A report prepared for the project

Lessons Learnt on Sustainable Forest Management in Africa

FOREST LIVE-STOCK INTERACTIONS IN WEST AFRICA

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Forest-livestock interactions in West Africa

by

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1.0 INTRODUCTION

The Sahel is a climatic zone that stretches from the Atlantic Ocean to the Red Sea with a width of 400 km to 600 km from North to South and a rainfall ranging from 100 to 600 mm. This zone is characterised by sandy soils supporting thorny vegetation and a discontinuous layer of herbaceous species. Transhumance and nomadic grazing are the main forms of land uses although in some areas there are some rain fed and/or irrigated cropping systems.

1.1 Socio economic contribution of livestock

About 40 million persons around the world, almost half of them African pastoralists, depend on livestock (*Sandford, 1983*). Animal husbandry on rangeland produces about 23% of the world cattle meat with thirteen percent of this production originating from Africa. Sub-Saharan Africa (SSA) represents 40% of the world's rangeland areas in arid and semi-arid zones, and equals the acreage covered by the OECD countries (essentially North America and Australia) but shelters 55% of the cattle of these livestock systems.

Livestock production contributes to nutritional and food security as well as to poverty reduction in the entire sub region. Livestock contributes to foreign currency earnings in most Sahelian countries. According to *Barry (2001)*, livestock and poultry production officially represent 17, 20 and 18% of GDP of Mali, Mauritania and Niger, respectively. For Burkina Faso, the currently estimate is 15%. These numbers appear, however, to be underestimations as many of the livestock products (skin & hide for instance) are accounted for in other sectors, and as several by-products (manure, draught power) are unaccounted for.

At household level, livestock contributes directly to nutritional security (meat and milk) and income earnings (sale of milk and fattened rams or bucks), and indirectly to food security (use of income generated to purchase grain or fertiliser, use of draught power, and use of manure to fertilise cereal fields) as well as to general well being (health, education, etc.). In fact, a large proportion of crop producers use livestock as a living bank account, where they draw cash by selling animals in response to unexpected situations requiring money. Livestock also play important cultural functions, particularly for important traditional (dowry) or religious events and ceremonies, and serves as a source of prestige for traditional chiefs and merchants.

Finally, livestock helps to reduce the workload on humans (draught power), to control weeds (particularly in tree plantations), to valorise marginal lands and protected forests, and to turn crop residues and other waste products into valuable food.

The nature of the contribution expected from livestock, however, depends on the production system.

1.2 Livestock production systems

SSA possesses a rich potential in terms of domestic animal biodiversity: more than 95% of the domestic ruminants found in the continent are indigenous breeds (*CIPEA, 1992*). Through natural selection over the years, these breeds have adapted to a variety of environmental conditions and management systems. The systems described here are based on the level of integration with crop production and of dependence on natural fodder.

1.2.1 Intensive production

Fattening ruminants for sale is a traditional activity for most Sahelian households. Several hundred thousand rams, bucks and bulls are kept in a stable to receive concentrate feeds (cottonseed, cottonseed meal or cake, groundnut meal, cereal bran, etc.) and a variable proportion of their forage requirement in a feed bin. In some cases the animals are freed to graze during part of the day in order to minimise feed costs. Net returns greater than 100% of investment are not uncommon when fattened rams are sold in large cities such as Abidjan or Dakar shortly before important religious feasts such as the Muslim "*Aid el Kebir*".

Another type of activity that is growing in importance is intensive dairy production. Owing to the cost of imported dairy products, and to the existence of a local demand for fresh milk products, many periurban small livestock enterprises have invested in imported dairy genes (pure or crossbreds imported from elsewhere in Africa or from Europe or the Americas); pregnant and lactating animals receive natural or cultivated forage and variable amounts of the concentrates indicated above.

While industrial production systems are common in Europe and the Americas, intensive meat and dairy operations represent a small proportion of ruminant livestock enterprises in West Africa. Nevertheless, these systems can be very productive and generate a much needed income at household and national levels while at the same time reducing the need for meat and milk from outside the sub-region. For this and other reasons, intensive systems are being promoted by most governments, in the hope that they will eventually replace low input but space consuming grazing systems.

1.2.2 Integrated mixed crop-livestock systems

Decreased availability of arable land and the need to diversify income and improve soil fertility have helped to promote mixed crop-livestock farming. Manure from the animals are composted and used to fertilise cereal fields, while crop residues are preserved and stored to feed cattle or small ruminants. For farmers without access to chemical fertilisers, mixed farming appears as the next best thing.

Additionally, the promotion of cash crops (cotton, peanuts, and rice) by agricultural corporations has increased the use of mostly cattle but also donkeys, horses and camels as draught animals. One year-old cattle are purchased from Fulani and other owners, trained and used for cultivation and transport of various products and materials. While draught cattle receive their feed in a bin during the dry season, small ruminants graze either freely under the control of a herder, or tied by a rope to a tree or other fixed items. During the dry season, both small ruminants and cattle generally graze in the vicinity of the farm. In some cases, male animals eventually undergo a fattening period where they receive feed concentrates before heading for the market.

Mixed systems promote an acceleration of nutrient turnover in the production cycle while reducing nutrient losses from the system. Most mixed systems in SSA are, however, not totally balanced - there is a nutrient deficit that is partially covered by a flow from communal grazing areas, leaving a negative balance that causes crop yields to decline. *De Witt et al. (1996)* reported deficits ranging from 15 Kg N/ha/year in Mali to 100/ha/year in the highlands of Ethiopia. Such deficits can be regulated by providing external nutrients in the form of fertilisers for the soil or feed for the animals. It should, however, be recalled that most farmers in the Sahel area have limited access to such options, either because of limited access to markets or to low incomes.

1.2.3 Grazing systems

Many areas of SSA are unsuited for crop production, for one or more reasons (insufficient or highly variable rainfall, land too poor, too rocky or too sloping). Although the productivity of the range may be low under such conditions, ruminants remain productive due to a great mobility (see *picture 2*) and an opportunistic behavior[1]. Additionally, herders and their livestock in such areas are able to wander freely with little risk of conflict, other forms of land use being marginal. However, the number of animals usually exceeds the carrying capacity of the land, forcing the herders to periodically leave their villages. Herders then move part of the herd to cultivated areas after grain harvest in order to benefit from standing crop residues; eventually the animals are moved to remote but more humid regions where both feed and water are assured. It is important to note that such favorable areas are found in sub humid and humid zones, but also in the many floodplains that are present in arid and semi arid Africa. The mobility of the herds is therefore a structural parameter characterising such production systems. These systems are the lifestyle of Tuareg owners and Fulani herders in the Sahara and Sahel areas. These communities live on milk from cattle, dromedaries and goats, and on money made from the sale of dairy products and animals.

Following the great droughts of 1973-74 and 1984, an large number of Fulani sold part of their cattle to sedentary farmers while others migrated from Sahelian to Sudanian areas where they have settled for good. These sedentary livestock owners have developed a system where they cohabitate with crop production. Livestock moves into marginal or fallow lands during the rainy season in order to avoid conflicts with crop farmers; then comes back after harvest, to benefit from crop residues left standing in cultivated fields, and may migrate to more remote areas in search for water and better quality fodder. However, the mobility is generally of smaller amplitude and of shorter duration. Since livestock owners in this sub-system are mostly crop producers, they live essentially on their crops. Livestock are used both as a savings account and a sign of wealth.

[1] Tendency to go where there is feed and water and to leave an area before it is degraded

1.3 Factors affecting livestock-forest interactions

Several factors affect livestock-forest interaction: animal behaviour, plant composition and density on the pasture, the management style of the herder, and climatic factors.

1.3.1 Animal behaviour

During feeding periods livestock walk, rest, eat, drink water and produce waste, thus interacting with land, water, air, and plant and animal biodiversity. *Kiema (1994)* found that of their daylight time, goats and sheep spend 59% and 65% eating, 12 and 13% walking and 17 and 23% resting, respectively. *Botoni (2003)* found that cattle spend only 50% of their time eating, but it is clear that the time spent on feed consumption depends on many factors, including animal species, plant density and pasture makeup. These activities affect the landscape in various ways: nutrient exchange and transfer, trampling, etc.

Livestock exploit natural pasture feeds, both herbaceous and ligneous plant species. The proportion of time spent on each plant category depends however on the livestock species, the makeup of the vegetation, and the period of year.

A study (*Ickowicz et al., 2000*) conducted in the Djoudj National Park (Senegal) found that livestock[2] spend less than 5% of their feeding time on browse plants. The Djoudj area is a 16 000 ha flood plain where herbaceous plants are dominant. The herbaceous plants cohabitate with *Prosopis chilensis, Parkinsonia aculeate, Indigofera oblongifolia, Trianthema portulacastrum, Tamarix senegalensis, Salvadora persica* and *Acacia nilotica*, the last three being dominant. It was also noted that *Scirpus littoralis,* the most common species, is not browsed, whereas *Sporobolus robustus* the next most common species is. *Sporobolus maritimus,* a rare species in the Djoudj context, is intensively browsed.

In a dry savannah area in Southern Burkina Faso, *Botoni (2003)* found the amount of time spent by cattle on ligneous species to be 6% of the total time spent eating. The time spent browsing was minimal during the rainy season (May to October), but increased to 10-13% during the cooler part of the dry season (December to February) and then to 30% during the warmer part of the dry season (April).

In another study where the behaviour of small ruminants on a free Sudanian range system[3] was monitored during 12 consecutive months, *Nianogo et al. (1998)* found that the average time spent browsing was 82% for goats and 15% for sheep. The rest of the time was spent grazing. The time spent on ligneous species was found to be lower during the rainy season, as good quality green herbaceous plants are abundant during that period.

