THE PRIMARY AND SECONDARY PRODUCTIVITY OF THE SAVANNAS IN THE 'MIDDLE BELT' OF NIGERIA

By

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1. INTRODUCTION

The origin of the term 'Middle Belt' as a geographical region can be traced to the beginning of this century. Although it is not clearly defined in terms of administrative units (of table 3), it has a recognisable and unique character produced by a combination of physical and cultural factors (Pullan, 1962).

Its northern boundary is close to the southern limit of the Sudan zone, whereas its southern edge roughly follows the northern limit of the Drained Savanna zone (Keys, 1959). In contrast to the cereal-based farming systems further North, rootcrops dominate in the subsistence economy of the diverse tribal groupings that live in the region. Population density, through variable is relatively low; hence, unused land is in plentiful supply.

Sheep, goats and often pigs are an important component in most farming systems, while resident cattle are restricted to small numbers of dwarf *Muturu*. However, following the territorial expansion of the Fulani in the early nineteenth century, nomadic pastoralists have gradually penetrated into the region. Although they have settled mostly in the fly-free Jos and Mambilla Plateaus, they have inco-operated large areas of the 'Middle Belt' into their dry season transhumance orbits (Grove, 1956; Fricke, 1969).

This southward 'drift' of Fulani pastoralists is continuing up to the present day and has accelerated as a response to the increasing scarcity of grazing in the traditional 'home lands' further North. During the 1960s, this 'outward' migration was regarded with dismay, in particular in those districts where cattle tax

was an important source of revenue. Consequently, little was done to encourage it.

Following the replacements of the *Jangali* tax with 'oil boom revenue', as well as the disastrous impact of the 1972-74 drought on the carrying capacity of the Sudanian rangelands, the necessity of 'the relocation of the National herd' to areas better endowed with grazing and water, was widely publicised and easily accepted. Action followed to the extent that in the 1975-1980 development plan, 95 million Naira was allocated to the development of grazing lands, water resources and to tsetse eradication. This 'relocation' would involve a planned movement of some 3 million cattle into 11 million hectares of hitherto unused savanna, mostly located in the 'Middle Belt'.

It is the aim of this paper to review the available information that is pertinent to the resources of this region. The data set in table 1 place the 'Middle Belt' in its Nigerian setting and grazing resources within the four climatic belts in the savanna region. It puts across — convincingly it is hoped — the severe overstocking in the Sudan zone in contrast to the understocking in the southermost belt. It is attempted to critically examine the grazing resources of the 'Middle Belt' and highlight its potential for and the constraints to livestock development.

2. CLIMATE

The 'Middle Belt' as defined in this paper has a monsoonal climate with a distinct dry season. Mean annual rainfall increases from 1100 mm in Samaru (11° Lat. N) to 1500 mm in Otukpo (7° Lat. N). While rainfall distribution is mostly influenced by latitude, mountains like the

TABLE I

Rangeland Resources, carrying capacity and cattle population in four rainfall zones in Northern Nigeria

<i>Rainfall zone (mean annual rainfall in mm)</i>	<i>500— 700</i>	<i>750— 1000</i>	<i>1000— 1250</i>	<i>Over 1250</i>	<i>Total</i>
<i>Land resource (million ha)</i>					
Rangeland	8.2	10.8	16.6	11.3	46.9
Farms and recent fallow	6.0	6.8	5.0	4.8	22.6
(towns, roads etc)	0.8	0.9	1.1	0.8	3.6
Total area	15.0	18.5	22.7	16.9	73.1
(Percent rangeland)	(55)	(58)	(73)	(67)	(64)
<i>Carrying capacity and cattle population</i>					
Carrying capacity (ha/1.U)	7.9	3.7	2.5	1.9	2.9
Potential Population (m.LU)	1.0	2.9	6.6	5.9	16.4
Actual population (m.LU)	2.1	2.2	1.2	0.8	6.4
Actual population (m.head)	2.7	2.0	1.5	1.0	8.2
Ratio actual/potential population	2.10	0.7	0.18	0.14	0.39

Derived from de Leeuw (1977 a).

