Sustainable management of endemic ruminant livestock of West Africa and their environment

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A. Fall, M. Fadiga, A. Ayantunde, K. Marshall and M. Said

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Patron: Professor Peter C Doherty AC, FAA, FRS
Animal scientist, Nobel Prize Laureate for Physiology or Medicine–1996

Box 30709, Nairobi 00100 Kenya
Phone +254 20 422 3000
Fax +254 20 422 3001
Email ilri-kenya@cgiar.org

ilri.org
better lives through livestock

ILRI is a CGIAR research centre

Box 5689, Addis Ababa, Ethiopia
Phone +251 11 617 2000
Fax +251 11 667 6923
Email ilri-ethiopia@cgiar.org

ILRI has offices in East Africa • South Asia • Southeast and East Asia • Southern Africa • West Africa

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Acronyms

AnGR	Animal genetic resources
CBD	Convention of Biological diversity
GDP	Gross Domestic Product
ILRI	International Livestock Research Institute
ITC	International Trypanotolerance Centre
FAO	Food and Agricultural Organization of the United Nations
ERL	Endemic ruminant livestock
POAS	Plan d'cccupation et d'affectation des sols/ land occupation and use mapping
PROGEBE	Projet de gestion durable du betail ruminant endemique de l'Afrique de l'Ouest
LUAP	Land use and allocation plan
NRM	Natural resources management

Executive summary

A significant portion of the land area in West African humid and subhumid region that supports the livelihoods of millions of people is affected by vector-borne diseases, such as trypanosomiasis, a disease which affects both livestock and humans and hence livelihoods. Endemic ruminant livestock (ERL) breeds of West Africa, such as N'Dama cattle, Djallonké sheep and West African Dwarf goats, are endowed with adaptive traits that enable animal agriculture in these areas. They remain productive in tsetse infested areas because of their resistance to trypanosomiasis and other infectious diseases. Despite their multiple adaptive attributes, ERL breeds are often perceived as inferior relative to other exotic breeds in term of productivity and marketing. The threat of declining populations of ERL in West Africa and the potential dilution of their unique genetic traits have become a cause of great concern. Major threats to the viability of ERL populations include: 1) Destruction and degradation of habitat critical for ERL; 2) Crossbreeding between ERL and exotic livestock breeds; and finally, and 3) Abandonment of ERL rearing due to production and market constraints.

The project on sustainable management of endemic ruminant livestock of West Africa (PROGEBE) was designed to experiment models that demonstrate the economic viability and competitiveness of West African animal genetic resources with the conservation of their habitat. The project design was experimental, developing and testing an integrated approach to livestock conservation and management that simultaneously addresses livestock breeding and productivity, market development and economic policies, incentives and distortions, traditional and evolving patterns of resource use and land tenure, policies and legal frameworks, and information sharing and communication at the national and international levels.

This present report highlights PROGEBE rationale, objectives, achievements and draws lessons learned for the long term sustainable management of endemic ruminant livestock of West Africa.

Choice of breeds in subhumid zones of West Africa where trypanosomiasis is endemic. When farmers in subhumid zones of West Africa decide to change the composition and their herds and flocks towards non-ERL breeds, they are influenced by a wide range of factors as follows.

- *Easy access to non-ERL through transhumance and trade* is the driving factor behind farmers' decision to change their herds or flock composition flock. Transhumant herds are the most important source of non-ERL for farmers keeping ERL in West African Subhumid zones. Both transhumant livestock keepers migrating seasonally back and forth from the Sahel to subhumid zones and settled pastoralists keeping Sahelian breeds make easily available various zebu breeds directly or through livestock markets. The local farmers who come in contact with these breeds are attracted by their large format and higher milk yield compared to local ERL breeds.
- *Cattle market prices and other attributes including draught animal power.* N'Dama cattle fetch lower prices where they have to compete in the market place with zebu cattle and crossbreeds. Farmers respond to market signals by attempting to shift from ERL toward zebu and crossbred cattle. In mixed crop-livestock systems, draught animal power is a key input to cropping that greatly influences farmers' incomes and livelihoods. Therefore, higher draught power exhibited by non-ERL cattle makes them appealing to crop-livestock farmers.

- *Access to trypanocidal drugs and other veterinary inputs and services.* The availability and affordability of trypanocidal drugs is a key determinant of farmer's decision to keep non-ERL and this in turn influenced by national animal health policies and remoteness. Where livestock keepers have easy access to trypanocidal drugs in subhumid zones, there is a tendency of massive use and even abuse of these drugs for preventive and curative measures. With available and cheap trypanocidal drugs, farmers may view it as profitable to invest in the purchase of drugs that enable them to keep non-ERL, although any short term private gain will be offset by the long-term social costs of trypanocidal drug resistance.
- *Effective land use plans (LUAP) with technological and institutional interventions* including bush fire control, zoning and rangeland management with strong local institutions. Preliminary assessments show that PROGEBE natural resources interventions have proved to bear the expected fruits.
- *N'Dama cattle have to compete in the marketplace* with larger frame breeds and their small size generally compromises their attractiveness. However, N'Dama cattle with good body conditions could compete with other breeds. Unfortunately, cattle fattening is not a common practice in the humid and subhumid zone of West Africa where N'Dama cattle are kept. Hence, a better prospect for the sustainable use of N'Dama cattle will hinge on the development of the capacities of farmers to invest in fattening schemes with the creation of conditions for better access to inputs, financial, knowledge and information services, and markets.
- *Other potential incentives that PROGEBE has endeavoured to develop* through project interventions include improved farmers' technical, institutional and organizational capacities through training, and improved access to markets through infrastructure development. It was hypothesized that farmers would be more inclined to use ERL when they realise productivity gains and improved income brought about by PROGEBE interventions.

Model for sustainable management of endemic ruminant livestock of West Africa

The effective PROGEBE model of sustainable management of ERL of West Africa is defined as an integrated cluster of technical, institutional and organizational interventions with their processes carried out by various actors at herd, household, community and national levels. These processes have proved successful in improving the production, productivity, marketing and conservation of ERL habitat, and hence making ERL more economically attractive in the long term, while remaining environmentally and socially sustainable.

PROGEBE made significant efforts to address key constraints that plagued existing breeding programs in the four countries. Target investments included the rehabilitation and restocking of breeding stations, and the strengthening of the capacity of farmers, scientists and managers on breeding and genetics.

PROGEBE was able to improve communities' access to input and veterinary services as a result of a combination of key interventions, including the training of farmers and extension agents on animal health and how to get organized to get easier access to veterinary services. The training of community animal health workers, the support to private veterinarians and the establishment of innovative vaccination committees were instrumental in the increased vaccination coverage and subsequent reduction of mortality rates in sheep and goats seen in some countries.

PROGEBE successfully addressed ERL feeding constraints as it yielded key project outputs in the form of increased farmers knowledge, skills and capacities in feeds, feeding technologies, and husbandry practices.

One of the most significant PROGEBE achievements is certainly the model of community natural resource management. With the technical guidance and facilitation of PROGEBE and national technical partners, communities were able to design and implement a community land planning tool, land use and allocation plans (LUAP), using participatory and inclusive processes. Keys steps in its development include the formal and participatory mapping of community land resources with the diagnosis of land management constraints and opportunities, the design of norm and regulations for land use with the zoning of community lands and finally the validation of the plan by local and administrative authorities. Key technical components of the LUAP include mechanisms and tools for bushfires control, management of

transhumance, the creation of stock routes and watering facilities, and training of communities on NRM best management practices. The application of LUAP was successful in significantly reducing conflicts among various land resource users and the reduction of bushfires, and better use of forest products. It is expected that in the long run these PROGEBE outputs will entail the stop or reversal of land degradation processes to some extent given other resource degradation drivers, such as climate change and population pressures, will not supersede the effects of PROGEBE interventions.

PROGEBE invested in ERL market development through the establishment of key target infrastructures at the site level or in the region, including national and regional markets, slaughter slabs, feeder roads, and milk processing units. Preliminary stakeholder's perceptions point to the beneficial impact of these investments in terms of easy access to market by ERL keepers for ERL livestock and their products.

Findings from PROGEBE studies confirmed that ERL are still appealing to the vast majority of farmers. This attitude among ERL keepers and other decision makers is highly likely to be further strengthened due to the better understanding of opportunities and advantages of ERL, their realization of improved income and livelihoods as a result of the improved ERL productivity, reduced habitat degradation and more income benefits from sales of ERL and their products. These all serve as key incentives ensuring the long-term survivial of viable populations of ERL in West African subhumid zones.

Although PROGEBE used the conservation of ERL and their habitat as an entry point, the resulting PROGEBE model turned out to feature as an effective model of rural development suitable for West African Subhumid zones. PROGEBE sites present a diversity of situations due to their remoteness, difficult access to markets, low input extensive production systems that rely on adapted genetic resources, vulnerable natural resources base, limited infrastructural development, and overall neglect from policy makers. That is the reason why technical components of PROGEBE model notably the development of infrastructures, natural resource management and interventions to improve livestock production have met with great success and could be adapted throughout the subhumid zones where conditions are similar.

The subcomponent with the most variable options was the choice of breeds to focus on to improve livestock productivity in subhumid zones. The process of autonomous anthropogenic control of trypanosomiasis has entailed in many places the decline and retreat of tsetse population with the resulting decline of disease risk. However, the disease risk still persists in a number of habitats (along rivers), protected areas and remote regions. Large subhumid zones of West Africa still fall in the category of very remote areas with medium to high disease risk, although land conversion to cropping is progressing. The interplay of factors, such as extent of land conversion to cropping, production systems' dynamics, overall economic development, and remoteness and policy environment, entail a range of disease risk situations and options for control strategies, including the sustainable use of ERL.

The introduction of exotic zebu breeds to be used as pure breeds or for crossbreeding with ERL is justified to intensify livestock production systems under the following scenario: disease risk is *zero or low disease* (PROGEBE site type 4, Table 3) as a result of being located at the northern fringe of tsetse population distribution, and where there is autonomous anthropogenic control of trypanosomiasis due to population pressure, or reduced rainfall and retreat of subhumid zones due to climate change (Type 4 sites). In fact, this is what actually has happened in the buffer zones at the northern fringe subhumid zones where ERL and non-ERL co-existed.

Most PROGEBE sites are located in areas with medium to high trypanosomiasis risk (site type 2 and 3 in Table 3) which elucidates why the vast majority of breeds in West Africa humid and subhumid zones are ERL types. Future stable habitat and remoteness will likely create conditions for prevalence of trypanosomiasis and other vector-borne diseases that will make ERL competitive for smallholder farmers making limited use of external inputs. This situation of '*default in situ conservation'* will prevail in most of West African subhumid zones. These areas may expand where climate change contribute to the conversation of humid to subhumid zones. However, as seen in some sites, production systems may intensify in these areas as a result of demographic or overall economic growth with the resulting shift to the low disease risk scenario above (Type 4 sites). The extent and pace of some changes are unpredictable. It is, therefore, most likely that both pure ERL and their crosses with Sahelian breeds will co-exist in the same countries.

Given the numerical strength of ERL, farmers will make smart choices on breed or combination of breeds that better fit their biophysical and socio-economic conditions with the possibility of their co-evolution towards future matching environments and ecotypes. Livestock development policies in subhumid zones should not, therefore, deter farmers from changing the composition of their herds if that meets their livelihood objectives as the fate of ERL are unlikely to be at risk in the near future. Where pure breed, exotic, or their crosses with ERL can survive because of not distorted disease control and prevention policies, farmers should take advantage of non-ERL genetic resources to meet their increasing income and livelihoods needs. Public policies will at the same time encourage the cryopreservation of ERL for future use. With current advances in conservation science and technology, the focus is now on conserving the underpinning gene networks for disease resistance.

Introduction

Agriculture, with the livestock sector as a major component, is the main source of livelihoods for the vast majority of people and remains the main contributor to gross domestic product (GDP) in many West African countries. A significant portion of the land area in the West African humid and subhumid region that supports the livelihoods of millions of people is affected by vector-borne diseases, such as trypanosomiasis, a disease which affects both livestock and humans and hence livelihoods. Endemic ruminant livestock (ERL) breeds of West Africa, such as N'Dama cattle, Djallonké sheep and West African Dwarf goats, are endowed with adaptive traits that enable animal agriculture in these areas. They remain productive in tsetse infested areas because of their resistance to trypanosomiasis and other infectious diseases such as helminth, dermatophilosis, heartwater, anaplasmosis and babesiosis (d'leteren and Kimani 2001; Grace 2015). The significance of ERL in West Africa does not rest solely on their resistance to diseases as they have evolved in diverse tropical environments and represent unique combinations of genes that define productive qualities and adaptive capabilities. Tolerance to high temperatures and humidity and ability to utilize low-quality (high fibre) diets allow ERL to prosper under varied and often severe conditions found in many low-income countries where rural populations rely heavily on domestic animal resources in environments with high diseases risks. These traits are often the only means for achieving sustainable agriculture in low-input production systems. ERL breeds remain critical contributors to maintaining household incomes and food security throughout large areas of sub-Saharan Africa. The unique genetic information that controls their productive and adaptive traits are global public goods that could benefit low-income farmers and herders now and in the future throughout the world if it is managed and used in a sustainable manner. Climate change scenarios for West Africa point to increased climatic variability with likely changes of vector bore diseases distributions. It is, therefore, apparent that ERL offer not just a combined nature solution to the complex current problems of food security, habitat conservation and disease control, but also an opportunity for future climate change adaptation option.