Additionally, the same study found that small ruminants spend little time in uncultivated lands when given a choice. While they are maintained in neighbouring natural savannah by a herder during the dry season, they feed only on remote cultivated fields (37-38%), house cultivated fields[4] (30-36%) or fallow lands (30-36%) during the dry season, when they are free to move about. Similar relations where found by *Kiema (1994)*, who also noted a preference of small ruminants for cultivated fields (70%) over the natural pasture (30%). This is partly explained by the fact that several palatable ligneous species are found in cultivated fields and fallow lands that are sufficiently small in height (*picture 3*) to be easily reachable.

With regard to trampling, the study by *Ickowicz et al. (2000)* showed that an impact could be noted only in cattle walkways - trampling did, for instance, not affect the percentage of bare soil in the pasture area.

1.3.2 Plant reaction

Ruminants consume certain leaves, buds and fruits directly on the trees, but also dead leaves, flowers and fruits found on the ground (*Botoni, 2003*). It is believed that where livestock numbers are not excessive, ruminants may contribute positively to plant growth and reproduction. By dispersing pollen and seeds, livestock help improve soil cover. Browsing helps regulate shrub growth while grazing removes herbaceous biomass which

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[2] Composed of 2742 cattle, 1002 sheep and 1107 goats

[3] Small ruminants were free to move about the village territory during the dry season, and restricted to non cultivated fields only during the rainy season (June to mid October).

[4] House fields are located right around the household, while remote fields may be quite distant (2-20 km).

may otherwise provide fuel for bush fires. Additionally, trampling breaks soil crusts. Many of these factors stimulate grass growth and seed germination, thus contributing to land and vegetation improvements.

Plant reaction to browsing varies with species. With *Acacia nilotica* and *Dichrostachys cinerea*, which are commonly browsed in African savannahs, buds and leaves emerging shortly (up to 18 days) after clipping showed the same nitrogen and tannin content as on non- clipped individuals (*Leriche et al., 2001a*). Additionally, the biomass of green shoots did not change in reaction to clipping on *Acacia nilotica*. In another study (*Leriche et al., 2001b*) the authors found that the nutritional quality of shoots is maintained for *Acacia nigrescens* and *Dichrostachys cinerea,* but improved for *Acacia nilotica* (N content was maintained while tannin content decreased following browsing). Such plant behaviour therefore stimulates continuous browsing by herbivores.

It is, however, noted that intensive browsing will only affect young plants and reachable parts of the canopy of older individuals. Additionally, *Gowda (1997)* reported that certain plants are able to protect themselves by growing an impenetrable canopy.

It is also known that heavy grazing decreases soil organic matter content, and causes soil compaction, which reduces water infiltration and storage and contributes to erosion. Continuous removal of leaves and buds in short time intervals depletes plant reserves, reducing the plant's ability to compete with other species for light, water and soil nutrients. Long term intensive browsing may eventually affect the presence of a given community in the ecosystem, with potential effects on herbivores that might be linked to that community. *Audru (1977)* listed an important number of tropical herbaceous and ligneous unpalatable species that tend to become invasive when palatable species are under heavy grazing or browsing pressure. Such plants are often used as indicators of degradation. *Botoni (2003)* found grass diversity and cover to be greatest in areas most intensely grazed, which was analysed to be the combined result of importation of seeds from other areas, increased growth of grazed perennials and the pressure exerted on palatable species which allow the installation of species that may normally not be competitive enough to manage on their own. He also found that, in spite of greater plant diversity, intensely browsed areas have a pastoral value 1.5 times lower than other areas.

It may be seen from the above discussion that the mobility of herbivores, particularly ruminants conducted by experimented herders is a key factor that may help regulate animal pressure on individual plants or areas.

1.3.3 Role of the herder

Although the effects of livestock on the vegetation is often attributed to the animals, it should be remembered that in many, if not most, cases livestock are driven by a professional herder who decides on the size and the itinerary of the herd, including the amount of time spent on each pasture area. In doing so, the herder has the ability to regulate the level of pressure exerted on a given area. Because ruminant rearing has been a traditional activity for them for centuries, Fulani herders are generally recognised as better livestock and pastoral resource managers than herders from other ethnic groups, while the latter are often more skilled in crop production.

Because of advantages expected from controlled grazing (better quality of life due to the absence of seasonal transhumance, no excessive surveillance of the herds and shorter distances to water points, more security against cattle theft, better nutritional and sanitary states of the animals, etc.), there have been some attempts to base ruminant production on the carrying capacity of the land in several countries. In the *Widou Thiengoly* area located in the northern part of Senegal that is called *Ferlo*, the following cattle loads were suggested after a 10-year (1981 to 1993) controlled grazing study:

- Loads of 6 to 8 ha/TLU (Tropical Livestock Unit[5]) in years with « normal » rainfall (biomass = 1 t/ha),
- Loads of 2 to 4 ha/TLU in productive years (biomass >1.1 t/ha)
- 10 to 14 ha/TLU during dry years (biomass <0.7 t/ha).

Additionally, it was found that fixed animal loads of 10 to 14 TLU did not favour the development of a stable and appreciable herbaceous stratum but these load levels were favourable for the invasion by tree species.

Another practice that has consequences on tree development is the fact that many herders cut branches from palatable trees that may be out of the normal reach of livestock to make them available to the animals. For Southern Burkina Faso, such mutilations were essentially attributed to Fulani by *Botoni (2003)*, who found that

[5] One UBT is the equivalent of a live animal weighing 250 kg.

species such as *Pterocarpus erinaceus, Afzelia africana* and *Acacia polyancantha* were more often cut than other species. He also found abusive pruning to be more frequent during the dry season.

1.3.4 Role of the land manager

To some extent, the plant composition and productivity of a given area may be the result of human management. The type of crop that is produced and the technologies (manual, mechanical or chemical means) used to prepare and maintain the land to some extent determines the diversity and productivity of plants found in cultivated areas. The latter will, in turn, affect the amount of time spent by livestock in cultivated fields, as compared to time spent in natural pastures. Additionally, livestock pressure on natural pastures will be greater in regions where crop residues are burnt than in those where they are left standing for ruminants to use.

Pasture plant product (wood, grass) exploitation by land owners or other resource users may also affect the vitality of plant groups in different ways. An important removal of trees will for instance favour the development of herbaceous plants.

1.3.5 Natural factors

Dry and semi arid SSA has been facing several drought episodes in the last thirty years, with the most severe ones in 1972-1973 and 1983-1984. Their impacts on Sahelian rangelands, with the poorest soils of the world (*Breman and Sissoko, 1998*), were evaluated in many studies (*Valenza, 1981; Grouzis, 1998; Boudet, 1989; Hiernaux et al., 1990*). The main findings from these studies are:

- the quasi disappearance of many perennial grasses (*Andropogon gayanus, Aristida stipoïdes, Diheteropogon hagerupii, Hyperthelia dissoluta)* that used to colonise more than 15% of the space in some areas;
- a rarefaction of certain woody species (*Acacia senegal, Commiphora africana, Combretum glutinosum, Dalbergia melanoxylon, Grewia bicolor, Pterocarpus lucens, Sclerocarya birrea, Terminalia avicennioides*) resulting in a simplification of the stratum. Few ubiquitous species such as *Balanites aegyptiaca* and *Boscia senegalensis* eventually tend to dominate;
- a decrease of the vegetation cover consecutive to an important mortality of woody plant species, and exposition of the grounds to wind and water erosion phenomena.

A study by *Miehe (1991)* showed a huge resilience of Sahelian ecosystems as illustrated by the capacity of the vegetation to restore itself and the livestock to continue to grow after a few years of favourable rainfall (*FAO, 1999*). However, many perennial herbaceous plant species have become rare. Furthermore, some authors are sceptical of the capacity of most natural woody species to regenerate. *Miehe (1991)*, for instance, found woody stands to be almost non-existent with the exception of ubiquitous ones, even after protection for more than 10 years. Climate variability, grazing pressure, wild fires and other factors may play a role in keeping many species from re-appearing.

Natural factors affecting the integrity and productivity of the natural vegetation therefore play a role by either aggravating or lowering the effect of grazing and browsing. Droughts affect plant biomass productivity as well as plant diversity (*Grouzis et al., 1991; Akpo et al., 1995*) and nutritional quality of the herbages (*Penning de Vries and Djiteye, 1991; Somé et al., 2000*). Additionally, plants under livestock pressure are much more affected by droughts than under normal conditions.

1.3.6 Conclusion

It appears that the relationship between ruminant livestock and vegetation is dynamic and depend on two major factors:

Plant species makeup and productivity, which depend on soil characteristics and topography, and on climatic factors like rainfall and ambient temperatures.

The total herbivore charge in the range area, which takes into account the animal species (and their daily dry matter intake) and numbers as well as the time spent on the particular pasture.

In ideal situations, both these factors can be managed by men. Land managers may play important roles through the use of tools such as early fires (to favour regrowth of perennial grass species and prevent devastating bush fires), and access regulation. Experimented herders can also keep their livestock moving to avoid degrading an area.

2.0 EFFORTS TO ACHIEVE INTEGRATION OF LIVESTOCK MANAGEMENT IN FORESTRY – CASE STUDIES

2.1 Potential and limits of Sudanian forests and cattle feeding in Senegal[6]

The Senegalese Institute for Agricultural Research (ISRA) and the Centre for International Cooperation in Agricultural Research Development (CIRAD) carried out a joint research programme on tropical cattle feeding in the Kolda region where average rainfall is 960 mm. The study dealt with the analysis of the dynamics of fodder based cattle feeding systems in this zone where sedentary Fulani herders feed their livestock either on the forests during the rainy season or mainly on crop residues in the dry season.

Land use mapping allowed, on the basis of height and density of ligneous vegetation, the identification of four main types of woody vegetation, from which two, viz. Sare Yero Bana (SYB) and Dioulacolon (DLC), were chosen. These two forest types were then continuously monitored during three years. In addition, three herds were monitored every two weeks in each forest, with the area visited and plants eaten recorded daily.

