IMPACT OF GULLY EROSION ON SMALL AND MEDIUM FARMS IN PONYAN COMMUNITY, KOGI STATE, NIGERIA

BY

AWONIYI, FEMI
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DEPARTMENT OF AGRICULTURAL AND BIORESOURCES ENGINEERING

SCHOOL OF ENGINEERING AND ENGINEERING TECHNOLOGY FEDERAL

UNIVERSITY OF TECHNOLOGY, MINNA, NIGER STATE

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DECLARATION

I hereby declare that this project is a record of a research work that was undertaken and written by me. It has not been presented before for any degree or diploma or certificate at any University or Institution. Information derived from personal communication, published and unpublished works were duly referenced in the text.

.... 26/11/2010 ....

AWONIYI, FEMI
Name of student

Date

CERTIFICATION

This project entitled "Impact of Gully Erosion in Small and Medium Farms in Ponyan community, Kogi State, Nigeria " by AWONIYI, Femi meets the regulations governing the Award of Post graduate Diploma Degree (PGD) of the Federal University of Technology, Minna, and it is approved for its contribution to scientific knowledge and literary presentation.

.... 04/02/2010
Mr. John Jiya Musa
Supervisor
Date

.... 04.02.10
Mall. M. A. Sadeeq
Co-Supervisor
Date

....
Engr. Dr. A. A. Balami
Head of Department Agricultural and Bio-Resources Engineering
Date

....
External Examiner
Date

....
Prof. S.L Lamai
Dean, Postgraduate School
Date

DEDICATION

This project is dedicated to Almighty God and to all those that contributed to the successful completion of this study.

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ABSTRACT

Rural communities within the low-lying contours are often subject to erosion which threatens their lives. Soil erosion is an important social and economic problem and an essential factor in assessing functional ecosystem. This necessitated the study of the impact of gully erosion in small/medium farms in Ponyan community, Kogi State, Nigeria. In carrying out this study, questionnaires were distributed to the various groups of farmers and individuals in the community. Descriptive analysis was used for the analysis to analysis. It was discovered that 38.46% of the respondents are on lease land, 57.69% are not lease landed property and 3.85% is not lease or lease land property (either inherited or family land).

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CHAPTER ONE

1.0 INTRODUCTION

1.1 Background of the Study

Rural communities are often subject to erosion which threatens their survival. Soil erosion and accompanying land degradation are typical of such stresses, and efforts to incorporate an understanding of the land users role in soil conservation have been made internationally (Graland et al, 2007).

Soil erosion is an important social and economic problem and an essential factor in assessing ecosystem health and function. Estimates of erosion are essential to issues of land and water management, including sediment transport and storage in lowlands, reservoirs estuaries, and irrigation and hydropower systems. Soil conservation specialists have for many years attempted to estimate soil. Recent environmental concerns require that soil loss and sediment yield predictions be made to evaluate the extent of non-point pollution sources (Santos *et al.*, 2003).

According to Chmelova *et al*; (2002), in the United State of America (U.S.A.) soil has recently been eroded at about 17 times the rate at which it forms Ninety percent of U.S. cropland is currently losing soil above the sustainable rate. Soil erosion rates in Asia, Africa and South America are estimated to be about twice as high as in the United States of America estimates that 140 million ha of high quality soil mostly in Africa and Asia, will be degraded by 2010, unless better methods of land management are adopted. Chinelova *et al*; (2002), further stated that the global rate of anthropogenic erosion, estimate at 27 billion tons of sediments transported to the oceans every year, is three times the natural rate. In the Czech Republic fifty-four percent of arable land is times the natural rate. In the Czech Republic fifty-four percent of arable land is endangered by water erosion.

Mitchell (1980) stated that soil erosion, soil loss, and sediment yield are terms with distinct meanings in soil erosion technology. Soil erosion is the gross amount of soil moved by drop detachment or runoff. Soil loss is the soil moved off a particular slope or field. Sediment yield is the soil loss delivered to a point under evaluation. For example, most slopes have topographic and cultural irregularities that cause both erosion and deposition to occur. Thus the erosion at selected points on the slope often differs from the soil loss at the base of the slope. Further deposition often occurs in field boundaries and watercourse borders, thereby reducing the sediment yield of the watershed (Pathak, *et al.*, 2004).

Soil erosion is an interactive process influenced by both natural and cultural factors. Such as precipitation, relief, geological and soil properties, vegetation cover and Land use (Nyakatawa *et al.*, 2001). Soil erosion is a natural process which is frequently exacerbated by human interventions in the environment. In extreme cases the topsoil can suffer services degradation. Limitations to the ecological function of soils include: human behaviour leading to soil erosion, the degradation or destruction of surface and ground waters, a decline in the water retention of soil, a decline in the regulatory rate of soil in the hydrosphere generally and a decline in soil biomass productivity (Qiangguo, 2002). Important indirect effects include in situation of streams, Lakes or reservoirs and entrophication. The main consequences of soil erosion by water on agricultural production and the environment can be divided into groups: loss of soil, transport and sedimentation of soil particles, and Transport and loss of chemical nutrients.

Soil loss is defined in the erosion literature as the amount of soil lost in a specified time period over an area of land which has experienced net soil loss. Soil loss is expressed in units of mass per unit area, such as t/ha or kg/m^2 . It may be for a single storm event, an average value for a number of years, or for any other specified time period, (Wall *et al.*, 2003) Soil loss prediction techniques have developed over the years as understanding of the erosion process expanded and increasingly more erosion research was conducted. Early estimates were primarily qualitative in nature and illustrated that some cultural practices differed in their ability to control soil erosion. Initially, equations were developed to describe soil loss using a single independent variable. These single factor equations were for local situations where other contributing factors were nearly constant. Multiple factor equations were developed as more data became available and researchers were better and able to describe contributing factors. This analysis culminated in the equation most widely used today for soil loss prediction- "The Universal Soil Loss Equation (USLE), Morgan, (2001).

Sediment yield is defined as the amount of sediment which leaves a specified area of land in a given time period. Sediment yield refers to a mass of sediment which crosses a boundary, such as the edge of a field or outlet of a watershed, and may be expressed in units of total mass (kg), mass per unit width of the boundary (kg/m), or mass per unit area (kg/m^2). Sediment yield prediction methods are quite varied in form and extent. Empirical methods have been developed which relate sediment concentrations to flow stage or which relate sediment yield to watershed and hydrologic parameters. In other cases, sediment yield is estimated from gross soil loss estimates using the sediment delivery sediment yield is estimated from gross soil loss estimates using the sediment delivery ration concept. Others have attempted to modify the Universal Soil Loss Equation (USLE) to estimate sediment yields (Pathak, 2004).

Accelerated soil erosion by wind or water mainly takes place on Lands used for agriculture. In the context of soil and water protection, the on-site as well as off-site damage needs to be minimized. As soil erosion is highly variable in the spatial as well as temporal domain, processes governing soil loss are different, too. Estimating amount and processes of soil erosion therefore requires the use of different methods and models. Soil erosion is one form of soil degradation along with soil compaction, low organic matter, loss of soil structure, poor internal drainage, salination and soil acidity problems. This may be a slow process that continues relatively unnoticed, or it may occur at an alarming rate causing serious loss of top soil. The loss of soil from farmland may be reflected in reduced crop production potential, lower surface water quality and damaged drainage networks (Basic *et al.* 2004).

Great deal of finance is been invested in agriculture each year in Kogi State to create and keep favourable-to-plant moisture and nutrient status in soils. Further rise in the efficiency of this investment can be achieved by improving the scientific basis, developing a precise estimation of soil loss, formation and creating a practical technology to reduce soil loss on available lands.