Despite their multiple adaptive attributes, ERL breeds are often perceived as inferior relative to their counterparts, including those from the Sahel region in term of productivity and marketing (Agyemang 2005). The threat of declining populations of ERL in West Africa and the potential dilution of their unique genetic traits have become a cause of great concern. In fact, biodiversity losses have become a serious concern in West Africa against a backdrop of food insecurity and poverty. It is estimated that 22 (13%) of the cattle breeds which existed at the beginning of the 20th century have become extinct, while biodiversity in the landscapes is threatened by fragmentation and habitat loss (PRODOC 2014). Although the population of ERL, such as N'Dama cattle, Djallonke sheep and West African dwarf goats, is still high, as is their geographic dispersion across many countries, their future should be protected from varied and complex sources of threats in order to maintain their key roles as the main source of sustenance for farmers in West African subhumid zones.

Major threats to the viability of ERL include: 1) Destruction and degradation of habitat critical for ERL; due to climate change and increases in the human population, habitat for endemic livestock is being increasingly converted to cropland, and deforestation is rampant due to high demand for firewood. These pressures are transforming the indigenous woodlands into croplands, open savannah and fallows; 2) Crossbreeding between ERL and exotic livestock breeds; and finally, 3) Abandonment of ERL raising due to production and market constraints (PRODOC 2004). The sustainable management of the ERL breeds (N'Dama cattle, Djallonke sheep and West African dwarf goat) is inseparable from sustainable management of the natural resources (land, vegetation, water and forestry). Natural

resource management includes not only sustainable models for rangeland conservation, feed and water resources management, but also broader habitat protection given that the main advantage of keeping the endemic livestock breeds in subhumid zones of West Africa is their ability to thrive well in tsetse infested habitat.

The multifaceted challenges that face farmers, communities and planners responsible for the sustainable management of livestock resources and the resources base in West African subhumid zones call for broad-based integrated approaches that address simultaneously socio-economic and biophysical constraints and exploit existing opportunities to ensure sustainable livelihoods. The project 'Sustainable management of globally significant ERL of West Africa', PROGEBE, was designed to conserve these breeds of global significance namely—the N'Dama cattle, the Djallonke sheep, and the West African dwarf goat, and their habitat. The project fits within the context of GEF goals, operational strategies, program priorities, Council guidance and relevant conventions, particularly the CBD, OP#13 (agricultural biodiversity) and OP#15 (sustainable land management). It also fits with the GEF's strategic priority to mainstream biodiversity in production sectors and landscapes.

PROGEBE was designed to experiment models at pilot sites that demonstrate the economic viability and competitiveness of ERL with the conservation of their habitat for replication by other communities in four countries in West Africa, namely the Gambia, Guinea, Senegal and Mali, and potentially in other areas throughout Africa with similar ecological and socio-economic conditions. Central to PROGEBE strategies to achieve this objective was the development and demonstration of incentives systems based on enhanced ERL production and productivity, ERL market development, and better natural resources management for habitat conservation. The project design was experimental, developing and testing an integrated approach to livestock conservation and management that simultaneously addresses livestock breeding and productivity, market development and economic policies, incentives and distortions, traditional and evolving patterns of resource use and land tenure, policies and legal frameworks, and information sharing and communication at the national and international levels (PRODOC 2004). The project used a comprehensive approach that combined all of these elements, and attempted to address the viability of ERL rearing at the community level (project pilot sites), as well as at the national and sub-regional levels.

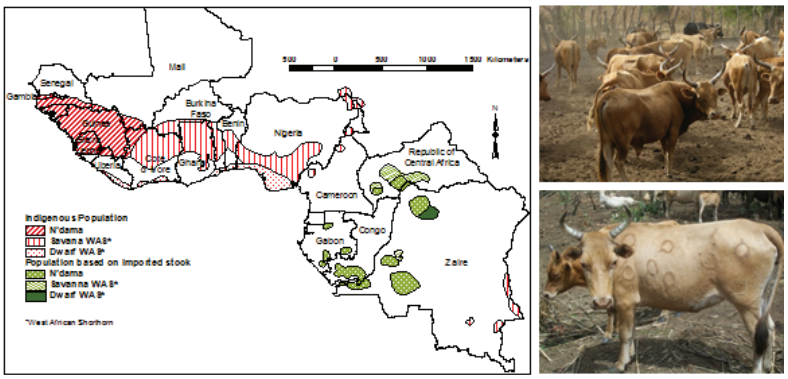
This present report highlights PROGEBE rationale, objectives and achievements, and draws lessons learned for the long-term sustainable management of ERL of West Africa. First, drawing from project appraisal documents (PRODOC 2004), this report reviews the original PROGEBE conceptual model of threats and root causes of biodiversity losses in West Africa that informed PROGEBE target interventions. The experimentation of the PROGEBE conceptual model is detailed in the second part of the document with the identification of project sites, and the indication of the clusters of interventions that have been designed and implemented to yield various project outputs within each of the five PROGEBE outcomes notably (1) Improvement in ERL production and productivity, (2) ERL market development, (3) Management of natural resources, (4) Policies and institutions and (5) Information exchange and knowledge management. The third part of the document deals with the assessment of PROGEBE interventions and draws lessons learned that will inform ways to bring to scale the PROGEBE model of sustainable management of ERL. The fourth part of the report describes the resulting validated PROGEBE model.

PROGEBE conceptual model of sustainable management of ERL and their habitat

Threats to endemic ruminants and their causes

The distribution of endemic ruminant cattle breeds across West and Central Africa is indicated in Figure 1. N'Dama is the most representative "*Bos taurus*" breed in West Africa. It originates from Fouta-Djallon highlands in Guinea (Conakry) and has spread in the Sudanian and Guinean regions (Shaw *et al.* 1987), including Guinea, the Gambia, Guinea Bissau, southwestern Mali, southern and eastern Senegal, Sierra Leone, Liberia, and in the northwest part of Côte d'Ivoire. As a trypanotolerant breed, N'Dama cattle were introduced in areas heavily infested by tsetse fly (Shaw *et al.* 1987) in Congo, Central African Republic, Gabon, Nigeria and Democratic Republic of Congo. The independent emergence of indigenous African cattle breeds in Neolithic times, of which the N'Dama is the only confirmed breed remaining, means that the genetic make-up of these breeds is not only unique, but also represents a heritage of thousands of years of adaptation.

Figure 1. Location of trypanotolerant cattle populations (Source: Shaw et al. 1987).



The PROGEBE's conceptual model (Figure 2) represents the primary immediate threats to ERL in the sub-region, their roots causes and the PROGEBE's proposed interventions during the project preparation phase. Primary threats were thought to include habitat destruction and degradation, crossbreeding with exotic livestock, and declining interest among local populations in raising endemic breeds (PRODOC 2004). The underlying causes for these threats were classified into four broad categories: socio-economic trends; unregulated and inefficient resource management; decision-making based on inadequate information; and policy incentives/disincentives and market distortions (PRODOC 2004).

Habitat destruction and degradation. Primary threats to ERL habitat destruction include extension of agricultural lands due to crop-biased policies and rapid population growth, unsustainable agricultural practices, demand for firewood and charcoal, and uncontrolled and increasingly severe bushfires due to hunting, apiculture and mining activities as livelihoods options. Increased demand for land as a result of population growth has entailed increased clearance of forest areas and the adoption of unsustainable land management practices, such as the reduction in fallow periods.

As a result, access to grazing lands has become more difficult for transhumant herders from the north. The resultant conflicts between farmers and herders have become increasingly common. While habitat conversion results in a local retreat of various diseases, in particular trypanosomiasis, the full eradication of vector-borne diseases is highly unlikely. Hence, there is still a need to maintain viable *in-situ* populations of genetically diverse endemic breeds in order to preserve the genetic traits necessary for disease resistance.

Crossbreeding and abandonment of ERL rearing. Crossbreeding between the three primary target breeds for PROGEBE (N'Dama cattle; Djallonke sheep, and the West African dwarf goat) and Sahelian breeds and the abandonment of ERL rearing were seen as the main causes of declining populations of these breeds. Because of their relative lower productivity, livestock herders and farmers choose to crossbreed them with their relatively more productive Sahalian counterparts in a response to increased demand for draught animal power for cash-crop production. In addition, market demand for meat and milk products has steadily increased in the sub-region. Crossbreeding is also encouraged by the increased proximity of endemic and exotic breeds through trade and transhumance. The third important threat to the long-term survival of ERL breeds in West Africa is the result of their perceived inferiority to Sahelian breeds in terms of productivity and marketing. Productivity in terms of animal products (milk, meat) and animal functions (draught power) in particular is cited by many livestock herders as a key reason for switching to exotic breeds and/or crossbreeds.

The trend of increased influx of significant numbers of people and livestock into the subhumid zones, and the changing patterns of resources use and demand, have led to a decline of traditional rules and practices for resource use and management. State-sponsored resource management systems were not successful to fill the need for coordinated control and use of resources, with existing laws, regulations and enforcement mechanisms for pastoral management, land tenure, and conflict resolution remaining piecemeal and inadequate. In particular, unclear land tenure, combined with increasing competition between agriculturalists and livestock herders for land and water resources, has led to increased conflict between farmers and herders. Inadequate management of resources is also exemplified by poor coordination between governments and local communities in forest management and protection.

There has been limited government support for resources management for habitats important to ERL breeds because of very low awareness among policy makers of their long-term value, including their important genetic traits (hardiness, disease resistance) and low-input needs (critical in marginal areas and for poor herders). Misunderstandings about the value of ERL also translates into a range of distorted policy and market incentives (disincentives) that further reduce the value of these breeds, and thus the desire among farmers/herders to conserve the animal genetic resources that the animals represent. The limited advocacy and organizational capacity among endemic livestock producers within the sub-region is also problematic. Owners of ERL maintain very few organizations at local, national, or sub-regional level to promote or educate themselves or others about these breeds. As a result, the majority of herders are unaware of the scope of the threats to these breeds, or of opportunities to improve management and production conditions.

Policy incentive (disincentives) and market distortions. Policies that promote and subsidize exotic livestock breeds over endemic breeds are widespread and have a distorting effect on the real cost of production and maintenance of exotic breeds or crossbreds in the subhumid zones. Meanwhile policy and economic incentives to support production and marketing of ERL breeds are largely non-existent. For instance, financing and marketing schemes that target livestock herders, especially those rearing endemic breeds for access to better input, husbandry techniques and marketing outlets are very limited. Such inappropriate policies and marketing constraints are leading more adoption of exotic breeds instead of helping the development of ERL.

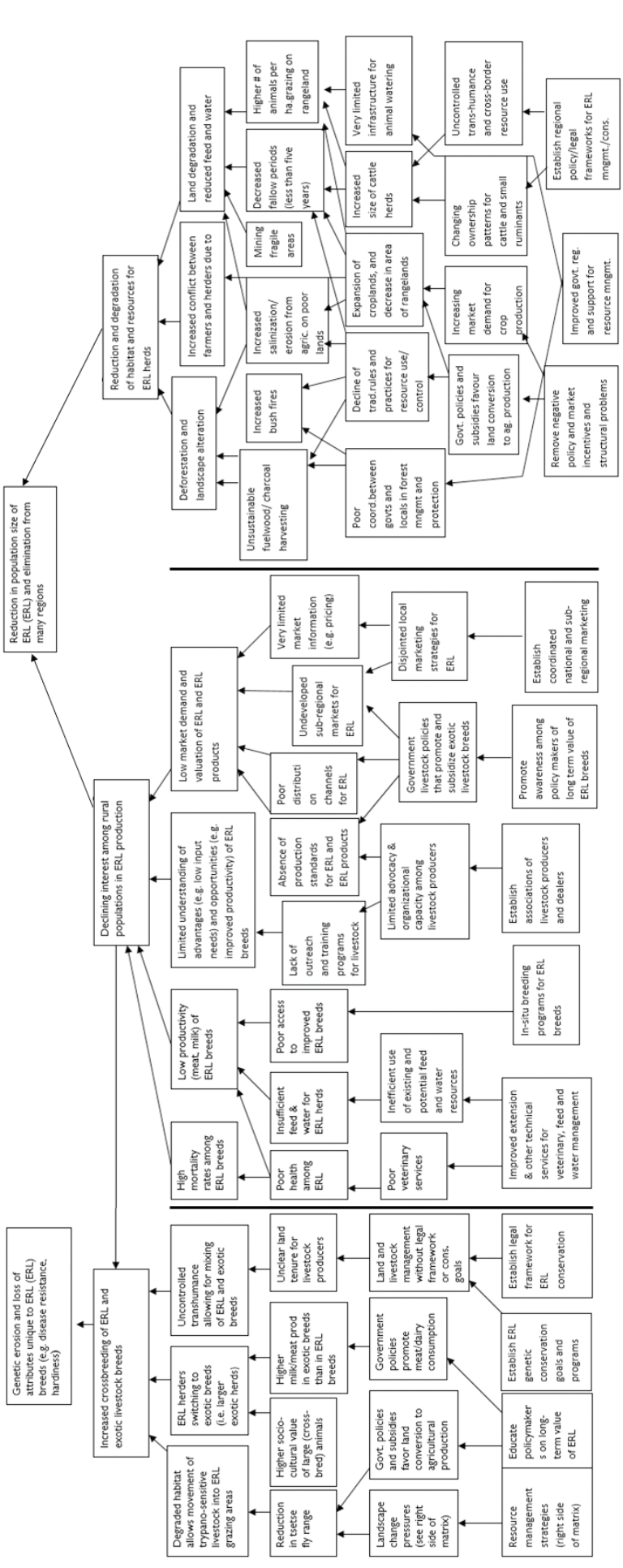


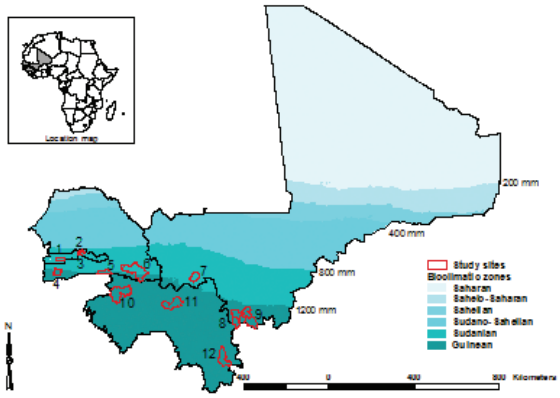
Figure 2. Conceptual model—Threats, root causes and interventions

