GLOBAL JOURNAL OF SOCIAL SCIENCES VOL 6, NO. 1, 2007: 19 - 29

 ISSN 1596-6216

AGRICULTURAL LAND USE PATTERNS AND THEIR RELATIVE GROSS MARGINS IN THE NORTH-WEST ZONE OF NIGERIA

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(Received 25 July 2006; Revision Accepted 23 April 2007)

ABSTRACT

This study aimed at providing information on the land use practices of farmers and the associated gross margins of different farm production systems in the North-West Zone (NWZ) of Nigeria Two States in the NWZ were surveyed, namely, Kano and Katsina. Two Agricultural Development Programme (ADP) zones were purposively selected in each of the two States. In Kano State, Rano and Danbatta zones were selected, while in Katsina State, Funtua and Ajiwa zones were selected The results of the survey showed that agricultural land was used by farmers for cropping purposes and extensive livestock activities. The cropland base was devoted to sole-and mixed cropping activities, with the latter predominating. Sorghum-based mixtures dominated in Rano zone, maize-based mixtures in Funtua zone and millet-based mixtures in Danbatta and Ajiwa zones. The results also indicated that gross margins computed on a per hectare basis were higher for two-crop production systems than sole-crop and three-crop enterprises in the study area.

KEYWORDS: Land use, gross margin, north-west zone, Nigeria

1. INTRODUCTION

The particular use to which a tract of land is put is described as the land use of that tract of land (Akamigbo, 1998). A land use system is thus a combination of specified land uses (or production systems) practised on a given land unit (FAO, 1976). A piece of land can be put to various (public and/or private) uses such as agricultural, residential, commercial, industrial and recreational uses. Each category too has specific uses (Barnard and Hexem, 1988). The implication is that there exist competition for a given tract of land for alternative uses

Farmers have usually been the main decision – makers on how the land they control can be used and not social planners or government agencies, unless compelling public interest requires land use restrictions with corresponding enforcement (Lutz and Daly, 1991). The implication is that private land owners or operators decide about land use choices in the light of their own objective functions, production possibilities and constraints – not on the basis of any theory of the social good (Lutz et al., 1999).

In developing countries, the primary focus of agricultural development is to raise agricultural production from a subsistence level to a higher-yielding level to produce income for poor farmers and food and fibre for these countries (Kiss and Meerman, 1991). The prevailing farming systems are commodity or co-commodities-based, but at the same time reflect specific resource management systems related to the prevailing environmental conditions and the culture of the people (Okigbo, 1994).

Determining an appropriate allocation of land between alternative, competing uses is a fundamental problem and economists have explored this resource allocation problem from the perspective of determining the optimal allocation of land (Barbier and Burgess, 1997). Similarly, agricultural economists have a long history of both forecasting costs and returns of agricultural commodities and of estimating and recording the income and expenses that occur during some specific period.

This paper is divided into six sections. Section 2 reviews literature on land use and associated regulations. Section 3 reviews literature on the measurement of farm profitability. Section 4 is the methodology. Section 5 describes the agricultural production systems adopted by farmers in the north-west zone of Nigeria and compares gross margins for the different crop production systems Section 6 contains the conclusion and recommendations

2. REVIEW OF LITERATURE ON LAND USE AND ASSOCIATED REGULATIONS

Boserup (1965) classifies land use systems into five main types which, in order of increasing frequency of cropping and hence increasing intensity of labour inputs per hectare of all land under both cultivation and fallow, are as listed below:

(i) forest-fallow cultivation, where land is left for as many as twenty-five years to regenerate forest, after a year or two of cropping;

(ii) bush-fallow cultivation, where the fallow period extends from about six to ten years, to allow the regrowth of small trees and bushes;

(iii) short-fallow cultivation, based on natural grasses, with cultivation recurring after intervals of perhaps one or two years;

(iv) annual cropping of land, which may be left fallow for some months or weeks only, between the harvesting and planting of annual crops; and

(v) multi-cropping of land, with each plot bearing two or more crops each year and virtually no fallows. In the past, the land-use patterns across the African savannas consisted of two to four years of cropping, followed by eight to fifteen years of natural bush fallow to allow the fertility of the land to be reconstituted through natural vegetative growth and decay (Weber et al., 1996). This extensive agricultural production system was an appropriate response to abundant land, limited capital and limited technical know-how (Cleaver and Schreiber, 1992). However, unprecedented rates of population growth have placed a severe strain on the traditional rural production and livelihood systems in sub-Saharan Africa, with the pace of evolution in key elements of these systems — farming practices and technology, land tenure and management arrangements, and the like — inadequate in the face of the dramatically intensifying pressure of more people on finite stocks of natural resources (Cleaver and Schreiber, 1992). The result has been that the cropping systems have

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been changing rapidly towards intensive land use, reduced fallow periods, and changing crop preferences and cropping patterns (Weber et al., 1996).

Data on land availability and its use in Nigeria presented in Table 1 show that agriculture is a major user of the total land area as both cropland and permanent pasture are major components of the land use series; for example, about 34% and 44% of the land surface are usable as cropland and permanent pasture, respectively Another 14% constitutes forest and woodland, while only 8% is used for a variety of nonagricultural and miscellaneous purposes.

Table 1. Land availability and its use in Nigeria.