1.2 Soil Erosion Process

Fornis *et al.* (2005) stated that erosion of topsoil begins when water detaches individual soil particles from clods and other soil aggregates. Raindrops are the major cause of soil particle detachment. A single raindrop may seem insignificant, yet when accumulated, raindrops strike the ground with a surprisingly large force. Raindrops can be especially erosive when residue, mulch, or vegetation is not present to absorb the impact forces. During an intense storm, rainfall can loosen and detach up to 100 tons of soil per area.

A raindrop falling on a thin film of water detaches soil particles more readily than a drop falling on dry soil. Detachment increases as the water on the soil surface becomes deeper, but only up to a depth about equal to the raindrop diameter. Once the water becomes deeper than this, detachment by rain drops is reduced and eventually eliminated because the water layer acts as a cushion.

During rainstorms, a two-fold problem often occurs. The rate of rainfall nay exceed the rate at which water can enter the soil. The excess water either collects above or runoff the soil surface. Secondly, raindrop impact forces can result in a partially sealed soil surface, thus reducing the infiltration of water into the soil which causes more runoff. If all water could always enter the soil, both the detachment and splashing of soil particles would be of minor concern and soil loss would be minimal. However, when the rainfall rate exceeds the soils infiltration rate and the soil surface storage is filled, runoffs begin. The runoff travels downhill, carrying soil particles with it.

Williams *et al.* (1985) stated that the transport ability of runoff is influenced by the amount and velocity of the flow, which in turn is dependent on the slope of the land. Flat areas may have little or no runoff; consequently, little transport of soil occurs. Runoff from steeper areas flows at greater velocities and may have considered transport

Soil particles size distribution, organic matter content, and the slope of the land all influence how susceptible different fields are to the forces of erosion (Torri *et al.* 2000). Large grained particles and aggregates are easily detached by raindrops or flowing water, but are not easily transported. Soils such as clay and fine silts that bond together tightly are not easily detached, but once free they are easily transported. For this reason fine materials can be carried along a considerable distance, whereas larger particles may be deposited within a short distance along the flow path.

1.3 Objective of the Study

1. To examine the impacts of gully erosion to the inhabitants of the community.
2. To assess the physical state of the insitu soil and
3. To determine the soil loss percentage on arable farmlands annually.

1.4 Scope of Study

This study is to cover the impact of soil erosion (gully) on agricultural lands and how such negates the activities of the farmers in Ponyan community of Yagbe East Local Government Area of Kogi State.

CHAPTER TWO

2.0 LITERATURE REVIEW

The first scientific study of erosion effects was thought to have been done by Wollny in the late nineteenth century (Hudson; 1971). The first quantitative experiments in America was carried out by the Forest Service in 1915 and in 1917, M. F. Miller began a plot study of the effect crops and rotations on runoff and erosion. Mitchell (1980), stated that the wide spread concern of the dangers of soil erosion in the 1920s and early 1930s resulted in an increase in scientific erosion research. However, a basic understanding of most of the natural rainfall studies of laws (1940) and the analysis of the mechanical action of raindrops was carried out by Ellison (1947).

2.1 Modeling Soil Erosion

Modelling generally is a mathematical process which describes the various stages of soil erosion such as soil particle detachment, transport and deposition on land surfaces. According to Chaneloro *et al*, (2002), there are at least three reasons for modeling erosion which are:

a. Erosion models can be used as predictive tools for assessing soil loss for conservation planning, project planning, soil erosion inventive and for regulation;

b. physically-based mathematical models can predict where and when erosion is occurring, thus helping the conservation planner to target his effort toward reducing erosion; and

c. Models can be used as tools for understanding erosion processes and their intersections and setting research.

2.2 The Universal Soil Loss Equation (USLE)

Several scientists began to develop empirical equations for soil erosion prediction as data were accumulated and exchanged. The first of these related soil loss to steepness and length of slope (Sonneveld *et al*, 2002). Using plots under simulated rainfall and field conditions, it was demonstrated that doubling the degree of slope increased the soil loss from 2.61 to 2.80 times and doubling the horizontal length of slope increased the soil loss in runoff by 3.03times. This relationship was expressed by

$$A = C\,S^{m}\,L^{n-1} \qquad (2.1)$$

Where A= Average soil loss per unit area from a Land slope of unit width

C= a constant of variation

S= degree of land slope

m & n=exponents of degree and horizontal length (L) of land slope respectively.

On comparing this equation with later developments, the constant of variation, C combines the effects of rainfall, soil, crop and management practice. Smith (1941) evaluated the effects of mechanical conservation practices for four combinations of crop rotation and soil treatment on one soil. He determined that:

a. The soil loss from contouring is 57%of that from up and down hill operations.

b. The soil loss from rotation strip cropping is 25% of that from up and down hill operation, and

c. The soil loss from terracing is 3% of that from up and down hill operation.

However, Broconing *et al.* (1947) expanded the procedure proposed by Smith (1947) for several crop rotations. Additionally, an estimate was made of the effect of soil treatment practices on soil loss.

The relationship of rainfall characteristics to this amount of soil eroded was introduced by Musgrave (1947). Using data from school stations, erosion, E, was determined to be proportional to $P_{30}^{1.75}$, where P_{30} is the maximum 30 minutes rainfall. The larger the data base analysed at that time indicated that the slope steepness and length factor exponents should be 1.35 and 0.35, respectively. A procedure was presented to estimate soil loss in mm for several vegetal covers and for soils of many portions of the eastern and Central United States.

Concurrently, Hudson (1961) presented an erosion equation

$$E = TSLPMR \quad (2.2)$$

Where E = erosion and the remaining factors are functions of soil type, slope gradient and length, agronomic or agricultural practice, mechanical protection and rainfall, respectively. The problems of adequately evaluating each of these factors were discussed by Hudson and can be reported on extensive research on the erosivity of rainfall in the sub-tropics of Africa. Equation 2.4 is the identical in concept to the Universal Soil Loss Equation.

Although not stated explicity, the equation proposed by Musgrave was

$$E = (0.00527)\,\mathrm{I\,R\,S}^{1.35} L^{0.35} P_{30}^{1.75} \quad (2.3)$$

Where

E=the soil loss mm per year

I=the inherent erodibility of a soil at 10% slope and 22m slope length, mm per year

R = a vegetal cover factor

S = degree of slope, percent

L = Length of slope, percent

P_{30} = the maximum rainfall, mm

The Musgrave equation was used extensively for estimating gross erosion from several sites.

Elwell (1977) developed a soil loss equation system for Southern Africa.

$$Z = KCX \qquad (2.4)$$

Where:

Z = Predicted mean annual soil loss

K = mean annual soil loss, a standard field plot 30m x 10m at a slope for a soil of know erodibility under bare fallow.

C = the ratio of soil lost from a cropped plot to that lost from the standard plot, and

X = the ration of soil lost from a plot of length L and slope S to that lost from the standard plot.

The K factor is dependent on rainfall kinetic energy and soil erodibility. The soil erodibility index is defined by basic soil type and may be adjusted for permeability structure, and conservation practices. The crop cover factor, C, is a function of the percentage rainfall energy intercepted which is determined for a crop and the distribution curve for the assumed crop and the distribution of rainfall energy. The X factor is the same as the LS factor of the Universal Soil Loss Equation.

