (PRA). When applied correctly, these methods enable local description and analysis of problems, and help both communities and researchers to identify best-bet interventions according to both local views and the technologies available.

In the 1990s, numerous research organisations in Africa began to implement community-based tsetse control projects. Typically, these projects aimed to transfer tsetse trapping or targeting methods to communities, and establish systems within communities for the long-term management and maintenance of the traps or targets. While initial results were often promising (with dramatic reductions in tsetse fly populations), in many cases the technology was not sustained and areas were re-invaded with tsetse (Barrett and Okali, 1998; Budd, 1999). Reasons for poor long-term impact included confusion over roles, responsibilities and ownership of projects, a tendency for researchers to focus on technical issues rather than developing local management capacity, and lack of clarity regarding project objectives i.e. tsetse control or tsetse eradication.

Other workers noted that initial assessments did not describe local perceptions of the importance of trypanosomosis relative to other livestock diseases or more general problems at community-level. In addition, researchers seemed to overlook trypanosomosis 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 and Leyland, 1998). In views of these apparent deficits, it was often difficult to ascertain whether communities were likely to embark on prolonged collective action to control tsetse flies. Analysis of trypanosomosis control within the broader context of animal health service delivery by numerous stakeholders was also lacking.

With this history of community-based tsetse control in mind, the Kenya Trypanosomiasis Research Institute (KETRI) began a research project in Tana River District, Kenya in 1999. The purpose of the research was to improve understanding of the tsetse and trypanosomosis situation in Garsen Division, Tana River District with a view to implementing control interventions in partnership with local stakeholders. This report describes an initial participatory assessment of bovine trypanosomosis in four Orma villages and the process of working with livestock keepers to analyse different disease and vector control methods.

The objectives of the research were:

- To explore and compare livestock keepers' and researchers' knowledge on bovine trypanosomosis.
- To identify best-bet trypanosomosis control options to be implemented and evaluated by KETRI and local stakeholders.

Some important features of the research were as follows:

- The research was small-scale. The research budget was KSh 1.5 million (approximately $19,000.00) over three years.

- In general, KETRI researchers were not experienced users of participatory methods. Therefore, the research was an opportunity for KETRI to learn more about participatory methods and compare a conventional 'top-down' approach with a participatory approach.

- The work was based on the principles of participatory research. Specifically, initial research findings were expected to inform a stakeholder analysis of the trypanosomosis problem, leading to an action plan to test one or more control options. In a participatory research approach, the process of taking action becomes an integral part of the research and lessons learned are used to modify research activities.

2 Approach and methods

A participatory research approach was used. This approach involved two main stages:

- The use of participatory appraisal (PA) methods to describe and analyse the problem of bovine trypanosomosis.

- A stakeholder workshop for identifying best-bet options for improving the control of bovine trypanosomosis and agreeing a plan of action for future work.

2.1 Background information

2.1.1 Tana River District

Tana River District in the Coastal Province of Kenya comprises approximately 39,000km^2 of semi-arid bush land around the flood plains of the Tana River (Figure 2.1). The district is divided into seven administrative divisions of which Garsen, in the south of the district, is the largest.

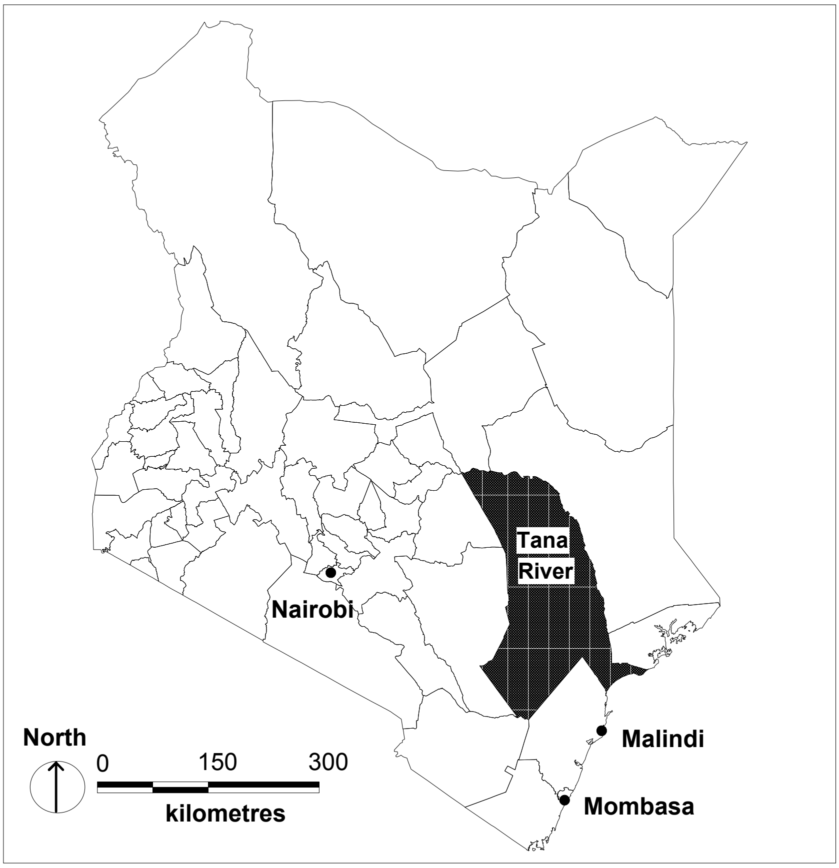


Figure 2.1
Tana River District, Kenya

Like most of Kenya's arid and semi-arid lands, Tana River District is characterised by limited development, poor infrastructure and a livestock-centred economy based on pastoral production systems. The human population is approximately 150,000 and the two main ethnic groups are the Orma and the Pokoma. The Orma are predominantly cattle-keeping pastoralists who undergo seasonal movements to and from the flood plain grazing areas.

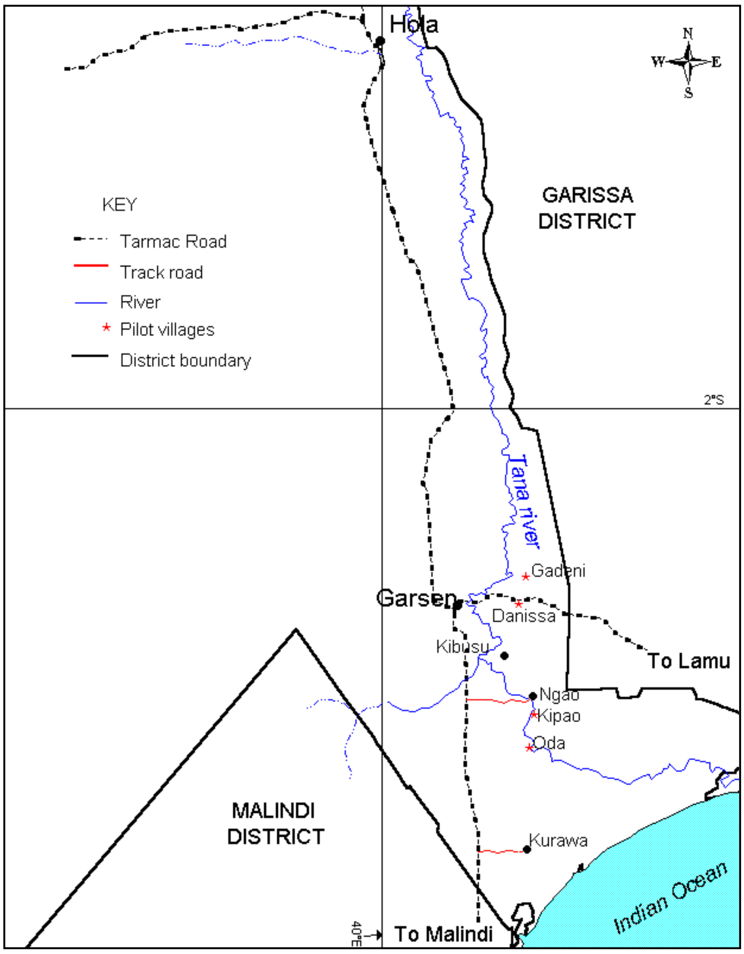


Figure 2.2
Location of study (pilot) villages in Garsen Division

The Pokoma 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, of which 120,000 are found in Garsen Division. Further background information on Tana River District and Orma pastoralism can be found in Ensminger (1984), Braaksma (1994) and Irungu (2000a).

2.1.2 Bovine trypanosomosis in Orma cattle

The southern parts of Tana River District and the riverine areas further north are heavily infested with tsetse. 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) between 1980 and 1996 showed that Orma Boran cattle were less susceptible to trypanosomosis than other breeds. However, apart from the Galana Ranch studies relatively little is know about bovine trypanosomosis in Orma cattle or the pros and cons of different disease control methods under traditional herding systems.

Preliminary work by the KETRI in Tana River District has collected background information on cattle keeping by Orma communities and outlined some of the trypanosomosis control methods currently in use (Irungu, 2000a). Further cross-sectional surveys provided estimates of trypanosomosis prevalence and information on tsetse challenge (Irungu 2000b).

2.2 Participatory assessment of bovine trypanosomosis in Orma villages

The participatory assessment was conducted in 4 Orma villages Gadeni, Danissa, Oda and Kipao,Garsen Division, Tana River District (Map 1 and Map 2) between 18th and 28th November, 2000. These locations were easily accessible by road except Kipao, which was reached by a river crossing by canoe and short walk. All locations could be reached within 1 hour from Garsen. The research used PA methods in combination with existing information, as outlined in Table 2.1[1].

Table 2.1
Summary of the participatory research methodology for assessing bovine trypanosomosis (*gandi*) in Garsen Division

Information required	Participatory appraisal methods		Use of existing data
	Method	Number of informants or informant groups	
Spatial limits	Participatory mapping	1 group of informants per village; group size 5-10 people	Conventional maps; tsetse distributions maps
Local characterisation of tryps-like diseases in cattle	Matrix scoring of disease-signs and disease-causes	3 groups of informants per village; group sizes 5-10 people.	1. Comparison of results with standard textbook descriptions of diseases. 2. Results of field diagnosis. 3. Veterinary department and veterinary investigation laboratory records. 4. Use of fly specimens to cross-check local names.
Temporal variations in vector populations and incidence of tryps-like diseases and rainfall	Seasonal calendar	1 informant group per village; group size 5-10 people.	1. Veterinary department and veterinary investigation laboratory records. 2. Meteorological data.
Estimates of incidence of tryps-like disease	Proportional piling	Minimum of 50 individual informants.	None
Pros and cons of different control methods already in use	Matrix scoring of control methods	1 informant group per village; minimum group size 15 informants.	None

[1] Note that the research team did not 'do a PRA'. PRA usually involves a multidisciplinary team who work with communities to analyse and prioritise key problems on a general level, and formulate a plan of action for solving those problems. In the research described in this report, bovine trypanosomosis had already been identified as key problem during a previous household survey (Irungu, 2000a) and therefore the work focussed on this topic alone. The methods used were adapted from some typical PRA methods.

2.2.1 Secondary data and interviews

Secondary data and interviews with key informants were used as background information to the research. Secondary data included published and grey literature on bovine trypanosomosis, 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.

2.2.2 Participatory mapping

Participatory mapping was used to describe features of each village such as:

- The geographical boundaries of the village;
- Natural resources such as water sources, vegetation types and areas of cultivation;
- Services, facilities and important infrastructure (including roads);
- The grazing areas for the milking herd;
- The distribution of tsetse flies.

