ANALYSIS OF POVERTY-ENVIRONMENTAL DEGRADATION NEXUS AMONG ARABLE CROP FARMERS IN PLATEAU STATE, NIGERIA

BY

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A DISSERTATION SUBMITTED TO THE SCHOOL OF POSTGRADUATE STUDIES, AHMADU BELLO UNIVERSITY, ZARIA, IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF DOCTOR OF PHILOSOPHY DEGREE IN AGRICULTURAL ECONOMICS

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NOVEMBER, 2012

DECLARATION

I hereby declare that the work in this dissertation entitled **"Analysis of Poverty–Environmental Degradation Nexus among Arable Crop Farmers in Plateau State, Nigeria"**has been written by me and it a record of my research work. No part of this work has been presented in any previous application for another degree or diploma at any institution. All borrowed ideas have been duly acknowledged in the text and a list of references provided.

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CERTIFICATION

This dissertation titled "**Analysis of Poverty – Environmental Degradation Nexus among Arable Crop Farmers in Plateau State, Nigeria**" by Sunday **Mailumo** meets the regulations governing the award of the degree of Doctor of Philosophy of the Ahmadu Bello University, Zaria and is approved for its contribution to knowledge and literary presentation.

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DEDICATION

This dissertation is dedicated to my two sons, Nathan Ramalon (The-Rock) and Rumah Nadab (The-Shepherd) who had to tolerate my long absence from home and who, during the period of this work were denied some FATHERLY LOVE, which must, of necessity, be readily available at all times for children of their ages.

ACKNOWLEDGEMENTS

First and foremost, I thank God almighty for His grace, mercy and favour upon me. May His name be praised forever in my life. Amen.

I am sincerely grateful to the Chairman of my supervisory committee, Professor B. Ahmed for his diligence and academic input into this work. From the beginning to the end, his comments, criticisms, suggestions and encouragement were highly invaluable. Working under him as a student turned out to be a great privilege and an advantage to me. Apart from academics, I learnt a lot from his hard work and tolerance. All these attributes make him a role model. I can never thank Professor Ahmed enough.

My heartfelt gratitude goes to Dr R. A. Omolehin who co-supervised this work, his support and constructive guidance brought this thesis to reality. Dr Omolehin knows exactly where to touch so as to make the work better. He remained a tremendous source of inspiration to me. In the same token, my appreciation also goes to my second co-supervisor, Professor M. K. Ajala for her immense contribution toward the success of this research. Severally, Prof Ajala had cause to pursue me to work, instead of me pursuing her because of my work.

I am especially grateful to Professor S. A. Rahman, who in my opinion, co-supervised this work and facilitated the completion of the dissertation. Despite being the current Deputy Vice Chancellor, Nassarawa State University, Keffi, Prof. Rahman had to create time to make valuable contributions to this dissertation.

My profound gratitude goes to the Executive Director, Forestry Research Institute of Nigeria (FRIN) Professor S. O. Badejo for graciously granting me approval to study for a Ph.D. I will forever remain appreciative of the Provost, Federal College of Forestry, Jos, Dr. S. O. Adepoju for his unending support and encouragement which greatly aided the completion of this dissertation. I am particularly grateful to my colleagues in the Department of Agricultural Extension and Management and staff of the Federal College of Forestry, Jos, who aided me in one way or the other.

I am also grateful to the Plateau Agricultural Development Programme (PADP) extension staff that assisted me in collecting my data; they include Mr F. Makwin and Mr D. Ventur. I met Mr M. Kulak through Yauna Magaji and he helped a lot during the data collection. My student, Mr Imil David too was of great assistance. The contributions of my classmates at ABU are gratefully acknowledged. My friend Dr. Charles Dawang with whom we share ideas and ran the analysis, I say thank you.

Finally, I am extremely indebted to the entire Mailumo's family for believing in me. Lastly, my dear wife (Nanmi) stood by me through all the thick and thin while the study last. I vividly remember the day I had to rush to Zaria just a day after the birth of our first son. Thanks a lot for being there for me.

This is my list of indebtedness. There are many others who have helped me write this thesis that will forever remain unknown. A phrase here or an experience there has sharpened my thinking and created a new idea. I could never trace these ideas to their

sources, for they have merged with the flow of ideas from a thousand others. But even if I cannot thank everybody individually, I can express indebtedness and I do.

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ABSTRACT

The study analysed the poverty-environmental degradation nexus among arable crop farmers in Plateau State, Nigeria. Using multi-stage sampling technique, 265 farming households were randomly sampled from 9 communities spread across three Local Government Areas of the three agro-ecological zones in the State. Primary data generated from farming household heads through well-structured questionnaires were mainly used for this study. The household's socio economic characteristics, income, expenditure, value of "free" natural resources, and information on factors that lead to environmental degradation dominated the bulk of the data. The data were analysed using descriptive statistics (mean, frequencies and percentages), Tobit regression, Foster, Greer and Thorbecke (FGT) index, Likert scale and probit regression model. Descriptive statistics revealed that the means of the farming households' age and years spent schooling were 47 and 7 years respectively. On the average, these farming households have 11 persons and farmed an average of 5 hectares. The total average monthly household expenditure was ₦67,5934 out of which 46% was spent on food and 23% on natural resources. Fuelwood accounted for the highest natural resource used with 41%. The Tobit regression analysis revealed that the number of years spent in school was significant ($P<0.01$) while farmer's income and size of farmland were significant ($P<0.05$). An increase in any of these variables would result to a probability of a decrease in the poverty level of the farmers. Age of the farmers was significant ($P<0.10$), implying that a unit increase in the age of the farmers, would result to the probability of increasing poverty. The monthly mean per adult equivalent household expenditure (MPAEHE) was ₦3,940. A poverty line of ₦2,627 was estimated, based on this poverty line, the FGT measures show that 42% of the farming households in the study area were poor. Out of the several causes of environmental degradation, not planting of trees because of non-ownership of farm lands was ranked as the first. The result of the Likert scale shows that most of the mean scores laid between 3.03 – 3.89 which implied that most of the farmers experienced moderate degradation on their farms. The probit regression result revealed that the quantity of wood collected, number of animals allowed to graze and length of time they graze were significant ($P<0.01$). A unit increase in any of these variables would lead to the probability of an increase in the poverty depth of the farmers. Knowledge of natural resource conservation was significant ($P<0.05$) and farm size was significant ($P<0.10$). Increasing any of these variables by a unit, would result to the probability of decreasing poverty among the households. Majority (69%) of the farmers deliberately make ridges on their farm lands against the gradient to serve as a control against washing of the topsoil. In conclusion, the study indicates that there is a direct relationship between poverty and environmental degradation. It is recommended that policy makers and managers of poverty alleviation programmes should identify the poor at community levels for policy targeting. Also, farmers, environmentalist, researchers and the government should form a synergy to abate environmental degradation.

Chapter 1

INTRODUCTION

1.1 Background to the Study

The poor have traditionally taken the brunt of the blame for causing society's many problems including, more recently, environmental degradation. There is a general consensus that poverty is a major cause of environmental degradation (WCED, 1987). For example, in one of the conclusions of the Bruntland Commission Report, which incidentally has been accepted as the blue print for environmental conservation, it was explicitly stated that, poverty is a major cause of environmental problems and amelioration of poverty is a necessary and central condition of any effective programmes addressing the environment (WCED, 1987). The poor are the victims of environmental degradation and the perpetrators of the degradation. They are basically short-run maximisers; they try to meet the needs of the present at the cost of the future. The poor and hungry often destroy their immediate environment for their survival. They cut down forests; their livestock overgraze grasslands; they overuse marginal lands; and they crowd into congested cities in growing numbers. The cumulative effect of these changes is so far-reaching as to make poverty itself a major global scourge. It is in this context that the first report on Human Development mentioned that "Poverty is one of the greatest threats to the environment" (UNDP, 1990).

Reduction of poverty is a tremendous and persistent challenge for the global community. Although everyone agrees on the goal of poverty reduction, policies towards achieving them often remain controversial or ineffective. Indeed, there is continual debate about which policies will be effective in different settings. Given that

livelihoods of millions are at stake, there is an urgent need to reconsider the causes of and the remedies for poverty.

Poverty and its reduction are often linked to the natural resource base (Adams *et al.,* 2004; Sunderlin *et al*., 2005; MEA, 2005). Teasing apart the direction of causality in this resource-poverty nexus is a serious empirical challenge. What is not in doubt is that livelihoods cannot be improved if the environmental settings and circumstances remain degraded. It is equally likely that local environmental conditions cannot be improved if most people are living at the very margin of survival. Moreover, it is clear that many poverty reduction efforts will fail if the environmental challenges are neglected (Adams *et al*., 2004).

The nexus of environment and poverty is especially strong in developing countries (Titilola and Jeje, 2005). The economic well being of many (especially rural) households directly depends on the quality of the environment and on the availability of natural resources, this is especially so for low-income countries like Nigeria where a substantial percentage of national income and even larger share of the active population directly depend on agricultural, forestry and fisheries resources (Titilola and Jeje, 2005).

Studies have shown that the poor peoples' economic dependence on natural resources makes them particularly vulnerable to environmental degradation (Cavendish, 1999; Cavendish, 2000; Kepe, 1999). If the above assertion is correct, then efforts to achieve poverty reduction in Nigeria may be ephemeral because major environmental concerns need to be addressed. For example, in many parts of Nigeria, environmental

degradation which refers to the deterioration of the natural environment including the atmosphere, bodies of water, soil and forest is an important cause of poverty (Titilola and Jeje, 2005). This takes various forms that include, land degradation due to soil erosion, deforestation and bush clearing, and over cultivation (NEST, 1991).

The links between poverty and the environment are conditioned by the interaction of economic, social, demographic and even climatic factors. These include the existence, structure and performance of markets (including institutions such as property rights); production and resource conservation technologies; relative input prices, output prices, wages and interest rates and community wealth. Other factors include physical assets, rural infrastructure and human capital (Reardon and Vosti, 1995; World Bank, 1997; Kabubo-Mariara, 2000). In addition, limited access to physical assets limits farmers' ability to engage in improved land use practices such as terracing, planting of trees and resistant vegetation and blocking of soil erosion outlets, which could enhance the productivity of farmers. In other words, these factors act as a disincentive for environmental conservation and often result in a fundamental process of cumulative causation of poverty, environmental degradation and under development (Barbier, 1997a).

These arguments notwithstanding, studies on poverty in Nigeria have somewhat ignored the links between the environment and poverty. Furthermore, existing policy result in marginal groups (poor) being relegated to fragile economic environments due to inability to access productive land and lack of technology to improve the productivity of their land. This calls for the need to understand and empirically

investigate these links as well as to assess the impact of the conditioning factors; these are the issues this study dealt with.

1.2 Statement of Problem

Althoughthe link between poverty and environment already became an issue of discussion along with the debate on sustainable development, research trying to grasp this link achieved indecisive results (Reardon and Vosti, 1995). The original Malthusian argument was that the poor peasants of developing countries over-exploit their environment out of sheer necessity, and the ensuing degradation further aggravates poverty (Ruijs *et al.,* 2008). The extension of this thought was that this poverty-environment "vicious circle" could be reversed, that poverty alleviation would automatically reduce environmental degradation and that reducing environmental degradation would alleviate poverty. Neither of the above argument received empirical support (Adams *et al.,* 2004). Poverty was not found to be the sole cause of environmental destruction, nor did increasing incomes guarantee improved environmental quality (Ruijs *et al.,* 2008). The concepts of poverty and environmental change had been traditionally approached as one dimensional internally homogenous phenomenon, which Reardon and Vosti (1995) were clearly far from. The strength and symmetry of the causal links between poverty and environment had been left out of the discussion and not enough attention had been paid to the farm household economics and food security links pertinent to the poverty-environment links. Therefore, the possible link between poverty and the environment could not be grasped with the traditional concepts.

Nowadays, the global concern about the natural resources conservation leads to projects and researches that aim at identifying the causes and the main consequences of environmental degradation as well as to search for alternatives and solutions to the problem. Banuri (1998) and Hayes and Nadkarni (2001) point out that this environmental degradation occurs both in developed and developing countries, in urban as well as rural spaces and is a consequence of the pressure due to the production's increase and the population growth.

However, after the "Our Common Future" Report (1987), the debate about environmental degradation in developed countries shifts its attention towards the fact that developing countries exert the most important role in the natural resources degradation. From Our Common Future, also called Brundtland Report, onwards the environmental degradation began to be associated and linked to the poverty level of the population, leading some scientists to analyze this topic aiming at detecting some relationship between the poverty condition and the degradation of the environment. This necessitates the need to understand and empirically investigate these links as well as to assess the impact of the conditioning factors. This study therefore addressed the following research questions:

(i) What are the demographic and socio-economic characteristics of farming households in the study area?

(ii) What is the influence of socio economic and demographic factors on poverty among farming households in the study area?

(iii) What is the level of poverty among farming households in the study area?

(iv) What are the causes and level of environmental degradation in study area?

(v) What is the relationship between poverty and environmental degradation in the study area?

(vi) What measures are employed by arable crop farmers to mitigate environmental degradation in the study area?

1.3 Objectives of the Study

The broad objective of this study is to analyze the nexus or link between poverty and environmental degradation in Plateau State, Nigeria. The specific objectives are to:

(i) describe the socio economic and demographic characteristics of arable crop farmers in the study area,

(ii) estimate the relationship between socio economic and demographic characteristics of the farming households and their level of poverty in the study area,

(iii) determine the poverty level of arable crop farmers in the study area,

(iv) identify the causes and establish the level of environmental degradation in the study area,

(v) determine the relationship between the poverty and environmental degradation in the study area, and

(vi) describe the mitigating measures of environmental degradation employed by arable crop farmers in the study area.

1.4 Hypotheses

According to Reardon and Vosti (1995), the relationship between poverty and environmental degradation is still scientifically yet to be exploited. The authors stated that the poverty-environment vicious circle originated from Malthus's theory, whereby the population growth demands an area's increase for feedstock and therefore push farmers towards the marginal lands accelerating the natural resources degradation. These farmers become poorer. The vicious circle suggests that the poverty alleviation will, necessarily, reduce the environmental degradation. According to these reasoning, hypotheses tested in this study include the following:

1. There is no relationship between the socio-economic characteristics of arable crop farmers and their level of poverty in the study area.

2. There is no significant relationship between poverty level and environmental degradation in the study area.

1.5 Justification for the Study

Recent participatory poverty assessments, conducted in 14 developing countries of Asia, Africa and Latin America, revealed a common perception by the poor that environmental quality is an important determinant of their health, earning capacity,

security, energy supplies and housing quality (Brocklesby and Hinshelwood, 2001). Rural studies commonly observe that poor people's economic dependence on natural resources makes them particularly vulnerable to environmental degradation (Ambler, 1999; Cavendish, 1999; Kepe, 1999; Reddy and Chakravarty, 1999; Cavendish, 2000). This population has a large dependency on the natural resources which are the bases of their lives, but because of the limitations regarding the quality and quantity of these natural resources, this population lack another economic alternative and therefore destroy this base. This raises concern about the future supply of goods and services provided by the natural resources on which the poor depend for their survival and sustainability of agriculture in these countries, that is a source of livelihood for the poor. Unless the environmental degradation is stopped or reduced, the current efforts might not provide long run solutions.

In Nigeria, about half of our citizens live under $2 a day – on the threshold of poverty. Two thirds of the population lives under or around $1.25 a day – in extreme poverty. This is because our economic growth since independence has bypassed the poor. Reviewing global Gini coefficients which measure income inequality within nations, Nigeria is one of the most unequal nations in Africa and the world.While our economy grew, the incomes of the poor have not (El-Rufai, 2011). This is especially true of the rural and urban poor who together, account for much of Nigerian poverty. At current rates, it is estimated that by 2015, Nigeria will have more poor people than India and China who have more than a billion people each (El-Rufai, 2011).

Nigeria's national poverty profile has generally been on the rise since 1980, with two significant dips during 1985-1992 and 1996-2004. Focusing on the most recent surveys

(1996 and 2004), the national poverty incidence was 65.6 percent in 1996 and declined to 54.4 percent in 2004. Similarly, in 1996, the poverty depth (P_1) and poverty severity (P_2) were 0.358 and 0.207, but these decreased respectively to 0.225 and 0.122 in 2004. The national poverty incidence has however surged higher to 69 percent as at 2010 (NBS, 2011).

Nigeria has been shown to possess one of the worst environmental records in the world (Butler, 2005). Deforestation is a serious problem in the country, which currently has one of the highest rates of forest lost (3.3 percent) in the world. Since 1990, the country has lost some 6.1 million hectares or 35.7 percent of its forests cover (Butler, 2005). Nigeria's most biodiverse forests are disappearing at a faster rate. Between 1990 and 2000, the country lost a staggering 79 percent of these forests and since 2000, Nigeria has been losing an average of 11 percent of its primary forests per year doubling the rate of the 1990s. It is estimated that Nigeria is currently losing about 351,000 hectares of its landmass annually. These figures give Nigeria the distinction of having the highest deforestation rate of natural forest on the planet (Butler, 2005).

In the context of the world community being committed to the achievement of the goals of reducing population living under poverty by half by 2015, the need to effectively inter-link natural resource conservation and poverty alleviation has become more pronounced (UNDP, 2006).Conceptually, the existence of "poverty-environment nexus" implies that one problem is a significant determinant of the other. Where this is the case, reducing poverty may be an effective way to reduce environmental damage, or vice-versa. Joint solutions may be highly cost effective policy options when the two problems are simultaneously determined.