The development of prediction equation was necessity evolutionary in nature. The predominantly qualitative descriptions led to the evaluation of one or two factors that could be quantified with the data from a local or region. The evolutionary process continued with additional factor being quantified as more data were obtained. The consolidation of data from many stations enabled researchers to develop prediction equations applicable to a region or a number of regions. Each of the predictive techniques was limited in its applicability by the limits of the data from which it was devel ›ed. Hence, it was usually useful only for a local area, specific soil type, or perhaps a region. As more data sources became available, more conditions could be estimated and the area of applicability expanded.

The Universal Soil Loss Equation (USLE) is the most widely used model for prediction of water hazards and planning of soil conservation measures. It was adopted in 1958 by the soil conservation services in the United States of America to make long :rm assessments of soil losses under different cropping systems and land management practices. On the basis of a considerable experience with more than 10,000 plots, 20 years later (Wishmeter and Smith, 1978), an updated equation was formulated which product form bears a resemblance to a Cobb-Douglas function with parameters of the value

$$A = R \times K \times L \times S \times C \times P \tag{2.5}$$

Where A=Soil loss (tones/ha/year

R= Rainfall erosion index (EI_{30})

K = Soil erodibility factor

L = Slope length (m)

S = Slope gradient

C = Protective coverage or crop cover factor

P = Soil conservation measures

2.2.1 The Rainfall Erosivity Factor, R

The rainfall erosivity factor in the Universal Soil Loss Equation is the rainfall erosion index as presented by Wischmerer (1959). The R factor is a definition of the erosivity of rainfall events and is defined as the product of two rainstorm characteristics: Kinetic energy and the maximum 30 minutes intensity.

Wischmeier and Smith (1958) analysed drop size distribution data published by Laws and Parson (1943) and rain drops terminal velocity reports by several researchers. A regression equation describing the kinetic energy of a rainstorm or portion of a rainfall event was developed

$$E = 1.213 + 0.890\,\mathrm{Log}_{10}\,I \qquad (2.6)$$

Where E = the kinetic energy, Kgm/m^2 mm and

I = rainfall intensity mm per hour.

The kinetic energy for an intensity increment is obtained by multiplying the kinetic energy from equation 2.7 by the rainfall amount for that intensity increment. The total energy in Kgm/m^2, for a rainfall event can be computed by accumulating the kinetic energy for each distinct intensity increment of the event.

When regression analysis is carried out, it will be observed that the soil losses from cultivated continuous fallow plots will be highly correlated to the cross-product of the total kinetic energy and the maximum 30 minutes rainfall intensity (Wischmeier, 1959). This product, designated by EI is a measure of the manner in which energy and intensity are combined in a storm and defines the combined effects of raindrop impact and turbulence of runoff to transport soil particles from a field. The rainfall erosivity factor, R, is obtained by dividing the EI product by 173.6. The computation of the rainfall erosivity factor, R, for a storm is defined by:

$$R = \frac{\left[\sum_{j-1}^{n} (1.213 + 0.890 \, \mathrm{Log}_{10} \, I_j)(I_j T_j)\right] I_{30}}{173.6} \tag{2.7}$$

Where R = the rainfall erosivity index

I_j = the rainfall intensity for a specific storm increment, mm/hr

T_j = the time period of the specific storm increment, hr

I_{30} = the maximum 30 minute rainfall intensity for the storm mm/hr

j = the specific storm increment

n = the number of storm increment

It is worthy of note that there are units associated with the R factor, the Universal Soil Loss Equation is not dimensionally correct without assuming units for the K factor. The rainfall erosivity indexes can be summed for any time period to provide a numerical measure of the erosivity of the rainfall during that period. The reduction of long time rainfall records provides average annual values of the rainfall erosivity index or rainfall factor, R. These rainfall factor values for a large area can be presented as curves of equal erosivity (Iso-erodents) on a map of the area of interest (Muysen et al., 2002).

An average annual R value of a large part of West Africa was developed by Roose (1977). A detailed study of the correlation between daily rainfall and the rainfall erosivity index was conducted that resulted in a single empirical relationship of:

from a standard plot. Direct measurement of the K factor requires considerable time and equipment and is costly to perform (Jacinthe *et al.*, 2004).

There are many variable factors that act in combination to determine erodibility. These factors can include soil texture and structure, infiltrations rate, soil permeability and depth and changes in soil character from top to bottom of the soil mantle. Others are the surface gradient, length and regularity of slope, which modify the erosive action of water even within small areas of otherwise uniform soil. In an effort to eliminate this procedure, a study was conducted to describe the K factor using 15 soil properties and their interactions (Wishmeier and Mannering, 1969). The soil erodibility nomograph is used to obtain the soil erodibility factor K, for soils for which the K value has not previously been determined.

According to Wishmeier et'al, 1971, five soil parameters are needed to use the nomograph; these are:

1. Silt (0.002-0.05mm)
2. Very fine sand (0.05-0.10mm)
3. Sand (0.10-2.0mm)
4. Structure of organic matter content and
5. Permeability of organic matter content.

2.2.3 The Slope Length Factor, L, and the Slope Gradient Factor, S

The effects of slope length and gradient are represented in the Universal Soil Loss Equation (ULSE) as L and S, respectively; however, they are often evaluated as a single topographic factor, (LS). Slope length is therefore defined as the distance from the point of origin of overland flow to the point where the slope decreases sufficiently for deposition to occur or to the point where runoff enters a defined channel (Matondo *et al.*, 2005). The channel may be part of a drainage network or a constructed channel. Slope gradient is the field or segment slope, usually expressed in percentage. The development of this Universal Soil Loss Equation was based on a standard plot length of 22.1 metres (Wishmeier and Smith, 1965); therefore, the slope-length factor was defined as

$$L = (\frac{x}{22.1})^m \tag{2.8}$$

where L = slope length factor

x = slope length (metres)

m = an exponent

Where currently, recommendations (Wishmeir and Smith, 1978) for the exponent m are:

$m = 0.5$ (if slope $\geq$ 5 percent)

$m = 0.4$ (if slope $<$ 5 percent and $>$ 3 percent)

$m = 0.3$ (if slope $\leq$ 3 percent and $\geq$ 1 percent and)

$m = 0.2$ (if slope $<$ 1 percent.)

It was determined that soil loss was correlated with a parabolic description of the effect of slope steepness or gradient. Normalizing this equation to a standard plot slope of a percent resulted in a description of the slope-gradient factor.

$$S = \frac{0.43 + 0.30s + 0.043s^2}{6.613} \tag{2.9}$$

where S = the slope gradient factor, and

s = the gradient, percent

The above equation is recommended for the slope gradient factor and used in the development of a slope effect chart- values of LS may be calculated from

$$L = (\frac{x}{22.1})^m (0.065 + 0.045s + 0.0065s^2) \qquad (2.10)$$

The above equation can only be used for a single uniform slope. The uses of the topographic factor, LS, described above, will usually over estimate soil loss from concave slopes and under estimate the loss from convex slopes. The first step in developing a method for computing profile was presented by Onstad *et al.*, (1967) and continued by Foster and Wishmeier (1974) to provide a methodology for evaluating the effects of LS for irregular slopes. The irregular slope is divided into a series of n segments. Each slope segment should be uniform in gradient and soil type. The soil loss for the entire slope is then corrupted using:

$$A = (0.244)RKCP\left[\frac{\sum_{j-1}^{n}(S_j X_j^{m+1} - S_j X_{j-1}^{m+1})}{X_e (22.1)^m}\right] \qquad (2.11)$$

Where X_j = the distance from the top of the slope to the lower end of the j^{th} segment, metres.

X_{j-1} = is the slope length from the top of the slope to upper end of the j^{th} segment, metres

X_e = the overall slope length, metres

S_j = the value of the slope-gradient factor for the j segment, and A, R, K, C, P and m are as defined previously.