Land Availability				
Total land area (000 ha)	Percent of total land area			Land with no inherent soil constraints (000 ha)
	Arid	Semi-arid	Humid	
91,077	0	8	92	7,797

Land use (as percent of total land area)			
Crop land	Permanent pasture	Forest and woodland	Other land
34	44	14	8

Source: Saito, 1994

Table 2. Land use and vegetation changes in Nigeria: 1976/78 and 1993/95.

Land use category	1976/78		1993/95		Change	% change*
	% of country	Km^2	% of country	Km^2		
Intensive (crop) agriculture	35.5	332,794	40.2	365,491	42697	+13.23
Extensive (grazing)	18.3	166,326	20.6	187,236	20910	+12.57
agriculture	12.5	113,880	9.0	81,694	-32186	-28.26
Sudan savanna	16.6	151,393	9.0	81,386	-69699	-46.04
Guinea savanna	1.0	9,451	2.3	20,918	11467	121.33
Floodplain agriculture	1.6	14,573	2.1	18,990	4417	30.31
Disturbed forest	0.0	122	2.0	18,517	18395	15077.87
Gully erosion	1.9	16,899	1.0	9,248	-7651	-45.28
Shrub swamp	20	18,316	1.8	16,499	-1817	-9.92
Freshwater swamp	2.9	12,549	1.3	11,983	-13837	-110.26
Undistubed forest	1.4	12,549	1.3	11,983	-566	-4.51
Sahel savanna	0 7	6,137	1.2	11,248	5111	83.28
Discontinuous grassland	1.1	9,994	1.1	9,977	-17	-0.17
Mangrove forest	0.4	3,518	1.0	9,206	5688	161.68
Agriculture/Denuded	0.1	1,034	0.9	7,989	6955	672.63
Continuous grassland	0.7	6,591	0.9	7,851	1260	19.12
Natural water	0.7	6,762	0.7	6,759	-3	-0.04
Montane forest	0.2	2,083	0.6	5,444	3361	161.35
Urban (major-minor)	08	7,402	0.6	5,254	-2148	-29.02
Riparian forest	0.1	812	0.5	4,829	4017	494.70
Sand dunes	0.2	1,739	0.3	3,112	1373	78.95
Montane grassland	0.2	1,327	0.3	2,882	1555	117.18
Reservoir	0.2	1,424	0.3	2,632	1208	84.83
Rock outcrop	0.1	830	0.2	1,641	811	97.71
Tree crop plantation	0.1	997	0.2	1,573	576	57.77
Forest plantation	0.1	628	0.1	11,156	10528	1676.43
Teak plantation	0.0	147	0.1	988	841	572.11
Irrigation project	0.5	4,882	0.1	871	-4011	-82.16
Grass marsh	0	4	0.1	545	541	13525.0
Salt marsh/Tidal flat	0	16	0.1	485	469	2931.25
Agricultural project	0.1	487	0.0	269	-218	-44.76
Alluvial	0.0	52	0.0	139	87	167.31
Livestock project	na	na	0.0	62	-	-
Minning	0.0	2	0.0	29	27	1350
Canal						

Source: FORMECU, 1996 as reproduced in Adeyoju, 1998.
*Authors' computations.

Related data on land use and vegetative changes in Nigeria between 1976/78 and 1993/1995 (Table 2) show that over the 18-year period, cropland expanded by more than 13 percent, grazing land expanded by a little more than 12 percent, the undisturbed, disturbed and riparian forests together, fell by over 33 percent, and the Guinea, Sudan and Sahel savanna zones contracted by 46 percent, 28 percent and 4.5 percent, respectively.

Table 3. Global trends in land area and use, 1980-1995.

Geographic region	Land area 1995 (million ha)	Population density 1995 (per 1,000)	Land use (million ha)					
			Cropland		Permanent pasture		Forest and woodlands	
			1995	Change since 1980	1994	Change since 1980	1994	Change since 1980
Africa	2,964	243	193	10.3%	884	-1.1%	713	-2.0%
Asia	2,678	1,284	472	3.5%	792	14.1%	537	-2.7%
Europe	473	1,541	135	-4.3%	79	-8.1%	157	1.0%
North and Central	2,137	213	277	1.1%	366	2.2%	824	2.1%
America	849	33	53	8.2%	429	-5.3%	200	-0.3%
Oceania	1,753	181	121	19.8%	495	4.2%	932	0.5%
South America	2,195	134	226	NA	355	NS	810	NA
USSR (former)								
World	13,048	436	1,476	3.4%	3,399	3.5%	4,172	-2.9%

NA = Not available

Source: FAO (1997), as reproduced in Barbier (1998).

Table 4. Global tropical deforestation trends, 1980-90

Geographic region	Number of countries	Land area (million ha)	Forest cover		Annual deforestation 1981-90	
			1980 (million ha)	1990 (million ha)	Million ha	% per annum
Africa	40	2,236.1	568.6	527.6	4.1	0.7
West Sahelian Africa	6	528.0	43.7	40.8	0.3	0.7
East Sahelian Africa	9	489.7	71.4	65.5	0.6	0.9
West Africa	8	203.8	61.5	55.6	0.6	1.0
Central Africa	6	398.3	215.5	204.1	1.1	0.5
Trop. Southern Africa	10	558.1	159.3	145.9	1.3	0.9
Insular Africa	1	58.2	17.1	15.8	0.1	0.8
Asia & Pacific	17	892.1	349.6	310.6	3.9	1.2
South Asia	6	412.2	69.4	63.9	0.6	0.8
Continental S.E. Asia	5	190.2	88.4	75.2	1.3	1.6
Insular S.E. Asia	5	244.4	154.7	135.4	1.9	1.3
Pacific	1	45.3	37.1	36.0	0.1	0.3
Latin America & Caribbean	33	1,650.1	992.2	918.1	7.4	0.8
C. America & Mexico	7	239.6	79.2	68.1	1.1	1.5
Carribean	19	69.0	48.3	47.1	0.1	0.3
Trop. South America	7	1,341.6	864.6	802.9	6.2	0.7
Total	90	4,778.3	1,910.4	1,756.3	15.4	0.8

Source: FAO (1993)), as reproduced in Barbier (1998).