Jos and Mambilla plateaus deflect isohyets and cause higher rainfall to fall on windward side (Kafanchan: 1650 mm) and much lower rainfall on the leeward (Yola: 680 mm), thereby producing a decreasing trend in rainfall from east to west. Single peak distributions prevail in the north whereas double-peak pattern with a short break in the rains during July or August becomes more frequent towards the south. The length of the rainy period is strongly associated with the annual mean, rising from a low of 160 days in Samaru to 230 days in Ilorin and resulting in growing seasons lasting 190 to 290 days (Kowal and Knabe, 1974).

Most other climatic parameters (mean maximum temperatures, hours of daily sunshine, net radiation, evapotranspiration and the severity of the Harmattan) decline from North to South, thus contributing towards a decreased seasonality and increased humidity of climate along this gradient.

3. SOILS

Two distinct geological formations characterise the region. Along the Niger and Benue valleys cretaceous sediments varying from coarse sandstones to fine-grained shales swing in a wide arc through the middle. The associated landscapes consist mainly of flat or gently undulating plains with occasional residual mesas and ridges. These plains are flanked on either side by more elevated and rugged land underlain by granites, schists and gneiss of the much older basement complex. Dissected foothills surrounding the Jos Plateau and the Northern outliers of the Cameroun Mountains as well as isolated hill complexes, Inselbergs, and elevated platforms contribute to a rugged and often scenic landscape. Further diversity is added by the wide-spread occurrence of ironpan cuirasses that are commonly overlying the plains and platforms west of the Jos Plateau. They are also found on the plains along the Middle Benue.

moderate shade under a tall tree canopy and in moister climates towards the south) tall (cover 2.5 m) grasses, mostly *Andropogon* and *Hyparrhenia* spp. become dominant. The same genera are usually found along valleys and in *fadamas*. The principal species in these different habitats are listed in table.

In fallows, several successional trends can be recognised. In the most recent fallow broadleaved weeds and annual grasses (*Pennisetum*, *Eragrostis*, *Andropogon*) indicate the pioneer stage being replaced by perennial grasses after 3 to 4 years. After 8 to 12 years the grass cover has reverted to its original precultivation composition. However, when fallow periods are short, annual grasses persist often in association with *Imperata cylindrica*. On deep sandy soils (nitosols) south of the 1200 mm isohyet, fairly stable *Andropogon gayanus* savanna occurs wherever the farming intensity is moderate. In the Forest/Savanna mosaic zone, fallows are frequently invaded by *Eupatorium odoratum*, a tall shrubby weed, which appears difficult to eradicate (Howard, 1977).

Except for the open growth in recent fallows, all communities are subject to frequent fires. Changes in species composition in response to different burning regimes are slow and are mainly associated with changes in tree density. Frequent grazing has a more pronounced effect in that the tall grasses are replaced by more resistant short grass (*Brachiaria*, *Setaria*, *Paspalum* and *Sporobolus*).

5. TSETSE FLY

Large parts of the 'Middle Belt' are infested with tsetse fly species, of which *Glossina morsitans* has the widest distribution. Most of Kwara State, including Borgu Division is heavily infested. Other extensive belts are found on the sandstone plains in Niger State and in the lowlands north of the River Benue, while Belt 27 extends southwards into the Kaduna plains. In contrast, Benue State is

relatively free from *G. morsitans*. Further east, in Gongola States south of the Benue, there is another large belt.

In 1971 a total of over 90,000 km² was infested with this fly species (see T.T.D. map, April 1971). However, it is believed that since 1970 some of these belts have contracted considerably because of:

- A reduction in tree cover due to the expansion of farming,
- A reduction in fly density following below-average rainfall since 1970,
- eradication of flies through ground and aerial spraying.⁽¹⁾

Other tsetse species (*G. longipalpis*, *G. tachnoides*) are mainly confined to dense vegetation along rivers and streams. They are found throughout the region, but since riverain forest and thickets become more common towards the south, fly density increases accordingly.

6. HUMAN POPULATION

A combination of historic events, tribal heterogeneity, tsetse infestation, and poor soils and water supplies is held responsible for the sparse population inhabiting the 'Middle Belt' as a whole. However, great differences in population density exists. While in Kaduna plains and Borgu Division the density does not exceed 10 people/km²) and Ilorin divisions 130/km²) are well populated followed by Tiv (80/km²) and Idoma (80/km²) Divisions. In most of the area population densities lies between these extremes; in over half the area the density is between 10 and 50 per square kilometre (table 3).