Wishmeier (1974) presented a more simplified method of solving complex slope which may be divided into two to five segments of equal length. To use equation 2.12, assume a course slope of the following segments: 50 metres at 5% slope, 40 metres at 8% slope and 30metres at 11% slope.

$$U_j = \frac{S_j X_j^{m+1}}{(22.1)^m} \quad \text{and} \quad U_{j-1} = \frac{S_j X_{j-1}^{m+1}}{(22.1)^m} \tag{2.12}$$

2.2.4 The Cropping Management Factor, C

The crop management factor, C, represents the ratios of soil loss from a specific crop or cover condition to the soil loss from a tilled, continuous fallow condition for the same soil and slope and for the same rainfall. This factor includes the interrelated effects of cover, crop sequence, productivity level, growing season length, cultural practices, residue C factor is often difficult because of the many cropping and management systems. Crops can be grown continuously or rotated with other crops. Rotations are of various lengths and sequences. Residues can be removed or left on the field or incorporated into the soil. The soil may be clean tilled or one of several conservation tillage systems may be used. Each segment of the cropping and management sequence must be evaluated in combination with the rainfall erosivity distribution for the region (Martinez-Meza *et al.*, 2000).

To calculate for a crop management factor, C, for a crop rotation, the year is divided into crop-stage periods as determined by the local ploughing, seeding and harvest dates. The appropriate erosion index distribution curve is entered to obtain the percentage of annual erosion index expected within each crop stage period (Santos and Serralheiro, 2000). The crop-stage (value multiplied by the corresponding values obtained from the distribution curve is the C value for that period. All the crop period C values are summed for the rotation and when divided by the number of years of the rotation the average annual C values for use in the Universal Soil Loss Equation is obtained.

$\therefore$ C = % Annual Erosion Index Crop Stage Soil Loss ration

Roose (1977), developed an average annual crop management factor, C, values for vegetal cover and cultural techniques for the area of West Africa as shown in Table 2.1 below.

Table 2.1: The Vegetal cover factor and cultural techniques (C factor) in West Africa.

S/N	*Practice*	*Annual Average Crop Factor*
1.	Bare soil	1
2.	Forest or dense shrub, high mulch crops	0.001
3.	Savannah, prairie in good condition	0.01
4.	Over-grazed savannah or prairie of flate land with few trees	0.1
5.	Crop cover of slow development or late planting: 1st year	0.3 - 0.8
6.	Crop cover of rapid development or early planting: 1st year	0.01- 0.1
7.	Crop cover of slow development or late planting: 2nd year	0.01 – 0.1
8.	Corn, Sorghum, millet (as a function of yield)	0.4 – 0.9
9.	Rice (intensive fertilization)	0.1 – 0.2
10.	Cotton, tobacco (2nd cycle)	0.5 – 0.7
11.	Peanuts (as a function of yield and the date of planting)	0.4 – 0.8
12.	1st year cassava and yam (as a function of yield and the date of planting)	0.2 – 0.8
13.	Palm tree, coffee, cocoa with crop cover	0.1 – 0.3
14.	Pineapple on contour (as a function of slope)	
	- Burned residue	0.2 – 0.5
	- Buried residue	0.1 – 0.3
	- Surface residue	0.01
15.	Pineapple and tie-ridging (slope 7%)	0.1

Source: Roose (1979)

2.7 The Erosion Control Practice; P

The erosion control practice factor is the ratio of soil loss using specific practice compared with the soil loss using up-and-down hill culture. The erosion control practices usually included in this factor are contouring, contour strip cropping and terracing.

Wishmeier and Smith (1978), recommended three major mechanical practices which are shown in Table 2.2 below.

Table 2.2: Erosion Control Practice Factor, P

Land Slope %	Contouring	Contours strip cropping and Irrigated Furrows	Terracing
1-2	0.60	0.3	0.12
3-8	0.50	0.25	0.10
9-12	0.60	0.30	0.12
13-16	0.70	0.35	0.14
17-20	0.80	0.40	0.16
21-25	0.90	0.45	0.18

Source: Wishmeier and Smith (1978)

Within a practice type, the P factor is most effective for the 3-8 percent slope range and values increase on the slope increases. It can be observed that as the slope decreases below α percent the practice factor value increases due to reduced effect of the practice when compared with the up-down-hill cultivation. The factor for terracing in the above Table 2 is for the prediction of the total off-the-field soil loss. If within the terrace interval soil loss is desired, the terrace interval distance should be used for the slope length factor, L, and the contouring, P, value used for the practice factor.

2.3 Modifications of the Universal Soil Loss Equation

Several modification of the USLE has been proposed to various applications. Most of the additional modifications are extensions that attempt to apply the USLE to sediment yield prediction have been either through the traditional avenues of inquiry. Along the traditional route, whereby we seek to improve the prediction capabilities of the model by focusing on better parameter estimations, the most extensive work is undoubtedly the Revised Universal Soil Loss Equation (RUSLE) (Renard et'al, 1998). The changes from the USLE to the RUSLE generally fir into two categories:

(a.) Incorporation of new or better data, and

(b.) Consideration of selected erosion processes.

The incorporation of selected erosion process into the RUSLE model has the potential for broader prediction improvements. Some of these improvements include functions for the seasonal variability in the soil erodibility factor, K; slope length and steepness factors that are dependent on rill to interrill erosion ratios: inclusion of support practice, P, factors for subsurface drainage, rangelands, off-grade contouring and strip-crop rotations; and the dependence of the contour P- factor on storm severity (Renard et'al, 1991, 1998). Perhaps the most extensive changes on the model are the inclusions of sub-factors in the cover-management factor, C, for the effects of prior Land Use, canopy cover, ground surface cover, surface roughness, and soil moisture. It is difficult to assess the improved function of the RUSLE as compared to the USLE because so many of the changes in the new model are targeted for specific applications. For example, improvements in the P-factor for subsurface drainage have significance only for the specific case of drained fields and do not affect the application of the model elsewhere. The increased prediction capability of the RUSLE might best be stated in terms of the increase in the scope of application, rather than its increased prediction accuracy for cases in which the USLE was developed. It should also be noted that the RUSLE focuses on application within the United States and adaptation and use elsewhere have as yet been limited.

The special conditions of semi-arid rangeland of the Southern United States as discussed by Renard et'al (1994) was applied to the sediment yield estimates from small watersheds using the USLE, this gave rise to

$$A = (0.224)\,(\mathrm{RKLSCP})\,E_c \qquad (2.13)$$

Where E_c = the channel erosion factor and the other terms are as defined previously.

The channel erosion term, E_c, is similar to a sediment delivery ratio used to predict sediment yield at an outlet. For some of the watersheds used for this study the E_c term was larger than unity because the erosion qualities form channel bed and banks were large and the sediment yield was greater than the gross upland erosion. Therefore, the term E_c was created because a sediment delivery ratio is usually considered to be less than one.

Williams and Bevndt (1976) modified the USLE for predicting sediment yield from watersheds as

$$Y = 11800\,(Qq_p)^{0.56}\ \mathrm{KCPLS} \qquad (2.14)$$

Where:

Y = sediment yield from an individual storm, Kg

Q = storm runoff volume, m^3

q_p = peave runoff rate m^3/sec, and

KCPLS are as defined in the USLE.

A sediment delivery ratio was considered not necessary when the rainfall energy term of the USLE was replaced by the runoff term shown in equation 2.14. The applications of equation 2.14 required evaluations of the K, C, P, and LS terms that were different than the methods specified for the USLE.