This study therefore is an attempt to assist policy makers to synergise with the farmers, environmentalist and researchers to facilitate the achievement of the first and seventh items of the millennium development goals; viz: eradicating extreme poverty and hunger; and ensuring environmental sustainability respectively.

1.6 Limitation of the Study

The limitation of the study is that due to time and financial constraints on the part of the researcher, the study was limited to only rural farming householdsin Plateau State,North-Central Nigeria. The study did not consider:

1. The willingness to repay for the environmental resources consumed by the farming households.

2. Poverty – environmental degradation among non – farming households especially urban dwellers.

Chapter 2

LITERATURE REVIEW

2.1 Contextual Definition of Poverty

Poverty is a concept which indicates absolute or relative welfare deprivation. It may be defined in terms of private consumption alone, or extended to include access to common property resources and state-provided commodities, personal assets or wealth, and even subjective assessments of "dignity" and "autonomy" (Baulch, 1996).

IFAD (1992) identified five types of rural poverty which have different links with agriculture and the environment. Material deprivation and alienation cause "interstitial poverty", or pockets of poverty surrounded by power and affluence. "Peripheral poverty" is similar, but found in isolated, marginal areas. "Overcrowding poverty" is material deprivation arising from population pressure and limits on resources. Vulnerability to natural calamities, labour displacement and insecurity produces "traumatic or sporadic poverty", which can be transitory. Isolation, alienation, technological deprivation, dependence and lack of assets are signs of "endemic poverty."

Reardon and Vosti's (1997) typology of poverty is explicitly linked to environment. They examine the asset portfolio of the rural poor, in terms of (1) natural resources, such as water, ground cover, biodiversity of wild and domestic fauna and flora, and soil; (2) human resources, such as education, health, nutrition, skills, number of people; (3) on-farm resources, such as livestock, farmland, pastures, reservoirs, buildings, equipment, financial resource, (4) off-farm resources, including local off-farm physical

and financial capital; (5) community-owned resources such as roads, dams and commons; and (6) social and political capital. Where assets are not completely fungible (markets are absent, underdeveloped or constrained), asset-specific poverty can influence livelihood activities and investment decisions. They note that "welfare poverty" criteria can miss a potentially large group of households that are not "absolutely poor" by the usual consumption-oriented definition, but are too poor, in that their surplus above the minimum diet line is still too small to make key conservation or intensification investments necessary to prevent their land use practices from damaging the resource base or leading them to push onto fragile lands. They prefer use of a measure of "conservation-investment poverty", the cut-off for which is site specific, a function of local labour and non-labour input costs and the types of investment that are needed for the particular environmental problems or risks faced.

2.2 Estimation of Poverty Line

Poverty measurement generally starts from the pre-determine poverty line, which must be reached if a person is not to be deemed poor. Poverty line is thus, the 'cut-off' that separates the poor from the non-poor.This means that an individual will be classified as poor if his initial resources y_i in terms of well being are below threshold z (Ponty, 2000; Ajakaiye and Adeyeye, 2002). There are two main broad approaches to the construction of poverty line namely absolute and relative poverty line.

2.2.1 Absolute poverty line

To estimate an absolute poverty line (the cost of basic needs) requires the idea of "minimum subsistence needs" to be specified precisely. In the case of food commodities, norms of intake of calories and other essential nutrient, for example

the recommended WHO rate of 2300 kilocalories per day for an equivalent adult can be used (WHO, 1985). When the nutrient contents of foods and their prices are known and considering the existing national diet has been considered, a basket of food commodities that satisfies these basic nutritional needs can be identified and costed at the reference prices. This price can be called the food poverty line z^F (known as the abject poverty line) and households for which the adjusted total food consumption expenditure are below these values are considered as poor (Ponty, 2000; Ajakaiye and Adeyeye, 2002; Bandabla, 2005). Where the standard of living measure is based on total consumption expenditure, the absolute poverty line should represent minimum levels of food and non-food consumption combined. In that case, the total poverty line z is constructed as the sum of minimum cost z^F of basic food and z^N of basic non-food needs (Datt and Jolliffe, 1999). However, a common short cut (suggested by Ravallion and Bidani, 1994), uses part of what they refer to as the Cost of Basic Needs method. This inflates the poverty line for food commodities by a factor of $^1/_{(1-X)}$, where x production of consumption expenditure is devoted to non-food commodities for the household whose standard of living measure corresponds to the food poverty line.

However, some studies use the most common method, which is based on the one dollar per day poverty line that was originally proposed by the World Bank (World Bank, 1997). But this is most usually suitable for cross country comparison and not a good basis for setting a meaningful poverty line for a study of poverty in a particular country.

2.2.2 Relative poverty line

An alternative to the absolute poverty line is the relative poverty line, which is not with reference to the overall distribution of the standard of living measure. Common

procedures include specific percentile point of the distribution or a fraction of the median or mean value of the distribution as a whole. If a relative poverty approach is fully adopted, then the poverty line will change in real terms from one year's survey to the next, reflecting improvement or worsening living conditions on average (McKay, 2000; Bandabla, 2005).

In the determination of the absolute and relative poverty line, common measures of living standard used are the income per capita and the expenditure per capita. Researcher's usually suggested the use of the per capita expenditure instead of the per capita income for the following reasons:

First, in most developing countries the agricultural economy forms a good percentage of income and income from agriculture is often very lumpy. Farming households receive a large amount of cash income in the harvest season, and very little for the rest of the year. On an income basis, a household (with a subsistence agricultural economy) which most would view as wealthy during the harvest season may be categorized as poor if the households were interviewed after all farming income for the year had been received. In contrast, households are constantly expending their income and consuming. Expenditure is therefore a better measure of welfare through time (Patrick, 2006). Secondly, expenditure can be viewed as realized welfare, whereas income is more a measure of potential welfare. The third reason is that data on expenditure are generally more reliable and stable than income data. Households are often more willing to truthfully report their consumption expenditure than their income, particularly when dealing with unfamiliar persons (Patrick, 2006). Finally, developing countries rely on a strongly subsistence-oriented economy and such an economy; much income is derived

from self employed business or subsistence-oriented agricultural production. Assigning income values to the proceeds of these enterprises is often problematic (Johnson, *et. al*., 1990; Englama and Bamidele, 1997; Omonona, 2001 and Bandabla, 2005).

2.3 Poverty Profile of Nigeria

About 70% of the African poor reside in rural areas and depend on agriculture for their subsistence (IFAD, 2001). Specifically, Nigeria occupies a land area of 923,768sq km while only 33.02% is arable and 2820sq km is irrigated as at 2003. This means that Nigerian farmers cultivate over 30 million hectares of crops annually, 80 – 90% of which are cereals (Mahmood, 2007). This shows that most Nigerians directly or indirectly depend on agriculture which in turn is dependent on the environment. As a case in mind, more than 55% of the work force is engaged in agricultural activities with about 70% of them residing in the rural areas (Mahmood, 2007). Literature is replete with empirical evidence of the linkages between poverty and the agricultural sector (FOS, 1999a).

Nigeria's national poverty profile has generally been on the rise since 1980, with two significant dips during 1985-1992 and 1996-2004. Focusing on the most recent surveys (1996 and 2004), the national poverty incidence was 65.6 percent in 1996 and declined to 54.4 percent in 2004. Similarly, in 1996, the poverty depth (P_1) and poverty severity (P_2) were 0.358 and 0.207, but these decreased respectively to 0.225 and 0.122 in 2004. The national poverty incidence has however surged higher to 69 percent as at 2010 (NBS, 2011). Estimates of inequality also indicate that Nigeria has more unequal distribution of income than Ethiopia, Madagascar, India, and Niger. Further analysis also suggests that poverty in Nigeria is predominantly a rural phenomenon, with rural

poverty increasing from 28.3 percent in 1980 to 63.8 percent in 2004. However, the proportion of the urban poor also rose from 17.2 percent in 1980 to 43.1 percent in 2004. Thus, within rural areas approximately 44.4 percent of households in 2004 could not meet their food expenditure requirements. Another 19.4 percent could meet their food expenditure requirements, but not the minimum expenditure to cover other basic needs (Omonona, 2001). In the case of urbanhouseholds, 26.7% were not able to meettheir required food expenditure requirements while16.4% could meet their food expenditure but not other non-food basic expenditure needs.

The predominance of rural poverty over urban has been consistent during 1996 to 2004 (World Bank, 1996). In 1996, about 70% of rural households were poor, as compared with 58% of the urban households. In 2004, the incidence of urban poverty declined more rapidly than rural poverty with 64% of rural households being poor (a 6% decrease) while urban poverty decreased by 15% to 43% (World Bank, 1996). The same pattern holds true for the other poverty indices (depth and severity). It is important to note that the incidence, depth and severity of poverty among rural households are higher than the national poverty figures, while those of the urban households are lower. These findings are consistent with earlier studies, which tend to suggest that poverty was more pronounced among rural than urban people (World Bank, 1996; Canagarajah *et al.*, 1997; Aigbokan, 1998; Ogwumike, 1998; FOS, 1999 and Okojie *et al.*, 2000).

The Nigerian economy is predominantly agrarian in nature; the pattern of the trend in national poverty is translated into agriculture with 87%, 67% and 77% of the core poor being farmers in 1985, 1992 and 1996 respectively (FOS, 1999a). This seems to follow

a global pattern as reported by API (2003) that over 70% of the world population are farmers living on less than two American dollars a day.

2.4 Causes and Dynamics of Environmental Degradation in Nigeria

Land, forestry and water are crucial components of the environment. Land degradation refers to a temporary or permanent decline in the productive capacity of the land, or its potential for environmental management (Scherr, 2000). Alternatively, land degradation can be defined as the decline in the biological productivity or usefulness of land resources in their predominant intended use (Gretton and Salma, 1996).

Land degradation is a major problem facing developing countries and is projected to become an even more severe constraint into the future (Barbier and Burgess, 1992; Pimentel *et al*., 1995). Some studies show that nearly 80% of rangeland and dry land 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, 1997b).

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, whereagricultural 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 limits countries' abilities to turn to other economic activities when the resource base can no longer sustain them (Warford and Partow,1990).

In Nigeria, erosion a form of degradation constitutes a major form of environmental problem. NEST (1991) identified five principal types of soil erosion in the country, namely, sheet, rill, gully, coastal and wind erosions. In terms of the area affected and the threat to agriculture, sheet erosion is considered to be the most serious type in Nigeria. However, NEST (1991), observed that gully erosion is the most observable, best documented, and most frightful type in Nigeria. The number of gully erosion sites is dauntingly large and the size of some individual gullies is astonishingly enormous. Some type of land degradation such as gully and advanced salinization are, for all practical purposes, irreversible. In these cases, the long term biological and environmental potential of the land has been compromised. Displacement of soil material (erosion) is also irreversible, although its long term effects on productive capacity depend on the depth and quality of soil remaining. Most types of soil degradation, however, can be prevented or reversed by, for example, adding nutrients to nutrient – depleted soil, rebuilding topsoil through soil amendments, re – establishing vegetation, or buffering soil acidity, the practicality of rehabilitating degraded landscapes depends on the costs relative to the value of output or environmental benefits expected. Where farmers wish to intensify agricultural production on a sustainable basis, it may be necessary to undertake such land enhancing or land protecting investments even in non degraded landscapes.

There are several causes of land degradation most of them stemming from excessive human pressure or poor management of the land. These are: overgrazing on rangeland, over cultivation of crop land, water logging and salinization of irrigated land, deforestation and inappropriate agricultural techniques such as the use of heavy equipment on fragile soils. Factors giving rise to resource deterioration are complex. There are direct and indirect causes. The most important factors appear to relate to land clearance for agriculture and for other economic purposes such as devegetation, mining, desertification and traditional land ownership.

According to Titilola and Jeje (2005), vegetation all over Nigeria has been severely depleted in the last 50 years and this in turn served as the driver for further land degradation all over the country. Devegetation all over the country has severely impaired the regenerative capacity of the soil with the consequent reduction in fallow periods and the attendant poor yield. Devegetation mainly through widespread bush burning by farmers and cattle herders has also led to loss of forest resources and biodiversity, degradation of watershed protection areas leading to downstream siltation of inland and coastal waterways, reservoirs, increased river flooding, loss of soil nutrients and organic matter and declining soil fertility and yield.

2.5 Classification of Environmental Degradation

Thedevelopment 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).

Environmental degradation has a negative connotation that implies the loss of something of value within the environmental economic system(Gretton and Salma, 1997). The loss value may be related to the productivity of land for agriculture, the environment as home 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).

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. Land resources have many possible uses, with changes to the landscape having both favourable and unfavourable 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 of 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 water logging or salinity, contour ridging, bands and the likes.
- Light degradation is degradation on good soils showing signs of degradation – some top soil 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 References and Information Centre in Wegeningen, Netherlands recently published more conservative estimates of the extent and severity of land degradation in Africa. Its data indicates that about 321 million hectares (14.4% of the total vegetated land surface) are moderately, severely or extremely degraded and an additional 174 million hectares (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 activities and the likes.
- 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 build up 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 mono cropping,cultivation of marginal lands and indiscriminate use of agrochemicals.

2.6 Adverse Environmental Practices by Farmers

Batjes (2001) reported that degraded soils amount to about 494 million ha in Africa. It is also estimated that 65 per cent of SSA's agricultural land is degraded because of water and soil erosion, chemical and physical degradation (Oldeman *et al., 1991*; Scherr, 1999). Forms of degradation vary with the causative factor: loss of topsoil, terrain deformation, mass movement or overblowing (water and wind erosion), loss of nutrient and organic matter, salinization/alkalization, acidification, pollution (chemical deterioration), compacting/crusting, waterlogging, subsidence of organic soils (physical deterioration). Of the total degraded area, overgrazing, agricultural mismanagement, deforestation and overexploitation of natural resources are said to account respectively for 49, 24, 14 and 13 percent (Oldeman *et al., 1991*; Batjes, 2001).

2.6.1 Bush burning

According to Andreae and Goldammer (1992) a large fraction of burning in the savannah 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. No statistics are also available, mostly because material of direct economic value is not involved. Nonetheless, Barnard (1991) estimated that the amount of crop residue produced equals about 1700 teragramme dry matter (Tgdm) (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 tgdm /year) is burned in the fields (Andreae and Goldammer, 1992). Biomass burning causes environmental degradation through short term and long term effects (Lal and Okigbo, 1990). 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 run off and erosion. 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.

2.6.2 Forest destruction for fuelwood

Forest and woodland destruction for fuel wood is the major cause of environmental degradation. Fuel wood is the dominant form of cooking energy for all rural farmers in

Nigeria (Maiangwa *et al*., 2007). Fuel wood 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 rent 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 fuel wood (Cleaver and Schreiber, 1992). When forests are unduly degraded or destroyed (for example unsustainably mined for fuelwood), 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 the findings of Lal and Okigbo (1990) to the effect that deforestation and wood harvest (for fire wood) is a major source of human induced environmental degradation, accounting for nearly 15% of the total land degradation in Africa.

2.6.3 Property rights

Farmers in Nigeria rarely possess non – attenuated (or unlimited) private property rights over land. The land use decree of 1978 vested titles to 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 leasehold,

they will be unwilling to incur short term costs (for example, expenditure 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 threefold. 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 land holder 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 tend to be lower (Wachter, 1992).

2.6.4 Grazing reserves

The unavailability of designated grazing lands makes the animals to graze uncontrollably (free range), this consequently leads to overgrazing. The result of this is that, often, soil surfaces are bare and without any vegetation as the livestock browse 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, 1998).

2.6.5 Intensity of farming

Increasing intensity of farming and shortening of the period of fallow is another adverse environmental practice. Continuous agricultural production is almost a norm in most Nigerian farming communities now. At best fallow periods last 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 very fertile, diminished fallowing often causes yields to fall because land is being given less time to recover between cropping cycles (Southgate*et al.,* 1990). As land deteriorates, farmers colonize marginal hinterland 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).

2.6.6 Agricultural practices

Most Nigerian farmers use agricultural inputs (especially fertilizers unoptimally). For example a study conducted by Maiangwa *et al*. (2007) reported that farmers in the North West region of Nigeria applied 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 (Lombin, 1988) and recommended organic manure application rates of 7.5-10t ha^{-1} of farmyard manure and 5-20t ha^{-1} of fresh animal manure (Lombin, 1988; Ofori, 1999). The implication is that inorganic fertilizer and organic manure used in Nigeria is low compared with the requirements of crops, hence their yield and soil

enriching effects are not fully realized. This is also corroborated by Reardon *et al.* (1999) whom point to the low use of fertilizers across Africa as a major cause of concern from both the food production and the environmental perspectives. The implication is that inorganic fertilizer and organic manure used in Nigeria is low compared with the requirements of crops, hence their yield and soil enriching effects are not fully realized.

2.6.7 Erosion

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).Accelerated erosion is a direct result of the adverse use of the environment particularly, 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). This 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 soil structure and aggregation, promotes water infiltration, enhances water retention capacity, increases the cation exchange (particularly in acid soils), fosters aeration tilth, retains otherwise

fixable or leacheable nutrients in a form available to plants and supplies most of the nitrogen and phosphorus required by plants (Sanchez, 1976).

