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REGULAR ARTICLES

Challenges of pastoral cattle production in a sub-humid zone of Nigeria

Abubakar Suleiman[1,2] · **Elizabeth Louise Jackson**[1] · **Jonathan Rushton**[1]

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Abstract
Purpose More than 80 % of the 20 million heads of Nigerian cattle are kept by pastoral households. As such, optimal herd management is important in maintaining human nutrition, livelihoods and socio-cultural balance. This study was conducted to contribute to discussions on emerging challenges of the Nigerian livestock sector and to estimate herd prevalence, relative incidence, case fatality and impact on livelihood of cattle diseases in pastoral areas.
Methods Participatory epidemiological approaches: listing; pairwise ranking; proportional piling; matrix scoring and probing were used to collect data through focus group interviews with Fulani herdsmen from selected pastoral areas of the country.
Results The main cattle production problems were as follows: conversion of land used for cattle routes into crop fields, cattle rustling and water scarcity with median scores for impact on livelihood being 19, 17 and 16 %, respectively. Animal diseases were fourth in the list of problems, and diseases reported to have significant impacts on livelihood were trypanosomiasis (25 %), contagious bovine pleuropneumonia (15 %), foot and mouth disease (13 %) and fascioliasis (13 %). High relative incidence rates were reported for trypanosomiasis (27 %), fascioliasis (24 %) and foot and mouth disease (19 %).
Conclusion Change of land use and rustling indicate weaknesses in the producers' institutional environments. Water scarcity, limited access to veterinary services and substandard drugs supplied by vendors were identified as key factors contributing to persistence and frequent outbreaks of diseases. The paper revealed a greater importance of land constraints and rustling relative to disease and highlighted policy issues on management of natural resources and livestock development given challenges associated with pastoralism and insecurity in Nigeria.

Keywords Cattle diseases · Livelihoods · Nigeria · Pastoralism · Participatory epidemiology · Production constraints

Introduction

Nigeria has approximately 20 million heads of cattle (FAOSTAT 2015) which are mainly (80 %) kept under different types of smallholder pastoralist systems in the semi-arid and sub-humid zones within the northern states (Blench 1999). Pastoralism is a traditional system of livestock production practised in dry areas where the length of crop growing periods is so short (less than 180 days) that livestock grazing has become a major form of land use (Otte and Chilonda 2003). Pastoral cattle provide more than just subsistence food. They also provide social satisfaction, domestic fuel and farm power. For cattle-crop households, cattle ownership is a safety net against droughts and other disasters impacting on crop yield. In addition, cattle value chains provide livelihoods to other entrepreneurs from whom sub-national governments generate substantial taxes. At the national level, cattle are the most important livestock species in terms of biomass and investment value and the provision of beef which is one of the most popular animal source foods, accounting for a quarter (391,630 tonnes) of the total meat consumption (FAOSTAT 2015).

✉ Abubakar Suleiman
asuleiman@rvc.ac.uk; abubakarsuleiman@abu.edu.ng

[1] Veterinary Epidemiology, Economics and Public Health Group, The Royal Veterinary College, Hawkshead Campus, AL9 7TA London, UK

[2] Department of Veterinary Microbiology, Ahmadu Bello University, Samaru Campus, Zaria, Nigeria

The role of livestock in rural poverty alleviation and food security in Sub-Saharan Africa is well documented (Pica-Ciamarra 2005), yet if Nigerian cattle systems are to contribute in this way, there will need to be change in production and productivity. For instance, human population growth had resulted in an increase in the utilisation of grazing lands for infrastructure, housing and intensive crop agriculture (Powell et al. 2004). Irrigation farming also makes access to communal water and dry season grazing key problems for cattle farmers (Majekodunmi et al. 2014). In response, some pastoralists migrate southwards into tsetse fly-infested zones which are endemic to trypanosomiasis. Most of those that remain within the northern states adopted a sedentary mixed crop-cattle farming which limits their stock sizes due to feed and labour constraints (RIM 1992; Blench 1999). Clashes between these sedentary pastoralists and crop farmers occur whenever cattle graze on crop fields or a cattle route has been converted into cropland. Productivity is also affected by diseases and poor access to veterinary services, with diseases such as trypanosomiasis, foot and mouth disease (FMD) and contagious bovine pleuropneumonia (CBPP) having serious consequences on production (Fadiga et al. 2011). The impact of these diseases can be separated into direct losses arising from mortality and reduced beef, milk and ox working hours and calf losses from abortion, and the human reaction to disease such as treatment, control and surveillance, and lost access to international livestock markets (Rushton 2009). Therefore, the study aimed to identify and rank husbandry problems of the pastoral cattle in selected pastoral areas of Nigeria with the specific objective of estimating impacts on livelihood, herd prevalence, relative incidence and case fatality rates of cattle diseases.