A modification of the USLE (Foster et'al, 1973) was used by Onstad *et al.*, (1976) as the major component in a sediment yield model for small watersheds.

$$A = (0.224)\ \mathrm{WKCPLS} \qquad (2.15)$$

Where W = hydrologic term and other terms are as defined in the USLE

$$W = \mathrm{a}\,\mathrm{R}_{\mathrm{st}} + (1 - \mathrm{a})\,0.40\,\mathrm{Q}\,\mathrm{q}_{\mathrm{p}}^{1/3} \qquad (2.16)$$

Where

R_{st} = storm rainfall factor (EI units of the USLE)

Q = Runoff volume, mm,

q_p = Peak runoff, mm/hr, and

a = a coefficient $(0 \leq a \leq 1)$ that represents the relative importance of rainfall energy compared with runoff energy for detaching soil.

A value of 0.5 was used for a in an earlier study by Onstad and Foster (1975). Equation 2.15 and 2.16 were the results of analysis to describe the sources of soil loss with respect to interrill and rill areas.

The first two modifications, i.e. equations 2.13 & 2.14 describe here briefly are the estimate watersheds sediment yield.

2.4 Types of Water Erosion

The rate and magnitude of soil erosion by water is controlled by the following factors:

2.4.1 **Raindrop Erosion**:

Erosions begin when rain or irrigation water loosens soil particles. Raindrops are the major cause of soil particles detachment which is as a result of soil splash resulting from the impact of water drops directly on soil particles or on thin water surface. Greater quantities of soil are quantities of soil are splashed into the air; most of which more than average. The amount of soil splashed into the air as indicated by the splash losses from small elevated pairs was found to move than that washed off.

The relationship between erosion and rainfall momentum and energy is determined by the raindrop mass, size distribution shape, velocity and direction.

The process of soil erosion involves soil detachment and transportation (Chmelova et'al; 2002). The soil characteristics that describe the ease at which soil particles increase, and soil transportability increases with a decrease in particle size i.e. clay particles are more difficult to detach than sand, but clay is more easily transported.

2.4.2 **Sheet Erosion**

The concept of sheet erosion has long ago been which is described as uniform removal of soil in thin layers at sloping land, resulting from sheet or overland flow occurring in thin layers. Recent studies show that this is the most common form of erosion.

2.4.3 **Rill Erosion**

This is the removal of soil by water from small but well-defined channels or streamlets when there is over concentration of overland flows.

Rill erosion occurs when the channels have become large and are readily seen. This is always over looked and it is a form in which most soil erosion occurs because off high runoff detachability and transportability becomes serious.

2.4.4 Gully and Channel Erosion

This is described as when rills combine and develop to the extent that they cannot be eliminated by removal tillage operations. Gullies are usually deep, steep-walled upland channels and commonly occur in areas of deep friable subsoils. A gully is often characterized by an over-fall at the gully head that advances upstream. Channel erosion is that soil loss due to the scour induced by the flow or that due to side slope instability. Woodbum (1949) and Prest et'al (1976) both stated that drainage way and gully erosion accounted for approximately 50% of the total water shed erosion.

Quantitative descriptions of gully have been primarily concerned with defining the advancement of the gully channel. These effects are of concern because gullies void farmland by dissecting fields and thereby interfere with efficient operations.

CHAPTER THREE

3.0 MATERIALS AND METHODOLOGY

3.1 Description of Experimental Site

Kogi State is one of the 36 States of the Federal Republic of Nigeria located within the middle belt of the country. The State is known to have sixteen (16) Local Government Areas and a total land mass of 32,500 square kilometers. The State shares her boundary with Edo, Ondo and Ekiti States to the South, while in the North with Niger, Federal Capital Territory and Nasarawa, and to the East with Benue and Enugu States. Kogi State is bounded by both the Rivers Niger and Benue and popularly known as confluence state, which provides fertile land for crop production. Human encroachment into the natural flood plain of River Niger and other rivers in the state has resulted in dire consequences of massive and destructive flooding during the periods of high rainfall.

The study site, Ponyan, is located at Yagba East Local Government Area of Kogi State. This falls between Latitude 6.7^{o}N and longitude 9.31^{o}E. Ponyan is bounded by Irele Local Government Area to the East and Ilae to the West, Ifeolukotun to the south and Agmi town to the North. The community lies within the transition belt of Nigeria with an estimated population of 7,500 (Census, 2006). Ponyan is integrated into two communities, namely: Odo Ponyan and Oke Ponyan. The common soil types within this community are loamy soil, clay and sandy-clay-loam.

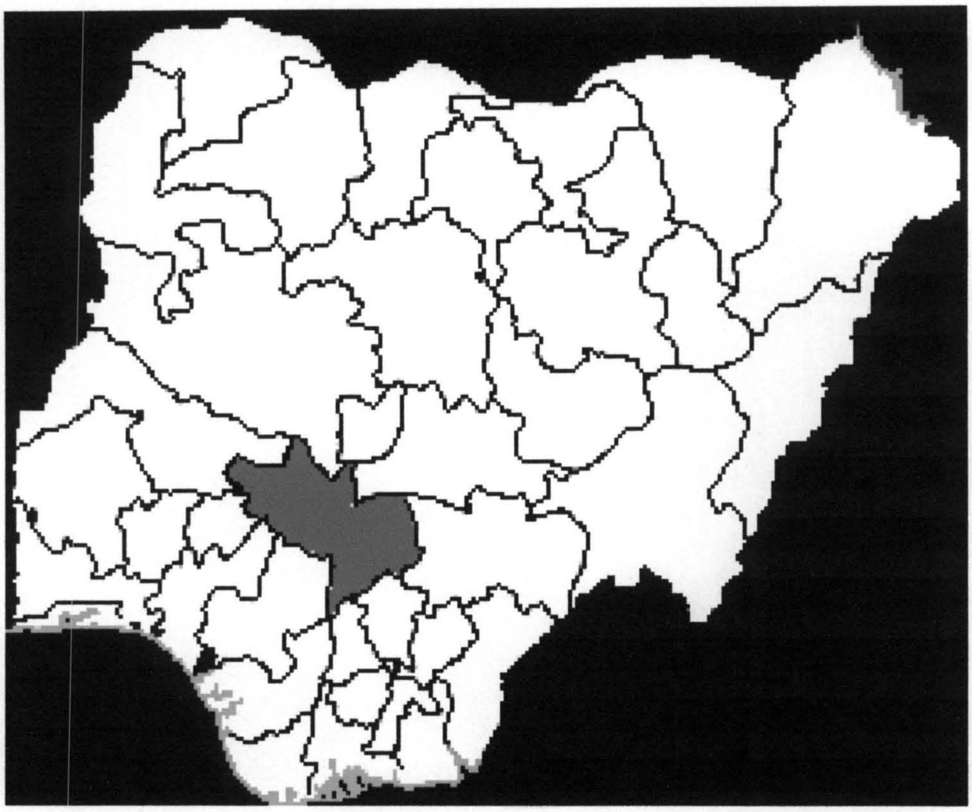

Fig 3.1: Map of Nigeria showing Kogi State

Ponyan falls within the Southern guinea Savanna, which is characterized by semi-wood land and tree forest vegetation belt. This is also known as the transition belt, constituting grass/shrub from the Northern region and the rain forest from the southern part (Musa, 2003). Based on the above geographical location characteristics, intensive agricultural practices and grazing of the land is the predominant occupation. The vegetation in this area is relatively dense.

