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ORIGINAL ARTICLE

Use of participatory epidemiology to compare the clinical veterinary knowledge of pastoralists and veterinarians in East Africa

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Abstract Because of severe resource and logistical constraints in large areas of Africa, disease surveillance systems need to maximize the use of information provided by livestock keepers and make correct interpretations of indigenous livestock knowledge. This paper describes the use of participatory epidemiology (PE) to compare the names, clinical signs and epidemiological features of cattle diseases as perceived by pastoralists and veterinarians. Using results from two previous studies with pastoralists in southern Sudan and Kenya, provisional translations of local disease names into modern veterinary terminology were used to develop a matrix scoring method for use with veterinarians. Matrix scoring data from pastoralists and veterinarians were then compared using simple visual comparison of summarized matrices, hierarchical cluster analysis and multidimensional scaling. The results showed good agreement between pastoralists' and veterinarians' disease names and diagnostic criteria. The matrix scoring method was easy to use and appropriate for use in under-resourced areas with minimal professional support or laboratory services. Matrix scoring could be used to assist livestock disease surveillance workers to design surveillance systems that make better use of pastoralist's indigenous knowledge and correctly interpret local disease names. The method should be combined with conventional veterinary investigation methods where feasible.

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Keywords Africa · Livestock disease surveillance · Participatory epidemiology · Pastoralists

Abbreviations

HCA	hierarchical cluster analysis
MDS	multidimensional scaling
PE	participatory epidemiology

Introduction

Pastoralist communities in Africa live in some of the most underdeveloped and harshest environments in the world. Although these communities are reliant on their livestock as a source of social and economic well-being, conventional veterinary services are poor and basic information on the epidemiology of important livestock diseases is limited. Epidemiological research and disease surveillance in pastoralist areas is difficult because human populations are relatively small and highly mobile, and they move their livestock across large areas with few roads or means of modern communication (de Leeuw *et al.*, 1995). Livestock population data are rarely accurate and in many areas, not available. These areas can also be insecure, as exemplified by major long-term civil conflicts in Sudan, Somalia and northern Uganda, and low-level insecurity in northern Kenya and eastern Ethiopia. Many pastoralists live in trans-boundary ecosystems and routinely cross national borders to access traditional grazing areas. In these situations, conventional approaches to research and disease surveillance require considerable flexibility, commitment and resources. However, government veterinary services are poorly funded and veterinarians tend not to want work in remote, underdeveloped and insecure areas.

Given the resource and logistical constraints in pastoralist areas, pastoralists themselves are a valuable source of disease information. Also, as the contact between surveillance workers and pastoralists is often irregular and resource-intensive, it is important that surveillance workers make best use of this contact and correctly interpret the descriptions of diseases reported by herders. Therefore, key issues affecting the design of livestock disease surveillance systems are the relationship between disease names in local languages and the disease names commonly used by veterinarians.

A conventional epidemiological approach to understanding local knowledge might compare pastoralist's diagnoses of diseases and their disease names with gold-standard diagnostic tests. However, this approach is hindered by the limited laboratory facilities in pastoralist areas and the logistical problems and cost of transporting samples to laboratories in urban centres or other countries. Furthermore, if a general surveillance system is to cover a range of diseases in different livestock species, numerous gold-standard tests are required. In addition to these problems, gold-standard tests are often not available or not easily used. For example, the microhaematocrit centrifugation technique is regarded as a sensitive parasitological test for the diagnosis of trypanosomosis in livestock, but the sensitivity of the test is approximately 50% (M. Eisler, personal communication, 2001). Similarly, the diagnosis of fasciolosis using the sedimentation method is only approximately 30%, but is reported to be the most sensitive method available (Happich and Boray, 1969). Although low test sensitivity can be overcome by procedures such as repeated sampling, cost and logistical constraints limit this approach in pastoralist areas. For many other diagnostic tests, the sensitivity and specificity are not known.

In the absence of gold-standard diagnostic tests, an alternative approach is to assess agreement between tests as a measure of validity, and use statistics such as kappa to express this agreement (Martin and Bonnett, 1987). To assess herder diagnoses, one might compare herder diagnoses and professional diagnoses of observed cases on clinical grounds. However, in practice this requires a longitudinal study and the continuous presence of veterinarians in representative pastoralist communities so that disease events can be observed and assessed as they arise. It also assumes that a sufficient range and number of disease events will occur during the study.

A third approach to the interpretation of pastoralist's observation and description of livestock diseases is retrospective, and involves the use of interviews or questionnaires to record local knowledge. Although commonly used in ethnoveterinary research, this approach has important weaknesses in terms of validity. For example, some ethnoveterinary studies rely on interpretation of diagnostic information by researchers who lack veterinary training (Martin, 1996). Even when veterinarians have been involved in ethnoveterinary research (Grandin and Young, 1996; Heffernen *et al.*, 1996; Jost, 1997), the use of conventional veterinary investigation techniques to validate herder diagnoses has been limited. In part this deficit relates to the problems of laboratory support outlined above but, despite this constraint, systematic clinical and postmortem examination of livestock is still possible even in the most difficult conditions.

Participatory epidemiology (PE) is a relatively new branch of veterinary epidemiology that adapts the methods of participatory rural appraisal and combines these methods with conventional veterinary investigation and epidemiological approaches (Thrusfield, 2005). Participatory rural appraisal evolved in the mid-1980s, largely as a response to the weaknesses of rural development projects in less-developed countries (Chambers, 1994). An important feature of the approach was the use of learning and analytical methods with communities, which enabled them to express their knowledge and priorities in their own language, thereby reducing the non-sampling errors commonly found in questionnaire surveys. Participatory methods include a variety of informal interviewing, visualisation and scoring methods, and these methods have been used by PE practitioners in various diagnostic and epidemiological studies in marginalized areas (Thrusfield, 2005).

