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Livelihood strategies in endemic livestock production systems in sub-humid zone of West Africa: trends, trade-offs and implications

L. Zaibet · S. Traore · A. Ayantunde · K. Marshall · N. Johnson · M. Siegmund-Schultze

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Abstract Rural livelihoods in West Africa depend largely on livestock. The sub-humid and humid zones of the region, however, are highly affected by the tsetse flies, vector of trypanosomosis, by severely limiting livestock production and livelihood options. Endemic ruminant livestock breeds are trypanotolerant, but perceived as inferior compared to other breeds in terms of productivity. The paper shows trends of relative decline in endemic population as a result of increased crossbreeding, largely with zebu cattle and Sahelian sheep and goats, and considerable decline in habitat quality due to forest conversion, logging activities and bushfires. The trade-offs between livelihoods and income strategies and endemic ruminant and habitat conservation are captured by an understanding of the socio-economic conditions and potential drivers of breed choices and forest use within households and communities. The paper shows that livelihood analysis is an important step in understanding impacts and therefore responses to development projects and to ensure that the poorest categories are not excluded from development interventions.

Keywords Endemic ruminants · Habitat · Livelihoods · Trade-offs · West Africa

1 Introduction

Livestock contributes significantly to livelihoods of rural populations in West Africa and plays a central role as an engine for rural development and sustainable food and nutritional

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L. Zaibet (✉) · A. Ayantunde · K. Marshall · N. Johnson
International Livestock Research Institute, Nairobi, Kenya
e-mail: l.zaibet@cgiar.org

S. Traore · M. Siegmund-Schultze
University of Hohenheim, Stuttgart, Germany

security for rural and peri-urban households (Agyemang 2005).[1] A significant area of the region (humid and sub-humid zones), however, is highly infected by the tsetse flies, a vector of trypanosomosis, which affects both livestock and therewith livelihoods. Besides indirect impacts, in terms of productivity deterioration, the disease engenders effective production forgone in meat and milk that amount to $1.3 billion per year in Africa (Kamuanga 2003). Being one of the major constraints to socio-economic development of infested areas (Kristajanson et al. 1999) trypanosomosis disease is an important factor shaping livelihood strategies in these regions. Efforts to control the vector such as using trypanocides to treat infected animals, spraying of tsetse-infested areas (vector control) or clearing tsetse habitats, although successful for some time, often didn't reach the expected success. In addition to the uncertain efficacy of such practices, they engender high costs both financially and ecologically, the latter because they may contribute to the pollution and degradation of the environment.

The use of endemics ruminant livestock (ERL), such as N'Dama cattle, Djallonké sheep and West African Dwarf goats, is seen as a better solution to overcome the trypanosomosis problem (Agyemang et al. 1991). They are well adapted and productive in tsetse-infested areas, tolerant to heat and resistant/resilient to helminths and tick-borne diseases (Grace 2005). They also have low nutritional and husbandry requirements which, along with the previous features, could be thought of as being preferred pro-poor options. Endemic breeds, despite their multiple adaptive attributes, are often perceived by farmers as inferior in term of productivity and marketing (Agyemang 2005).

Threats to these breeds (Agyemang 2005) include degradation and destruction of their natural habitat, as well as increased prevalence of zebu and sahelian genotypes often perceived to be more productive.[2] A number of research projects have addressed different dimensions of endemic ruminants to investigate their adaptive and productive characteristics. These projects are either increasing the adoption of ERL by improving productivity or promoting non-ERL and improving the capacity of farmer management of trypanosomosis and drug resistance. The International Trypanotolerance Centre (ITC) which operated in the region for many years has made significant contributions to improve the health and productivity of ERL in different tsetse-risk areas (Clifford 1993). Further, a BMZ/GTZ funded project (ILRI 2007) examined the use of trypanocides as a component of integrated control of trypanosomosis to reduce the risk of trypanocide resistance.

Breed choice is based on trade-offs in the choice of traits within particular breeds (Sy et al. 1997; Ouma et al. 2007) or between desirable overall characteristics rather than individual traits (Tano et al. 2003). Studies assessing the relative importance of traits are numerous (e.g. Sy et al. 1997; Tano et al. 2003; Scarpa et al. 2003; Roessler et al. 2008). They also show clear context-depending differences leading to specific choices of traits and finally breeds by farmers living under specific frame conditions. It is, however, recognized that the trade-offs between maintaining breed diversity and single breeds of recognized value needs sufficient information about "the long term" expected benefits (Simianer 2005). "Sustainable management of endemic ruminants" in West Africa requires information about trade-offs between both, desirable breed traits or characteristics and between breeds, the natural agro-ecosystem and the livelihoods of local populations.

[1] Livestock production contributes about 20–25% of the agricultural GDP in West Africa (Agyemang 2005).

[2] According to Thévenor and Belemsaga (2005), the proportion of N'dama has declined from 13.10% in 1985 to only 10.5% in 1998; and that of West African Shorthorn from 5.3 to 4.2%.

Development efforts to maintain the natural resource base, including in our case forests, as well as the ERL populations, would be more effective if these go along with improved income from forest and ERL exploitations. This paper aims to show the trade-offs arising from these objectives using field data from the Gambia. Understanding these trade-offs begins with a careful assessment of the different wealth categories in the community as well as their livelihood strategies. Specific objectives of the paper are

1. To evaluate the contribution of forest income and the status and trends of forest and other natural resources endowments. These facts are meant to show the level of the trade-offs between income generation and forest and natural resources quality.
2. To assess livestock production objectives and breed composition trends and contribution to income and general livelihoods of the diverse wealth categories. This would provide an indication of potential trade-offs between income increase and the use of ERL.

2 Conceptual framework

According to the sustainable livelihoods framework, household livelihood strategies—defined as the activities that households engage into make a living—are a function of the assets to which the household has access, given the broader socio-political and agro-ecological context. Household assets, or capitals, can be divided into five categories: human, social, physical, natural and financial (DfID 2001 in Adato and Meinzen Dick 2007).

