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Land Degradation: Theory and Evidence from the North-West Zone of Nigeria

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Abstract: This study discusses land degradation in the context of its definition, classification and the theories in environmental economics explaining the phenomenon. The study also discusses the causes of land degradation in the north-west zone of Nigeria and their associated consequences. The locations surveyed were the Rano and Danbatta Agricultural Development Programme (ADP) zones of Kano State and the Funtua and Ajiwa ADP zones of Katsina State. For each ADP zone, a sample of 60 farmers were randomly selected, giving a total sample size of 240 farmers. Data were collected between 2002 and 2003 using structured questionnaire and were analyzed using descriptive statistics. The results showed the major causes of land degradation to include farm vegetation burning, existence of attenuated property rights over land, forest and woodland destruction, overgrazing, increased intensity of farming and contraction of fallows, low-input agriculture, erosion, absence of regulations on land use and absence of a social organisational structure conducive to a sustainable use of land. The recommendations made included: preparation of simple and well-illustrated materials to increase public awareness of the problem of land degradation; discouraging the burning of farmlands preparatory to planting; assignment of secure, inheritable and transferable land rights to individuals and groups; supplemental applications of inorganic and organic amendments to land; adoption of concrete mechanisms to foster participation and action towards sustainable use and management of land and the adoption of environmentally benign agricultural production technologies such as well-designed rotations of crop mixtures, crop-livestock integration and agroforestry systems.

Key words: Land degradation, definition, classification, theories, causes, Nigeria

INTRODUCTION

Land degradation is a major problem facing developing countries and is projected to become an even more severe constraint into the future (Chisholm and Dumsday, 1987; Eckholm, 1976; USAID, 1979; Ward, 1979; Brown and Wolf, 1984; Bennett, 1931; Barbier and Burgess, 1992; Pimentel *et al*., 1995). Some studies show that nearly 80% of rangeland and dryland forest areas, 30% of tropical forests and around 50% of all irrigated cropland in developing countries are classified as degraded (Leonard *et al*., 1989). Other studies also show that much existing (as much as half) as well as potentially productive agricultural land in developing countries is being lost through the processes of land degradation and abandonment (Cleaver and Schreiber, 1992; Barbier, 1997).

Given that land is an essential input in farming, the impacts of land degradation and the depletion of soil resources have profound economic implications for low-income countries and poor rural regions of the world (Barbier, 1998). This is especially true in Africa, where agricultural production is crucial to development and the livelihoods of the rural population depend on the primary sector (Barbier, 1998). The vulnerability of countries dependent on agrarian and pastoral activities to the effects of environmental degradation is also due in part to shortages of human and financial capital that severely limit countries' abilities to turn to other economic activities when the resource base can no longer sustain them (Warford and Partow, 1990).

This study investigates the causal factors of farmland degradation in the north-west zone of Nigeria and their associated on-site impacts. This approach is necessary because empirical researches on the economic costs of land degradation in the developing world are confined largely to analysis at the level of individual farms or watersheds (Barbier, 1998). Studies have also shown that though land degradation as engendered by its causal factors also inflicts external or off-site costs, these off-site impacts are much harder to evaluate because they are indirect, non-marketed and often difficult to trace (Barbier, 1998).

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Definition and classification of land degradation: The development of the agricultural sector in the face of rapid population growth has involved progressively more intensive use of land resources for cropping and grazing and with this, greater control and pressure on local habitats, leading to environmental change (Gretton and Salma, 1997). The development of the agricultural sector (along with other sectors of the economy) has therefore involved adaptation to a changing environment (Gretton and Salma, 1997).

