THE RELATIVE ROLES OF LIVESTOCK, TERMITES, WILD ANIMALS AND HUMAN BEINGS IN NUTRIENT RECYCLING IN NIGERIA.

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ABSTRACT
Primary production of savanna woodland and cropland vegetation in semi-humid tropical Nigeria was 990t/km^2 and contained 8.0 t of nitrogen (N) and 1.4 t of phosphorus (P). Of this biomass livestock, termites and humans consumed 4, 29 and 6% respectively; 18% was burnt. Of the N and P stocks, livestock, termites and humans consumed 9 and 5%, 17 and 22%, and 10 and 9% respectively. The liveweights per km^2 of livestock, termites and humans were 3.5, 10.0 and 2.3t respectively. Annual grass burning consumed 25% of N and 16% of P. The role of wild animals was negligible. About 2/3 of the crops were exported to the cities, entailing loss of 5.6 kg N and 0.8 kg P/ha/year. It was concluded that the roles of termites and humans in nutrient recycling deserve more research attention.

KEYWORDS
Livestock, termites, humans, nutrient recycling, Nigeria

INTRODUCTION
The role of cattle in nutrient recycling is well known, that of humans is seldom considered, that of termites has been totally ignored. This paper makes a preliminary assessment of the relative amounts of nutrients recycled by these different groups in the sub-humid Southern Guinea Savanna of Nigeria, covering 145 thousand ha. The growing season is 6-7 months, the population density is 46.3 persons per km^2 (Jagtap, 1995). The ruminant population is 14 Tropical Livestock Units (TLU of 250 kg) per km^2, 18% of the area is cropped (de Leeuw *et al.*, 1995) with sorghum, maize, groundnut, cowpea, yam and sweet potato. The termite population, to a depth of 2 m is 3-4,000/m^2 (Wood *et al.*, 1979) with a biomass of >10g/m^2.

MATERIALS AND METHODS
Data were gathered at Mokwa, 9^o 18'N, 5^{o}14', altitude 152 m, annual rainfall of 1120 mm. Soils are Ultisols with 0.3-0.5% organic C, 0.08-0.09% total N and 2.0-3.5 meq/100g ECEC. The vegetation is open savanna woodland with a grass cover dominated by *Andropogon gayanus*.
The following data sources and assumptions were made: Wood *et al*. (1977) measured primary productivity of cropped land, aboveground biomass of wooded savanna, and vegetation lost by annual burning. Below ground productivity of wooded savanna was 60% of above ground productivity (Menaut and César, 1979). Each square kilometer contained 82 ha of savanna woodland and 18 ha of land cropped with equal proportions of maize, groundnut and yams. Consumption by livestock was 3.1 t dry matter/TLU/year (Lamprey, 1983), crop residues and grassland each provided half the annual intake (Powell, 1986). The grass grazed contained double the average N concentration of the sward (Diarra *et al.*, 1995). In savanna woodland termites consumed 60% of wood litter, 3% of tree leaf litter (Collins, 1981), 2.5% of living grass (Wood *et al.*, 1977), 60% of grass litter (Ohiagu and Wood, 1979) and 35% of roots (personal assumption). In cropped land termites consumed 20% of maize stover and all maize and groundnut roots (Wood *et al.*, 1977). Humans consumed 100% of maize grain, 80% of yams and 70% of groundnut (République francaise, 1984). Food consumed by the local population was estimated as the percentage of the crops produced needed to provide 2600 kcals/person/day (Warren and Mahmoud, 1984).