Human capital consists of the quantity and quality of labour that a household has available. This can, for example, be increased by education and reduced by ill health. Social capital is defined as the relationships, networks and the trust to which a household has access. Social capital can influence the livelihood strategy by providing information or access to markets or other shared resources, or reducing transaction costs. Physical capital consists of tools and machinery, and financial capital includes both savings as well as access to credit. Natural capital is generally defined to include land and other resources such as forest, water or wildlife. Natural capital can be owned outright or can be accessed through different types of use-right regimes. Livestock do not fit easily into one asset category; they can be considered natural, physical, or financial depending on which aspect is being considered.

Different livelihood strategies require different endowments of the different assets. Household asset endowments, along with their preferences, determine the strategies in which they can engage. According to microeconomic theory, households choose strategies and decide how to allocate their resources across them in order to maximize utility subject to prices, technology, and full income and credit constraints. On the basis of the returns it expects to obtain a particular strategy, a household will decide whether or not, and how much, of its assets to invest in it, subject to the household having the asset endowment necessary to undertake the strategy. Over time, in addition to livelihood strategies, households can also invest in accumulating assets, which can then broaden the set of possible strategies from which they can choose.

Several factors complicate the decision on the use of forests and their products. Households can generate regular returns from sustainable harvesting of non-timber forest products (NTFPs), or they can generate high short-term returns through logging and extraction of other valuable species followed by burning the forest to open new land. The

returns to clearing forest would then consist not only of the benefits from the forest products in the short term but also the benefits that could be obtained from cropping or livestock production in the longer term. It would be difficult for the returns from NTFPs alone to compete with that and in fact the optimal solution is likely to be complete destruction of the forest. This especially when not accounting for the accruing environmental costs. In the absence of clear property rights, or institutions regulating the use of the forest, including the enforcement of rules, people have even more incentives to act quickly to clear it before someone else does it. This is explained by the assumption that insecure tenure causes people to be influenced by what they think their neighbours will do.

Another way that people are influenced by the behaviour of others with regard to the forest is that depending on how much total forest is cleared by all community members combined, the tsetse pressure could be affected which in turn would affect the breed choices available to households. Further, presence of tsetse can affect human reduce labour productivity and reduce welfare directly. Key issues will be relative returns to NTFPs versus clearing, to the household and to other household. This project is attempting to increase household welfare and at the same time maintain forest and ERL populations.

The effectiveness of these interventions will depend on access to resources and assets but also on the impacts of the relative returns to forests and ERL compared to alternative activities and investments. Our aim is to examine (1) whether the trade-off is real, i.e. the sustainable use of forest and ERL use versus increased income from alternative activities, such as clearing of forest to extend crop farming and adoption of "perceived more productive" non-endemics livestock? (2) How big is the trade-off? And (3) how might the costs and benefits of any potential interventions be distributed across different types of households?

The paper uses the results from a baseline study in three sites in the Gambia to investigate the questions above and identify the opportunities and constraints that households face in terms of livelihood strategies and asset allocation and accumulation. It also begins to explore the size and determinants of the returns that households—disaggregated by poverty status—receive from investing their assets in alternative livelihood strategies and what these imply for possible intervention options. An examination of how diverse wealth categories derive their income is the first step to shed some light on the above questions.

3 Data collection: site descriptions and PRA approach

A participatory rural appraisal (PRA) survey was carried out during June 2009 in The Gambia. It covered the districts of Nianija, Niamina East and Kiang West. These sites were selected to reflect different agro-ecological conditions; Kiang West is the Lower River Division, whereas Niamina East and Nianija are in the Central River Division (see Fig. 1).

Three villages were selected in each site. The selection was stratified based on the number of households in the village, since the last population census, done in 2003, shows a very large range in the size of villages within the sites. The project agreed that varying sizes of villages, from very small (<20 independent households) to large (>80 independent households) could be characterized differently, in terms of opportunities for off-farm income, access to market, and natural resources. In each district, one village was randomly selected from each village size category. Thirty to 35 villagers at least 18 years of age and representing livestock owners, herders and non-owners were invited to the PRA workshops. Table 1 presents site characteristics in terms of population, households, rainfall and livestock (cattle, sheep and goat) distribution, from previous census estimates. In particular, Kiang West receives more rainfall than the other two, somehow similar sites.

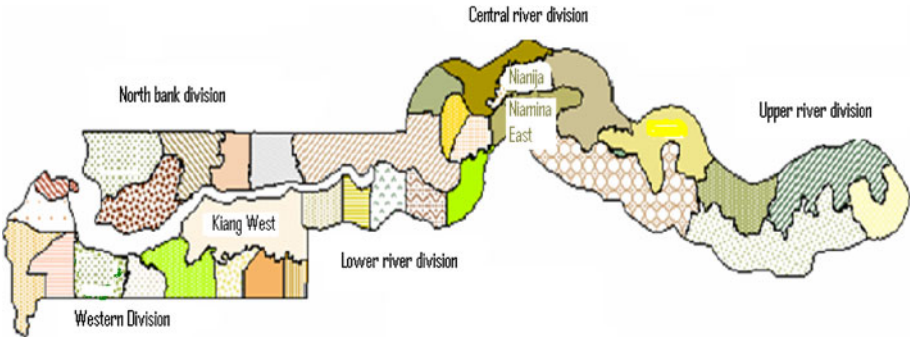

Fig. 1 The Gambia map showing project sites: Kiang West, Niamina East and Nianija

Table 1 Demographic and socio-economic profiles of the study sites

District	Kiang West	Niamina East	Nianija
Population (caput)[a]	14,610	19,320	8,305
Number of households[a]	1,646	1,949	701
Average household size[b]	8.56	10.43	10.43
Ethnic groups[c] (%)	M (72), F (21)	M (31), F (39), W (21)	M (29), F (40) W (34)
Average rainfall (mm)	884	660	669
Cattle number[d]	5,253	6,646	3,226
Sheep number[d]	2,022	6,066	1,000
Goat number[d]	6,955	5,818	1,225

M Madinka, *F* Fula, *W* Wollof; Only ethnic background represented by more than 20% indicated

[a] *Source*: National Population and Housing Census (Gambia Bureau of Statistics 2003)

[b] *Source*: Preliminary Census estimates (CSD 2003)

[c] *Source*: Bourn et al. (2001)

[d] *Source*: Livestock Census (DLS/ITC 1993)

PRAs have been widely used in development studies and recognized as supporting a new development paradigm (Chambers 1994). It is based on timely participatory feedback from the concerned local communities. It is argued that research that disregard farmers' views will risk non-adoption. Therefore, it is recommended that baseline studies include a strong socio-economic focus to ensure the participation of farmers in the design of appropriate research/development interventions. This approach has, however, been facing empirical challenges, mainly related to data integration and aggregation and statistical analysis (Collinson 2000).