The data was fed into a geographical information system (GIS) that allowed the identification of pastures as well as the species used by the animals from one season to the next one. The data also allowed the assessment of the quality of diets and levels of cattle production.

The main findings of this study were the following:

- The two chosen forested areas are different in phyto-sociological terms, and are also subjected to different anthropological pressures, which have shaped the profiles of their strata.
- The potential available fodder biomass from ligneous origin in the two forests varies from 443 Kg of dry matter (DM) per hectare to 1062 kg DM/ha, in comparison to 1200 to 3000 kg of DM/ha for the herbaceous biomass.
- Around 71% of the available fodder biomass from ligneous origin in SYB is used by cattle whereas only 24% in DLC.
- The following four species constitute about 40% of the fodder biomass from ligneous origin: *Combretum nigricans, C. collinum, C. glutinosum* and *Terminalia macroptera*.
- The average consumption of fodder from ligneous origin by cattle represents 11% of the diet, with large variations ranging from 1 to 29%, and a maximum occurring in May.
- The most browsed plant species are *Oxytenanthera abyssinica, Holarrhena floribunda, Dichrostachys cinera, Baissea multiflora,* and *Khaya senegalensis.*
- Animal browsing reduces by 20% leaf biomass at the end of the dry season but this is offset by the observed new growth following the onset of the rainy season.
- Animal browsing by diminishing the density of the herbaceous layer contributes to the reduction of damages that forest fires might cause and, hence, it favours the development of young seedlings (regeneration).

[6] Adapted from Ickowicz and Mbaye, (2001).

2.2 Reconciling livestock production with natural resource management in the Inner Delta of the Niger River (Mali)[7]

Mopti, the fifth region of Mali is located in the central part of the country and encompasses the Inner Delta of the Niger (IDN) River. Several ethnic groups, organised in a hierarchical order with casts, make up the populations of this area. All ethnic groups raise livestock, but those recognised as true pastoralist are *Tuareg, Moorish* and *Fulani*, the *Fulani* being the most numerous. Other tribes include the *Bozo* (renowned fishermen) and *Somono, Sonraï Bambara* and *Marka* who are mostly crop producers.

2.2.1 Livestock production in the Mopti area

In 1980, with over 1.6 million heads of cattle and 2.3 million heads of small ruminants, the Mopti region sheltered more than 20% of the livestock population in Mali, making it the primary livestock region in the country. Today the livestock population in the area has grown to over 5 million heads.

Large herds are generally more mobile than small ones. The Delta region welcomes hundreds of herds during the dry season from the Mopti, Gao and Timbuctou regions in Mali, and from Burkina Faso and Mauritania. During the rainy season, Fulani from the Delta move outside the area to avoid conflict with crop producers.

Livestock mobility and access to the richest grazing areas of the IDN has always been strictly organised through a pastoral code of conduct since the reign of Cheikou Amadou. The latter divided the flood plains in 30 pastoral areas and attributed them to Fulani clans. Each clan had a family that acted as the *Dioro* or "pasture master". Nowadays livestock movements and access to the *Bourgoutières*[8] are regulated by an annual workshop that is held in June in the city of Mopti.

2.2.2 Ecology of the Delta

The Inner Delta is a network of lakes, ponds and tributaries to the Niger River. Although the climate is Sahelian (300 mm rainfall/annum), surface water is rather abundant, particularly during the flood period[9], and in spite of the fact that almost half the 60 billion cubic meters of water the Delta receives annually is lost by evaporation, transpiration or infiltration. Seasonal variations in the abundance of water determine the ecology of the region. The level of the water table determines the duration of the flooding and the soil type determines the makeup of the vegetation.

The vegetation in the Delta is one of the most characteristic and original of Mali. It includes important forests (Dentaga, Akkagoun[10]) bearing endemic plant species such as *Acacia kirkii* and shelters 350 bird species, including 108 *palearctic* migratory species, more than 300 fish species, manatees and hippopotamuses. The area shelters three Ramsar sites - the Debo Lake (105 000 ha), lake Horo and the Séri plain. Plant communities are organised in concentric patterns from low lands to higher areas.

One finds aquatic meadows, shrubby lands and mixed vegetation of alluvial banks where predominant *Echinochloa stagnina* is accompanied by *Vossio cuspidate*, *Nymphaea lotus*, *Pistia stratiotes*, *Oryza longistaminata, Vetivera nigritiana, Andropogon gayanus* eand *Mimosa pigra*. The flooded plains present a herbaceous vegetation that develops after the first rains. On adjacent lands, deposits allow the survivals of mostly grasses but also shrubs and a few trees, the most frequent being *Mitragina inermis, Piliostigma reticulata, Ficus* sp., *Mimosa pigra, Syzygium guineense* and *Nauclea latifolia.*

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[7] This case study is adapted from Mahalmoudou, 2003.

[8] *Bourgoutière* is the French name given to floodplain pastures where aquatic perennial grasses such as *Echinochloa stagnina* dominate. Such grasses are highly palatable because of high digestible organic matter content and because they are available during the dry season, where most grasses are in the form of straw.

[9] The water height varies by as much as 3 to 5 meters between low and high water periods.

[10] The forests of Akkagoun and Dentaga located in the Ramsar site of Wallado-Debo are rest and reproduction areas for thousands of water birds. Lake Debo and the forests of Dentaga and Akkagoun are located inside Youwarou, a 7139 km² circle located in the heart of the IDN.

On low sloping banks, the vegetation is dense patches of shrubs, interrupted here and there by grassy or bare areas. Woody species include *Diospyros mespiliformis, Balanites aegyptiaca, Acacia seyal, Piliostigma reticulata, Tamarindus indica, Guiera senegalensis, Capparis tomentosa* and *Leptadenia hastate.*

On lower plains, *Terminalia macroptera, Piliostigma reticulate* and *Gardenia* sp., as well as *Pterocarpus erinaceus, Pseudacedrela kotschvii, Acacia seyal, Mitragina inermis, Diopyros mespiliformis* and *Ximena africana* are found.

Communities of *Borassus aethiopum* and of *Hyphaena thebaïca* also border the Delta and lake area.

2.2.3 Natural Resource management

Natural resource management systems evolved from free access some 150 years ago to different types of regulatory systems. The founder of the theocratic Fulani Empire (19th century), Cheikou Amadou, imposed a new administrative structure that took care of almost every aspect of community life, including natural resource management. Migratory herders and fishermen were sedentarised and access to critical resources (crop lands, flood plain pastures, fish resources) was methodically organised, while access to others (forest resources, wild plants) was unlimited. This system operated well due to the ability of the rulers to enforce their laws, the existence of conflict resolution mechanisms and the low population pressure that prevailed at that time.

With the colonisation of Mali by the French at the end of the 19th Century, the management system implemented by Cheikou Amadou was no longer recognised. Forest services were created and many of the forests in the Delta area were classified. While access to forest resources was prohibited to local communities, the colonial ruler organised the harvesting of timber and its transportation on the river. A similar behaviour was applied by the authorities after independence, thus promoting more frustration for communities and less environmental friendly behaviours.

2.2.4 Degradation and its consequences

The Delta is home to the *Bozos,* an ethnic group that specialises in fishing, and to the *Soninké*. But because of the variety and abundance of resources, the Delta has always attracted people from all over Mali and neighbouring Burkina Faso and Niger. High quality grasses attract large numbers of herders who converge towards the Delta with sometimes close to a million heads of livestock from remote places in Mali and Burkina Faso during the off-flood period. Their encounter is a cause for ritual celebrations. The availability of water throughout the year allows the production of more than one harvest per year (due to the possibility to irrigate), making the area a heaven for crop producers.

However, there has been a significant increase in human and livestock population numbers that has caused the availability of crop land to decrease drastically (down to 0.45 ha per inhabitant in 1995). Recurring droughts have forced many Fulani to sell their cattle to absentee owners (people living outside the Delta).

Furthermore, dams built in upstream (Sélingué, Markala and Sotuba) areas and climate change (decline in the amount of rain received annually) have affected the extent and the duration of the flood, and consequently primary and secondary production as well as plant diversity. Annual plants now tend to be dominant, and pasture productivity has decreased from 20t DM/ha in the past to 15t DM/ha today. Fish captures have declined from more than 100 000 t/year to 40-50 000 t/year.

Because of harvesting of timber and non timber products, overgrazing and clearing for crop land, only a few of the numerous original forests remain today. The forests of *Akkagoun* and *Dentaga* owe their survival to restoration and management initiatives by local communities, the central government and international institutions such as IUCN (*IUCN, 1989a*).

2.2.5 Resolving the livestock feed and the environmental crises

Because of the importance of livestock in the area, several steps were taken to try and resolve the feed crisis:

- Decentralisation of *bourgoutière* management (power to the head herder rather than to the head of the clan for the management of smaller plots of pasture) (*IUCN, 1995*).
- Introduction of an annual workshop on *bourgoutières* in the city of Mopti, discussing questions of access, passage, etc.

- Restoration of 1420 ha *bourgoutières* (*IUCN, 2001*) and empowerment of specialised farmers for their maintenance, harvesting and commercialisation
- Delimitation, plantation, direct seeding and protection helped to restore the forest (174 ha at Akkagoun and 60 ha at Dentaga) (*IUCN, 2001*).
- Elaboration and implementation of local conventions for the conservation of the restored forest and of the biodiversity that it shelters. The conventions define the management system as well as the rights and duties of users. Four such conventions were implemented in the Youwarou area, related to the forests of Akkagoun and Dentaga, the fisheries of the commune of Youwarou, and the Bourgoutières of Débaré and Akkagoun. The local conventions draw from the pastoral code of conduct (Charte Pastorale) as well as from the Law on decentralisation. They help regulate legal and equitable access to NR. These conventions have, for instance, listed *Acacia kirkii* as a protected species, and prohibited timber and wildlife exploitation from the restored forests, the penetration of domestic livestock in the forests, forest fires, unauthorised visits as well as clearing new land for cultivation.
- Empowerment of a 12-member local management committee for both the *bourgoutières* and the forest of Akkagoun. The committee is in charge of surveillance, forest and natural resource law enforcement, forest fires, recovering fees and fines, prevention and management of conflicts.

