



# IMPACT OF DEFORESTATION ON AGRICULTURAL PRODUCTIVITY IN NORTHERN PART OF NGURU YOBE STATE, NIGERIA, USING REMOTE SENSING AND GIS TECHNIQUES

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## Abstract

This study examines the impact of deforestation on agricultural productivity in Northern parts of Nguru, Yobe State, Nigeria, from 2015 to 2023. Using remote sensing and GIS techniques, the analysis focused on the extent of forest cover loss and its relationship with crop yield trends during the study period. Surveys were conducted to identify the causes of deforestation in the area. Results indicated a significant decline in forest cover, leading to reduced soil fertility and lower crop yields. The results show that between 2015 and 2023, Northern part of Nguru LGA experienced significant deforestation, with a loss of 30% of its forest cover. The main drivers of deforestation were identified as agricultural expansion, urbanization, and fuelwood harvesting. Regression analysis revealed a significant negative relationship between deforestation and agricultural productivity, with a 20% decrease in crop yields attributed to deforestation. The findings underscore the need for sustainable land management practices and reforestation efforts to enhance agricultural productivity.

## I. INTRODUCTION

Nguru, located in Yobe State, Nigeria, is a semi-arid region highly dependent on agriculture for livelihood. The region's economy relies heavily on crops such as millet, sorghum, and groundnut, which are sensitive to environmental changes. Deforestation in Northern parts of Nguru has become a critical issue, leading to soil degradation, reduced agricultural productivity, and increased vulnerability to climate change.

### 1.1 Statement of the Problem

Deforestation in Nguru, Yobe State, has increased significantly in recent years, threatening sustainable agricultural practices, particularly in the northern regions. This study investigates the extent to which deforestation affects agricultural productivity in the area, aiming to provide data-driven insights for policy development.

### 1.2 Objectives of the Study

- To identify the extent of deforestation in Northern part of Nguru, Yobe State.
- To determine the level of agricultural productivity from 2015 to 2023.
- To ascertain the causes of deforestation in the area.
- To examine the effect of deforestation on agricultural productivity.

### 1.3 Significance of the Study

Understanding the link between deforestation and agricultural productivity is crucial for designing strategies to mitigate forest loss and promote sustainable agriculture. This study provides valuable insights for policymakers, environmentalists, and agricultural stakeholders in Nguru and similar regions.

## II. RESEARCH METHODOLOGY

Nguru in Yobe State, located in Nigeria's semi-arid northeast, relies heavily on soil and vegetation cover for agriculture due to its dry climate and low rainfall. To assess the impact of deforestation on agricultural productivity, this study utilized Landsat and Sentinel satellite imagery from 2015 to 2023, analyzing land cover changes with GIS tools. Data on crop yields were collected through local reports and farmer interviews, and correlation analysis was used to evaluate the relationship between forest loss and productivity trends.

### 3.1 Population and Sample

In this study, the population consists of farmers and residents of Northern part of Nguru, Yobe State, Nigeria, who are affected by and involved in agricultural activities and are familiar with the trends of deforestation in the area. The sample was drawn from this population using a purposive sampling technique, targeting individuals who possess relevant knowledge and experience regarding local farming practices, land use changes, and the impact of deforestation on agricultural productivity.

A total of 100 participants were selected for structured interviews, which included farmers with at least five years of experience in the region. This sample size was chosen to provide a diverse representation of views, considering the variations in farming practices, crop yields, and deforestation observations. The data gathered from this sample was instrumental in identifying the main causes of deforestation and its perceived impacts on agricultural productivity.

### 3.2 Data and Sources of Data

Landsat satellite image of the study area for 2015 and 2023 were acquired from national center for remote sensing and land cover global website. Individual interview was also carried with the populace during the field survey. Some question asked among others from the farmers are the age of the respondent, years being in to farming, yield harvested by each farmer in 2015 and 2023 and the courses of deforestation in the area.

### 3.3 Data Acquisition

- a. **Satellite Imagery Retrieval:** Landsat satellite images for the years 2015 and 2023 were acquired from the National Center for Remote Sensing and Land Cover Global website. This data was chosen to provide a historical context for land cover changes over the specified period.
- b. **Agricultural Productivity Data:** Data on crop yields were collected from local agricultural offices and reports
- c. **Surveys:** Structured interviews were conducted with 100 local farmers to identify the cause of deforestation.

### 3.4 Methods of Data Analysis

The quantitative data derived from satellite imagery will be analyzed using geographic information system (GIS) tools, specifically through Land Use/Land Cover (LULC) analysis in the ArcGIS environment. Data collected through interviews will be presented in tables, illustrating the level of agricultural productivity before and after deforestation, specifically from 2015 to 2023. This data on agricultural yield will be analyzed using simple statistical method to highlight trends and impacts.