During the PRA workshop, participants were asked to identify the main wealth indicators (assets and income) and to attribute them proportionally to the different wealth groups in their community. The main assets and their levels were then identified and four wealth categories (very poor, poor, moderately rich and rich) were recognized in local language.[3] Following the wealth ranking exercise, the PRA attempted to capture livelihood strategies for all social categories combined. An additional objective of the PRA was to

[3] *Miskeno* (very poor); *Fuwaro* (poor); *Temakundako* (moderately rich) and *Fankamaa* (rich).

capture the proportion of different breeds of cattle, sheep and goats currently used in the village areas. This was achieved by asking the PRA participants to divide ten stones into groups representing each breed.

The PRA assessed further the specific objectives of the livestock keepers for rearing cattle, sheep and goats. This was performed by utilization of a preference rating matrix, with species, respectively, animal categories (cows, bulls, sheep, goats) as column headers and production objectives (11 pre-set, as well as 'other') as row headings. Participants, who had been divided into groups based on cattle herd size, were asked to place between 0 and 10 stones in each cell, with the number of stones proportional to the importance of the production objective. This was done here for livestock keepers owning less than ten cattle, which represented the majority (70%) of the total PRA participants. Nine groups (one per village) completed the matrix, with group sizes ranging from 8 to 25 persons. In total, 136 persons were involved, about half (48%) were women.

It is recommended that household systems be combined to provide assessment of aggregated impacts (Collinson 2000). Having three villages per site, we need to present the wealth ranking per site in a simple but meaningful way. To overcome this aggregation problem, this paper uses typical farm-households for each site. For statistical analysis, the nature of PRAs and their small sample size raise problems for conventional statistical analysis and interpretation; however, non-parametric techniques are applied[4] (Abeyasekera 2001; Riley and Fielding 2001).

4 Livelihoods in ERL systems

This section uses the livelihood framework in the conceptual framework section to identify different wealth categories based on asset ownership and access to assets and analyse the livelihoods and related sources of income. It looks at the current situation as well as trends in livelihood strategies observed by villagers.

4.1 Household assets and wealth ranking

Participatory wealth ranking was used to gain farmers' perception of wealth levels and criteria. Table 2 presents typical farm-households for each wealth category in each site. Physical capital assets (e.g. livestock, land, and farm implements) and financial assets (e.g. off-farm income and household remittance) were the main assets considered for wealth ranking by these communities. This assumes that natural assets (agro-ecological potential) and social and human assets are either equally shared or were not considered relevant for wealth ranking. But based on PRA discussions[5], a strong distinction between the poor and very poor reside in the human assets (e.g. the ability to work, the size of the household and education of children).

[4] We applied Non parametric Kruskal–Wallis test to questions "do farmers perceive the contribution of different livestock and general activities to have different impact?" The Kruskal–Wallis tests show insignificant differences between communities/villages.

[5] In local language, *Miskeno* is the one who is unable to gain his basic needs (may afford one meal per day) and rely on community support. A very poor household does not have assets (or minimal assets) but has the ability to make his living (can afford two meals per day). The very poor cannot meet the educational expenditure of their children, who always drop out at the lower level, whereas the poor can educate children up to upper basic.

Table 2 Characteristics of typical farm-households from PRA wealth ranking in each site

	Very poor	Poor	Moderately rich	Rich
Kiang West	30%	43%	17%	10%
Livestock				
Cattle	0	1–2	5–15	>15
Sheep	0	2–4	4–5	10–15
Goats	1	3–5	5–10	10–20
Donkeys	0	1–2	2–3	4–5
Horses	0	0	0	0
Land[a]	0	1	2	3
Farming implements[b]	0	1	2	3
Housing[c]	1	2	3	4
Off-farm income[d]	1,500	4,000	10,000	20,000
Niamina East	12%	63%	17%	8%
Livestock				
Cattle	0	1–2	10–20	+20
Sheep	0	1–5	10–15	15–30
Goats	1	2–5	5–10	15–30
Donkeys	0	1	2–3	+4
Horses	0	0	1–2	+4
Land[a]	1	2	3	4
Farming implements[b]	0	1	2	3
Housing[c]	1	2	3	4
Off-farm income[d]	1,000	5,000	10,000	25,000
Nianija	27%	53%	13%	7%
Livestock				
Cattle	0	1–5	10–20	+50
Sheep	0	1–3	10–20	+30
Goats	1	2–31	5–10	+20
Donkeys	0	1	2	+3
Horses	0	0	1	+2
Land[a]	1	2	3	4
Farming implements[b]	0	1	2	3
Housing[c]	1	2	3	4
Off-farm income[d]	500	2,500	10,000	20,000

The ranges and respective means were derived from the three individual village rankings per site

[a] Limited/restricted access and poorly used = 1; adequate access but poorly used = 2; Adequate access and use = 3; Good access and high production = 4

[b] No implements = 0; limited (1 sine hoe and 1 seeders) = 1; adequate (2 sine hoes, 2 seeders and oxen) = 2; good implements (2–3 seeders, 2–3 sine hoes and pair of oxen)

[c] Bad/inadequate (mud house, leaking-thatched roofs) = 1; fair (mud house, corrugated roof) = 2; good (mud house plastered with cement) = 3; Very good (cement house) = 4

[d] Off-farm income (as financial assets) includes remittances per year in Local currency, i.e. Dalassi

Livestock ownership was found to be distributed in a highly skewed manner across wealth categories in all districts, especially for cattle with rich households owning 10–50 and the poor household categories with less than 2. Despite these differences, ruminants and in particularly small ruminants are an important asset for farmer of poor socio-economic status, since very poor households were said to own at least one goat and poor households owned, in addition, a few goats and sheep and one to two cattle. Draft oxen and horses were owned only by moderately rich and rich households, whereas donkeys were owned by all categories expect the very poor. Only two villages (Manduar and Sankandi) have not mentioned horses as a criterion to differentiate the different wealth categories, since horses were not common in these villages.