Land degradation has negative connotations that imply the loss of something of value within the environmental-economic system (Gretton and Salma, 1997). The lost value may be related to the productivity of the land for agriculture, the environment as host to naturally-occurring species of flora and fauna or to the environment as a place for other human activities (such as mining and secondary industries, human habitation and waste assimilation) (Gretton and Salma, 1997). Some of the definitions of land degradation which have appeared in literature include the following:

- It is a reduction in the land's actual or potential uses/a diminution or complete loss of the productive potential of the soil for current and or future use (Blaikie and Brookfield, 1987).
- It is the decline in soil quality caused through misuse by humans and results in deterioration of soil's life support processes and decline in its capacity to produce food, feed, fibre and fuel (Lal and Okigbo, 1990).
- It is the diminution of the soil's current and/or potential capability to produce quantitative or qualitative goods or services as a result of one or more degradative processes (UNEP, 1982, 1984) and
- It is the decline in the biological productivity or usefulness of land resources in their predominant intended use ... stemming from human activity and encompasses soil degradation and changes in the traditional landscape and vegetation due to human interference (Gretton and Salma, 1996).

Usefulness is a crucial attribute of land degradation (Gretton and Salma, 1997). The declining usefulness of land resources indicates that human activity is crowding out pre-existing ecosystems at a rate above what would normally be expected in nature and the associated changes would be considered to be degradation once they infringe on the intended use of the land resources affected (Gretton and Salma, 1997). As land resources have many possible uses, with changes to the landscape having both favourable and unfavorable effects depending on use, the qualification of predominant intended use is necessary in order to make the definition of land degradation workable (Gretton and Salma, 1997).

Land degradation can be extreme, severe, moderate or light. The definitions for these categories of land degradation as given by Oldeman *et al.* (1990) and the World Resources Institute (WRI) (1992) are:

- Extreme degradation is degradation that occurs on poor soils and restoration is impossible.
- Severe degradation is degradation involving severe nutrient depletion and deeper, more frequent gullies and hollows; extensive restoration is required involving physical structures, drainage works, terraces, mechanised deep ploughing and reseeding.
- Moderate degradation is degradation that involves loss of topsoil from water and wind erosion, nutrient decline, some salinization and soil compaction, all of which contribute to loss of potential productivity; restoration is essential to reverse productivity declines and requires both soil conservation practices and major structural interventions, such as drainage for waterlogging or salinity, contour ridging, bands and the like.
- Light degradation is degradation on good soils showing signs of degradation-some topsoil loss, nutrient decline and increased salinity-that can be restored through standard conservation practices, such as crop rotation, minimum tillage and other on-farm practices.

The Soil Reference and Information Center in Wageningen, Netherlands, has recently published more conservative estimates of the extent and severity of land degradation in Africa. Its data indicate that about 321 million ha (14.4% of the total vegetated land surface) are moderately, severely or extremely degraded and an additional 174 million ha (7.8% of the vegetated area) are lightly degraded (Oldeman *et al.*, 1990).

Distinguishing between the agents, processes and factors of land degradation is also crucial. According to Lal and Okigbo (1990), the differences are as follows:

- The agents of land degradation are the forces involved such as population pressure, development of infrastructure including roads and buildings, socio-economic conditions and the like.
- The processes are the physical, chemical, or biological mechanisms that lead to decline in land productivity, the most common of which include depletion in soil fertility, deterioration of soil structure leading to compaction and accelerated

erosion, nutrient imbalance caused by salt accumulation or leaching and buildup of organic or inorganic pollutants and

- The factors are the natural or man-made parameters that determine the magnitude and relative predominance of the process of degradation such as deforestation, burning, continuous monocropping, cultivation of marginal lands and indiscriminate use of agrochemicals

Theories for explaining land degradation: In environmental economics, there are three theories for explaining land degradation and all are closely related to the concept of externality, namely, the theory of social cost, the theory of collective goods and the property rights theory (Mishan, 1981).