These trends in land area and use are, to some extent, consistent with those for the African continent (Table 3), which show that over a 15 – year period (1980 and 1995), cropland in Africa expanded by more than 10 percent, whereas grazing land and forest/woodlands fell by 1 percent and 2 percent, respectively. According to Barbier (1998), the loss of permanent pasture may be the result of both the serious degradation problems posed by overgrazing and also the conversion of pastureland to cropland and that, the decline in Africa's forest and woodlands is mainly the result of land conversion associated with agricultural expansion. Table 4 also confirms that loss of closed forest area is a major problem in Africa. The 1990 global forest resource assessment of tropical deforestation estimated the annual deforestation rate across tropical Africa at 0.7 percent, which is just below the global average of 0.8. Over half of the deforestation appears to be occurring in Central Africa and Tropical Southern Africa, where much of the continent's remaining tropical forest cover is found. Taken together, these two tables (Tables 3 and 4) suggest that land uses in Africa have been characterized in recent years by a significant amount of land conversion from one use to another, such as from forests, woodlands and pastures to cropland.

Though cropland is the second largest area among major uses (Table 1), it has been argued that cropland used for crops in any geographical setting fluctuates from year to year in response to weather, crop demand and supply levels, and other economic conditions (Barnard and Hexem, 1988). In the same context, neither demographic growth nor land-use change in an area is uniform over time (Heimlich and Vesterby, 1991). An area's rate of demographic growth and consequent land use change is affected by land supply and demand and differing needs for non-residential infrastructure such as roads, schools, and shopping centres to service changing populations (Heimlich and Vesterby, 1991). Studies (Barnard and Hexem, 1988; USDA, 1994) have also shown that cropland fluctuates widely as a consequence of farm programme such as acreage reduction programmes as are prevalent in the United States by which farmers voluntarily reduce their planted acreage of a programme crop by a specified proportion of that crop's acreage base to become eligible for d eficiency payments, loan programmes, and other United States Department of Agriculture (USDA) programme benefits.

Some authors (Abalu and D'Silva, 1979; Abalu et al., 1979; van Ek et al., 1997) have argued that farmers' land use

patterns are shaped by the interaction of factors like tradition, level of technology, availability of resources, physical environment, food preferences and economic conditions. Others (for example, Southgate, 1988; Lutz and Young, 1990) have argued that the use and management of a parcel of land have much to do with its legal status (that is, with whether or not it is, for example, a private property, owned by a group, or an open-access resource) and that how small farmers alter land use and soil management in response to a change in economic incentives depends on the tenure regime.

Land-use controls and related regulations which require farmers to adopt environmentally favourable practices are rare and largely unenforceable in most developing countries (Runge, 1990a). This is partly because food production and agricultural development remain the primary focus of concern in these countries at the expense of environmental quality considerations (Runge, 1990b). The regulatory approach has also been found to be less applicable in developing countries because the institutional capabilities are generally weak, enforcement difficult, monitoring expensive and, often, the literacy skills of farmers and farm workers are also limited (Lutz and Young, 1990).

3.0 MEASUREMENT OF THE RELATIVE PROFITABILITY OF FARM ENTERPRISES.

Relative profitability has to do with answering the question: which farm enterprise is more profitable? (Etuk, undated). Profit is traditionally defined as gross returns minus costs, but there are difficulties in defining profitability or net return in an environment where much of the labour comes from family sources and where the opportunity cost for family labour is difficult to establish (Hays and Raheja, 1977; Abalu, 1978). Net return is therefore defined in three different ways, depending on the way labour is costed (Hays and Raheja, 1977). The first is to assume that family labour is perfectly substitutable for hired labour, and therefore can command the same remuneration as it would get from working on other farms (Hays and Raheja, 1977). Using this method, all inputs and labour are costed. The second method used is to cost only hired labour, which gives the net return in actual cash terms, since family labour is not explicitly paid for; and the third method is one in which no labour is costed at all (Hays and Raheja, 1977).

The net profitability of an enterprise is measured as the net margin of that enterprise. This is obtained by complete cost accounting which involves the splitting up and apportionment of all farm costs including fixed or overhead costs. Net return per hectare is defined as the gross value of harvest less the imputed value of seed, seed dressing, chemical fertilizer and organic manures, less all payments to hired labour (including both cash payments and imputed value of kind payments) and less the imputed value of family labour divided by the number of hectares. Net return per man-hour is defined as the gross value of harvest less the imputed value of seed, seed dressing, chemical fertilizer and organic manures, divided by the total number of man-equivalent labour hours applied to the field. Net return per kilogramme is calculated the same way as net return per unit of land except that the net return is divided by the yield from the field