2.2.6 Lessons learnt

The restoration and management mode of the Dentaga and Akkagoun forests are considered a success story by the local population and many observers. Community members proudly explain to visitors what they have done to restore the forests and how there has been a notable increase in the number of birds nesting in the flooded forests, causing the amount of bird litter falling in the waters to also increase, with a positive effect on both the grass cover and the fish living in it. The site is considered a well managed Ramsar site (*IUCN, 1989b*) and properly managed *Echinochloa stagnina* pastures and livestock provide substantial income to the communities around it. The collective bargaining that led to the current management system has brought resident and non-resident communities, administrative authorities and elected representatives much closer than before.

It is, however, fair to recognise that as livestock numbers continue to increase in the Delta, the management system will continue to be challenged by risks of conflicts around cattle transhumance corridors and around access to the *bourgoutières*.

2.3 Accommodating migratory livestock in Central Burkina Faso[11]

The Bougnounou area is located 150 km south of Ouagadougou. Thirty villages totalling 52 000 inhabitants are found in the area. While *Nuni* are the aboriginal ethnic group, other groups have moved into the area either for cropping land (the *Mossi*) or for exploiting the natural fodder (the *Fulani*).

2.3.1 Livestock production systems

Cattle, sheep and goats in the Bougnounou area essentially depend on the natural vegetation for their survival and production, as little or no concentrate feed nor cultivated fodder is provided.

Local herds are run for different purposes - for animal traction (cotton cultivation), beef steers (where the animals are resold after a year or two), and cow-calf operations. While the first two modes are more often run by Mossi and Nuni, the latter is mostly found with the Fulani and includes by far the largest number of cattle. During the rainy season, ruminant livestock are driven away from growing crops and into parts of the forest under management where grazing is allowed. During the post harvest season (October to December), all ruminants stay on cultivated fields to benefit from crop residues (sorghum, millet and groundnuts). During the rest of the year, small herds graze freely in and around the villages while most of the larger ones[12] remain in the

[11] Adapted from *Ouédraogo, 2003*.

[12] As conditions may vary from year to year depending on actual rainfall some herds may travel small distances to areas where water and fodder are more available.

forest. Those that go to transhumance away from Bougnounou head southward where permanent rivers and ponds are more frequent

Cattle from other regions (up to 150 km northward and away from Bougnounou) of Burkina Faso move into the Bougnounou area during the dry season, to benefit from the managed forest and from the wells, and dams constructed by government projects in the area. Livestock numbers thus increase dramatically during the dry season, thus putting additional pressure on the resources. Past the month of February, much of the grass has been burnt or grazed several times, after which ruminant livestock browse reachable parts of ligneous plants. In addition, herders cut branches of some preferred species to supplement feed.

2.3.2 Ecology of the area

With an annual rainfall of 900 to 1000 mm the territory is essentially a savannah area mostly covered by shrubs (47%) and trees (33%); the rest of the surface area is covered by river forests (7%) cultivated fields (5%), fallow land (7%), or bare areas (2%). Ligneous plants include 96 species representing 63 genus and 30 families. *Combretum micranthum, Detarium microcarpum, Acacia macrostachya, Piliostigma thonningii, Pteleopsis suberosa,* and *Vitellaria paradoxa* are among the most frequently met species. Trees higher than seven meters include *Anogeissus leiocarpus, Crossopteryx febrifuga, Lannea acida, L. microcarpa, L. velutina, Terminalia macroptera, Vitellaria paradoxa, Isoberlinia dalgielli, I. doka,* and *Khaya senegalensis.*

The forest is the habitat of numerous birds, reptiles and mammal species, although great mammals (antelopes, elephants and carnivores) have become rare (*Ouédraogo et al., 2003*).

2.3.3 Natural Resource management

With the guidance of the forest service, the local population has accepted to put part of its land under protection and specific management. The territory of the area has thus been classified in two sectors - the agricultural sector, where agricultural activities are conducted, and the forestry sector (25 200 ha under management). The forest area has been further divided into several blocks to facilitate management and exploitation. Only one block can be exploited in any given year, and each block is exploited only every twenty years. Exploitation takes place from February to March and includes the cutting of tree species meeting certain criteria for fuel wood. Species such as *Vitellaria paradoxa* and *Parkia biglobosa* are protected, while *Detarium microcarpum* and other species are cut at a height of about 15 cm. Removed trunks are then processed and transported to large cities for sale.

Freshly exploited blocks are reseeded by hand during the following rainy season and protected from fires and animal grazing for two consecutive years. Fire stoppers (alleys where all burnable materials are eliminated) and early, controlled fires (set right after the end of the rainy season) are used to avoid possible damage from wild fires.

The management of the forest of Bougnounou is taken care of by an independent federation gathering 30 woodcutters associations. The federation employs a forester and a small team to help plan field activities. The woodcutters themselves take care of activity implementation (tree cutting and marketing, reseeding, forest protection from fires and illegal activities, etc.). A survey conducted in 2002 in the area indicates that members of the association have an income greater than the national poverty level, in a country where about 44% of the total population is below the poverty level.

In spite of the protective measures taken by the management authority and the local forest service, most forests under management, including the Bougnounou forest are still the subject of occasional wild fires, and some illegal activities such as poaching, wood removal, grazing by transhumant livestock, and harvesting of ligneous fodder by cattle herders. Furthermore, certain of the ligneous species that are reseeded do not grow well.

However, recent surveys show that the Bougnounou forest under communal management is in relatively good shape and in any case far less degraded than other forests with “free” access in the same area.

2.3.4 Impact of migratory cattle

Before the forest was protected and put under the responsibility of a local authority, the entire area used to be invaded by numerous cattle from various regions in the country, which caused many conflicts with foresters as well as with the residing population, particularly those involved in irrigated vegetable production.

Certain trees species, such as *Balinites aegytiaca*, *Afzelia africana* and *Pterocarpus erinaceus* are frequently found branchless, particularly between February and May, as herders cut branches to supply browse to the cattle. Such behaviour is further stimulated by the fact that bush fires frequently eliminate a large part of the herbaceous vegetation.

2.3.5 Resolving the livestock feed and the environmental crises

The current management plan provides for livestock grazing under specific conditions:

- cattle are allowed only in those parts of the forest that are not under total restriction,
- herders must show proof that their animals have been immunised against known contagious diseases,
- any resident welcoming a herder must immediately inform the management authority,
- tree fodder may be harvested only following well defined guidelines designed to avoid serious damage to the tree.

Additionally, the new national pastoral code of Burkina Faso clearly indicates that livestock owners may be asked to pay access rights before grazing in the forest.

2.3.6 Lessons learnt

Uncontrolled access to forest resources from non-resident cattle contributes to tree damage and other forms of degradation, as well as to conflicts between herders on the one hand and landowners and foresters on the other hand. Land use planning processes that provide for all stakeholders may be a solution to such situations.

2.4 Changes in livestock systems in Torokoro (Burkina Faso)[13]

2.4.1 Characteristics of the area

The land of Torokoro lies in the southernmost part of Burkina Faso, just a few tens of kilometers from the border of Ivory Coast. It covers an area of about 16 500 ha. From a phyto-geographic point of view, it is located in the south Sudanian zone in an open forest area. In the last ten years, annual rainfall averages have ranged between 900 and 1100 mm.

The inhabitants of the village belong to the Doghosé ethnic group. Historically the region is known to have been scarcely populated (less than 4 inhabitants per sq km in 1975). It has, however, turned into an agricultural and a pastoral immigration zone since the beginning of the 1980s. Farmers were the first to massively settle in the village (70% of new settlers) in the early 1990s. They were followed by livestock producers in the mid-1990s. The incoming populations came mostly from saturated cotton production zones (36%), but also from Côte-d'Ivoire (16%), from the Mossi region (15%), from within the province (23%), and from South-West villages (9%). The growth rate of the population went from only 18% between1975 and 1985 to 40% between 1985 and 1996 (*Botoni, 2003*). According to INERA/GRN-SP (1999), non-native farmers represented 72% of the region's farmers in 1998.

The agricultural production systems are generally rotational, with two parallel farming systems: the system of the natives, which is based on yams, cereals and arboriculture, and that of the non-natives, which is based on cereal grain and arboriculture.

2.4.2 Land use and the grazed vegetation

The land in the area is used in three ways: an agro-sylvo-pastoral zone (ASPZ) where both crop and livestock production are accepted, a pastoral zone (PZ) that is reserved for livestock and a classified forest (CF) that is not open to livestock or crop production. Cropped land covered 21% of the land, wooded savannah 62%, and open

[13] Adapted from *Botoni, 2003*

forests 14% of the land in 1998 (*Botoni, 2003*). The other plant formations covered the remaining 3%. However, cultivated areas are rapidly gaining on other land uses.

An analysis of about a hundred vegetation surveys has helped to identify the following three vegetation groups:

- *Vitellaria paradoxa* shrubby to woody savannah. The species characterising this group are *Vitellaria paradoxa, Andropogon gayanus, Parinari polyandra* and *Terminalia laxiflora.* These are all post-cultivation vegetation groups, and they present various appearances.
- Dry forests located near flood-prone areas and on drained areas. The species found here are: *Anogeissus leiocarpus, Acacia polyacantha and Mitragyna inermis.*
- *Isoberlinia doka* open forests. The following species characterise this group: *Isoberlina doka, I. dalzielli, Percopsis laxiflora, Monotes kerstingii, Uapaca togoeanis, Ximenia americana* and *Andropogon ascinodis* as well as the grass *Chizachyriam sanguineum*.