Maps were constructed on the ground by 1group of informants in each village. The map was copied on to newsprint and this copy was left with the informants. Other copies were made into the researchers' notebooks.

2.2.3 Matrix scoring

a. Disease-signs

Matrix scoring was used to understand local perceptions of the main clinical signs of trypanosomosis-like disease and relate these perceptions to modern veterinary thinking. In other words, how do Orma livestock keepers characterise tryps-like disease in comparision with other diseases?

The method used two suspected forms of trypanosomosis called *gandi* and *buku*. Three control diseases were also used in the matrix. These diseases were *hoyale* (foot and mouth disease, FMD), *somba* (contagious bovine pleuropneumonia, CBPP) and *madobesa* (rinderpest). The use of control diseases was intended to avoid exaggeration of responses to *gandi* and *buku*, and check that informants understood the matrix scoring method. FMD and CBPP were thought to be endemic in Garsen Division.

The 5 diseases named above were represented using every-day objects and placed along the top 'x-axis' of the matrix. Each of the 5 diseases in the matrix were scored against a list of 10 clinical signs or features of diseases. These clinical signs were illustrated using simple line drawings that were placed along the left 'y-axis' of the matrix. For each disease-sign, informants were asked to score each disease by dividing piles of 20 stones against the 5 diseases. The more important a particular disease-sign, the greater the pile of stones assigned to it. After the scoring of each disease-sign, the researchers prompted the informants to check their scoring and confirm that as a group, they agreed that the scores were correct. When all the disease-signs had been scored, the results were 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.

The disease-signs matrix scoring was repeated with 3 informant groups in each of the 4 villages (total 12 informant groups). Group sizes varied from 5 to 12 individuals. The level of agreement between informant groups was assessed using Kendall's Coefficient of

Concordance (W)(SPSS Version 9.0). Confidence interval software (Gardner *et al.*, 1992) was used to calculate 95% confidence limits.

b. Disease-causes

When the disease-signs matrix scoring was completed, the card illustrations of disease-signs were removed and replaced by illustrations of disease-causes. These illustrations were supported by samples of biting flies such as tsetse, Hippoboscids and Tabanids. These samples were passed around the informants in order to elicit the Orma name for the flies. A similar scoring and questioning procedure was used as for the disease-signs matrix. The disease-causes matrix scoring was repeated with 3 informant groups in each of the 4 villages (total 12 informant groups). Group sizes varied from 5 to 12 individuals. The level of agreement between informant groups was assessed using Kendall's Coefficient of Concordance (W).

c. Control methods for trypanosomosis

In order to understand the advantages and disadvantages of different control methods for trypanosomosis, a third matrix scoring method was used. This matrix comprised different control methods (both indigenous and modern methods) along the x-axis of the matrix and various features of these methods (e.g. cost, effectiveness) along the y-axis of the matrix. Each feature of the control methods was scored using piles of stones. The number of stones used was selected by the informants. This method was conducted with 1 large group of informants (15-24 people) in each of the 4 villages.

2.2.4 Proportional piling of livestock diseases

Proportional piling was used to estimate the relative incidence of livestock diseases in different age groups of cattle. Orma pastoralists categorise their cattle as follows[2]:

Jabie Calves up to around weaning age; the 0-2 years age group.

Waela Weaner group, 2-3 years old.

Goromsa Young adult stock, including heifers and young bulls; age group 3 to 4 years.

Hawicha Adult stock, particularly the milking cows kept around the permanent villages; > 4 years of age.

The proportional piling method was repeated with each of the 4 age-groups of cattle and involved the following stages:

1. Using a pile of 100 stones to depict the age group, the stones were divided by informants into 'sick cattle during the last year' and 'healthy cattle during the last year'.

2. The pile of stones representing sick cattle was then sub-divided by informants to show the relative numbers of cattle suffering from *gandi, hoyale, buku, somba, madobesa* and 'other diseases'.

[2] There are also specific names for the different sexes in each age group. The *hawicha* group are the milking herd whereas there are also *jida matta* adult groups, being cattle herded away from the village. As the initial parasitological survey by KETRI had sampled the *hawicha* animals, these animals were included in the method and the *jida matta* groups were excluded. Also, news about diseases in *jida matta* cattle may take some time to reach the villages.

This method was repeated with 6 informants in Gadeni, 15 informants in Danissa, 19 informants in Oda and 10 informants in Kipao (total 50 informants). Data was entered into an SPSS (version 9.0) spreadsheet. 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.

2.2.5 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. Diagrams depicting diseases and parasites, and specimens of parasites, flies and ticks were placed along the y-axis of the diagram. This type of seasonal calendar was used with 1 group of informants from each village.

2.3 Stakeholder workshop

The stakeholder workshop was held in Minjila, near Garsen, on 29th and 30th November 2000. The following people attended the workshop[3]:

Community representatives:	
Gadeni	6 participants
Danissa	5 participants
Oda	5 participants
Kipao	7 participants
Other stakeholders:	
KETRI	1 socioeconomist, 1 veterinarian, 1 entomologist
Catholic Diocese of Malindi[4]	2 representatives
Department of Veterinary Services	District Veterinary Officer, Tana River District
Private sector	Representative from Agrovet store, Garsen
PAVE Project	1 veterinarian

The stakeholder workshop aimed to conduct a joint-analysis of trypanosomosis control methods and identify a best-bet option to be supported by KETRI and the four villages. Therefore, the workshop involved the following activities:

Day 1

- Welcome, introduction, aims and objectives of the workshop.
- Feedback from communities on participatory assessment of trypanosomosis conducted in villages.
- Presentations by KETRI staff on four possible control interventions:
  - community-based tsetse control using targets and traps;
  - better use of trypanocides (including monitoring drug resistance);
  - use of pour ons;
  - use of dips.

Day 2

- Ranking of four possible control interventions against sustainability indicators.

[3] Note that the primary stakeholders i.e. livestock keepers, were the largest stakeholder group.
[4] The Catholic Dioces of Garissa was split recently into the Diocese of Garissa, encompassing the northern part of Tana River District, and the Diocese of Malindi comprising Garsen Division and Malindi and Lamu Districts.

- Ranking of commitments by public, private and technical stakeholders.
- Analysis of results and joint-identification of 'best-bet' control intervention.
- Outline of intervention by KETRI.
- Agreement of roles and responsibilities of different players.
- Formulation of draft action plan.

3 Results

3.1 Participatory assessment of bovine trypanosomosis in Orma villages

3.1.1 Secondary data and background information

The secondary data and background information used during the research is summarised below.

- ***Studies on trypanotolerance in Orma cattle, Galana Ranch, 1983-1996 (Dolan, 1998).***

Detailed research on trypanosomosis prevalence, seasonal factors, production losses, trypantolerance and other topics. Relates to cattle under ranch management.

- ***Survey of Orma households and cattle keeping practices in Tana River District (Irungu, 2000a).***

Data on cattle production, important cattle diseases, disease control and other topics.

- ***Ethnoveterinary practices among Orma pastoralists, Tana River District (Mahdi, 1999).***

Questionnaire survey of indigenous animal health knowledge and practices. Includes Orma names for cattle diseases and indigenous treatments. No validation of local terminology.

- ***Monthly reports from the Garsen Division Veterinary Office, 1998-1999; discussion with Dr G.K.Gakuo, Divisional Veterinary Officer, Garsen.***

Trypanosomosis reported each month as endemic (or enzootic) in Garsen Division. Other endemic diseases were CBPP and FMD. No laboratory confirmation of disease diagnosis was viewed.

- ***Monthly meat inspection reports for Garsen from the Department of Public Health (1999); discussion with Israel Komoro, Public Health Officer.***

Regular condemnations of lungs and livers. Prevalence of liver flukes was estimated at approximately 30% of animals slaughtered.

- ***Records from Witu Veterinary Investigation Laboratory[5] (1992-1995).***

Daybook records show regular and frequent diagnoses of bovine trypanosomosis due to *T.congolense* and *T.vivax*. Occasional reports of haemorrhagic syndrome due to *T.vivax*, including detection of haemorrhagic lesions at post mortem and identification of *T.vivax.* Relatively few confirmations of tick-borne diseases (babesiosis, anaplasmosis) compared with trypanosomosis.

[5] Witu is in Lamu District but the area has a similar environment to the river delta area of Garsen Division.

- ***KETRI cross-sectional survey of trypanosomosis and tsetse flies in Garsen Division, 2000 (Irungu, 2000b).***

Trypanosomosis prevalence in 4 Orma villages was estimated using the MHCT as summarised in Table 3.1. There was widespread use of trypanocidal drugs in the survey sites and therefore the results are probably under-estimates of the true prevalence. *Glossina pallidipes* was the most commonly trapped species of fly, with low numbers of *G. brevipalpis,* Stomoxys and Tabanids also caught.

Table 3.1
Estimated prevalence of bovine trypanosomosis in Garsen Division, Tana River District

Location	Trypanosome prevalence (%)	Mean packed cell volume (%)	Trypanosome species (number of cases)
Gadeni	6.8 (n=118)	29.8	*T.congolense* (4)
Danissa	3.1 (n=163)	27.0	*T.congolense* (3)
Oda	5.3 (n=75)	26.8	*T.congolense* (5); *T.vivax* (3)
Kipao	3.0 (n=100)	25.5	*T.congolense* (3); *T.vivax* (2)
Total	5.0 (n=456)	27.0	*T.congolense* (15); *T.vivax* (5)

3.1.2 Characterisation of trypanosomosis and other diseases

Summarised matrix-scoring diagrams for disease-signs and disease-causes are shown in Figure 3.1 and Figure 3.2.

Figure 3.1 shows moderate to high levels of agreement (W=0.256 to W= 0.856) between the 12 informant groups for the disease-signs. The disease called *gandi,* a name commonly used by vets as a synonym for trypanosomosis, was associated with weight loss, abortion, reduced appetite, diarrhoea, coughing and loss of tail hair. After death, these animals had a 'watery' (oedematous) carcass. Further questioning about the signs of *gandi* showed that informants also noted swollen lymph nodes and poor coat condition. Figure 3.2 shows that *gandi* was thought to be caused by flies called *gandi* (tsetse) and *shilmi* (ticks). Further questioning about the role of ticks in transmitting *gandi* indicated that informants considered ticks to sometimes cause a disease similar to *gandi*. This tick-borne disease was identified by an enlarged liver at post mortem and no general oedema. Other informants described how large numbers of ticks caused animals to become debilitated, 'like they have *gandi*'.

The matrix scoring method also included a disease called *buku*. In terms of disease-signs, the disease was characterised by rapid onset and short duration, diarrhoea, abortion and death. After death, a 'bloody carcass' was observed with bleeding from internal organs (Figure 3.1). The researchers suspected that *buku* could be a form of acute, haemorrhagic trypanosomosis caused by *T.vivax*. However, as other diseases such as anthrax (Orma; *bashash*) might also cause similar disease-signs further questions were used to probe if and how *buku* was distinguished from *bashash*. Results are summarised below Figure 3.2.