The theory of social cost goes back to Pigou (1920) and his recognition of the relation between private and social cost (Watcher, 1992). The argument is that if economic agents do not bear the full (social) costs of their actions-if there are externalities-factors of production will not be optimally allocated and the assumption is that the market cannot cope with the externality problem by itself (Wachter, 1992). The theory of social cost explains land degradation as the result of farmers' use of practices for which they do not bear the full costs; for example, downstream costs of water pollution or erosion), or of positive externalities (related, say, to protective functions or biodiversity values) that cannot be transformed into income and so force land users to adopt inappropriate production practices (Wachter, 1992).

The theory of collective goods is closely related to the theory of social cost since externalities are a constituent part of collective goods (Wachter, 1992). A pure collective good has three properties: non-excludability (nobody can be excluded from consumption so anybody can benefit), non-rivalry in consumption (one person's consumption does not impair that of another) and externalities (the possibility of free-riding because of non-excludability) (Wachter, 1992). Many environmental goods have the properties of collective goods, particularly non-excludability and externalities. However, most environmental problems arise when non-rivalry no longer applies (Wachter, 1992). According to this theory, environmental problems such as land degradation emerge when users can exploit scarce environmental goods, such as grazing areas, without contributing to their maintenance or conservation (Wachter, 1992). No one has an incentive to conserve the land because the benefits of conservation are dissipated among all users (Wachter, 1992).

The property rights theory shares with the first two approaches the belief that externalities cause land degradation. However, property rights theorists argue that the main problem is not externalities but rather absent or poorly defined property rights to environmental goods (Wachter, 1992). If land rights are unclear, unspecified, disputed, or nonexistent, then land users are less likely to be interested in conserving resources or in making investments that improve the long-term productivity of resources; that is, the land resource users would have no incentive to take care of their land resources and use them in a socially optimal way (Wachter, 1992; Hazell and Lutz, 1999).

MATERIALS AND METHODS

Description of the study area: The study was carried out in two States in the north-west zone of Nigeria, namely: Kano and Katsina. 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 (NARP, 1995; Ogungbile *et al*, 1999). Approximately 90% of Kano Sate lies within the Sudan Savanna zone and the other 10% within the Northern Guinea Savanna zone, while Katsina State covers three agro-ecological zones: the Sahel, the Sudan and the Northern Guinea Savanna zones (Ogungbile *et al*., 1999). The rainfall pattern in the two States is unimodal and ranges between 350 and 500 mm in the Sahel, 600 and 850 mm in the Sudan Savanna and between 900 and 1000 mm in the Northern Guinea Savanna (Ogungbile *et al*., 1999). The onset of rains, which marks the beginning of the growing season starts in May in the Northern Guinea and June in the Sudan agroecological zones (Elemo *et al*., 1990). Concomitantly, the duration of the growing season spreads from a range of 140 to 200 days in the Northern Guinea, 95 to 140 days in the Sudan to 68 to 102 days in the Sahel (Elemo *et al*., 1990). Consequently, crops of longer growing cycles dominate the Northern Guinea while those requiring shorter growing cycles dominate the Sudan and Sahel zones (Elemo *et al*., 1990).

The soils in the two States belong mostly to the Ferruginous tropical soils group and, depending on hydrology, parent material and age, soil types such as alfisols, entisols, inceptisols, regosols, ferrisols are found (Elemo *et al*., 1990). Hydromorphic soils are found in pockets in the States and these soils have fluctuating water tables and occur in valley bottoms and floodplains (Ogungbile *et al*., 1999). Characteristically, most of the soils in the two States are generally low in organic matter and phosphorus levels (Jones and Wild, 1975). Also, as a result of the dominant kaolinitic type of clay (due to the

type of parent material), the cation exchange capacity is low, resulting in reduced buffering capacity (Elemo *et al*., 1990). In general terms, therefore, the soils are poor in fertility status and structure and are readily susceptible to degradation where the protective cover of vegetation is weakened or removed (Odunze, 1999; Harrison, 1990).