Land ownership and/or access alone were not seen as sufficient for ranking crop farming. A clear distinction between the poor and rich with regard to access to land was actually perceived from land productivity. For the poor and very poor categories, land access was restricted or productivity constrained by limited access to farm implements. The very poor did not have any implements. The ownership of draught animals by the moderately rich and the rich allowed them to cultivate larger areas. Another difference reported was the practice of fallow (leaving ploughed land to rest for a season or more), which was generally only done by the richer households.

Livestock and land ownership provide assets for farm income. Other sources of income include off-farm income derived from petty trading and business activities (more important for the rich), services such as carpentry, masonry, blacksmith and sewing (more important for the moderately rich and poor) as well as from household remittances. Remittances were reported in all villages; every family seems to have some family relative in a city within Gambia or abroad sending them money. Off-farm income varied considerably between the different wealth categories.

Wealth ranking results averaged over the three villages per site show that the larger group was the poor with 43–63% of village households, followed by the very poor with 12–30% and the moderately rich with 13–17%. The richer category amounts to 7–10% of the village households. The ranges also show a higher variation in the proportion of very poor and poor across villages and sites. Figure 2 displays wealth ranking in Kiang West which shows an unequal distribution of assets; for example, almost 98% of cattle and 85% of sheep are owned by 32% of the community (the rich and moderately rich people). It also shows that the very poor (30% of the community) have no or very limited access to productive resources (cattle, land and farming tools). Similar results were found in both Niamina East and Nianija. Such distribution of assets within these communities is helpful to understand and explain observed activities and income sources.

4.2 Socio-economic characteristics and wealth-generating resources

During the PRA workshops, participants were invited and selected based on socio-economic characteristics that reflect the diversity of the community. Specifically, selection criteria included gender balance, livestock ownership, including herders and non-owners. Other socio-economic data such as age distribution and education levels of surveyed farmers are captured by a household survey conducted to complement the PRA in the same communities.

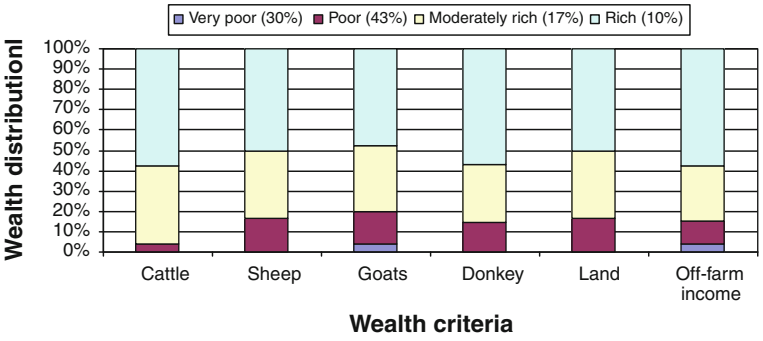

Fig. 2 Wealth distribution among social categories in Kiang West site

Table 3 Level of education of household members by age

	Age class (years)			Total
	≤12	13–19	>19	
Never been in school	14.5	10.0	35.4	24.4
Koranic	36.4	46.3	47.8	44.8
Some primary education	46.4	15.3	4.8	16.9
Completed primary education	1.7	4.5	1.4	2.2
Some secondary	1.0	21.0	4.6	7.8
Completed secondary	0.0	2.7	5.1	3.3
Post secondary	0.0	0.0	0.9	0.5
Total	483	510	1,104	2,097
	100.0%	100.0%	100.0%	100.0%

Table 3 provides cross-tabulated data on education and age class. Looking at the age distribution, about 50% of the surveyed population is below the age of 19. Overall, 86% is falling below primary education level, which shows a high level of illiteracy. Those between the ages of 13 and 19 (assuming at the age 19 pupils have completed primary education and eventually secondary education), only 28% have primary education and above, i.e. about 70% dropped out before completing their primary education. The education of children is indeed a major discriminate factor among the different social categories as identified during the PRA workshops; the poor children drop out at lower grades due to financial and living standards, whereas the rich children go all the way to university, which requires additional expenses affordable by the rich. These features (overall high illiteracy, high level of drop out among the poor categories) "can have profound effects on wealth creation and access to human, social and financial capital, and indeed to all wealth generating resources".[6]

4.3 Livelihoods and income sources

The most important activities were crop farming, livestock holding and forest product harvesting (including cutting and collecting wood) (Fig. 3). These are well related to assets, i.e. land access and farm implements, livestock and labour (human assets). The assets required for crop production are land, labour, tools and, possibly, cash if purchased inputs are used. Livestock is as well an important asset for integrated crop-livestock production. Harvesting forest products requires labour and possibly tools but might also require social capital depending on forest governance. Livestock keeping requires animals and labour, as well as land or capital.[7] Forest may or may not be a direct input into livestock production. The presence or absence of forest is, however, a major determinant of tsetse pressure and therefore may affect the set of breeds from which households will choose. Finally, off farm employment is a function of the quantity and quality of labour available, of physical and/or financial capital in the case of trading or running a small business, and possibly also social capital if it is used to obtain jobs or access to markets.

In all districts, crop farming was the activity contributing the most to livelihoods as affirmed by the majority of people in the villages surveyed. Livestock rearing was reported

[6] This section was added based on one reviewer comment. The last sentence is quoted from the reviewer.

[7] Animals can graze, fodder can be collected, or purchased.