Piloting the PROGEBE model of sustainable management of ERL

Project countries and sites

Four countries in West Africa (Senegal, Mali, Guinea and the Gambia) have pooled their resources and efforts to design and implement PROGEBE, an innovative project on the sustainable management of ERL of West Africa. In each of the four participating countries, three primary and two secondary priority pilot sites have been selected. These sites were selected primarily because they are centres of diversity and geographical distribution of pure populations of endemic livestock, and because they are sub-regional biodiversity hotspots for native flora and fauna. In addition to biodiversity factors, the initial criteria for priority pilot site selection included: 1) Breed "purity"; 2) Presence of diversified production systems (involving cattle, sheep and goats); 3) State of the natural environment and scope of threats to the ecosystems; 4) Level of tsetse challenge; 5) Scope of threat to endemic breeds; 6) Priority given (but not exclusively) to transboundary sites; 7) Presence of ongoing projects and baseline activity (PRODOC 2004).

Figure 3. Map showing PROGEBE study sites in the four West African countries, the sites are highlighted in red.



The labels of sites are as follows: Gambia – 1=Kiang West, 2=Nianija, 3=Niamina West 3; Senegal – 4= Tenghory, 5= Wassadou, 6= Bandafasi; Mali – 7= Sagabary, 8=Madina Diassa, 9= Manankoro; Guinea – 10=Gaoual, 11=Dinguiraye, 12=Beyla.

PROGEBE outcomes, outputs and interventions

Outcome 1: Production and productivity of ERL is sustainably improved. A key strategy of PROGEBE was to improve the performance of ERL, so that farmers can benefit from increased production, through the inter-related outputs: 1) Characterize ERL and their production systems; 2) Improve management systems for livestock production and productivity (animal health, nutrition, housing, vaccination committees,); 3) Establish genetic improvement systems for ERL; 4) Identify, demonstrate and disseminate information on incentive systems for farmer participation in endemic livestock raising; and 5) Strengthen capacity for participatory community management of livestock production. The main clusters of interventions that were designed and implemented to improve ERL production and productivity are indicated in Table 1.

Table 1. PROGEBE interventions designed to improve production and productivity of ERL

Cluster of interventions	Activities
Breeding plans for N'Dama cattle	Baseline and end line studies to characterize ERL production systems before and after project interventions
	Rehabilitation of four cattle breeding programs in four countries
	The Gambia: re-establishing procedures to operationalize the nucleus breeding activities (data recording, genetic evaluation, selection of animals as nucleus breeders and disseminators), with the updating of the data recording and evaluation software, establishment of multiplier herds and dissemination of selected bulls into village multiplier herds; and upgrading of infrastructure (mating pens, feed storage facilities, improved pasture plots, provision of motorbikes)
	Senegal: Rehabilitation of the Kolda cattle breeding station (restocking of the breeding herd using animals belonging to farmers and hence participation, ownership and management of the on-station breeding stock by farmers under a collaborative agreement with ISRA; Breeding and multiplier herds for N'Dama cattle in place; Distribution of selected bulls from legacy breeding herds
	Mali and Guinea: Restocking of breeding station with public funds
	Capacity building targeting farmers, scientists and increased awareness among policy makers
	Building local expertise for future work in breeding (post-graduate training in animal breeding and genetics)
Breeding plans for Djallonke sheep and goats	Rehabilitation of Gambia sheep and goat breeding program (infrastructure, restocking)
Animal health	Support to vaccination campaigns and veterinary services
	Establishment of a vaccination committees in sites in Senegal
	Capacity strengthening: training of CAHW; livestock technicians, farmers and support private veterinarians with equipment
Animal husbandry (housing) and feeding systems	Design and establishment of improved small ruminant housing in all four countries
	Cattle dry season stabling in Guinea
	Fodder cropping (seed collection, panicum, andropogon, cowpea)
	Bush fire control to conserve fodder
	Use of crop residues (Community fodder banks)
	Production of multi-nutrients blocks by farmers
Capacity strengthening for farmers and extension agents	Training of technicians and farmers on fodder cropping, minerals blocks, housing, health, breeding and reproduction
	Training of scientists on breeding and genetics (MSc)
	Training of managers of breeding stations and farmers groups; CAHW, extension services

Outcome 2. Commercialization and marketing systems of ERL and livestock products are strengthened. To achieve longer-term market development, the project pursued the inter-related outputs: 1) Identify marketing opportunities; and 2) Establish marketing, distribution and processing infrastructures for ERL and livestock products including the establishment of national and regional livestock markets, feeder roads, slaughter slabs and milk processing units with the establishment of committees for the sound management of the infrastructures.

*Outcome 3. Natural resources in project pilot sites conserved and sustainably managed for the benefit of ERL, ecosystem services, and human livelihoods***.** PROGEBE worked to ensure that natural resources are used sustainably at the pilot sites through community-based land use planning and natural resource management. PROGEBE pursued four inter-related outputs: 1) Strengthen capacity of local inhabitants to develop strategies to conserve and manage livestock habitat; 2) Develop and implement project site-level landscape management planning processes and institutional structures; 3) Recognize and implement locally adapted and supported norms and regulations for the sustainable management of habitats and resources important for livestock production and ecosystem services. Table 2 shows interventions actually undertaken by PROGEBE.

Table 2: PROGEBE natural resources management interventions

Cluster of interventions	What has been done? Project interventions actually implemented?
Land use plans (Plan d'cccupation et d'affectation des sols, POAS)/local conventions	Land use plans established in all primary and some secondary sites (formal documents signed between community leaders and local admin authorities, and other local organizations including NGOs)
	Participatory designs of LUPs (Communities, technical departments)
	Participatory mapping and validation of the LUPs
	Implementation and evaluation of the plans on-going in all countries
	Establishment of watering points
	Afforestation
	Community forestry management plans established in the Gambia and Guinea
	Updating NRM indicators
	Resource mobilization to support natural resources management
Bush fire controls strategies and mechanisms	Establishment of firebreaks
	Establishment of bush fire committees with equipment, surveillance committees and sensitization of communities with annual consultation meetings and radio shows
	Development of community skills on apiculture on fire control through training
Transhumance	Stock routes for all countries except Mali
	Transhumant action plans elaborated and implemented by all countries
	National and regional transhumance workshops
Capacity building	Training on NRM methods: apiculture, soil conservation, forest management; conflict management; compost making; bushfire control.

Outcome 4. Legal, policy and institutional frameworks established at the local, national, and sub-regional level for in-situ conservation of ERL. The principal objective of outcome 4 was to identify and assess policy options to support and complement the objectives of the other PROBEBE outcomes on improved production and productivity of ERL, strengthening commercialisation and marketing systems of ERL and sustainable management of natural resources. PROGEBE analysed policy and legal frameworks that have an influence on the sustainable management of ERL. Review studies were carried out to identify policy, legal and institutional issues and constraints and to formulate recommendations on reforms that address the gaps identified. Country surveys were conducted to document stakeholder experience with, and responses to, the existing institutional, legal and policy frameworks. Following this initial analysis, stakeholders' workshops were organized to present and validate findings of country desk reviews on policy and legal issues. These were opportunities for participatory analysis of causation, solution identification and analysis as well as formulation of recommendations to address identified policy options. Policy briefs that highlight key gaps and alternative options in policy, legal and institutional frameworks regarding the management of ERL, delivery of veterinary inputs and services and management of natural resources were drafted from country studies. These materials were inputs to stakeholders' consultations that were organized to raise awareness among the community and administrative leaders and community-based organizations on key gaps in policy, legal and institutional issues and on ways to address them. In addition, workshops were also held in all countries to develop the capacities on these targeted leaders on negotiation skills, lobbying and advocacy.

Outcome 5. A sub-regional system is established for cooperation, information exchange, and coordinated support for the conservation of endemic livestock. PROGEBE was designed to develop and implement a system for cooperation, coordination and information exchanges relevant to endemic livestock, linked to existing regional programs. Adaptive management based on the lessons learned at the pilot sites were used in adapting on-going project activities at the primary sites, and in designing activities in secondary sites. In order to achieve these objectives, the project pursued five inter-related outputs: 1) Develop mechanisms such as innovation platforms for coordination of activities at the

site and national levels, for information sharing and lessons learned among project participants, and for adaptive management based on lessons learned during project implementation; 2) Establish and operationalize long-term sub-regional networks for information exchange; 3) Enable replication of selected site level activities from primary project pilot sites to secondary project pilot sites. PROGEBE animated a project bulletin, served as the regional focal point of the Food and Agricultural Organization (FAO) on AnGR, and facilitated e-forums on AnGR-related issues. For the dissemination of project outputs, PROGEBE organized various workshops and radio programs. Numerous reports and journal articles were also produced and posted on target websites. Finally, PROGEBE conducted a multilevel, bottom up, participatory lesson-learning processes to take stock of successful PROGEBE experiences for future use.

Assessment and demonstration of the PROGEBE effective model of sustainable management of ERL: Lessons learned and best practices

Lessons learned:

1. Drivers of and incentives for the sustainable management of ERL

Approach to identify incentive systems for sustainable use of ERL

Despite their competitive advantages, ERL are often perceived by farmers and especially by livestock policy makers as inferior in term of productivity and marketing. ERL adaptive traits are not of direct use and consequently they are not valued in the marketplace. The sustainable management of AnGR and their environment is dependent on incentive measures that can stimulate their sustained use by farmers and the adoption of management practices enabling the sustainable use of the natural resource base. PROGEBE sought to improve ERL productivity and profitability, preserve their habitat, and help define the appropriate policy and legal framework to incentivize their sustainable use. In that connection, PROGEBE investigated existing and potential incentives (disincentives) that influence the competitiveness of ERL. A number of questions related to the use of ERL versus non-ERL emerged prior to and during the course of project implementation:

- What are the existing incentives that explain the widespread adoption of ERL in subhumid zones of West Africa despite their perceived low productivity and income generation potential? Alternatively, how to explain limited adoption of other exotic breeds despite a perceived "superior" productivity and market value in some PROGEBE sites?
- Why in certain sites such as in Mali, and to a certain extent in sites in the Gambia and Senegal, farmers are increasing adopting non-ERL cattle and their crosses with Sahelian breeds?
- Could the observed adoption patterns in PROGEBE sites be the result of natural comparative advantages of ERL in their local habitat, or could it be the result of market, policy and institutional failures favouring (limiting) the adoption of more (less) productive breeds?
- If the adoption of ERL is the result of such failures, what incentive systems are needed to make it more worthwhile in financial and livelihood terms for communities to maintain ERL and their natural habitat in the long run?

The conservation of ERL and their habitat is a public good creation activity. Conceptually, it may be thought of as a "contractual" relationship between conservation institutions and producers. While public institutions have incentives to

conserve ERL breeds and their habitat, private producers also may find "private incentives" to keep them and protect their natural environment. Therefore, the conservation of ERL depends on a set of incentives at different levels and for different actors:

- Private incentives: What incentives or drivers (internal or external) may favour the adoption of ERL?
- Community, traders or industry level: What incentives are seen by the community or livestock traders and organizations as drivers to encourage the adoption of ERL?
- Government and other regional or international organizations: Governments and other international bodies enact *ex ante* national-level or regional/international-level legislation for management and conservation of local breeds and their habitat. These laws are incentives or constraints for private producers and traders/industry to conserve these breeds.