Figure 3.1
Summarised matrix scoring of disease-signs

Signs	Diseases: *Gandi*	*Hoyale*	*Buku*	*Somba*	*Madobesa*
Chronic weight loss ($W=0.587^{***}$)	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 ($W=0.599^{***}$)	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 ($W=0.779^{***}$)	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 ($W=0.825^{***}$)	3.0 (0-5.0)	0 (0-0)	17.0 (15.0-20.0)	0 (0-0)	0 (0-0)
Coughing ($W=0.856^{***}$)	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 ($W=0.256^{*}$)	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 ($W=0.645^{***}$)	14.2 (10.0-19.0)	0 (0-0)	0 (0-2.5)	0 (0-0)	3.5 (0-7.0)
'Death is sudden' ($W=0.776^{***}$)	0 (0-3.5)	0 (0-0)	17.5 (13.5-20.0)	0 (0-0.5)	0 (0-1.5)
Oedematous carcass ($W=0.456^{***}$)	11.0 (5.5-17.5)	0 (0-0)	0 (0-5.0)	4.0 (0-10.0)	0 (0-0)

Number of informant groups = 12; W = Kendall's Coefficient of Concordance (*$p<0.05$; **$p<0.01$; ***$p<0.001$). W values vary from 0 to 1.0; the higher the value, the higher the level of agreement between informants. The black dots represent the median scores (number of stones) that were used during the matrix scoring. 95% confidence limits are shown in parentheses.

Figure 3.2
Summarised matrix scoring of disease-causes

Causes	*Gandi*	*Hoyale*	*Buku*	*Somba*	*Madobesa*
Sick cow entering herd ($W=0.710^{***}$)	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 ($W=0.667^{***}$)	11.5 (6.0-16.0)	0 (0-0)	5.0 (0-8.5)	0 (0-0)	0 (0-0)
Kobabe Tabanids ($W=0.381^{**}$)	10.0 (0-13.0)	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-0)
Gandi 'kawaida' Tsetse ($W=0.862^{***}$)	15.0 (11.5-17.5)	0 (0-0)	5.0 (2.5-8.5)	0 (0-0)	0 (0-0)
Gandi buku ?Tsetse ($W=0.884^{***}$)			7.5 (0-12.5)		
Gadarsi with buffalo ($W=0.746^{***}$)	0 (0-0)	8.25 (7.0-10.0)	0 (0-0)	1.5 (0-3.0)	9.5 (7.0-12.0)

Number of informant groups = 12; W = Kendall's Coefficient of Concordance (*p<0.05; **p<0.01; ***p<0.001). W values vary from 0 to 1.0; the higher the value, the higher the level of agreement between informants. The black dots represent the median score for the 12 groups. 95% confidence limits are shown in parentheses.

Distinguishing between *buku* and *bashash*

Buku

- carcase not harmful when eaten;
- no or little blood from orifices;
- blood clots in the carcass;
- lymph nodes not swollen, but bloody;
- spleen swollen and 'bursts';
- bloody diarrhoea
- no cow to cow transmission; caused by *gandi*

Bashash

- people become sick if the carcass is eaten;
- blood from orifices;
- blood remains unclotted in the carcass;
- swollen lymph nodes;
- spleen swollen;
- no or less diarrhoea;
- cow-to-cow transmission

Buku was thought to be caused by biting flies called *gandi* (tsetse) and was particularly prevalent in coastal areas. Six informant groups described two types of fly called *gandi* and *gandi buku* (or *gandi bola*).

When cross-checking the identity of tsetse flies, informants consistently called these flies *gandi* and described *gandi buku* and a shorter, blackish fly that lived in crevices in the ground or on bark. A specimen of *gandi buku* was caught in Kipao and although this fly has not yet been formally identified, it appeared not to be a biting fly.

Specimens of tabanids and hippoboscids were also identified consistently by informants and called *kobabe* and *kitani* respectively. Neither of these two flies were associated with disease transmission although *kobabe* was said to cause a painful bite and prevent animals from grazing. These factors explained the association between *kobabe* and *gandi* (Figure 3.2).

The control diseases in the disease-signs and disease-causes matrices were scored by informants as expected by the researchers. For example, *somba* (CBPP) was linked to weight loss and coughing whereas *madobesa* (rinderpest) was linked to diarrhoea. In some villages, informants scored the disease *hoyale* (FMD) by considering both *hoyale* and a chronic form of FMD called *chukurdi*. The disease *churkurdi* affected animals that seemed to recover from FMD but later developed long coats and heat intolerance. The contagious nature of these diseases was understood, with both cattle and buffalo associated with the transmission of *hoyale* and *madobesa* (Figure 3.2).

3.1.3 Estimates of disease incidence

Estimates of disease incidence by age group are summarised in Figure 3.3.

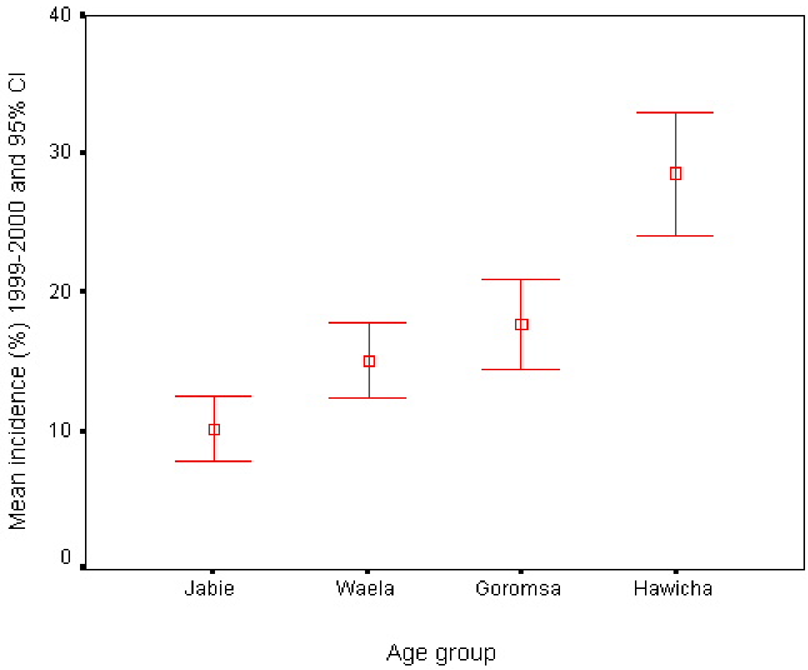
Figure 3.3
Mean incidence of important cattle diseases by Orma cattle age groups, 1999-2000

a. *Gandi*/trypanosomosis

Age groups:

Jabie	0-2 years
Waela	2-3 years
Goromsa	3-4 years
Hawicha	> 4 years

(n=50)

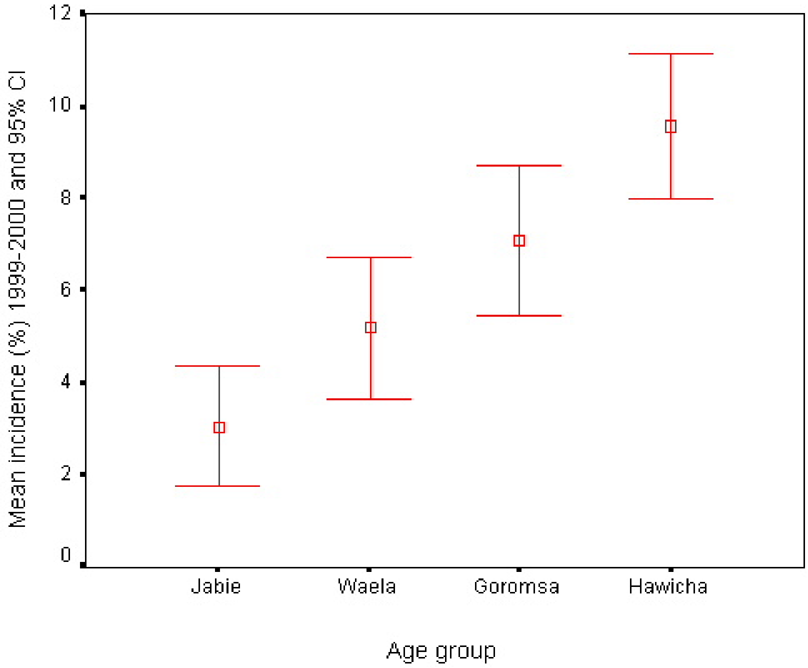


b. *Buku*/haemorrhagic
T.vivax

Age groups:

Jabie	0-2 years
Waela	2-3 years
Goromsa	3-4 years
Hawicha	> 4 years

(n=50)

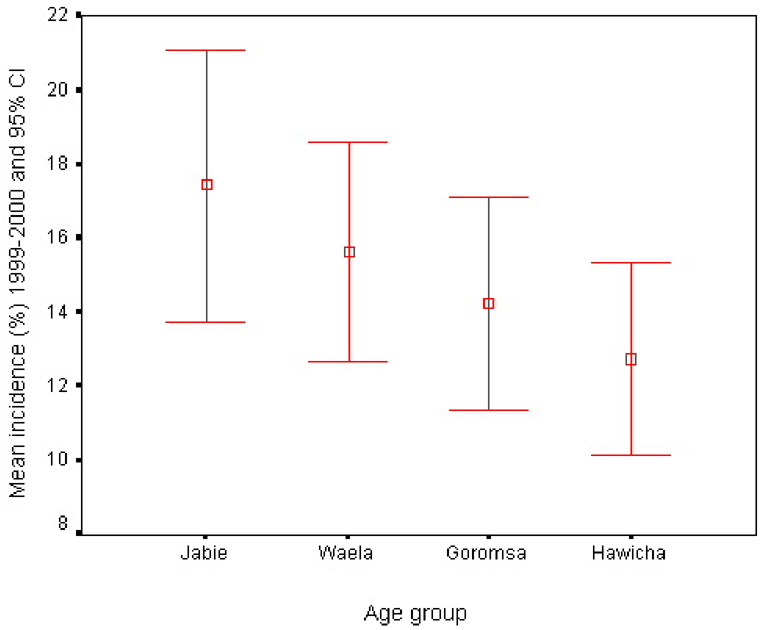


c. *Hoyale*/FMD

Age groups:

Jabie	0-2 years
Waela	2-3 years
Goromsa	3-4 years
Hawicha	> 4 years

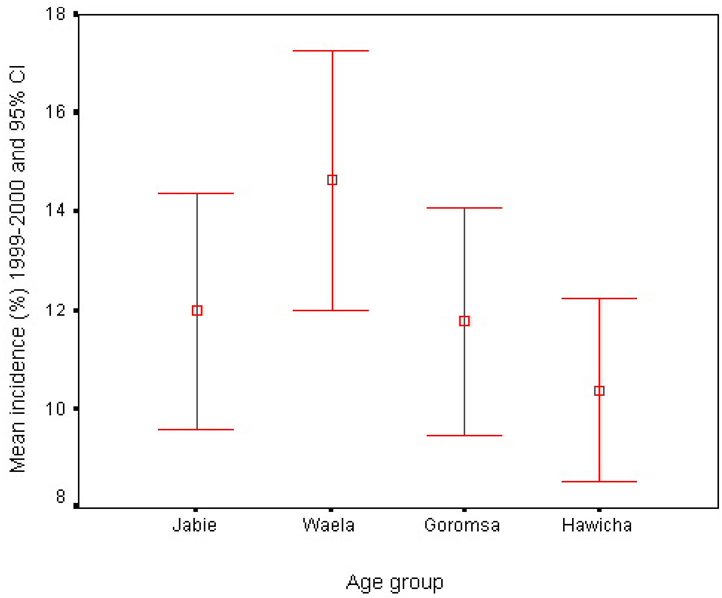
(n=50)



d. *Somba*/CBPP

Age groups:
Jabie 0-2 years
Waela 2-3 years
Goromsa 3-4 years
Hawicha > 4 years

(n=50)



According to the results of proportional piling, the incidence of *gandi* and *buku* both increased with age. In the *jabie* age group (calves to 2 years of age), the mean incidence of *gandi* was 10.2% whereas in the *hawicha* age group, mean incidence was 28.6% (Figure 3.3a). A similar pattern of disease but lower incidence was estimated for cases of *buku* (Figure 3.3b).