2.6.8 Land use regulations

The absence of regulations on environment use and cost share arrangements for conservation also affects the way the environmental resources are used. The lack of landuse 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 activities on marginal lands, conversion of forests, woodlands, uplands, pasture lands and marshlands to crop lands and subsequently degraded land. Cost share programmes as exist in developed countries which subsidize the adoption of the best land management practices are almost nonexistent. 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.

2.6.9 Knowledge of natural resource conservation

The lack of knowledge about environmental conservation is a big problem in Africa. Barbier (1998) argued that the conventional approach to land conservation in Africa has been to encourage farmers to adopt 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).

2.6.10 Social organisations

There's absence of collective action and appropriate forms of social organisation in most communities. The difficulty of organising farmers into effective and stable groups for social organisation structure to conduct their members to a sustainable use of land resources contributes a great deal to land degradation (Cernea, 1992; Ostrom, 1994; Rasmussen and Meinzen-Dick, 1995).

2.7 Theories for Explaining Environmental Degradation

In environmental economics, there are three theories for explaining forest and 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).

2.7.1 The theory of social cost

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) cost of their agents – 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. 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 (example, to protective functions or biodiversity values) that

cannot be transformed into income and so force land users to adopt inappropriate production practices (Watcher, 1992).

2.7.2 The theory of collective goods

The theory of collective goods is closely related to the theory of social cost since externalities are constituent part of collective goods (Watcher, 1992). A 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). Many environment goods have the properties of collective goods, particularlynon- excludability and externalities. However, most environmental problems arise when non-rivalry no longer applies (Watcher, 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. No one has an incentive to conserve the land because the benefits of conservation are dissipated among all users.

2.7.3 The property right theory

The property right 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 (Watcher, 1992). If land rights are unclear, unspecified, disputed, or non-existent, 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 incentives to take care of their land resources and use them in a socially optimal way (Watcher, 1992, Hazzel and Lutz, 1999).

2.8 Evolving Thought on Links between Poverty and Environment

Perceptions of how poverty alleviation, agriculturalintensification, and environmentaloutcomes interact have evolved importantlyover the past four decades. The current evolution began with Boserup's (1965) attack on Malthusian thought. She argued that population does not result from limited carrying capacityof the land.Rather, population density isa key cause driving agricultural intensificationwhich can lead to economic growth and sustainedproductivity increases.An importantcorollary of her thesis is that although environmentaldegradation may result from populationgrowth, it is not a necessary result. This claim by Boserup (1965) has been supported by a number of subsequent studies(Templeton &Scherr, 1999).If the good news is that environmental degradationneed not occur, the bad news is thatdegradation still does occur in certain circumstances.Some authors have pinned the blameon poor farmers who intensify production withlabour-led strategies, unable to afford suchcomplementary capital inputs as fertilizers andconservation investments that might supportsustainable intensification (Clay, Reardon, and Kangasniemi, 1998; Mink, 1993).This line ofargument shifts the blame for environmentaldegradation from population to poverty.Butpoverty is not a simple substitute for population,for agriculturally related environmentaldegradation often occurs in economically depressedrural areas that are experiencing outmigration(Garcia-Barrios & Garcia-Barrios,1990; Zimmerer, 1993).This suggests a dynamicinterplay between population and povertywhereby intensification may fail to occur iftoo many people ‘‘vote with

their feet'' anddepopulate a region.The environmental effectsmay be especially severe if the emigrants areworking-age adults (Garcia-Barrios & Garcia-Barrios, 1990).

Natural resourcesprovide the setting that makes attractivetheir exploitation by humans.Inagriculture, this is largely determined by theavailability and quality of soils, moisture,warmth, and sunshine.Agriculturally relatednatural resource problems can be divided intotwo categories. Resource depletion encompassesproblems of aquifer exhaustion, soil fertilitymining, soil erosion, deforestation, and overgrazing(the latter two both being forms ofbiodiversity loss). Resource contamination encompasseswater pollution (e.g., by agrochemicals,fertilizers or excess manure runoff),land salination, pesticide and antibiotic residuesin food, andat the large scaleglobalwarming.Either of these two classes of problemcan result either from mistake due to gapsin farmers' information and knowledge orelse from rational behaviour by farmers withmultiple objectives, including risk aversion.But if farmers are reasonably well informedand if maximizing consumption or net incomeis their primary objective, then it is reasonableto associate wealth with the contaminationproblems and poverty with the depletionproblems.

If this conjecture is true, then neither populationgrowth nor poverty leads simply to naturalresource degradation.Instead, degradationwill depend on the kind of farming practicesand their natural resource setting.The severityof the environmental problem is likely to dependnot only on its causes, but also on thevulnerability of the specific natural resource setting (Lutz, Pagiola, and Reiche, 1994). Moreover, in some settings, the agricultural determinantsof natural resource problems may turnout to have little link to conventional definitionsof poverty.

2.9 Theoretical Framework for Poverty – Environment Studies

The link between poverty and environment has often been mentioned in the 'sustainable development' debate and is seldom systematically explored (Lele, 1991). The literature that treats the link usually focuses on the 'vicious circle' between poverty and environmental degradation; the circle is Malthusian in inspiration where farmers pushed by population increase and poverty extend cropping to fragile marginal lands and degrade them. As a result the yield is reduced and this further impoverishes farmers (Pearce and Warford, 1993; Mink, 1993;Dasgupta and Maler, 1994).

A new dimension to the link between poverty and environmental degradation was brought out in 1995 when Reardon and Vosti introduced the concept of 'investment poverty' and related the same to other measures of poverty (Reardon and Vosti, 1995). The notion of poverty was examined by them in the context of categories of assets held and categories of environment change with particular focus on farm household income generation and investment strategies as determinants of the links. According to them the strength and direction of the poverty-environment links in rural areas are to differ (even invert) depending on the composition of the assets held by the rural poor and the types of environmental problems they face. One of the major findings of their study is that the level of poverty conditions the links. People having incomes above an established welfare poverty line can still be too poor in key assets and thus overall cash and human resources to be able to make critical investments on soil conservation or follow key land use practices to maintain or enhance their natural resource base. They might thus be better off than the 'welfare poor' but still be 'investment poor'. Finally they opined that the links between poverty and environment in a given setting depend on the level, distribution and type of poverty and environmental problems.

The above discussion on the various studies conducted worldwide reveal that there is atwo-way linkage between poverty and environmental degradation. Degradation of environmentcaused either by the poor or the rich has both direct and indirect impacts not only on the cost ofproduction but also on the productivity of crops and thus on the income of the people. The poor getmore affected than the rich and become poorer due to environmental degradation manifestedthrough destruction of forest for fuel wood, timber, cultivation; degradation of land and waterthrough the use of chemical fertilizer, pesticide, etc in modern farming; and pollution of air dueto consumption of biomass fuel. Thus a vicious link is established between poverty andenvironmental degradation. Each becomes the cause and effect of the other. This study attempts to quantify the magnitude of both poverty and environmentaldegradation over time and verify empirically the link between them. Thoughestimates are available on poverty for both rural and urban areas of Nigeria and the natureof environmental degradation in rural and urban areas, the present study is confined to farming communities only.

Reardon and Vosti (1995) observed that the discourse around the poverty-environment nexus needed a new framework with a more practical and strategic understanding of the complexity of the issue. Their aim was to differentiate types of poverty and types of environmental change, and to show the household behaviour determinants of the environment-poverty links. They also had an emphasis for demonstrating how the household behaviour is conditioned by policy and other intervening factors, which so often had been neglected.

The framework is built around four blocks of variables interacting as shown in figure 1. The main argument is that the assets a household possesses dictate the household and

village behaviour, which in turn has impacts on the environment and on the household and village assets (Figure 1). There are conditioning factors influencing both the link between types of poverty and behaviour, and the link between behaviour and natural resources.

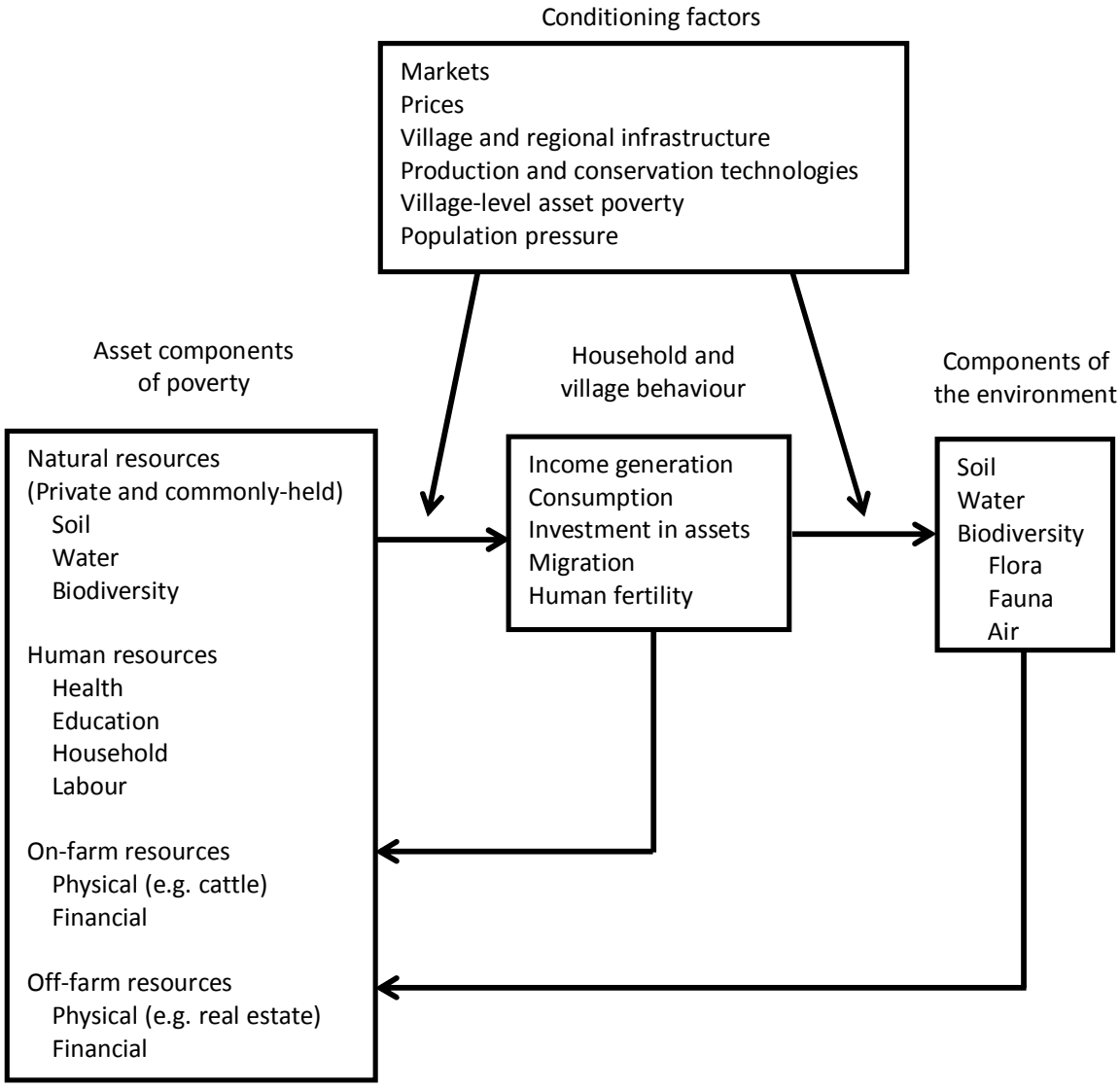


Figure 1. Poverty and environment links according to Reardon &Vosti (1995)

The structure of this framework is very similar to a number of other frameworks on the topic. Rather than being a unique contribution of Reardon and Vosti, the central role of assets as determinants of household behaviour has been emphasized by many

theoretical frameworks (e.g. Bebbington 1999; Shiferaw and Bantilan 2004; Ngugi and Nyariki 2005; Dorward *et al.* 2003; Barrett *et al.* 2004). Similarly, household and village behaviour is depicted as the most important determinant of natural resource and livelihood outcomes in a number of other frameworks (e.g. Holden &Shiferaw 2004; Ngugi and Nyariki 2005; Shiferaw and Bantilan 2004; Scherr 2000). The role of what Reardon and Vosti term conditioning factors, such as markets, prices, infrastructure, institutions, and so on, has also been recognized in most of the other frameworks (e.g. Barrett *et al.* 2004; Shiferaw and Bantilan 2004; Holden and Shiferaw 2004; Dorward *et al.* 2003; Scherr 2000). With the exception of the bioeconomic model of Holden and Shiferaw (2004), which depicts a complex net of interconnected variables, the basic deterministic structure of the framework of Reardon and Vosti is also shared by many other theoretical frames.

2.10 Review of Empirical Studies on Poverty

A review of related literature that have used the poverty measurement indices and modelling is carried out in this section.

Of all the methods used for measuring poverty, one of the most prominently used in poverty assessment in recent time is Foster, Greer and Thorbecke's (FGT) Pα weighted poverty measure that is based on income/expenditure of the households. Most of the poverty measurement methods available in literature calculate only the poverty incidence to determine the proportion of the poor in various sub groups and the total. The Pα weighted poverty measurement, apart from calculating the poverty incidence also determines the poverty depth and severity.

Another advantage of the *P-alpha*measure is its decomposability. For example, the overall measure of poverty can be expressed as the sum of group measures weighted by the population share of each group. This additive property of the index implies that when any group becomes poorer, aggregate poverty will increase. The contribution to overall poverty, like in the case of inequality, will provide a guide as to where poverty is concentrated and where policy intervention should be targeted. Hence this study used FGT weighted measure to profile poverty among the farming households in the study area.

In recent times the prominent models that have been used to analyse the relationship between poverty and its determinants are Logit and Probit regression models. Though quite a number of studies have used the Logit and Probit models, they have some number of drawbacks. These models give the poor households a value of one and non-poor ones the value of zero for the dependent variable without differentiating between the extent of poverty among the poor. It is discovered that there exists a difference in the level of poverty among the poor households. Hence, the Tobit model in which the poor households have their poverty depth index as their dependent variable while non-poor one have zero as their dependent variable is preferred (Tobin, 1985). This differentiates among the poor because the poor are not equally poor. The Tobit model was used by this study to analyse the relationship between poverty depth of the farming households and the factors adjudge to be responsible for the poverty experienced by households in the study area.

Omonona (2001) examined poverty and its correlates among rural farming households in Kogi State, Nigeria. Data employed for the study was obtained from 550 randomly

selected farming households from two randomly selected Agricultural Development Project Zones with the aid of well – structured questionnaire. The data was analysed using Foster, Greer and Thorbecke (FGT) weighted poverty index for the measurement of poverty. Tobit regression model estimated relationships between the determinants and the poverty levels of farmers.

The FGT analysis as reported by Omonona (2001) showed that the incidence, depth and severity of poverty among farming households decreased as the years of formal education of households head, extent of output commercialization, farm size, farm income and amount of agricultural loan increased. But, poverty incidence, depth and severity increased with increase in household size, age of household head, child and adult dependency ratios, years of farming experience and distance to market, drinking water source and health clinic. In addition, farming households having access to remittances, off farm income, extension services, modern farming inputs and storage facilities have higher levels MPAEHE and hence lower levels of poverty. On the other hand, farming households cultivating only dry land, land acquired through tenancy and family land and those living in single rooms, houses built with mud, houses without any toilet facility (bare ground), drinking stream water and patronising native healers have higher levels of poverty than their counter parts. For the study area, 58% of the households were poor, while the poverty depth was 21%. The severity of the poverty was 10%.

The Tobit regression result of Omonona (2001) revealed that a unit increase in non-farm income, farm income, extent of output commercialization, farm size and amount of agricultural loan led to a decrease in the level of poverty. On the other hand, a unit

increase in child dependency ratio, adult dependency ratio, household size, ratio of food to total expenditure, experience in farming and distance to health clinic increased the level of poverty.

Omonona (2001), therefore, recommend that poverty alleviation strategies should include strategies such birth control, provision of employment or enabling environment for self-employment, improvement in human capital, provision of rural infrastructure, agricultural credit and marketing facilities among others. These recommendations collaborate that of Maxwell (2003).

Bandabla (2005) carried out a study on the comparative study of statistical distribution and efficiency of some poverty estimators in Ibadan North – East Local Government Area, Oyo State, Nigeria. He used two poverty lines calculated using expenditure per capita per month and the other income per capita per month. It was found that the measurements were different for each poverty line and it was recommended that the expenditure per capita poverty line was the best to use. The study also used the FGT measure and the expenditure per capita poverty line was high (50%) for the whole LGA.

The result of the Tobit and Logit analyses revealed that there is a significant relationship between household poverty and the socio-economic characteristics (sex, employment status, occupation, educational status and household size) of the household head. Female headed households had a high probability of being poor, and also the households where heads were unemployed or unskilled workers. Also the larger the household size, the higher the incidence of poverty.

This study used consumption expenditure as a proxy for poverty measurement. The consumption expenditure is the most widely used and gives a better measure for determining the poverty line. This is because consumption data are better indicators for living standards than income data, which tend to reflect the current well being. In addition, consumption may be easier to measure in households with their own farms and small businesses, and following the permanent income hypothesis, it should reflect long term economic status better (Bandabla, 2005, Johnson, *et. al.*, 1990).

