LIVESTOCK, LAND USE AND AGRICULTURAL INTENSIFICATION IN SUB-SAHARAN AFRICA

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ABSTRACT

This paper focuses on extracts from a recent comparative analysis of livestock and land use surveys across a range of agro-climatic conditions in sub-Saharan Africa, based on information from systematic low level aerial reconnaissance and complementary ground studies in Mali, Niger, Nigeria, Sudan and Tchad, between 1980 and 1993. Results indicate a highly significant relationship between livestock biomass and the intensity of land use, and suggest that cultivation and human habitation are the best predictors of livestock distribution.

These findings are consistent with expectations of the Boserup hypothesis, and are indicative of the `autonomous intensification' of agricultural production associated with the growth of human population, through closer interaction between livestock and arable farmers. The autonomous control of tsetse and trypanosomiasis is a further consequence of the environmental impact of human population growth, which has favoured the southward dispersal and year-round presence of cattle in the Nigerian sub-humid zone. This in turn has created circumstances which have favoured the spread of animal traction and livestock fattening, which are themselves indicative of the intensification process.

INTRODUCTION

Over the years, various authors have tried to explain the wide variation in distribution and abundance of African large herbivore populations in terms of relatively simple mathematical models incorporating one or more environmental variable(s). In a regional study of wildlife and pastoral systems in East and Southern Africa, Coe *et al*. (1976) demonstrated strong positive correlations between large herbivore biomass, mean annual rainfall and above-ground primary production, and suggested that mean annual rainfall might provide useful first order predictions of carrying capacity in savannah regions.

The underlying thrust of their argument was that wildlife systems, having evolved over millions of years, provided a relatively good indication of animal populations that might be sustained in the medium to long term. They noted that wildlife and livestock biomass in six pastoral areas of Kenya surveyed by Watson (1972) exceeded that of wildlife systems with equivalent rainfall. Many domestic animals died in those areas during the 1973-74 drought, and this was interpreted as an indication that previous stocking levels were above the long-term carrying capacity.

While acknowledging that other factors, such as soil fertility and ground water availability, also influence primary production (and hence carrying capacity) at the local level, Coe *et al*. (1976) argued that rainfall was the primary determinant of large herbivore biomass across a broad range of savannah regions with mean annual rainfall of between 160-700 mm.

Extending this approach to tsetse-free zones of Ethiopia, Bourn (1978), using estimates based on rinderpest vaccination returns, showed that cattle biomass increased with human population density, rainfall and altitude. Tsetse-infested areas generally supported much lower cattle densities than those which were tsetse-free. This pattern was repeated across the continent, with FAO's national cattle biomass estimates for tsetse-free countries increasing with mean annual rainfall. Tsetse-infested countries had substantially lower levels of livestock biomass, however, and countries with significant numbers of trypanotolerant cattle had intermediate levels. Building on these findings and incorporating additional sources of information, Bell (1982, 1985) drew attention to the important modifying influence of soil nutrient status on the general relationship between plant and large herbivore biomass, with higher biomass values being supported in areas of greater soil fertility.

More recently, in a regional assessment of rangelands in Argentina and Uruguay, Oesterheld *et al*. (1992) found that domestic ungulate biomass for a given level of above-ground primary production ($\approx$ rainfall) was greater than that for wild herbivores in natural ecosystems world-wide, and concluded that `elementary' (*i.e.* extensive) animal husbandry practices raise the carrying capacity of rangelands for large herbivores. The general validity of this conclusion, however, has been disputed by Fritz and Duncan (1993, 1994), who were unable to find any significant difference between comparable pastoral and natural sites in savannah regions of Africa. Instead, their analysis demonstrated that, at any given rainfall level, a key determinant of large herbivore biomass in both pastoral and wildlife systems was the soil type and nutrient status, presumably reflecting the quality of available grazing.

In the meantime, the relevance of some of the basic tenets of range management, in the African pastoral context of communal land tenure and erratic rainfall, have been questioned, and the usefulness of issues such as *carrying capacity*, *land degradation* and *desertification* has been widely debated (*e.g.* Sandford 1983; Abel and Blaikie 1989; Behnke *et al*. 1993; Toulmin 1993).