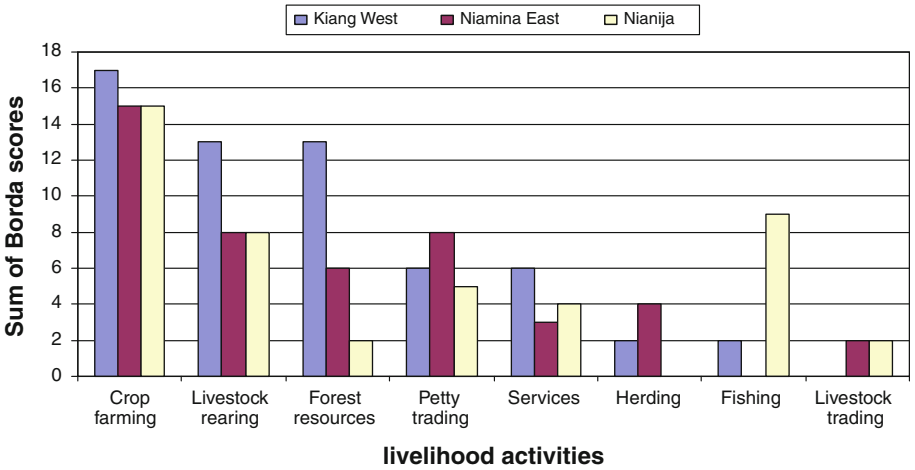

Fig. 3 Farm activities as components of livelihood strategies in the three sites

as the second most important activity in the majority of villages in each district; though its contribution was reported to be less important in one village (Sinchu Demba in Nianija) since only one cattle herd was owned by one family of the village. The gathering of forest products was perceived as the third main source of livelihoods in Kiang West and Niamina East, whereas ranked as the last main source of livelihoods in Nianija. This difference can be explained by the lower forest covers in this district, indeed during resource mapping in the village of Chamen (located within Nianija), no forest was reported.[8] Petty trading and services were ranked as the fourth and fifth most important source of livelihoods, respectively. Fishing had a considerable contribution to livelihoods in the district of Nianija, and to a lesser extent in Kiang West; in these districts, fish was the main source of protein for most of the households.

An important feature of livelihoods was the observed trends in the main activities over the last 10 years. Figure 4 shows that activities related to livestock and forests (mainly logging) are becoming more important. Activities such as petty trading and services are also becoming more important for all the villages. Crop farming, however, is becoming less important in one of the three villages surveyed in Niamina East and Nianija. In addition, in Kiang West, two villages have reported crop farming as becoming less important. One reason given for such a decline in farming in Kiang West is rural migration, especially among youth reducing the availability of labour for fieldwork. In the other districts, the decline of farming was attributed to difficulties with marketing and decreasing prices over the last years, specially for groundnut, which is the main cash crop in the region.

According to our conceptual framework, households are likely to engage in different activities based on their varying resources and socio-economic features. The wealth ranking showed which wealth categories owned which types and quantities of assets. Since in the present study no distinction was made between the different social categories when exploring the most important source of livelihoods, the asset ownership gives us some

[8] During NRM workshop, organized to validate these results, community forest was reported as well as national forest which is not far away from Chameh. This arises questions regarding the access to these resources.

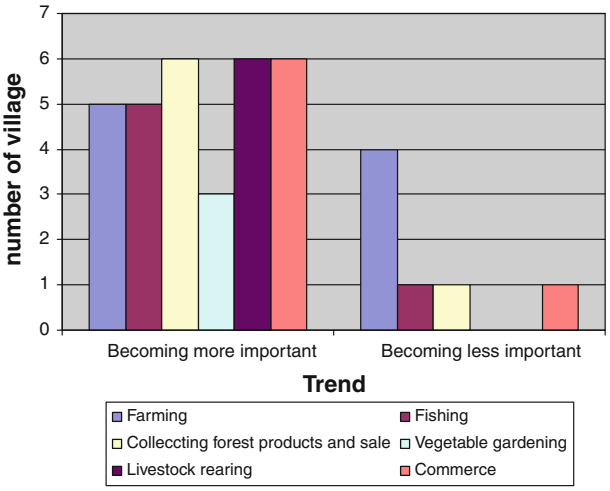

Fig. 4 Trends in livelihood activities

indications. The poor and the very poor, having limited farming tools and financial capital as well as low socio-economic standards (such as education), are more likely to be involved in the gathering of forest products, livestock rearing (especially small ruminants) and work on larger farms as a wage labourer or other service jobs (especially the very poor). It follows that increased non-sustainable forest activities are related to the disproportional access to land and livelihood assets. This also implies that interventions based on specific productive assets to reduce poverty and habitat degradation may not be beneficial to the poorest categories.

5 ERL habitat quality and trends

There is an extensive literature that shows the positive correlation between habitat/natural resources use, conservation and livelihoods (Cleaver and Schreiber 1994; Gjertsen 2005). In Sect. 4, we showed that forest activities, being the third source of income after farming and livestock, are becoming even more important in all sites. In the present section, we try to assess the state of forests and other natural resources as well as the trends as perceived by the communities. Conservation will depend on current status, trends and interventions to internalize the externalities associated with non-sustainable forest activities (logging, bushfires/grazing and cropping).

5.1 Current status of natural resources (habitat)

Habitat quality is assessed based on three features: available land types, vegetation cover and the frequency of bush fires whether controlled or uncontrolled. Within the PRA, the current status of different land types was assessed based on availability, on the scale of 0 (not available at all) to 5 (very abundant). Results, averaged over the three villages surveyed for each site, are shown in Fig. 5.