2.11 Measurement of Poverty – Environmental Degradation Linkages

Models of dichotomous variables, or of binary choice, assume that individuals face alternatives choices of the type (0) and (1) or "no" or "yes"; that is, they face models with discrete (and not continuous) variables. These models may be used for studying decision to buy or not to buy a good or for analysing the choice of a candidate to vote in an election. In order to do so, we need to obtain data on some individual attributes as age, educational level, number of children, marriage status, among others, to model individual behaviour. One of a few models that can express these dichotomous variables is the Linear Probability Model (LPM), as follows:

2.11.1 Linear probability model (LPM)

The Linear Probability Model (LPM) is expressed as follows:

$$\boldsymbol{Y_i = \beta_1 + \beta_2 X + \mu_1} \text{ ---------- 1)}$$

where (X) is family income, (Y=1) if the family owns a house and (Y=0) if the family does not. The conditional expectation of (Y_i) given (X_i), that is $E(Y_i/X_i)$, is interpreted as the conditional probability that the event will occur if (X_i) occurs, that is, $P(Y_i = 1/X_i)$. Thus, in the mentioned example $E(Y_i/X_i)$,expresses the probability that a

family with income (X_i) owns a house. Therefore, one can infer that the i-th individual (i^n) has an answer function that can be represented by a random variable – Y_i – that, due to its dichotomous nature, may be represented by (0) or (1) values. From the definition of expectation, we have that:

$$\boldsymbol{E(Y_i) = 0(1 - P_i) + 1(P_i) = P_i} \text{----------(2)}$$

And the basic assumption that $E(u_i) = 0$, guarantees that $E(Y_i/X_i) = \beta_1 + \beta_2 X_i$, confirming that the conditional expectation of the model may be interpreted as the conditional probability of Yi. And as the probability P has to be in the interval (0, 1), we got the restriction:

$$\boldsymbol{0 \leq \in (Y_i/X_i) \leq 1} \quad \text{---------- (3)}$$

that is, a conditional (expectation) probability must stay in this interval.

Details of model specification can be found in the literature review by McFaden (1973) and Gujarati (1995). The LPM was not used in this study due to some limitations that may affect the final estimation result. According to Gujarati (1995) the main problem with LPM is its assumption of a linear increase in (X), that is the marginal effect of (X) is constant for all estimative, a very unrealistic assumption. These difficulties suggest the use of alternative models of dichotomous regression. These models must guarantee that $E(Y_i)$ is inside the interval (0,1) and that marginal effects of independent variables are not constant during estimation.

We need, therefore, a (probability) model that has two basic characteristics: i) as (X_i) increases, P_i $E(Y = 1/X)$ increases, but without going beyond the interval (0,1) and ii) the relationship between P_i and X_i is no linear. These characteristics may be achieved in

a cumulative distributive function (CDF) of a random variable. The use of a CDF guarantees a growing monotonic function.

$$\boldsymbol{P_i} = \boldsymbol{F}(\propto -\boldsymbol{\beta X_i}) = \boldsymbol{F}(\boldsymbol{I_i}) \text{----------} \quad (4)$$

The researcher has chosen a normal cumulative density functions for the model, known as *Probit* model.

2.11.2 The Probit model

Models with discrete dependent variable are frequently specified as *index* function models. An example is the decision to buy something. Economic theory emphasises that the individual will evaluate this decision, based upon the obtained utilities that he/she will evaluate marginal costs and benefits of making the decision to buy. As marginal benefits are not observed, usually one models the difference between benefit and cost through a variable (Z*):

$$\boldsymbol{Z^*} = \boldsymbol{\beta' X} + \boldsymbol{\varepsilon} \text{----------} \quad (5)$$

In other words, it is not possible to observe the net benefit of buying, only whether the purchase was made or not. Then, we have:

Z=1 and Z* > 0, (he/she bought)

Z=0 and Z* ≤ 0, (he/she did not buy)

In (5), β ' is an *index* function. Thus, as in the majority of cases it is not possible to preview how each individual will behave, it is more reliable to estimate a probability that an individual with some attributes will choose a given alternative. Models of qualitative choice are based upon a relationship between attributes that describe an individual and the probability that he/she will have a given choice. In this context,

McFadden (1973) explains the *Probit* model through the analysis of utility theory, that is, based upon the rational choice behaviour.

Suppose that the individual will buy or not according to the utility *index,* denoted as (I),the utility *index* is determined by the explanatory variables. Therefore, the bigger (I) the higher will be the probability of an individual buying the good. Suppose also that (I) is a linear function of the explanatory variable (X), such that:

$$\boldsymbol{I_i} = \propto + \boldsymbol{\beta X_i} \text{----------} \quad (6)$$

where (X_i) is income of the I^nindividual. Thus, each individual would have a critical value to his/her correspondent indices (I_i*). This critical value is not observed, but if we assume that it is normally distributed with the same mean and variance, it is possible to estimate parameters in equation (6). If the indices value (I) for a given individual is bigger than the critical (I_i*), he/she will buy the good and if the indices value is smaller, the good will not be bought.

In relation to the *Probit* model, the researcher will test the hypothesis:is the relationship between poverty and factors that lead to environmental degradation significant? This model specification is very relevant because few studies deal with the poverty environment nexus in a context of a poor and unequal society.

Chapter 3

METHODOLOGY

3.1 The Study Area

The study was carried out in Plateau State, located in north central geo-political zone of Nigeria. The State derives its name from the geographical landscape that predominates in this part of the country. The state lies between latitudes 8^{o} N and 10^{o}N and longitude 7^{o}E and 11^{o}E of the prime meridian(GTZ, 2010).The altitude ranges from around 1,200 meters (about 4000 feet) to a peak of 1,829 metres above sea level in the Shere Hills range near Jos. The state has a land mass covering nearly 30,913 km^2 (11,935.6 sq mi) and ranked as the 12^{th} out of the 36 states in Nigeria. The state has a population of 3,206,531 based on the 2006census (NBS, 2009). The projected population by 2011 stands at 3,681,299 people going by a population growth rate of 2.8% per annum.

The landscape of the state is slightly undulating and rises from the steep escarpment of the riverine plains of River Benue and descends towards Bauchi state. It is surrounded by four other states. To the North and Northwest of the state are Bauchi and Kaduna states respectively; to the Southwest is Nassarawa state and Taraba to the Southeast. The state is accessible by road via Jos – Bauchi road to the North, Mararraba Jama'a – Keffi – Abuja road to the Southwest and Jos – Zaria road to the Northwest. The Heipang Airport is a potential international Airport that makes the state accessible by air.

Though situated in the tropical zone, a higher altitude means that Plateau State has a near temperate climate with an average temperature of 20°C. Harmattan winds cause

the coldest weather between December and February. The warmest temperatures of 30^0C usually occur in the dry season months of March and April. The average lower temperature recorded in Plateau State has led to a reduced incidence of some tropical diseases such as malaria.The mean annual rainfall varies from 131.75 cm (52 in) in the southern part to 146 cm (57 in) on the Plateau. The highest rainfall is recorded during the wet season months of July and August. The Plateau makes it the source of many rivers in northern Nigeria including the Kaduna, Gongola, Hadejia and Yobe rivers(GTZ, 2010).

The state comprises 3 agricultural zones and 17 administrative Local Government Areas, viz: The northern agricultural zone consisting of Bassa, Barkin Ladi, Jos East, Jos North, Jos South and Riyom Local Governments. Bokkos, Kanke, Mangu, Kanam and Pankshin Local Government Areas make up the central agricultural zone. The local governments of Langtang North, Langtang South, Mikang, Qua'an Pan, Shendam and Wase make up the southern agricultural zone.

Though situated in the tropical zone, the climate on Jos plateau and environs simulates that of the temperate region while the southern part is much more tropical and warm. With adequate fertilizer supplement and the use of improved varieties, good crops of maize, Irish potato, cocoyam, upland rice, sorghum and vegetables are being produced. In addition, there are potentials for the production of tree crops like apples, grapevines, mangoes, citrus, cashew and coffee. Also, productions of floricultural plants and straw berries have high prospects (PADP, 2000).

Livestock types found in the state include cattle, sheep, goats, pigs and poultry. Numerous mining paddocks which serve as reservoirs for rain water are yet to be exploited for dry season production of vegetables and cultured fisheries. Also due to the low temperature on the Jos-Plateau, great potentials exist in poultry production and dairy cattle. The Federal Capital Territory – Abuja provides a suitable market for all these agricultural products.

The Plateau was formerly open savannah woodland but now is almost entirely grassland, and most of the trees presently growing are exotics, such as eucalyptus. Elaborate rock formations and stony soils make agriculture problematic, but terrace agriculture has made effective use ofthe sparse soil (Bagudu, 2001). However, the advent of colonialism brought about two important changes; tin-mining and the expansion of pastoralism. Tin-mining still continues, although not on the scale of the period up to the Second World War. Failure to make good on environmental damage has resulted in many areas made unusable with tall heaps of waste and ponds with high levels of heavy metals leached from the mine tailings (Bagudu 2001). Indeed a key feature of Plateau State that makes it rather distinct from the other regions is the absence of any large rivers; mine-ponds represent an important locus of dry-season cultivation.

The other aspect of the Plateau environment is the high pressure on grazing from pastoral cattle. Fulanis seem to have first entered the Plateau in numbers shortly after 1900 apparently attracted by the low levels ofdisease and the wide grasslands (Bagudu, 2001). It is likely that their cattle would have been too vulnerable prior tocolonialism, when slave-raiding was the principal interaction of the indigenous populations with

theirneighbours further north. Very large numbers of cattle have caused degradation on a massive scale and sheetand gully erosion are omnipresent. Indeed, the consequent lack of open grazing has paradoxically driven thepastoralists to keep their cattle off the Plateau for most of the year. The ADPs had encouraged farmers to take out trees to ease tractorploughing, thereby exposing the fragilesoils of the Plateau to greater levels of wind erosion (Bagudu, 2001).

3.2 Sampling Procedure and Sample Size

A multi stage sampling was used to select respondents for the study. One local government area was purposively selected from each of the three agricultural zones of the state. The purposive sampling ensures that the researcher does not end up with a sample concentrated in one ecological and or agricultural zone. Qua'anPan was selected from the southern zone while Bokkos was selected from the central zone. Bassa from the northern zone brought the total number of the local governments to three (3). These LGAs have been shown to be engaged in intensive crop cultivation (PADP, 2000). From each of these LGAs, three communities were randomly selected,making a total of ninecommunities. The farming communities are; from Qua'an Pan LGA – Namu, Kwalla and Kwande; from Bokkos LGA – Bokkos, Manguna and Mushere while from Bassa LGA – Jengere, Jebu-Bassa and Kwall were selected. The sampling frame was made up of a list offarming households obtained from PADP found in the communities. The simple random sampling method was used to draw atleast 10% from the list to constitute the sample size.The total number of the sample size was 265. These were selected by the use of the table of random numbers. The numbers of farming households that were administered questionnaire from the nine communities are presented in Table 1:

Table 1: Sample Size for the Study

L.G.A	Community	Sample Frame	Sample Size
Qua'an Pan	Namu	410	41
	Kwalla	385	38
	Kwande	432	43
Bokkos	Bokkos	250	25
	Manguna	300	30
	Mushere	181	18
Bassa	Jengere	347	34
	JebbuBassa	156	16
	Kwall	204	20
Total		**2,665**	**265**

Source: Computed from List of farmers provided by PADP, (2010)

3.3 Data Collection

For the purpose of this study, only primary data were used. The data were collected using structured questionnaires. The questions were structured to elicit answers on the objectives of the study. The data collected include the socio-economic characteristics (educational status, age, household size, size of farm land and farming experience of farmers/respondents). These were measured as follows:

i. Age of respondents: means the age of an individual measured in numerical years

ii. Household size: means the total number of people in the house, which includes wives, children and dependants who reside within the same family and eat from "the same pot".

iii. Educational status: refers to acquisition of knowledge through formal or informal organized means or through schooling. This was measured as the total number of years spent in school.

iv. Farming experience: refers to the number of years that a farmer has actively undertaken farming as occupation. This was measured in years.

v. Farm size: refers to the total hectaresof land put under cultivation as of the time of interview.

To determine their poverty level, information on both quantifiable and non-quantifiable factors affecting income and household expenditure pattern were elicited. These factors include:

vi. Household income and expenditure: household income refers to the disposable cash income which is the total receipt (mainly from the sales of farm produce and other off farm activities) less personal taxes plus gifts earned by members of the household, while household expenditure refers to all spending on goods and services intended for consumption. It includes payment by the household for goods and services supplied, accommodation, natural resources, education, health, transportation, communication, clothing, utility supplies, bills and food.

The environmental utilization variables as it pertains to the use of land and forestry resourceswere also determined. The following primary data werecollected from the respondents to achieve the stated objectives:

vii. Forest and woodland destruction: refers to the destruction of the forest arising from gathering of wood for fuel.

viii. Animals allowed to graze:refers to the number of animals farming householdsallowto graze uncontrollably (free range) on their farms.

ix. Shortening of periods of fallow: refers to whether the farmers cultivate their farms year-in-year-out or the farms are allowed to undergo periods of fallow.

x. Knowledge of natural resource conservation: refers to the access to information on land and forest resource conservation and management practices.

xi. Duration of graze per week: refers to the number of hours animals are allowed to graze on farm lands in a period of one week.

3.4 Analytical Techniques

The tools used for data analysis to achieve the objectives of the study include Descriptive statistics, Tobit regression, Foster Greer and Thorbeck (FGT) index, Likert scale and Probit regression model.

3.4.1 Descriptive statistics

The descriptive statistics is used to describe and summarise data. It includes percentages, mean, range and frequency. This was used to achieve objectives 1, and 6.

3.4.2 Tobit regression

The Tobit regression was used to achieve objective 2. The model is expressed following Tobin (1958). Tobit decomposition framework examined the effect of changes in the explanatory variables (X_i) on the probability of being poor and the depth or intensity of poverty could be determined. It was also adopted and used by Olaniyan (2000), Omonona (2001), Adejobi (2004) and Bandabla (2005).

There is no problem if the individual is non-poor for there are no data on the poverty gap for the non-poor (since the poverty gap is the measure of how far the MPAEHE falls below the poverty line). The households are divided into two groups; V_1poor individuals (whose MPAEHE falls below the poverty line) about whom we can have information about the regressors (educational status, household size, annual income, farm size, experience and age) as well as the regress and (poverty gap), and the V_2 non-poor individuals (whose MPAEHE is not below the poverty line) about whom we can have information about the regressors but not on the regress and. This is censored sample (a sample in which information on the regress and is available only for some observations). The Tobit Model can be mathematically expressed as:

$$V_i = V_1 = \beta X_i + \varepsilon_i \text{ if } V_1 > V_1^*$$

$$V_0 = \beta X_i + \varepsilon_i \text{ if } V_1 \leq V_1^* \text{ ---------- (7)}$$

Where:

V_i = the dependent variable, it is discrete when the households are not poor and continuous when they are poor.

i =1, 2,..., N_i, where N_i is the total number of poor households.

V_1 =Limited dependent variable, it is the poverty depth/intensity defined as $(Z - Y_i)/Z$, where Z is the poverty line and Y_i is MPAEHE

V_1^* =the poverty depth when the poverty line (Z) equals the MPAEHE (here $V_1^* = 0$)

X_i =vector of explanatory variables

β =vector of unknown parameters

ε_i =independently distributed error term.

The empirical model used for determining socio economic factors that influenced poverty among farming households in Plateau State, Nigeria, was specified as:

$V_1 = \beta_0 + \beta_1X_1 + \beta_2X_2 + \beta_3X_3 + \beta_4X_4 + \beta_5X_5 + \beta_6X_6 + \varepsilon_i$ ---------- (8)

Where:

V_1 = Limited dependent variable, it is the poverty depth/intensity

β_0 = Constant (autonomous poverty depth)

β_i = vector of unknown parameters

ε_i = independently distributed error term

X_i= The independent variables specified as determinants of intensity ofpoverty and defined as follows:

X_1 = Years of formal education of household head

X_2 = Household size (number)

X_3 = Annual income of household head (₦)

X_4 = Farm size (hectares)

X_5 = Experience in farming (years)

X_6 = Age of household head (years)

The presence or absence of multicollinearity was verified by comparing the number of significant coefficients of the regressors with the coefficients of determination. According to Gujaratti (1995) and Omonona (2001) multicollinearity among explanatory variables is likely with a high coefficient of multiple determination and very few significant t-ratios of the regressors. This method according to Gujaratti (1988), Olayemi (1998) and Omonona (2001) is better than the pair-wise correlations among regressors because high level zero-order correlations are a sufficient but not a necessary condition for the existence of multicollinearity because it can even exist

when the correlations are comparatively lower than 0.5. The regression parameters and diagnostic statistics were estimated using the NLOGIT version 4.1 software package (Appendix II).

3.4.3 Measurement of poverty

The standard of living of households in the study area was measured based on consumption expenditure. The focus is clearly on consumption goods, such as food (value of own produced food items consumed and those purchased from the market), non-food items (expenditure on clothes, health, education, transportation and farm inputs). Other sources of household expenditure that were considered are the values of the free environmental resources (fire wood, wild animals, wild fruits/vegetables, medicinal plants and fish) consumed. The values of natural resources consumed by a farming household was estimated by asking the household heads the amount (quantity/unit) utilized or collected by his household for subsistence. The estimated quantities of extracted free natural resources were then multiplied by their prevailing market prices. Their computed values were then summed up to arrive at the total value of free natural resources consumed by a household. The households' expenditure were then summed up to get the total expenditures of the households.