Of greater interest than the population density, is the proportion of land that is being farmed and under recent fallow. Although a close relationship between population density and the proportion of land in the farming cycle is generally accepted, estimates of land farmed by rural family units, differ widely. Around Zaria it is assumed that one adult male can farm 2 ha per annum (Huizinga 1978) while the JPC/FMANR (1974) predicted an

TABLE 2
Land Use in the Jema'a Flatland and the Benue Valley

<i>Land Use</i>	<i>Jema'a Platform</i>	<i>Benue Valley</i>	<i>Mean</i>
Farmed land	5.3	9.5	8.7
Fallow	9.2	11.5	11.0
Savanna	85.5	79.0	80.3

Derived from: Hill (1976) and based aerial photographs taken between 1968—1972.

average farming of 0.8-1.2 ha for a rural family of six. Mutter (1972) pointed out that farm size decreases from North to South and also with diminishing population density, as the annual rate at which bush can be cleared becomes the major factor limiting farm size.

(1) It is planned to eradicate *G. morsitans* from 19,300 km² per annum over 1971—1980, thus adding 193,000 km² to the tsetse-free land area (NPC/FMANR 1974). During the 1974—75 dry season, over half this target (10,700 km²) was reclaimed (Prof. A.N. Mohammed, personal communication).

In his report a farm size of 2 ha per 3.3 adults (male and female) is quoted to obtain in Tivland.

The most reliable data have been obtained from aerial photography. In the land resources studies of Central Nigeria the distribution of farmland and recent fallow was examined and mapped in 86,000 km² within the 'Middle Belt' (Hill 1976). From these maps the proportion of cultivated, fallow and unused land was calculated (table 2). Correlating these data with the population density of the surveyed area, it was found that per caput there was 0.19 ha of farmed land and 0.24 ha of fallow. Thus, the amount of land under cultivation per adult rural male approximates about 1 hectare.⁽¹⁾

- (a) Derived from Agricultural Development in Nigeria 1973—1985 (JPC/FMANR, 1974) tables 3.6 and 10.3.
- (b) The 'Middle Belt' consists of the following administrative areas: Benue State; Kwara State; Niger State minus the Northern half of Kontagora Division; Kaduna State

minus Katsina Province and the Northern half of Zaria Province; Muri and Southern Sardauna Division of Gongola State; Lowland and Akwanga Divisions of Plateau State. Surface areas were derived from Statistical Year-book (1964).

- (c) An allowance of 5% is made for land use for other purposes (towns, roads, waterways etc.).

(1) The rural male population was calculated by assuming that 75% of the population is living in rural areas, 53% of the total population is adult and 50% is male (JPC/FMANR, 1974.).

The data so obtained have been used to calculate the land use distribution for the whole of the 'Middle Belt' (table 3), projected for the estimated population in 1980. Assuming the calculated farm size per caput is correct and has remained static since 1970, it is shown that about 75% of the land in the 'Middle Belt' is not utilised for farming purposes. However, if an average farm size per adult rural male of 2 ha is closer to the truth, the proportion of unused land would be reduced to 56%.

7. LIVESTOCK POPULATION

By using the same sources of data from which table 1 was compiled, the cattle population resident in the 'Middle Belt' during the rainy season is estimated at around 900,000 head. In addition, there are probably some 750,000 sheep and one million goats resident in the area (Rains, 1975; JPC/FMANR, 1974).

The distribution of cattle is uneven and much influenced by the presence of *G. morsitans* belts, into which herds rarely

TABLE 3

*Estimated population and land use in the 'Middle Belt'
in 1980*

<i>Population density People/km² (a)</i>	<i>Area (1000 ha) (b)</i>	<i>Population (1000)</i>	<i>Farmed land</i>	<i>Fallow land</i>	<i>Unused land (c)</i>
Below 10	2,820	167	1.1	1.4	91.4
10—50	15,970	5,033	6.3	7.6	81.1
51—100	6,910	5,028	13.8	17.5	63.7
Above 100	1,370	1,913	26.5	33.5	35.0
44.9	27,070	12,141	8.5	10.8	75.7

venture, at least during the rainy season. Thus, the majority of stock are spread over the remaining 18 million hectares of land free of *G. morsitans*, amounting to about 10 ha of savanna rangeland per head (see table 3). The highest concentration of stock is found in the foothills west of the Jos Plateau and in the Minna, Akwanga and Lafia Divisions.