Results indicate that cropland and rangeland are more abundant in Kiang West compared to the other two sites (Niamina East and Nianija). Kiang West also has a significant

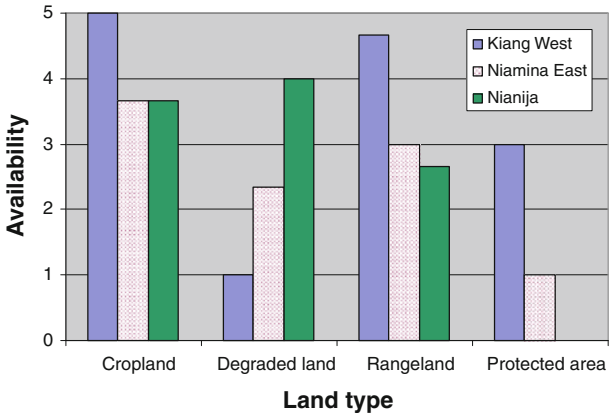

Fig. 5 Current status of land types in the three sites (a scale of 0–5 was applied, with 5 indicating the most available)

area of protected forest, whereas there is none in Nianija. The degraded land reported in Nianija during the PRA is high compared to the other two sites. This portrays two contrasting set of sites—one with abundant natural resources (Kiang West) and the other with depleting resources (Niamina East and Nianija).

Attributes of the vegetation in the three project sites were assessed based on availability, on a 0–5 scale as above. The presence of invasive weeds was reported in all the study sites (Table 4) but seems more common in Niamina East and Nianija. The abundance of annual grasses in the vegetation of all the study sites is a possible explanation for the good pasture quality reported. Given the availability of rangeland and protected forest, and relatively good quality vegetation in Kiang West, it is not surprising that the community reported an increase in population of N'dama breed in these villages (see below). Uncontrolled bush fire is a major problem in all the project sites and this is a major threat to conservation of habitat for the endemic ruminant livestock. The control of bush fire was reported to be practiced in the project sites at a small scale and inadequate to combat the menace of uncontrolled bush fires.

5.2 Trend and magnitude of changes in habitat

During the PRA, it was also explored whether there had been changes in availability of major natural resources in the project sites in the past 30 years and, if so, their trends and magnitudes on the scale of 0 (none at all) to 4 (widespread). The direction of the trend is indicated by a positive or negative sign for increasing and decreasing trend, respectively. The value for each site is an average of the scores reported for three villages where the PRA was conducted in each site.

Results (Table 5) show that the habitat (natural vegetation and agro-ecosystem) for the endemic breeds has declined significantly in Niamina East and Nianija, whereas it increased significantly in Kiang West. The explanation given for the trend in Kiang West was significant emigration from the community to urban areas which led to abandonment of crop fields and conversion of cropland into grazing areas. This is supported by the declining trend of area of land cropped reported during the PRA workshops. The increasing trend in the habitat for endemic breeds in this site might have encouraged the reported increase in the population of N'dama.

Table 4 Attributes of the vegetation in the three project sites in the Gambia

Attribute	Project site		
	Kiang West	*Niamina East*	*Nianija*
Annual/seasonal vegetation production	4.00	3.00	2.67
Quality/palatability	4.00	3.33	3.67
Presence of invasive weeds	2.00	3.00	3.33
Dominance of annual grasses	4.33	3.33	3.67
Dominance of perennial grasses	3.00	2.00	2.00
Dominance of annual legumes	3.33	0.33	0.67
Dominance of perennial legumes	4.33	0.00	1.00
Shrub population	4.33	3.33	2.00
Incidence of controlled bush fire	2.67	1.67	2.33
Incidence of uncontrolled bush fire	4.33	3.67	4.33

A scale of 0–4, with 4 being highest, was applied

Table 5 Trends and magnitude of changes in the past 30 years of natural resources

Natural resource characteristics	Project site		
	Kiang West	*Niamina East*	*Nianija*
Land available for cropping	3.67	1.00	−0.67
Area of land cropped	−1.00	−1.00	2.00
Crop yield	−3.33	−4.00	−3.33
Grazing areas for livestock	3.67	−2.33	−2.33
Expansion of crop field to grazing areas	−3.00	0.67	3.67
Population of livestock in the territory	3.67	−1.67	0.67
Population of N'dama cattle	3.67	−3.67	0.67
Population of Djallonké sheep	−0.67	−1.67	−1.33
Population of West African Dwarf goat	−0.67	−1.67	−1.33
Habitat of endemic breeds	3.67	−3.67	−3.33
Population of tsetse fly in the territory	−1.00	−3.33	−1.33
Clearing of forest for cropping	−4.00	−2.67	0.00
Harvest of forest products	1.67	0.00	2.67

The scores are averages of the single scores reported for the three villages per site

In the case of Niamina East and Nianija, the reported decline in the habitat of endemic breeds could be attributed to the expansion of crop fields (Nianija only) to the detriment of grazing areas and significant decline in the population of tsetse fly in the sites. The population of N'dama cattle was reported to have declined sharply in Niamina East and this could be associated with decline in the habitat and consequently inadequate feed resources. Introduction of Zebu breeds (non-endemic breeds) and animal diseases were also reported as reasons for the decline of the N'dama breed in the site. The general decline in population of tsetse fly reported in all study sites may have created a favourable environment for the introduction of non-trypanotolerant breeds as reported in Niamina East and Nianija.

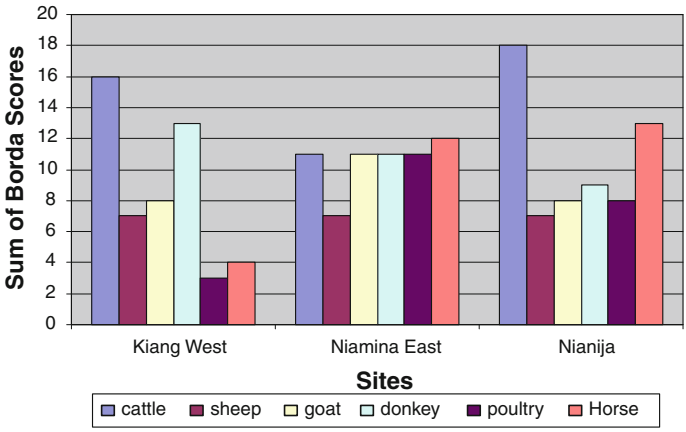

Fig. 6 Ranking of the relative contribution to livelihoods of diverse livestock species per site

6 Production of endemic ruminants: current status and trends

Habitat degradation resulting from changes in the system (livelihood activities and interventions) may be considered[9] a driver of introduction of non-ERL livestock in the study regions.