While it may be theoretically possible to define a maximum sustainable stocking level for a given area of land, it is argued that prevailing systems of communal land tenure and opportunistic pastoral management in Africa preclude the effective regulation of animal numbers. Many believe that the very idea of a fixed and constant sustainable stocking level is fundamentally flawed when applied to pastoral systems, because there is too much variation in production (locally and inter-annually) and because livestock are not generally kept in one place for the whole year. They argue that conventional theories and recommended management practices derived from the carrying capacity concept are inappropriate for much of Africa. In particular, they emphasise the need to establish new models of natural variability and pastoral adaptation and the importance of developing more appropriate techniques for assessing rangeland potential.

Much of this debate has focused on pastoral populations and rangelands in arid and semi-arid areas with less than 1000 mm rainfall *per annum*. It is, however, important to recognise that pastoralism (*i.e.* keeping livestock as a primary source of income or sustenance) is not confined to these two zones, and that animal husbandry is no longer restricted to traditional pastoral societies. The purpose of this paper, therefore, is to broaden the environmental perspective of the discussion, with extracts from a recent comparative analysis of results from livestock and land use surveys across a range of agro-ecological conditions in sub-Saharan Africa (Wint and Bourn 1994a,b). The study, supported by OXFAM and the ODA, was based on aggregated data from field surveys in Mali, Niger, Nigeria, Sudan and Tchad between 1980 and 1993.

LIVESTOCK AND LAND USE SURVEYS

Field work covered a total land area of more than 1.5 million square kilometres, and was carried out on behalf of national governments and various agencies, including the International Livestock Centre for Africa (ILCA), the Irish Development Agency (DEVCO), OXFAM, the World Bank and the United States Agency for International Development (USAID). Survey locations are shown in figure 1 and further details are given in table 1. Wet and dry season coverages were obtained for most sites.

A distinctive feature of these surveys is that they were all based on standard, systematic methods of data collection, combining low level aerial reconnaissance and complementary ground studies. Systematic reconnaissance flights (Norton-Griffiths 1978; ILCA 1981; GEMS/UNEP 1986) provided uniform sample coverage and assessed pastoral livestock and rural habitation, while ground surveys determined concealed village livestock to roof-top ratios (FGN/RIM 1992; Bourn *et al*. 1994). These ratios were applied to aerial roof-top counts to estimate village livestock numbers, which were then added to aerial estimates of pastoral livestock to give population totals.

In addition to pastoral livestock and human habitation, aerial surveys also assessed various environmental parameters, including vegetation and land use in terms of percentage cultivation, grassland, scrubland, woodland and forest. Ground studies were more variable in nature, but usually included assessment of herd structures, calving histories, animal husbandry practices, marketing and farming system characteristics.

Figure 1. Livestock and land use surveys

Whilst large scale field data collection exercises of this kind, carried out over a period of time and under a variety of local circumstances, cannot claim to be wholly representative, livestock distribution and land use data from the different surveys are, nevertheless, compatible and comparisons are justified because standard methods of assessment were used.

Information from the various surveys was aggregated into a single geo-referenced database containing 7,656 sample points. Each point was associated with values for different types of livestock, human habitation, vegetation and land use, obtained from field work, plus additional attributes such as mean annual rainfall, agro-climatic zone, and the presence of tsetse, encoded from cartographic sources. Mean values were calculated for duplicate coverages of the same point and season. Whilst the National Livestock Survey of Nigeria covered just under one million square kilometres of land, and thus represents almost two-thirds of the total area surveyed, it contributed about half of the sample points used because sample intensity was greater in other surveys.

Table 1. Livestock and land use surveys

Country	**Locality**	**Agency**	**Date**	**Area km^2**	**Reference**
Mali	Inland Delta	ILCA	10-80	34,944	Milligan *et al*. 1982
	Inland Delta	ILCA	03-81	34,944	Milligan *et al*. 1982