The major crops grown in the two States are sorghum, millet, maize, rice, groundnut, cowpea, soybean and cotton. Pepper, onion and tomatoes are also grown. Though sole-cropped fields of crops occur, intercropping is the dominant practice. There is, however, always one crop dominant on any mixed-crop field (Ogungbile *et al*., 1999). The relative importance of crops also varies according to location (Ogungbile *et al*., 1999). Livestock production is also an integral part of the farming system as both crops and animals are sources of food and cash income for farmers (Ogungbile *et al*., 1999). The livestock kept include cattle, goats, sheep, donkeys, horses, camels and poultry.

Sampling procedure, data collection and data analysis: Given that each State is divided into three agroecological zones, two Agricultural Development Programme (ADP) zones (one located in the southern-most and wettest parts of a State and the other in the northern-most and driest parts) were purposively selected in each State. Actually, purposive sampling ensured that one does not end up with a sample concentrated in one ecological zone. In Kano State, the actual survey took place in Rano (wet) and Danbatta (dry) ADP zones, while in Katsina State, the survey took place in the Funtua (wet) and Ajiwa (dry) ADP zones. The unit of analysis was the individual farm operators. A total of 240 farmers, consisting of 60 farmers from each ADP zone were randomly selected, based on the sample frame of farmers obtained from the ADP zones. Data collection occurred between 2002 and 2003 using structured questionnaire. The data collected were analyzed using descriptive statistics.

RESULTS AND DISCUSSION

The causes of land degradation identified in the study area include the following:

Fire and burning of vegetation: All the 240 farmers sampled used fire for the burning of agricultural residues on farmlands and clearing of vegetation under the traditional slash-and-burn farming systems. According to Andreae and Goldammer (1992) a large fraction of burning in the savanna takes place during the dry season and is most intense in the northern hemisphere from November to March. However, consistent with experiences in tropical countries, burning was observed almost whenever and wherever there was plant material dry enough to burn. The burning of agricultural wastes in the fields is extremely difficult to quantify because of its distributed nature (Andreae and Goldammer, 1992). No statistics are also available, mostly because material of direct economic value is not involved (Andreae and Goldammer, 1992). Barnard (1991) estimated that the amount of crop residue produced equals about 1700 teragramme dry matter (Tg dm) (one teragramme = one million tonnes = 10^{12} grammes) per year in the developing world and that a similar amount is produced in the developed countries. Following the suggestion of Crutzen and Andreae (1990), it is estimated that 25% of agricultural waste (that is, 850 Tg dm/year) is burned in the fields (Andreae and Goldammer, 1992). Biomass burning causes land degradation through short-term and long-term effects (Lal and Okigbo, 1990): (i) The short-term effect relates to high temperatures generated during the fire which completely sterilizes the top 5 cm of soil, alters soil chemical properties and soil structure and its wettability and predisposes soil to excessive runoff and erosion; (ii) Repeated cycles of fire accentuate ecological instability, resulting in denudation of vast areas of their protective vegetation cover, soil compaction and unprecedented runoff and accelerated rates of erosion.

Forest and woodland destruction: Fuel-wood gathering was the major cause of forest and woodland destruction. Fuel-wood was the dominant form of cooking energy for all farmers sampled. Fuelwood has generally been considered a free-good, taken largely from farmlands and from lands to which everyone has the right of access (open-access lands) so that there are no incentives for individuals to replant the trees. Economic theory clearly shows that unregulated open-access will cause excessive rates of exploitation. This result normally arises because of two factors. First, when profits or rents exist, agents will enter the market to extract some of this rent. Second, even if others are barred from entering the activity, those already engaged in the activity have an incentive to try to capture more profit, even though this will decrease the total rent available in the future (Ruitenbeek, 1992). This has impeded the development of efficient markets for fuelwood (Cleaver and Schreiber, 1992). When forests are unduly degraded or destroyed (for example, unsustainably mined for fuel-wood), the productive capacity of the exposed soil is rapidly depleted through nutrient leaching, desiccation and outright erosion (Myers, 1988). Alternative fuels such as kerosene or Liquefied Petroleum Gas (LPG) are more costly to obtain, not available in open-access conditions and are therefore