#### 3.4.1 Preprocessing of Satellite Images:

- a. **Image Importation:** The acquired satellite images were imported into the ArcGIS environment.
- b. **Atmospheric Correction:** Atmospheric conditions that may have affected the clarity and accuracy of the images were corrected using appropriate techniques, ensuring consistent data quality.
- c. **Geometric Correction:** Geometric distortions were rectified to align the images accurately with geographical coordinates, allowing for precise comparisons.

#### 3.4.2 Land Use/Land Cover (LULC) Classification:

- a. **Classification Techniques:** Supervised and unsupervised classification techniques were employed to categorize the satellite images into distinct land use/land cover classes, such as forest, agricultural land, and urban areas. This classification process facilitated a clearer understanding of land use dynamics.
- b. **Validation of Classification:** The classification results were validated against ground truth data, when available, to ensure the accuracy of the land cover classifications. Field surveys and local knowledge contributed to this validation process.

### 3.4.3 Change Detection Analysis:

- Comparison of Classified Images:** A change detection analysis was performed by comparing the classified images from 2015 and 2023. This involved overlaying the two datasets to identify areas of change.
- Identification and Quantification:** Changes in land cover were systematically identified and quantified, with a particular focus on areas that had experienced deforestation. The extent of deforestation was calculated to illustrate its impact on the landscape.

### 3.4.4 Quantification of Deforestation:

- Measurement of Forest Cover Loss:** The extent of deforestation was quantified by measuring the area (in hectares or acres) of forest cover lost between the two time points. This quantitative assessment provided critical data on the scale of environmental change.
- Creation of Spatial Maps:** Maps were generated to visually represent the spatial distribution of deforestation in relation to agricultural land use, enhancing the understanding of geographic patterns.

### 3.4.5 Correlation Analysis:

- Overlay of Deforestation and Agricultural Data:** The relationship between changes in land cover and agricultural productivity was analyzed by overlaying the deforestation data with agricultural yield data collected through farmer interviews.
- Statistical Analysis:** Statistical tools available in ArcGIS were employed to explore potential correlations between the degree of deforestation and agricultural outcomes, providing insights into the impacts of environmental changes on farming practices.

### 3.3 Data Collection

- Deforestation Data:** Landsat and Sentinel satellite images from 2015 to 2023 were used to assess changes in forest cover.
- Agricultural Productivity Data:** Data on crop yields were collected from local agricultural offices and reports.
- Surveys:** Structured interviews were conducted with 100 local farmers to identify the causes of deforestation.

## III. RESULTS AND DISCUSSION

### 4.1 INTRODUCTION

This section outlines the findings regarding deforestation and its impact on agricultural productivity in Northern part of Nguru, Yobe State, from 2015 to 2023. The results indicate a significant reduction in forest cover, which correlates with lower crop yields, underscoring the need for sustainable farming practices in this semi-arid region.

### 4.2 Extent of Deforestation in Northern part of Nguru Yobe State as at 2015

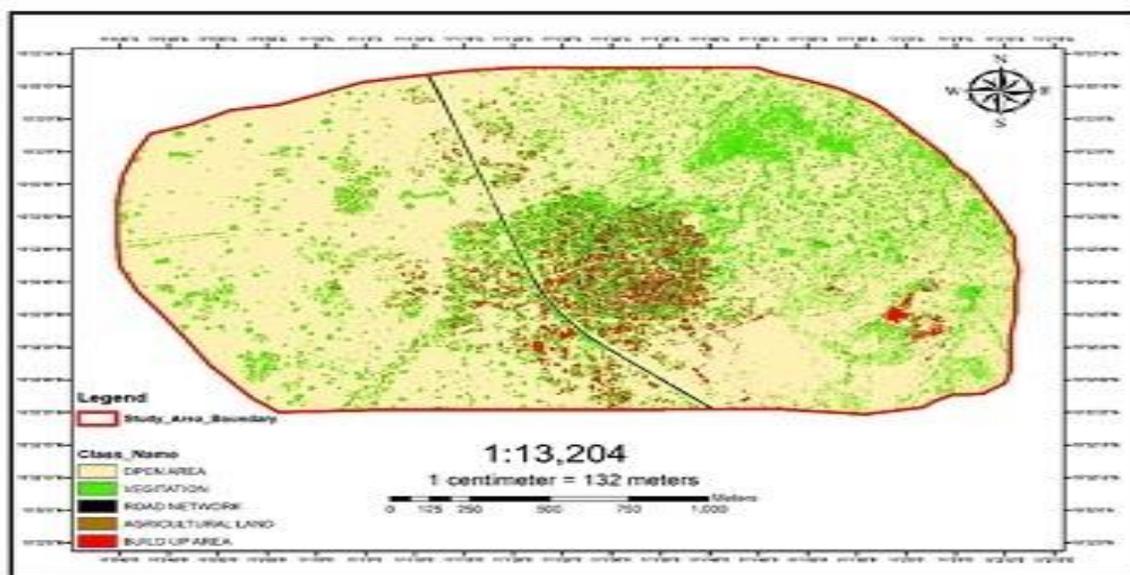


Figure.4.1 Classified Map of Northern Part of Nguru Yobe State 2015

Source: - Author Analysis, 2024.