For both *hoyale* (FMD) and *somba* (CBPP), disease incidence peaked in younger stock with most cases seen in *jabie* and *waela* respectively (Figure 3.3c and 3.3d).

Pearson's correlation coefficients for disease incidence by age group are detailed in Table 3.2.

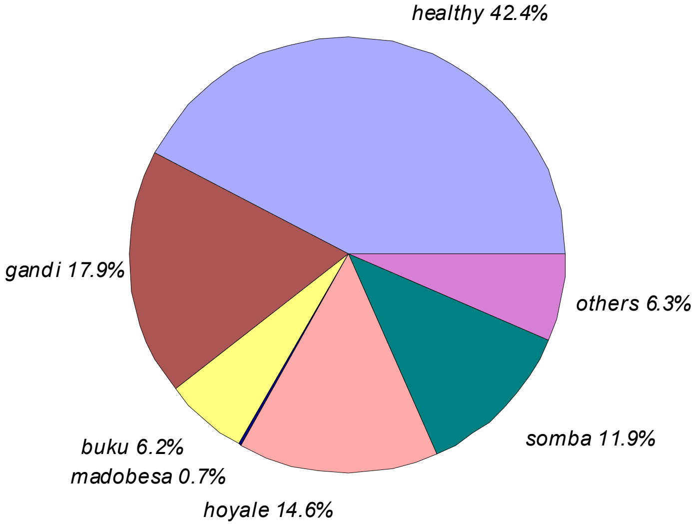
Table 3.2
Correlation coefficients for disease incidence by age group,1999-2000

Disease	Pearson's correlation coefficient	Significance (2-tailed)
Gandi/trypanosomosis	0.498	$p<0.01$
Buku/haemorraghic *T.vivax*	0.396	$p<0.05$
Hoyale/FMD	-0.149	$p<0.05$
Somba/CBPP	-0.116	ns

Compared with other important diseases such as somba (CBPP) and hoyale (FMD), gandi was the most commonly observed disease and when all age groups of cattle were considered, *gandi* affected 17.9% of cattle for the year 1999-2000 (Figure 3.4).

Figure 3.4
Mean incidence of important cattle diseases relative to healthy cattle, all age groups, 1999-2000.

(Estimates based on proportional piling with 50 informants).



3.1.4 Geographical factors

Participatory mapping was used to map out the 4 villages and identify grazing areas and areas of tsetse infestation. Maps for each village are shown in Figures 3.5 to 3.8.

<u>Notes for Gadeni map</u>

Where are the flies called *gandi* found?
They are all over the area; they are everywhere.

When you were boys, was the number the flies the same as it is now?
There were less flies then. At that time, our parents were still using the drugs to control gandi*.*

Why are there more flies now?
We don't really know, but we have ideas. In the past there was more rain and this area was flooded every year.

When the floods retreated, good grass grew for grazing. Now there is much less flooding and these bushes grow instead of the grass.The bushes harbour the flies and cannot survive in the flooded areas. Also, the ground is now drier than before and in the large cracks lives one type of gandi.

Years ago we used to burn the bush, just before the rains. The elders would go to a place and light the bush (or tell other people to do it). The burning cleared the bushes and flies, but it is no longer allowed. A law to stop burning had been there for years but only recently was it enforced. The problem has worsened because there is also less rain now.

The flies also increased because of the vehicles. With the parastatal farm[6] *there came tractors and there were always many flies attracted to them and other vehicles along the roads.*

What about wild animals? Have they changed over the years?
Only the elephants and rhinos are reduced in numbers. The other game like buffaloes, kopi, water buck, warthogs, hippos and baboons are the same as before. The buffaloes are very near-by and people collecting firewood had to run from them this morning.

[6] The parastatal farm was the Tana and Athi River Development Authority (TARDA) Rice Irrigation Scheme.

Figure 3.5
Map of Gadeni village

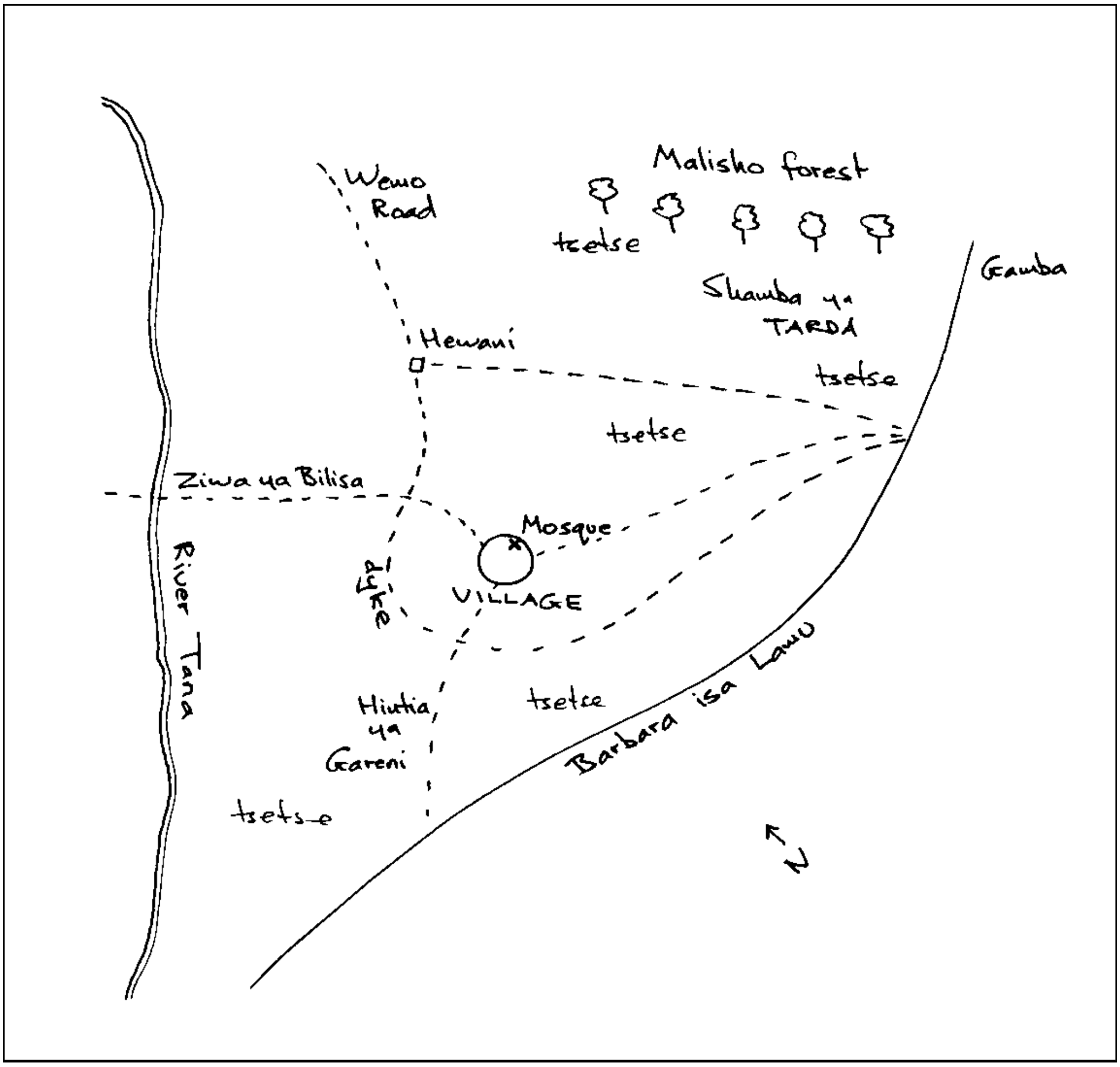
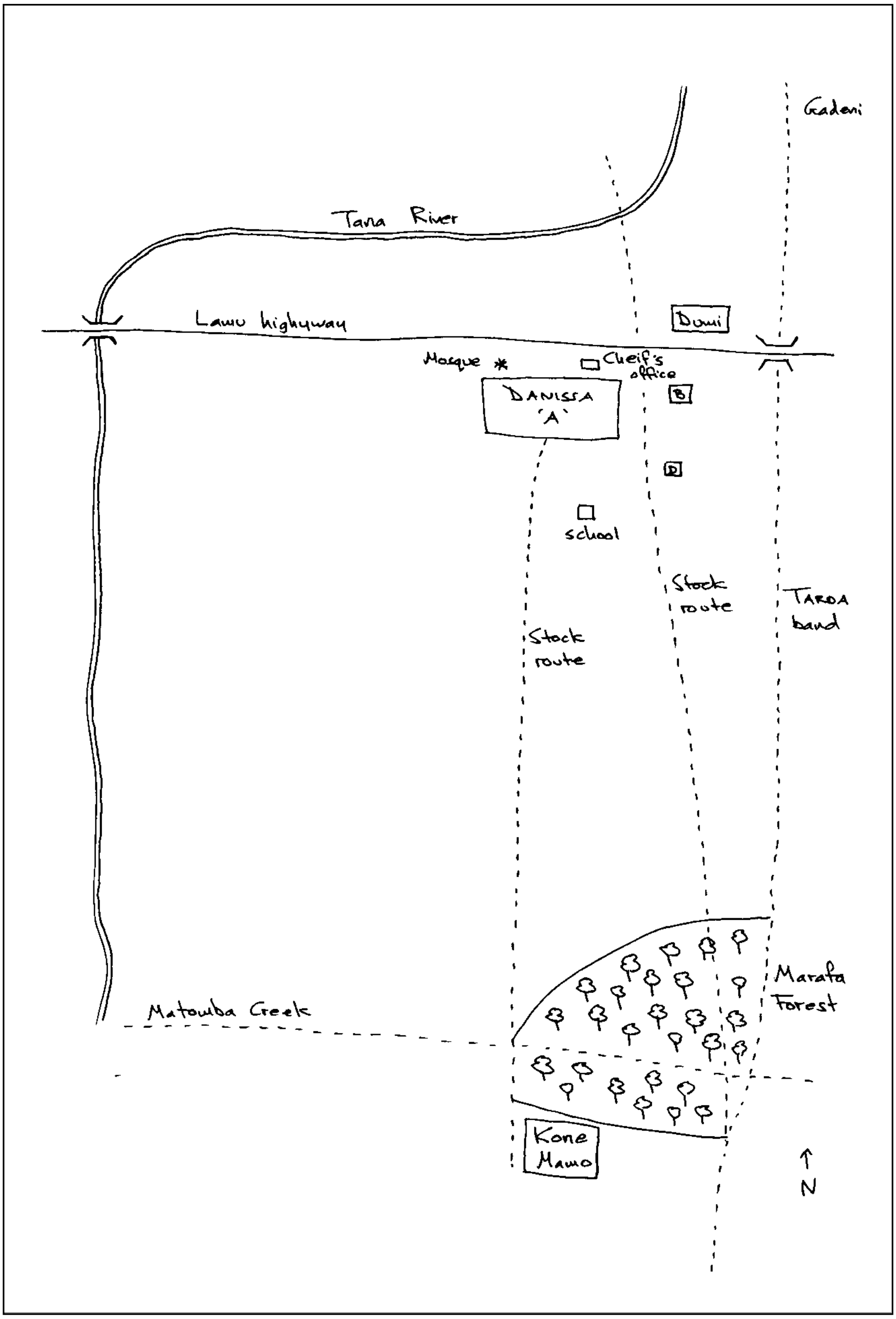