To convert the total household expenditure into individual expenditure, it was divided by the number of members of the household to get the per capita expenditure as used by the World Bank (1996). This was further converted into adult equivalent based on the nutritional requirement, sex and age of the members of the households, using the nutritional based adult equivalent scales provided by FOS (2004) as contained in Table 2. The nutrition equivalent scale was multiplied with the number of household

members that fall in any of the age distribution by sex. By this, the monthly mean per adult equivalent household expenditure (MPAEHE) for the sampled households were arrived at.

Table 2: Nutritional (Calorie based) Equivalent Scales

Age in Years	Male	Female
0 – 1	0.27	0.27
2 – 3	0.45	0.45
4 – 6	0.61	0.61
7 – 9	0.73	0.73
10 – 12	0.86	0.78
13 – 15	0.96	0.83
16 – 19	1.02	0.77
20 and above	1.00	0.73

Source: FOS 2004

3.4.3.1 *Estimation of absolute poverty line*

The poverty line used for this study was calculated from the monthly mean per adult equivalent household expenditure (MPAEHE) of the sampled households. Two-third of the means of MPAEHE of the sampled households was used as the poverty line for the study as also used by host of other studies in Nigeria (World Bank, 1996; FOS, 1999a, 1999b; Omonona, 2001; FOS, 2004; and Bandabla, 2005). This was done by ranking the MPAEHE of the households and then dividing the population into equal increments. For this study, the divisions were based on deciles or 10% increments such that the first decile represents the bottom 10% of the sampled households in terms of consumption expenditure (or presumably the poorest) and the highest or the 10^{th}decile was that increment which represents the highest 10% of the sample in terms of

consumption (or presumably the richest). The MPAEHE of the deciles were then summed up and divided by ten to get their mean. Two-third of the mean was then computed to arrive at the MPAEHE that served as the poverty line for the study.

3.4.3.2 *FGT weighted poverty measure*

The Foster, Greer and Thoebecke (Foster, *et al.,* 1984), weighted poverty index were used for the quantitative poverty assessment, to achieve objective 3 specifically. TheP–alpha (P^{α}) measures in analysing poverty relate to different dimensions of the indices of poverty, P_0, P_1 and P_2 and used for headcount, depth and severity of poverty respectively.The measure is able to accomplish this, through the choice of a poverty aversion parameter α (alpha). The larger the α, the greater the weight given by the index to the severity of poverty. The three measures are all based on a single formula, but each index puts different weights on the degree to which a household or individual falls below the poverty line. This measure is also useful due to its decomposability among sub groups. To see how the measures are defined, the consumption or household expenditures were arranged in ascending order, from the poorer Y_1, next poorest Y_2... with the least poor Y_q. The poverty index is defined mathematically as follows:

$$\boldsymbol{P}_{\propto} = \frac{\mathbf{1}}{\boldsymbol{n}}\sum_{\boldsymbol{i}=\mathbf{1}}^{\boldsymbol{q}}\left[{}^{(\boldsymbol{z}-\boldsymbol{y}_{\boldsymbol{i}})}/_{\boldsymbol{z}}\right]^{\propto} \text{----------(9)}$$

Where

α = the FGT index and takes values 0, 1 or 2

n = total number of households

q = number of households below the poverty line

Z = poverty line

Y_i = the MPAEHE of the household in which individual i^{th} lives

Three members of the FGT index are:

1. Suppose α = 0: This equals the headcount ratio, the index measures no aversion to poverty:

$$\boldsymbol{P_0} = \frac{1}{n}\sum_{i=1}^{q}\left[\left(z - y_i\right)/_{z}\right]^{0} = \frac{q}{n} = H \text{ ---------- (10)}$$

2. Suppose α = 1: the Pα is the headcount times the average expenditure shortfall:

$$\boldsymbol{P_1} = \frac{1}{n}\sum_{i=1}^{q}\left[\left(z - y_i\right)/_{z}\right]^{1} = HI \text{ ---------- (11)}$$

Here, P^{α} = Headcount × average income shortfall.

In otherwords, it measures the depth of poverty (the proportion of the expenditure shortfall from the poverty line). It is otherwise called the poverty gap between the i^{th} poor farming household and the poverty line

3. The FGT poverty measure for α≥ 2, this weighs the poverty of the poorest individual more heavily than those just slightly below the poverty line. Squaring the gap between their expenditure and the poverty line in order to increase its weight in the overall poverty measure does this:

$$\boldsymbol{P_2} = \frac{1}{n}\sum_{i=1}^{q}\left[\left(z - y_i\right)/_{z}\right]^{2} \text{ ---------- (12)}$$

This measure, unlike the first two Pα measures is sensitive to the distribution of expenditure among the poor. Here, the Pα is the weighted sum of individual expenditure shortfalls where income gaps themselves are the weights. Thus, the

expenditure gap ratios of poorer households weigh more importantly in the calculation of Pα than the expenditure gap ratios of less poor households. Most analysts prefer this measure because it has desirable properties and exhibits some consistency between the values that underlie the measure and the values of the policy maker.

Because the FGT index satisfies all the required conditions, it has been widely used (Kakwani, 1990; Grootavi and Kanbur, 1990; Ravallion and Huppi, 1990 and Canagarajah *et. al.*, 1997). This study also adopts the index to analyse poverty in the study area.

3.4.4 Likert scale

This was used to satisfy objective 4. A Likert scale measures the intensity or degree of agreement by the respondents to a statement that describes a situation, phenomenon, item or a treatment. The respondents were given a range of five (5) categories depicting the level of environmental degradation in the study area. They were expected to make their choices based on the causes of environmental degradation. The observed categorisation of degradation as extreme, severe, moderate or light as reported by Oldeman *et. al*. (1990) and WRI (1992) were used.

Likert-type scale is a psychometric scale commonly used in questionnaire and is the most widely used scale in survey research. With Likert scale data, the best measure to use is the mode, or the most frequent. When responding to a Likert questionnaire item, respondents specify their level of agreement or disagreement on a symmetric agree-disagree scale for a series of statements. Thus the scale captures the intensity of their feelings. Data from Likert scales are sometimes reduced to the nominal level by

combining all agree and disagree responses into two categories of "accept" and "reject". The chi-square, Cochran Q, or McNemar tests are common statistical procedures used after this transformation. The likert scale is expressed as:

(i) Weighted Average $X_w = \frac{5(N_1) + 4(N_2) + 3(N_3) + 2(N_4) + 1(N_5)}{F}$ ----------(13)

Where;

X_w =Weighted average

$N_1 + N_5$ = Rating scale

F = Frequency of respondents =265

(ii) The mean score of respondents was set at 3.00 that is

$$X = \frac{5 + 4 + 3 + 2 + 1}{5} = 3 \text{----------(14)}$$

3.4.5 Probit regression

The probit regression was used to analyse objective 5. Probit regression analysis involves modelling the response function with the normal cumulative distribution function. The probit of a proportion *p* is just the point on a normal curve with mean of 0 and standard deviation of 1 which has this proportion to the left of it. For logistic and probit regression, the binomial, rather than the normal distribution describes the distribution of the errors and is the statistic upon which the analysis is based. The principles that are used for ordinary linear regression analysis could be adapted to fit both regressions. However, instead of using least square method to fit the model, for logistic and probit regressions, it is more appropriate to use maximum likelihood estimate. The likelihood function is given as:

$$\boldsymbol{L} = \prod_{i=1}^{m} \boldsymbol{P_i^{ri}(1 - P_i)^{ni-nr}} \text{----------} (15)$$

This is the cumulative distribution function of the standard normal distribution.

$$\boldsymbol{P = \emptyset(2) = \int_{-\infty}^{2} \frac{1}{\sqrt{2\pi}} exp(-\mu^2/2)\partial\mu} \text{---------- (16)}$$

where*p* is the proportion and Φ^{-1} is the inverse of the cumulative distribution function of the standard normal distribution. The model can be presented as:

$$\boldsymbol{\emptyset^{-1}(Pi) = Z = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_{6+\mu}} \text{------(17)}$$

where the *pi* are defined in terms of the parameters β_0, β_1,... $\beta_6$and the known values of the predictor variables. This has to be maximized with respect to the parameters. The parameters to be investigated will include:

P = poverty index of households (where P =1 if household's income is above the poverty line and P = 0 if otherwise).

X_1 = Quantity of wood collected in (kg)

X_2 = Number of cattle that graze on farmland

X_3= Number of years farmland is allowed to lie fallow

X_4 = Knowledge of natural resource conservation (dummy where 1 = if source of information is formal, 0 = otherwise).

X_5 = Duration of graze per week (hrs)

X_6 = Size of farm land owned as personal property (ha)

Chapter 4

RESULTS AND DISCUSSION

4.1 The Socio – Economic and Demographic Characteristics of the Arable Crop Farmers

Data on socio – economic and demographic characteristics of the arable crop farmers considered included age, educational status, size of household, income, farm size and years of experience.

4.1.1 Age of household heads

Analysis of the age distribution of the farming households is presented in Table 3. Thirty one (31%) fell within the age group of 46 – 55 years while 29% of the household heads fell within the age group greater than 56 years. The result further revealed that 22% and 13% were within the age groups of 36 – 45 and 26 – 35 years respectively. Household heads that were less than 25 years constituted only 5%. The mean age of the farmers was found to be 47 years, implying that most of the farmers were advanced in age.

Analysis of the household heads based on their age is very important because the level of poverty may be directly related to the age of the household head. The older the household head, the higher the probability of the household being poor (World Bank, 1996). This may be due to inability of the household head to expand the farm enterprise because ofsenility. This is in contrast with the findings of Kabubo-Mariara (2002) who reported that an increase in age lead to a reduction in the probability of being poor

among farmers in Kenya. The study also reported that younger herders record higher productivity (and thus use the environment unsustainably) than their older counterparts.

Table 3: Age Distribution of Household Heads

Age (years)	Frequency	Percentage
≤25	13	4.9
26 - 35	34	12.8
36 - 45	59	22.3
46 – 55	81	30.6
≥56	78	29.4
Total	**265**	**100.00**
Mean=47		

4.1.2 Years spent in school by household heads

The distribution of the household heads according to their educational attainment is presented in Table 4. It showed that 40% of the household heads had no formal education while 38.5% had primary school education.It also showed that 17% and 4.5% of the household heads had University degrees and Diploma/NCE certificates respectively. The mean of the years spend by farming households in acquiring formal education was 7 years, implying that most of the farmers had atleast attended primary school. As stated by Amaza (2000) in Patrick (2006), the level of education (years of schooling) helps farmers to use production information efficiently, as more educated persons acquire more information and to that extent, is a better producer. Many studies in Nigeria have shown that educational level of the household head affects the incidence of poverty among farming households. World Bank (1996) and FOS (1999a),

showed that incidence of poverty among households headed by a person with primary certificate and below was high, while it was less in households headed with secondary education and above.

Table 4: Distribution of Household Heads based on Educational Status

Educational Status	Frequency	Percentages
Non – formal	106	40.0
Primary certificate	102	38.5
Diploma/NCE	12	4.5
University degree	45	17.0
Total	**265**	**100.00**

4.1.3 Size of households

The size of household of the respondents is presented in Table 5. In this study, it was found that 54% of the households had 6 -10 family members. Also, 20% had 11 - 15 persons as dependents. The Table also indicated that 16% had more than 16 family members while households with 1 – 5 family members were the least with 10%. The mean of the number of persons per household was found to be 11. This shows that most of the households were relatively large.

Classification of households by sizes becomes necessary because poverty is directly related with household size. Cavendish (1999) in his study in Zimbabwe revealed that as household size increases, the poverty extent also increases and so is their contribution to whole group poverty. FOS (1999b), using the National Agricultural Sample Census of 1993/94, revealed that households with more than 20 members have poverty incidence of 85% while those with not more than 4 have poverty incidence of

65%. Though this is consistent with studies on poverty, it refutes the economies of scale hypothesis that due to consumption pooling, larger households may face a lower risk of poverty than their smaller counterparts.

Household size has a positive impact on production, which implies that the larger the household, the more the labour (population) available for boosting productivity (Ahuja, 1998;Boserup, 1965). This however contradicts Maler (1997), Deininger and Minten (1999) and Reardon and Vosti (1995) who argue that population pressure can result in an extended period of land over-use resulting to unsustainable shortening of fallow periods, deforestation, cultivation and overgrazing on marginal lands and thus lower productivity.

Table 5: Distribution based on Size of Households

Household size	**Frequency**	**Percentages**
1 -5	26	9.8
6 – 10	142	53.6
11 – 15	53	20.0
≥16	44	16.6
Total	**265**	**100.00**
Mean=11		

4.1.4 Farm size of households

Farm size as estimated in this study refers to the land area that was actually utilized by the households for crop production during the survey year. The distribution of the households by farm size is presented in Table 6. The result shows that majority of the households (35%) and 27% cultivated 2.0 – 3.9 and 4.0 - 5.9 hectares of farm land respectively. The Table further shows that 21.9% cultivated farm lands that were more

than 8 hectares while 10% and 6% of the households cultivated 6.0 – 7.9 and less than 2 hectares respectively. The mean of the farmland cultivated by the farmers was found to be 5 hectares, implying that most of the farms cultivated by the households were medium sized.

The classification of households by farm size in poverty study becomes important because it is expected that poverty among households decreases as the farm size farmed increases. This is expected because, all things being equal (*ceteris paribus*), an increase in farm size will raise the output level and consequently income. However, the *apriori* expectation is that farmers with large farm sizes experienced higher levels of degradation. This is because of the high cost involved in implementing mitigation measures to environmental degradation.

Table 6:Distribution of Households based on Farm Size

Farm size (ha)	**Frequency**	**Percentages**
≤ 2.0	15	5.7
2.0 – 3.9	93	35.1
4.0 – 5.9	73	27.5
6.0 – 7.9	26	9.8
≥ 8.0	58	21.9
Total	**265**	**100.00**
Mean=5		

4.1.5 Years of experience in farming

The years of farmingexperience byhouseholds is shown on Table 7. The result shows that 24% of households each had 20 – 29.9 and 30 – 39.9 years experience in farming

while 21% had over 40 years experience. The result further showed that 20% and 11% had 10 – 19.9 and less than 10 years experience respectively. The mean of the number of years of experience in farming was 27 years which imply that most of the households had been practicing farming for a good number of years.

It is generally held that the more experience a household head has in farming the lesser the incidence of poverty and the lesser the experience, the higher the incidence of poverty. Finco (2009) argues that the more experience a farmer is, the lesser the probability of using agro toxins, thus decreasing the chances of degrading the environment.

Table 7: Distribution based on Years of Experience in Farming

Farming Experience (years)	**Frequency**	**Percentages**
<10	28	10.5
10 – 19.9	54	20.4
20 – 29.9	64	24.2
30 – 39.9	64	24.2
≥ 40	55	20.7
Total	**265**	**100.00**
Mean=27		

4.1.6 Income of households

Table 8 present the distribution of households based on income earned per annum. The main source of income to the farming households is mainly from the sales of their farm produce (tubers and cereals) and to a little extent, off farm activities. Majority of the households (25%) earned income ranging from ₦100,001 –₦200,000 closely followed

by those in the region of ₦300,001 –₦400,000 with 23%. Households who earned ₦400,001–₦500,000 and less than ₦100,000 constituted 22% and 13% respectively. The least (8%) was made up of households who earn more than ₦500,000. The mean income earned by the households stood at ₦313,182. The expectation is that households that have higher incomes will readily implement measures that will guard against environmental degradation than their counterparts that are relatively poor. On the otherhand, Finco (2009) argues that an increase in income leads to an increase in the probability of agro toxin's usage thus, increasing the environmental degradation scenario.

Table 8: Distribution of Households based on Income earned annually

Income (₦)	**Frequency**	**Percentage**
≤100,000	35	13.2
100,001-200,000	65	24.5
200,001-300,000	61	23.0
300,001-400,000	59	22.3
400,001-500,000	25	9.4
≥500,001	20	7.6
Total	**265**	**100.00**
Mean = 313,182		

4.1.7 Monthly expenditure on basic needs

The total average monthly household expenditure shown on Table 9 is ₦67,593.67. Out of this amount, 47% was spent on food, 23% on natural resources, 9% on education, 6% on clothing and 4% each on housing, health care and transportation. Water had 3% and electricity had 1%. The fact that 46% of the total expenditure was spent on food

implies that poverty incidence was high in the study area because, according to Engel's law, the higher the incidence of poverty, the higher the proportion of the household's expenditure on food (Ferguson and Gould, 1975).

Table 9: Distribution of Households based on Monthly Expenditure on Basic Needs

Items of expenditure	**Amount (₦)**	**Percentage**
Food	31,481.87	46.58
*Natural resources	15,347.04	22.70
Education	5,897.60	8.73
Clothing	4,122.35	6.10
Housing	2,992.73	4.43
Health care	2,875.66	4.25
Transportation	2,362.15	3.49
Water	2,142.42	3.17
Electricity	371.85	0.55
Total	**67,593.67**	**100.**

*See Table 10 for a list of items that constitute natural resources

4.1.8 Expenditure on natural resources consumed by households

Table 10 shows the distribution of the farming households based on the value of natural resources consumed. The result clearly revealed that firewood accounted for the highest natural resource used by households with 41%. This is not surprising because fuelwood is the dominant source of energy in almost all rural and urban communities in Nigeria. The value of timber was 32% while vegetables and fruits was 8%. Other natural resources consumed are sand/ gravels (7%), medicinal herbs (6%), bush meat and fruit nuts accounted for 4% and 2% respectively. The extraction of trees for fuel and

construction leads to forest recession and serves as a human induced agent of erosion, thus resulting in environmental degradation.