The wet season usually commences as from April to October and sometimes extending to the month of November. Intensive crop cultivation is often carried out during this harmattan and other dry season covers November to March in recent years.

The community experience rainfall between the months of April to October with its peak in July/August. The average annual rainfall ranges from 1000mm to 1500mm (MNAR, 2003).

The maximum temperature period in this area is usually between the months of February to April, which gives the minimum average temperature of 30^oC and a maximum average temperature of about 35^oC (MNAR, 2003).

3.2 Method of Data Collection

The simple random selection method was employed to cover the people residing within the Ponyan community. This involves the use of the questionnaires which were administered to the people concerned and personal interview. This method eliminates discrimination and favouritism of some villages or sets of people. For example, during the market days of Ponyan, people were randomly chosen and the questionnaires administered and interviews conducted. Following this method, farmers in the various villages were chosen and interviewed. The questionnaires were interpreted were necessary and they were prepared to collect information such as type of farming practice, ownership of the land type of crop planted etc. A sample of the questionnaire is attached in the appendix.

3.3 Method of Data Analysis.

Descriptive methods were used to analysis the various information obtained fro the famers and people of the community.

CHAPTER FOUR

4.0 DISCUSSION OF RESULT

4.1 Presentation and analysis of data

This is to present and analyze the data the researchers acquired through questionnaires. In view of this about twenty six (26) questionnaires were formulated. Thus the method (formula) used in the calculation is x 100/1

Table 4.1: Size of the land

Responses	No of respondents	Percentage
Below 1ha	9	34.62
Below 2ha	5	19.23
Below 3ha	6	23.08
Below 4ha	3	11.54
Above 5ha	3	11.53
Total	26	100%

From the Table 1 above the size of land from the respondents, most respondents 34.62% used below 1hectare of land which they used for land, while 19.24% used below 2hectare, 23.08% used below 3 hectares, 11.53% used below 4 hectares and above 5 hectares respectively.

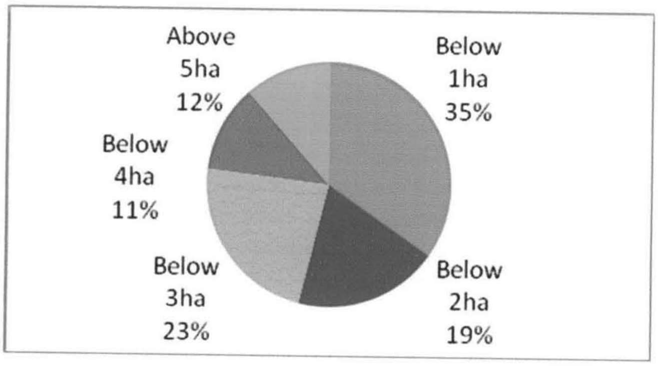

Figure 4.1: Chart of sizes of farmland in Ponyan community.

Table 4.2: Land used

Responses	No of respondents	Percentage
Farming	21	80.78
Housing	3	11.54
Others	3	7.69
Total	26	100

From the table 2 above, most respondents 80.78% used the land for farming, 11.54% used land their for housing, while 7.69% used their land for other purpose such as business office.

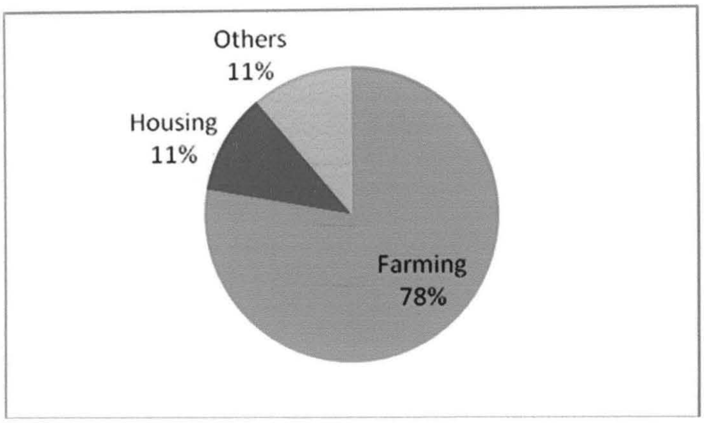

Figure 4.2: Chart for which land is used for

Table 4.3: Is the land your personal property

Responses	No of respondents	Percentage
Yes	18	69.23
No	8	30.77
Total	26	100

In the Table 3 above, 69.23% chose yes which shows that they are the owner of their landed property, 30.77% chose no, which shows that they are not the owner the landed property.

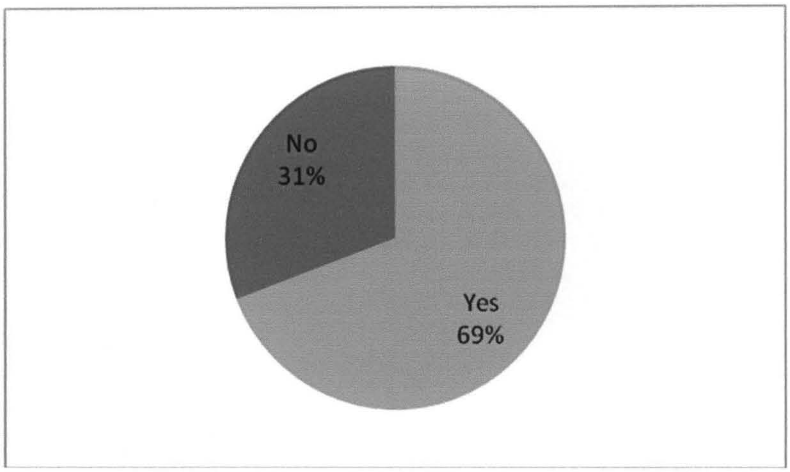

Figure 4.3: Land ownership type

Table 4.4: Is the land on lease to you

Responses	No of respondents	Percentage
Yes	10	38.46
No	15	57.69
None	1	3.85
Total	26	100

Table 4.4 shows the number of respondents that use lease land in Ponyan. 38.46% of the respondents are on lease land, 57.69% are not lease landed property and 3.85% is not lease or lease land property (either inherited or family land).

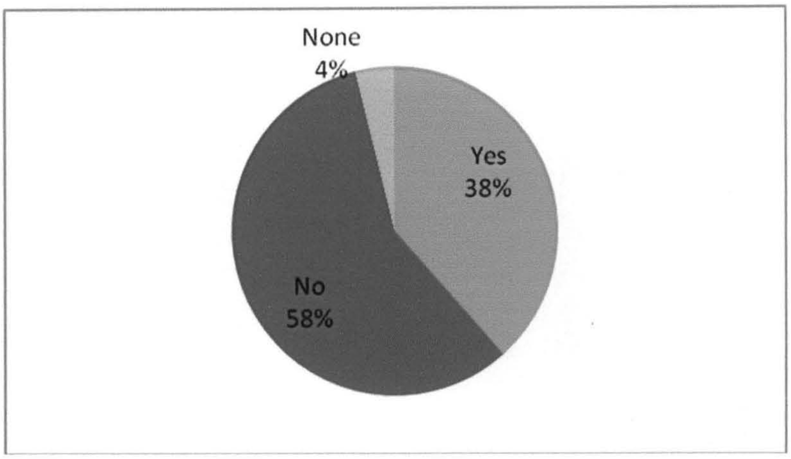

Figure 4.4: Land on lease to respondent

Table 4.5: Type of openings on the land

Responses	No of respondents	Percentage
Narrow and continuous	11	42.31
Point source opening	7	26.92
Wide and continuous	5	19.23
None	3	11.54
Total	26	100

From the Table 4.5, the respondents describe the type of openings on their farmland, 42.31% of the respondents have narrow and continuous, 26.92% of the respondents have point source opening, 19.23 % of the respondents have wide and continuous of their land and 11.54% of the respondents did not chose any option.