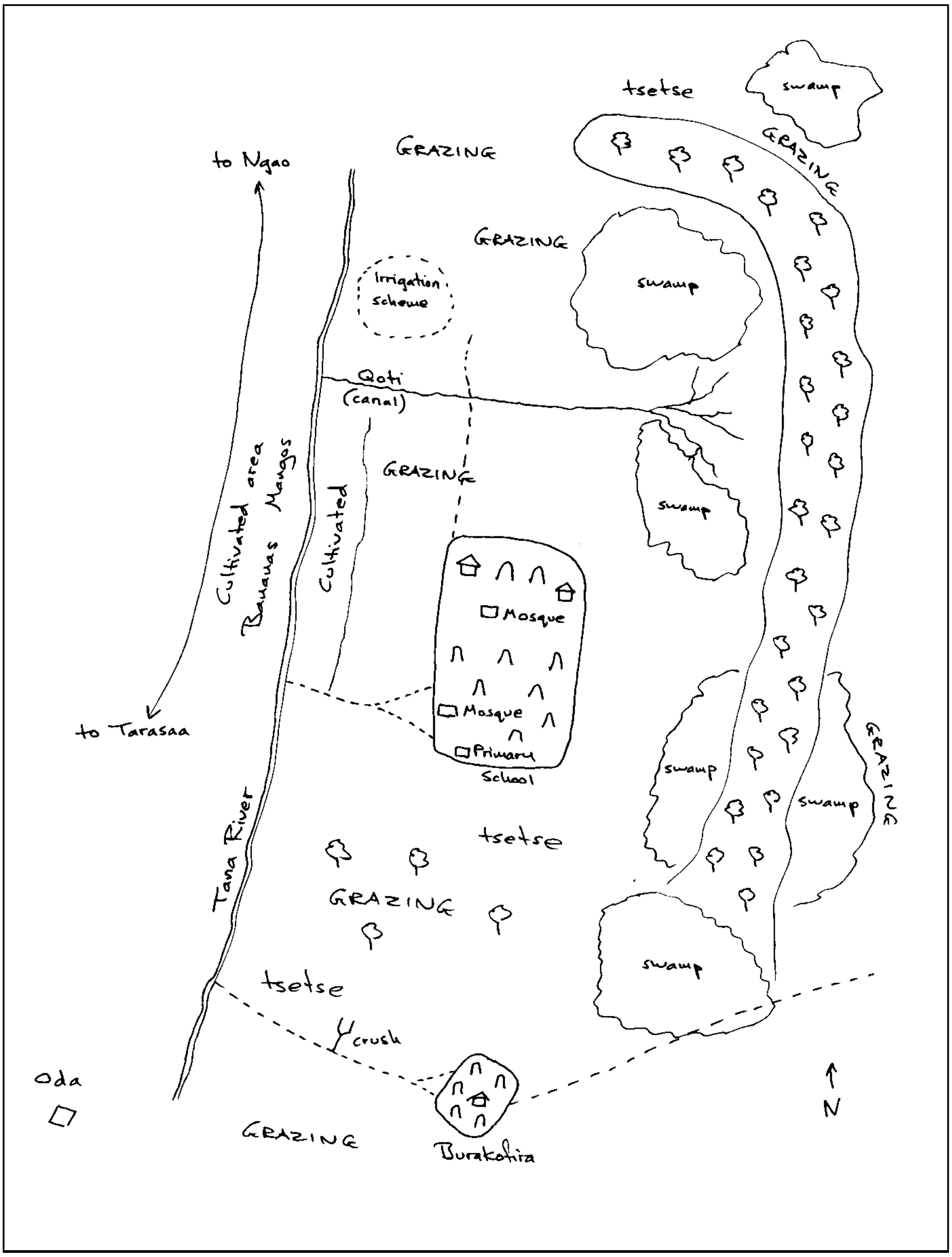
Figure 3.6
Map of Danissa village



<u>Notes for Danissa map</u>

The main source of tsetse flies was thought to be Marafa forest, although flies were present all over the grazing areas to the south of the village.

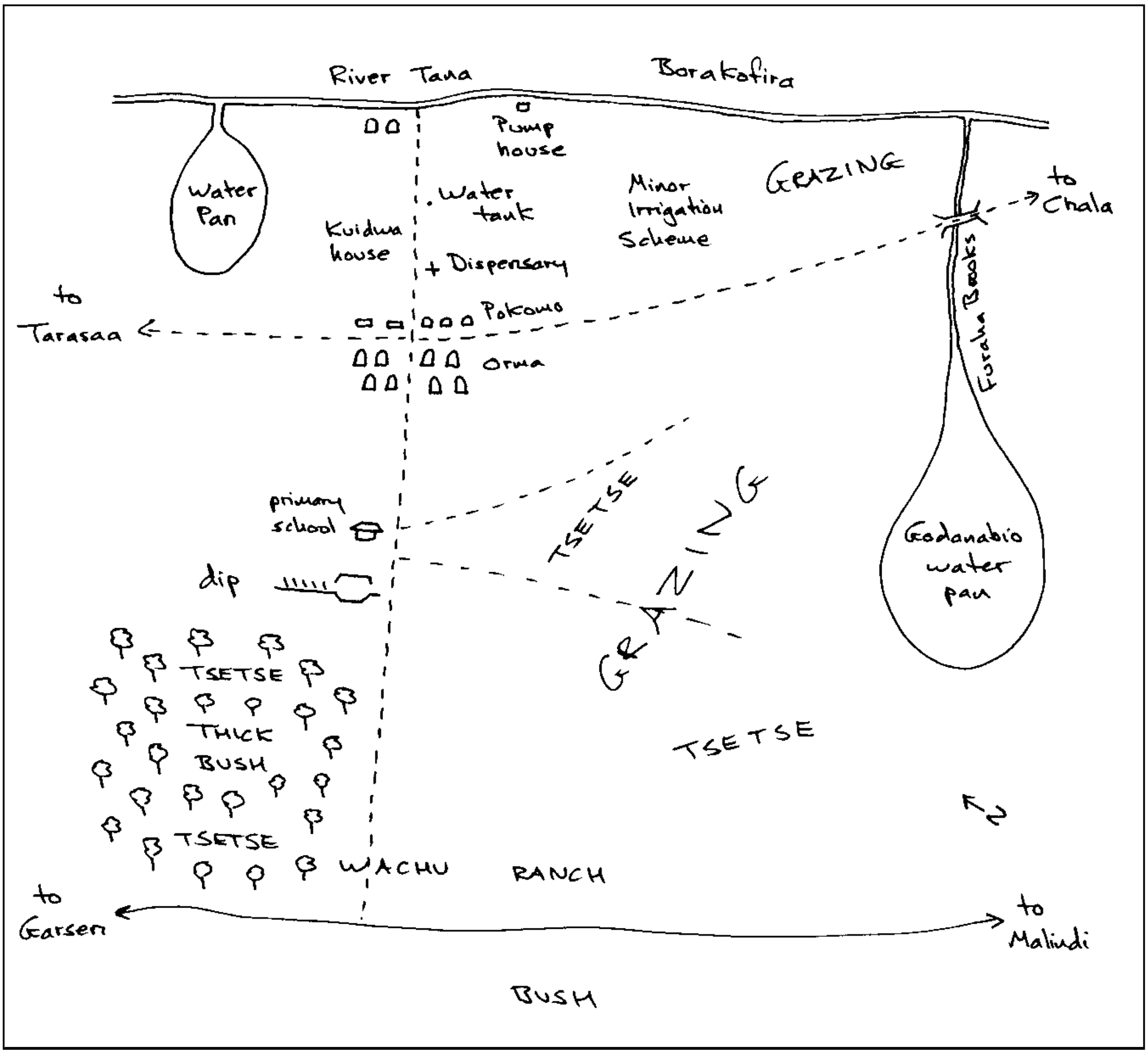
Figure 3.7
Map of Kipao village



Notes for Kipao map

The main grazing areas were to the north, east and south of the village. All these areas were infested with tsetse. Swamps to the east fed into the Tana River delta and acted as a natural barrier against movement of cattle in that direction. The village could only be reached by canoe across the Tana River.

Figure 3.8
Map of Oda



Notes for Oda map

Oda village was split by Pokoma houses on one side and Orma houses on the other. A dip was present but required some repairs. Tsetse flies were present all over the grazing areas, and in the thick bush near the Malindi to Garsen road.

3.1.5 Changes over time

a. Long term environment changes

When discussing tsetse populations, informants in Gadeni described environmental changes that had taken place over many years. These changes were described in more detail by Joseph Dadye, a long-term resident of the area. He is currently the Technical Livestock Officer in the Catholic Diocese of Garissa.

Box 3.1
Experience of a resident of Idsoe village, neighbouring Danissa and Gadeni villages

I am Joseph J. Dadye, born in 1940 at Malengo (Kokane Gobu), about 2km north west of Danissa 'A' village or at the old ferry crossing point, east bank of the Tana River. I grew up in the village, starting my early education in the same village up to Standard IV, when I sat my competitive entrance examination in 1952, and passed, and went to Intermediate School at Ngao in 1953.

I remember herding our small flock of sheep and goats since I was in Standard II up to early Standard IV, when I left to continue studies. Our farming lands were near the Tana River and areas of old river, with some slightly raised areas with big fig trees. These farmlands were easily recognised by the tall grasses and the good fertile soils that one could easily see.

The grazing areas were less fertile than the farmlands, although one could still see long grasses up to 1.5 yards tall. Some grazing areas had short, lush leafy grasses that were good grazing for the animals. These areas were wide and open, and so large that our eyes could not cover the area. The long grass was cut down by the Orma women for thatching their houses. Also, the Pokomos cut the same grass to thatch their houses.

At this time, there were very few bushes in the area because they were restricted by periodic burning, especially in the dry spells before the rain (March and April). During the burning period, bush fires could be seen for even a week. The Garsen-Lamu road always acted as a firebreak for the big fires. The small bushes that you see now could not survive the periodic flooding of the areas. The open grasslands could be seen up until the 1980s, but after that things changed very fast.

In our climate, there was always a lot of rain with flooding due to water from up country moving down the Tana River and other seasonal rivers from the Ukambani highlands to the west of the district. We usually had floods in late April, and continuing until the end of June. In wet years, there was flooding again in November. When there was no flooding in November, although a blessing for herders, it always acted as a strong reason to burn the grasses earlier i.e. in March, as people suspected that the long rains would come early.