This paper describes the use of a PE method called matrix scoring to compare perceptions of livestock diseases between pastoralists and veterinarians. The value of the method is discussed, particularly in relation to its use in resource-poor settings with limited professional or specialized epidemiological support or laboratory services.

Materials and methods

Matrix scoring with pastoralists

Between 1999 and 2000 two studies were conducted to assess the reliability and validity of PE methods. One study included an investigation into a chronic wasting disease in cattle in Nuer communities in southern Sudan (Catley *et al.*, 2001) and the other study was an investigation into bovine trypanosomosis in Orma communities in Kenya (Catley *et al.*, 2002a). Both studies used matrix scoring to explore livestock keepers' perceptions of the clinical and epidemiological features of diseases, and the relationship between local and modern veterinary terminology. The matrix scoring method was adapted from a disease scoring method (Catley and Mohammed, 1996) and required informants to compare the disease under investigation with other diseases. As informants were not aware of the specific topic of the research, these other diseases acted as controls in the matrix and were intended to reduce exaggerated responses.

In summary, the matrix scoring method involved the construction of matrix on the ground with different local disease names represented along the top *x*-axis of the matrix, and clinical and epidemiological features of the diseases, called 'indicators', illustrated along the left *y*-axis of the matrix. The indicators were generated by an earlier pairwise comparison of diseases in which informants explained the difference between pairs of diseases using clinical, epidemiological or other factors. To prevent the matrix becoming too complex and taking too much time to construct, the number of diseases was restricted to five and the number of indicators to no more than 12. Groups of informants showed the relationship between the diseases and the indicators using piles of 20 counters (such as stones or seeds) per indicator. Two matrix scorings were conducted with each informant group. One matrix used disease signs as indicators and the other matrix used disease causes as indicators. When informants had completed the scoring, the researchers used open and probing questions to check the scores and prompt further discussion about the diseases.

The matrix scoring method was standardized and repeated with different informant groups (Table 1). The level of agreement between informant groups was assessed using the Kendal coefficient of concordance, *W* (Siegel and Castellan, 1988), calculated manually in the field and later cross-checked using the Statistical Package for the Social Sciences (SPSS, 1999). Evidence of agreement between informant groups was categorized by the author as 'weak', 'moderate' and 'strong' according published guidelines on the interpretation of *W* (Siegal and Castellan, 1988) and the

Table 1 Use of the matrix scoring method for disease signs and disease causes

	Informant samples and timing	
Description	Livestock keepers	Veterinarians
Investigation into a chronic wasting disease in cattle with Nuer communities, Western Upper Nile, southern Sudan (Catley *et al.*, 2001)	Groups of informants ($n =$ 12); group sizes from 4 to 9 individuals; May 1999	Annual Scientific Meeting of the Kenya Veterinary Association; individual informants ($n = 12$); April 2000
Investigation into bovine trypanosomosis with Orma communities, Tana River District, Kenya (Catley *et al.*, 2002a)	Groups of informants ($n =$ 12); group sizes from 5 to 12 individuals; November 2000	Faculty of Veterinary Medicine, Sokoine University of Agriculture, Tanzania; individual informants ($n = 11$); May 2001

p-values assigned to W by SPSS software. Therefore, agreement was termed weak for $p > 0.05$, moderate for $p < 0.05$, and strong for $p < 0.01$. Confidence limits for median scores at the 95% confidence level were calculated using confidence interval analysis software (Gardner *et al*., 1992).

Local disease names were interpreted using two approaches. First, the pattern and relative importance of the clinical and epidemiological scores for each disease were compared with standard descriptions of diseases in veterinary textbooks. Second, conventional veterinary investigation methods were used to verify the presence of the diseases under investigation. In the study on the chronic wasting disease in cattle in southern Sudan, these methods were clinical examination of affected and non-affected animals, postmortem examination, and various laboratory tests including histopathology (Catley *et al*., 2001). For the study on bovine trypanosomosis in Kenya, trypanosomes were detected using the microhaematocrit centrifugation technique (Catley et al., 2002a).

Matrix scoring with veterinarians

In order to examine further the relationship between local and scientific disease characterization by disease signs and disease causes, a paper version of the matrix scoring method was developed for use with veterinarians. Using the results from the two studies with Nuer and Orma pastoralists, a provisional translation of each local disease name was used in the paper versions of the matrices (Table 2).

The paper matrices for cattle diseases in Nuer communities, southern Sudan, and instructions on how to complete the matrices were pre-tested with eight individual veterinarians with field experience in southern Sudan. The matrices and instructions were then provided to 12 Kenyan veterinarians attending the Annual Scientific Meeting of the Kenya Veterinary Association in Mombassa, Kenya, in April 2000. These informants had no previous field experience in southern Sudan. It was assumed that in terms of veterinary knowledge, the Kenyan veterinarians could not have been influenced by contact with Nuer herders and vice versa. This assumption was checked prior to administering the matrices.

The paper version of the matrices for cattle diseases in Orma communities in Kenya was pre-tested with five veterinarians working on regional livestock programmes at the African Union/Interafrican Bureau of Animal Resources in Nairobi, Kenya. These matrices and instructions were then given to 11 veterinarians attending a training course at the Faculty of Veterinary Medicine, Sokoine University of Agriculture, Tanzania in May 2001. It was assumed that these veterinarians had not been in contact with Orma herders in Kenya, and vice versa. This assumption was checked prior to administering the matrices.