The estimated biomass production in the different groups, varied between 1.3 and 3.7 tons of dry matter (DM) per ha. *Table 1* below presents the different figures.

Table 1. The biomass of a few plant groupings in Torokoro in November 2001 (*Botoni, 2003*)

Plant grouping	Topography	Texture	Biomass (t DM.ha^{-1})
Isoberlinia doka open forest	Plateau	Gravel + crust outcropping	1.56 ± 0.24
Isoberlinia doka open forest	Slope	Alluvium-sandy	1.32 ± 0.15
Shrubby savannah	Slope	Sandy-alluvium	2.27
Vitellaria pardoxa wooded savannah	Slope	Sandy-alluvium	1.98 ± 0.49
Vitellaria paradoxa woody savannah	Slope	Gravelly	2.59
Daniela oliveri wooded savannah	Down slope glacis	Alluvium-sandy	3.69 ± 0.88
Anogeissus leiocarpus dry forest	Medium slope glacis	Alluvium-sandy	1.88

The flora was found to be richer in the forest, with 16 species against 9 and 10 for the other two sites. The protected area status of the classified forests may account for this. In the ASPZ, the ligneous stratum is less rich on account of the different types of domestic wood harvesting practiced there.

2.4.3 Dominant livestock production systems

Most crop farmers are also livestock producers. Small ruminants are reared in 55% of farms, with an average of 9 heads per farm. Sheep are preferred to goats. Out of 311 farms surveyed in 1998, 45% owned at least one head of cattle. The livestock population is composed of small size herds - about 60% of the farms own between 1 and 10 cattle heads. Only 10% of the farms, primarily Fulani breeders, but also some agricultural farmers, have large herds. A third of the cattle population is made up of draught animals.

It is noteworthy that the Torokoro area is traditionally a *Bos taurus taurus* production region. It was only in the 1970s that Fulani herders began to use the area during the transhumance seasons, which then lasted two to three months. The first Fulani settlement dates back to 1995. The cattle population was estimated in 1998 at 1 745 heads, of which the Fulani owned 17%, the Doghosé 39%, the Mossi 37%, and other ethnic groups 7%. More recent figures (*Augusseau et al., 2003*) indicate the presence of 2 138 heads of cattle, of which 59% are owned by the Fulani, 29% by immigrants and 12% by native Doghosé. As for small ruminants, they were estimated at about 1600 heads. The animal load is rather low, being estimated at 9 ha/TBU[14] during the rainy season when the grazing area shrinks, against 4ha/TBU, the accepted norm for the south Sudanian zone.

[14] A Tropical Bovine Unit (TBU) refers to a live animal weighing 250 kg

Three cattle production systems have been identified:

- An integrated mixed system. Herds are composed of 1 to 10 heads of cattle and include mostly draught animals, with an average of three heads per farm. At the moment, the objective is to use animal power for crop production. Crop residues are stored in order to supplement grazing on communal pastures during the difficult periods of the dry season. Successful farms may eventually shift to a cow-calf system, thus changing the production objective from agricultural intensification to capitalisation. About 65% of cattle breeders (owning less than 14% of the livestock) are found in this system.
- A sedentary cow-calf system. Based on the ethnic group and the status (native or non- native) of the breeder, two sub-groups have been identified. The status determines the breeder's rights in terms of access to land:
- In the Mossi sub-system which generally includes large herds, Taurus breeds are highly preferred because these show a greater resistance to trypanosomiasis. The cattle are usually under the care of children, but they are increasingly being replaced by salaried Fulani herdsmen. One important feature of this system is that it benefits from external investments (from coffee and cocoa plantations in Côte-d'Ivoire) for the purchase of cattle.
- The Doghosé sub-system. In this system the average herd size is 26 heads of cattle, with Zebu and Zebu *x* Taurus crosses are preferred. Shepherding is exclusively the task of salaried Fulani herdsmen. Most herds include one pair of draught animals and ownership is on an individual basis. This system results from former large family herds. In the past, the animals lived around the huts and rarely went far from the village. But because of cattle theft and the development of perennial crops (cashew trees), cattle owners were eventually compelled to shepherd them better. Most family herds have been decimated by contagious diseases, and the few that survived have been taken over by the current generations.
- A pastoral system. In this system, mainly practiced by the Fulani, the cattle move seasonally between two or more grazing areas. The herds comprise pure zebu and zebu cross-breeds. The system occupies only 1-4% of the community members and the average size of herds is about 80 heads of cattle. Seasonal transhumance concerns a part of or the whole herd and is conducted by either young men or salaried herdsmen.

2.4.4 Contribution of various plant groups to cattle feeding

The type of vegetation visited by cattle herds varies with season. More than 79% of cattle feed is taken from the herbaceous stratum, of which about 66% are from perennial grasses. These grasses thus account for 30 to 90% of the feed intake depending on the progress of the rainy season. From August onward, the herds tend to return to young fallow lands where annual grasses are dominant. During that period, the contribution of annual grasses reaches about 40% of the feed intake. Outside the post harvest period (December-January) when crop residues provide 30 to 70 % of the feed eaten, the pressure on the herbaceous stratum remains high all year long.

Ligneous fodder also plays a part in cattle rations, mainly during the dry season, which in this region lasts about 6 months (November-April). Throughout the year, only an average of 6% of feed taken by cattle comes from the ligneous fodder.

2.4.5 Impact of grazing on floral composition and plant structure

The agro-sylvo-pastoral zones (ASPZ) are characterised by a richer flora in the herbaceous stratum with 26 species listed against 19 in the pastoral zone (PZ) and 22 in the classified forests (CF). The contribution of hardy grasses is particularly high in the ASPZ, which may indicate a positive impact of grazing on the growth of hardy grasses. In addition, areas experiencing the highest pastoral pressure possess the highest specific diversities (richness of flora and abundance of individual species). Dominance is then less marked, as is the case with less disturbed stations where it has been possible to observe that species like *Hyparrhenia subplumosa* or *Andropogon ascinodis* alone contribute about 60% to the herbaceous cover. Furthermore, areas with the highest specific diversity possess the lowest pastoral value[15]. This is probably the result of competition against the most

[15] Pastoral value reflects potential nutritional value and is an index closely related to floral composition and to structure

productive species, i.e. savannah grasses. Finally, herbaceous plant yield was found to be 1.5 times lower in the ASPZ compared to the values assessed in the PZ and CF.

With regard to woody plants, livestock sample fallen tree organs and accessible shrubs and tree parts. Species sampled include Diospyros mespiliformis, Saba senegalensis, Dichrostachys cinerea, Tamarindus indica, Maranthes poynadra, Securinega viros, Guiera senegalensis, Pteleopis suberosa, Gardenia spp, Acia dudgeoni, Annona senegalensis, Strycnos inocuia, parinari curatelifolia, Hymenocardia acida, Vitex sp, Vitellaria paradowa, and Prosopis africana. Except for a few species, it seems that all the existing ones are taken by cattle provided the organs from the plant are tender (leaves, pods, small twigs, etc.). The bulk of the ligneous fodder used during this period is however made available to the livestock through the herdsman's action of pruning species like Pterocarpus ernaceus, Azfelia africana and Acacia polyancantha.

The direct effect of browsing concerns shrubs and trees with accessible shoots or re-growths. In the shrubby stratum of the open forests, one may frequently come across the following species: *Combretum nigricans, Pericopsis laxiflora, Monotes kerstingii, Ximenia americana* and *Terminalia laxiflora*. The highest plant densities (up to 580 individual plants per hectare) are found in situations with a high pastoral pressure. In these formations some rather unusual new species are noted, namely *Acacia dudgeoni,* which generally contributes to close the shrubby stratum.

Shoots of *Monotes kerstingii* and *Isoberlinia doka* more than 2 meters high are abundant. The number of shoots varies greatly depending on livestock pressure and on the area under consideration with the largest number found in the CF (where pastoral pressure is low) and the lowest (13 to 26 shoots) in the PZ. In the ASPZ, situations with the lowest pastoral pressure present the lowest number of shoots. Additionally, areas with the highest pastoral pressure have the lowest indices of specific diversity. This may be interpreted as the ligneous stratum is getting homogenised when the pastoral pressure is high and as the result of only a few species being selected.

2.4.6 Resolving the cattle feed crisis

In the Torokoro area, a limited number of owners purchase small amounts of concentrate (cottonseed cake) for draught animals and a few milking cows. No fodder is cultivated and almost no one harvests the natural vegetation to preserve it for livestock. The use of mineral blocks is however more general. Livestock therefore depends on crop residues and the natural vegetation. Stored crop residues are used as supplementary feed for draught animals, milking cows, sick animals and donkeys during the dry season. The total amount of residues stored annually represents only 1% of the available crop residues but the amount is slowly increasing. While almost all peanut and bean residues are systematically stored, only part of sorghum and rice residues are kept. Maize is the most popular food crop in the area, but it is harvested before the end of the rainy season causing any stock of residues to be exposed to rain and to deteriorate.

Most crop producers also protect their standing residues until they put their own animals on them. This however may work for house fields but very remote ones are more difficult to protect. Some therefore simply burn the residues to avoid leaving it to others. The proposed reason is that cattle dung propagates a variety of weeds that may increase the work load of farmers during the rainy season.

As a result of the situation of a rapidly declining area of available pasture per unit livestock and in the absence of constructive dialogue, cattle owners resort to two options. Either transhumance, particularly for people owning larger (> 30) numbers of cattle, and even for those owners that do not have mobility in their tradition herders progressively spend less and less time in the area and more time away driving their livestock to remote pastures. Other owners turn a small proportion of their fallow land into an individual pasture area.