The gross margin of a farm enterprise is sometimes used as a measure of the profitability of that enterprise (Etuk, undated) Thus, the relative profitability of different enterprises can be obtained by computing and comparing their gross margins. The most profitable enterprise is the one with the highest gross margin. The gross margin of an enterprise is defined as the enterprise gross income minus the variable expenses attributable to that enterprise Therefore, to compute gross margin, we need to calculate the gross income and the variable costs. The enterprise gross income is the value of the total output of that enterprise. It is obtained by multiplying the quantity of output by the market price of output. The variable expenses are those expenses that vary more or less in direct proportion to the scale of the enterprise. Enterprise gross margins are usually expressed on a per unit basis, that is, per hectare (Etuk, undated). The sum of all the enterprise gross margins on a farm is the total gross margin. The enterprise gross margin is not a measure of the net profitability of the enterprise because it does not take account of the fixed costs The gross margin is sometimes called the gross profit

4.0 METHODOLOGY

4.1 Description of the study area: The study was carried out in two States in the north-west zone of Nigeria, namely, Kano and Katsina States (Figure 1).

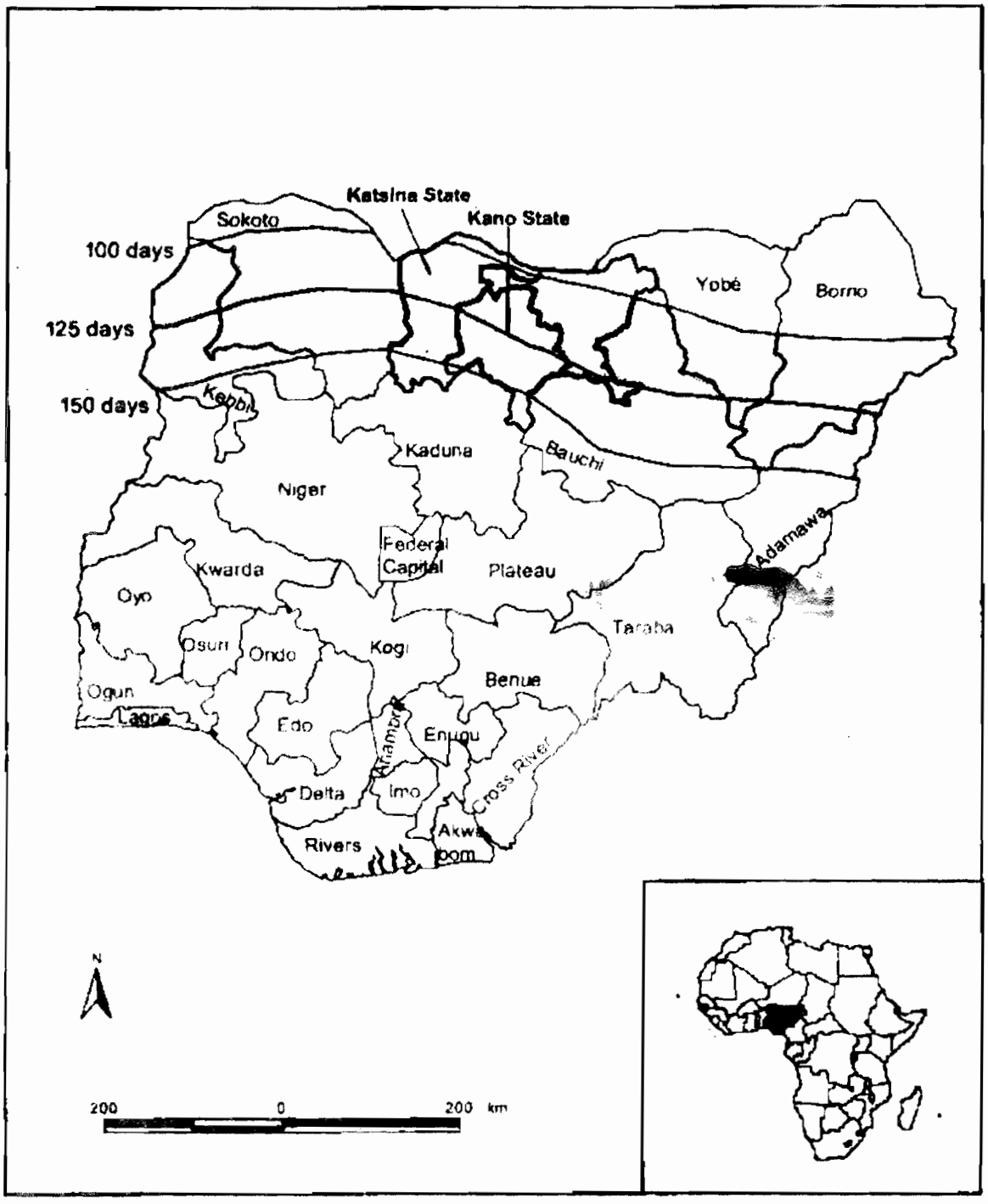

Fig. 1: Nigeria's two States-Kano and Katsina-and the Sudan savanna zone, with length of growing period between 100 and 150 days.