The level of agreement between veterinarians was assessed using W in SPSS software (SPSS, 1999). Confidence limits at the 95% confidence level for median scores were calculated using confidence interval analysis software (Gardner *et al*., 1992).

Table 2 Provisional translation of local names for cattle diseases

Local disease name	Provisional translation
Nuer, southern Sudan	
Liei	Trypanosomosis
Dat	Foot and mouth disease (FMD)
Maguar	Parasitic gastroenteritis (PGE)
Doop	Contagious bovine pleuropneumonia (CBPP)
Macueny	Fasciolosis
Orma, Kenya	
Gandi	Chronic trypanosomosis
Buku	Acute haemorrhagic trypanosomiasis due to *Trypanosoma vivax*
Hoyale	FMD
Somba	CBPP
Madobesa	Rinderpest

Comparison of results from pastoralists and veterinarians

Matrix scoring data obtained from livestock keepers and veterinarians were compared using three methods.

1. *Direct visual assessment of summarised matrices*. A simple visual assessment of the summarized matrices of the herders' and veterinarians' scores was conducted to identify general similarities in scoring patterns, and assess differences in median scores by comparison of 95% confidence intervals.
2. *Hierarchical cluster analysis*. Hierarchical cluster analysis (HCA) was conducted using SPSS software (SPSS, 2001). In the analyses, data from the disease signs and disease causes matrices were combined into a single data set for each study because it was assumed that the diagnosis of a disease by either herders or veterinarians depended on a mental picture comprising both clinical and epidemiological information. The squared Euclidean distance was used as a measure of similarity between diseases and the average linkage method was selected as the clustering method.
3. *Multidimensional scaling*. Multidimensional scaling (MDS) was conducted using SPSS software (SPSS, 2001). All the disease signs and disease causes indicators were used in the analysis (as for HCA) and the squared Euclidean distance was used a measure of similarity between diseases. Distance was calculated from the data assuming an ordinal level of measurement.

Results

Comparison of matrix scoring by Nuer herders (southern Sudan) and veterinarians from Kenya

Matrix scoring of disease signs by Nuer herders and Kenyan veterinarians is summarized in Fig. 1. For Nuer informants there was evidence of strong agreement between the 12 informant groups for 8/9 disease signs, and moderate agreement for the remaining disease sign. For the 12 Kenyan veterinarians there was evidence of strong, moderate and weak agreement for 6/9, 2/9 and 1/9 disease signs, respectively. Each matrix comprised 45 cells (five diseases by nine indicators) and when comparing corresponding cells there was no difference in the median scores of the herders and veterinarians at the 95% confidence limit for 42 cells. Differences in median scores were evident for the diseases *macueny*–fasciolasis, disease sign 'chronic weight loss', and the diseases *liei*–trypanosomosis, disease-signs 'animal seeks shade' and 'loss of tail hair'.

Matrix scoring of disease causes by Nuer herders and Kenyan veterinarians is summarized in Fig. 2. For Nuer informants there was evidence of strong agreement between the 12 informant groups for 7/8 disease causes and moderate agreement for 1/8 disease causes. Matrix scoring of disease causes by 12 Kenyan veterinarians shows evidence of strong, moderate and weak agreement for 6/8, 1/8 and 1/8 disease causes, respectively. These informants did not agree on the role of ticks as causes of disease ($W = 0.08$), whereas Nuer informants consistently disassociated ticks with the five diseases ($W = 1.00$; median score $= 0$ for all five diseases). Each matrix comprised 40 cells and, when comparing corresponding cells, there was no difference in the median scores of the herders and veterinarians at the 95% confidence limit for 38 cells. Differences in median scores were evident for the indicator 'snails' and the diseases *macueny*–fasciolosis and *maguar*–PGE.

Hierarchical cluster analysis (Fig. 3) and MDS (Fig. 4) outputs indicated five primary clustered pairs of disease corresponding to the disease pairs in Table 2. Two secondary clusters each comprising two diseases pairs were also evident from HCA. These cluster were *dat*/FMD and *doop*/CBPP (being infectious diseases with cow-to-cow transmission), and *macueny*/fasciolosis and *maguar*/PGE (being parasitic diseases caused by macroscopically visible parasites).

Comparison of matrix scoring by Orma herders (Kenya) and veterinarians in Tanzania

Matrix scoring of disease sign by Orma herders and Tanzanian veterinarians is summarized in Fig. 6. For Orma informants there was evidence of strong agreement between the 12 informant groups for 8/9 disease signs, and moderate agreement for the remaining disease sign. For the 11 veterinarians there was evidence of strong and weak agreement for 7/9 and 2/9 disease signs, respectively. In 40/45 corresponding cells in the two matrices there was no difference in the median scores at the 95% confidence limit. Differences in median scores were evident for the diseases *gandi*–chronic trypanosomosis and *somba*–CBPP and

a. Nuer informant groups, southern Sudan (n=12)