RESULTS AND DISCUSSION
Primary productivity of vegetation and the biomass and nutrient content of the fractions consumed by livestock, termites humans and fire (Table 1) was integrated at an ecosystem level (Table 2).
Primary productivity in cropped land (7.77 t/ha) was less than savanna woodland (10.37 t/ha). Termites had the highest live biomass >10 t/ha, and consumed the most (30.5%) of the vegetation produced, processing 17% of the N and 22% of the P. They consumed 3.1 t/ha in savanna woodland, and 1.5 t/ha in cropped land. Subterranean fungus-growing *Microtermes, Ancistrotermes, Microcerotermes* and *Amitermes* spp were mainly responsible. These species do not build mounds but have diffuse nest systems within the top meter of soil (Wood *et al.*, 1977).
Humans (biomass of 3.5 t/km^2) were the next most important consumers, taking 5.9% of the biomass, 10.4% of the N and 9% of the P. Crop yields were normal and provided 3 times the calories needed by the local population. Export to the cities of 2/3 of crops produced entails annual depletion of 30.9 kg N and 4.5 kg P/ha of cropped land or 5.6 kg N and 0.8 kg P/ha on an ecosystem level.
Livestock biomass (2.3 t/km^2), was less than humans and termites. Livestock consumed 4.4% of the vegetation, and 8.9% each of N and P. The crop residues available (37.9 t/km^2) exceeded the dry season food requirements of local livestock (21.7 t/km^2). Grass production (112 t/km^2) equally surpassed their rainy season feed requirements (21.7 t/ha). The portion of the remainder consumed by wild life was probably insignificant. Excessive hunting in the West African savanna has so reduced the populations of large mammals, that their ecological role has been taken over by herbivorous invertebrates (Menaut and César, 1979).
Annual grass burning in savanna woodland consumed an average of 1.8 t biomass/ha, (18% of the total production), losing 14.1 kg N from the burnt land but most of this is returned in the rain.
Conclusions. Termites recycle approximately one third of the biomass produced in savanna ecosystems, and deserve more research attention. The fate of nutrients recycled by subterranean termites needs quantification. The possibility of enhancing recycling by managing termite species and behaviour needs investigation. Termites consume dung in Nigeria thereby affecting the ability of ruminants to recycle nutrients.
Soil depletion due to the export of food to the ever-growing mega-cities also needs serious consideration. Use of night soil to maintain soil fertility is rare in Nigeria, where there are serious problems of environmental hygiene because of failure to recycle human waste.

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Table 1
Primary production of vegetation at Mokwa, Nigeria and the biomass and nutrient content of fractions consumed by livestock, termites and humans.

Parameter	Biomass (kg/ha)	Nutrient content (kg/ha) N	P
Production			
Savannawoodland			
Wood litter	1400	4.20	1.40
Leaf litter 2350	23.50	4.00	
Grass	2730	30.03	4.37
Roots	3888	13.60	3.88
Woodland total	10368	71.33	13.65
Cropped land			
Yams	8016	111.3	10.8
Maize	7750	86.1	14.0
Groundnuts	7549	162.3	17.1
Crop average	7772	119.9	14.0
Consumption			
Livestock			
Grassland	265	5.8	0.5
Crop Residue	1206	13.3	1.3
Livestock total	4340	7.2	0.6

Parameter	Biomass (kg/ha)	Nutrient content (kg/ha) N	P
Production			
Termites			
Wood litter	840	2.5	0.8
Leaf litter	70	0.7	0.1
Live grass	.68	0.9	0.1
Grass litter	790	2.5	0.7
Roots	1361	4.7	1.2
Termite savanna Total	3129	11.3	2.9
Maize stover	590	14.2	0.6
Maize roots	1415	11.3	1.3
Groundnut roots	2610	52.2	7.8
Termite cropland Average	1541	22.6	3.2
Humans			
Maize grain	2538	40.6	8.1
Yams	5905	53.1	8.3
Groundnuts	1228	45.4	3.8
Humans average	3223	46.4	6.7

Table 2
The percentage of biomass consumed by livestock, termites, wild animals and humans calculated at an ecosystem level.

	Biomass	N	P
	———t/km^2———		
Total Productivity	990.1	8.01	1.37
Consumption			
Livestock	43.4 (4.4)	0.72 (8.9)	0.07 (5.4)
Termites	301.7 (30.5)	1.64 (20.5)	0.35 (25.8)
Humans	58.0 (5.9)	0.84 (10.4)	0.12 (8.9)
Fire	177.8 (18.0)	1.16 (24.7)	0.22 (16.1)
Wild animals	———Trace———		

() As percentage of total productivity