Materials and methods

Methodological framework

Participatory epidemiology refers to the application of participatory approaches and methods to improve knowledge of animal health and management alternatives (Catley et al. 2012). Specifically, the term "participatory" relates to community involvement in identifying animal health problems and developing solutions. Participatory methods in livestock production (Waters-Bayer and Bayer 1994) and epidemiology (Catley et al. 2012) were developed alongside the increasing use of participatory methods, such as rapid rural appraisals (RRAs), that became popular in rural development studies in the 1980s (Chambers 1994; Rushton 2009). Participatory methods are popular in certain circumstances of disease investigation, where it is difficult to apply classical approaches to understanding disease in populations (Rushton 2009; Toribio and Rushton 2012).

Several participatory methods have been used to prioritise animal production and health problems (Bedelian et al. 2007; Ahlers et al. 2009; Bett et al. 2009; Catley et al. 2012; Onono et al. 2013). These are broadly categorised into informal interviews, visualisation, ranking and scoring methods which were often applied in various combinations (Catley et al. 2012). In this study, data were collected using semi-structured interviews with focus groups of pastoralists. The participatory methods used included listing, pairwise ranking, proportional piling and disease impact matrix scoring. Probing was used to obtain specific details on interesting and unexpected responses from participants attending focus group sessions. These methods are described in detail in the "Participatory data collection" section.

Study area

The study was conducted in Kaduna State of Nigeria. The state is divided into local government areas (LGAs) comprising of wards, the lowest administrative units. The wards are too varied with respect to land size, livestock population and rural-urban compositions to be considered as sampling units. However, a traditional establishment runs parallel to this administrative organisation. The traditional authority is made up of emir, district and village heads in descending order of authority. Village heads coordinate flow of resources to villagers. Their approval is necessary to establish any form of research contact with individuals within their domains. For these reasons, villages were considered as sampling units in this study.

Kaduna State lies on the sub-humid agro-climatic belt of West Africa and has a total land area of 43,000 km^2, 40 % of which is under agricultural utilisation (Olugbemi and Erinle 1996), making Kaduna a strategic zone for livestock production (RIM 1992). Most of the cattle are kept under crop-livestock systems in which cattle mobility is limited to few kilometres within village radius. Grazing is on communal basis within uncultivated and fallow lands.

Selection of villages and focus group participants

Kaduna State was purposely selected for the study because it has a sizeable number of agricultural research institutes. These institutes have field stations and farmers residing around the sites have benefited from several programmes. It was thus expected that pastoralists in the state were familiar with field research and would be more willing to share their experiences and knowledge. Suggestions about villages with proportionately higher numbers of cattle herds and accessible roads were sought from district heads and state veterinary officers. Thirteen villages were selected for focus group interviews. Pastoralists were mobilised by village heads and resident livestock officers. Due possibly to incidences of rustling in the area, pastoralists in one of the 13 villages declined to participate in the interview because of fears that information shared would be disclosed to investigation authorities. Participant

consent was sought after the study objectives, participants' confidentiality and roles were explained by the team leader.

All participants were men because it is against customary practices for women to engage in conversations with outsiders. Where possible, middle-aged men were selected to participate because they are responsible for daily care of cattle and might possibly have more accurate information than other age groups. It was also anticipated that members of this age group would be more able to freely express opinions if they were separated from the older group as it is considered disrespectful to have a contrary view with that of an older person.

Participatory data collection

Ten focus group interviews were conducted with a total of 86 pastoralists (Table 1). The interviews were conducted in Hausa, which is more fluently spoken by participants, and later translated into English. A checklist of open-ended key questions which were piloted and modified in two villages, not included in the final study, was used as interview guide.

Cattle husbandry problems and diseases

Participants were asked to list husbandry problems and diseases of cattle impacting on their livelihoods. Responses were followed up by re-phrased questions to probe for detailed descriptions and explanations of answers. These details were validated by local livestock assistants and ambulatory veterinarians. The "Local diagnosis of cattle diseases" section describes the system employed to assess consistency of diagnosis amongst focus groups. The participants were requested to rank husbandry problems and diseases using a pairwise ranking method (Catley et al. 2012).