Source: Ogungbile *et al.* (1999)

These States have a high agricultural production potential and are considered representative in terms of biophysical characteristics and population density for the larger part of northern Nigeria (Ogungbile et al., 1999). Rainfed agriculture predominates, with only one cropping season per year. The average growing season extends from June to October (Henriet et al., 1997). Dry season irrigated farming on lowlands bordering streams (fadama) is also common (Udry, 1990). The most important and traditional staple food crops in the two States are sorghum, millet, groundnut, cowpea and cotton (Weber et al., 1996). Crops such as yam and cassava are minor (Ogungbile et al., 1992). Interest has also been growing in nontraditional crops such as maize and upland rice because of improved access to fertilizer and the availability of improved varieties (Weber et al., 1996). These crops occur in the fields in various mixtures and various combinations and are cultivated mostly by settled Hausa-speaking farmers, though the land is also shared with nomadic Fulani herders (Hazell and Roell, 1983; Henriet et al., 1997). The Hausa villagers often own some small livestock such as goats, sheep, poultry, and donkeys, and a few of them own one or several pairs of oxen to complement crop activities (Hazell and Roell, 1983). Thus, the Hausa villagers are essentially agropastoralists who raise some livestock within the same production unit (Williams et al., 1999).

4.2 Method of sampling: A two-stage sampling procedure was adopted in the study. First, two Agricultural Development Programme (ADP) zones (one located in the southern-most and wettest parts and the other in the northern-most and driest parts) were purposively selected in each State. In Kano State, the Rano and Danbatta zones of the Kano Agricultural and Rural Development Authority (KNARDA) were surveyed, while in Katsina State, the Funtua and Ajiwa zones of Katsina Agricultural and Rural Development Authority (KNARDA) were surveyed (Table 5). These ADP zones have traditionally served as sites for collecting diagnostic data and validating new and improved technologies and, most often, their results are extrapolated to other areas with similar agroecological and socioeconomic conditions (Ogungbile et al., 1999). Secondly, sixty farmers were selected in each of the four ADP zones using random sampling method (Tables 5).

Table 5. Main characteristics of the selected ADP Zones in Kano and Katsina States.

State	ADP zone	Relative climate	Rainfall (mm)	No. of Local Government Areas	No. of villages	Headquarters of Extension service	*No. of farmers	No. of farmers selected
Kano	I	Wet	909	11	269	Rano	34394	60
	II	Dry	710	11	385	Danbatta	35032	60
Katsina	I	Dry	416	11	127	Ajiwa	34543	60
	II	Wet	1050	7	78	Funtua	34440	60

Source: Adapted partly from Ogungbile et al , 1999; *Field survey, 2002-03

4.3 Data collection: The survey conducted between 2002 and 2003 consisted of a series of interviews with the selected households heads who constituted the units of analysis. The questionnaire was designed to generate data on the sampled household heads' farm production (land use) practices and average costs and returns for the different farm enterprises.

4.4 Data analysis: Simple descriptive statistics such as frequency distributions, percentages and means were used to determine the average areas devoted to the various crop enterprises, while simple budget analysis was used to calculate the relative profitability of the various enterprises.

5.0 RESULTS AND DISCUSSIONS

Land use in the study area comprises both cropping and livestock activities.

5.1 Livestock activities: No lands were designated as pastureland, as nomads and semi-nomads (agropastoralists) raise their livestock by employing a free-grazing feeding pattern. According to Swallow and McCarthy (1999), extensive livestock-production is one of the most common types of land use in the arid areas of Africa because of its adaptability to the highly variable environmental conditions. Under this system, small and large ruminants graze indigenous pastures during the rainy seasons and crop residues during the dry season. An advantage of extensive livestock production is that it requires little in terms of inputs and management and the tedious work of searching for consumable plants is carried out by the animals (Agboola and Kintomo, 1993). The system also offers the possibility of converting rangeland vegetation and crop residues that are not suitable for human consumption into products which are consumable by man (Agboola and Kintomo, 1993). Since animals are not intensively managed, the animal stocking rate is not controlled and over-grazing occurs (Agboola and Kintomo, 1993). The presence of several overgrazed and bare ground areas susceptible to degradation as a result of the removal of the protective cover of vegetation complicates the task of restoring the fertility status of soils for sustainable crop and livestock production, considering that, at harvest, both crops and residues are removed from the field (Odunze, 1999; Odunze et al , 2004). Studies (Agboola and Kintomo, 1994; Odunze et al , 2004) have also shown that the removal of crops and residues at harvest limits potential nutrient recycling between crop and soil, further impoverishing the nutrient status of the soils and that crop residue grazing results in the removal of organic matter, nitrogen and phosphorus from the cropping system. Furthermore, since nomadic herdsmen often set fire to native pastures during the dry season to stimulate regrowth of grasses, large quantities of nutrients especially nitrogen and sulphur are lost in the process (Agboola and Kintomo, 1993). This is made worse by the fact that: (i) the soils in the study area are characteristically sandy to sandy-loam in texture and low in organic carbon, available phosphorus and cation exchange capacity and are therefore poor at holding water and nutrients; and (ii) crop production in the zone involves ploughing, harrowing and ridging with no special attention to conservation measures against soil nutrient depletion, soil erosion and runoff (Harrison, 1990; Elemo et al., 1990; Odunze et al , 2004). The soils thus become more (easily) degraded due to the effects of overgrazing, soil erosion, nutrient mining and poor soil management strategies adopted by farmers.

Though a 25 – hectare government grazing reserve exists in Ajiwa zone, limited monitoring and enforcement capabilities on the part of the government has resulted in encroachments for cropping purposes and the conversion of the reserve into a defacto open access resource. Under such open access resource settings, ownership arises from capture and not from

prior legitimization by the state and individuals are free to use the resource without regard for the implications accruing to others (Bromley, 1999). The loss of the government grazing reserve is consistent with findings from earlier studies in Africa to be the result of land conversion associated with agricultural expansion (Barbier, 1998). The vulnerability of the grazing reserve itself to conversion to cropland may be reflective of: (i) the breakdown of a management and authority system over the resource whose very purpose was to introduce and enforce a set of norms of behaviour among users of the resource (Bromley and Cernea, 1989); and (ii) the creation of an ownership structure without the attendant capacity to control individual user behaviour (Bromley, 1990).