	Inland Delta	ILCA	06-82	34,944	Milligan *et al*. 1982
	Gourma	ILCA	03-83	81,640	Milligan 1983
	Gourma	ILCA	08-84	81,640	Bourn & Wint 1985
	Fifth Region	IBRD	07-87	102,137	RIM 1987a
Niger	Tohoua-Agadez Rangelands	USAID	09-82	81,550	Milligan 1982
	Tohoua-Agadez Rangelands	USAID	09-85	81,550	Bourn & Wint 1986
Sudan	Gezira Region	DEVCO	02-86	50,569	RIM 1987b
	Gezira Region	DEVCO	03-86	37,969	RIM 1987b
	Red Sea Province	OXFAM	03-89	119,900	ERGO 1990
	Red Sea Province	OXFAM	09-89	119,900	ERGO 1990
Tchad	Bahr El Ghazal	IBRD	08-91	59,800	RIM 1992
	Zone d'Organisation Pastorale	IBRD	03-93	147,600	RIM 1993
Nigeria	Gongola State	IBRD	07-83	43,875	RIM 1984
	Gongola State	IBRD	03-84	43,875	RIM 1984
	Anambra State	IBRD	05-89	17,675	RIM 1989
	Niger State	IBRD	05-89	59,600	RIM 1989
	National Livestock Survey	IBRD	03-90	924,000	RIM 1992
	National Livestock Survey	IBRD	09-90	924,000	RIM 1992

Analysis took the form of a series of bivariate and multivariate comparisons, numerical transforms and regression analyses to establish significant correlations between variables, and identify interesting trends for the future. Data were examined on a seasonal basis by species and, following Jahnke (1982), as collective livestock biomass in tropical livestock units, where 1 TLU represents 250 kg live weight, equivalent to 1 camel, 1.43 cattle, or 10 small ruminants.

Wildlife were noted in all surveys, but were encountered so infrequently that the contribution to herbivore biomass was negligible. Horses and donkeys were only recorded in later surveys, and were excluded so that earlier surveys could be incorporated within the analysis. Even where equines are relatively common they represent a very small fraction of total livestock numbers present. It is unlikely, therefore, that the exclusion of these two groups made any substantial difference to overall estimates of livestock biomass.

MAJOR CORRELATES OF LIVESTOCK DISTRIBUTION

A large number of statistically significant correlations between livestock (cattle, camels, small ruminants) and environmental parameters (rainfall, grass cover, grassland, open woodland, dense woodland, forest, cultivation and rural settlement) were generated by the analysis. For simplicity, however, we restrict ourselves here to considering the more significant and interesting relationships relating to livestock biomass as a whole, rather than individual species.

The three most significant bivariate correlates of livestock biomass distribution were: **percentage cultivation, or land use intensity** (accounting for 54% variance); **density of rural settlement** (51% of variance) and **mean annual rainfall** (37% of variance). These relationships are shown in figures 2-4, which also indicate best-fit data transforms and linear regression equations. Given the large number of data points involved, R^2 values greater than 0.02 are statistically significant.

Livestock biomass and cultivation

The strongest association in the dataset was between livestock biomass and the percentage of land under cultivation (figure 2). Not only is there a more or less even incremental rise in biomass density across the complete spectrum of cultivation levels, but the degree of variation, as shown by the vertical bars (indicating two standard errors), is surprisingly low. Statistical levels of significance are astronomical for this level of association, with probabilities of chance occurrence much less than 1 in 1,000,000. There is, therefore, little room for doubt that livestock tend to congregate where land is cultivated.

Livestock biomass and rural settlement

Not surprisingly, there is also a strong positive correlation between livestock biomass levels and the density of rural settlement, as recorded by aerial survey, in terms of number of roof-tops per square kilometre (figure 3), although the linkage is marginally weaker than for cultivation. The relationship is slightly less robust than for cultivation, with greater variation in more densely settled areas.

Livestock biomass and rainfall

Livestock biomass is also strongly correlated with mean annual rainfall (figure 4), although not in the straightforward linear fashion demonstrated by the two previous relationships.

Figure 2. Livestock biomass: % cultivation

Log10 (y)=0.3014 + 0.5561 Log10(x) R^2=0.535; n=3663; $\rho \ll 0.0001$

Figure 3. Livestock biomass: habitation density

Log10 (y)=0.3582 + 0.5897 Log10(x) R^2=0.507; n=3663; $\rho \ll 0.0001$

Figure 4. Livestock biomass: rainfall

$\mathrm{Log10}(y)=1.082 - 0.00007(x) - 50.59/(x)$ $R^2=0.3681$; $n=3663$; $\rho \ll 0.0001$

The driest areas (with less than 250 mm precipitation per year) have the lowest livestock biomass - an average of 1.28 TLU (320 kg) per square kilometre. However, a doubling of rainfall to 500 mm is associated with a fourteen-fold increase in livestock levels to 18.29 TLU (approximately 4600 kg) per square kilometre. Peak values are reached at around 825 mm rainfall per annum, after which biomass density declines with increasing rainfall. These biomass values are comparable with those reported by Coe *et al*. (1976), Bell (1982, 1985) and Fritz and Duncan (1993), but their observations were confined to the arid and semi-arid zones, with less than 1000 mm *per annum*.