Herd prevalence, relative incidence and case fatality rates of cattle diseases

To estimate herd prevalence for listed diseases, participants were asked to indicate if they had encountered any of listed diseases in their herds within the past year, and a count was made for the listed diseases. Herd prevalence was obtained by dividing these counts by the total number of participants attending group interviews (Onono et al. 2013). Proportional pilings were used to estimate relative incidence and case fatality rates for diseases encountered by participants (Rufael et al. 2008; Catley et al. 2009; Hendrickx et al. 2010). Piles of 100 white beans, each representing an animal in a herd, were used as counters. Each participant was asked to split a pile to show the proportion of sick and healthy cattle in their herd within the past one year. Participants were further asked to divide pile representing sick cattle to show incident scores of diseases. In a similar way, participants subdivided each pile representing a particular disease into cattle that died and those that recovered from the disease, thereby showing case fatality scores for those diseases. Relative incidence and case fatality rates were obtained by dividing the scores for disease-specific sub-piles by the sum of sub-piles at both incidence and case fatality levels, respectively. Participant scores from proportional piling exercises were averaged to obtain group scores for each group interview.

Local diagnosis of cattle diseases

Matrix scoring method was used to assess consistency of pastoralists' diagnoses of diseases which were based on their knowledge of specific clinical indicators of diseases common in the area (Catley 2006; Shiferaw et al. 2010; Onono et al. 2013). Matrix scoring uses the principle of agreement amongst informants to judge validity of diagnoses. It was performed by writing clinical signs recognised (from veterinary literature) to be caused by listed diseases down the leftmost column of a matrix drawn on a flip chart sheet, while the diseases were written across the first row of the matrix. Scores, using a pile of 30 white beans for each clinical sign, were used for distribution to diseases based on the extent to which they showed the clinical signs as noticed by participants.

Table 1 Age of focus group participants from ten villages in selected pastoral areas of Nigeria

Village	Number of participants	Average age of participants (standard deviation)
Dallatu	15	40 (13.51)
Gimba	12	40 (15.59)
Kafin Mardanni	11	37 (12.74)
Kinkiba	6	57 (12.52)
Maigana	10	34 (9.10)
Sabon Fegi	7	48 (17.95)
Tankarau	6	49 (10.85)
Tashan Icce	5	56 (5.66)
Tashar Zomo	10	45 (16.73)
Zangon Aya	4	61 (17.00)

Data management and analysis

Participant-identifiable data were de-identified using assigned codes. Quantitative data were entered into databases created on spreadsheets. Scores for impacts of husbandry problems, cattle diseases and clinical signs were converted to percentages before analysis. Kruskal-Wallis one-way ANOVA at 5 % significance level was used to check for associations between villages and median scores for impacts of cattle diseases and husbandry problems using Instat Plus version 3.36 (Statistical Services Centre, the University of Reading, UK). The level of diagnostic consistency amongst focus groups was assessed by Kendall's coefficients of concordance (W) at 5 % significance level using SPSS package version 20. Agreements were classified as strong ($W>0.38$, $P<0.01$), moderate ($W=0.26$–0.38, $P<0.05$) and weak ($W<0.26$, $P>0.05$) based on the criteria for interpretation of W reported by Shiferaw et al. (2010).

Results

Husbandry problems

Median scores for husbandry problems impacting on cattle production were significantly different (P value<0.001). Husbandry problems with high impact on production included conversion of land demarcated as cattle routes into croplands ($Z=3.45$), rustling ($Z=2.33$) and water scarcity ($Z=2.51$) (Table 2). However, individual villages were not significantly associated with median scores for husbandry problems. In seven of ten focus group interviews, pastoralists ranked change of land use of cattle routes into agricultural land in the first three husbandry problems impacting on production. Participants stated that cattle could not have access to adequate grazing lands and water sources if they were blocked by crop fields, often causing cattle to trample on cropland, and affected herdsmen were fined for crop damages. Cattle theft was ranked the second most important husbandry problem. Half of the group interviews considered it to be the most important constraint. Water scarcity and cattle diseases were ranked third and fourth. Search for water was noted as a major reason for transhumant migrations and took most of daily herding time for sedentary pastoralists. Participants blamed water scarcity for persistence of contagious cattle diseases in the area as most herds share a few available sources.