Signs	Diseases: Liei	Dat	Maguar	Doop	Macueny
Chronic weight loss ($\underline{W}$=0.51***)	10 (6.0-16)	1 (0-2.5)	3 (0-3.0)	1 (0-2.5)	1 (0-2.0)
Animal seeks shade ($\underline{W}$=0.88***)	0 (0)	20 (17-20)	0 (0)	0 (0-3.0)	0 (0)
Diarrhoea ($\underline{W}$=0.52***)	4 (0-8.5)	0 (0)	11 (6.0-16)	0(0)	4 (0-7.5)
Reduced milk yield ($\underline{W}$=0.51***)	2 (0-4.0)	13 (7.0-20)	3 (0-9.0)	1 (0-2.5)	0 (0-1.0)
Coughing ($\underline{W}$=0.76***)	0 (0-0.5)	0 (0-0.5)	0 (0-2.0)	19 (16.5-20)	0 (0-0.5)
Reduced appetite ($\underline{W}$=0.54***)	0 (0)	13 (7.0-20)	0 (0)	5 (0-10)	0 (0)
Loss of tail hair ($\underline{W}$=0.89***)	20 (16.5-20)	0 (0)	0 (0-3.5)	0 (0)	0 (0)
Lachrymation ($\underline{W}$=0.28*)	6 (3.0-13)	2 (0-6.5)	4 (0-8.5)	0 (0-1.5)	3 (0-8.0)
Salivation ($\underline{W}$=0.50***)	2 (0-3.0)	14 (7.0-20)	3 (0-6.5)	1 (0-2.0)	0 (0-0.5)

b. Veterinarians, Kenya (n=12)

Signs	Diseases: Trypanosomiasis	Foot and mouth disease	Parasitic gastroenteritis	CBPP	Fascioliasis
Chronic weight loss ($\underline{W}$=0.53***)	6 (5.5-8)	1 (0-2.5)	3.5 (2.5-4.5)	3.5 (1.5-5)	5 (4-6.5)
Animal seeks shade ($\underline{W}$=0.77***)	6 (4-8.5)	9 (6.5-13)	0 (0)	3.75 (2-6)	0 (0)
Diarrhoea ($\underline{W}$=0.23*)	3 (0.5-5.5)	2 (0-3.5)	8 (4-12.5)	2(0-5)	3 (0-5)
Reduced milk yield ($\underline{W}$=0.73***)	4.5 (2.5-7)	10 (8.5-14)	0.5 (0-1.0)	3 (0.5-5.5)	0 (0-1.0)
Coughing ($\underline{W}$=0.56***)	0.5 (0-1.5)	0 (0-0.5)	0 (0-0.5)	16 (9.5-20)	0 (0-2)
Reduced appetite ($\underline{W}$=0.48***)	3 (0-4)	8.5 (5-13.5)	1 (0-2.5)	3.5 (0-7)	0.5 (0-1.5)
Loss of tail hair ($\underline{W}$=0.15)	0 (0)	0 (0-1)	0 (0-1)	6 (0-10)	0 (0-0.5)
Lachrymation ($\underline{W}$=0.27*)	8 (0-13)	0 (0-4.5)	0 (0-3)	0 (0-2)	0 (0-0.5)
Salivation ($\underline{W}$=0.70***)	0 (0-1)	20 (14-20)	0 (0)	0 (0-1.5)	0 (0)

Fig. 1 Matrix scoring of disease-signs for diseases of adult cattle by Nuer herders in southern Sudan and veterinarians in Kenya. W = Kendal coefficient of concordance (*$p < 0.05$; **$p < 0.01$; ***$p < 0.001$). Medians are presented (95% confidence limits). The black dots represent the stones or seeds that were used during matrix scoring by Nuer informants. Nuer names for cattle diseases are underlined. CBPP, contagious bovine pleuropneumonia

a. Nuer informant groups, southern Sudan (n=12)

Diseases

Causes	Liei	Dat	Maguar	Doop	Maceuny
Liver fluke Daichom ($\underline{W}$=0.68***)	2 (0-4.5)	0 (0-2.5)	3 (0-7)	0 (0)	15 (10.0-20.)
Sick cow entering herd ($\underline{W}$=0.74***)	0 (0-1)	8 (5.0-10.0)	1 (0-3)	9 (5.0-12.0)	0 (0-0.5)
Paramphistomes Chuie ($\underline{W}$=0.33*)	5 (0-12)	0 (0)	5 (0-12.5)	0 (0)	5 (0-13.5)
Stomach worms Luok ($\underline{W}$=0.45**)	3 (0-5.5)	0 (0)	8 (3.5-14.0)	0 (0)	5 (5.0-10.0)
Flooding ($\underline{W}$=0.49***)	8 (2.5-13.0)	0 (0)	6 (2.5-12.5)	0 (0)	4 (3.75-10.0)
Biting flies Rom ($\underline{W}$=0.82***)	19 (15.5-20)	0 (0)	0 (0-6)	0 (0)	0 (0-1.5)
Ticks Chak ($\underline{W}$=1.00***)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Snails Chom ($\underline{W}$=0.60***)	2 (0-4.5)	0 (0)	5 (2.5-9.0)	0 (0)	10 (5.0-15.0)

b. Veterinarians, Kenya (n=12)

Diseases

Causes	Trypanosomiasis	Foot and mouth disease	Parasitic gastroenteritis	CBPP	Fascioliasis
Liver fluke ($\underline{W}$=0.83***)	0 (0)	0 (0-0)	0 (0-0)	0 (0-0)	20 (20-20)
Sick cow entering herd ($\underline{W}$=0.86***)	0 (0)	10 (7.5-12)	0 (0-0)	10 (6.0-10)	0 (0)
Paramphistomes ($\underline{W}$=0.53***)	0 (0)	0 (0)	1 (1-20)	0 (0-0)	0 (0)
Stomach worms ($\underline{W}$=0.71***)	0 (0)	0 (0)	15 (10-20)	0 (0)	2 (0-2)
Flooding ($\underline{W}$=0.25*)	1 (0-5)	0 (0-2.5)	3 (0-10)	0 (0-0.5)	3 (0-9.0)
Biting flies ($\underline{W}$=0.93***)	20 (17.5-20)	0 (0-0.5)	0 (0)	0 (0)	0 (0)
Ticks ($\underline{W}$=0.08)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Snails ($\underline{W}$=0.89***)	0 (0)	0 (0)	0 (0-1)	0 (0)	20 (19-20)