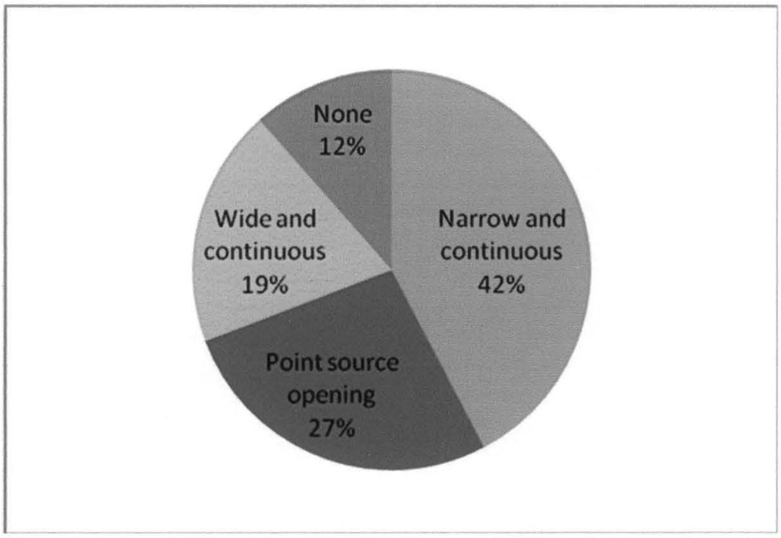

Figure 4.5: Type of opening on farm land.

Table 4.6: Notice of opening

Responses	No of respondents	Percentage
6months ago	3	11.54
1year ago	5	19.24
2yrs ago	4	15.38
3yrs ago	4	15.38
Above 3years ago	10	38.46
Total	26	100

From the Table 4.6, the respondents said the opening has been existing not less than 6months. 11.54% of the respondents said the openings has been existing for past six months, 19.24% said the openings has been existing for the past 1years, 15.38% have the openings for past 2years and 3years respectively and 38.46% notice the openings since past 3years.

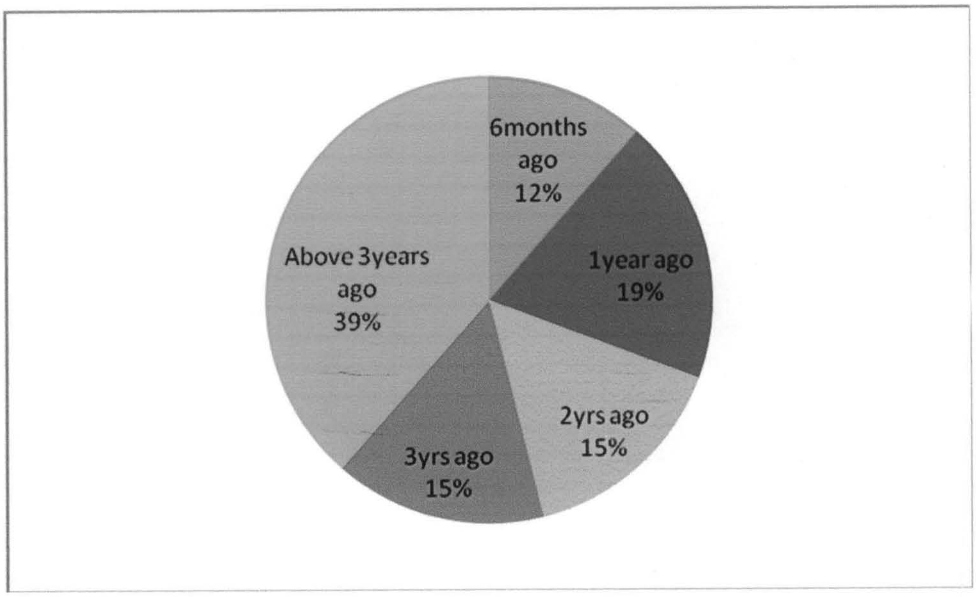

Figure 4.6: Notice of opening on farm land.

Table 4.7: Experience of flood on the land

Responses	No of respondents	Percentage
Yes	15	57.78
No	11	42.31
Total	26	100

From the Table 4.7, above 57.78 experience flood on their land, while 42.31 did not experience flood on their land. This shows that most of the land in Ponyan experience flood on their land.

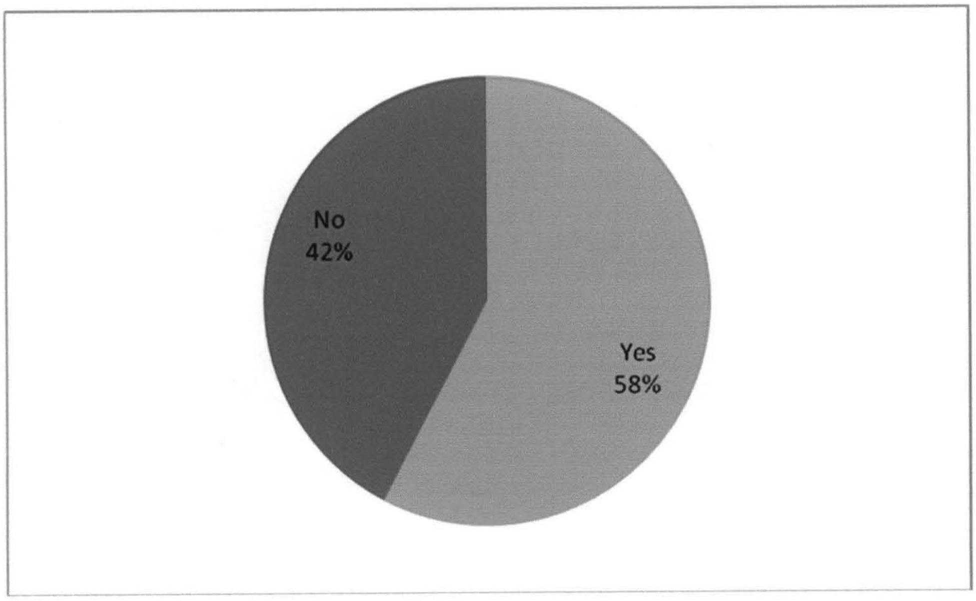

Figure 4.8: Experience flood on farm land

Table 4.8: Duration of the flood

Responses	No of respondents	Percentage
1month	7	26.92
2months	6	23.08
3months	3	11.54
4months	5	19.23
6months	1	3.85
1year	1	3.85
Others	3	11.54

From Table 4.8 above, 26.92% of the respondents experience flood for month, 23.08% of the respondents experience flood for 2months, 11.54% of the respondents experience flood for 4months, 3.85% of the respondents experience flood for 6months and 1year, and 11.54 did not experience flood at all.