A number of studies have been implemented during the course of PROGEBE implementation to inform this debate:

- Study 1 was conducted in Mali to analyse benefits and costs of raising ERL versus other Sahelian breeds (ILRI 2012).
- Study 2 was carried out in Mali to analyze the impact of transhumance on ERL (Hirsoux 2011).
- Study 3 analysed existing and new incentive systems for the sustainable management of ERL (ILRI 2012b). This was completed by a participatory review and validation if the study finding by communities in the PROGEBE sites.
- Study 4 was conducted in Mali to look at how the different attributes of ERL are valued at the market place (Fadiga 2013).
- Study 5 was designed to analyse farmers' objectives and strategies for crossbreeding ERL and non-ERL in Mali. It focused on the analysis of factors driving farmers to change the breeds in their herds (Corsius and Fall 2012).
- Study series 6 analyses the 4 countries legal and institutional frameworks.
- Study 7 investigated the influence of transhumance on the sustainable management of ERL (Ayantunde *et al.* 2014)

Drivers of changes influencing the use of ERL

Habitat integrity and trypanosomiasis risk

One major effect of ERL habitat degradation is the change in the risk of trypanosomiasis that in turn is a major determinant of the presence of ERL in specific ecosystems. The different fly vectors are highly dependent on particular habitats for their survival, therefore ecological and land use change has a major impact on fly populations and the associated disease risks. Equally, the probabilities of infection by people and livestock are influenced by the presence and distribution of hosts, including wildlife, and so disease dynamics are equally affected by ecology, and the social, economic and cultural habits of people and their livestock. Vector species in Africa have adapted to ecosystems ranging from humid forests to dry savannahs. As these ecosystems change so will the distribution of vectors species. For example, for trypanosomiasis vectors, *Glossina morsitans* is mainly a savannah dweller has been affected by land degradation and *G. palpalis,* a riverine species, survive along river ecosystems. Climate change, human population growth and expected disease control activities have and will impact on tsetse distribution and trypanosomiasis risk. These changes will tend to contract areas under trypanosomiasis risk. The greatest decrease in the impact of animal trypanosomiasis is projected to occur in the semi-arid and subhumid zones of West Africa, where the climate will be drier, human population will increase, and disease control will have greater impacts. The disease situation in the humid zone of central and western Africa will be less affected (McDermott et al. 2006).

There is little recent entomological data available upon which to draw general conclusions concerning the distribution and abundance of tsetse in PROGEBE sites. Only Mali among PROGEBE countries updated the situation regarding trypanosomiasis incidence in project sites. The entomological review conducted during the preparation of PROGEBE concluded that broadly, based on the little available data, known trends in human population growth and changes

in vegetation, particularly forest cover, that tsetse abundance is likely to have consistently declined in ecologically vulnerable areas on the northern fringes of tsetse distribution, and that the distribution has also regressed southwards slightly in response to climate, vegetation and population density changes (ITC 2004). However, the spatial distribution in areas south of the northern limits of *Glossina* infestation (*i.e.* the south bank of the Gambia; Casamance; southern Mali and Guinea) is likely to have remained unaltered except in small, fragmented areas. Results of tsetse monitoring by PROCORDEL in representative sites throughout the Gambia in 2001-2002 do not suggest that there have been any significant changes in the intervening period. *Glossina m. submorsitans* is much more susceptible to change than *G. p. gambiensis* (particularly to change resulting from human population growth) as the latter species can survive in fairly small gallery forest vegetation. *G. longipalpis* is also a susceptible species and appears to have disappeared from Senegal north of the Gambia and from southern Mali: areas in which that species had previously been reported but which was not detected in more recent studies. As the Gambia has one of the highest human population densities in Africa, it may be reasonable to assume that if tsetse populations have remained largely unchanged in that country, a similar situation would be found in Mali, Guinea and southern Senegal.

Implications of transhumance of sustainable management of ERL

A driving factor that influences farmers keeping ERL to decide to change the composition of their herds or flock is access to non-ERL which is determined by their availability and costs. The trend of seeing more crossbreeding between ERL and Sahelian breeds occurs where there is a close proximity between the two populations of breeds. For instance, in buffy zones between subhumid zones and semi-arid areas, farmers have ample opportunities to access the Sahelian type of breeds. As a result, a stable composite (N'Dama/zebu) has evolved over the years in transition areas.

Over the past 50 years, global economic factors, national policy, and local agricultural technology adoption have interacted in a manner that has facilitated migratory drift and settlement by Sahelian pastoralists in southern Mali (Ayantunde *et al*. 2014). The current presence of Sahelian long-distance transhumant herds is part of a long-term dynamic involving periodic in-migration of transhumant herds and small numbers of transhumant pastoralists settling permanently or temporarily in the southern Mali area. With deforestation in southern Mali for cotton production and availability of cheap generic subsidized trypanocidal drugs, a growing number of pastoralists from the Sahel are moving farther southward to graze pastures in the Sudano-Guinean zone. Besides, many pastoralists have settled in the Sudano-Guinean zone of Mali to grow crops and raise their livestock, which implies that they have become agro-pastoralists.

The presence of markets is a key economic stimulus-response factor that pulls transhumant pastoralists towards particular areas. In that connection, local crop farmers keeping ERL breeds can also source Sahelian breeds from transhumant herds or from local markets supplied by transhumants. ILRI's study 2 conducted in southern Mali (Hirsoux 2011) has shown that transhumant herds are one of the most important source of non-ERL breeds for farmers keeping ERL in West African subhumid zones. Both transhumant livestock keepers migrating seasonally back and forth from the Sahel to subhumid zones and settled pastoralists make easily available various zebu breeds directly or through livestock market places, non-ERL to local farmers who are attracted by the large format of non-ERL.

The ILRI-led analysis of the history of crossbreeding in southern Mali (Corsius 2012) showed that in all surveyed villages, markets played a major role in how the first exotic cattle breeds arrived in the villages. The most common way to access new (exotic) animals by settled transhumant farmers and local farmers was to buy them from local livestock markets. Sometimes it could happen that a stray bull or a cow from transhumant people entered the herd of a local farmer; however, these accidents were very rare.

There are also instances where national policies and programs have encouraged the import of Sahelian breeds into subhumid zones with the purpose of making available cattle with higher draught power to boost cash crop production such as cotton. This has been experienced in southern Mali. The situation in southern Mali where there is a strong influence of transhumants from the north is quite different from other sites in Senegal, Guinea and the Gambia. In

Guinea, transhumance involving non-ERL breeds is minimal and the tsetse challenge is still high. Because of ecological conditions favourable to high vector-borne diseases risk and difficult market access, the availability of zebu breeds from neighbouring Mali is limited although there is an increasing presence of non-ERL in Guinea.

Farmers decisions to change the composition of their herds

Cattle attributes: Size, draught animal power, body conditions and market prices

ILRI analysed farmers' decision to change the composition of their breed and the way they engage into crossing their native ERL with Sahelian breeds in southern Mali (Corsius *et al.* 2012). Community participants in focus group discussions reported that farmers first attempted to use purebred zebu and lost all their cattle because of trypanosomiasis and other feed constraints that prevented zebus from thriving in the area. They ended up changing in favour of crossbreed cattle which are less demanding than Zebu but have higher feed and water requirements than purebred N'Dama cattle. Livestock market prices played a key role in the change toward crossbreeds. The objective of maximizing profits from their farm enterprises through increased income from livestock sales led farmers to invest in purchasing Sahelian trypano-susceptible breeds.

Higher market price, larger body size and greater draught power of the crossbreds relative to purebred Ndama were the major drivers that led farmers to start crossbreeding to change the genetic make-up of their cattle herds. In southern Mali, crossbreeding between N'Dama and zebu cattle has also been promoted by rural development projects that aimed to supply more draught animal power by using crossbred cattle to boost cotton production. Cattle prices reported by farmers indicate variations associated with breeds and seasons. For instance, zebu bulls had the highest market price in the dry and wet season, whereas N'Dama bull had the lowest market price in the dry and wet season. There was a significant difference in prices between a crossbred bull and N'Dama bull in the dry and wet season. There was also a significant difference in price between the crossbreed and the N'Dama cows in dry season and wet season (Corsius *et al.* 2012).

At the market place, zebu and crossbreeds were sold at a higher price compared to N'Dama, for all categories of cattle (adult, young, female, male and castrated). Adult female N'Dama have significantly lower selling price than female zebu or crossbreeds. For N'Dama and crossbreeds, adult castrated males for draught fetch the highest price, while for zebu, adult intact male for breeding were the most valued category (Fadiga 2013). With respect to market, the central issue is to identify the appropriate incentives for livestock producers to keep ERL. A strong incentive base for ERL keepers could be achieved by improving market agents and producers' understanding of how ERL traits are valued in marketplace (Fadiga 2013).

A study was conducted by ILRI to gain a firmer understanding of the relative importance of phenotypic traits buyers seek when buying live animals for breeding, resale or slaughter; to assess how these attributes are valued across the various categories of buyers; and to identify marketing opportunities for ERL producers in Mali based on the premiums and discounts each attribute command in the marketplace (Fadiga 2013). The study found that key determinants of cattle price include breed (N'Dama, crossbred, zebu), category (castrated, cow, bull), body condition (mediocre, average, excellent), geographical origin (humid and subhumid, north Sudan, and south and north Sahel), and coat colour (white, red, gray, black). When the various attributes were classified by order of importance in terms of their impact on prices, body condition, agroecological origin and category emerged as the three most important attributes. The importance of body condition illustrated by the high premium paid for excellent body condition across all levels of analysis, combined with the relatively low discount rates on N'Dama and crossbreeds further confirms that if all maintenance costs are accounted for, N'Dama cattle with excellent body condition could be as profitable as zebu.

The findings have production and marketing implications, as they would enable ERL producers and traders to make more informed production and marketing decisions because they would be better informed about how the attributes of cattle they put on the market are rewarded or penalized. Hence, fattening is a good option that could lead to better prospects for ERL producers. It leads to better prices while protecting the breed for future use. This would require some investments by ERL producers, which could help sustain any gains in quality as long as the market continues to

reward attributes such as excellent body condition more so than they penalize N'Dama relative to zebu. A recent study on marketing of ERL in PROGEBE countries indicated that the vast majority of surveyed farmers and livestock traders recognized the benefits of finishing animals to improve N'Dama prices at the market place. They, however, observed that a limited number of farmers have adopted cattle fattening although they recognize the economic benefits of such practices (Fadiga 2013).

Diseases and treatments

ILRI studies in PROGEBE sites in southern Mali (ILRI 2012a) investigated farmers' practices in terms of prophylactic and treatment measures with respect to cattle herd composition. Results indicated that 96% of the cattle were subjected to treatments against trypanosomiasis. On average, cattle received 2.1 treatments/year against trypanosomiasis. When farmers treat or vaccinate their animals, they indiscriminately treat or vaccinate the whole herd, irrespective of breed. They made no differences between N'Dama, zebu or crossbred cattle. All cattle were subjected to the same number of treatments regardless of breed. Eighty one per cent of all cattle keepers applied preventive treatment against trypanosomiasis during the past 12 months prior to the surveys. The percentage of household categories (keeping N'Dama, zebu or crossbreed) which administrated preventive treatments against trypanosomiasis did not differ significantly. In other words, N'Dama keeping households do not appear to take full advantage of the genetic traits of the N'Dama compared to zebu cattle. About 50% of the N'Dama herd owners reported the use of curative treatment within the last year against only 15% for zebu herd owner. This was also unexpected based on the vulnerability of the zebu relative to N'Dama in the subhumid ecosystem.

Benefits and costs of rearing ERL

The study on the profitability of raising N'Dama cattle in comparison with other cattle breeds in southern Mali (ILRI 2012a) was conducted in the PROGEBE site of Manankoro. PROGEBE baselines studies in this site revealed increasing preference for the non-ERL zebu cattle breed. Surveys were carried out in households who own dominantly N'Dama, zebu, or their crossbreed. Enterprise budgeting was carried out to evaluate the economic efficiency of cattle production as indicated by the net benefit (NB) over a period of one year. Accounting for the change in stock value, crossbreed-keeping households have the highest net benefit compared to N'Dama, zebu, or households keeping all breeds (mixed households). This is because of the combination of many factors, including higher selling price for crossbreeds, especially for castrated males, and the value of draught service. The net benefit per active household member is significantly lower for N'Dama keeping households than any other household types. While this was somewhat expected, the magnitude was not. This was puzzling because the zebu breed is known to require more veterinary inputs and more labour than N'Dama in terms of herding, watering and feeding. The net benefit per cattle did not deviate much between household types, indicating in some contexts N'Dama can be competitive. Excluding the change in stock value, N'Dama was more profitable on a per unit basis than crossbreeds.

It was difficult to draw firm conclusions from this study on the profitability of keeping Ndama versus zebus and crossbreeds because of some limitations of the study, such as estimates of productivity parameters of different breeds under village conditions. Pre-weaning calf mortality was two times higher in crossbreeds and zebu than N'Dama, confirming that they adapt better to the disease environment relative to other breeds. But, at the same time, diseases seem to equally affect all three breed categories, including trypanosomiasis. The reason is not known and perhaps may be due to disease identification by owners.