However, it should be realised that these projections are mainly based on census data collected between 1962 and 1970. Since then, great changes in the distribution of mobile herds have taken place. There is sufficient evidence that the general trend of Fulani migration towards to south and the east (which started during the early 19th century and accelerated during the colonial era) has gained great momentum during the 1970s. The rapid decline of grazing lands in the Sudan zone was exacerbated by the severe 1972—74 drought and forced many pastoralists to move south. It should therefore surprise nobody if an accurate census would reveal a much higher cattle population than expected.

Traditionally the 'Middle Belt' has been an important dry season grazing area, although data on population are virtually absent. Ogunfowora *et al* (1975) assumed that 6.8 million head (72% of the overall total) grazed south of the 10° latitude, while de Leeuw (1977a) believed that south of the 1000 mm isohyet the dry

season, thus arriving at 4.6 million head. In support of such guesses, Fricke (1969) showed that during the 1962—1965 Rinderpest Campaign, inoculation numbers in the 'Middle Belt' were 2.5 times higher than the Jangali census data.

Analysis of movement patterns has indicated massive seasonal long-distance treks from Kano and Bauchi States and shorter ones away from the Jos and Mambilla plateaus. The Benue River and the lower reaches of its major tributaries which are bounded by vast expanses of swamp grass savanna of high productivity (390,000 ha Mutter, 1972) is the terminal point of many transhumance orbits. The second important dry season grazing is bounded by the line Bida-Minna-Abuja and the floodplain of the lower Niger (Fricke 1969).

8. PRIMARY PRODUCTIVITY

Herbage Production

Data on herbage production in the 'Middle Belt' savanna are very scarce and therefore some of the standing biomass figures represented in table 4 were derived from locations outside the area.

To overcome this lack of information, it has been attempted to generate herbage yield estimates in savanna through assuming a linear relationship between yield and mean annual rainfall. De Leeuw (1977) modified the equation established by Le Houerou and Hoste (1976) for fran-

cophone West Africa, to predict herbage production in the four Nigerian rainfall zones (see table 1). This regression ($Y = 2.36 P + 34.7$ in which Y is DM yield in kg/ha and P is rainfall in mm) puts the limits of production between 2400 kg/ha at the 1000 mm isohyet and 3500 kg/ha at 1500 mm. A comparison with the data in table 4 shows that at higher rainfall, herbage productivity is much greater than predicted and it appears that the length of the rainy season might provide a better correlation with yield than mean annual

rainfall.

Soils conditions determine herbage growth to a greater extent. Within the same climate, tall *Hyparrhenia* savannas found on deep soils with a watertable within reach of the rooting zone during most of the year, produce more than twice as much as rangelands on shallow soils (table 4, types 3 & 6).

In shrub savanna, tree cover density is usually inversely related to herbage yield. Rose-innes and Mansfield (1975) estimated the standing biomass in wooded

TABLE 4
*Maximum Standing biomass of the herbaceous cover in
Guinean and derived Savannas*

Location	Rainfall (mm) (days)	Vegetation type (a)	Standing biomass (kg/ha)	Burning treatment
Shika 11°12' N	1130 (160)	1. <i>Isberlinia doka</i> - <i>Terminalia</i> shrub Savanna	2700	LB
		2. Idem	3400	LB
		3. Grass Savanna	6800	LB
Borgu 10°00' N	1075 (170)	4. <i>Detarium</i> savanna woodland	3620	LB
		5. <i>Isberlinia tomentosa</i> woodland	3520	LB
		6. <i>Terminalia macroptera</i> tree savanna	6890	LB
Afaka 10°35' N	1285 (190)	7. <i>Isberlinia doka</i> open savanna woodland	2670	EB
		8. Idem	3340	EB
Fashola 7°55' N	1120 (250)	9. <i>Andropogon</i> grass savanna	17800	EB
Olokemiji 8°57' N	1230 (270)	10. <i>Butyrospermum</i> <i>Pterocarpus</i> savanna	16400	LB
Lamto 7°43' N	1300 (240)	11. <i>Loudetia</i> savanna ^(c)	6300	EB
		12. <i>Andropogon</i> savanna	5500 (6800)	EB
		13. <i>Andropogon</i> wooded savanna	8000 (10000)	EB
			6400 (11000)	EB

fallows of 4–8 years of age to be 1000–1200 kg DM/ha or less than half than that found in older tree savanna and savanna woodland. The latter often have a herbaceous stratum of tall high-yielding grasses with a high shade tolerance (table 4, types 5 & 13).