The inclusion of the study of values of environmental resources in the consumption expenditure of the sampled households support the view of Dasgupta (1993), that omission of environmental resources from household budget survey suggest that there is a substantial gap in our understanding of rural households. The information contained in Table 10 further revealed that all the sampled households had access to free natural resources that can be obtained in their commons (forest, rivers and lakes), to derive part of their livelihood requirements. This justifies the findings of Cavendish (1999) that about 35% of incomes of rural households in Malawi come from natural resources.

Table 10: Distribution of Expenditure on Natural Resources

Types of Natural resources	**Amount(₦)**	**Percentage**	**Rank**
Fuelwood	6,242.65	41	1st
Timber	4,870.11	32	2nd
Vegetables/fruits	1,240.02	08	3rd
Sand/gravels	1,008.68	07	4th
Medicinal herbs	996.28	06	5th
Bush meat	689.12	04	6th
Fruit nuts	300.18	02	7th
Total	**15,347.04**	**100**	

4.1.9 Sources of water

The sources of water available to the farming households in Plateau State are tap/boreholes, wells, ponds/reservoirs and rivers/streams. Table 11 shows that the overwhelming source of water supply to the farming households was from open wells

dug by the households, community and the Local Government in or near their compounds of abode; or in choice locations around the community. About 56% obtained their water supply from the open wells, 31% from ponds/reservoir and 8% obtained theirs from tap/borehole. Few of the respondents (5%) obtained their water supply from surface sources such as river/stream

It is expected that poverty may tend to be more among households who obtain their drinking water from streams and rivers than those who obtain theirs from tube well/boreholes. This can be explained by the fact that those who obtain their drinking water from surface sources are exposed to water borne diseases, which may result to sickness. This phenomenon tends to reduce productivity, lower income and increase household expenditure on medication amongst other factors.

Table 11: Distribution of Households based on Sources of Water

Water source	Frequency	Percentage
Tap/Borehole	22	8.30
Open Well	149	56.22
Pond/Reservoir	81	30.57
River/Stream	13	4.91
Total	**265**	**100.00**

4.1.10 Time spent fetching water

Information on the distribution of households based on time spent fetching water for domestic use is presented in Table 12. As presented in the table, 44% spent 30 minutes to 1 hour to get water, 39% and 14% of the respondents spent times ranging between less than 30mins and 1.01 hours – 1.30 hours respectively to fetch water for domestic uses. The mean time spent in fetching water was 50 minutes.

The significance of the time spent to get water to poverty hinges on the fact that family who travel longer distances to fetch water spent considerable time, which could have been utilized for other economic purposes or even on leisure. Hence poverty may be expected to be more among households that have to spend more time to obtain water than otherwise *ceteris paribus.*

Table 12: Distribution of Households based on Time Spent to Fetch Water

Time spent	**Frequency**	**Percentages**
≤30 mins	104	39.25
31 - 1.00hrs	116	43.77
1.01 – 1.30hrs	37	13.96
1.31 – 2.00hrs	05	1.89
2.01 – 2.30hrs	03	1.13
Total	**265**	**100.00**
Mean=50mins		

4.1.11 Preference of social amenities among households

Table 13 indicated that households ranked health care as their most preferred social amenity (51%), followed by transportation and market with 34% and 26% respectively. This was trailed by housing (25%) and roads (22%). The last on the preference scale by households is surprisingly credit with 15%. This finding agrees with Yusuf (2000) who reported that in the rural areas of Kwara state, Nigeria, most of the rural dwellers patronize traditional healers and birth attendants in their localities apparently for inadequate health care institutions.

Table 13: Ranking of Preferred Social Amenities among Households.

Amenity	Frequency*	Percentage	Rank
Health care	135	51	1st
Transportation	89	34	2nd
Market	70	26	3rd
Housing	65	25	4th
Roads	59	22	5th
Primary school	54	20	6th
Water supply	51	19	7th
Electricity	50	19	8th
Storage facilities	44	17	9th
Credit	41	15	10th

* multiple responses allowed

4.2 Relationship between the Socio Economic Characteristics and Poverty Level of the Households

The regression parameters and diagnostic statistics were estimated using the Maximum Likelihood Estimation (MLE) technique (Table 14). From the MLE of the Tobit regression, the results reveal that sigma (δ) is 0.2163 with a Z - value of 22.869 and is significant ($P<0.01$). This implies that the model has a good fit to the data and the model as specified, explained significant non-zero variation in factors determining poverty depth.

The result showed that four out of the six listed regressors had significant influence on the poverty depth of the farming household's head. The variables that had significant co-efficient are educational status, arable farmer's income, farm size and age of household head. It should be noted that a positive sign on a parameter indicated that

higher values of the variables tend to increase the likelihood of poverty depth. Similarly, a negative value of a co-efficient implied that higher values of the variables would reduce the probability of the depth of poverty.

Specifically, educational level of household head, farm income and farm size with negative parameter co-efficients agreed with the *a priori* expectations. Only one parameter (age of household head) had positive co-efficient which again agreed with the *a priori* expectations. Household size and years of experience of household were however not significant. The coefficient of education is significant ($P<0.01$). This implies that one year increase in years of schooling will decreased the probability of poverty depth among farming households 1%.This may be attributed to the fact that educated household heads have the tendency to adopt improved farming techniques better and faster than the uneducated ones. This however raises the productivity and incomes of the educated heads with subsequent improvement of welfare amongst them.

The coefficient of farm income is significant ($P<0.05$) implying that a unit increase in farm income would decrease the probability of poverty by 75%. This is because higher income tends to bring about welfare improvement hence reduction in poverty levels. Results are consistent with findings by Etim (2007) who reported a similar finding in his study on determinants of rural poverty among broiler farmers in Uyo. The coefficient of farm size is significant ($P<0.05$) implying that a unit increase in the farm size will result in a probability of reducing the poverty depth of the farming households by 65%. This is obvious because *ceteris paribus* the expectation is that an increase in farm size should result in a concomitant increase in output, and consequently income. The regression coefficient for age of farming household head is significant ($P<0.10$)

meaning that increasing the age of household head by a year will lead to a probability of an increase in poverty depth. This is attributable to the fact that older farmers are less receptive to the adoption of farm improvement techniques.

Table 14: Tobit Regression showing the relationship between the Socio Economic Characteristics and Poverty Depth of Households

Variable	Coefficient	S E	Z-value
Constant	-0.0726	0.0651	-1.115
Education ($X_{1)}$	-0.0110*	0.0022	-4.886
Household size (X_2)	0.0001	0.0022	0.050
Annual income (X_3)	-0.7530**	0.2526	-2.980
Farm size (X_4)	-0.6459**	0.2636	-2.450
Experience (X_5)	0.0003	0.0014	0.230
Age (X_6)	0.0027***	0.0015	1.766
SIGMA	0.2163*	0.0094	22.869

*, **, ***, = Significant @ 1%, 5% and 10% respectively

4.3 Poverty Profile of the Farming Households

To evaluate the welfare of the households, the study tabulated the welfare indicator (expenditure pattern) by consumption level as monthly MPAEHE by deciles (Table 15). The result shows that the sampled households that fell in the first decile or the bottom 10% survived on an average of ₦1,382 per month and their share of the total monthly MPAEHE was 3.51% while those in the last decile spent on an average, ₦9,525 per month and their share of the total monthly MPAEHE was 24.17%. The first decile represented the poorest twenty six households from the sampled two hundred and sixty five richest households of the sample. The poverty line of ₦2,627 which was the $^2/_3$ of the means of the MPAEHE was located within the twenty six households of

the fourth decile. The MPAEHE of the remaining deciles and their corresponding percentages are as presented in Table 15.

Table 15: Distribution of the Monthly MPAEHE by Deciles

Deciles	MPAEHE(₦)	Expenditure Distribution (%)
1st	1,382	3.51
2nd	1,934	4.91
3rd	2,272	5.77
4th	2,748	6.97
5th	3,173	8.05
6th	3,591	9.11
7th	4,017	10.20
8th	4,761	12.08
9th	5,998	15.22
10th	9,525	24.17
Total	39,401	100.00
Mean	3,940	
$^2/_3$ MPAEHE	2,627 (Poverty line)	

4.3.1 The poverty line

The poverty line used for this study was calculated from the monthly MPAEHE of the sampled households as shown in Table 16. Two third (₦2,627) of the monthly MPAEHE of the sampled households was used as the poverty line. This was also used by similar studies in Nigeria (World Bank, 1996; FOS, 1999a; 1999b; Omonoma, 2001; FOS, 2004; and Bandabla, 2005). This poverty line based on 2005 prices was expected

to meet the minimum basic requirements (food and non-food) of an adult per month in the study area.

The result from this study showed that any household in the study area with per capita monthly expenditure greater than or equal to ₦2,627 was considered to be non – poor or rich whereas any household with per capita monthly expenditure below ₦2,627 is considered poor. This figure is far lower than the national relative poverty line of ₦66,802.20. However, the measurement of poverty as used by the NBS (2010) is about individuals in poverty, contrary to the adult equivalent used in this study which has been shown to under estimate the population (NBS, 2010). Also the core poverty line or (one third MPAEHE) was constructed to be at per capita monthly expenditure of ₦1,313. This means that any household in the study area with per capita monthly expenditure greater than ₦1,313 but less than ₦2,627 is considered to be moderately poor, but any household in the study area with per capita monthly expenditure below ₦1,313 is considered to be extremely poor.

4.3.2 Poverty profile

The poverty profile of the farming households which include poverty headcount or incidence (P_0), poverty gap or depth (P_1) and squared poverty gap or severity (P_2) were calculated. The $P_0$for the entire farming households was 0.42 (42%). The relative smallness of this figure when juxtapose by the findings by Yusuf (2000) who reported a poverty incidence of 52% in Kwara State; Omonona (2001) who reported a poverty incidence of 58% in Kogi State; Bandabla (2005) who reported a poverty incidence of 50% in Ibadan metropolis, Oyo State and Patrick (2006) who reported a poverty incidence of 62% in Borno State may not be unconnected to the report by the NBS

(2009) that Plateau State had the least unemployment rate of 7.1% among the states of the federation in 2008. This means that 42% of the farming households in the study area were poor (Table 16). This again is lower than the relative poverty incidence for the state as published by the NBS (2010). The NBS report put the poverty incidence in the state at 79.7% while Kwara had 74.3%. Other states in the north central zone of the country captured in the report include Kogi (73.5%), Benue (74.1%) and Nassarawa (71.7%). The result shows that 3.4% of the total households sampled were below core poverty level (i.e people who could not spend more than ₦1,313 a month to buy the basic necessities of life). These were considered as the extreme poor. The result also shows that 27.6% of the households were moderately poor. Their monthly consumption per person was below the poverty line of ₦2,627, but more than ₦1,313. In all, the analysis showed that 42% of the sampled households were relatively poor and could not attain the minimum standard of living; this leaves 58% of the total households sampled to be non – poor. These were the households with per capita monthly expenditure equal or higher than ₦2,627. Although the poor are conventionally defined as the population that fall below a certain poverty line, it is assumed that even individuals above the poverty line may suffer from "investment poverty" (Reardon and Vosti 1995).

The poverty gap index (P_1), usually referred to as the depth of an average poor person from the poverty line was 21%. This implies that 21% of the poverty line (₦552) was required to bring an average poor person in the study area to the poverty line. The poverty severity index (P_2) which measures the distance of each poor person to one another was found to be 0.11. This means that among the poor households, 11% were

severely poor. This shows that the poor households were not equally poor but they vary in their degree of poverty.

Table 16: Poverty Profile of Households

Index	₦/Percentage
MPAEHE	₦ 3,940
$^2/_3$ (MPAEHE)	₦ 2,627
$^1/_3$ (MPAEHE)	₦1,313
Head Count Index (P_0)	0.42
- Core Poor (%)	0.03
- Moderate (%)	0.27
- Non Poor (%)	0.58
Poverty Gap Index (P_1)	0.21
Poverty Severity Index (P_2)	0.11

4.4 Causes and Level of Environmental Degradation

The result in Table 17 shows the causes of environmental degradation as ranked by the respondents. Out of the several causes of environmental degradation, the problems associated with the ownership structure of farm lands was ranked as the first. This agrees with *apriori* expectation that in most parts of sub Saharan Africa, the living hold the land in trust for the unborn generation. Thus, permanent crops are hardly planted on such farms.The arguments have been that where farmers do not own farmlands in perpetuity but rather possess only leasehold, they will be unwilling to incur short term costs (for example, expenditure 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.

Felling of farm trees for fuel and other domestic uses was ranked second. This is because the hitherto nearby forests has receded to far distances, such that the respondents had to resort to the indiscriminate felling of any available tree to meet their needs. This agrees with the findings by Maiangwa *et. al*. (2007) cited in the review who reported that fuelwood is the dominant form of cooking energy for all rural farmers in Nigeria. Mailumo *et. al.* (2011) also reported that the clearing and burning of vegetation accounted for 28% of the causes of environmental degradation in Kebbi State, Nigeria. Lack of allowing farms to fallow and overgrazing by animals as causes of environmental degradation tied at the 3rd position.Lal and Okigbo (1990) cited in the review reported that nowadays, at best, fallow periods last between 1 to 2 years – a period much shorter than the 5 to 7 years required to restore soil fertility. IAR (1996, 1998) as cited in the review also reported that the unavailability of designated grazing lands makes the animals to graze uncontrollably, leading to overgrazing. The likely consequences of these 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. Mailumo *et. al.* (2011) reported that overgrazing by animals accounted for 25% of the degradation in Kebbi State, Nigeria.

The result of the Likert scale is also presented in Table 17.With Likert scale data, the best measure to use is the mode, or the most frequent Therefore the implication of the result is that most of the farmers experienced moderate degradation on their farms. The mean score of most of the farmers was slightly above 3.00 which is an indication of moderate degradation. This agrees with findings by the Soil References and Information Centre in Wegeningen, Netherlands, who recently published more

conservative estimates of the extent and severity of land degradation in Africa. Its data indicates that about 321 million hectares (14.4% of the total vegetated land surface) are moderately, severely or extremely degraded.

Table 17: Causes and Level of Environmental Degradation

Causes of Degradation	**ED**	**SD**	**MD**	**LD**	**ND**	**Raw**	**Mean**	**Rank**
	(5)	(4)	(3)	(2)	(1)	score	score	
Ownership structure of farm lands	109	57	68	23	08	1031	3.89	1st
Felling of farm and forests trees	51	68	101	60	35	985	3.72	2nd
Lack of allowing farms to fallow	65	88	70	16	26	945	3.57	3rd
Overgrazing by animals	52	99	74	21	19	939	3.54	4th
Burning of crop residues on farm	56	88	59	52	10	923	3.48	5th
Over usage of agro chemicals	68	62	84	20	31	911	3.44	6th
Non-existence of organisations	76	60	56	45	28	906	3.42	7th
Non application of organic manure	03	99	116	47	00	853	3.22	8th
Continuous tillage of farmlands	67	48	52	42	56	823	3.11	9th
Over usage of chemical fertilizers	25	67	80	77	16	803	3.03	10th
Lack of information	32	51	63	71	48	743	2.80	11th

ED=Extreme degradation; SD=Severe degradation; MD=Moderate degradation; LD=Light degradation and ND=No degradation

4.5 Relationship between Poverty and Environmental Degradation

Result of the probit model is shown on Table 18.The signs of the parameter estimates indicate the direction of change in the probability of increasing or decreasing the dependent variable (poverty depth). All interpretations are assessed on the basis of reference categories of the categorical explanatory variables. While positive parameter estimates imply an increase in the probability of the poverty depth, negative parameter estimates indicate a decrease.

It is possible to draw conclusions about the magnitude and direction of each variable on the probability of poverty level. The log likelihood ratio statistic was significant ($P<0.01$) suggesting that the independent variables taken together influence the poverty depth of the farmers. The result showed that five out of the six listed regressors had significant influence on the poverty depth of the farming household's head. The variables that had significant co-efficient are the quantity of wood collected (X_1), number of cattle that graze on farm lands (X_2), knowledge of natural resource conservation (X_4), duration of graze per week (X_5) and size of farm land (X_6). The only variable that was not significant is number of years farm land is allowed to lie fallow (X_3).

The result of the analysis indicated that the coefficients of the quantity of wood collected is0.0404 and significant ($P<0.01$). This implies that a percentage increase in the quantity of wood collected would result to a probability of an increase in the poverty depth of the farmers and consequently environmental degradation by 4%.This agrees with *apriori* expectation that the indiscriminate felling of trees makes the farmlands prone to degradation. This finding is consistent with the findings by

Okwi*et.al*. (2006) and Dasgupta (2003).It is also in conformity with the findings of Lal and Okigbo (1990) to the effect that deforestation and wood harvest (for fire wood) is a major source of human induced environmental degradation, accounting for nearly 15% of the total land degradation in Africa. Karee *et. al*. (2009) stated that Nigerians consume from 1.9kg to 4.0kg per day per capita of firewood depending on household size. When applied to the country's population currently put at about 150 million people, the country consumes about 285 million kilogrammes of firewood daily. Maiangwa *et al*.,(2007) also reported that fuel wood is the dominant form of cooking energy for all rural farmers in Nigeria. Poverty constrained options may induce the poor to deplete resources at rates that are incompatible with long term sustainability (Holden *et. al.,* 1996). In such cases, degraded resources precipitate a "downward spiral," by further reducing the income of the poor (Durning, 1989; Pearce and Warford, 1993). In summary, this result supports the downward spiral hypothesis and by implication, alleviating absolute poverty would likely reduce poverty-induced deforestation. Deforestation is therefore important in the poverty-environment nexus in Plateau State.