Fig. 2 Matrix scoring of disease-causes for diseases of adult cattle by Nuer herders in southern Sudan and veterinarians in Kenya. W = Kendal coefficient of concordance (*$p < 0.05$; **$p < 0.01$; ***$p < 0.001$). Medians are presented (95% confidence limits). The black dots represent the stones or seeds which were used during matrix scoring by Nuer informants. Nuer names for cattle diseases are underline. CBPP, contagious bovine pleuropneumonia

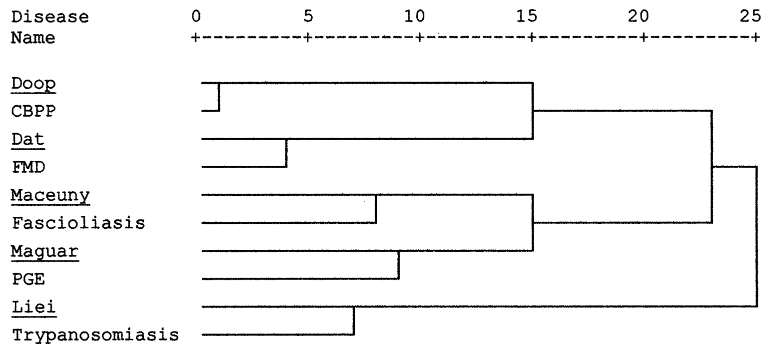


Fig. 3 Comparison of matrix scores from groups of Nuer herders ($n = 12$) and Kenyan veterinarians ($n = 12$) for five disease of adult cattle using hierarchical cluster analysis. Nuer names for cattle diseases are underlined. CBPP, contagious bovine pleuropneumonia; FMD, foot and mouth disease; PGE, parasitic gastroenteritis

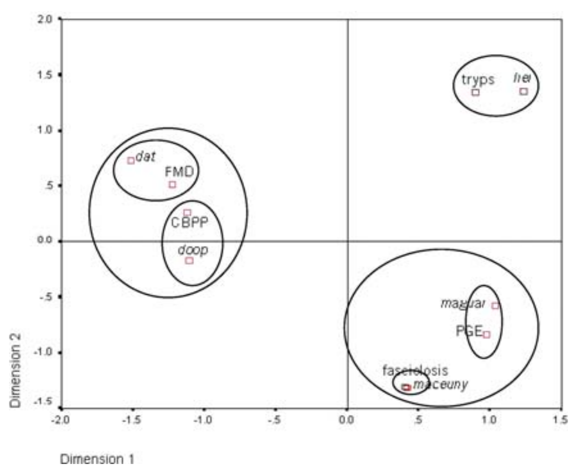


Fig. 4 Plot of matrix scores from groups of Nuer herders ($n = 12$) and Kenyan veterinarians ($n = 12$) for five diseases of adult cattle using multidimensional scaling and hierarchical cluster analysis. Nuer names for cattle diseases are italicised. CBPP, contagious bovine pleuropneumonia; FMD, foot and mouth disease; PGE, parasitic gastroenteritis; tryps, trypanosomiasis

the indicator ‘chronic weight loss’; for the disease *madobesa*–rindeperpest and the indicator ‘reduced appetite’; and for the diseases *buku*-acute trypanosomosis and *madobesa*–rinderpest and the indicator ‘death is sudden’.

Matrix scoring of disease causes by Orma herders and Tanzanian veterinarians is summarized in Fig. 5. For Orma informants there was evidence of strong agreement between the 12 informant groups for all five disease causes, whereas among veterinarians there was strong agreement for 4/5 disease causes and moderate agreement for 1/5 disease causes. In 24/25 corresponding cells in the two matrices there was no difference in the median scores at the 95% confidence limit. Differences in median scores were evident for the diseases *gandi*–chronic trypanosomosis and the indicator ‘ticks’. The apparent difference between the perceptions of veterinarians and herders regarding the role of ticks is explained by reference to herders’ observations that ticks were attracted to sick cattle.

Hierarchical cluster analysis (Fig. 7) and MDS (Fig. 8) outputs indicated five primary clustered pairs of diseases corresponding to the disease pairs in Table 2. In the HCA dendogram, a secondary cluster comprised the diseases *hoyale*/FMD and *madobesa*/rinderpest, and a tertiary cluster linked these two diseases to *somba*/CBPP. Therefore, the epizootic diseases were clustered.

Discussion

Matrix scoring was judged to be a simple and appropriate method for understanding indigenous disease names and diagnostic criteria, and for comparing indigenous and professional knowledge. The method relies on the principle of agreement between observers to judge the validity of diagnoses, and assumes that in remote areas of Africa, laboratory support is rarely available or accessible. Matrix scoring can be used by veterinary workers and paraveterinarians with minimal training, and the production of summarized matrices (Figs. 1, 2, 5, 6) requires only basic statistical knowledge.