- (a) The species composition of the herbaceous stratum of types 1–8 and 11 is given in table 5.
- (b) EB = early burning; from mid-December to mid-February
LB = late burning; from late February to April.
- (c) In types 11–13 biomass data between brackets indicate total biomass of living and dead material.

Source: Types 1,2,3,7,8 de Leeuw (unpublished data)

Types 4,5,6 Dr. T.A. Afolayan (personal communication).

Type 9 Egunjobi (1973); Type 10: Hopkins (1968);

Types 11,12,13: Lamotte (1975).

Apart from destroying the standing forage at the time of burning, the effect of fire on the end-of-season biomass appears site-dependant. In Shika, a 6-year comparison of annual early, annual late burning and protection had little influence on yield and caused only minor changes in species composition (de Leeuw, unpublished data). In contrast, a reduction of 40–50% in yield occurred after a few years of early burning or protection in comparison to late burned sites in three vegetation types in the Borgu Game Reserve (Afolayan, personal communication).

Similarly, in *Andropogon gayanus* fallow, a higher biomass was obtained after burning during the December – February period than following protection (Egunjobi 1973). In total, these results confirm that fires are an inherent ecological factor within the savanna ecosystem and do not-at least in the short term – have a marked deteriorating effect on sustained production.

Carrying capacity

Carrying capacity is defined in terms of the quantity of forage available to stock without regard to forage quality. In this limited sense, end-of-season grass biomass can be used to estimate the capacity in grazing days by assuming that a 300 kg livestock unit (LU) requires a daily dry matter intake of 7.5 kg. To allow for inefficiency, wastage in consumption and to ensure the sustained productivity of rangeland, the level of utilization is set at 50% of the total consumable herbage. Following this procedure, rangeland producing 3000 kg DM/ha per annum would carry 0.5 LU/ha and a type with a 7000 kg DM/ha biomass 1.2 LU/ha.

Although these calculations of the carrying capacity throw light on the great potential for livestock production of savannas in the 'Middle Belt', actual or potential scope for useful exploitation is much less because it is limited by powerful constraints; chief among these are:

- the destruction of half or more of the annual end-of-season biomass by fires
- the inaccessibility of large areas to stock because of difficult terrain, seasonal flooding and high tsetse challenge
- the poor palatability of many rangeland grasses⁽¹⁾.

Carrying capacity estimates tend to differ greatly depending on the allowances made for these constraints. For instance, de Leeuw (1977) put the average carrying capacity of the drier savanna (1000–1250 mm) at 2.5 ha/LU and that of the moister savanna at 1.9 ha/LU without considering any of the constraints mentioned above. On the contrary, Rose-Innes and Mansfield (1975) incorporated all constraints except the tsetse challenge and consequently arrived at a lower capacity of 3.6 ha/LU for the Northern and 2.8 ha/LU for the Southern Guinean savanna.

TABLE 5
Species composition of the herbaceous cover in guinean
and derived savannas

Perennial grasses	Location and Vegetation type (see table 3)									
	Shika			Borgu		Afaka		Olok		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(11)	
Short (below 1.5m)										
Loudetia flavida(a)				xxx						
L. simplex	x(b)						xxx	x		
Trachypogon spicatus	p						xx	x		
Adropogon ascinodis	xx	x					xx	xx		
A. schirensis	xx						xxx	x	xxx	
Monocymbium cerasiiformis	xx				xx		xx	xx	xxx	
Schizachyrium sanguineum	x	x			xx		xx	x	xxx	
Elyonurus pobeguini	xxx	x					p	x		
Panicum phragmitoides	xxxx									
Sporobolus pyramidalis	p	x	x							
Brachiaria jubata	p	xx								
Hyparrhenia dissoluta	x	xxxx	xx							
Setaria anceps	xx	xxxx	xxx							
Tall (above 1.5m):										
Adropogon gayanus	xx	xxx		xx	xx		x	xx		
A. tectorum					xx				x	
Beckeropsis uniseta					xx			xx		
Urelytrum muricatum	xxx	p					x	xx		
Hyparrhenia smithiana					xx	xx	x	xx		
H. subplumosa	p	x					x	xx		
H. rufa		x	xxx			xxx				
H. cyanescens			xxxx							
Annual grasses:										
Hyparrhenia involucrata	p	x	x	xx			x	x		
H. bagirmica	p	x								
Andropogon pseudapricus	p	p		xx		xx				
Aristida spp.				xx						