Mohammed (2001) reported that Charcoal plays an important role in both the energy sectors and the economies of most African countries. Charcoal making provides a considerable amount of employment in rural areas; it also allows for a quick return on investments. However, the inefficiencies inherent in the production and use of charcoal place a heavy strain on local wood resources, resulting in severe environmental consequences. He further stated that in many parts of the world, the use of charcoal has been blamed for deforestation. Deforestation in the drier parts of Africa has led to an even worse problem - desertification and the loss of thousands of species. Deforestation

is the product of the interaction of many environmental, social, political, economic and cultural forces at work in any given region.

The illegal removal of trees to produce charcoal for export is an action destroying the common natural capital, which the society does not benefit. Public awareness of the impact of deforestation needs to be increased. Mohammed (2001) reported that as a result of deforestation in Somalia, land suitable for grazing is destroyed. This inevitably affected the nomadic communities who entirely depend on grazing. The most visible results of this action are desertification, soil erosion, and general environmental degradation. The highest price will be the long-term effect in desertification.

Number of cattle allowed to graze on farmlands and the duration of graze per week were significant ($P<0.01$). This implies that a percentage increase in the number of cattle allowed to graze and the duration of weekly graze would lead to a probability of increasing the poverty level of the farmers by 25% and 14% respectively. Again, this agrees with *apriori* expectation. Oldeman *et al.,* (*1991*) and Batjes (2001) showed that overgrazing account for 49% of the degradation witnessed in Sub Saharan Africa (SSA). IAR(1996; 1998)reported that the unavailability of designated grazing lands makes animals to graze uncontrollably (free range), this consequently leads to overgrazing. The average number of cattle owned by households in the study area is 5. Because the prevalent land tenure arrangement in the study area is communal, households that have interest in land allowed these animals to graze uncontrollably thus, conforming to the theory of "tragedy of the common".

The tragedy of the commons is a dilemma arising from the situation in which multiple individuals, acting independently and rationally consulting their own self-interest, will ultimately deplete a shared limited resource, even when it is clear that it is not in anyone's long-term interest for this to happen (Hardin, 1968). The cost of each individual's usage is shared equally by the entire community. In Hardin's theory, it is in each herder's interest to put the next (and succeeding) cows he acquires onto the land, even if the quality of the common is damaged for all as a result, through overgrazing. The herder receives all of the benefits from an additional cow, while the damage to the common is shared by the entire group. The result of this is that, often, soil surfaces are bare and without any vegetation as the livestock browse 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. This results to low productivity and consequently poverty. This necessitates the need for policies which promote the expansion of private property.

Under normal grazing conditions one hectare of pasture or grazing land can support an average of 3 livestock heads in rain fed areas and 6 livestock heads in extensively irrigated areas. As against this, the actual number of animals which depend on each hectare of such lands is much higher - anything from 2.4 to 4.5 times their carrying capacity. According to Mohammed (2001) in Jammu and Kashmir, for example, 16.8 animals are supported by each hectare of grazing and foraging land. The grazing and foraging lands are thus being over-grazed.

Overgrazing results when more animals than a piece of land can support are allowed to graze in that area. This can cause serious damage to the land. When too many animals

are allowed to graze on a piece of land they eat the plants that hold the soil in place. Too many animals may mean that the grass is eaten down to the roots faster than it can grow back. This in turn leads to overgrazing. Overgrazing can cause and accelerate soil erosion and with it a loss of soil fertility. When large herds are concentrated around one particular area the animals compact the soil by trampling on it resulting in the soil being unable to retain as much moisture as it needs. Once the animals have overgrazed an area it is often left barren with no protection and the wind blows away the topsoil. This is accentuated by the fact that most of the households are poor consequent upon which they cannot afford supplemental feeding.

Knowledge of natural resource conservation was negatively significant ($P<0.05$), implying that a percentage increase in the knowledge of natural resource conservation would lead to the probability of a decrease in poverty by 46% among the farmers. The lack of knowledge about environmental conservation has been shown to be a big problem in Africa. Barbier (1998) argued that the conventional approach to land conservation in Africa has been to encourage farmers to adopt 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). Farmers will therefore need to be educated on sustainable management practices such as the right tillage practices and the harmful effects of bush burning.

Finally, size of farm land was significant (P<0.10), which implies that a percentage increase in the size of farmland would lead to a probability of a decrease in poverty by 4% among farmers in the study area. This agrees with the *apriori* expectation that the larger the farm size, the lesser the incidence of poverty. This is expected because, all things being equal, an increase in farm size will raise the output level and consequently income.

Hence it can be noticed in the present study, that the relationship between poverty and environmental degradation is characterised by the relation among specific variables, showing that the relationship is dynamic and context-specific. Thus, agreeing with the hypothesis in the literature that there is a direct relationship between poverty and environmental degradation. The aim of the study was to empirically test the bi-directional relationship between rural poverty and environmental degradation. The results provide evidence in consonance with the dominant view in the literature that poverty spurs environmental degradation since five of the environmental variables exhibit a significant relationship with poverty depth of the households in the study area. From this study, it could be stated that the poverty-environmental degradation nexus is a one way traffic as is been suggested by the Brundtland report and a host of others such as Barbier and Burgess (1992); Pimentel *et.al*., (1995); Cleaver and Schreiber (1992); Barbier (1997) and Barbier (1998).

These however contrast with the findings by Broad (1994) as well as Reardon and Vosti (1995) that "not all environmental degradation in developing countries is linked to poverty; for example, pollution as an externality of the agriculture of richer farmers

or forest or commons overexploitation by large and capital-intensive lumber and cattle operations can ravage the environment without the poor's lifting a hand".

Table 18: Probit Regression showing the Relationship between Poverty Level and factors that lead to Environmental Degradation

Variable	Coefficient	SE	Z-value
Constant	0.7574**	0.3360	2.254
Quantity of wood (X_1)	0.0403*	0.0106	3.809
Grazing cattle (X_2)	0.2545*	0.0657	3.870
Fallow period (X_3)	-0.0005	0.0009	-0.636
Knowledge of conservation(X_4)	-0.4629**	0.1936	2.391
Duration of graze (X_5)	0.1392*	0.0404	3.438
Farm size (X_6)	-0.0409***	0.0234	-1.750
Log – Likelihood = -128.6677			
McFadden Pseudo R – Squared = 0.6215			
P – Value = 0.00011			

***, **, *, = Significant @ 1%, 5% and 10% respectively

4.6 Mitigation Measures to Environmental Degradation

Measures applied by arable crop farmers to mitigate environmental degradation in the study area were identified and described (Table 19). The result shows that majority (69%) of the farmers deliberately tilled their farm lands against the gradient to serve as a control terrace to washing of the top soil. This was followed by the creation of wide furrows and planting of cover crops with 45% and 35% respectively in 2nd and 3rd positions. This is in tandem to Mailumo *et. al.* (2011) who reported that the creation of water channel was significant as a mitigation measure to environmental degradation in Kebbi State, Nigeria. Other measures employed by the farmers included fallowing of

farm lands with 34%, planting of grass for border demarcation with 19% and the practice of zero tillage with 12%. The respondents also plant trees (9%) and practice mixed cropping (6%) to mitigate the effects of environmental degradation. Mailumo *et. al.* (2011) also reported that planting of trees was a significant measure in the mitigation of environmental degradation in Kebbi State, Nigeria.

The valuable role of trees in controlling water runoff and the positive interaction of trees such as acacias with crops and animals are reasons why much more emphasis needs to be given to them for environmental protection (Mohammed, 2010). Deforestation will have major adverse impacts on rainfall availability, capacity of the soil to hold water, local climate, and habitat for animal species and bio-diversity. Basically, humans abandon areas that have been cleared, particularly when the community is nomadic depending on grazing for their animals. All these will collectively affect the livelihood and socio-economic aspectof the society.

Table 19: Ranking of the Mitigation Measures to Environmental Degradation

Mitigation Measure	**Frequency***	**Percentage**	**Rank**
Tilling the farm against the gradient	182	69	1st
Creation of wide furrows	118	45	2nd
Planting of cover crops	92	35	3rd
Allowing farm lands to fallow	91	34	4th
Planting of grass for border demarcation	50	19	5th
Zero tillage	33	12	6th
Planting of trees	24	09	7th
Mixed cropping	16	06	8th

*multiple responses allowed

Chapter 5

SUMMARY, CONCLUSION ANDRECOMMENDATIONS

5.1 Summary

The study was carried out in Plateau State, Nigeria. The major objectives of the study are to determine the poverty level of arable crop farmers and to estimate the relationship that exists between the socio economic characteristics of the farmers and their level of poverty. Other objectives include to establish the level of environmental degradation and to determine the relationship between the poverty level and factors that lead to environmental degradation in the study area.

The study utilized primary data. Using multi stage sampling technique, primary data were collected from 265 farming households using structured questionnaires administered by well-trained enumerators. Various analytical techniques were used to analyse the data that were collected from the farming households in the study area. These include descriptive, the FGT (P_α measure), t-test and Tobit regression. Others are the Likert scale and the Probit regression. The FGT (P_α measure) was used to calculate the poverty profile of the farming households, while the Tobit regression model was used to estimate the relationship between the socio economic characteristics of the farming households and their poverty level. The Likert scale was used to establish the level of environmental degradation in the study area. Finally, the Probit regression was used to determine the relationship between the poverty level and factors that lead to environmental degradation.

The distribution of the sampled household's heads by age revealed that the mean age of the household's heads was 47 years old. The result also showed that the mean of the years of formal education was 7 years which implies that at least, household heads in the study area attended basic primary education. The distribution of the households by number of individual showed that the mean number of people per household was 11, which shows that the culture of having large families still dominates in the study area.

The study revealed that the average farm size owned by the respondents was 5 hectares while the average years of farming experience was 27 years. This suggests that a lot of the household's heads were mainly engaged in agriculture as their primary occupation. Result of the income distribution of the household's heads shows that on the average, they earned ₦313,182 per annum as income majorly from the sales of farm crops.

The result further showed that the total average monthly household expenditure was ₦67,594 with 47% spent on food while 23% was spent on natural resources. The fact that 47% of the total expenditure was spent on food implies that poverty incidence was high in the study area because, according to Engel's law, the higher the incidence of poverty, the higher the proportion of the household expenditure on food. Also for the households to spend 23% on natural resources means that a lot of pressure is exerted on this resources. The result also indicated that households ranked health care as their most preferred social amenity (51%).

The monthly mean per adult equivalent household expenditure (MPAEHE) of the households in the study area stood at ₦3,940. A poverty line of ₦2,627 representing $^2/_3$ of the monthly MPAEHE was estimated to be the poverty line for the farming

households in the study area. This was believed to provide an adult in the study area with monthly minimum basic requirements for existence (food and non-food). The FGT as measured by the head count index (P_0) shows that 42% of farming households of the study area were poor, the average depth of the poor households from the poverty line was 21% (₦552) of the poverty line and those that were severely or critically poor constituted 3% while 27% were moderately poor. The poverty gap index (P_1), also referred to as the depth of an average poor person from the poverty line was 21%. The last of the FGT known as the poverty severity index (P_2) which is a measure of the distribution of the poor below the poverty line or the distance of each poor person to one another was calculated as 0.11, indicating an uneven distribution of the poor below the poverty line.

The relationship between the socio economic characteristics and the poverty level of the farming households was determined using the Tobit regression model. The regression parameters and diagnostic statistics were estimated using the MLE technique. From the MLE of the Tobit regression, the results revealed that the sigma (δ) was 0.2163 with a Z - value of 22.869 and was significant P<0.01) probability level. This explained significant non-zero variation in factors determining poverty depth.

The result showed that the variables that had negatively significant co-efficients are educational status, arable farmer's annual income and farm size while the coefficient of age of household head was positively significant. It should be noted that a positive sign on a parameter indicated that higher values of the variables tend to increase the likelihood of poverty depth. Conversely, a negative value of a co-efficient implied that higher values of the variables would reduce the probability of the depth of poverty.

Out of the several causes of environmental degradation, farm ownership structure was ranked as the first (41%). This agrees with *apriori* expectation that in most parts of sub Saharan Africa, the living hold the land in trust for the unborn generation. The likert scale result showed that most of the farmers experienced moderate degradation on their farms. The mean score of most of the farmers was slightly above 3.00 which is an indication of moderate degradation. This agrees with findings by the Soil References and Information Centre in Wegeningen, Netherlands, who recently published more conservative estimates of the extent and severity of land degradation in Africa. Its data indicates that about 321 million hectares (14.4% of the total vegetated land surface) are moderately, severely or extremely degraded.

The Probit model was used to determine the relationship between the poverty level and factors that lead to environmental degradation. The log likelihood ratio statistic was significant ($P<0.01$), suggesting that the independent variables taken together influence the poverty depth of the farmers. The result showed that the variables that had significant co-efficient included the quantity of wood collected, number of cattle that graze on farm lands, knowledge of natural resource conservation, duration of graze per week and size of farmland of the farmers.

Finally, the measures used by the farming households to mitigate environmental degradation were identified. The result shows that majority (69%) of the farmers deliberately ridged their farm lands against the gradient to serve as a controlled against washing of the topsoil. This was followed by the creation of wide furrows and planting of cover crops with 45 and 35% respectively in 2nd and 3rd positions

5.2 Conclusion

The arable crop farming households in the study area were fairly poor requiring a monthly income of ₦552.00 to bring them to the poverty line. Specifically, educational level, income of household, farm size and age significantly influenced poverty depth of farming households. The farm ownership structure, indiscriminate felling of farm and forests trees, lack of allowing farms to fallow and overgrazing by animals were responsible for the moderate environmental degradation in the study area.

The study revealed that environmental degradation spurs rural poverty and rural poverty spurs environmental degradation – thereby providing evidence in support of the poverty environment nexus in the study area. Finally, the farming households employ strategies such as tilling of farm against the gradient, creation of wide furrows and planting of cover crops to mitigate the effects of environmental degradation.

5.3 Recommendations

Based on the findings of this study, the following policy measures aimed at reducing poverty and sustaining the environment among farming households in the study area are recommended.

1. This study revealed that 42% of the farming households lived below the poverty line. There is the need for policy makers and managers of poverty alleviation programmes to identify the poor at community levels so as to direct poverty alleviation programmes and projects towards them.

2. The study also showed that the relationship between poverty and education, income of farmers and farm size was negative; implying that an increase in these variables among the farming households' heads will lead to a decrease in the poverty incidence. Therefore policies that will provide education to the farming households are recommended. To this end, entrepreneurial and environmental education should be availed to the farmers.

3. Farming households ranked the non-planting of trees because of non-ownership of farmlands, felling of farm and forest trees and the lack of allowing farms to fallow among the highest causes of environmental degradation. To discourage the indiscriminate felling of trees by farmers to meet their daily energy needs, technologies that utilized the ample solar and wind energies are suggested or technologies that convert local waste materials to energy should be developed.

4. The government should as a matter of policy, established ranches in all farming communities in the country. This will encourage sedentary animal production. Private ownership of grazing lands should also be encouraged such that farmers should pay some stipend before their animals could graze controllably. This will avoid the vicious cycle of the "tragedy of the common" pitfall.

5. There should be strong advocacy on the need for every community to own its woodlot and to embrace agro-forestry. Communities should also be sensitized on the need to come up with simple rules and regulations governing the use of existing adjoining natural forests. This will ensure a systematic harvest and or felling of forest resources

6. It is recommended that environmental aid be introduced to abate environmental degradation. Environmental aid will to a large extent be significant in accelerating economic growth. The aid should be targeted at preserving the environment or facilitating environmental-friendly infrastructural development that will directly benefit the poor people. This should be backed by a strong environmental policy with the political will to enforce it.

5.4 Suggestion for Further Study

This study examined the poverty-environmental degradation nexus among arable crop farmers in Plateau State. Areas recommended for further studies are:

1. The willingness of farming households to pay for environmental resources consumed.

2. Assessment of poverty – environmental degradation among non – farming households especially urban dwellers. This will offer an opportunity for comparison.

3. Also, it is suggested that a comparative study on influence of property rights on poverty - environmental degradation between farming households that owned natural resources and those that don't be carried out.

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Appendices

Appendix I: QUESTIONNAIRE

DEPARTMENT OF AGRICULTURAL ECONOMICS AND RURAL SOCIOLOGY
FACULTY OF AGRICULTURE
AHMADU BELLO UNIVERSITY, ZARIA

QUESTIONNAIRE

Dear respondent,

Kindly fill and or answer the questions below. All information provided will be used for academic purpose only.