not replacing wood fuels in significant quantities (Cleaver and Schreiber, 1992). This finding is to some extent consistent with those of: (i) the Institute for Agricultural Research, Zaria in Nigeria (1998) to the effect that deforestation in Katsina State results partly from indiscriminate exploitation for firewood, encroachment and conversion of forest estates to farmland or settlements and expansion of human settlements and (ii) Barbier (1998) to the effect that deforestation and wood harvest (for firewood) is a major source of human-induced land degradation, accounting for nearly 15% of the land degradation in Africa.

Existence of attenuated property rights in land: Farmers in Nigeria rarely possess non-attenuated (or unlimited) private property rights over land. The land use decree of 1978 vested titles to all land in the government, so that individuals have rights only of use and occupancy. The arguments have been that where farmers do not own farmlands in perpetuity but rather possess only a leasehold, they will be unwilling to incur short-term costs (for example, expenditures on erosion control) for the sake of benefits realized after the terminal date of that leasehold (Southgate, 1988). Similarly, the risk of future dispossession makes them disregard the benefits of land conservation realized only after the passage of several years. The status of government as the repository of all land has also restricted the emergence of formal land markets. Studies have shown that where land markets are severely restricted, the value of land as an asset becomes adversely affected. The reasons are three-fold. First, if land were a tradeable asset, there would be an incentive for land conservation because land could be sold or rented, allowing the previous landholder to realize the value of the land. Second, the greater the restrictions on the sale of land, the less the land is worth as collateral, since in case of loan default, the lender cannot easily sell the land and recover the loss and third, where land markets are restricted, credit is likely to be more expensive and investment in farm productivity and land conservation to be lower (Johnson, 1972; Wachter, 1992).

Over-grazing: All the farmers sampled had no lands specifically designated for grazing. Thus, uncontrolled (free-range) grazing by cattle, sheep, goats, donkeys and camels was a common practice. The result of this was that, often, soil surfaces were bare and without any vegetation as livestock browsed any available vegetation in search of fodder. The likely consequences are the loss of soil to wind and water erosion, destruction of soil as a result of trampling by livestock and degradation of arable lands (IAR, 1996; IAR, 1998). This finding agrees with those of the following: (i) Mohamed-Saleem and Fitzhugh's (1993) and Powell and Williams' (1993) to the effect high animal stocking rates and densities and the confinement of herds to smaller grazing areas during the cropping season to avoid crop damage increase the risks of overgrazing and predispose lands to degradation and (ii) Barbier's (1998) to the effect that overgrazing accounts for nearly half of the human-induced soil erosion in Africa and that 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.

Increasing intensity of farming and shortening of the period of fallow: Continuous agricultural production was found to be the norm in all the sampled locations. Fallow periods were found to have lasted between 1 to 2 years-a period much shorter than the 5 to 7 years required to restore soil fertility (Lal and Okigbo, 1990). Since soils in the Sudano-Guinean zone tend to be thin and not very fertile, diminished fallowing often causes yields to fall off substantially because land is being given less time to recover between cropping cycles (Southgate *et al*., 1990). As land deteriorates, farmers colonize marginal hinterlands or migrate to urban areas (Southgate *et al*., 1990). Several studies have also indicated drastic decline in soil fertility due to continuous cropping, reflected largely in rapid acidification and reduction in organic carbon, total nitrogen, effective cation exchange capacity and exchangeable cations (Lal and Okigbo, 1990).