Multiple regression analyses

Results of stepwise multiple regression confirmed the close association between livestock biomass and the presence of people. Cultivation and rural habitation were the primary predictors of livestock biomass distribution. Rainfall was of secondary importance, with measures of natural grazing availability, either grassland or grass cover, explaining little of the residual variation. Similar trends were evident for disaggregated cattle and small ruminants populations. Statistical correlates of camel distribution, however, remained somewhat elusive.

Habitation accounted for 60% of the variance in seasonal mean livestock biomass, with rainfall accounting for a further 7%. During the wet season, habitation accounted for 54% of the variance, and cultivation for another 5%. During the dry season, cultivation accounted for 37% of the variance, and habitation for an additional 9%. These figures suggest that livestock distribution is more strongly associated with human habitation than with cultivation in the wet season (*i.e.* during the crop growing period) and that this relationship is reversed but weaker during the dry season (*i.e.* when crop residues are available for some livestock, whilst others go on transhumance).

Seasonal changes in livestock biomass distribution

Analysis of matching wet and dry season surveys of the same area showed only minor differences in the seasonal distribution of biomass in relation to rainfall (figure 5). At the macro level this implies that a high proportion of animals are resident, or at least remain within the same rainfall zone throughout the year, and that long distance seasonal movements are relatively uncommon (unless of course livestock movements in one direction are offset by equal and opposite movements in the other, which seems somewhat unlikely).

On closer inspection seasonal differences were largely confined to the 750-1250 mm rainfall band, corresponding to the interface between semi-arid and sub-humid zones, where wet season biomass densities were 25-30% higher in the wet season than in the dry season. In contrast, arid and humid zones showed only very modest changes in seasonal biomass densities. These observations reflect a seasonal flux of livestock into the southern semi-arid and northern sub-humid zones during the wet season, which is perhaps somewhat surprising, but may indicate the return of transhumant herds.

Figure 5. Seasonal change in livestock biomass distribution

Table 2 compares livestock biomass densities for each of the major agro-climatic zones obtained from contemporary field surveys with Jahnke's more subjective assessments, derived from the FAO's Production Yearbook figures for 1979 (Higgins *et al.* 1978; OAU/STRC/IBAR 1976). Some fairly major differences are apparent. Jahnke's figures are some 30% lower, overall, with substantial under-representation of livestock biomass in both semi-arid and sub-humid zones.

Table 2. Livestock biomass density by agro-climatic zone

Agro-climatic zone	Total (this study)			1979 [1]
	Dry	Wet	Mean	
Arid	4.2 [2]	4.6	4.4	3.5
Semi-arid	21.7	23.5	22.6	14.4
Sub-humid	14.0	15.6	14.8	6.3
Humid	8.9	9.2	9.0	9.1
Total	7.6	8.3	7.9	5.59

[1] From Jahnke (1982)
[2] Densities are in TLU per square kilometre.

Livestock biomass composition in agro-climatic zones

The variable composition of livestock biomass in each of the four agro-climatic zones, in terms of the relative proportions of camels, cattle and small ruminants is shown in figure 6. The limited extent of the Jos and Mambila plateaux highlands did not justify separate consideration, and their livestock have therefore been included within the sub-humid zone. For reasons explained earlier, horses and donkeys were excluded from the analysis, but their contribution to livestock biomass is very small.

Camels are largely confined to the arid zone, although some extend into the semi-arid zone. Cattle account for around two-thirds of livestock biomass in the arid, semi-arid and sub-humid zones, although the proportion declines with increasing humidity, as the contribution of small ruminants increases. Their relative proportions are reversed in the humid zone, where small ruminants account for some 80% of livestock biomass.

Figure 6. Livestock composition by agro-climatic zone

TRENDS FOR THE TWENTY-FIRST CENTURY

Intensification of agricultural production

The strong anthropogenic links of livestock distribution focused on previously, may come as something of a surprise to some, and may even be greeted with disbelief by others. Why should the most significant correlates of overall livestock distribution be with cultivation and rural settlement? Surely conflicting interests and land requirements should keep them apart. Why is livestock distribution not more closely associated with more obvious indicators of feed availability such as the extent of rangeland or the amount of grass cover? More importantly perhaps, the findings imply that livestock biomass increases with rising levels of human population and increasing intensity of land use. Is this a reasonable expectation, and how has it happened?