Before around 1979 we had relatively heavy rains, and flooding that lasted a long time. However, the following year we had little rain and the river waters did not rise to cover the riverbanks (although the water pans were filled). The small bushes grew up and the situation worsened when the early bush fire restrictions were announced and after being caught red-handed, some people were prosecuted.

The strengthening or building or dams to generate electricity in the upper Tana River (the Kiambere dams) decreased the water flow for almost 6 years or more. As the rains became more irrgegular, the grassy areas were overgrazed as more animals moved in from the hinterlands in search of grazing and water. Small bushes that were not eaten by animals and which could survive flooding began to establish themselves in wide areas that previously, had only supported grasses.

By 1995, the TARDA Rice Irrigation Scheme at Gamba forced pastoralists to move further south east, where there was more bush and forest, inhabited by tsetse and buffaloes. Although I lived on the east bank of the river, similar changes were taking place on the west bank also, with bushes invading areas that used to be grassy. On both sides of the river, these bushes supported the spread of tsetse.

b. Seasonal factors

In each village a seasonal calendar was used to understand seasonal changes in cattle diseases and contact between cattle and biting flies, ticks and buffalo. Results are summarised in Figure 3.9.

Figure 3.9
Summarised seasonal calendar for livestock diseases, biting flies, ticks and cattle-wildlife contact

		Orma seasons				
		Hageiya	*Bona hageiya*	*Gana*	*Shur-icha*	*Bona adolesa*
		Months by Gregorian calendar				
		O N D	J F M	A M J	J	A S
	Rainfall *Roba*	●●●●●		●●●●●●●●●●	●●●●	
Diseases	Trypanosomosis *Gandi*	●●●●●●●●●	●●●●●●●●●	●	●	●●
Diseases	FMD *Hoyale*	●●●●	●●●●●●●●●	●●	●●	●●●●
Diseases	Haemorrhagic form *T.vivax* *Buku*	●●●●●●●●	●●●●●●●●●●●●●●●●		●	●●
Diseases	CBPP *Somba*		●	●●●●	●●●●●●	●●●●●●●●●●
Diseases	Rinderpest *Madobesa*					
Contact with flies, ticks and wildlife	Contact with tsetse *Gandi*	●●●●●●	●●●●●●	●●	●●●●●	●●
Contact with flies, ticks and wildlife	Contact with Tabanids *Kobabe*	●●●●●●●●●●●●●●●●●●	●●●●	●●		
Contact with flies, ticks and wildlife	Contact with ticks *Shilmi*	●●●●●	●●●●●●●●●●●	●	●	●●
Contact with flies, ticks and wildlife	Contact with buffalo *Gadarsi*	●●	●●●●●●●●●●●			●●●●●●

Notes

- More cattle are present in the delta and permanent villages during *hageiya* and *bona hageiya.* As the delta is wet (during *hageiya*) and hot (during both *hageiya* and *bona hageiya*) during these seasons, exposure to biting flies and ticks is high.
- As the main rains (g*ana*) begin, cattle move out of the delta to avoid flooded areas, and into the hinterland. As the hinterland is drier than the delta and has different vegetation, exposure to biting flies and ticks reduces.

- This pattern of seasonal movement into and out of tsetse and tick-infested areas in the delta determines the level of contact between cattle and these vectors. Although the *hawicha* milking herds can be permanently in the delta, these herds are relatively small in size.

- Contact between cattle and buffalo peaks during the dry periods *bona hageiya* and *bona adolesa* because animals congregate around dry season water points.

3.1.6 Analysis of control methods

In each village a matrix scoring of control methods was conducted. Full results for each village are presented in Annex 1. Table 3.3 shows summarised results for all 4 villages. As different numbers of stones were used during the scoring in different villages, scores have been converted into ranks for the purpose of summarising the data.

Table 3.3
Preference ranking of control methods for *gandi* in Gadeni, Danissa, Oda and Kipao

	Median rank for control methods									
								Trypanocides from:		
Indicator	Herbal remedy	Burning the bush[1]	Bleeding[2]	Movement[3]	Dung fires[4]	Pour On	Dips	Hawkers and shops	CAHV[5]	Agrovet
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 is 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 are lit among the cattle in the kraals every evening.
5. Community animal health volunteers were unpaid workers trained by the 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 organised 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.

Table 3.3 shows that Orma informants used various indigenous and modern methods for controlling trypanosomosis. Indigenous methods included movement of cattle away from tsetse-infested areas, bush clearance, use of dung fires in the 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 use of trypanocidal drugs, pour ons and dips. Although termed 'modern' Orma herders had clearly been using trypanicides for many years and could recall their parents using the drugs regularly. At the present time, herders obtain trypanocides from three main sources viz. informal traders (*duka za magendo*), CAHVs and an Agrovet shop in Garsen. Ranking of these three sources of trypanocides indicated that only minor differences in cost and effectiveness (see Annex 1 for more detailed results from each village). According to the District Veterinary Officer, only 1 out of 12 dips in Tana River District was not in a state of disuse.

Overall, the results showed that herders were already using an integrated trypanosomosis control approach that included 10 or more control options, with varying degrees of cost, effectiveness and ease of use.

3.2 Stakeholder workshop

3.2.1 Researchers' initial assessments of trypanosomosis control methods

During the stakeholder workshop, it was anticipated that the researchers' would present their views, as a team, to community representatives on best-bet trypanosomosis control interventions. This required the researchers to conduct their own analysis of various trypansomosis control options before the workshop in order to reach some form of consensus and ensure clarity concerning the advice to be offered.

The researchers' own analysis of trypanosomosis control options involved two main activities:

1. Discussion and ranking of different trypanosomosis control methods based on technical knowledge and knowledge of project resources. This process was intended to narrow down a wide range of options to a smaller number of best-bet researchers' preferences. Six researchers conducted the ranking and Friedman's Test and Kendall's Coefficient of Concordance were used to determine levels of agreement between the 6 researchers who conducted the ranking.

   Results are presented in Table 3.4. There was good agreement between the 6 researchers and the three most preferred control interventions were better use of trypanocidal drugs, use of pour ons and community-based tsetse control.

2. Ranking of the best-bet options identified from activity 1 above against sustainability indicators. The ranking was based on increasing knowledge of the technical and social features of the project area as the fieldwork progressed. Five researchers conducted the ranking and levels of agreement were determined using Kendall's Coefficient of Concordance (W).

   Results are presented in Table 3.5 and show high levels of agreement between the researchers for 4/5 indicators. The researchers did not agree on ranking of the indicator 'resistant to crises' (W=0.078).

Table 3.4
Researchers' assessment of trypanosomosis control methods

Trypanosomosis control method	Advantages	Disadvantages	Median rank[1]
Community-based targets and traps	• Effective • Environmentally friendly • Relatively inexpensive • Easy to use and train users	• Agency resources insufficient relative to coverage area required for adequate tsetse control. • Limited evidence of sustained benefits; weak hand-over to community management • Traps and targets easily stolen or damaged	2.5
Trypanocidal drugs	• Easy to use and train users • Effective • Depends on an individual's private action	• Limited information on usage at community level • Relatively expensive • Potential drug resistance • Drug residues may affect human health	1.0
Pour-ons	• Easy to use and train users • Effective • Depends on an individual's private action	• Very expensive	2.5
Bush clearance	• Community already knows how to use the method • Good sustainability	• Requires potentially difficult agreements between neighbouring communities • Legal implications	4.5
Cattle movement	• Community already knows how to use the method • Good sustainability • Effective	• Potential conflict with settled farming communities	5.0
Deltamethrin dips	• Effective[2]	• Requires expensive rehabilitation or building of dips • High management inputs from community	5.5
Insecticide spraying	• Effective short-term	• Adverse environmental effects • Expensive • Repeated spraying needed to prevent re-invasion of tsetse	6.5

1. Each method was ranked from 1 to 7 by each of 6 researchers. Friedman Test and Kendall's Coefficient of Concordance showed agreement between researchers at $p<0.01$ for both tests. Median ranks are presented; the lower the rank, the greater the preference.

2. At the time of the discussion and ranking, the researchers were uncertain about the effectiveness of deltamethrin dips for tsetse control.

Using the advantages and disadvantages of control methods listed in Table 3.4 and the sustainability indicators listed in Table 3.5, the researchers prepared presentations on community-based tsetse control using targets and traps, use of trypanocidal drugs and use of pour ons. It was intended that the presentations would assist different stakeholders to judge the feasibility of each of these control methods.

Table 3.5
Researchers' ranking of best-bet control interventions against sustainability indicators

Sustainability indicator	Median ranks for control intervention: Community-based tsetse control project	Improved use of trypanocides	Wider use of pour-on
Low financial cost to individual end-users (W=0.958***)	1.0	2.0	3.0
Builds on existing systems (including indigenous knowledge) (W=0.958***)	3.0	1.0	2.0
An individual can benefit by acting alone (W=0.933***)	3.0	1.0	2.0
Resistance to crises (e.g. drought, conflict) (W=0.078)	3.0	2.0	1.0
Avoids conflict with neighbours (W=0.844*)	3.0	1.0	2.0
Overall rank	3.0	1.0	2.0

Ranking by 5 researchers; the lower the rank, the greater the preference. W=Kendall's Coefficient of Concordance (*p<0.05; ***p<0.01).

Although use of dips was not a preferred control option among the researchers (Table 3.4), this control method was highly ranked for 'overall preference' in 3 out of 4 villages (see Annex 1). This high overall preference ranking did not seem to evolve from the ranking of indicators such as low cost, effectiveness etc. because overall, dips did not rank particularly highly for these indicators. For example, informants noted how dips were relatively expensive, not easy to use and required group collaboration and action. Therefore, it seemed that a 'hidden' indicator was influencing the overall ranking of dips in 3 villages.

Further discussion among the researchers on this point indicated that despite careful introduction and explanation of the aims of the work, there were expectations at community-level that KETRI would support the rehabilitation of dips. In part, these expectations were thought to have arisen because of KETRI's activities in Galana Ranch. In order to revisit the issue of dipping during the stakeholder workshop, 'use of dip' was added to the three best-bet control methods listed in Table 3.5.

3.2.2 Assessment of different control methods during the stakeholder workshop

According to the experiences described above, the assessment of control methods during the stakeholder workshop followed presentations by KETRI staff on the pros and cons of four possible control interventions as follows:

- Community-based tsetse control using targets or traps;
- Better use of trypanocidal drugs, including monitoring drug resistance;

- Use of pour ons;
- Rehabilitation (or construction) of dips and community-based dip management.

In order to conduct the assessment, the researchers used a short list of 'sustainability indicators'. These indicators were considered to be important because previous community-based trypanosomosis control initiatives, particularly tsetse control, had met with limited long-term impact. The indicators did not include 'effectiveness' because the team considered all four of the control methods to be effective if properly used.

The workshop participants were divided into 2 main groups – 'community representatives' and 'other stakeholders'. The community representatives were further divided in four groups by village and their assessment of the four control methods is summarised in Table 3.6 and Table 3.7.

Table 3.6
Ranking of possible control interventions against sustainability indicators by community representatives

	Median ranks for possible control intervention[1]			
Sustainability indicator	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 systems (including indigenous knowledge)	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. Ranking method based on ranks 1st = most preferred to 4th = least preferred. Number of groups conducting the ranking = 4.

While the community participants were ranking their preferences, the other stakeholders were asked to summarise their commitments to the four possible control interventions. These commitments could include contributions in the form of finance, management support, technical support or the private supply of goods or materials. Results are presented in Table 3.8.