Diseases in pastoralists' herds were noted to cause serious losses in the form of mortalities, weight loss and abortions. Participants observed that access to veterinary services was difficult due to challenges of transporting sick animals to veterinary clinics. They argued that drug and transport costs for veterinarian visit were not affordable. Participants residing close to veterinary hospitals also noted poor access due to bureaucratic difficulties. In addition, veterinary drugs sold to pastoralists by vendors were less effective. Participants noted that annual vaccination campaigns had not been conducted in the last couple of years.

Cattle diseases

Participants identified 19 diseases commonly occurring in their herds (Table 3). There was significant difference in median scores for impact of diseases on livelihood (P value<0.001). Diseases with higher impacts on livelihood included trypanosomiasis ($Z=4.82$), fascioliasis ($Z=3.35$), dermatophilosis/streptothricosis ($Z=3.03$) and CBPP ($Z=2.93$). Trypanosomiasis had the highest impact on livelihood. Five focus groups ranked it as having the highest impacts on livelihood. In remaining groups, it was ranked second. Participants said that trypanosomiasis occurred all year round, particularly in tsetse fly-infested areas. CBPP was ranked second. Although the disease is not currently a problem, participants suggested that a CBPP outbreak causes more losses than other listed diseases and is expensive to control because of prolonged morbidity. Although it

Table 2 Scores for husbandry problems that impact on cattle production in selected pastoral areas of Nigeria

Husbandry problems	Mean %	Median %	Range %	Z-score	Rank
Diversion of cattle routes to croplands	21	19	3–30	3.45	1
Cattle rustling	17	17	0–40	2.33	2
Scarcity of water for livestock use	16	16	0–33	2.51	3
Cattle diseases	10	10	0–30	1.07	4
Inadequate pasture lands	9	7	0–29	0.46	5
High cost of supplementary feeds	8	5	0–27	0.25	6
Lack of extension services and education	6	3	0–24	−0.13	7
Poor access to veterinary services	5	0	0–21	−0.91	8
Lack of subsidised inputs	5	0	0–20	−0.92	9
Poor implementation of intervention programmes	2	0	0–17	−2.41	10
Conflicts with crop farmers	1	0	0–7	−2.65	11
Low productivity of cattle breeds	0	0	0–0	−3.04	12

Table 3 Scores for impact of cattle diseases on the livelihoods of households in selected pastoral areas of Nigeria

Diseases	Local name	Mean %	Median %	Range %	*Z*-score	Rank
Trypanosomiasis	*Sammore/taki*	25	25	17–42	4.82	1
Contagious bovine pleuropneumonia	*Huhu/Kuhu*	14	15	0–33	2.93	2
Fascioliasis	*Hanta*	16	13	0–40	3.35	3
Foot and mouth disease	*Bouru/Kofato*	13	13	0–33	3.03	4
Dermatophilosis/streptothricosis	*Kirci*	5	5	0–10	1.27	5
Brucellosis	*Bakkale*	8	0	0–24	0.68	6
Black quarter	*Daji*	4	0	0–29	−0.58	7
Tick infestation	*Kaska*	6	0	0–50	−0.63	8
Ruminal impaction	*Tsumma/leda*	3	0	0–14	−0.75	9
Cowdriosis	*Gabi-gabi*	2	0	0–12	−0.87	10
Ascariasis	*Weire/Heire*	3	0	0–25	−1.14	11
Nematodiasis	*Matsatsaku*	1	0	0–8	−1.37	12
Dystocia/retained placenta	*Yorniya*	1	0	0–8	−1.37	13
Rectal/uterine prolapse	*Basir/Mahaifa*	1	0	0–6	−1.40	14
Mange	'*Balla*'/*Kircin giwa*	0	0	0–4	−1.43	15
Hardwire disease	'*Karfe*'/*Kusa*	0	0	0–4	−1.43	16
Choke	*Mangoro*	0	0	0–2	−1.45	17
Colibacillosis	*Zawo*	0	0	0–0	−1.83	18
Bloat	*Gamba*	0	0	0–0	−0.86	19

was ranked sixth, participants reported brucellosis to be the major cause of abortion.