Low-input agriculture: The survey showed that a farm household applies between 41.5 and 67.2 kg ha^{-1} of inorganic fertilizer and between 517.4 and 943.3 kg ha^{-1} of organic manure. These contrast with recommended inorganic fertilizer application rates for some staple crops of 126 kg nutrient ha^{-1} for sorghum, 120 kg nutrient ha^{-1} for millet and 170-215 kg nutrient ha^{-1} for maize (Enwezor *et al*., 1989) and recommended organic manure application rates of 7.5-10 t ha^{-1} of farmyard manure and 5-20 t ha^{-1} of fresh animal manure (Lombin, 1988; Ofori, 1999). The implication is that inorganic fertilizer and organic manure use in the study area is low compared with the requirements of crops, hence their yield-and soil-enriching effects were not fully realized. This finding agrees with Reardon *et al*. (1999) who point to the low use of fertilizers across Africa as a major cause of concern from the both the food production and the environmental perspectives. The authors particularly argued that widespread capital deficient unsustainable intensification is a major force behind farmland degradation and productivity loss.

Accelerated erosion: Soil erosion was identified by 156 farmers (65% of those sampled) as a principal and pervasive mode of degradation of land. According to Lal and Okigbo (1990), erosion is a selective process which removes the topmost fertile 0-5 cm of soil and its ability to grow crops. More specifically, the effects of erosion include the removal of nutrients such as phosphorus, nitrogen, potassium and calcium, the reduction of organic matter and the restriction of rooting depth as the soil thins (Myers, 1988). When this happens, the closely correlated property of water infiltration may decline by as much as 93% (Myers, 1988). The impairment of water infiltration results in runoff and erosion and prevents the achievement of high soil-moisture content necessary to provide some measure of safety against short-term drought particularly in the semi-arid zone. Soils that are deficient in organic matter tend to be more readily eroded (Myers, 1988). The reason is that organic matter improves structure and aggregation, promotes water infiltration, enhances water-retention capacity, increases the cation exchange (particularly in acid soils), fosters aeration and tilth, retains otherwise fixable or leach able nutrients in a form available to plants and supplies most of the nitrogen and phosphorus required by plants (Sanchez, 1976). Since the development of agriculture some 12,000 years ago, soil erosion is said to have ruined about 4.3 million km^2 of agricultural lands, or an area equivalent to more than one-third of today's crop land (Kovda, 1983).

Absence of regulations on land use and cost-share arrangements for conservation: The absence of both regulations on land use and cost-share arrangements for conservation practices were contributory to land degradation. Under the existing land resource regime by which all lands are government-owned, individual land users here a duty to observe access and, more importantly, use rules determined by the controlling or management agency of the state and government agencies have a right to determine use and access rules, in addition to the enforcement of these rules. All the 240 farmers sampled, however, indicated the complete absence of statutory regulations and land use controls compelling the adoption of specific agricultural practices regarded as environmentally favourable as well as those preventing the cultivation/cropping of marginal agricultural lands and the conversion of lands designated for other uses to cropland, similar to the sodbuster and swampbuster provisions of the 1990 Farm Bill in the United States of America. The sodbuster programmes were designed to limit the ploughing of cropland designated as highly erosive and the swampbuster schemes to limit the conversion of designated wetlands to croplands. The lack of land use regulations may lead to the cultivation of highly erosive and already degraded lands and possibly, repeated cycles of land abandonment, excessive migration to and expansion of agricultural activity on marginal lands, conversion of forests, woodlands, uplands, pasture lands and marshlands to cropland and land degradation. Cost-share programmes as exist in developed countries which subsidize the adoption of the best land management practices were also non-existent. According to Lutz and Young (1990), land use regulations have been inapplicable in developing countries, because the institutional capabilities are generally weak, enforcement difficult and monitoring expensive and that, often, the literacy skills of farmers and farm workers are also limited.

Lack of knowledge about land conservation: A total of 108 farmers (45% of those sampled) indicated having access to information on cropping and related farming systems, but not on land conservation and management practices. Barbier (1998) has argued that the conventional approach to land conservation in Africa has been to encourage farmers to adopt a limited range of improved farming systems and crop production techniques and packages, not necessarily those which are compatible with conservation objectives. Some authors have also argued that, often, the appropriate land management technologies exist but that information about their use has not reached the end users because of deficiencies in extension and education (Anderson and Thampapillai, 1990; Reganold *et al*., 1990).