Table 3.7
Summarised ranking of control options by village

Village (number of representatives)[2]	Ranks for control intervention[1]			
	Community-based tsetse control project	Improved use of trypanocides	Use of pour-on	Community-based dips
Oda (n=5)	4th	1st	2nd	3rd
Kipao (n=7)	4th	1st	2nd	3rd
Danissa (n=5)	3rd	1st	2nd	4th
Gadeni (n=6)	4th	1st	2nd	3rd
Overall rank	4th	1st	2nd	3rd

1. 1st=most preferred; 4th=least preferred.
2. Village representatives ranked each control option as a group rather than as individuals.
3. There was no significant difference between the ranks of the 4 villages (Friedmans test, p=1.000); there was significant difference between the ranks of the 4 control options (Friedmans test, p=0.011).

Table 3.8
Commitments to contribute to different control interventions by outside agencies

Indicator – capacity to contribute resources (e.g. time, labour, management support; technical support, material supplies; finance)	Ranks for possible control intervention[1]			
	Community-based tsetse control project	Improved use of trypanocides	Use of pour-on	Community-based dips
KETRI (group size=3)	1st	4th	1st	1st
Catholic Diocese of Malindi (group size=2)	2nd	1st	4th	2nd
Veterinary Department (group size = 1)	2nd	1st	2nd	4th
Private sector - Agrovet (group size = 1)	4th	1st	1st	3rd
PAVE Project (group size =1)	3rd	1st	2nd	3rd

1. Each stakeholder group ranked only their own commitment to contribute and gave a single rank e.g. the three KETRI staff gave combined 'group rank' of =1st, 4th, =1st and =1st for the 4 control options.

Comparison of the views of researchers (Tables 3.4 and 3.5) and community representatives (Tables 3.6 and 3.7) indicated agreement that the preferred control method was 'better use of trypanocides'. In addition, 4 out of 5 technical stakeholders seemed to be more willing to contribute towards this control intervention relative to the other three options (Table 3.8).

According to this finding, KETRI staff outlined a series of activities to improve the use of trypanocides as summarised in Box 3.2. These activities were based on a limited budget within KETRI for the work of approximately KSh 1.5 million over three years.

Box 3.2
Proposed activities for a project to improve the use of trypanocides in Orma communities

Activity 1	Conduct participatory research to quantify trypanocidal drug use, including timing of treatments, use 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 a herd(s) 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 CAHVs; conduct training for Agrovet staff.
Activity 4	Conduct impact assessment. Measure levels of knowledge and use of trypanocidal drugs relative to baseline data.

4 Discussion

4.1 Local characterisation of bovine trypanosomosis

4.1.1 Signs and causes of disease

When beginning participatory research on a specific disease, it is useful to assess how local characterisation of the disease and the local disease-name compare with the western perceptions of the disease and the 'scientific' disease-name. In other words, are livestock keepers and researchers talking about the same disease? This initial comparison of views is important when interpreting research findings and evaluating the outcome of control methods.

Findings from the participatory assessment of important cattle diseases in the four villages demonstrated much overlap between the Orma disease *gandi* and bovine trypanosomosis. For example, *gandi* was associated with chronic weight loss, mild diarrhoea, mild coughing, reduced appetite and loss of tail hair (Figure 3.1) In the dead animal, oedema and haemorrhage were observed. Apart from coughing, these signs are indicative of trypanosomosis and are well known by veterinarians working in pastoralist areas[7]. Other disease-signs might have been added to the matrices e.g. swollen lymph nodes, but the researchers assumed that the other four diseases in the matrix might also cause this sign. If too many signs are used in the matrices, the scoring process becomes tedious and informants can begin to lose interest.

Assessment of disease-causes showed that the disease *gandi* was strongly associated with the fly called *gandi* (tsetse)[8]. 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) (Figure 3.2). Further questioning about *kobabe* and *shilmi* indicated that both these parasites were associated with thin cows and prevented cattle from grazing normally. This finding indicates that cattle that lose weight for reasons other than trypanosomosis might also be called *gandi* by some people. 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 trypanosomosis 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 trypanosomosis, due to *T.vivax*, has been reported in coastal areas of Kenya (Mwongela et al, 1981) and was diagnosed at the Witu Veterinary Investigation Laboratory. 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). Although Orma knowledge of *buku* seemed to be valid when viewed from a modern veterinary perspective, one point of disagreement was the role of the fly called *gandi buku.* Only a single specimen of this fly was collected and identified as *Oestrus ovis* by the researchers. The fly was consistently described by informants as dark-coloured, smaller and broader than *gandi* (tsetse), and found in cracks in dry earth or bark.

These findings indicate that although there is general agreement on the main characteristics of *gandi*, as the research progresses the roles of *kobabe, shilmi* and *gandi buku* as causes of trypanosomosis 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.

4.1.2 Estimates of disease incidence

In common with previous descriptions of trypanosomosis 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. Relative to other cattle diseases, *gandi* was observed most frequently (Figure 3.4) and incidence was estimated at 28.6% in adult animals (Figure 3.3). Combined estimated incidence of *gandi* and *buku* for all ages groups totalled 24.1% (Figure 3.4).

It is possible that these estimates of incidence are exaggerated because informants were aware that the researchers had a particular interest in *gandi*[9]. The incidence of *buku* reached 9.6% in adult cattle and this figure appears to be particularly high. Limited data is available for triangulating the results although a preliminary cross-sectional survey was conducted by KETRI earlier in the year (Irungu, 2000b). Using the MHCT, this survey estimated

[7] Loss of tail hair is rarely cited in veterinary textbooks as a sign of trypanosmosis although this sign is widely reported in the ethnoveterinary literature from pastoralist areas.
[8] Similar names are found in other areas. Veterinarians working in Somali areas have used the Somali word *gendi* as a synonym for trypanosomosis (Mares, 1954; Dirie, 1984; Catley and Mohammed, 1996). Working with the Yaa Galbo, a Gabra sub-group, Lindquist and Adolph (1992) used the name *gundi* for trypanosomosis.
[9] For example, previous work by KETRI in Garsen Division demonstrated their interest in trypanosomosis to local people; KETRI vehicles carry a characteristic logo.

trypanosomosis prevalence at 5.0%[10] (n=456) (Table 3.1). 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 Figure 3.3a. When comparing the two sets of data, it should be noted that the sensitivity of the MHCT is usually 50% or less (Eisler, personal communication) and there is widespread use of trypanocides in Tana River District. Therefore, the MHCT results are probably an underestimate of trypanosome prevalence.

4.1.3 Spatial and seasonal factors

Seasonal variations in the incidence of *gandi* indicated that most cases were observed in the short rains *hageiya* (mid-October to December) and the main dry season *bona hageiya* (January to March) (Figure 3.9). This seasonal pattern of disease was associated with movement of cattle into tsetse-infested areas in the Tana River delta. When the main rains began in *gana* (April to June), cattle were moved out of the delta to avoid flooded areas and tsetse, and the incidence of *gandi* decreased. 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 the haemorrhagic disease due to *T.vivax* along the Shabelle River in southern Somalia (Dirie et al., 1984).

The seasonal trends described above vary from those described for Orma Boran cattle on Galana Ranch. On the ranch, trypanosome prevalence[11] followed a bimodal pattern in line with rainfall (Dolan, 1998). Prevalence peaked in December and January and was followed by 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.

Mapping of the four Orma villages in the assessment showed that in all cases, informants identified and illustrated specific tsetse-infested areas near to, or comprising cattle grazing areas (Figures 3.5 to 3.8). These grazing areas were utilised most heavily during the *bona hageiya* dry season when cattle moved into the delta from the hinterland. If the four maps are viewed in relation to Garsen Division as a whole, each village is situated near to large areas of thick bush which account for much of the delta’s vegetation.

4.2 Local characterisation of other cattle diseases

When designing a matrix scoring method, a number of diseases are selected for comparison of disease-signs and disease-causes. This aspect of the methodology is intended to highlight differences between important diseases and limit exaggeration concerning the specific interests of the researchers (*gandi* and *buku*). The ‘other diseases’ can also act as a type of control in the matrix scoring, but only if the researchers are reasonably confident about the interpretation of the Orma disease-names. For example, if researchers suspect that the Orma disease *somba* is CBPP, one would expect *somba* to receive high scores for disease-signs such as coughing and weight loss, and zero (or low) scores for diarrhoea or sudden death. If informants score *somba* in this manner, it indicates that they understand the scoring procedure.

The matrix scoring methods used during the research included *somba* (CBPP), *hoyale* (FMD) and *madobesa* (rinderpest) as the ‘other diseases’. Figures 3.1 and 3.2 show that the scores for most of the disease-signs and disease-causes match conventional veterinary opinion. For example, *hoyale* was associated with shade-seeking behaviour (fever) and reduced appetite whereas *madobesa* was associated with diarrhoea, reduced appetite and loss of tail hair (due to scalding of the tail and perineum) (Figure 3.1). When scoring disease-

[10] The MHCT survey measured trypanosome prevalence not disease incidence.
[11] The Galana Ranch research measured trypanosome prevalence not disease incidence.

causes, *hoyale, somba* and *madobesa* were strongly associated with contact with sick cattle and buffaloes, but were not scored for ticks, Tabanids or tsetse (Figure 3.2).

4.3 Assessing options for community-based tsetse/trypanosomosis control

4.3.1 Community-based livestock disease control

In recent years there has been increasing interest in community-based approaches to livestock disease control. Regarding bovine trypanosomosis in Kenya, community-based initiatives can be categorised into two main groups. First, within general, primary-level animal health services some community-based animal health workers (CAHWs) are using trypanocides. These projects have tended to draw on the principles of community participation as advocated by NGOs, and many have considered animal health in the broader context of rural development or food security programmes. In these projects, measures of impact that are specific for trypanosomosis are usually confined to indicators such as quantities of trypanocides administered by CAHWs rather than changes in disease prevalence or economic indicators. While the use of trypanocides by unsupervised CAHWs contradicts government policy, when linked to private suppliers and veterinary-supervised, these projects seem to offer better financial sustainability than systems that are subsidised by government or other agencies. Policy reform related to CAHW activities is in process in Kenya. In the assessment areas in Garsen Division, CAHVs trained by the Catholic Diocese of Malindi can be regarded as equivalent to CAHWs. However, unlike many CAHW projects the CAHVs in Garsen did not receive financial incentives for their work and therefore, the sustainability of the system could be questioned.

The second main group of community-based initiatives is community-based tsetse control using targets or traps. Unlike the CAHW approach, these interventions are trypanosomosis-specific and have usually been implemented by technical agencies with a mandate for trypanosomosis or vector control. Commonly, the underlying philosophy has been technology transfer, but using a community-based approach as the vehicle for encouraging livestock keepers to adopt new disease control methods. Although the relatively simple target and trap technologies may appear to be well suited to a technology transfer package, experiences with community-based tsetse control have been mixed at best. Typically, initial reductions in tsetse populations have been dramatic but the long-term management of the traps or targets at community-level has not been sustained (Barrett and Okali, 1998; Budd, 1999).