5.2 Cropping activities: Given the predominance of crop-based land use activities within the farming system, a description of the crop production systems prevalent in the study zones is particularly appropriate. Various types of cropping systems are observable within a crop production system at household level (Ogungbile et al., 1999). The different cropping systems observed among farmers in the study zones and the average areas devoted to the various crop enterprises are as shown in Table 6. The cropping systems were those of sole- and mixed-cropping. Sole cropping was particularly more prevalent in Funtua and Danbatta zones, occupying 69.8% and 45.6% of total cropped land, respectively (Table 6).

Table 6: Land uses (cropping systems) in the study area.

	Kano State				Katsina State	
	Rano		Danbatta		Funtua	Ajiwa
Type	% Cropped		% Cropped		% Cropped	% Cropped
Sole:						
Sorghum	11.0		20.1		21.9	8.2
Millet	0.4		22.1		-	2.3
Rice	15.0		-		7.0	-
Maize	1.5		-		30.7	3.7
Cowpea	4.7		0.4		-	6.6
Groundnut	-		3.1		-	2.4
Soybean	0.2		-		-	
Bambara groundnut	0.2		-		-	
Sesame	0.3		-		-	
Cotton	-		-		9.7	0.2
Cassava	0.3		-		-	1.2
Cocoyam	-		-		0.2	-
Onions	0.1		-		-	-
Pepper	0.3		-		-	
Sub-total	34.0		45.7		69.5	24.6
2-Crop Mixture:						
Sorghum/millet	13.9		1.2		1.7	8.6
Sorghum/maize	13.0		0.4		18.5	-
Sorghum/groundnut	20.5		8.9		-	9.2
Sorghum/cowpea	2.5		6.1		0.4	8.2
Sorghum/soybean	3.3		-		0.8	-
Sorghum/rice	2.0		-		0.8	-
Sorghum/pepper	1.5		-		-	-
Millet/cowpea	0.4		8.9		-	5.3
Millet/groundnut	1.9		17.2		-	24.8
Millet/cotton	-		-		-	2.9
Maize/rice	-		-		0.4	-
Maize/cotton	-		-		5.6	-
Maize/pepper	2.5		-		-	-
Maize/cocoyam	-		-		1.9	-
Onion/pepper	1.9		-		-	-
Sub-total	63.4		42.9		30.1	59.0
3-Crop Mixture						
Sorghum/millet/cowpea	2		5.7		0.4	10.2
Millet/groundnut/cowpea	-		2.0		-	6.2
Maize/cowpea/pepper	0.3	-	-	-	-	- -
Maize/onion/pepper	0.3	-	-	-	-	- -
Sub-total	2.6		7.7		0.4	- 16.4
4-Crop Mixture						
Sorghum/millet/groundnut/ Cowpea	-	8.2	3.7	-	-	- -
Sub-total	-		3.7		-	-
Total	100.0	0.2	100.0	11	100.00	100.00

Field survey, 2002-03.
- = Data not available

In relation to the total cropped land for all the sampled locations, sole cropping occupied 43.5% of total cropped land and mixed cropping 56.5% (Table 6). The relatively large percentage of cropped area devoted to single crops is consistent with Manyong et al's (2000) finding to the effect that agricultural transformation in the cereal-based systems of the dry savannas of Nigeria has been reflected in changes in cropping (land use) patterns, with shifts from crop mixtures

which were important in the 1970s and occupied 77% of fields to sole cropping which was widely practised in 1997 and occupied 81% of fields. These findings, however, contrast with earlier localized surveys in the study area which showed much smaller incidences of sole cropping; for example, the survey by Norman (1974) and Ogungbile et al. (1999) showed that sole crops accounted for only about 17% and 20% of total cultivated hectarage, respectively. There is also some evidence that the relative emphasis placed on sole cropping in an area is a reflection of the existence of an established technology for sole stands production and the success of external support systems (that is, external institutions) which encourage the growing of crops according to official recommendations (Abalu et al., 1979). The adoption of improved technologies has also been shown to result in a significant movement towards sole cropping and that this is particularly so because technology development and extension programmes have often concentrated on working with sole cropping (Abalu et al., 1979).

Though in general, mixed cropping predominated, 2-crop mixtures were the most prevalent, occupying 48.9% of total cropped land, as against 6.8% for 3-crop mixtures and 0.9% for 4 – crop mixtures. The most important cereals grown sole and in mixtures were sorghum, millet, rice and maize while the dominant legumes in sole stands and in combination with other crops were cowpea and groundnuts (Table 6). Sole crop sorghum occupied between 20 and 22% of cropped land in Danbatta and Futua zones respectively (Table 6). Sole millet was very popular in the Danbatta zone, occupying 22% of cultivated land. Sole rice and sole maize were more important in Rano and Funtua zones, occupying 15% and 31% of cropped land, respectively (Table 6). Sole cowpea occupied 4.7 and 6.6% of total cropped in Rano and Ajiwa zones, respectively, and sole groundnut 2.4 and 3.1% of cropped land in Ajiwa and Danbatta zones, respectively. However, in mixture with other crops, the variations were 0.4 – 10.2% for cowpea, and 1.9 – 25% for groundnut across the study locations.