6.1 Role of livestock and breed composition

The overall contribution of livestock to livelihoods was first assessed to understand the objectives for keeping animals. The contribution to livelihoods was disaggregated into contribution to general livelihoods and contribution to cash income. This distinction will be more apparent when we discuss production objectives in the following section. Ranking was used to capture the relative contribution of the diverse species. Whereas cattle was ranked first, i.e. is the most important to livelihoods in general, followed (in order of importance) by horses, donkeys,[10] goats and sheep (Fig. 6), from PRA discussion, the contribution to cash income shows opposite direction, i.e. goats and sheep were most important, whereas cattle, horses and donkeys were least important.

In relation to the cattle population, Kiang West was reported to comprise close to 100% N'Dama, whereas Niamina East and Nianija comprised 70–80% N'Dama with the remainder Zebu by N'dama crosses or, less predominantly, purebred Zebu. The pattern was similar for sheep, with close to 100% Djallonké indicated for Kiang West, and the other two sites comprising 70–80% Djallonké with the remainder Sahelian by Djallonké crosses or purebred Sahelian. For goats, the proportion of non-ERLs was reported to be lower than that for cattle and sheep. In Kiang West, close to 100% West African Dwarf goats (WAD) were reported, whereas for the other two sites, about 90% were WAD, with the remainder

[9] Results indicate (though not prove) that in two of our Gambia sites change in breeds is due to habitat degradation (less tsetse). We, however, acknowledge that there may be other influencing factors not captured in our study.

[10] Horse and donkey were ranked second and third because they are for many families the only means of transportation to purchase or sell their products on local markets. Horses and donkey are also preferred as draught power for field work because they work faster than cattle.

Sahelian or Sahelian crosses. It should be noted, however, that these figures are based on perceptions of the PRA participants, and were not validated by a proper livestock census, they may deviate from the true situation.

6.2 Specific objectives for keeping cattle, sheep and goats

According to exclusive consideration of herds up to ten cattle, mentioned herd or flock sizes per livestock keeper were 0–9 for cattle, 1–20 for sheep and 1–14 for goats. Ninety to 100% of animals owned by each group were purebred ERL. Table 6 gives the mean and range of ratings for each production objective by species, over all PRAs. The most noticeable result is that the objective of savings and insurance scored the highest for all species. For cattle, the next highest scoring objectives were draught and manure, followed by (for cows) domestic milk consumption and milk sale, and then ceremonial/dowry. The other remaining traits (including income and domestic meat consumption) received relatively low ratings. For sheep and goats, the next highest scoring objectives were income and ceremonial/dowry, followed by manure. Again ratings were relatively low for the other remaining traits (including domestic meat and milk consumption, and milk sale).

It is of interest to note that whilst cattle rated somewhat higher than the small ruminants for savings and insurance (with average ratings of 9.74 and 7.44, respectively) the opposite trend was observed for income where the small ruminants (averaging 6.98) were considerably more important than cattle (averaging 3.13). This indicates the tendency to sell sheep or goats, in preference to cattle, in times of cash needs. Domestic milk consumption rated moderately high for cows (6.07) but low for the small ruminants (averaging 0.75). In addition, only cows' milk was sold. Domestic meat consumption rated low for all species, but was highest for goats (2.73, though with a high across-village variation), followed by sheep (1.79) and then cattle (0.56).

Table 6 Production objectives by livestock category across study sites[a]

Objective	Animal species or categories							
	Cows		Bulls		Sheep		Goats	
	Mean	Range	Mean	Range	Mean	Range	Mean	Range
Savings/insurance	9.61	8–10	9.86	9–10	7.75	6–10	7.79	5–10
Manure	6.67	(4–10)	6.67	(4–10)	4.49	(2–8)	5.27	(2–9)
Draught	6.28	(0–10)	7.13	(2–9)	0.00	(0–0)	0.00	(0–0)
Domestic milk consumption	6.07	(2–9)	0.00	(0–0)	0.56	(0–5)	0.93	(0–5)
Milk sale	5.86	(2–9)	0.00	(0–0)	0.00	(0–0)	0.00	(0–0)
Ceremonial/dowry	5.34	(2–10)	4.77	(3–7)	6.68	(2–10)	7.30	(2–9)
Income	2.93	(1–9)	3.33	(1–9)	6.30	(5–8)	7.65	(6–9)
Transport	2.06	(0–8)	2.84	(0–8)	0.00	(0–0)	0.00	(0–0)
Hides/skin	0.56	(0–4)	0.56	(0–4)	0.99	(0–9)	1.11	(0–10)
Domestic meat consumption	0.56	(0–2)	0.56	(0–2)	1.79	(0–5)	2.73	(0–10)
Sale of breeding animals[b]	0.00	(0–0)	0.00	(0–0)	0.00	(0–0)	0.00	(0–0)

Means of ratings from nine single villages and their ranges (in brackets) are displayed

[a] In the case where a group did not give any rating (over all objectives and species) as 10, all values were first adjusted by multiplication by (10/highest score). Ranges are rounded to the closer integer

[b] The full objective description was "sale of breeding animals or their services"

The importance of cattle for draught (averaging 6.71), and all species for manure (6.67–4.49), is reflective of these livestock owners also engaging in cropping activities. The use of cows (rather than bulls) for draught was strongly location dependent, with the highest observed across-village variation. The relatively low score of cattle for transport (average 2.45) is likely indicative of other species, such as donkeys or horses, fulfilling this role (Bennison et al. 1997).

All species were important for ceremonial/dowry purposes, with goats rating the highest (7.30), closely followed by sheep (6.68) and then cattle (5.00). One group indicated that goats were favoured for this purpose due to their high multiplication rate. Hides/skin received ratings of zero in all villages except one, indicating that this product is not commonly utilized. Ratings of zero were always given for sale of breeding animals or their services, indicating that these small-holders do not supply this service.