Fifty per cent (50%) of the zebu and crossbreeds were sold to trader/brokers, while only 7% of N'Dama was sold to this group, suggesting less market preference for N'Dama. Zebu and crossbreeds were sold at a higher price than N'Dama, for all categories of cattle (adult, young, female, male and castrated), suggesting a lower market value of N'Dama. However, focusing on price solely would not be appropriate to capture the profitability of one breed relative to another, as the maintenance costs are not accounted for. However, N'Dama keepers are not taking full advantage of the genetic attributes of the breeds as their expenses on drugs such as trypanocides are not significantly different

from those of households rearing other breeds. Probably, the level of trypanosomiasis risk in the area even warrants treating N'Dama cattle against the disease. Farmers' attitudes regarding indiscriminate use of trypanocidal drugs may also be a result of the easy access to available and cheap drugs encouraged by generous national animal health policies combined with the drive of private veterinarians to maximize profits by proposing treatments in instances where they is not warranted.

Productivity enhancing initiatives

PROGEBE was designed to demonstrate the applicability of project activities to strengthen economic and social incentives for raising ERL. To what extent productivity gains brought about by project interventions would incentivize their sustainable use of ERL? This is addressed in subsequent chapters. The key issue is what the outcomes at farmer and societal levels would be if investments to improve productivity of ERL and to develop infrastructure for the benefits of ERL were directed to non-ERL?

Policies, institutional and legal frameworks

Animal health delivery systems

The key comparative advantage of ERL is their ability to live, survive and produce in areas where trypanosomiasis is prevalent without the need for trypanocidal drugs. However, where the tsetse challenge and the disease risk are high, the use of trypanocidal drugs on ERL is justified to reduce the disease burden. The availability and affordability of trypanocidal drugs and other veterinary services have a profound influence on a farmer's decision to keep non-ERL where trypanosomiasis and other vector-borne diseases constitute serious constraints to livestock production. These factors are in turn determined by national policy and programs on veterinary inputs and services delivery systems. Generous animal health policies have created conditions for easy access to trypanocidal drugs in some countries such as Mali.

Local conventions for natural resources management

It was also hypothesized that any measure that would lead to better regulation and more efficient resource management would be a key incentive for livestock keepers to remain interested in ERL. PROGEBE natural resource-based interventions were designed to first reduce then stop ecosystem degradation through the development and implementation of adequate land use systems that minimize the conversion of ERL habitat into croplands and ensure effective control of bush fires. The outcomes of these interventions in terms of it induced stability of the integrity of the ecosystems were perceived as incentives that would further motivate farmers to keep ERL to support their livelihoods.

The influx of large number of people and animals into subhumid zones and the changing patterns of resource use and demand have led to a decline of traditional rules and practices for resource use related to ERL herds and rangelands. As traditional mechanisms have declined, state-sponsored resource management systems have not materialized to fill the need for coordinated control and use of resources, with existing laws, regulations and enforcement mechanisms for pastoral management, land tenure, and conflict resolution remaining piecemeal and inadequate. In particular, unclear land tenure systems—combined with increasing competition between agriculturalists and livestock herders for land and water resources—have led to increased conflict between farmers and herders, as well as over-grazing of communal pastures.

Summary on existing and potential incentive systems

Existing incentives (disincentives)

Easy access to non-ERL through transhumance and trade. The findings of various studies in previous chapters have shown that the easy access to non-ERL is the driving factor behind farmers' decision to change their herds or flock composition flock. This, in turn, is determined by the availability and relative affordability of these breeds. Transhumant herds are the most important source of non-ERL for farmers keeping ERL in West African subhumid zones. Both transhumant livestock keepers migrating seasonally back and forth from the Sahel to subhumid zones and settled pastoralists keeping Sahelian breeds make easily available various zebu breeds directly or through livestock markets. The local farmers who come in contact with these breeds are attracted by their large format and higher milk yield compared to local ERL breeds.

Cattle market prices and other attributes including draught animal power. Both household and market studies have shown that N'Dama cattle fetch lower prices where they have to compete in the market place with zebu cattle and crossbreds. Farmers respond to market signals by attempting to shift from ERL toward zebu and crossbred cattle. In mixed crop-livestock systems, draught animal power in a key input to cropping that greatly influence farmers income and livelihoods. Therefore, higher draught power exhibited by non-ERL cattle makes them appealing to crop-livestock farmers.

Access to trypanocidal drugs and other veterinary inputs and services. The availability and affordability of trypanocidal drugs is a key determinant of farmer's decision to keep non-ERL and this in turn influenced by national animal health policies and remoteness. Where livestock keepers have easy access to trypanocidal drugs in subhumid zones, there is a tendency of massive use and even abuse of these drugs for preventive and curative measures. With available and cheap trypanocidal drugs, farmers may see it as profitable to invest in the purchase of drugs that enable them to keep non-ERL, although any short-term private gain will be offset by the long-term social costs of trypanocidal drug resistance.

Effective land use plans (LUAP) and local conventions with technological and institutional interventions, including bush fire control, zoning, and rangeland management with strong local institutions. Preliminary assessments are showing that PROGEBE natural resource interventions are proving to bear the expected fruits. Effective bush fire controls, the creation of water points, and the establishment of local conventions for better management of natural resources are likely to have great positive impact on the conservation of the habitat of ERL.

New incentives

N'Dama cattle have to compete in the marketplace with larger frame breeds and their small size generally compromises their attractiveness. However, studies conducted under PROGEBE have shown that N'Dama cattle with good body conditions could compete with other breeds. Yet, it requires some improved husbandry techniques, especially fattening, which is not a common practice in the humid and subhumid zones of West Africa where N'Dama cattle are kept. Hence, a better prospect for the sustainable use of N'Dama cattle will hinge on the development of the capacities of farmers to invest in fattening schemes with the creation of conditions for better access to inputs, and financial, knowledge and information services and markets that would enable them to profitably engage in productivity enhancing innovations.

Potential incentives that need further evidence

Other potential incentives that PROGEBE has endeavoured to develop through project interventions include improved farmers' technical, institutional and organizational capacities through training, and improved access to markets through infrastructure development. It was hypothesized that farmers would be more inclined to use ERL when they realize productivity gains and improved income brought about by PROGEBE interventions.

Lessons learned

2. Effective PROGEBE model of sustainable management of ERL

The effective PROGEBE model (PM) is defined as an integrated cluster of PROGEBE technical, institutional and organizational interventions with their processes carried out by various actors at the herd, household, community, and national levels. These processes have proved successful in improving production, productivity, and marketing, and the conservation of the ERL habitat, hence making ERL raising economically attractive over the long-term, while remaining environmentally and socially sustainable. The main features of the PM are indicated in Figure 4 summarizing main interventions, outputs and outcomes.

The demonstration of the PROGEBE model effectiveness is based on providing evidence that clusters of PROGEBE interventions have brought about or have the potential to bring about changes leading more competitive and, therefore, more appealing ERL that remain key a livelihood strategy in West Africa subhumid zones. As this document was prepared during the last project year, it may have been challenging to assess its impact. For instance, some of the project's key interventions, such as market infrastructures, were only newly established in some countries. Two approaches were used to provide evidence that PROGEBE interventions worked well or were likely to yield their expected outcomes. First, principles of theory of change and impact pathway analysis were used to design various ILRI-led studies that investigated changes brought about by PROGEBE interventions in knowledge, attitudes and practices among farmers and other key actors and stakeholders:

Study 7. Surveys of individuals and local institutions involved in PROGEBE national resource management (NRM) interventions in Gambia, Guinea, Mali and Senegal were conducted in all the project sites to assess the social processes involved. The objectives of this study were: (i) to assess the knowledge, attitudes and skills of the community members in relation to NRM interventions in the PROGEBE sites, (ii) to document the processes involved in NRM interventions by PROGEBE and the perceptions of the local communities concerning these interventions.

Study 8. A key element of the PM development is the demonstration that the gains in production and productivity have in fact, or will be, translated to improved incomes and livelihoods, hence, as incentives for livestock keepers to continue raising ERL as a livelihood source. Field surveys were conducted to assess the change processes taking place regarding PROGEBE productivity enhancing interventions (Fall 2014). Three broad categories of households were sampled: 1) Households who are managing herds/flocks under the PROGEBE herd/flock monitoring scheme or are managing multiplication herds and received knowledge through training and agricultural guidance from PROGEBE; 2) Households who don't have herds under PROGEBE monitoring scheme or a multiplication herd, but which benefited from PROGEBE training; and 3) Households who neither benefit from PROGEBE training nor own herds/flock under the PROGEBE herd monitoring scheme or a multiplication herd. The first two categories of households could be referred to as 'household-with-PROGEBE' in relation to their strong interactions with PROGEBE teams. As a result, they have directly benefited from PROGEBE interventions in the form of advisory services and knowledge transfer through training in various areas. The third category of household could be called 'household without-PROGEBE'. These households have not directly benefited from PROGEBE interventions albeit they may have been influenced by PROGEBE activities in the project sites.

The second approach is based on the PROGEBE design and implementation of a bottom up, participatory and inclusive 'capitalization' process. This was meant to highlight stakeholder perceptions of PROGEBE interventions that worked well, and to identify the main reasons for success and how to ensure their sustainability and replication (see PROGEBE capitalization process reports). Following community assessment of PROGEBE interventions, country and regional workshops were held for the participatory selection and analysis of major successful project interventions from community and stakeholder perceptions.

Best practices for improving production and productivity

Productivity enhancing innovations including selective breeding, better health care and feeding, and other improved management practices, such as housing, have been promoted in project sites. The project interventions have also put emphasis on strengthening farmers' and extension workers' technical capacities through training workshops and the post-graduate training of scientists. Through the local, national and regional 'capitalization' consultations carried out in 2013 in Guinea, Mali, Senegal and the Gambia, PROGEBE interventions were listed by stakeholders as successful project activities with greatest impact on ERL productivity. They are analysed in the following chapters.

Breeding plans for ERL

Description

The PROGEBE baseline studies confirmed the low-input nature of crop-livestock systems in PROGEBE sites where ERL still play a major role in securing livelihoods of farmers. In these systems, changes in environment stresses will likely occur at a slow pace; hence, genetic improvement through pure breeding was seen as a sound option to improve ERL productivity in the long-run if breeding goals and objectives took both the adaptability and production function into consideration. The existence of sufficient demand for genetically improved animals exists, and of long-term public sector support for the breeding program were key prerequisites for a viable ERL breeding plan. N'Dama cattle in PROGEBE sites play savings and insurance functions. They are also major providers of cash, meat, milk and draught power. In the Gambia the N'Dama cattle breeding program was already operational using a three-tier open nucleus breeding model. This breeding program was in the Gambia was perceived as a robust model that could be adapted and replicated in the other three countries. This is because of its main following features: 1) Emphasis on meat and milk without the loss of disease resistance; 2) Use of the best linear unbiased prediction animal model for the evaluation of breeding values for meat and milk; 3) Use of multiplication herds as a mechanism to disseminate genetic gains; and 4) Regular introduction of new breeding material identified through large-scale screening of outstanding village cows with respect to milk production.

PROGEBE made investments for the rehabilitation of four cattle breeding programs in the four countries. These programs were halted for many years for a multitude of reasons, including lack of manpower, obsolete infrastructure and difficulties in securing funding for sustained breeding station operations. Key innovative features with these breeding programs included the active involvement of herd owners in restocking and managing on station breeding herds in Senegal. In Mali, the restocking of the breeding station of Madina Diassa was secured through public counterpart funds. The distribution of legacy selected bulls from breeding stations into villages was also resumed. A key PROGEBE achievement dealt with the building of local expertise for sustainable work on breeding in the four countries. Significant investments have been devoted to building the capacity of scientists and target farmers. Seven scientists from the four countries completed their MSc degree in quantitative genetics. PROGEBE also organized practical training courses on breeding, targeting breeding station personnel and livestock ministry officials.

Potential for impact

Selective breeding plans are long-term processes. Their impact in terms of increased productivity at farm level takes time to materialize. The extent of genetic gains transmitted to village herds is also an important consideration in impact assessment. As pointed out by (Marshall 2010), for a within-breed improvement program rates of genetic gain are typically 1-2% of the trait mean per annum, meaning the breeding program needs to be sustained for many years to achieve a meaningful impact. Rates of genetic gain achieved in the breeding nucleus are dependent on a number of factors, such as mortality rates, age at first calving, calving intervals, and inaccurate pedigree recording that lower the rates of genetic gains as estimated by breeding values that are directly influenced by how the animals are managed. Assessments of the breeding programs (Marshall 2010) indicates that mortality rates have been high, age at first calving not regularly recorded, and pedigree not accurately assigned to all animals. This requires urgent addressing through

sustained improvement to the breeding herds management conditions. The scale of operations is a second important consideration. The number of bulls that the breeding stations can deliver to the second tier for multiplication is currently limited. However, the distribution of selected bulls from legacy on-station breeding herds was a way to ensure rapid impact for countries where there was a legacy breeding herd (the Gambia and Senegal) with available breeding males. In Guinea and Mali, PROGEBE made efforts to restock breeding stations, but actual performance recording and evaluation, and selection have not taken place.