The results (Table 6) indicate considerable variability with respect to both sole crops and components of crop mixtures as well as the proportion of different sole crops and crop combinations between and among locations. An example of a locational difference in terms of the importance of major intercrops is that sorghum – based mixtures were dominant in the Rano zone, maize-based mixtures in the Funtua zone and millet-based mixtures in Danbatta and Ajiwa zones (Table 6). The dominance of cereals both sole and in mixtures in the sampled locations agrees with Weber et al.'s (1996) finding to the effect that cereal-based cropping systems predominate in the West African savannas, with one or several other crops in mixture or in rotation with the cereals. The complexity of traditional intercropping systems has been noted to be partly an outcome of farmers' informal experimentation with crops that satisfy their requirements and also fit the agricultural environment of their regions (Jodha, 1979). Similarly, since units of production and consumption are intimately linked, pronounced complexity may also arise from the multiple objectives of crop enterprises which are to produce food and cash (Elemo et al., 1990). Often, these find expression in the existence of multiple farm enterprises, with resources allocated to maximizing output of the whole farm, rather than just an enterprise (Elemo et al., 1990).

5.3 Gross margins of cropping systems: The peasant farmer, although producing primarily for family consumption, often produces a marketable surplus of his farm products to meet increasingly dynamic family demand patterns for non-farm items (Olayide and Heady, 1982). This tendency had earlier been confirmed by Schultz (1964) in his analysis of production responses of peasant smallholders in Africa. Gross margins for different production systems were computed as the difference between the market value of farm products and the farmers' variable costs of production, expressed on per hectare basis (Table 7).

Table 7: Revenues, costs and gross margins ('000 Naria ha^{-1}) for different land use options (crop production systems) in Kano and Katsina State

Land uses (cropping systems)	Kano State																Katsina State			
	Rano Zone				Danbatta Zone				Funtua Zone				Ajiwa Zone				All locations (pooled)			
	TR	TVC	GM	t-value	TR	TVC	GM	t-value	TR	TVC	GM	t-value	TR	TVC	GM	t-value	TR	TVC	GM	t-value
Sole																				
S	19 2	13.8	5 4	-2.33*	9.5	7.7	1.8	-2 51*	24 0	21 0	3 0	-0 7	24 5	18 7	5 8	-1 68	16 7	13 9	2.8	-2.40*
MI	12.8	12.1	0.7	-1 60	8 9	8.2	0.6	-0 70					25.2	9 9	15 3	-1.79	9.6	8.5	1 1	-1.55
Mz	38.6	28.5	10.1	-1 20					37 5	21 1	16 4	-8.52*	29.4	17 7	11 7	2.13*	36.4	21 4	15 0	-7 92*
R	43.5	23.9	19 6	-7 01	10.5	10.2	0 3	-0 13	35.0	24 3	10 7	0.08					39.0	24.7	14.3	-0.84
G													26.6	22.8	3.8	-1.24	16.4	14.8	1.6	-
BG	16.0	6.1	9.9	-	14.0	10.2	3.8	-									16.0	6.1	9.9	-3.12*
C	20.5	13.6	6.9	-2.45*									25.7	13.9	11.8	-1.92*	21.6	13.5	8.1	-
SB	50.0	21.7	28.3	-													50.0	21.7	28.3	-1.05
SS	32.0	31.6	0.4	-													47.9	39.3	8.6	-4.05
CT									50.2	25.5	24.7	-3.78*	32.0	12.9	19.1	-	48.7	24.5	24.2	-
CC									100.0	53.6	46.4	-					100.0	53.6	46.4	-
CS	58.0	30.9	27.1	-													58.0	30.9	27.1	-
PP	31.2	16.8	14.4	-													31.2	16.8	14.4	-
ON	88.0	65.2	22.8	-													88.0	65.2	22.8	-
Two-crop:																				
S/MI	27.0	20.4	7.5	-4.19*	13.6	8.3	5.3	-2.64*	46.0	26.8	19.2	-3.09*	39.3	17.5	21.8	-3.47*	29 7	19.1	10.6	-5.69*
S/Mz	34.6	25.9	8.7	-2.14*	24.3	16.5	7.8	-0.52	41.1	27.2	13.9	-4.17*					37.3	26.4	10.9	-4.36*
S/R	48.6	35.3	13.3	-1.33					46.5	37.8	8.7	-0.49					48.1	35.9	12.2	-1.45
S/G	49.5	19.8	29.7	-3.79*	14.0	10.8	3.2	-1.98*					50.7	24.1	26.6	-4.47*	41.9	18.8	23.1	-4.92*
S/C	33.9	20.3	13.6	-2.93*	29.8	11.1	18.7	-1.98*	52.6	33.2	19.4	-8.43*	38.4	24.7	13.7	-3.63*	28.2	19.7	8.5	-4.40*
S/SB	52.0	27.4	24.6	-3.15					61.3	30.7	30.6	-2.55					53.2	27.8	25.4	-3.67*
S/PP	26.0	19.5	6.5	-0.93													26.0	19.5	6.5	-0.93
MI/CT																	39.6	21.5	18.1	-4.64*
MI/G	51.4	45.5	5.9	-0.52	13.5	10.5	3.0	-1.96*					39.6	21.4	18.1	-4.64*	35.0	18.3	16.7	-7.13*
MI/C	34.5	12.5	22.0	-1.02	14.6	9.9	5.7	-1.24					52.3	24.0	28.3	-8.04*	22.7	13.2	9.5	-2.69*
Mz/CT									48.7	30.0	18.7	-3.33	55.1	20.9	34.2	-2.38*	48.7	30.0	18 7	-3.33*