(a) Nomenclature of the grasses according to Clayton (1966)

(b) Abundancy classes: xxxx abundant
 xxx very common
 xx locally common
 x Rare
 p present, very rare

Source: as for table 4

9. SECONDARY PRODUCTIVITY

Livestock

It is difficult to obtain meaningful

estimates of livestock productivity in savanna. It is true that long-term grazing experiments on unimproved savanna have

provided comparative figures of liveweight gains per annum, but such data do not reflect the productivity of pastoralist herds.

(1) Under permanent stocking relative acceptability during the rainy season varied less than expected and only a few grasses remained entire untouched (de Leeuw 1975).

Gain per annum of cattle grazing Northern Guinean savanna range from 10 to 25/ha, increase to 40–45 kg/ha on the *Andropogon gayanus* savanna in Mokwa (de Leeuw, 1971) and to 115 kg/ha on

similar savanna in Fashola (Adegbola *et al.*, 1968). Most of this gain is put on during the rainy and early dry season and yearly gains would be lower without the supplementary protein that was provided to stock in most trials.

Productivity in pastoral herds was assessed at 5–9 kg/ha (de Leeuw 1977). However, such yields should be regarded as the lower limit and would greatly rise with changes in herd composition, sales strategy, level of feeding and management.

TABLE 6
Herd composition (%) and productivity of two herds with different production goals^(a)

Category	TYPE I		TYPE II			
	Closing Inventory	Losses (b)	Off take	Closing Inventory	Losses (b)	Off take
Adult cows	41.5	2.0	4.1	49.2	1.4	4.1
Calves, 0–1 year	9.8	2.4	—	14.5	0.7	—
Heifers, 1–2 years.	8.7	1.0	—	13.8	0.5	—
Heifers, 2–4 years.	13.9	1.5	—	5.7	0.2	7.6
Total females	73.9	6.9	4.1	83.2	2.8	12.0
Breeding bulls	6.7	0.3	0.7	2.3	—	—
Bulls, 0–1 year	9.8	2.4	—	14.5	0.7	—
Bulls, 1–2 years	9.6	1.9	7.6	—	—	13.6
Total herd	100.0	11.5	12.4	100.0	3.4	25.6
Total LU ^(c)	71.0	—	8.2	64.9	—	16.5
<i>Total Coefficients (of total herd)</i>						
Calving percentage		60%			65%	
Calf mortality		20%			5%	
Adult mortality		5%			4%	

(a) Source: Type I: Emirate Technical Services (1977)
Type II: Fed. Min. Agric. Nat. Res. (1972)

(b) Losses and off-take are expressed in percentages of the closing inventory.

(c) The equivalent of each herd in livestock units (LU) has been calculated using the following conversion factors:

Adult cows:	0.90	Calves 0–1 yrs:	0.25
Breeding bulls	1.00	Heifers/bulls 1–2 yrs:	0.50
Heifers 2–4 yrs.			

To illustrate the effect of these variables on productivity, two production systems have been compared (table 6). Type I comes close to the traditional system and is oriented to maximise stock numbers and milk production. It suffers from a conflict between two management goals, that of maximum milk production pursued by the female members of the unit and that of stock production by the males. These opposing goals result in high calf mortality, low reproductive rate, a low off-take of mainly culled cows and young bulls, while the herd is estimated grow at a rate of 2.2% per annum. Total productivity is 10.4% of the 'livestock biomass'.

A constant herd strategy is followed by

Type II: Off-take is much higher as surplus heifers are sold. Calf mortality is low because all milk is fed to calves or consumed by the family unit. Productivity equals off-take and amounts to 16.5% of the 'biomass'.

In table 7 the productivity of the two systems is compared in terms of products (stock and milk) and gross revenue. It is seen that the type oriented to breeding alone has greater financial returns.