Answering these questions requires conceptual clarification, and recognition of the fact that arable farming and animal husbandry need not be, and indeed rarely are, mutually exclusive activities. Where there is cultivation, there are people; where there are people, there are markets for the exchange of produce. Where there is cultivation, there are crop residues and fallow land for the use of livestock, and where there are livestock there is manure and potential draught power for the use of arable farmers. Where arable farmers and pastoralists co-exist, conditions must surely be right for the establishment of mixed farming systems and sustainable forms of production.

We take the view, therefore, that the findings reported here are consistent with expectations of the `Boserup hypothesis', and reflect the process of `autonomous intensification' of agricultural production (Boserup 1965, 1980, 1981), through initial co-existence and gradual integration of animal husbandry within local farming systems. Autonomous intensification of agricultural production is associated with the growth and increasing density of human populations, and the creation of conditions where `necessity becomes the mother of invention'. Other recent accounts of this process in Africa include Mortimore (1989), McIntire *et al*. (1992), FGN/RIM (1994), Tiffen and Mortimore (1994), Tiffen *et al*. (1994) and Morton (1994).

Population growth, agricultural expansion and environmental change

With the continued growth of the human population, competition for limited land resources has steadily increased over recent years and most countries in sub-Saharan Africa have experienced a progressive expansion of their agriculture and rural settlement. Renewable natural resources and human populations, however, are far from evenly distributed across the continent or within individual states.

Nigeria is a case in point, with a marked north-south zonation in agro-climatic conditions, and major concentrations of human settlement and agricultural production in the north and south of the country. While more intensive farming systems have become established in these areas of concentrated human settlement, such as the `close-settled zone' around Kano (Mortimore 1989), cultivation has also spread into the less densely populated sub-humid zone, or Middle Belt, channelled by a widening road network, and accelerated by an ever-increasing urban demand for food, fuelwood and timber.

The cumulative impact of human activity on the environment has had far reaching consequences. Deforestation continues apace, vegetation and land use patterns are being transformed. Compound rates of change are indicated in figure 7, which demonstrates the expansion of cultivation and contraction of other vegetation types (Wint and Bourn 1994c).

With the widespread transformation of natural vegetation to farmland and the hunting of wildlife to extinction in many parts of the country, a major constraint on livestock production has been neutralised (Bourn 1983).

Declining importance of tsetse and trypanosomiasis

Tsetse (*Glossina spp*.) and trypanosomiasis were once regarded as the most important constraints on cattle production in northern Nigeria and the Middle Belt (Colville and Shaw 1950; Glover 1965; FAO 1966). Figures 8 and 9 show

the wet and dry season distributions of cattle observed during the 1990 National Livestock Survey, together with an indication of the former limits of tsetse infestation. Clearly nowadays, with almost half Nigeria's cattle population of some 14 million head resident within the sub-humid zone throughout the year (FGN/RIM 1992), the threat of tsetse and trypanosomiasis must have declined substantially.

Agricultural expansion, deforestation and the removal of wildlife have greatly reduced the natural habitats and wildlife hosts of tsetse over much of the country. Tsetse infestation in the region is now far less widespread, and has been eliminated completely from many areas. Through natural selection and co-adaptation of both parasite and host, milder forms of the disease have evolved, and zebu cattle populations have acquired a tolerance to trypanosomiasis infection (Putt *et al*. 1980; Bourn 1983). This man-induced shift in the epidemiological balance of trypanosomiasis is a well established and widespread phenomenon, which has taken place in many regions across Africa (*e.g.* Ford 1971; Kjekshus 1977; Jordan 1986). It is an autonomous and sustainable form of disease control, and is a major factor to be considered in the expansion of cattle distribution and animal husbandry practices and the overall process of agricultural intensification.