Results of this study agreed well with a previous study of Bennison et al. (1997) on the production objectives of livestock keepers in the Gambia (with the only noteworthy discrepancy, a higher average rating of cows for draught in this study compared to the previous). This indicates that the objectives for keeping cattle, sheep and goats have generally remained consistent over the last 10 or more years.

7 Trade-offs and implications

The overall picture shows that crop farming is currently the most important livelihood activity, but becoming less important for communities in four villages of the study region. On the other hand, income from forest logging, clearing and grazing is becoming more important in all villages. These trends are associated with observed trends of considerable forest and natural resource reduction or degradation and a relative decline in ERL. The results point to the main trade-offs in the choice of livelihood activities. The features of the poor categories have profound implications on current and future wealth creation; an increase in income imply, at least for these poor categories, forests and other natural resources being more depleted (logging, clearing and grazing). Also: more income while well-adapted ERL are being replaced with breeds being "perceived" as more productive.

On the livestock side, whereas the current situation show prevalence of ERL in all sites, the results also show a move away (although still limited) from these breeds in Niamina East and Nianija, where cattle herds are composed of crosses of Zebu by N'Dama or, less predominantly, purebred Zebu. Similar trends were observed for sheep and goats. These trends are validated by group discussion in Mamut Fana (Niamina East), where crossbreds and Zebu were estimated at 30%, whereas the proportions of non-endemic breeds of goats were lower compared to cattle or sheep. The main reason indicated by farmers for keeping Zebu was to fatten young animals, since the fattening of Zebu is more beneficial than fattening N'Dama. Given the decline of tsetse fly pressure, this can be considered a site-specific rationale decision by farmers.

The trade-offs in the preference for breeds maybe constrained or enhanced by the agro-ecological conditions. To understand the above trends, further insights about forest and natural resources status and trends are required. The results point to significant depletion of resources and decline in quality in two of the three sites, namely Niamina East and Nianija. The prevalence of uncontrolled bush fire is also a major problem and represents a major threat to conservation of habitat for the endemic ruminant livestock. Interestingly, the highest proportion of crossbreds and non-endemic breeds is found in these two sites, i.e. in Niamina East and Nianija. On the contrary, where the agro-ecological conditions are

suitable and therefore ERL are more productive, results show that ERL have been increasing. The availability of rangeland and protected forest, and relatively good quality vegetation in Kiang West, was related to an increase in the population of N'dama cattle. These trends could suggest a trade-off between income (from livestock) and conservation of ERL and their natural habitat. However, it is not clear whether income from ERL is really lower than income from non-ERL breeds under current conditions.

Trends in habitat quality likely represent one driver of change in breed composition at the site levels, and also a driver of change in livelihood activities. On the other side, controlled and uncontrolled bush fires to fight tsetse, or resulting from conflicts in interests between the livestock owners and non-owners, is a threat to the ERL. There was a general decline in population of tsetse fly in all the study sites, which may have created a favourable environment for the introduction of non-trypanotolerant breeds in Niamina East and Nianija. Here, the introduction of Zebu breeds (non-endemic breeds) was reported as driving the relative decline in N'dama. Fighting tsetse by the use of chemicals and bush fires could imply not only breed changes but also more forest degradation and therefore changes in livelihoods.

This last point arises as a trade-off between (a) conserving forests and thus tsetse—meaning the less-productive ERL breeds are required due to their adaptive attributes versus (b) removing forests and thus decreasing tsetse. The latter would immediately affect forest-related livelihood activities, but would increase the potential for cropping as well as utilization of the non-endemic breeds.

The implications of the above trade-offs are, however, meaningful for livelihoods and livelihood decisions (breed choice, forest use and cash crop cultivation versus the conservation of endemic ruminant genetic resources and their habitat). These trade-offs coupled with wealth analysis are important to inform the design of the project interventions in the region. The above trade-offs are correlated to wealth distribution in the communities. In particular, there is a risk that only households in possession of resources and assets (the rich and moderate) are likely to take part of and benefit from development interventions. The trend of increased contribution of forests (non-sustainable activities) could be attributed to the finding of disproportional access to assets. The wealth ranking points to the social categories most likely to be affected by changes in the system. It is found that cattle are primarily kept by the richer categories for savings and insurance, whereas the poor and very poor categories focus more on keeping small ruminants.[11] Also, the poor, being deprived of farming tools rely more on forest logging and related activities and to a lesser extent livestock rearing. The fact that crop farming is increasing in Niamina East and Nianija, but becoming less important in Kiang West when compared to ERL livestock rearing may be in both situations more beneficial to the richer categories.

This project is attempting to increase household welfare and at the same time maintaining the natural resource base for sustainable management of ERL. These trade-offs require interventions designed to simultaneously:

1. increase the returns to households from maintaining the forest by improving markets for NTFPs, or through some type of payment for environmental services schemes, that would internalize the externalities associated with deforestation;
2. increase the returns to households of maintaining ERL through increased productivity and markets for ERL and their products and services and, as above, through an

[11] The ethnic bias in keeping cattle is also important but not captured during the PRA; ethnic groups with pastoral tradition (Pula) tend to have more cattle than the other ethnic groups.

incentive scheme based on payment of environmental services (PES) for conservation of ERL genetic resources; and
3. increase costs to households of clearing forests through strengthening of institutions dealing with natural resource management.

The trade-offs and related interventions are areas where more research is needed. The focus should be on long-term effects resulting from a decline in ERL or forest degradation or clearing to ascertain that the benefit of maintaining forests outweighs the benefits of clearing them. So, more data are required before final recommendations can be made. Additional surveys should be done to provide accurate data on the Gambian breed composition in order to clarify the trends of breed use. The result of the survey can serve as reference data for the assessment of the future impacts of the project. There is also a need for more research to validate the "perception" of superiority of Zebu or crosses in terms of marketing merits. In addition, current and probable future market opportunities of endemic versus non-endemic breeds should be explored. This would serve as a basis for breed decision for farmers and the potential need of governmental engagement in breed conservation policies.

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