2.4.7 Conclusions

Increased grazing pressure from cattle results in increased trtampling and greater plant diversity but decreased pastoral value for the herbaceous stratum. Because cattle maintain a far greater pressure on the herbaceous stratum than on ligneous plants, the latter are favoured. Important grazing pressure on the herbaceous stratum reduces the strength of bushfires, thus regulating the herbaceous-ligneous balance. The ligneous re-growths therefore become more competitive. In clear forests, this results in a multiplication and development of *Acacia dudgeoni*, which is known to impede grazing.

In the absence of dialogue between land owners and cattle owners, cattle owners are resorting to alternatives that may prove to be non-sustainable. With regard to individual pastures, it is obvious that unless appropriate steps are taken to increase the productivity and quality of the fodder produced there, the number of cattle that they will

be able to support will remain rather small. The issue about transhumance is further discussed in other parts of this paper.

2.5 Livestock-forest interaction in the sub-regional W-Arly-Pendjari park complex

2.5.1 Characteristics of the complex

The sub-regional W-Arly-Pendjari (WAP) park complex includes park W, a national park that is shared by Benin, Niger and Burkina Faso, the Pendjari national park in Benin and the Arly national park in Burkina Faso, and the surrounding game reserves (*Figure 4*). The complex covers over 5 million hectares and its climate ranges from Sahelian (500 mm annual rainfall) in its northern section to Sudano-Guinean (1200 mm annual rainfall) in its southern sections. With several semi-permanent to permanent ponds and many rivers (including the Niger, the Mékrou, the Tapoa, the Pendjari, the Kourtiagou, the Goroubi, the Bali-bali and the Arly), the complex is also a network of wetlands. Because of the above mentioned characteristics, the complex is exceptionally rich in landscapes and biological diversity.

Plants and animals from Sahelian, Sudanese and Guinean areas are found in the WAP area. More than 544 plant species, 70 mammal species, 300 bird species, 150 reptiles and amphibians, and more than 100 fish species have been recorded. Recent findings from ECOPAS, a European Union funded sub-regional conservation project, have even revealed the existence of previously unknown micro fauna in the area.

With regard to mammals, important species present in the complex include elephants, buffaloes, lions, defassa waterbucks (*Kobus defassa*), common reedbuck (*Redunca redunca*), Kob (*Kobus kob*), hartebeest, sassaby (*Damaliscus lunatus*), hippopotamuses, cheetahs (*Acinonyx jubatus*), red fronted gazelles (*Gazella rufifrons* roan antelopes (*Hippotragus equines)*, and a diversity of monkeys (baboons - *Papio anibis,* patas monkeys, green monkeys, etc.), as well as several rare endemic species, such as the sea cow. Additionally, the presence of the giant ground pangolin (*Manis gigantea*), common jackal (*Canis aureaus*), hunting dogs (*Lycaon pictus*), common zorilla (*Ictonyx striatus*), Cape clawless otter (*Aonyx capensis*), spotted necked otter (*Aonyx congicus*), serval (*Felis serval*), and caracal (*Felis caracal*) have been noted. Certain species such as hunting dogs and cheetahs are threatened and others are believed to have disappeared (giant derby eland - *Taurotragus derbianus*).

From all available information, it appears that the complex represents the largest transborder savannah/dry forest ecosystem in West Africa. Recent studies have shown that it represents a unique chance for the sub-region to conserve the most complete spectrum of great mammals characteristic of this ecologic area.

2.5.2 Natural Resource management

Owing to the importance of the complex, several national and regional initiatives are under way to try and:

- Improve knowledge of the ecosystems.
- Implement a sub-regional coordination mechanism for natural resource management and use.
- Sustainably manage the complex and improve the utilisation of its resources, with the implication of relevant institutions and communities.

Improved management of the complex includes such measures as a coordinated anti-poaching and anti domestic cattle surveillance, the management of pastures through the use of early fires, the development of permanent water reservoirs and of salt licks.

Although most of these initiatives are relatively new, some success is already being noted with regard to biodiversity conservation. However the complex still faces a number of threats, including the continuous expansion of crop land and illegal grazing from migratory cattle, mostly during the dry season.

2.5.3 Land occupation and use around the complex

Numerous migrants in search of fertile land continue to arrive and settle in the vicinity of the park, further reinforcing population growth in the area. Insufficient crop yields and population growth cause cultivated areas to increase each year, to the detriment of access of livestock to natural areas. The cotton production companies of the three countries are also actively promoting an increase in areas devoted to this crop around the park area. While food crops are low input undertakings, cotton production implies the use of pesticides and chemical fertilisers with possible consequences on the micro fauna of the park.

At the same time, much of the territories bordering the parks have been turned into privately managed game reserves.

The result is strong and increasing pressure on remaining communal land and resources. Many of these areas are used as pasture land, but the great number of animals per hectare and the lack of an adapted pasture management system make them contribute little to domestic ruminant nutrition. For these reasons, non-resident cattle herders see no solution but to feed their animals in the parks (see dry season grasses in the parks in *picture 4*).

It is found that pastoral wells are often surrounded by traps in the form of crop fields put by landowners. Any damage to these fields is then taken by crop producers as an excuse to harass the herders.

2.5.4 Illegal grazing in the park

While most pastoralists are just trying to reach destinations in Southern Burkina Faso, or Northern Benin and Togo, others have deliberately chosen the park complex area as their dry season feeding ground. Most migratory livestock therefore feed in the park areas for varying lengths of time. Recent data from *ECOPAS (2004)* show that more than half the pastoralists use the Benin portion of the park, while the rest are equally distributed between Niger and Burkina Faso.

Domestic cattle compete with wild fauna for pastoral resources in the park and may contribute to disease propagation. Herders also keep carnivorous animals away by use of poisonous meat, and are also suspected to either poach themselves or help poachers. In fact, many herders are armed and will shoot at foresters if they encounter surveillance teams.

2.5.5 Resolving the livestock feed and the environmental crises

Proposed solutions to the recurrent conflicts are the following:

- Improvement of park surveillance.

- Controlled access to park resources under specific conditions.
- Improved dialogue among the countries visited by migratory herders to try and agree on how to handle the issue.
- Rehabilitate pastoral resources (wells, enriching natural pastures with perennial grasses and palatable shrubs and trees) both in the regions of origin of the livestock and around the protected areas.
- Participatory management systems for the improved pastures.
- Facilitate legal reforms promoting more equity between livestock and crop production as means to access land ownership.
- Find ways to stop crop land expansion (intensification).
- Negotiate, materialise and protect pass ways, rest areas and watering points.
- In the dry season destination areas located outside the protected areas and into Southern Burkina Faso, Northern Benin and Togo, facilitate the negotiation of access periods and rights to defined pastoral resources among landowners and pastoralists.
- Park development and management must necessarily take into account sedentary as well as mobile peoples' domestic cattle needs.

A recent meeting, that brought together relevant Ministers from Niger, Burkina Faso and Benin, adopted an agreement allowing the implementation of many of the solutions mentioned above. Decisions included the definition of transhumance routes, rest areas, welcome areas, authorised cattle entry points at borders, areas where pastoral management is to be undertaken, etc.

2.5.6 Lessons learnt

Because of the sub-regional nature of the issues in this case, solutions had to be negotiated both at local (among relevant stakeholders) and regional levels (among relevant national authorities from the three countries). Such negotiations are slow to produce agreements, and will probably be even slower to produce results on the ground. This is because the governments still have to find the funding for the proposed field investments (materialisation of routes and rest areas, pasture development projects, etc.). Additionally, unless an adapted information/explanation campaign is conducted to advise relevant stakeholders (foresters, mobile communities, landowners, private and public resource managers, etc.) of the new situation, little participation is to be expected from certain communities or groups. Finally, such solutions are to be considered rather experimental, as they will need periodic evaluation and readjustment to become really effective.

3.0 THE FATE OF LIVESTOCK IN THE CURRENT CONTEXT

3.1 Opportunities and constraints

It appears that the per capita consumption of meat has declined in some countries (from 20 kg in 1970 to 10 kg today in Senegal) due mostly to decreased per capita net income. But with respect to total consumption, the continuous population growth tends to offset this trend.

Rapid population growth has caused the demand for meat and dairy products to increase significantly, while rapid urbanisation has caused an increasing proportion of African citizens to turn from net food producers (i.e. farmers) to net food consumers (urban workers). But livestock productivity in SSA is generally far below European standards - milk yields of lactating females, growth rate of young or fattening animals and adult body weights of endogenous cattle, sheep and goats breeds are generally lower than those found in the developed world. For these and other reasons, most Sahelian countries remain net importers of dairy products while coastal countries are net importers of both meat and dairy products. Senegal, for instance, imports about 30 billion CFA worth of dairy products annually. Coastal countries cover their meat deficit (50% for Côte d'Ivoire, 30% for Ghana, 60% for Togo and 70% for Benin) by importing meat and livestock essentially from Sahelian countries, but also from countries outside the sub-region.

Needless to say, the importation of meat and dairy products is an economic burden that is growing heavier for countries in SSA, many of which are among the poorest in the world.

For these reasons, and in spite of various constraints, African governments are faced with tremendous challenges to try and increase domestic livestock productivity. The question is finding a balance between livestock, agriculture and the environment, as many livestock projects, valued at millions of dollars, have not yielded the expected results, leading several financial partners and other international institutions to reduce their support towards the sector (*Baxter, 1994*; cited by *Scoones, 1992*).