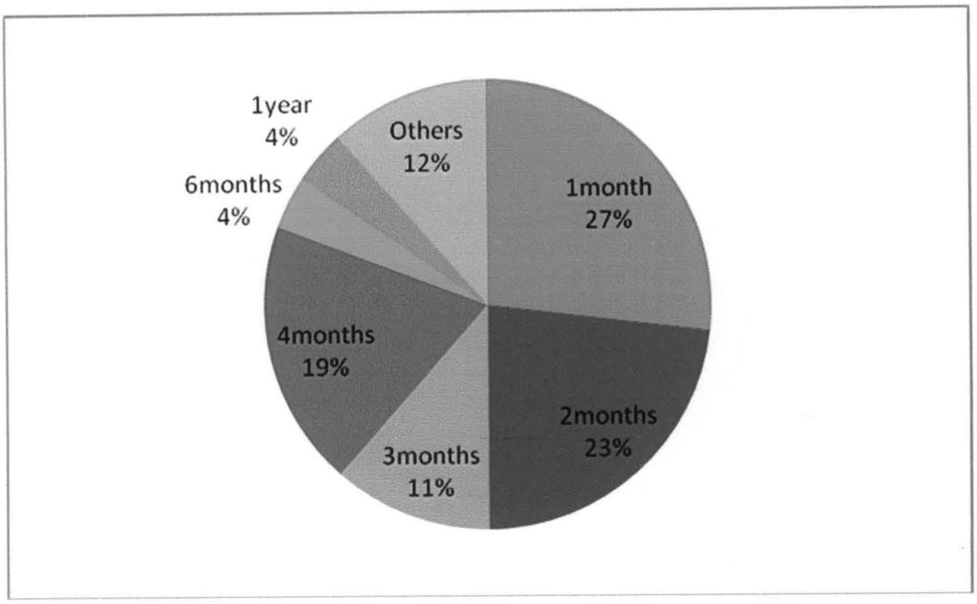

Figure 4.8: Duration of flood expirenced on farm land

Table 4.9: Types of plant on the land

Responses	No of respondents	Percentage
Tuber crops	12	46.15
Cereal crops	9	34.62
Vegetables	2	7.69
Mixed crops	2	7.69
Cash crops	1	3.85
Total	26	100

From Table 4.9 above, 46.15% of the respondents plant tuber crops, 34.62% of the respondents plant cereals crops, 7.69% plant both vegetables and mixed crops, and 3.85% plants cash crops on their land in Ponyan, Yagba East Local government of Kogi State.

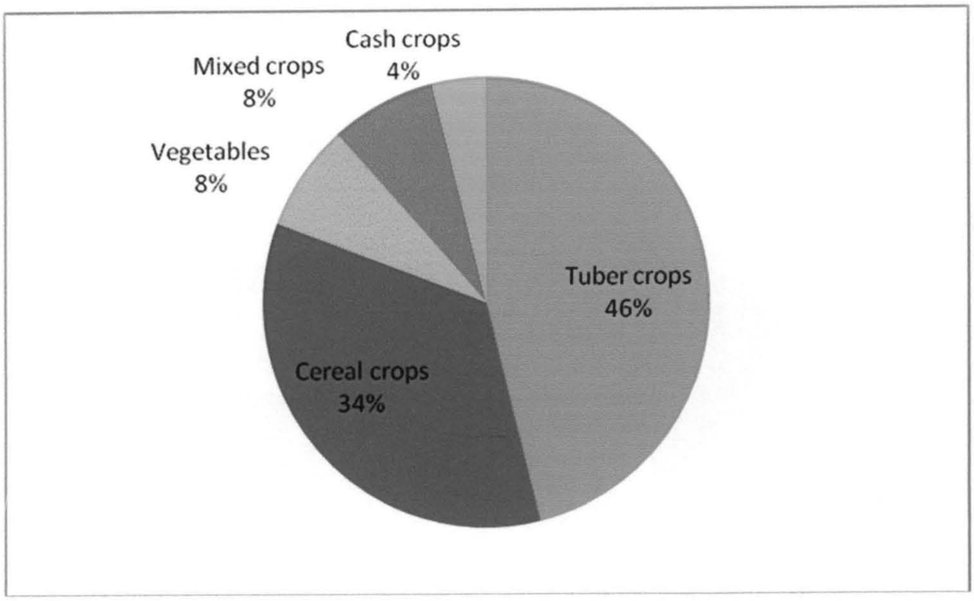

Figure 4.9: Types of crops planted on the farm land.

Table 4.10: Quantity of farm produce for past 5years

Responses	No of respondents	Percentage
Low yield	19	73.08
High yield	7	26.92
Total	26	100

From Table 4.10 above, 73.08% of the respondents have low yields of plant on their farmland and 26.92% have high yield of plants on the farmland.

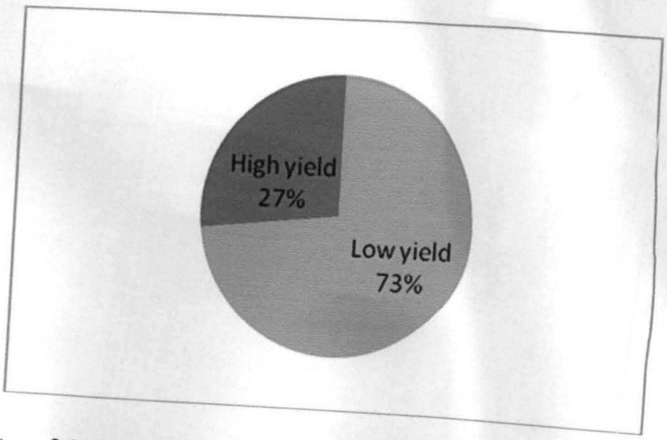

Figure 4.10: Quantity of farm produce in the last 5 years

Gully erosion is a major problem both in developed and developing countries especially in Nigeria. Gully erosion has caused serious effect in the eastern part of Nigeria which include eroding away houses, farm plants and products, by making roads inaccessible which links rural and urban together (Garland and Pile 2007). Gully erosion is one of the major factors that cause low crops yields in Nigeria today, since Ponyan is part of Kogi State in Nigeria. The gully erosion renders the top soil infertile by exposing the subsoil which is not fertile in minerals that will benefits the plants.

CHAPTER FIVE

5.0 CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

Erosion in all its forms involves the dislodgement of soil particles, their removal and eventual deposition away from the original position. This natural process is fundamental in landscape and soil development. Susceptibility to erosion and the rate at which it occurs depend on land use, geology, geomorphology, climate, soil texture, soil structure and the nature and density of vegetation in the area.

Generally mass movement occurs when the weight (shear stress) of the surface material on the slope exceeds the restraining (shear strength) ability of that material. Factors increasing shear stress include erosion or excavation undermining the foot of a slope, loads of buildings or embankments, and loss of stabilizing roots through removal of vegetation. Vegetation removal and consequent lower water use may increase soil water levels, causing an increase in pore water pressure within the soil profile. Increased pore water pressure or greater water absorption may weaken inter-granular bonds, reducing internal friction and therefore lessening the cohesive strength of the soil and ultimately the stability of the slope. In rural areas mass movement inhibits farm production and land use by loss of accessibility, exposure of infertile subsoil and loss of stock and capital items.

- Soil erosion also reduces the ability of soil to store water and support plant growth, thereby reducing its ability to support biodiversity.
- Erosion promotes critical losses of water, nutrients, soil organic matter and soil biota, harming forests, rangeland and natural ecosystems.

- Erosion increases the amount of dust carried by wind, which not only acts as an abrasive and air pollutant but also carries about 20 human infectious disease organisms, including anthrax and tuberculosis.

5.2 Recommendations

It is there recommended that

1. Extension agents be fully trained on how to provide interim prevention measures to assist the local farmers on how guide against any type of erosion.
2. Adequate training should be given to the people in these areas as to how to construct local drainage systems that will channel away excess rainfall to major streams and rivers.
3. The farmers should be encouraged to make prompt complains at relevant offices and agencies that can help control erosion activities in these areas.
4. The government should pay more attention to flood and erosion prone areas with a view of providing suitable control equipments to reduce the impacts of erosion in the society.