Potential and challenges for replication and sustainability

The N'Dama cattle breeding scheme of the Gambia was seen as a relatively robust model that could be replicated in other countries. ILRI reviewed this breeding scheme and developed guidelines for its adaptation in other PROGEBE countries as well as guidelines for documenting the necessary plans to underpin a successful breeding program drawing from breeding guidelines developed by the FAO. ILRI also supported countries to develop sustainability plans for country breeding programs. Key issues related to sustainability of the breeding programs include financial and human resources requirements and enabling policies. The breeding programs are currently resourced by PROGEBE (research station rehabilitation, the funding part of the program), while salaries and some operational costs are paid by the breeding stations. Filling the gap in funding after the cessation of PROGEBE will be a serious challenge and little action was taken to ensure the continuous operations of the breeding programs, although some resource mobilization activities were underway. The required human resources to run the breeding programs are still missing despite efforts made by PROGEBE to train geneticists.

Animal health

A solid livestock development strategy requires, first and foremost, a better handle of the animal health component. In the four PROGEBE countries, vaccination coverage is very low, very few private veterinarians are serving in remote areas, and animal health issues are negatively affecting productivity gains. The PROGEBE team designed and implemented an organizational innovation intervention in the form of community vaccination committees in project sites in Senegal that have proved effective in increasing the percentage of ERL vaccinated each year. Other key successful activities designed to improve herd and flock health included improved access to veterinary services through the training of community animal-health workers and support to the private providers by offering them equipment, and the strengthening of the capacity of farmers in animal health care.

Potential for impact

PROGEBE studies (Fall 2014) indicated that households who maintained herd and flocks subjected to frequent monitoring and those that benefited from training courses have seen a significant gain in knowledge regarding disease recognition and ways to provide simple treatments using appropriate drugs. In Mali, Senegal and Guinea, the project interventions influenced non-PROGEBE farmers, i.e., those that did not have any direct interaction with PROGEBE. There was a significant change in their knowledge on animal health. From farmers' standpoint, PROGEBE interventions led to reduced flock death rates (PROGEBE capitalization report 2013). Survey findings (Fall 2014) also indicate that the vast majority of farmers applied their knowledge on animal health on their own farms. The use of community radio stations to broadcast the immunization schedule and mobilize farmers is a major accomplishment of the project as far as the animal health awareness campaign is concerned.

Potential and challenges for replication and sustainability

Enlisting and training individuals at local level as community animal-health workers is a type of institutional arrangement that seeks to ease the burden posed by health issues in remote areas where the fragmented demand is not conducive to a profitable private veterinary practice. The underlying hypothesis is that, provided with the right

incentives, animal health service providers will move into areas where most end users of health services are located or take the necessary institutional measures to reach them. The project has enabled the emergence of indigenous organizations and had encouraged them to get involved in vaccination committees and census taking, to raise awareness about animal health issues, and plan and implement prophylactic measures. Coupled with their improved knowledge on good vaccination practices, and the presence of community animal-health workers, it is assumed that where vaccination committees were established there would be a greater likelihood of improved health care to the benefit of ERL now and in the future.

Improved feeding and husbandry practices

PROGEBE emphasized strategies to improve ERL feeding systems in terms of increased availability of feed resources and upgraded feed quality. The PROGEBE entry point to ensure impact on ERL feeding systems was the strengthening of the capacity of farmers and extension agents through training on feeds and feeding. Efforts have also been geared towards the improvement of the productivity of selected grazing lands. This successful cluster of interventions included: 1) The production of multi-nutrient and mineral blocks by farmers for own herds/flocks and for commercial purposes; 2) Dry season cattle stabling (with supplementation) including lactating cows; (3) the establishment of small ruminant housing with high rates of adoption by farmers; 4) The construction of boreholes; and 5) The establishment of livestock tracks and improved pasturelands. Pasture improvement interventions were based on bush-fire control to conserve existing standing plant biomass for dry season feeding, the demarcation of cattle tracks and the improvement of pasture quality through the dissemination of legume species. Individual farmers and site communities have been trained and supported to produce fodder seeds and seedlings, and to establish individual and community fodder plots. The targeted fodder crops were cowpea, maize, panicum and andropogon.

Potential for impact and challenges for replicability and sustainability

The ERL keepers in project sites in the four countries significantly improved their knowledge in fundamental areas that determine the herd productivity, notably feeds and feeding (Fall 2014). Farmer training courses by PROGEBE in these areas resulted in the desirable effects because the majority of households had applied new knowledge and practices they have learned on their own farms. The results of the surveys also showed a net increase in knowledge, even among non-PROGEBE households who had not benefited directly from PROGEBE interventions. In some PROGEBE sites, selected farmers who benefited from the training modules on feeds and feeding were able to set up small-scale family businesses producing and selling locally multi-nutrient blocks to other farmers. The sustainability of the fodder cropping initiatives still strongly rests on the existence of effective seed production system. The production and distribution of target seed is still a serious challenge in PROGEBE countries where there is a need for a fodder seed system involving research stations and farmers. Effective and sustainable fodder collection is still a problem because of seasonal labour shortages and a lack of equipment. The significant knowledge gain among producers who in fact have actually applied this new knowledge on their own farms, combined with a strong in ERL breeds and a willingness to invest for to improve their productivity indicate a great future for these breeds in the PROGEBE countries.

Best practices for market development

Although it may be premature to suggest that the infrastructure developed by PROGEBE has had an impact, the ‘capitalization’ exercise highlighted two major interventions that were rated highly by stakeholders for their potential impact on ERL market development. These were:

- The construction of infrastructure, such as market outlets, slaughter slabs and small-scale dairy processing units, to stimulate and improve the marketing of ERL and their products.
- The training of women in various dairy processing techniques contributing to better utilization of milk and dairy products, which has contributed to increasing women’s incomes.

The results of ILRI ERL hedonic demand analysis could be used to establish a livestock market information system. This was an important aspect of the project that did not materialize. Though such research was implemented for cattle in Mali, it could be easily reproduced in the other countries. The underlying framework is an econometric model that links price to agro-ecological origin, breed, body condition, category, and coat colour to calculate the premiums or discounts associated with each attribute. It was found that body condition, agro-ecological origin, and category are the three most important attributes regardless of the buyer. Breed and coat colour are less significant, except in the case of people buying for family ceremonies. The derived premiums and discounts are the information used by market agents to predict cattle price. It goes without saying that these premiums and discounts are seasonal as the underlying prices from which they are derived are also seasonal. Hence, in a market information system, cattle prices and associated attributes are collected on a regular basis, posted and broadcasted. For cattle, sheep and goat, information such as date of transaction, time of transaction, market (primary, intermediary, or terminal), sale price, age category (young, sub-adult, or adult), animal type (castrated male, male intact, or female adult), breed type (ERL, non-ERL, or crossbred), body condition (excellent, average, or poor) could be useful for traders in the price discovery process. An accurate diffusion of information related to price and quality attributes enables producers to time better their marketing decisions. This proves to be important given the seasonality of livestock price. ILRI research under PROGEBE has shown that N'Dama start putting weight at the beginning of the month of May as they originate from humid zones where the rainy season begins as early as April, whereas the dry season continues to prevail in areas where the zebu breed originates. Exploiting the difference in the production calendar between the two breeds could be beneficial to N'Dama, if producers timed their destocking period to coincide with periods when zebu breed is still recovering from the dry season.

Potential for impact, replicability and sustainability

In order to keep the infrastructure operational in the long run, the project has induced innovative institutional mechanisms at local level, including the formation of committees to manage the market infrastructure before beginning its construction. Training and awareness campaigns were also organized on behalf of market agents, including women involved the dairy value chain. Central to the successful establishment and effective operations of facilities was the early involvement of beneficiaries in their design, location within or close to project sites, and in their sustainable management.

Best practices for improved natural resources management

PROGEBE has promoted a number of NMR interventions including broad habitat protection measures in the project countries. They aimed at the conservation and sustainable management of natural resources in the project pilot sites for the benefit of ERL, ecosystem services and human livelihoods. The PROGEBE interventions related to NRM could be broadly classified into bush-fire management, forest/rangeland management, soil and water management, strengthening local institutions particularly land use plans and income-generation activities through value addition. The project also worked to influence policies and programs for ERL habitat management through the participation and leadership of local populations and authorities. The development of technical and institutional capacities of local communities in designing and implementing community management was seen as a key vehicle towards changes in norms and regulations on communal use of natural resources. Stakeholders' assessments pointed to the best practices related to natural resources management analysed in the following sections.

Land use plans. Strengthening the local institutions in land use plans and local conventions is one major NRM intervention by PROGEBE in all the four countries. This entailed participatory formalization of LUAP that contributed to integrated management of the natural resource base. Participatory and inclusive processes involving farmers, local community leaders, administrative authorities and transhumant pastoralists were used to develop LUAPs aligned with on-going decentralization policies.

Countries mapped the current state of land use and allocation in PROGEBE sites taking into account the current main land uses with respect to what should be the right use of the land. The following step was the preparation of a planning and decision-making tools in the form of LUAP. PROGEBE supported local communities in the preparation of LUAPs. For instance, the LUAP of Manakoro in Mali used the collaborative framework between the PROGEBE and the National Direction of Waters and Forests, with the participation of many local actors. At the beginning of the process, the two parties signed a protocol for collaboration. Subsequently, they worked on the methodology and conducted a situational analysis and collected secondary data on the current state of land use and allocation practices. The diagnosis continued with the organization of stakeholders' consultations that brought together elected community officials and local technical and administrative services, representatives of other "communes". Based on the results of the diagnosis, a LUAP was proposed. A second series of consultations were convened to gain the actors' consensus on solutions in terms of important regulations, and the organization and zoning of the landscape. Following these consultations, local conventions were prepared on various sites of the project. The proposed LUAP was validated by various actors. The next critical step was the approval of the plan by the "commune".

The LUAP defines the use of different land types (forest, rangeland/grazing area, cropping zone, water-logged area, transhumance routes, etc.) for a defined period of time long enough for tangible benefits, while conserving the natural resource base. Technological innovations being implemented by PROGEBE are applied to different land use types as appropriate. Of all the PROGEBE countries, Senegal has made a very strong progress in the development of land use plans, including the mapping of the study sites and zonation for different land use types. Appendix 1 indicates the Senegal case study of LUAP. The strong point of the development of land use plan and local conventions was the involvement of the local government authorities. As components of the LUAP, corridors for livestock passage were established in Senegal, the Gambia and Guinea, and mechanisms and rules to better manage transhumance were put in place. LUAPs were instrumental in the application land zoning principles for the consensual allocation of different land units for specific pastoral or cropping purposes. The LUAP frameworks were exploited as suitable frameworks to design and implement key natural resources management technologies, such as soil conservation and restoration techniques, water retention ponds, and afforestation initiatives.

Bush-fire control. Bush-fire management was a common intervention in all the project sites. It included the establishment of a fire belt, prescribing early burning and strengthening the committees to increase awareness, and providing materials to fight bush fires. In the project sites in Senegal, 42km of fire belt and about 170 bush-fire management committees were established and revitalized. Several meetings were organized in the PROGEBE sites in all the four countries to strengthen awareness on bush-fire control and train community members on strategies for effective bush-fire control.

Pasture improvements and fodder banks. Community and individual pasture plots were established thanks to PROGEBE support with the diffusion of productive fodder varieties.

Better use of forestry products. The collection of forest products proved effective in increasing and diversifying farmer incomes and, therefore, stimulating community motivation to conserve the resource base. Success factors for the improved use of forest products included the integration of this cluster of interventions in the LUAPs, and the strengthening of the capacity of community members to collect, process and market forest products.

Livestock watering points. PROGEBE assisted communities to establish and effectively manage small-scale watering facilities. Livestock keepers have always stressed the need to improve access to water for their livestock, a major cause of conflicts when transhumant herds compete with humans for scare water resources from wells supplying water for household needs.

Potential for impact

The development of LUAPs with the involvement of local institutions and organizations enabled the strengthening of local collective actions and raised better awareness on collective management of common resources. The combination

of cattle tracks demarcation with clear indicators, the creation of watering facilities, and improvement of community and individual pasture plots, and the constitution of local committees in charge of guiding transhumant herders and herds, was determinant in the significant reduction of conflicts between crop and livestock farmers. This entailed fewer damages to crop by livestock and contributed to ease drudgeries and costs in cattle management. The greatest impact of the establishment of boreholes was to make cattle management easier with the reduction in the daily and seasonal drudgeries and costs associated cattle watering. The sustainable use of these water facilities rests on their sound collective management.

Bush-fire control interventions were successful in reducing the frequency and incidence of bushfires. The concerted approach for effective bush-fire control was based on broad communication and the involvement of many categories of natural resource users and managers with special attention to professionals (honey collectors, hunters, and charcoal makers) who are partly responsible in fire breakouts. The objective was to promote a change in attitudes among users of natural resources over the long term. Key success factors for bush-fire control include community engagement in the creation of fire breaks, the application of agreed upon norms and rules under the LUAP, the creation and maintenance of firebreaks, and the existence of close water points.