Herd prevalence, relative incidence and case fatality rates

Median herd prevalence differed significantly amongst diseases reported by pastoralists (P value<0.001). Fascioliasis (Z=3.79), trypanosomiasis (Z=3.98) and FMD (Z=2.46) had higher median herd prevalence (Table 4). Median scores for relative incidence also differed amongst diseases (P value<0.001). However, the differences in median scores for relative case fatality were not significant (P value=0.3). Cattle diseases with higher relative incidence rates included trypanosomiasis (Z=3.59), fascioliasis (Z=3.79) and FMD (Z=3.16) (Table 5).

Herdsmen's diagnosis of cattle diseases

Strong agreements were observed amongst the ten focus groups for all but one of the clinical indicators pastoralists used to identify common diseases (Table 6). Participants reported that weight loss, fever, diarrhoea, ocular discharges and sudden death were common signs of trypanosomiasis.

Table 4 Scores for the estimated herd prevalence of cattle diseases as reported by herdsmen in selected pastoral areas of Nigeria

Disease	Mean %	Median %	Range %	*Z*-score	Rank
Fascioliasis	54	63	0–86	3.79	1
Trypanosomiasis	60	59	0–100	3.98	2
Foot and mouth disease	33	27	0–100	2.46	3
Dermatophilosis/streptothricosis	22	13	0–83	1.21	4
Colibacillosis	10	0	0–75	−0.80	5
Contagious bovine pleuropneumonia	7	0	0–50	−0.88	6
Brucellosis	6	0	0–50	−0.95	7
Tick infestation	5	0	0–50	−1.34	8
Black quarter	4	0	0–30	−1.04	9
Cowdriosis	3	0	0–25	−1.44	10
Mange	3	0	0–25	−1.44	11
Ruminal impaction	3	0	0–20	−1.09	12
Choke	2	0	0–20	−1.49	13

Table 5 Scores for the relative incidence and case fatality (in brackets) rates for cattle diseases as reported by herdsmen in selected pastoral areas of Nigeria

Disease	Mean %	Range %	Median %	*Z*-scores	Rank
Trypanosomiasis	27 (42)	0–63 (0–100)	28 (42)	3.59 (3.36)	1 (1)
Fascioliasis	24 (13)	0–94 (0–33)	18 (13)	3.79 (2.2.4)	2 (2)
Foot and mouth disease	19 (16)	0–67 (0–100)	14 (0)	3.16 (1.39)	3 (3)
Dermatophilosis/streptothricosis	9 (1)	0–45 (0–7)	3 (0)	1.72 (0.38)	4 (4)
Black quarter	4 (9)	0–30 (0–60)	0 (0)	−0.29 (0.34)	5 (5)
Ruminal impaction	4 (0)	0–20 (0–0)	0 (0)	−0.25 (−0.86)	6 (13)
Mange	2 (2)	0–22 (0–21)	0 (0)	−0.83 (−0.30)	7 (9)
Contagious bovine pleuropneumonia	2 (5)	0–12 (0–30)	0 (0)	−0.40 (0.25)	8 (7)
Colibacillosis	2 (5)	0–17 (0–40)	0 (0)	−0.41 (0.27)	9 (6)
Brucellosis	2 (3)	0–14 (0–30)	0 (0)	−0.41 (−0.29)	10 (8)
Ascariasis	2 (0)	0–13 (0–0)	0 (0)	−0.45 (−0.86)	11 (14)
Dystocia/retained placenta	1 (2)	0–8 (0–20)	0 (0)	−0.46 (−0.32)	12 (10)
Choke	1 (0)	0–8 (0–0)	0 (0)	−0.95 (−0.86)	13 (15)
Nematodiasis	0 (1)	0–4 (0–10)	0 (0)	−1.00 (−0.36)	14 (11)
Cowdriosis	0 (1)	0–2 (0–7)	0 (0)	−1.02 (−0.38)	15 (12)

Signs shown by CBPP-infected cattle were coughing, nasal discharges, lost appetite, weight loss and sudden death. Focus groups reported that abortion was observed only in brucellosis, trypanosomiasis and FMD-infected cows.