(A) Demographic Information

1. Name(optional) .....
2. LGA.....
3. Village/Ward.....
4. Please read out and fill the following information

Age (years)	Sex (M/F)	Main Occupation	Years of Experience	Farm size (Hectares)

5. Please provide the following information on your household members.

Age (years)	Number	Males	Females
0 –1			
2– 3			
4 – 6			
7 – 9			
10 – 12			
13 – 15			
16 – 19			
>20			

6. Level of education and years spent schooling
   i. No formal education [ ]
   ii. Primary education [ ]
   iii. Secondary education [ ]
   iv. Post secondary education [ ]

7. How did you acquire your farm?

Mode of acquisition	**Condition attached to use (cost)**
Purchase	
Rent	
Family/community	
Others(specify)	

8 Please estimate your income

Time period	**Estimated Amount (₦)**
Daily	
Weekly	
Monthly	
Annually	

9 Sources of cash income (Please specify the actual amount from each source)

a. Crop farming [ ]
b. Off-farm occupation [ ]
c. Remittances from friends and relatives [ ]
d. Rent [ ]
e. Others (specify)..... [ ]

10 Provide an estimate of how much is spent on food

Time period	**Estimated amount/individual(₦)**	**Estimated amount/household (₦)**
Per meal		
Daily		
Weekly		
Monthly		
Annually		

11 Please give the following information about the major items purchase or bills you settled last month **(₦)**.

S/n	**Items**	**Daily**	**Weekly**	**Monthly**	**Yearly**
2	Water				
3	Clothing				
4	Health				
5	Education				
6	Transport				
7	Electricity				
8	Housing				
9	Others (Specify)				

12 Do you have access to credit? Yes [ ] No [ ]

13 If yes, what is the source of the credit?

i. Personal savings [ ]

ii. Income from friends [ ]

iii. Credit [ ]

If credit; from where?

Commercial Bank [ ] Community Bank [ ] Co-operative Bank [] NACRDB [ ]

Contributions [ ] Cooperative societies [ ]

iv. Others (specify) …….....

14. Do you have access to credit? Yes [ ] No [ ]

15. If yes, what type of credit did you obtain? Formal [ ] Informal [ ]

16 How much was the amount?.....

17. What is the interest rate charged? .....….....

18. How many years were you given to pay back? [..... Years]

19. Do you have access to output market for your agricultural commodities?
Yes [ ] No [ ]

20. Where do you sell your products?

a) Production site (farm gate) [ ]

b) Local market [ ]

c) Both production site and local market [ ]

d) Others (specify)..... [ ]

(B). SOCIAL INFRASTRUCTURE

1. Source of water in your community

a. Tap/Borehole [ ]

b. Well [ ]

c. Pond/Reservoir [ ]

d. River/ stream/Spring [ ]

e. Rain water [ ]

2. What time do spent every day on fetching water?

a. < 30 minutes [ ]

b. 31 mins – 1 hr [ ]

c 1.01 – 1.30 hrs [ ]

d. 1.31 – 2.00hrs [ ]

e. 2.30 -3.00hrs [ ]

f. > 3.00hrs [ ]

3. Is there any health centre in your community? Yes [ ] No [ ]

4. Is there any primary school in your community? Yes [ ] No [ ]

5. Is there any secondary school in your community? Yes [ ] No [ ]

6. If the answer to questions 3 – 5 is No, estimate the distances from your community.

Infrastructure	**Distance (km)**				
	<2	**2.1 – 4**	**4.1 – 6**	**6.1 – 8**	**>8**
Health centre					
Primary school					
Secondary school					

7. Please rank in order of preference what you consider as pressing needs in respect of your present economic activities.

S/n	**Pressing Needs**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
1	Health care											
2	Roads											
3	Primary school											
4	Market											
5	Water supply (Tap/Borehole)											
6	Electricity											
7	Housing											
8	Credit											
9	Storage facilities											
10	Transportation											
11	Others (specify)											

(C) Environment

1. How will you describe the level degradation on your farmland/environment?
   a. Extreme degradation (**5**) [ ]
   b. Severe degradation (**4**) [ ]
   c. Moderate degradation (**3**) [ ]
   d. Light degradation (**2**) [ ]
   e. No degradation (**1**) [ ]

Key

- Extreme is when restoration is impossible.
- Severe is when extensive restoration is required e.g physical structures, drainage work, terraces etc
- Moderate involves loss of topsoil from water and wind erosion, nutrient decline etc. Restoration here involves soil conservation practices, contour ridging, bands etc.
- Light involves some topsoil loss, nutrient decline and increased salinity. Restoration could be through crop rotation, minimum tillage.
- No degradation is when the farm remains unchanged

2. What is the level of environmental degradation on your farms/environment?

	Factors that lead to degradation	**5**	**4**	**3**	**2**	**1**
1	Burning of crop residues on farm					
2	Felling of farm and forest trees					
3	Lack of allowing farms to fallow					
4	Overgrazing by animals					
5	Not planting of trees because of non ownership of farmlands					
6	Lack of information on natural resource conservation					
7	Non existence of collective organizations dedicated to environmental conservation					
8	Over use of chemical fertilizers					
9	Non application of organic manures					
10	Continuous tillage of farmlands					
11	Over usage of agro chemicals on farmlands					
12	Intensification of cropping					

4. How do you get rid of crop residues and other shrubs from your farm?

a. Set it on fire [ ]
b. Allow to be burned by wild fire [ ]
c. Others (specify) ..... [ ]

5. What month of the year do you usually get rid of the residues?.....

6. What is your dominant source of energy?

a. Fuel wood [ ]
b. Charcoal [ ]
c. Kerosine [ ]
d. Gas [ ]
e. Electricity [ ]
f. Others (specify) ..... [ ]

7. What quantity(ies) of the energy do you use?

Energy Source	Unit of measure	Quantity used daily	Cost/unit
Fuel wood			
Charcoal			
Kerosine			
Gas			
Electricity			
Others (specify)			

8. How many trees did you felled both from your farm and from the adjoining forest last year? [ ]

9. How many trees did you plant on both your farm and around your compound last year? [ ]

10. List the types of trees you planted.

a. .....

b. .....

c. .....

d. .....

11. Did you plant any tree(s) on your farm or compound last year? Yes[ ] No [ ]

12. If no, why didn't you plant?

a. Farm not my personal property [ ]

b. Non availability of seedlings [ ]

c. Non availability of water [ ]

d. Fear of trees being burned by fire [ ]

e. Fear of trees being eaten by grazing animals [ ]

13. Do you allow your farm(s) to fallow? Yes [ ] No [ ]

14. If yes, for how many years does it lie fallow?.....

15. Provide the following information on your animals

Type of animal	**Number owned**	**No. that graze/coral on farm daily**	**Duration of grazing/corralling**	
			Hours/day	**Days/Week**
Cattle				
Sheep				
Goat				
Others specify)				

16. From what month do they start grazing and or you start coralling them?.....

17. Provide the following information on animals not owned by you but grazed on your farm.

Type of animal	**No that graze/coral on farm daily**	**Duration of grazing/corralling**	
		Hours/day	**Days/Week**
Cattle			
Sheep			
Goat			
Others specify)			

18. Have you any knowledge of resource conservation? Yes [ ] No [ ]

19. What is your source of information on resource conservation?

a. Radio [ ]

b. Television [ ]

c. Extension agent [ ]

d. Newspapers/Bulletin [ ]

e. Friends [ ]

f. Knowledge from parents [ ]

g. Others (specify) ..... [ ]

20. Do you belong to any association dedicated to resource conservation?
Yes[] No [ ]

21. If yes, what is the name of the association?.....

22. Provide information on your use of chemical fertilizer

Fertilizer	**No. Of Bags used**	**Cost / Bag**
NPK		
CAN		
UREA		
Others (specify)		

23. Provide information on your use of organic manure

Type of manure	**Unit of measure**	**Quantity used**	**Cost / Unit**
Poultry dropping			
Cowdung			
Plant materials			
Poultry/cowdung			
All of the above			
Others (specify)			

24. What type of herbicide do you usually use?
a. Pre-emergence [ ]
b. Post-emergence [ ]
c. Both [ ]
d. Others (specify)..... [ ]

25. Provide information on the agro chemicals you use on your farm

Agro chemical	**Litres/container**	**Cost / Unit**	**Quantity used**
Names of Herbicides			
Names of Pesticides			

26. Do you use protective cover when using agro chemicals? Yes [ ] No [ ]

27. If no, why don't you use them?
a. .....
b.....
c.....
d. .....

28. Do you practice zero tillage on your farm? Yes [ ] No [ ]

29. If no, what do you use in tilling your farm?

a. Hand plough [ ]
b. Tractor [ ]
c. Animals [ ]
d. Others (specify) ..... [ ]

30. What type of cropping do you practice on your farm?

a. Mono cropping [ ]
b. Mixed cropping [ ]
c. Others (specify) ..... [ ]

31. What measures do you apply to protect your environment against environmental degradation?

a. .....
b. .....
c. .....
d. .....
e. .....

(D) Production Information

1. Major crops and annual income

S/n	Crop	Unit of Measure	Total Production	Unit Price	Total Income
1	Rice				
2	Maize				
3	Sorghum				
4	Millet				
5	Potato				
6	Sweet potato				
7	Cowpea				
8	Soybean				
9	Vegetables				
10	Others (specify)				

2. Inputs used

S/n	Inputs	Unit	Total quantity	Unit price	Amount spent
1	Labour				
2	Seeds				
3	Seedlings				
4	Ploughing				
5	Weeding				
6	Herbicides				
7	Pesticides				

8	Fertilizer				
9	Manure				
10	Transportation				
11	Harvesting				
12	Land				
13	Others (specify)				

3. Off-farm income

S/n	Sources	Amount per month	Amount per year
1	Salary		
2	Business		
3	Services		
4	Wage labour		
5	Remittances		
6	Pension		
7	Others (specify)		

4. Monthly expenditure on natural resources

S/n	Product	Unit of measure	Unit price	Quantity	Total Amount (₦)
1	Firewood				
2	Fish/Bushmeat				
3	Tree fodder				
4	Timber				
5	Leafy vegetables				
6	Thatching grass				
7	Fruit nuts				
8	Medicinal herbs				
9	Sand/Gravel				

5. What are the visible signs of climate change on your farm/environment?

S/n	Signs	1	2	3	4	5	6	7	8	9
1	Flood									
2	Drought/Famine									
3	Change in rainfall pattern									
4	Shortening of the rainy season									
5	Extreme temperatures (heat, cold)									
6	Windstorm									
7	Health challenges (upsurge in malaria)									
8	Change in ecosystem (decline in biodiversity, loss in vegetation, reduction in forested area)									
9	Others (specify)									

6. What are the coping and or mitigation strategies you employ on your farm/environment?

S/n	Mitigation strategies	1	2	3	4	5	6	7	8
1	Creation of wide furrows								
2	Mixed cropping								
3	Planting of trees								
4	Tilling of farmland against the gradient								
5	Planting of cover crops								
6	Allowing farmlands to fallow								
7	Planting of grass for border demarcation								
8	Zero tillage								

Appendix IIA: COMPUTER PRINT OUT OF TOBIT REGRESSION

```
--> RESET
Initializing NLOGIT Version 4.0.1 (January 1, 2007).
--> READ;FILE="C:\Users\User\Documents\mss 2 tobit.xls"$
-->
TOBIT;Lhs=POD;Rhs=ONE,EDS,HHS,INC,FAS,EXP,AGE;Margin;Parameters;PrintV
C
;List;Maxit=0$
Maximum iterations reached. Exit iterations with status=1.
Maxit = 0. Computing LM statistic at starting values.
No iterations computed and no parameter update done.

+---------------------------------------------+
| Limited Dependent Variable Model - CENSORED |
| Maximum Likelihood Estimates                |
| Model estimated: Jul 23, 2011 at 00:26:44PM.|
| Dependent variable                  POD     |
| Weighting variable                 None     |
| Number of observations              265     |
| Iterations completed                  1     |
| LM Stat. at start values       .9369025E-01 |
| LM statistic kept as scalar    LMSTAT       |
| Log likelihood function        33.19944     |
| Number of parameters                   8     |
| Info. Criterion: AIC =          -.19018     |
|   Finite Sample: AIC =          -.18806     |
| Info. Criterion: BIC =          -.08212     |
| Info. Criterion:HQIC =          -.14676     |
| Threshold values for the model:             |
| Lower=     .0000     Upper=+infinity        |
| ANOVA  based fit measure =    .069357       |
| DECOMP based fit measure =    .095564       |
+---------------------------------------------+
+--------+--------------+----------------+--------+--------+----------
+
|Variable| Coefficient  | Standard Error |b/St.Er.|P[|Z|>z]| Mean of
X|
+--------+--------------+----------------+--------+--------+----------
+
---------+Primary Index Equation for Model
 Constant| -.08697080       .07822605    -1.112   .2662
 X1      |   -.01323289       .00269259    -4.915   .0000   6.75094340
 X2      |    .00013484       .00268892      .050   .9600   10.5509434
 X3|  -.901517D-07    .301845D-07    -2.987   .0028   627283.774
 X4|  -.645930701       .26362268    -2.450   .0141   5.42415094
 X5      |    .00039546       .00171595      .230   .8177   26.8226415
 X6      |    .00331684       .00187620     1.768   .0771   49.5283019
---------+Disturbance standard deviation
 Sigma   |     .21631667       .00945887    22.869   .0000
```

Matrix: Cov
[8,8]

```
+-----------------------------------------+
| Partial derivatives of expected val. with |
| respect to the vector of characteristics. |
| They are computed at the means of the Xs. |
| Observations used for means are All Obs.  |
| Conditional Mean at Sample Point    .2298 |
| Scale Factor for Marginal Effects   .8353 |
+-----------------------------------------+
+--------+-------------+----------------+--------+--------+----------
+
|Variable| Coefficient  | Standard Error |b/St.Er.|P[|Z|>z]| Mean of
X|
+--------+-------------+----------------+--------+--------+----------
+
 Constant|  -.07264470       .06513496    -1.115   .2647
 X1      |   -.01105313       .00226240    -4.886   .0000   6.75094340
 X2      |    .00011263       .00224599      .050   .9600   10.5509434
 X3|  -.753016D-07    .252678D-07    -2.980   .0029   627283.774
 X4|  -.645930701      .263622680    -2.450   .0143   5.42415094
 X5      |    .00033032       .00143331      .230   .8177   26.8226415
 X6      |    .00277048       .00156835     1.766   .0773   49.5283019
 Sigma   |    .21631667       .00945887    22.869   .0000
Predicted Values          (* => observation was not in estimating
sample.)
```

Appendix IIB. COMPUTER PRINT OUT OF PROBIT REGRESSION

```
--> RESET
Initializing NLOGIT Version 4.0.1 (January 1, 2007).
--> READ;FILE="C:\Users\User\Desktop\mss probit.xls"$
-->PROBIT;Lhs=POD;Rhs=ONE,FWD,OGZ,IFP,KRC,DPW,FAS;Margin$
Normal exit from iterations. Exit status=0.

+--------------------------------------------+
| Binomial Probit Model                      |
| Maximum Likelihood Estimates               |
| Model estimated: Feb 01, 2012 at 11:04:14PM.|
| Dependent variable                  POD    |
| Weighting variable                 None    |
| Number of observations              265    |
| Iterations completed                  5    |
| Log likelihood function       -128.6677    |
| Number of parameters                  7    |
| Info. Criterion: AIC =          1.02391    |
|   Finite Sample: AIC =          1.02555    |
| Info. Criterion: BIC =          1.11847    |
| Info. Criterion:HQIC =          1.06190    |
| Restricted log likelihood     -163.9415    |
| McFadden Pseudo R-squared      .6215161    |
| Chi squared                   70.54762    |
| Degrees of freedom                    6    |
| Prob[ChiSqd> value] =         .0000000    |
| Hosmer-Lemeshow chi-squared =  29.62836    |
| P-value=  .00011 with deg.fr. =       7    |
+--------------------------------------------+
+--------+-------------+----------------+--------+--------+----------
+
|Variable| Coefficient  | Standard Error |b/St.Er.|P[|Z|>z]| Mean of
X|
+--------+-------------+----------------+--------+--------+----------
+
---------+Index function for probability
 Constant|    .75749467       .33608819     2.254   .0242
 X1      |    .04037402       .01060034     3.809   .0001   13.8603774
 X2      |    .25454326       .06577105     3.870   .0001   1.33584906
 X3 |    -.00057963       .00091197     -.636   .5250   58.6150943
 X4      |   -.46295710       .19365504    -2.391   .0168    .64905660
 X5      |    .13921086       .04049574     3.438   .0006   5.29056604
 X6      |   -.04097757       .02341766    -1.750   .0801   5.42415094
```

```
+-------------------------------------------+
| Partial derivatives of E[y] = F[*]   with |
| respect to the vector of characteristics. |
| They are computed at the means of the Xs. |
| Observations used for means are All Obs.  |
+-------------------------------------------+

+--------+-------------+---------------+--------+--------+----------
+
|Variable| Coefficient  | Standard Error
|b/St.Er.|P[|Z|>z]|Elasticity|
+--------+-------------+---------------+--------+--------+----------
+
---------+
 Constant|    .28577828       .13131020     2.176   .0295
 X1      |    .01313573       .00337741     3.889   .0001   -.24654796
 X2      |    .08281596       .02136571     3.876   .0001   -.14981090
 X3      |-.00018858       -00029657     -.636   .5249   -01496869
---------+Marginal effect for dummy variable is P|1 - P|0.
 X4      |   -.15609245       .06690681     2.333   .0196    .13719442
 X5      |    .04529242       .01300491     3.483   .0005    .32448877
 X6      |   -.01333210       .00761401    -1.751   .0799   -.09792700
```