Other expected impacts such reduced habitat degradation will take more time to materialize. However, a major output of PROGEBE interventions was increased community knowledge, and strengthened awareness and capacity on NRM issues through training and active participation in PROGEBE-led processes. It is, therefore, expected that the changes in knowledge and practices will ultimately lead to the improved management of natural resources in the long run. In fact, the results of the study 7 (Ayantunde 2013) showed that the knowledge of those interviewed on NRM issues had increased over the previous three years of PROGEBE interventions. The biggest increase in knowledge was observed in the sites where the previous knowledge of the NRM was lowest. The level of awareness of those interviewed was generally good for interventions such as bush-fire control. In terms of participation, the results showed that awareness largely determined the level of participation by the respondents.

Potential for replication and sustainability

The community-based NMR model requires the enabling environment of strong institutional support and incentive mechanisms. Processes involved in the elaboration and development of LUAP are well documented by PROGEBE Senegal (See Annex 1). The development of the LUAP in Senegal is a model that could be replicated in other sites and similar NRM projects subject to the country-specific decentralization reforms. The Senegal LUAP is being replicated at the secondary sites.

Local conventions are defined as ‘any agreement, written or not, between two or several local actors, that defines the rules on access and use of resources for their conservation and sustainable use’ (Djire 2012). The local conventions are adequate tools for sustainable and equitable management the common resources that proved effective in conflict prevention and resolution. Nevertheless, they are confronted by many problems regarding their effectiveness and legal stability. There are many conditions for the effectiveness and sustainability of local conventions including LUAPs. In general, sustaining local conventions will depend on having an adequate framework that secures their legal stability and capacity to take into account the legitimate concerns of all interested parties and to adapt it to the dynamic socio-economic and political context. Their effectiveness depends on actions to be taken at three critical stages of the process of establishment, validation and implementation of a local convention. It is equally necessary that the conventions benefit from political support at all the possible levels of decision making and that the process be owned and managed by local and administrative authorities. Local conventions go beyond just natural resources management. Effective local conventions are an indicator that communities themselves are managing their own affairs and constitute a key instrument to consolidate the decentralization process, thereby deepening local democracy.

The effectiveness and sustainability of local conventions are also confronted with other challenges, including the lack of awareness of their content, and the constant contestation of their clauses, by stakeholders. These are fundamentally related to their legitimacy and legality. There have been significant advances like in Senegal in terms of enforcing the decisions issued by local convention authorities. Other key challenges are climatic hazards, such as droughts,

deepening poverty among the population, a lack of political support, opposition from local administrative and technical services, and the weakened influence of traditional institutions. Other key challenges of local conventions deal with the availability of funding required for technical interventions that support LUAPs.

Bush-fire management interventions could be replicated by strengthening the local committees to increase awareness of bush-fire control. The main challenge is the availability of materials for bush-fire management. It is also necessary to: 1) Develop good linkages with forestry department; 2) Adopt early-control burning as the best option; and 3) Develop a national strategy for bush-fire control.

Summary of PROGEBE model of sustainable management of ERL

The effective PROGEBE model was defined as the integrated clusters of PROGEBE technical, institutional and organisational interventions carried out by various actors at herd, household, community and national levels. PROGEBE interventions described in previous sections have proved successful in improving the production, productivity and marketing of ERL, as well as the conservation of ERL habitat. Hence, they will make raising ERL economically attractive over the long term, while remaining environmentally and socially sustainable. The main features of PROGEBE model are indicated in Figure 4 summarizing main interventions, and their outputs and outcomes.

PROGEBE made significant efforts to address key constraints that plagued existing breeding programs in the four countries. Target investments to rehabilitate breeding stations and restock them with breeding females brought in thanks public funds, and to strengthen the capacity of farmers, scientists and managers on breeding and genetics were conducive to the re-activation of effective cattle selective breeding plans in some countries. Key PROGEBE achievements in terms of ERL breeding included the strengthened national capacities to run breeding programs, the continuation of the Gambia cattle breeding program, and the reactivation of the Senegal cattle breeding programs. In all breeding stations, it was possible to resume the dissemination of selected bulls into village herds. Despite these efforts, serious gaps remain.

PROGEBE was also able to improve communities' access to input and veterinary services in PROGEBE sites as a result of a combination of key interventions, including the training of farmers and extension agents on ways to recognize diseases and various prophylactic and treatment measures and how to get organized to improve their access to veterinary services. The training of community animal-health workers, the support to private veterinarians and the establishment of innovative vaccination committees were instrumental in the increased vaccination coverage and subsequent reduction of mortality rates in sheep and goats seen in some countries.

PROGEBE was also successful in addressing ERL feeding constraints as it yielded a key project outputs in the form of increased farmers knowledge, skills and capacities in feeds, feeding technologies and husbandry practices (small ruminant housing, dry season stabling). Farmers in project sites applied their new knowledge and skills through the wide-scale adoption of fodder cropping techniques, better use of crop residues, individual and community fodder banks, and the fabrication of multi-nutrients and mineral blocks. It is hypothesized that these trends would ultimately entail increased availability of feed resources of higher quality in the medium and long term.

One of the most significant PROGEBE achievements is certainly the model of community NRM, the community LUAP. With the technical guidance and facilitation of PROGEBE teams and other national technical partners, communities were able to design and implement a community land planning tool, LUAPs, using participatory and inclusive processes. Keys steps in its development include the formal and participatory mapping of community land resources with the diagnosis of land management constraints and opportunities, the design of norm and regulations for land use with the zoning of community lands, and finally the validation of the plan by local and administrative authorities. Key technical components of the LUAP include mechanisms and tools for bush-fire control, management of transhumance, the creation of stock routes and watering facilities, and training of communities on NRM best management practices. The application of LUAP was successful in significantly reducing conflicts among

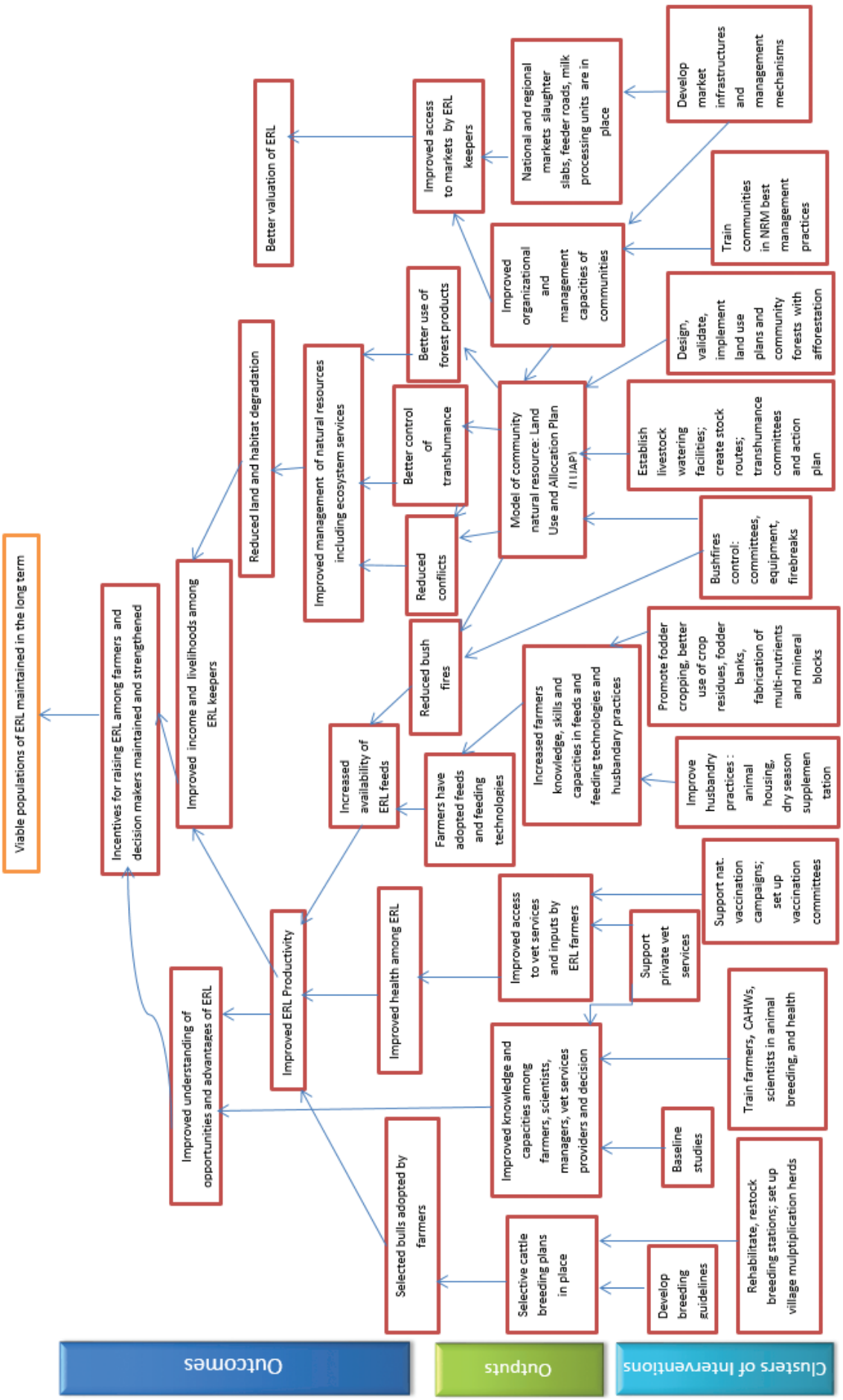


Figure 4. PROGEBE Model of sustainable management of endemic ruminant livestock of West Africa

various land-resource users and the reduction of bushfires, and better use of forest products. It is expected that in the long run these PROGEBE outputs will entail the end or reversal of land degradation processes to some extent given other resource degradation drivers, such as climate change and population pressures, will not supersede the effects of PROGEBE interventions.

PROGEBE invested in ERL market development through the establishment of key target infrastructures at site level or in the region, including national and regional markets, slaughter slabs, feeder roads and milk processing units. Preliminary stakeholder perceptions point to the beneficial impact of these investments in terms of easy access to market by ERL keepers for ERL livestock and their products.

As the PROGEBE has just ended, it was only possible to assess effective project outputs and some intermediate outcomes. The translation of the outputs into expected intermediate and ultimate outcomes can only be hypothesized at this moment, but it is very likely that this will happen. In that regard, the understanding of opportunities and advantages of ERL among ERL keepers and most decision makers will be strengthened by their realization of how ERL improved productivity was positively affected by PROGEBE interventions, notably their investments to increase availability of feed resources and use improved bulls, as well as the improvement in ERL health.

Findings from PROGEBE studies confirmed that ERL are still appealing to the vast majority of farmers. This attitude among ERL keepers and other decision makers is highly likely to be further strengthened due to the better understanding of opportunities and advantages of ERL, reduced habitat degradation, and the realization of improved incomes and livelihoods of ERL keepers as a result of the increased sales of ERL and related products, as well as enhanced ERL productivity. These all serve as key incentives that ensure long-term survival of viable ERL populations in West African subhumid zones.

Mapping of effective PROGEBE model with respect site typology

Although PROGEBE used the conservation of ERL and their habitat as an entry point, the resulting PROGEBE model turned out to feature as an effective model of rural development suitable for West African subhumid zones. As indicated in Table 3, PROGEBE sites are mainly characterized by their remoteness, difficult access to markets, low input extensive production systems that rely on adapted genetic resources, vulnerable natural resources base, limited infrastructural development, and overall neglect from policy makers. Hence, it is apparent that the technical components of PROGEBE model notably infrastructural development, natural resources management and interventions to improve livestock production will likely be met with great success and could be adapted throughout the subhumid zones where conditions are similar.

The subcomponent with the most variable options is the choice of breeds to focus on to improve livestock productivity in subhumid zones. Previous chapters have highlighted the critical role of ERL in securing the livelihoods of millions of farmers in subhumid zones. Although the population of ERL is still large, there are still a number of drivers of change that will influence their long-run survival as a viable part of existing production systems. Among these are changes in climate, evolution of production systems as a result of population growth and market demands, changing policy context and overall socio-economic development. The way the interplay of these factors will influence

trypanosomiasis and other vector-borne disease risk will have a significant bearing of the competitive advantage of ERL and therefore how appealing these breeds will be from farmers and planners standpoint. Bourne *et al.* (2001) pointed out the process of autonomous anthropogenic control of trypanosomiasis, and land conversion to agricultural and economic development with expansion of trade and road networks due to demographic and economic growth are driving causes of habitat fragmentation and the elimination of wildlife reservoirs. This has entailed in many places the decline and retreat of tsetse population with the resulting decline of disease risk. However, the disease risk will persist in remnant habitats, protected areas and very remote regions (Bourne *et al.* 2001). Large subhumid zones of West Africa still fall in the category of very remote areas with medium to high disease risk, although land conversion to cropping is progressing.