In pastoralist communities, people can spend most of their lives in close proximity to livestock and, to a large extent, human survival depends on people’s ability to manage their animals. Everyday conversation tends to focus on the condition of pasture, the

a. Orma informant groups, Kenya (n=12)

Signs	Diseases: Gandi	Hoyale	Buku	Somba	Madobesa
Chronic weight loss ($\underline{W}$=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 ($\underline{W}$=0.59***)	1.0 (0-3.5)	15.8 (10.0-20)	1.5 (0-4.0)	1.0 (0-4.0)	0 (0)
Diarrhoea ($\underline{W}$=0.78***)	3.0 (1.0-5.5)	0 (0)	5.5 (3.0-8.5)	0 (0)	12.5 (8.5-15.5)
Haemorrhagic carcass ($\underline{W}$=0.83***)	3.0 (0-5.0)	0 (0)	17.0 (15.0-20)	0 (0)	0 (0)
Coughing ($\underline{W}$=0.86***)	4.25 (2.5-6.5)	0 (0)	1.0 (0-2.0)	14.5 (12.5-16.5)	0 (0)
Reduced appetite ($\underline{W}$=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 ($\underline{W}$=0.65***)	14.2 (10.0-19.0)	0 (0)	0 (0-2.5)	0 (0-0)	3.5 (0-7.0)
'Death is sudden' ($\underline{W}$=0.78***)	0 (0-3.5)	0 (0)	17.5 (13.5-20.)	0 (0-0.5)	0 (0-1.5)
Oedematous carcass ($\underline{W}$=0.46***)	11.0 (5.5-17.5)	0 (0)	0 (0-5.0)	4.0 (0-10.0)	0 (0)

b. Veterinarians, Tanzania (n=11)

Signs	Diseases: Chronic trypanosomiasis	FMD	Acute trypanosomiasis due to T.vivax	CBPP	Rinderpest
Chronic weight loss ($\underline{W}$=0.81***)	9.75 (8-11)	2 (1-3.5)	0 (0-1)	5.5 (4-7)	2.25 (0.5-4)
Animal seeks shade ($\underline{W}$=0.10)	2.0 (1-10)	6 (3-11)	3.75 (1-6.5)	2.75 (1-5)	2.5 (0.5-4)
Diarrhoea ($\underline{W}$=0.75***)	1 (0-2)	0 (0-2)	2 (0-3.5)	0 (0-2)	16.8 (12-19)
Haemorrhagic carcass ($\underline{W}$=0.75***)	0.5 (0-3)	0 (0-1)	16.8 (13.5-20)	0 (0-1)	0.75 (0-3.5)
Coughing ($\underline{W}$=0.83***)	0 (0-3)	0 (0-2)	0 (0-1.5)	17.5 (15-20)	0.75 (0-3.5)
Reduced appetite ($\underline{W}$=0.49**)	2 (1-3.5)	6.5 (4.5-9)	3.5 (2-4.5)	3.5 (3-4)	4.5 (3.5-6)
Loss of tail hair ($\underline{W}$=0.77***)	18.5 (10-20)	0 (0-1.5)	0 (0-1)	0 (0-1)	0 (0-2.5)
'Death is sudden' ($\underline{W}$=0.66***)	0 (0-0)	0 (0-4.5)	8.25 (4.5-12.5)	1 (0-3)	5.75 (3-10)
Oedematous carcass ($\underline{W}$=0.13)	5 (0-10)	0 (0)	0 (0-7.5)	1 (0-7.5)	2.5 (0-4.5)

Fig. 5 Matrix scoring of disease-signs for diseases of adult cattle by Orma herders in Kenya and veterinarians in Tanzania. W = Kendal coefficient of concordance ($^*p$ <0.05; $^{**}p$ <0.01; $^{***}p$ <0.001). Medians are presented (95% confidence limits). The black dots represent the stones or seeds which were used during matrix scoring by Orma informants. Orma names for cattle diseases are underline. FMD, foot and mouth disease; CBPP, contagious bovine pleuropneumonia

a. Orma informant groups, Kenya (n=12)

Causes	Diseases: Gandi	Hoyale	Buku	Somba	Madobesa
Sick cow entering herd ($\underline{W}$=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 ($\underline{W}$=0.67***)	●●●●●●●●●●●● 11.5 (6.0-16.0)	0 (0)	●●●●● 5.0 (0-8.5)	0 (0)	0 (0)
Kobabe Tabanids ($\underline{W}$=0.38**)	●●●●●●●●●● 10.0 (0-13.0)	0 (0)	0 (0-0)	0 (0)	0 (0)
Gandi Tsetse ($\underline{W}$=0.86***)	●●●●●●●●●●●●●●● 15.0 (11.5-17.5)	0 (0)	●●●●● 5.0 (2.5-8.5)	0 (0)	0 (0)
Gadarsi Contact with buffalo ($\underline{W}$=0.75***)	0 (0)	●●●●●●●● 8.25 (7.0-10.0)	0 (0)	●● 1.5 (0-3.0)	●●●●●●●●●● 9.5 (7.0-12.0)

b. Veterinarians, Tanzania (n=11)

Causes	Diseases: Chronic trypanosomiasis	FMD	Acute trypanosomias is due to T.vivax	CBPP	Rinderpest
Sick cow entering herd ($\underline{W}$=0.86***)	0 (0-0.5)	●●●●●●● 6.5 (6-8)	0 (0-0.5)	●●●●●● 6 (5.5-7)	●●●●●●● 7 (5.5-8)
Ticks ($\underline{W}$=1.00***)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Tabanids ($\underline{W}$=0.42*)	●●●●● 5 (0-10)	0 (0)	●●●●● 5 (0-10)	0 (0)	0 (0)
Tsetse ($\underline{W}$=0.93***)	●●●●●●●●●● 10 (10-15)	0 (0)	●●●●●●●●●● 10 (5-10)	0 (0)	0 (0)
Contact with buffalo ($\underline{W}$=0.60***)	0 (0)	●●●●●● 6 (2.5-10)	(0)	●●● 2.5 (0-3.5)	●●●●●●●●● 9 (5-15)