Mz/R									51.0	27.8	23.2	-16.57*					51.0	27.8	23.2	-6.57*
Mz/PP	83.5	44.9	38.6	-1.825													83.5	44.9	38.6	-1.825
Mz/CC									74.7	39.9	34.8	-1.54					74.7	39.9	34.8	-1.54
ON/PP	116.9	62.2	54.7	-4.09*													116.9	62.2	54.7	-4.09*
Three-crop:																				
S/M/C	39.5	16.9	22.6	-2.99*	15.7	10.1	5.6	-2.66*	37.3	29.2	8.1	-0.39	67.1	29.7	37.4	-4.26*	45.3	21.5	23.8	-4.86*
MI/G/C	94.5	68.3	26.2	0.28	16.5	11.6	4.9	0.85					70.0	29.8	40.2	-4.70*	60.8	26.7	34.1	4.57*
Mz/ON/PP	66.0	44.1	21.9	-1.15													94.5	68.3	26.2	1.28
Mz/C/PP																	66.0	44.1	21.9	-1.15
Four-crop:																				
S/MI/G/C					13.6	6.1	7.5	-3.82*									13.6	6.1	7.5	-3.82*

Field survey, 2002-03.
S= Sorghum, MI = Millet, Mz = Maize, R = Rice, G = Groundnut, BG = Bambara groundnut, C = Cowpea, SB = Soybean, SS = Sesame, CT = Cotton, CC = Cocoyam, CS = Cassava, PP = Pepper, ON = Onion.
* = Significant at the 5 per cent level of significance.; t-values with asterisk indicate land uses (cropping systems) for which significant statistical differences were observed between costs and returns.
-[a] = t-values were not obtained for some cropping systems because only single farmers practised them. Thus, their costs and returns were single constants with no variation, hence t-values could not be calculated for them.

The results showed that 2-crop enterprises had higher gross margins than those of sole-crop and 3-crop. In Rano zone, the 2-crop systems with the highest gross margins (in decreasing order of value) were onion/pepper (₦54,700), maize/pepper (₦38,600), sorghum/groundnut (N29,700), while the 3-crop system with the highest gross margin was millet/groundnut/cowpea (₦26,200) and the sole crops with the highest gross margins were soybean (₦28,300), cassava (₦27,100) and onion (₦22,800). In Danbatta zone, the 2-crop system with the highest gross margin was sorghum/cowpea (₦18,700) and the sole crop with the highest gross margin was bambara groundnut (₦3,800). The highest gross margins for 2-crop systems in Funtua zone were for maize/cocoyam (₦34,800), sorghum/soybean (₦30,600) and maize/rice (₦23,200), while the sole crops with the highest gross margins were cocoyam (₦46,400) and cotton (₦24,700). The Ajiwa zone had maize/cotton (₦34,200), millet/cowpea (₦28,300) and sorghum/groundnut (₦26,600) as the 2-crop systems with the highest gross margins and millet/groundnut/cowpea (₦40,200) as the 3-crop system with the highest gross margin and cotton (₦19,100) as the sole crop with the highest gross margin. The pooled result for the sampled locations (Table 7) showed the 2-crop systems with the highest gross margins to be onion/pepper (₦54,700), maize/pepper (₦38,600) and maize/cocoyam (₦34,800), while the 3-crop systems with the highest gross margins were millet/groundnut/cowpea (₦34,100) and maize/onion/pepper (₦26,200), and the sole crop with the highest gross margin was cocoyam (₦46,400).

6.0 CONCLUSION AND RECOMMENDATIONS

Land use in the study zones consisted of crop-based and free-range livestock production practices. The variability in both sole crops and crop mixtures in the same area and also between different locations is somewhat illustrative of the great diversity which exists in the cropping systems practised in the study area. The following recommendations become important:

RECOMMENDATIONS

(1) Given the prevalence of sole and mixed-cropping practices, research efforts should be intensified in the search for crop varieties specifically improved under sole and mixed-cropping conditions. For mixed cropping, such varieties should be those which decrease intercrop competition and at the same time increase complementary effects, while for sole-cropping, the use of high yielding materials selected under sole cropped conditions is necessary. In general, crop varieties to be grown sole and intercropped should be chosen and combined to obtain the greatest yield and environmental advantages.

(2) The existing free-range (unregulated) grazing-pattern has the potential of degrading land. It is therefore important that grazing fields planted with fodder crops are established and managed in partnership with local communities. These fields can be divided into paddocks and optimally and routinely grazed insitu with some supplementation. Livestock could also be stall-fed with cut forages and crop residues, with high supplementation. Agropastoralists should be encouraged to set up and manage their personal grazing paddocks. This will reduce the risk of over-utilization of a common property resource based on a single resource user's perception that the costs of resource depletion are shared by all users while the benefits are internalized (Demsetz, 1967).

(3) The allocation of land between alternative, competing uses should be such that assures maximization of total net present benefits from the alternative uses over time and recognizes the biophysical use capacity of land (most appropriate usage). For example, using land according to its capacity will increase economic efficiency and avoid the reduction of capacity resulting from uses for which the land is unsuited (Lutz and Daly, 1991).

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