Figure 7. Compound rates of change in Nigerian vegetation cover; 1976-1990

Expansion of cattle distribution

The great majority of Nigerian cattle are of the supposedly non-trypanotolerant zebu type, whose distribution was once largely confined to the northern tsetse-free arid and semi-arid zones, except for a few months each year during the dry season when herds moved south into tsetse-infested

regions on seasonal transhumance to take advantage of better grazing and the greater availability of water (Colville and Shaw 1950; Glover 1965; FAO 1966). This conventional picture of the Nigerian pastoral scene is no longer valid. More recent studies have commented on the reduction in extent of seasonal transhumance, the decline in nomadism and the widespread sedentarisation of pastoralists (van Raay 1975; Kaufmann and Blench 1989). The southward dispersal of cattle and settlement of pastoralists in the middle belt has been recognised for some time (Fricke 1979; Putt *et al*. 1980; David-West 1981), but until recently has been difficult to substantiate. However, the 1990 National Livestock Survey (FGN/RIM 1992) confirmed the southward expansion and year-round presence of cattle in the sub-humid zone, as reflected in the dry and wet season distribution maps shown in figures 8 and 9.

Expansion of animal traction and small holder fattening

In addition to assessing the distribution and abundance of livestock populations in Nigeria, the National Livestock Survey (FGN/RIM 1992) also recorded the presence or absence of various animal husbandry practices in more than 2000villages throughout the country. Mapping the distribution of agricultural practices provides a yardstick for monitoring the intensification process. The use of animals for ploughing and the fattening of livestock by smallholders are obvious indicators in this respect, and their current distributions are shown in figures 10 and 11. It is interesting to reflect on the fact that ox-drawn ploughs were introduced into Gombe Emirate in north-east Nigeria during the 1920s. It has taken over sixty years for ploughing to spread as far as it has (Tiffen 1976; Blench 1987).

SUMMING UP

In their study of population pressure, the environment and agricultural intensification, Lele and Stone (1989) observed that `data on some of the most basic facts needed to plan agricultural development are scarce in Africa'. This statement has certainly been borne out by Nigeria's recent experience:

- **The 1990 National Livestock Survey demonstrated that livestock populations were far more numerous and widely distributed than was generally recognised (FGN/RIM 1992). Total livestock biomass was 25% greater than indicated by contemporary Federal Government and FAO figures;**

- **Provisional results of the 1991 census (New Nigerian, 20 March 1992) revealed that previous projections, based on the 1963/64 census had overestimated the size of the Nigerian human population by some 26%.**

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Discrepancies of that kind clearly undermine the credibility of national statistics and *per capita* indicators. Nigeria accounts for a sizeable proportion of the total population of sub-Saharan Africa, and one suspects that such anomalies may apply to other countries and other sectors.

This paper has illustrated some of the links in the chain of intensification of agricultural production in sub-Saharan Africa. Whilst causal relationships cannot be `proved', the strong positive correlations between livestock biomass, intensity of land use and density of human habitation, suggest that as human populations and rural settlements increase in size, there are likely to be commensurate increases in livestock biomass, as cultivation expands and land use intensifies.

At first sight, this may appear rather a bizarre observation, but it can be interpreted as a reflection of the gradual process of agricultural intensification. If that process is an inevitable consequence of population growth (Boserup 1965, 1980, 1981), why should agricultural and livestock development be actively pursued? What is to be gained from promoting the inevitable? These are complex and controversial issues, which continue to be debated.

A counter-argument to the `do nothing, just let it happen' point of view is that `autonomous intensification' may not always be able to keep up with high population growth rates, and that `the relevant question in the context of Africa is, whether the catalysing factor of population is ahead, or behind, the pace of farmer-based innovation' (Lele and Stone 1989). If population is ahead, then farmers will be forced to extend cultivation into more marginal lands and/or reduce periods of fallow, leading to soil exhaustion and further poverty, rather than intensification and development. Others, for example Morton (1994), have argued that many years of international development assistance to promote agricultural development in countries such as the Sudan has been thoroughly counter-productive (see also Adams 1994).

We would like to conclude this piece with a plea for wider appreciation and better understanding of the dynamic interactive processes of human population growth, agricultural expansion and environmental change that are occurring throughout the continent. Far reaching changes are undoubtedly taking place; new patterns of resource utilisation are emerging and traditional systems of production are responding to new circumstances. However, because the processes are slow and incremental in their effect, changes often go unrecognised, and are poorly documented. There is a clear need to strengthen national capacity and establish effective monitoring systems to ensure that policy makers are made aware of the processes and consequences of change.

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