3.1.1 Pastoralism in relation to the current environment

Studies by *De Haan et al. (1999)* and others have shown that as an opportunistic way of exploiting natural resources, pastoralism appears to be not only ecologically sustainable, but also relatively productive. This is particularly true for several fragile ecosystems in the Sahel. In fact, based on a study conducted in the Sahel area of five countries (Burkina Faso, Chad, Mali, Niger, Senegal, and Sudan), it was shown that contrary to popular belief, livestock productivity per area unit (+93%) and per head (+47%) increased, at the same time as livestock numbers did during the past three decades in the Sahel.

However, it appears that competition (*Shanmugaratnam et al., 1993*) from crop production, herd dispossession, wars, droughts and population growth have undermined traditional pastoral institutions and contributed to mass displacement of pastoralists. There has also been a trend towards voluntary and involuntary settling of pastoralists, particularly following the 1973 and 1984 droughts. Many pastoralists have gone from pure pastoralists to agro-pastoralists in which crop production is subsistence oriented and highly risky (conflicts, rainfall variability, lack of experience in the new activity). The problem is that prospects for significant increases in range productivity are limited for technological as well as for economic reasons; in fact, many of the traditional range areas are either no longer available or seriously degraded.

For remaining mobile herders, the situation is further complicated by the fact that livestock tracks have either been occupied by other land users or have totally disappeared. In some cases, borders between neighbouring countries have been closed due to long periods of conflicts. As a result, pure pastoralism seems to be fighting a losing battle as a way of life and a production system.

3.1.2 Sedentary systems as alternatives to pastoralism

Governments all over Africa have tried to implement various livestock development schemes, with varying degrees of success.

Because of the higher productivity expected, ***intensive systems*** have been favoured by many governments as a way to rapidly increase production. There are, however, many obstacles to overcome:

- The availability of the concentrates (grain, oil seed cake or meal) on which intensive systems normally depend remain tied to crop (sorghum, millet, corn, cotton, peanut, etc.) yield and production. Unfortunately, important investments in both research and extension are still to show the expected positive impact on agricultural productivity. Farmers are slow to adopt research results because of (i) inefficient extension systems, (ii) lack of access to rural loans to purchase fertilisers and improved seeds, and (iii) the variability of rainfall.
- The promotion of cultivated fodder have had limited impacts in most countries. Following the 1972-73 drought, CILSS[16], FAO and cooperating agencies jointly initiated a project promoting the production of cultivated fodder. Numerous grass and legume species were tried and species such as siratro, *Dolichos lab-lab*, *Stylosanthes* spp., *Mucuna* spp. and *Cenchrus* spp. gained some interest at first, but only multipurpose species such as beans (or black eye peas), peanuts and *Andropogon gayanus* remain popular today. In fact, the level of adoption has remained very low in most countries (less than 4% adoption rate and 1000 Tons of dry matter produced in Burkina Faso in 1996) in spite of important research and extension efforts.
- Productivity remains limited for genetic as well as for technological reasons.
- Government agencies have often pushed for development schemes (i.e. importation of exotic breeds and artificial insemination[17]) that eventually proved to lack adaptation to the region, or for technical solutions

[16] Interstate Committee for Combating Desertification in the Sahel.

[17] Many African countries have adopted an ambitious policy option favouring artificial insemination with the pre-conceived idea that local breeds have a low production potential.

to problems that were really of a socio-economic or institutional nature (export taxes on livestock, import taxes on livestock inputs, inappropriate markets).

The other types of systems that are being promoted are ***mixed crop-livestock systems***. Such systems promote the multipurpose herbaceous species mentioned above for the production of good quality extra fodder. Additionally some multi purpose (soil fertility improvement, fodder production, fruits, timber) ligneous species such as *Combretum aculeatum*, *C. nigricans, Pterocarpus lucens, P. erinaceus*, *Glyricidia sepium*, *Albizia lebbeck*, *etc.,* have been promoted but with limited success, due to difficulties in protecting the plants from grazing and wild fires during the early stages of plant growth. Progress made in promoting mixed systems remains tied to the efficiency of extension services and to the availability of financial support to fund the purchase of livestock or to build the type of compost pits usually recommended. Nevertheless, mixed systems seem to have a great future because they blend into natural endogenous trends and also because almost all livestock owners now produce some type of plant crops.

Other ***general considerations*** and problems include the fact that the proportion of public funds allocated to livestock development by most Sahelian country governments remains insignificant. For instance, government budget allocated to livestock development fell from 1.52 to 0.51% of the total budget between 1961 and 1990 in Burkina Faso. Also non-adapted policies and incentives have often influenced management decisions in a way that favoured either environmental degradation through wasteful use of natural resources or lack of return from invested budgets. The Christine Well[18] in Northern Burkina Faso is a good example of well-intended initiatives that turned into ecological disasters.

3.1.3 Livestock related conflicts

Many of the conflicts in which livestock are involved are internal to a single community, since the majority of crop producers in Sudano-Sahelian Africa now own livestock. Because most communities have traditional resolution mechanisms for disputes among their own members, this type of conflict is generally considered of little consequence. More dramatic situations may, however, arise as a result of certain specific situations:

- In many SSA countries land has been nationalised by governments following independence, causing a weakening of traditional landowners and of conflict resolution mechanisms (e.g. the case of Youwarou in Mali). Thus, disruption of traditional rules and mechanisms has therefore sometimes resulted from government made policies.
- In general, the traditional organisation of a given community will favour the lifestyle and production targets of that particular community. Thus, in areas traditionally inhabited by Fulani and other pastoral communities, access rights to land and pastoral resources were well organised by local institutions and favoured livestock. On the other hand, land and access rights in areas traditionally inhabited by crop producers favoured plant crop growing. The risk and occurrence of conflict may therefore increase as a result of new groups migrating into an area where the established traditional laws are unfavourable to their preferred activity. Such groups will generally show some reluctance to respect established rules, particularly if the number of incoming community members is significant enough compared to the population of residents
- The other major cause of conflict is related to the movement of livestock. Migratory herders driving their livestock through various territories and to pastoral resources in areas that are ruled by other groups quite often run into conflicts with landowners or land managers at a national or sub-regional level, including with public or private protected area managers.

Resolving the livestock crisis therefore requires action at local, national and sub regional levels.

3.2 Conflict management

Because livestock related conflicts are recurrent and sometimes dramatic, management systems are being tried at local, national and sub-regional levels.

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[18] The Christine Well was constructed in a vast plain rich in good quality pastures, which were normally not accessible to livestock. Humans and livestock stay far away from the area because of flooding during the rainy season, and due to the lack of water during the dry season. The well attracted so many cattle that the entire area. was rapidly turned into bare soil, eventually causing thousands of cattle trapped too far from other watering points to die of either hunger (for those that remained near the well) or of thirst (for those who tried to find food).

3.2.1 Local perspectives

In many cases, traditional institutions have been able to play a decisive role in negotiating agreements between different stakeholder groups. As pointed out earlier, the difficulty lies in the fact that the institutional setup has been changing, one of the results being that traditional institutions are progressively being relegated to marginal roles.

Almost all SSA countries are now in a decentralisation process that promotes the election of governing bodies at village, departmental and regional levels. In Burkina Faso, for instance, village resource management committees (VRMC) are being established in all villages. The VRMC is composed of representatives of all resident stakeholder groups and they oversee village development planning and implementation, including landscape planning and conflict management. Such local governing bodies may negotiate agreements with other groups or institutions (including pastoralists). Although different countries are at different stages of the decentralisation process, it is expected that these bodies will be able to play important roles in conflict resolution at village level. Some capacity building may, however, be necessary before local governments reach the expected level of efficiency in their function.

3.2.2 National perspectives

Mauritania, Burkina Faso and other Sahelian countries have developed, or are developing, a national law dealing with access to pastoral resources. These laws recognise the rights of national and non-national herders to travel with their animals for pastoral reasons, including across borders. Transhumance is, however, regulated by a number of rules:

- herders must move about with travel documents (health certificate and international certificates for trans-boundary transhumance) required by the law,
- herders must follow specified tracks during the rainy season for local pass-ways and at all times for international corridors,
- in addition, for international transhumance, herders have an obligation to conform to specified transhumance periods, entry and exit points as well as designated destination areas.

The Pastoral law of Burkina Faso defines four types of areas, each with specific conditions for access: pastoral areas, reserved pasture areas, areas open to pasture and forest areas open to pasture.

- *Pastoral areas* relate to areas identified and specifically developed and managed to promote pastoral activities (implies water and pasture management as well as implementation and maintenance of salt licks).
- *Reserved pasture areas* are areas traditionally devoted to pastoral activities (such as flood plains).
- *Areas open to pasture* include cultivated fields after harvest, fallow lands, and unclassified forests.
- *Forest areas open to pasture* relate to protected or classified forests.

Access to pastoral areas is subject to authorisation while forest areas can be accessed only when specifically accepted by the management plan and then under specified conditions. Access to reserved pasture areas and to areas open to pasture is generally free, but may be regulated by landowners and herders organisations.

The innovation in the existing pastoral laws is that the law recognises the landowner's right to regulate access to his resources, and even to perceive a "just price" for the service rendered to the herder.

However, for several reasons these laws still have to show an effect on the ground:

- Most of the countries that have developed a pastoral law are Sahelian. While they receive part of the mobile livestock during the dry season, the coastal countries do not consider the issue at the same level of priority.
- These laws are new and therefore not well known by the public, including by relevant stakeholders. This also means that they are still to demonstrate the expected efficiency when applied. Some observers have

already expressed concern that the Burkinabé law may not be sufficiently fair to farmers on certain particular issues[19].

- The new laws lack the instruments necessary for their enforcement.

Also, some countries, such as Senegal, are still to develop a pastoral law. So far, the only official existing piece of legislation is an ordinance that defines the conditions for grazing on public lands but remains silent about the separation between pasture lands *per se* and forest lands.