Crops

According to Hill (1976) several distinct farming systems exist in the 'Middle Belt'. Along the northern fringe there is the Sorghum-millet system which has been described by Norman (1974) and Huiz-

TABLE 7
The productivity of two management systems

Type	kg/ha		Naira/ha	
	I	II	I	II
Biomass	150 ^(a)	150		
Stock sales/yr.	12.3	24.7	8.00 ^(b)	16.10
Milk sales/yr.	27.6 ^(c)	—	4.14 ^(b)	—
Total			12.14	16.10

(a) The biomass is 0.5 LU/ha

(b) Sale price of stock: N0.65/kg liveweight

Sale price of milk: N0.15/kg.

TABLE 8
Crop yields (kg/ha) for different management systems

	Mixed cropping (a)	Low fertiliser (b)	High fertiliser (b)	National average (c)
Millet	370	205	490	560
Sorghum	725	365	630	670
Maize	—	60	200	1120
Groundnuts	440	255	300	780
Cowpea	132	65	80	250
Yams	—	1100	1470	9000
Cassava	—	—	—	12000

(a) Yields in two-crop mixtures in the Zaria area (Norman, 1974).

(b) Yields in the Zaria area at two fertiliser levels;
lows: 5 kg/ha, high: 65 kg/ha (Huizinga, 1978).

(c) Derived from JPC/FMANR (1974).

inga (1978). With increasing rainfall maize replaces millet and rootcrops such as yams and cassava become the dominant. Sorghum, Cowpeas, groundnuts, and soyabeans are the main subsidiary crop

Crops yields vary widely between ecological zones and even more with the level of soil fertility, management and fer-

tiliser inputs. Some yield estimates have been tabulated in table 8, showing that yields recorded in the Zaria area are much lower than the national average.

Financial returns calculated from yield records may be inaccurate as the price which the farmer can realise are influenced by many variables. Huizinga (1978) estimated gross values of crops at

TABLE 9
*The year-round potential livestock population in the
'Middle Belt' (in million LU)*

(1) HIGH ESTIMATE

Type of land	c.c.	ha	rainy season		dry season	
	ha/LU/ 6 mo.	(10 ⁶)	% land grazed	LU (10 ⁶)	% land grazed	LU (10 ⁶)
Tsetse-free	1.5	9.0	87%	5.2	13%	0.8
Tsetse-infested ^(a)	1.5	9.0	—	—	50%	3.0
Inaccessible	—	2.0	—	—	—	—
Flooded	1.0	0.5	—	—	100%	0.5
Fallows	3.0	2.9	—	—	100%	0.9
Farmed	—	2.3	—	—	—	—
Other (towns etc.)	—	1.4	—	—	—	—
Total		27.1		5.2		5.2

(2) LOW ESTIMATE

TABLE 9 (Continued)

Type of Land	c.c.	ha	rainy season		dry season	
	ha/LU/ 6 mo.	(10 ⁶)	% land grazed	LU (10 ⁶)	% Land grazed	LU (10 ⁶)
Tsetse-free	1.5	3.8	100%	2.5	—	—
Tsetse-infested	1.5	9.0	—	—	52%	3.1
Inaccessible	—	2.0	—	—	—	—
Flooded	1.0	0.5	—	—	100%	0.5
Fallows	3.0	5.8	80%	1.5	20%	0.4
Farmed	—	4.6	—	—	—	—
Other (towns etc.)	—	1.4	—	—	—	—
Total		27.1		4.0		4.0

(a) c.c. = carrying capacity (a) *Glossina morsitans* only

Foremost among the constraints that may limit the full exploitation of these grazing resources are:

- The widespread occurrence of *Glossina longipalis* and *G. tachnioides* in riverain forest and thickets,
- the inadequate water supplies in many of the areas underlain by sandstone parent materials,
- problems associated with the integration of large groups of emigrants having a different culture and mode of living into resident rural societies.

₦140—170/ha for high inputs. Hill (1976) gave gross returns for individual crops: they range from ₦144/ha for maize to ₦244/ha for groundnuts.

Even though these revenue predictions are far from reliable they bring out the unescapable fact that crop farming as a land use systems is much more productive than livestock husbandry.

10. CONCLUSION

It is evident that the grazing resources in the 'Middle Belt' as such do not constitute an obstacle to the expansion of livestock husbandry. On the contrary, the region as a whole can provide year-round roughage to between 4 and 5 million livestock units or some 6—7 million head. This estimate is a conservative one since a rather low carrying capacity of 3 ha is used in the calculations in table 9. In addition, an ample allowance has been made for inaccessible land.

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