Absence of collective action and appropriate forms of social organization: The survey revealed that there were no groups or organizations in the sampled locations specifically concerned with the management and improvement of land or having land conservation as an integral component of their programmes. This finding agrees with that to the effect that the difficulty of organizing farmers into effective and stable groups for collective action and the absence of appropriate forms of social organization structured to conduct their members to a sustainable use of land resources contributes to land degradation (Uphoff, 1986; Cernea, 1992; Ostrom, 1994; Rasmussen and Meinzen-Dick, 1995).

Cernea (1991) attributes the difficulty in organizing farmers into effective and stable groups for collective action partly to the following:

- Communities and villages are geographical residential units, not necessarily corporate

organizations and that, physical vicinity alone is not sufficient to engender the type of long-term collective action required for land conservation.

- The interests of community subgroups often differ to such an extent that the kind of collective unified action required by long-term land management schemes is generally not possible, as communities are heterogeneous population clusters, stratified and split in factions and subgroups with fragmented socioeconomic interests such that what is advantageous for one subgroup is not necessarily advantageous for another
- Local community leaders often appear reluctant, or not strong enough, to mobilize the individuals belonging to different subgroups to work for establishing land conservation programmes, or to enforce restrictions to protect land and
- Distributional arrangements for benefit-sharing to ensure that the benefits of land conservation reach the entitled recipients (land resource users) as input contributors to conservation efforts are usually not thought through at the outset and have not worked in practice. Specified intragroup rules and guarantees for distribution commensurate with labour and other input contributions are lacking, in much the same way as are exclusionary rules against non-contributors. The fact that the benefits of land conservation accrue to the farmer in the future and the direct and foregone output and income costs are incurred in the immediate term (as soon as the farmer begins to undertake conservation), weakens farmers' confidence that they would be able to withstand the associated hardships to reap the future benefits of their present conservation efforts and also reinforces the lingering suspicion that the benefits will be appropriated by the state under the existing usufructuary arrangement.

CONCLUSION AND RECOMMENDATIONS

Land degradation was found to be pervasive and multi-causal in the north-west zone of Nigeria. Accurate information on the actual areas and farming communities where land degradation is taking place and the nature of its effects is crucial for guiding interventions and related targeted policy actions. Other related arguments to the effect that growth in developing countries will have to come about mainly through yield increases from existing agricultural lands makes the proper management of land of central importance and particularly compelling. The following recommendations are necessary:

- Given the severity of the problem of land degradation in the study area, the preparation of materials for general dissemination to increase public awareness will be necessary. As an initial first step, a small public enlightenment and education bulletin should be prepared and aimed at indicating the nature and magnitude of land degradation, the causes and processes involved and what needs to be done by private individuals and communities to address the problem. Such bulletins should be non-technical, simple and well-illustrated and aimed for the man in the street, farmers and policy makers.
- The burning of farmland preparatory to planting each cropping season should be discouraged. The clearing and removal of plant residues should be done manually and such residues returned to soil to contribute chemical and biological nutrients for improving soil tilth and maintaining the long-term productivity of soils. An important factor for the increasing use of agricultural residues for soil fertility improvement is farmer education.
- Given that low-input agriculture is a major cause of land degradation in the study area, supplemental applications of judicious levels and appropriate types of chemical fertilizers and organic amendments are necessary. Preference, however, should be for Integrated Soil Fertility Management (ISFM) so as to expand the choice set of farmers by increasing their awareness of the variety of options available and how they may complement or substitute for one another. According to Buresh *et al.* (1997) and Vanlauwe *et al.* (2002), the ISFM paradigm acknowledges the need for both organic and mineral inputs to sustain soil health and crop production due to positive interactions and complementarities between them.
- Given that land degradation in the study area as partly driven by fertility-mining practices such as the intensive use of land, it is essential that increased farm productivity per unit area be achieved with minimum destruction of the environment. The supplemental application of nutrients must be accompanied by the adoption of environmentally benign agricultural technologies such as the use of well-designed and well-tested rotations of crop mixtures that assure constant vegetative cover, terracing and bands often with vegetative matter such as vetiver to prevent water turnoff, integration of livestock and cropping to maintain soil fertility, development of crop varieties that emerge early and protect the soil more rapidly against early rains, contour farming to prevent surface runoff; reduced