Table 6 Matrix scores of clinical indicators used by herdsmen to recognise common cattle diseases in selected pastoral areas of Nigeria

Clinical signs (*W*)	Diseases										
	BQ	Brucellosis	CBPP	Choke	Colibacillosis	D/R	D/S	Fascioliasis	FMD	Nematodiasis	Trypanosomiasis
Abortion (0.611**)	0 (0–0)	24 (0–30)	0 (0–0)	0 (0–0)	0 (0–0)	0 (0–0)	0 (0–0)	0 (0–0)	0 (0–20)	0 (0–0)	6 (0–30)
Coughing (0.772**)	0 (0–0)	0 (0–0)	19 (10–25)	0 (0–0)	0 (0–0)	0 (0–0)	0 (0–20)	10 (0–20)	0 (0–0)	0 (0–0)	0 (0–3)
Diarrhoea (0.863**)	0 (0–0)	0 (0–0)	0 (0–0)	0 (0–0)	0 (0–15)	0 (0–0)	0 (0–0)	0 (0–0)	0 (0–0)	0 (0–0)	30 (15–30)
Fever (0.688**)	0 (0–0)	0 (0–0)	0 (0–0)	0 (0–0)	0 (0–0)	0 (0–0)	0 (0–0)	5 (5–25)	0 (0–1)	0 (0–3)	25 (3–30)
Lesions around mouth and foot (1.000**)	0 (0–0)	0 (0–0)	0 (0–0)	0 (0–0)	0 (0–0)	0 (0–0)	0 (0–0)	0 (0–0)	30 (30–30)	0 (0–0)	0 (0–0)
Lost appetite (0.832**)	0 (0–0)	0 (0–0)	2 (0–60)	0 (0–0)	0 (0–0)	0 (0–0)	0 (0–3)	15 (10–20)	0 (0–5)	0 (0–0)	10 (9–10)
Lost weight (0.752**)	0 (0–0)	0 (0–0)	1.5 (0–10)	0 (0–0)	0 (0–0)	0 (0–0)	0 (0–0)	2.5 (0–15)	0 (0–0)	0 (0–0)	21 (15–30)
Nasal discharges (0.677**)	0 (0–0)	0 (0–0)	20 (10–30)	0 (0–0)	0 (0–0)	0 (0–0)	0 (0–20)	1.5 (0–12)	0 (0–0)	0 (0–0)	0 (0–10)
Ocular discharges (0.889**)	0 (0–0)	0 (0–0)	0 (0–0)	0 (0–0)	0 (0–0)	0 (0–0)	0 (0–0)	12.5 (0–15)	0 (0–0)	0 (0–0)	17.5 (15–30)
Pelleted faeces (1.000*)	0 (0–0)	0 (0–0)	0 (0–0)	0 (0–0)	0 (0–0)	0 (0–0)	0 (0–0)	30 (30–30)	0 (0–0)	0 (0–0)	0 (0–0)
Scabs on skin (1.000**)	0 (0–0)	0 (0–0)	0 (0–0)	0 (0–0)	0 (0–0)	0 (0–0)	30 (30–30)	0 (0–0)	30 (30–30)	0 (0–0)	0 (0–0)
Sudden death (0.549**)	0 (0–18)	0 (0–0)	1.5 (0–10)	0 (0–1)	0 (0–0)	0 (1–0)	1 (0–3)	6.5 (0–20)	1.5 (0–5)	0 (0–3)	12.5 (0–25)

Number of informant groups=10. Cells showed median scores (range) for clinical sign against a corresponding disease; maximum obtainable score=30

W Kendall's coefficient of concordance, *BQ* black quarter, *CBPP* contagious bovine pleuropneumonia, *FMD* foot and mouth disease, *D*/*R* dystocia/retained placenta, *D*/*S* dermatophilosis/streptothricosis

*$P<0.05$; **$P<0.01$

Pelleted faeces were seen only in cases of fascioliasis, skin scabs observed only in cases of dermatophilosis/streptothricosis, while lesions around mouth and feet were noted only in FMD-infected animals.

Discussion

The research identified conversion of land used as cattle routes into crop fields, rustling and water scarcity as the main husbandry problem impacting on production in pastoral areas. The problem of rustling has not been previously studied in Nigeria, but impacts of limited access routes and water scarcity on pastoral livelihoods on the Jos plateau have been investigated (Majekodunmi et al. 2014). Poor access to these resources was reported as the main reason for seasonal migrations of transhumant pastoralists. Even during wet seasons when water and grasses are widely available, access was restricted by expanding crop fields (Majekodunmi et al. 2014). The current study confirms that this has become a major problem for cattle keepers. To avoid cattle trampling on crops, pastoralists were required by "land-rich" crop farmers to remove cattle from villages until post-harvest. Extension of croplands into cattle routes was one of the main causes of farmer-pastoralist conflicts (Blench 2004, 2010). These conflicts had serious consequences on food and national security in Nigeria. Another study analysed the implications of water scarcity on pastoral livelihoods (Iro 1994). The author-categorised constraints related to water scarcity into limited access, utility and extraction of water. Herdsmen walked kilometres to reach water sites which had many animals taking turns to drink.