4.3.2 How are people already controlling bovine trypanosomosis?

The ranking of control methods in the four villages indicated that Orma livestock keepers were already using an integrated approach for the control of bovine trypanosomosis (Table 3.3 and Annex 1). This approach involved up to 10 control methods that varied in their effectiveness, cost and ease of use. It is well known that Orma herders 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 sub-divided into at least four specific remedies viz. soups prepared from sheep's head or tail fat[12], soups prepared from fish waste, use of roasted coffee beans and a drench prepared from *hargesa*, an Aloe species (Mahdi, 1999). 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.

[12] The use of soups and broths by pastoralists as supportive treatments of trypanosomosis in cattle and camels is widely reported in the ethnoveterinary literature.

Although not discussed in detail during the assessment, different livestock keepers use different combinations of control methods according to their own preferences and situation in a given year. Therefore, the combination of methods used is complex and can vary over time. This type of information is useful when considering if and how to introduce a new control method, particularly if the new method requires prolonged and collective action at community level e.g. community-based tsetse control using targets or traps. In areas where many people are already taking individual, private action to control a problem with reasonable success, the incentives for investing time and money in a collective scheme become less obvious. This situation contrasts markedly with some other community-based disease control programmes in pastoralist areas, such as the use of heat-stable vaccine to control rinderpest. In the case of rinderpest, community-based initiatives were established in the absence of existing, effective services and few disease control methods based on private, individual action were in use[13].

4.3.3 Preferences for improving control of bovine trypanosomosis

The original proposal formulated by KETRI for Tana River District was prompted by the development of a Technology Transfer Fund by KETRI-DFID. The proposal aimed to reduce tsetse and trypanosomosis using community-based tsetse trapping. Activities included initial entomological and epidemiological surveys followed by 'community capacity-building' during which 'the community will be shown how to make traps using locally available materials and also how to set the traps and empty the cages'. It was expected that 'the community will adopt the control methods after the training and start using them'. Therefore, the proposal reflects a predetermined solution to the problem of bovine trypanosomosis in the study areas.

This information is relevant to this participatory assessment because as the work progressed, a number of resource and sustainability issues emerged which indicated that community-based traps or targets were unlikely to be sustained in the four villages. Therefore, the researchers were faced with new information that prompted a change of opinion regarding the 'best-bet' intervention. This shift in thinking is demonstrated by the researchers' own assessment of control options (Table 3.4) and their subsequent ranking of the preferred options against sustainability indicators (Table 3.5). As a result of this process, 'Improved use of trypanocides' was considered by the researchers to be the most appropriate control intervention.

During the stakeholder workshop, KETRI staff explained the advantages and disadvantages of different tsetse and trypanosomosis control methods to community representatives through a series of short presentations. These presentations were designed to focus not on the effectiveness of different methods, but on the material and management inputs required for the maintenance of the intervention. These inputs included financial costs and community contributions in the form of on-going costs, labour and management. On the following day, community representatives ranked these sustainability indicators against four possible control interventions. Other sustainability indicators were also included in the ranking (Table 3.6). In common with the researchers' assessment, community representatives identified better use of trypanocides as the preferred control intervention.

The stakeholder workshop also enabled government, private sector and NGO stakeholders to consider their role in trypanosomosis control, and predict if and how they might contribute towards different interventions (Table 3.8). These results show that among these stakeholders, KETRI felt least able to contribute towards better use of trypanocides. In part,

[13] An example of individual action might be movement of animals away from a suspected outbreak of the disease.

this was because the KETRI researchers lacked experience in designing and implementing the type of community-based activities that would result in improved use of drugs (Box 3.2). Exposure of KETRI staff to experiences of other projects and participatory methodologies for developing and testing extension materials would alleviate this concern.

4.4 Implications of the research for KETRI

A participatory research approach provides important challenges for research institutes who are more accustomed to formal, top-down ways of working. These challenges relate not only to the proper use of PA methods, but also to broader issues concerning the overall research approach and the design of projects.

4.4.1 Lessons learned about participatory appraisal methods

The assessment was an opportunity for KETRI staff to practice PA methods such as mapping, matrix-scoring and proportional piling. A few lessons learned about these methods were as follows:

- The use of PA methods enabled 144 informants to be involved in the assessment over a short time period of 10 days. Although not all informants discussed all issues, in terms of researchers' time inputs, the participatory methodology compares favourably with more formal approaches.

- The use of PA requires much concentration on the part of the researchers, careful listening and a willingness to cross check information on the spot using open and probing questions. Researchers also need to be constantly aware of their own behaviour and body language, and understand how this affects the interaction with informants. For people who are not accustomed to PA, this level of concentration can be tiring but with practice, becomes second nature.

- In relation to the point above, the use of standardised PA methods affords opportunities to make direct comparisons between different informant groups both within and between villages. Levels of agreement can be assessed and results can be summarised (e.g. Figures 3.1 and 3.2). However, when using standardised methods that generate ranks or scores, there is a strong tendency for researchers to focus on collecting the ranks or scores, rather than cross checking results and following-up interesting leads with additional questions. Consequently, important qualitative aspects of the method can easily be lost. This problem becomes most evident when the researchers lose concentration or rush the method.

- The use of PA methods requires careful thought during the design stage. When teams of researchers are planning to use the same methods, it is important that a common explanation of the methods to informants is used and that the precise wording of questions is agreed among the researchers. Small changes in the way that questions are asked by different researchers can greatly hinder comparison of responses from different informants.

- When using PA methods, some of the data that results might be of limited technical interest or outside the scope of the research. However, the process of sitting and listening to people, and using innovative methods to understand local perceptions and ideas, has value in itself. This value takes the form of giving people opportunity to express their views and in helping to create open and constructive relationships between the researchers and local people. Therefore, PA methods should not be assessed solely in terms of the data and information that arises, but also by the quality of the relationships which develop as the research progresses.

These points indicate that future KETRI research based on PA methods should include sufficient time for methodology development and fine-tuning of methods in the field, and evaluation of the methods by the research team at the end of the study. These activities will help to ensure that as a research institute, KETRI continues to develop better understanding of PA methods.

4.4.2 Lessons learned about research approaches and project formulation

An important feature of participatory research is a capacity to alter research activities as new learning takes place. With this approach, the initial research objectives in a proposal might be restricted to a single learning or information-gathering objective, based on a participatory assessment or feasibility study. The results of this assessment then define further objectives and activities. This kind of open-ended approach to research requires much flexibility on the part of both research institutes and donors. For the research institute, precise objectives linked to the research agendas of scientists might be difficult to identify at the onset. Commonly, this makes some researchers feel uncomfortable because research outputs (e.g. in the form of scientific publications) cannot easily be predicted. For donors, participatory approaches require reversals in funding patterns with more resources required as the project progresses, and new objectives and activities materialise. The research described in this report is a good example of how research activities identified by scientists were modified according to the findings of participatory assessment.

4.4.3 Further activities

Some activities designed to improve the use of trypanocides in the four villages are summarised in Box 3.2. For the in-depth study on trypanocidal drug use (Activity 1), PA methods could be used to complement structured interviews. For example, matrix-scoring of different trypanocides against indicators such as cost, effectiveness, duration of action, convenience of packaging, availability and other indicators would be useful for understanding local preferences for different products. Proportional piling could be used to ascertain proportions of cattle treated per herd, and numbers of treatments per animal; seasonal calendars could be used to describe the timing of treatments in a given year.

In order to implement the participative training (Activity 3), KETRI may need to draw on experiences from participative training courses for CAHWs, and the design of education materials for adult learning. Considerable expertise in these topics is present in Kenya and it seems likely that existing materials can be modified for use in Orma villages.

Regarding the monitoring of trypanocide resistance (Activity 2) KETRI will need to decide whether to assess resistance before conducting the participative training at village-level, or to use the training as an opportunity to identify herds for monitoring purposes. The former approach offers the potential to incorporate up-to-date information on drug resistance into the training course, but will delay the implementation of the training.

Closer contact with communities during the research might also provide opening to investigate other issues, such as:

a) the epidemiology of *buku* and the role of biting flies other than tsetse in the transmission of the disease. Haemorrhagic disease in cattle due to *T.vivax* has been reported in apparently tsetse-free areas (Roeder et al., 1984);

b) local perceptions on the role of ticks, and biting flies such as Tabanids and Stomoxys in the transmission of *gandi*;.

c) local perceptions of economic losses due to chronic and acute trypanosomosis.

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Annex 1

Matrix scoring of control methods for *gandi* in 4 Orma villages.

The matrix scoring method involved the use of piles of stones to score various indicators against the different control methods. The control methods were identified by the informants; the indicators were identified by the researchers. Informants selected the number of stones that they wanted to use during the scoring.

Table A1 Analysis of control methods for *gandi* in Gadeni.

	Burning the bush	Bleeding	Movement	Trypanocides from:		
				Hawkers and shops	CAHV	Agrovet
Cost	0	0	0	36	37	40
Effectiveness	20	8	20	3	12	10
Requires group action	19	0	20	0	0	0
Individual action	5	4	0	4	4	4
Easy to use	13	15	15	3	13	3
Overall preference	0	0	0	20 for 'drugs'		

Notes
In Gadeni, when asked about their overall preference the informants grouped trypanocidal drugs from dukas, CAHVs and AgroVet stores as 'drugs'. It was explained that the use of drugs was combined with other methods, such as bush burning and movement.

Table A2 Analysis of control methods for *gandi* in Danissa.

	Burning the bush	Bleeding	Move -ment	Dung fires	Oil in nose	Herbal remedy	Pour-On	Dips	Trypanocides from:		
									Hawkers and shops	CAHV	Agrovet
Effectiveness	21	7	0	31	0	0	15	0	0	28	11
Cost	0	0	12	0	0	0	45	42	5	12	33
Easy to use	42	15	28	47	25	30	0	0	0	0	0
Availability of drugs	-	-	-	-	-	-	-	-	9	44	35
Requires group action	0	0	39	0	0	0	0	32	0	0	0
Individual action	10	14	0	19	7	10	33	0	33	33	33
Overall preference	2	18	25	20	2	2	0	30	40		

Table A3 Analysis of control methods for *gandi* in Oda.

	Burning the bush	Bleeding	Move -ment	Dung fires	Koran	Herbal remedy	Pour-On	Dips	Trypanocides from:		
									Hawkers and shops	CAHV	Agrovet
Effectiveness	2	2	1	2	3	1	36	34	20	20	20
Cost	1	1	1	0	1	1	28	28	15	15	15
Availability	3	0	5	30	7	1	0	2	10	25	20
Ease of use	16	3	15	24	12	12	4	2	5	5	5
Requires group action	7	0	9	0	23	0	0	62	0	0	0
Individual action	0	12	0	32	0	20	14	0	26	26	26
Overall preference	4	0	6	7	0	0	35	30	5	9	10

Table A4 Analysis of control methods for *gandi* in Kipao

	Herbal remedy	Burning the bush	Bleeding	Move -ment	Dung fires	Koran	Pour-On	Dips	Trypanocides from:		
									Hawkers and shops	CAHV	Agrovet
Effectiveness	3	12	7	11	5	8	14	18	19	34	24
Cost	0	0	0	0	0	0	44	22	22	29	42
Requires special expertise	0	2	11	0	0	22	25	9	39	39	39
Easily applied	2	34	6	19	49	30	0	0	10	7	1
Requires group action	0	0	0	42	0	26	0	67	0	0	0
Individual action	1	0	1	0	1	0	0	0	1	1	1
Overall preference	0	16	0	11	5	0	33	76		21 for drugs	