3.2.3 Sub-regional perspectives

In recognition of the importance of transhumance for member States of ECOWAS, the Conference of Heads of State and Government of the Community adopted, in 1998, a decision[20] to regulate it. The decision authorises the crossing of national borders for the purpose of transhumance among all member countries and for the following livestock species: cattle, sheep, camels, donkeys. Herders must, however, hold a valid ECOWAS International Transhumance Certificate and accept official laws.

The ECOWAS Council of Ministers meeting held in Dakar from January 26 to 28, 2003, further made recommendations and adopted rules on the effective implementation of ECOWAS decisions on transhumance as well as a better management of cross-border movement of cattle. The Council stressed the need to find appropriate solutions to minimise conflicts and set up surveillance and transhumance monitoring mechanism as well as strategies and Action Plans. It recommended to the Executive Secretariat to:

- Increase budgetary resources allocated to livestock programmes and the monitoring of transhumance in particular.
- Develop information, sensitisation and education programmes for the target populations.
- Prepare annual technical monitoring reports for the Council of Ministers on the monitoring of the resolution of transhumance related conflicts.
- Propose concrete programmes with the capacity to improve existing livestock breeding systems.

However, not only are these recommendations still to be implemented, but some countries (mostly coastal ones) have shown reluctance to accept the terms of the agreements. Until recently, Benin for instance had braved the agreement by prohibiting transhumance in its territory.

4.0 LESSONS LEARNT AND ASSOCIATED RECOMMENDATIONS

4.1 Land tenure and landscape use planning

Since livestock production is generally not recognised as a true way to exploit a piece of land, it is also not considered an acceptable means to gain access to land property rights in most traditional land tenure systems. Some countries have tried to address the issue either by adopting more equitable tenure systems, or by specifically designating certain areas as areas devoted to pastoral activities. However, few countries have been able to actually enforce the new laws for reasons already discussed. Furthermore, pastoral areas in Burkina Faso are frequently the subject of sabotage by crop producers who wish to re-conquer the "lost" land.

Stakeholder dialogue at sub-regional, national and local levels should be promoted in order to address land tenure, land development planning, land management and natural resource access rights issues in a participatory and equitable manner. Additionally, new agreements and laws should be published in a form accessible to all stakeholders.

[19] One such example is the fact that following harvest, farmers only have a fixed time period to remove the desired quantity of crop residues from their field; once the period is passed, all fields are officially declared "open to pasture" by the local government, who is also responsible for determining the length of the fixed period.

[20] Decision A/DEC.5/10/98 relative to the regulation of transhumance among ECOWAS member countries.

4.2 Managing land for optimal fodder quality

Regardless of land use type, the quality of herbaceous plants is maximal during the rainy season. Except in lowlands and other wetlands, the nutritional value of plants starts decreasing towards the end of the rainy season as they mature, and it eventually becomes rather low (with digestible protein below 1% for most grass species) during the last part of the dry season (March to May). Ligneous plants therefore play a rather important role during the dry season, providing dry matter and much needed digestible protein and vitamin A. Early fires set right after the rainy season promote perennial plant re-growth when there is sufficient residual humidity in the soil. They also help limit the otherwise devastating effect of fires occurring more than three months after the end of the rainy season. These destroy herbaceous and young ligneous plants while weakening many older trees.

Landscapes visited by ruminant livestock include cultivated lands, fallow lands, uncultivated marginal lands, managed forests and protected areas (*table 2*). There are also wetlands dedicated to one or more uses (crop production, grazing, biodiversity conservation).

4.2.1 Cultivated areas

Cultivated areas are obviously accessible for grazing only during the dry season, but it is found that some farmers harvest and store part of the crop residues for their own livestock, while others burn the residues to try and control plant parasites. Considering the amount of time spent by small ruminants in cultivated fields (more than 70% of the time spent eating according to *Kiéma, 1994*) and the continuous expansion of cultivated areas, these will probably continue to contribute significantly to ruminant feeding. Feeds found in cultivated areas include crop residues, weeds and shrub species trying to re-grow after harvest. Possibilities to further enhance the contribution of cultivated areas include alley planting of multipurpose ligneous species, promoting double purpose legume crops such as beans and peanuts as well as cereal varieties with higher quality residues.

4.2.2 Wetlands

Wetlands are particularly prized by livestock herders, because they frequently offer green grass of good quality (including *Echinochloa stagnina* and similar grasses) and water during a time period that very much exceeds the rainy season. Results from Youwarou show that commercial production of high value fodder species may be a good option for increasing the carrying capacity of wetlands in such areas. However, wetlands have to be shared with other users (rice or vegetable growers, fishermen, wild animals, etc.) and can only support a given number of livestock.

4.2.3 Managed forests

Managed forests are normally open to grazing all year round, except for blocs where timber has been freshly harvested. Such blocks are reseeded during the following rainy season, and then protected from grazing for at least one year so as to facilitate the establishment of seedlings and the re-growth of mutilated plants. To improve the contribution of such areas, plant well-being should be monitored and measures taken to prevent wild forest fires.

4.2.4 Protected areas

Most protected areas are very attractive to domestic animals, as they generally offer appreciable amounts of good quality water and fodder. This is so since wild herbivore numbers are usually below the carrying capacity of the land because of poaching and other constraints. In addition, there are efforts from park managers to maintain watering points and to increase pasture productivity. Protected areas are generally not open to domestic livestock, but certain pastoral laws provide for their use in case of droughts and other emergencies. Efforts should be made to monitor plant well-being and voluntary fires set by forest managers to prevent wild forest fires is an efficient means of maintaining such plant well-being.

Table 2. Potential nutritional contribution of various land management setups.

Land use	Period of access to livestock	Condition for access	Vegetation type	Potential nutritional contribution during the dry season
Cultivated lands	Only during the dry season	Negotiation with land owner	Crop residues, various weeds and shrub regrowth	Relatively high right after harvest, due to the availability of fresh residues and of various weeds; lower during the rest of the dry season
Fallows	All year round	Generally free	Ligneous regrowth and herbaceous plants	Variable depending on climatic area
Uncultivated marginal lands	All year round	Generally free	Ligneous and herbaceous plants	Variable depending on climatic area
Wetlands	Variable (regulated)	Often traditionally regulated	Various herbaceous (including aquatic ones) and ligneous plants	Usually very high due to the presence of highly palatable aquatic grasses
Managed forests	All year round*	Free	Ligneous and herbaceous plants in variable proportions	Variable depending on climatic area
Protected areas	None	Not applicable	Ligneous and herbaceous plants in variable proportions	Variable depending on climatic area

* Except immediately following organised timber exploitation

4.3 Policy and related issues

As already discussed, many governments promote intensification to try and meet the ever increasing demand for livestock products. There is, however, little hope that the pursued goal will be reached faster through this approach, considering that traditional systems continue to produce the vast majority of meat and milk in Sahelian countries. Furthermore, it is not clear that intensification will actually reduce livestock pressure on the environment. In fact, investments in intensive production systems will only affect a small percentage of producers, while those directed to traditional systems will affect the vast majority of livestock owners.

In relation to policy and related aspects, *Steinfeld et al. (1999)* recommended the following:

- Levying grazing fees for communal areas to reduce grazing pressure and favour collaboration between migratory herders and landowners.
- Creation of market economic incentives for adapted systems and behaviour.
- Removal of tariffs and other barriers to export for products and import of materials and equipment that will improve production efficiency.
- Promotion of information exchange among stakeholders, systems and countries.
- Training and extension to promote more adapted methods and behaviour.
- In drought prone countries, full cost recovery for services (especially for water and animal health) should facilitate rapid destocking of pastoral areas when necessary.
- Well conceived investments in roads, markets, slaughterhouse, and cold storage will also support rapid destocking in times of droughts.

5.0 CONCLUSIONS

Migratory livestock production systems are exposed to various risks (low access to land ownership, problematic access to natural resources, vulnerability to climatic disasters, high frequency of conflicts, etc.) but they offer, in compensation, a relative flexibility (possibility to readily cash back the capital invested in cattle in case of need, ability to move from one area to various other areas in response to climatic or social constraints, etc.). In addition, it is proven that in many areas of the world, pastoralism is the only option available to turn natural resources into food and income.

Livestock depend on a variety of plant resources, including ligneous vegetation. This provides for a dynamic relationship between livestock and the natural vegetation, the result of which will depend on the composition and density of the vegetation and the number and species of livestock as well as the management style of the herder. While some livestock pressure is beneficial to most plants, exaggerated pressure on the natural vegetation will invariably lead to environmental degradation.

However primordial, the efficiency of the herder depends on the access to various pastoral resources. By regulating (and sometimes prohibiting) livestock access to certain resources, land owners and land managers participate in livestock production, nutrient transfer and the maintenance of environmental integrity.

There are natural complementarities between arid to semi arid areas and more humid ones in SSA. Natural ecological conditions favour livestock production in the drier regions, and crop production in the humid regions. Each region can therefore provide something in exchange for what it does not produce. Humid areas in West Africa contribute to the feeding of a significant proportion of Sahelian livestock by providing dry season grazing areas to migrating cattle. The same complementarity exists at local levels between livestock owners and crop producers, each group benefiting from the other in some way (meat, milk, manure and draught animals being traded for grain and access to crop residues and other pastoral resources).

Livestock is therefore a potential integration factor between communities and between countries in the sub region.

With regard to land and resource use planning, there is a need to strengthen existing dialogue mechanisms and facilitate the implementation of additional mechanisms where needed. This should be complemented with adapted mechanisms to monitor the well-being of the environment so that corrective measures can be taken when necessary.

With regard to production systems it is clear that livestock will continue to depend on the natural vegetation. Productivity will therefore continue to depend on climatic factors, livestock numbers, herder management and access to pastoral resources. A variety of technological as well as policy measures can be taken at local, national and sub-regional levels to promote the systems most efficient for humans as well as for the environment.

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