Participants noted that rustling had taken on a large-scale dimension. In the past, rustling was limited to occasional theft of few animals. Studies conducted in Uganda and Kenya suggested that livestock theft had cultural underpinnings related to loss of population resilience and as a way of restructuring wealth amongst pastoralist societies (Gray et al. 2003; Bond 2014). However, both studies concluded that cattle raiding could have profound impacts on sustainability of pastoralism. The origins of cattle raiding in the study area need further work as the continuation of such problems will undermine efforts to manage disease and improve productivity.

Disease is another problem impacting on pastoral productivity, with trypanosomiasis, CBPP, fascioliasis and FMD having higher impacts on livelihoods. These diseases have been reported to be endemic for decades across Nigeria (Suleiman et al. 2015; Alawa et al. 2011; Fasina et al. 2013; Majekodunmi et al. 2013). A Kenyan study also showed that trypanosomiasis, FMD and CBPP had greater impacts on livelihoods of Maasai pastoralists (Onono et al. 2013). In this study, pastoralists admitted that they rarely report outbreaks but responded by distress sales of sick animals to minimize losses or self-medication with antimicrobials bought from drug vendors or using medicinal plants. They argued that poor access to veterinary facilities and high costs of veterinarians' visits were responsible for their decisions. Interviews conducted with local livestock officers revealed that annual vaccination campaigns were being undertaken by governments as part of agricultural development programmes. Vaccines were procured by governments and freely distributed to veterinary officers who often charged fees for the logistics of vaccination. But livestock officers noted that mass vaccinations had not been conducted in the last few years, and no explanation was given for the reasons behind the absence.

Although pastoralists reported that brucellosis caused the highest abortion rate, it was ranked sixth based on its impact on livelihood. They noted that it rarely occurred in the study area. Losses from dermatophilosis/streptothricosis were related to weight loss and poor market value of affected animals because of unsightly lesions. In the last two decades, CBPP has been believed to be the most important cattle disease in Sub-Saharan Africa, especially with eradication of rinderpest. Pastoralists in the studied area noted that its occurrence in herds was sporadic. Some authors argued that routine treatment of other cattle diseases with antimicrobial agents which inhibit growth of the CBPP causative agent (Niang et al. 2010) might have been responsible for its relative absence in pastoral herds (Onono et al. 2013).

The study identified conversion of cattle routes into croplands, rustling and water scarcity as the major constraints to pastoral production in Nigeria. These factors deviate from popular opinions related to challenges of pastoral cattle production in African livestock systems. Previously, endemic diseases were seen as the most significant threat to pastoral cattle. CBPP is particularly seen to be the single most important livestock disease in Africa, but pastoralists believed trypanosomiasis caused more losses because of its endemicity which represented a continuous burden on their resources. The study also showed that disproportionate allocation of natural resources contributes to persistence of diseases.

The growing application of participatory methods is being attributed to its low cost and suitability in circumstances where formal survey designs cannot be implemented (Bett et al. 2009). Because of community involvement, participatory approaches allow for development of follow-up plans and intervention strategies with active participation of target communities. Data were collected via different techniques from different individuals or groups. This process of comparative data validation, termed triangulation, is essential for cross-checking information obtained from specific participatory methods. Comparison of data obtained from this study with information provided by field veterinarians showed that pastoralists had a good understanding of clinical manifestations of common diseases.

Like conventional epidemiological tools, participatory methods have disadvantages too. In proportional pilings for instance, sequential division of counters into piles and subpiles to estimate disease incidence and case fatality meant it

was not possible for an animal to experience more than one disease event within a given period. This assumption could lead to imprecise estimates. Nonetheless, the estimates showed pastoralists' perceptions on incidence and mortality patterns for specific diseases. Furthermore, a review of participatory methods identified priority differences between farmers and policy makers as a critical factor affecting the relevance of these methods in designing interventions (Toribio and Rushton 2012). However, such differences can be minimised where participatory methods are successfully combined with conventional tools. Therefore, it is recommended that livestock development and health planning related to pastoral systems in Nigeria and other countries with similar production constraints should focus on the challenges identified in this study.

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Compliance with ethical standards The manuscript does not contain clinical studies or patient data.

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