Fig. 6 Matrix scoring of disease-causes for diseases of adult cattle by Orma herders in Kenya and veterinarians in Tanzania. W = Kendal coefficient of concordance (*p < 0.05; **p < 0.01; ***p < 0.001). Medians are presented (95% confidence limits). The black dots represent the stones or seeds which were used during matrix scoring by Orma informants. Orma names for cattle diseases are underline. FMD, foot and mouth disease; CBPP, contagious bovine pleuropneumonia

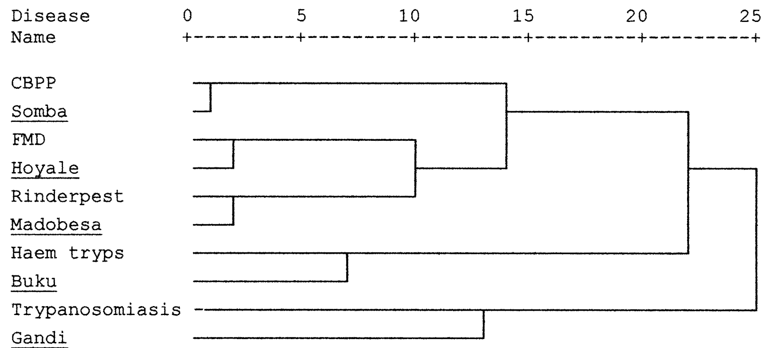
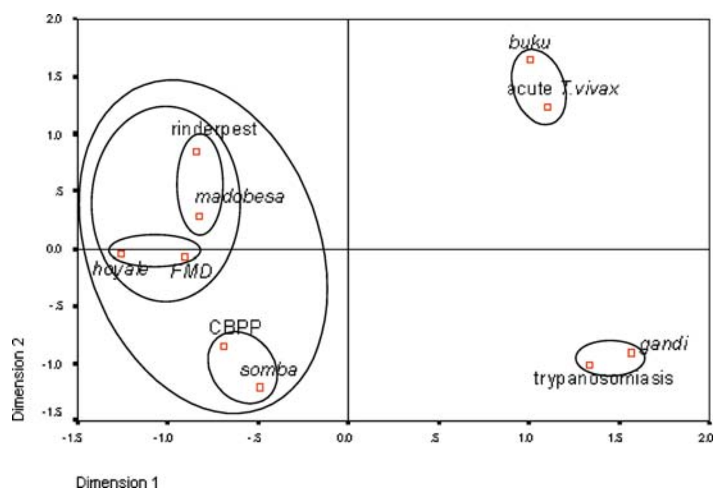


Fig. 7 Comparison of matrix scores from groups of Orma herders ($n = 12$) and Tanzanian veterinarians ($n = 11$) for five diseases of adult cattle using hierarchical cluster analysis. Orma names for cattle diseases are underlined. FMD, foot and mouth disease; CBPP, contagious bovine pleuropneumonia; 'Haem tryps', acute haemorrhagic trypanosomiasis due to *T.vivax*

Fig. 8 Plot of matrix scores from groups of Orma herders ($n = 12$) and Tanzanian veterinarians ($n = 11$) for five diseases of adult cattle using multidimensional scaling and hierarchical cluster analysis. Orma disease names are italicised. FMD, foot and mouth disease; CBPP, contagious bovine pleuropneumonia



health and productivity of animals, the availability of water, and local security issues. In some communities, daily meetings are held between elders to discuss livestock issues and these discussions include the exchange of information related to disease outbreaks. These aspects of pastoralist behaviour explain the strong agreement between informant groups when relating livestock diseases to clinical and epidemiological indicators (Figs. 1, 2, 5, 6). Although a possible weakness of the study was the comparison of groups of pastoralists with individual veterinarians, in practice it was difficult to access sufficient numbers of veterinarians and organize them into groups (between 80 and 100 veterinarians would have been needed for each comparison).

In the author's experience, veterinarians may disregard indigenous disease names because the literal interpretation of the name is thought to have a non-specific meaning. For example, the literal meaning of the Orma word *somba* is 'lung' whereas in southern Sudan *liei* means 'to steal slowly'. However, the two field studies used as the basis for this research (Catley *et al*., 2001, 2002a) showed that livestock keepers possessed specific mental pictures of the diseases in question. Disease names were assigned to health problems showing specific combinations of disease signs, lesions or parasites observed post-mortem, and contact with risk factors such as exposure to swamps, biting flies, wildlife or sick cattle. Matrix scoring also distinguished between diseases of similar clinical appearance. The matrix scoring method in southern Sudan included three diseases with a similar clinical presentation (*liei*, *maguar* and *macueny*), but informants differentiated between these diseases using post-mortem findings and observations on the exposure of cattle to disease vectors (Catley *et al*., 2001).

The inclusion of both clinical and epidemiological information in the method distinguishes it from other diagnostic approaches that have been proposed for developing regions. Both pattern-matching (Cockcroft, 1999) and Bayesian belief networks (McKendrick *et al*., 2000) rely on clinical signs *per se* in the diagnostic process and therefore exclude important diagnostic information, such as exposure to parasites and seasonality of disease occurrence. These approaches also overlook the possibility of mixed parasite infections in livestock in the tropics, as reported in Kenya (Griffin *et al*., 1981), The Gambia (Dwinger *et al*., 1994), Ethiopia (Mathewos *et al*., 2001) and southern Sudan (Catley *et al*., 2001), and clinical presentations that result from the combined, simultaneous effects of different parasites.