tillage systems and agroforestry. These technologies need to be mastered by both the zonal and state agricultural research and extension systems and more widely adapted and introduced to farmers in the study area. The establishment of farm demonstrations may be useful in showing farmers the use and benefits of conservation technologies and improved agricultural practices.

- The existing arrangement by which the state owns all land and assigns only rights of use to individuals has not encouraged land conservation. This is because, in many cases, state ownership has meant defacto non-property, since limited financial and managerial capacities do not allow the state exercise effective control over much of the land it owns. In particular, the most appropriate arrangement is one in which state ownership of land still persists but use rights assigned to individuals and group are transferable and inheritable and the contract sufficiently long-term and secure. This will foster land markets which will increase the value of land and provide the incentive for land conservation. This implies that the state does not act arbitrarily by frequently changing use rights or inappropriately regulating land use.
- While individual actions on privately-owned farmlands may be important in alleviating land degradation, collective and coordinated action at the local level should be preferred to the independent and random actions of individual land users. Land resource users at the local level should see themselves as having duties with respect to the sustainable use and proper management of land. Identifying concrete practical mechanisms to foster popular participation and action at the village and community level, using and developing local skills and responding to the particular characteristics of each area is critical (Cleaver and Schreiber, 1992). Grassroots organizations and NGOs have a particularly valuable role to play in this respect. Studies have shown that entrusting responsibilities to local institutions of the direct users is the most appropriate strategy for successful management and control of the environment (Cernea, 1992).
- Given that forest and woodland exploitation to meet domestic energy needs was a major cause of land degradation, attention needs to be focused on the role of trees in agriculture, as well as on the prospects of restoring soil fertility by combining trees and tree products with crops and livestock in integrated farming systems (agroforestry systems). Considering that farmers are most likely to adopt those systems that are congruent with local culture, improving the use of indigenous trees will be preferable to introducing exotic species. Similarly, multipurpose trees will be more acceptable than single-purpose trees and fast-growing trees are more likely to be adopted than slow-growing trees. Thus, it may be necessary to integrate agroforestry extension into programmes of national agricultural extension services. Trees, in the main agroforestry systems, have been reported to play the role of nutrient pumps by bringing to the surface nutrients that rains have leached down beyond the reach of other plants, since their root systems are deeper than those of non-woody plants (Cook and Grut, 1990). Other researchers have also reported the beneficial role of agroforestry in the control of run-off and water and wind erosion (Young, 1989; Kiepe, 1995; Sanchez, 1995).
- The problem of overgrazing can be addressed by establishing grazing grounds planted with fodder crops. These grazing sites can be divided into paddocks and optimally and routinely grazed in-situ by livestock, or harvested and fed to livestock. Rotational grazing would relieve pressure and permit a better mix of grass varieties to be maintained or to develop (Lutz and Daly, 1991). Studies have also shown that the management of pastureland by local peoples, grouped into associations is the most effective management mechanism (Cleaver, 1993). It is important, however, that these associations be provided ownership of pastureland or be assured long-term user rights if they are to be interested in conservation and in sustainable management.
- Considering that farmers make their land use choices according to their judgement of their best interest coupled with the absence of enforceable land use regulations, careful planning of the use and management of land should be done with farmers in a participatory framework. The most important incentive for investment in land resource conservation or productivity enhancement is resource ownership: the certainty that resource degradation will be a cost directly borne by the current owner users and by their descendants, that is, by the present and future members of the group.

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