Table 3. Mapping of effective PROGEBE model with respect site typology

Features	Type 1. Three sites in Mali: Manankoro, Tousseguela, Madina Diassa	Type 2. Three sites in Guinea: Beyla, Dinguiraye, Gaoual	Type 3. Three sites in Senegal: Ouassadou, Bandafassi, Tenghory, and one site in the Gambia: Kiang west	Type 4. Two sites in the Gambia: Nianija and Niamina east
Length of growing period	176 (151-205)	192 (157-251)	156 (112-201)	130 (115-151)
Population density	15 people/km^2	21 people/ km^2	28 people km^2	52 people /km^2
Vegetation cover	Shrub cover, closed-open, evergreen (78%), tree cover, broadleaved, deciduous, closed (20%) and mosaic cropland (2%)	Tree cover, broadleaved, deciduous, closed (59%), shrub cover, closed-open, evergreen (34%), and mosaic cropland (7%)	Shrub, cover, closed-open, evergreen (72%), tree cover, broadleaved, deciduous, closed (18%), mosaic cropland (6%), flooded areas (2%) and water bodies (1%)	Mosaic cropland (57%), water bodies (20%), shrub cove, closed-open, evergreen (12%) and cultivated and managed areas (11%)
Extent of habitat fragmentation and land conversion to cropping	Expansion of crop lands, land clearing for cotton production	Limited habitat fragmentation. Limited land conversion for cash crop production	Expansion of crop lands, land clearance for cotton production	Extensive land clearance but existence of the river Gambia that maintain riverine tsetse species
Production system	Mixed crop livestock system, extensive, low input systems with cash crop (cotton), extensive use cattle for animal traction	Mixed crop livestock systems, extensive low input system, no cash crop, limited use of cattle for draught power	Mixed crop livestock systems with cash crops (groundnut and cotton), extensive use of cattle for draught power	Mixed crop livestock system with groundnut and rice production, use of cattle for traction
Presence of transhumant herds from the Sahel	Seasonal influx of cattle herds from the Sahel. Pastoralist have settled down with their Zebu cattle herds	No transhumant herd from the Sahel	No cattle transhumance in the sites in Senegal, small ruminants in Bandafassi but increasing extent of transhumance in	Presence of Zebu breeds in north bank and small ruminant transhumant herds from the north
Trypanosomiasis risk	Medium to high	Medium to high or severe	Medium to high	Medium close to the river bank (2km); low away from the river bank
Remoteness/ accessibility	Remote areas, difficult to access, poor road networks	Remote areas, difficult to access, poor road network and infrastructure	Easy access	Easy access
Policies (health, decentralization, land use)	Generous animal health policy with easy access to trypanocides and presence of private veterinarians	Difficult access to trypanocides; little penetration of decentralization policies	Decentralization policies enforced, fair access to trypanocides	Limited application of decentralization policies; poor animal health delivery systems

The interplay of factors such as extent of land conversion to cropping, production systems dynamic, overall economic development, remoteness and policy environment entails a range of disease risk situations and options for control strategies including the use of ERL. In that regard, Snow and Rawlings (1999) suggested control and management responses to different rank intensities of African animal trypanosomiais that are still relevant and valid.

Scenario 1. Zero or low disease risk (PROGEBE site type 4, Table 3) could be the result of being located at the northern fringe of tsetse population distribution, the autonomous anthropogenic control of trypanosomiasis due to population pressure, or reduced rainfall and, therefore, retreat of subhumid zones due to climate change (type 4 sites). The introduction of exotic zebu breeds to be used as pure breeds or for crossbreeding with ERL is justified here to intensify livestock production systems. In fact, this is what actually has happened in buffer zones at the northern fringe subhumid zones where ERL and non-ERL co-existed.

Scenario 2. Medium to High disease risk. Most of PROGEBE site are located in areas with medium to high trypanosomiasis risk (site type 2 and 3 in Table 3) which elucidates why the vast majority of breeds in these areas are of ERL types. Future stable habitat and remoteness will likely create conditions for prevalence of trypanosomiasis and other vector-borne diseases that will make ERL competitive for smallholder farmers with limited use of external inputs. This situation of '*default in situ conservation*' will prevail in most of the West African subhumid zones. These areas may expand where climate change contributes to the conversion of humid zones to subhumid zones. However, as seen in some sites, production systems may intensify in these areas as a result of demographic growth or overall economic growth with the resulting shift to scenario 1 of low disease risk (type 4 sites). The extent and pace of some changes are unpredictable. It is, therefore, most likely that both pure ERL and their crosses with Sahelian breeds will co-exist in the same countries. Given the numerical strength of ERL, farmers will make smart choices on breed or combination of breeds that better fit their biophysical and socio-economic conditions. Livestock development policies in subhumid zones should not, therefore, deter farmers from changing the composition of their herds if that meets their livelihood objectives as the fate of ERL are unlikely to be at risk in the near future. Where pure breeds, exotics, or their crosses with ERL can survive because of undistorted policies on diseases control and prevention, farmers should take advantage of non-ERL genetic resources to meet their increasing income and livelihoods needs. Public policies will at the same time encourage the cryopreservation of ERL for future use. With current advances in conservation science and technology, the focus is now on conserving the underpinning gene networks for disease resistance and this can be done without necessarily conserving the pure-bred population in situ.

References

Agyemang, K. 2005. Trypanotolerant Livestock in the Context of trypanosomiasis Intervention Strategies. *PAAT Technical and Scientific Series* no. 7.

Ayantunde, A., Asse, R., Said, M. and Fall, A. 2014. Transhumant pastoralism, sustainable management of natural resources and endemic ruminant livestock in the subhumid zone of West Africa. *Environ Dev Sustain*. DOI 10.1007/s10668-014-9515-z.

Corsius, J. and Fall, A. 2012. *Sustainable Management of Globally Significant Endemic Ruminant Livestock in West Africa (PROBGEBE): Farmers' decisions about crossbreeding N'Dama and zebu cattle in Garalo community in Mali*. ILRI/PROGEBE Report.

D'Ieteren, G.D.M., Authie, E., Wissocq, N. and Murray, M. 1998. Trypanotolerance, an option for sustainable livestock production in areas at risk from trypanosomosis, *Revue scientifique et technique (International Office of Epizootics).*,17 (1), 154-175.

Grace, D. 2005. *Epidemiology and control of cattle trypanosomosis in villages under risk of trypanocide resistance in West Africa*. PhD Thesis, Free Universitat Berlin, Berlin, Germany.

Fadiga, M. L. "Valuation of Cattle Attributes in the Malian Humid and subhumid Zones and Implications for a Sustainable Management of ERL." *Environmental Economics*, vol. 4 Issue 1 (2013): 39-50.

Fall, A. 2014**.** *Gestion durable du bétail ruminant endémique de l'Afrique de l'Ouest. Evaluation des interventions visant l'amélioration de la productivité du bétail ruminant endémique.* ILRI PROGEBE Report. 2014.

Hirsoux, C. 2011. *Connaissances locales des pratiques de transhumance et les impacts sur les races de bétail endémique dans la zone soudano-guinéenne d'Afrique de l'Ouest : Etude de cas du sud du Mali*. Rapport ILRI/PROGEBE.

ILRI. 2012a. *Comparative Economic Analysis of N'Dama, zebu cattle and their Crossbred in the Bougouni area – Mali*. ILRI/PROGEBE Report.

ILRI. 2012b. *Participatory analysis of incentives systems for sustainable management of ERL*. ILRI/PROGEBE.

PRODOC. 2004. *In situ conservation of endemic ruminant livestock in West Africa*. PIMS 1119. GEF/UNDP.

ITC. 2004. *Entomological review for preparation of the GEF project*. ITC Report. 2014.

Shaw, A. P. M. and Hoste, C. H. 1987a. *Trypanotolerant cattle and livestock development in West and Central Africa Vol.1.The international supply and demand for breeding livestock.* FAO Animal Production Health Paper 67/1, Rome, Italy: FAO.

Annex. Senegal land use and allocation plan (Mamadou Diop 2015)

LUAP (POAS) is a tool of management of the community land and the exploitation of natural resources. Its development was based on the principle of the participation of the people and dialogue among the key land users. Its development should thus be based on principles that can ensure the participation of all components of the community and of all users of the natural resources. The development of the POAS relies on four basic principles:

- Principle 1: The rural community is prime contractor for the development of the land use plan. The choices and orientations of the LUAP are determined by the people themselves through their representatives in the consultation workshops;
- Principle 2: Throughout the elaboration process, the facilitation team only has a strict role of guiding the community consultation. The views of the technical services should in no case affect the choices and decisions of populations. Nevertheless, the team can orient their thinking to get them to take into account other dimensions or issues relating to the land use they might have considered, provide information to clarify certain points, and facilitate power analysis and/or choices, etc.
- Principle 3: The process of development of the LUAP is inevitably official in nature. It belongs to the rural community to demonstrate officially its interest in the realization of the LUAP with the support of the project. However, the operation occurs under the tutelage of the local administrative authorities and other representatives of the state.
- Principle 4: Beyond maps, the team responsible for conducting the operation must ensure that all products (information and rules) are presented in a format accessible and directly usable by populations, the primary users of the LUAP.

Steps

- Formulation of the need by the rural council and signing of a protocol with the PROGEBE: The rural community is the prime contractor for the development of the implementation of the LUAP. It officially manifested its interest in the realization of the LUAP under the tutelage of the local administrative authority of the district and state representatives. A protocol that formalizes the partnership between the rural council and the PROGEBE was signed by both parties.
- Development of a methodological note: The methodological note outlines the general principles of the approach of the LUAP, its minimum content and the procedures for its implementation. The note is then approach by the stakeholders.
- Information and awareness: Information and awareness-raising meetings are held with people and partners involved in the development of the LUAP (technical services, administrative authorities, president of elected rural council). Documentation is collected from them which serves as a basis for the pre-diagnosis. This information gathering work is continued throughout the process.

- Mapping of the land: The dynamics of land use patterns were mapped over several years. This work led to the first thematic maps which have served as support for the designation of areas for the LUAP.
- Participatory diagnosis of the land use changes and participatory validation of maps: To establish the reference situation, a participatory diagnosis has been undertaken for each, targeting the more structured village. This diagnostic has helped:
    - profile the history of land use to understand the dynamics of natural resources in the site.
    - the focus group with regard to the NRM; the pyramid of constraints prioritizing the limits in the management of the NRM.
    - the array of preferential classification of plant species allowing the identification of the pressures on natural resources and their trends.

The results of this work were presented at meetings bringing together representatives of the communities, rural consultants, technical services and other development actors. These results will constitute the bedrock of the discussions at the workshops on zonal cooperation.

- Zoning of the land (areas of coverage of LUAP): Delineation of the areas covered by LUAP is usually done on the basis of eco-socio-cultural criteria to facilitate the holding of the meetings on awareness raising and facilitation in the development of the POAS. Consensually, after examination of the maps, the community representatives from each village will approve the land area allocated to each activity.
- Participatory elaboration of the rules for the different land types: After the adoption of the mapping of different land types, the facilitation team members define the basis of the rules constituting the local land use conventions in the rural community.
- Feedback is provided on the rules laid down by the rural council in the presence of representatives of the state, the community, and projects/programs, as well as council advisers and officials of the decentralized technical services. A second evaluation will be conducted regarding the compliance of the LUAP with national legislation before presenting the LUAP document to the rural council for approval.
- Approval of the document by the rural council and the sub-prefect: LUAP is then presented to the President of rural council during a session for review and validation. Once validated by the rural council, the LUAP is subject to the approval of the sub-prefect. After this last step, the implementation of the LUAP begins.

A number of land use management rules adopted in the LUAP to resolve conflicts require special attention. This entails the delineation and marking of corridors for livestock passage, herd management to avoid damage to crop fields and transhumance management.

- Opening of corridors for livestock passage: Cattle access to pastoral water (wells, wells and ponds) and grazing areas are identified by the populations and marked by tags;
- Herd management to reduce conflicts: Opening and closing of the crop residue grazing periods are defined in the LUAP and are the subject to approval by village chiefs. This rule, combined with the opening and the markup of the passage of the cattle corridors, serves to regulate herd management to reduce conflicts.
- Management of transhumance: Communities with rules for the management of transhumance are obliged to establish committees to manage the arrival of transhumant herders, ensure their registration with the village chief, and organize briefings and raise awareness regarding the conduct of transhumant herders in the exploitation of natural resources (cutting trees, wildfire prevention, access to water points) in the community.

The implementation of the LUAP is based on a timeline focusing on three critical periods for the application of the rules: The cropping period, the harvest period and the period of managing the bush fires. For each period, a workshop is organized. This workshop is an opportunity to assess the activities of the previous period and to plan the next period on the basis of lessons learned. Meetings are reserved exclusively for the management of the transhumance.

Lessons learned

- The time taken for the participatory development of the rules, taking into account all stakeholders and users, awareness raising, implementation and evaluation contributed to the success of the development and implementation of the LUAP;
- The subdivision of the rural community into homogenous land use types from the point of view of eco-sociological context helped in discussing and defining the rules for land use plan and natural resource management, and the communication between the various stakeholders;
- The importance of the presence of the local leadership (head of village, rural community) to ensure the smooth implementation of the LUAP and the application of established rules.

Conditions

- The expression of the need of the rural community in favour of a LUAP and the community's commitment to its development and implementation are critical to the success of the process.
- The provision of necessary information on the objectives of the LUAP, the process of its elaboration and implementation are essential to its appropriation by populations.
- The commitment of technical support structures (utilities, projects, NGOs) present in the site to assist the community in the development and implementation of the LUAP is important to ensure recognition of the rules and facilitate their acceptance by populations.

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