The disease names used by pastoralists for the diseases investigated in the two study areas were judged to be sufficiently specific to contribute to the design of disease surveillance systems. Although only five diseases were used in each matrix (to limit the time required to use the method), recent work in southern Sudan has used 10 diseases in matrix scoring and informants were able to construct the matrices without confusion (M. Barasa, personal communication, 2005). An important aspect of developing the method is attention to the specificity of the indicators, and ensuring that each indicator has a clear meaning. In part, the different scores for some indicators between herders and veterinarians in this study arose because these two groups interpreted the indicators in different ways. A further consideration is attention to dialectic variations within a broad linguistic or ethnic group. For example, it should not be assumed that all Nuer herders in southern Sudan use the same disease names presented in this paper, because different Nuer clans have different dialects. Therefore, sampling of ethnic groups to identify disease names for surveillance purposes requires an understanding of ethnic subgroups and variations in dialect between groups. Collaboration between epidemiologists and ethnographers would probably be beneficial.

Although matrix scoring was considered to a useful method, its use should be combined and triangulated with other methods. Basic veterinary investigation methods such as clinical and post-mortem examination are feasible even in resource-poor settings and, when used systematically, can validate local diagnoses for some diseases. Information on the seasonal occurrence of diseases and disease vectors and their spatial distribution is also useful for diagnosis. Therefore, PE methods such as seasonal calendars and mapping can complement matrix scoring data (Catley *et al*., 2002b).

A final consideration is the use of PE methods to improve interaction and trust between surveillance workers and livestock keepers. The process of involving local people and recognizing the value of their knowledge would help to strengthen relationships between communities and government veterinary workers, and thereby encourage flow of information. Similarly, the wider use of community-based animal health workers who are selected by postorilist communities and who are pastoralists themselves would help to ensure that local knowledge contibutes to official disease surveillance systems. Research on pastoralist community-based animal helth workers inTanzania has demonstrated substabtial impact on disease surveillance indicators (Allport *et al*., 2005).

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Utilisation d'une épidémiologie participative pour comparer les connaissances de vétérinaires cliniques et de chercheurs pastoralistes en Afrique de l'Est

Résumé – En raison de sévères limitations des ressources et de la logistique dans des zones étendues de l'Afrique, les systèmes de surveillance des maladies ont besoin de maximiser l'utilisation des informations fournies par les gardiens du bétail et d'interpréter correctement les connaissances tirées du bétail indigène. Cet article décrit l'utilisation d'une épidémiologie participative (PE) pour comparer les noms, les signes cliniques et les caractéristiques épidémiologiques des maladies du bétail telles qu'elles sont perçues par les chercheurs pastoralistes et les vétérinaires. En puisant dans les résultats tirés de deux études précédentes menées par des chercheurs pastoralistes dans le Sud du Soudan et au Kenya, les traductions provisoires des noms de maladies locales ont été utilisées en terminologie vétérinaire moderne pour développer une méthode de cotation matricielle à usage vétérinaire. Les données de la cotation matricielle émanant de chercheurs pastoralistes et de vétérinaires ont été comparées en utilisant une simple comparaison visuelle des matrices récapitulées, une analyse de groupes hiérarchiques et une mise en échelle multidimensionnelle. Les résultats ont mis en évidence une bonne corrélation entre les noms de maladies des chercheurs pastoralistes et des vétérinaires et les critères de diagnostic. La méthode de cotation matricielle était facile à utiliser et appropriée à une utilisation dans des zones à ressources insuffisantes avec un soutien professionnel ou des services de laboratoire minimaux. La cotation matricielle pourrait être utilisée pour aider les personnes travaillant sur la surveillance des maladies du bétail à concevoir des systèmes de surveillance faisant un meilleur usage des connaissances indigènes des chercheurs pasteuralistes et interprétant correctement les noms des maladies locales. La méthode devrait être combinée, dans la mesure où ceci est faisable, à des méthodes d'investigation vétérinaires conventionnelles.

Empleo de epidemiología participativa para comparar el conocimiento veterinario clínico de ganaderos y veterinarios en África del Este

Resumen – Debido a serias limitaciones logísticas y de recursos en grandes áreas de África, los sistemas de vigilancia de enfermedades necesitan maximizar el uso de la información suministrada por los cuidadores de ganado y hacer correctas interpretaciones del conocimiento ganadero indígena. Este estudio describe el uso de la epidemiología participativa (EP) para comparar los nombres, síntomas clínicos y rasgos epidemiológicos de las enfermedades de ganado como son percibidas por los ganaderos y veterinarios. Utilizando los resultados de dos estudios previos con ganaderos en el sur de Sudán y Kenia, se utilizaron traducciones provisionales de nombres de enfermedades locales incorporados en la terminología veterinaria moderna para desarrollar un método de puntuación en matrices para uso por veterinarios. Los datos de las puntuaciones en matrices provenientes de los ganaderos y veterinarios se compararon luego utilizando una simple comparación visual de las matrices resumidas, un análisis jerárquico de conglomerados y escala multidimensional. Los resultados mostraron un buen acuerdo entre los nombres de las enfermedades y los criterios de diagnóstico de

los ganaderos y los veterinarios. El método de puntuación en matrices fue fácil de usar y apropiado para uso en áreas con pocos recursos y mínimo apoyo profesional o servicios de laboratorio. El método de puntuación basado en matrices puede usarse para ayudar a los trabajadores de vigilancia de enfermedades del ganado a diseñar sistemas de vigilancia que hagan mejor uso del conocimiento ganadero indígena y que interprete correctamente los nombres de las enfermedades locales. El método deberá combinarse con métodos convencionales de investigación veterinaria cuando fuese posible.