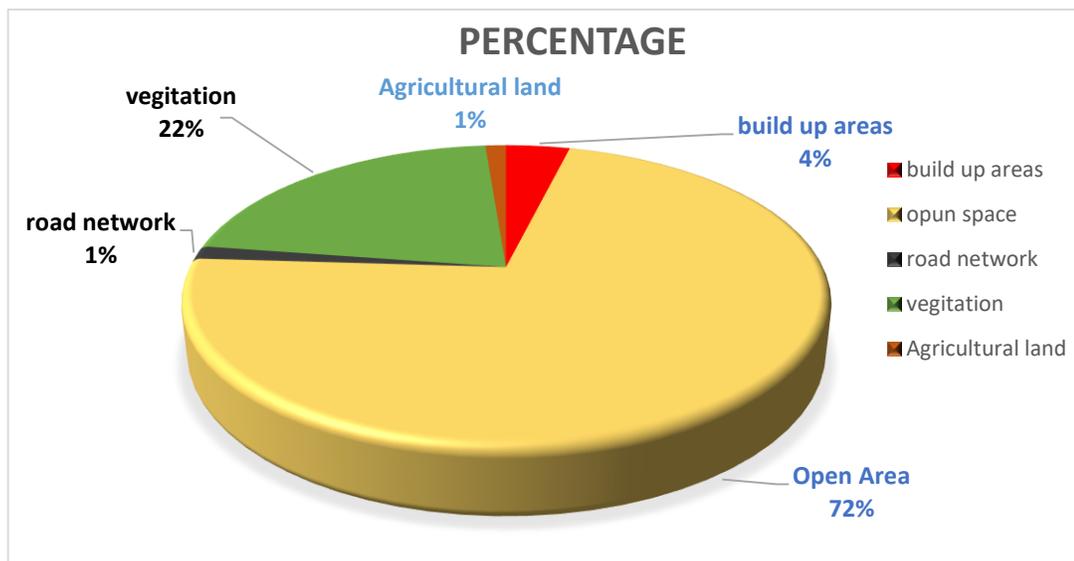


Figure 4.2 Percentage of land use land cover changes for the year 2015

The analysis from figure 4.1 and 4.2 shows that vegetation covers almost 22% of the study area and build up area cover 4%, road network covers 1%, agricultural land, also 1%, and the 72% of the land area is open space

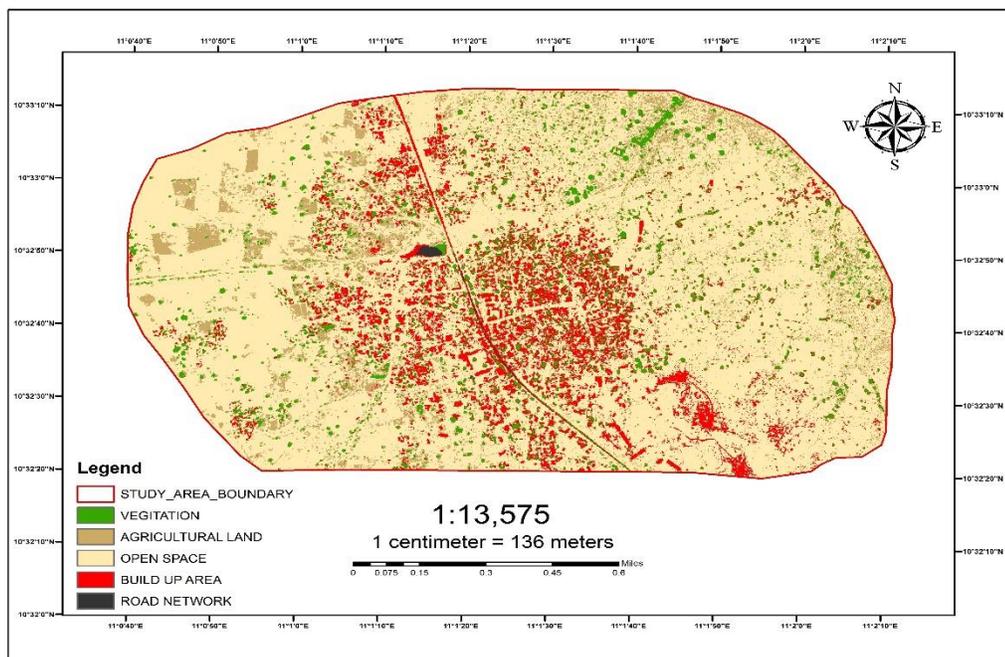


Figure 4.3 Classified image of Northern Part of Nguru Yobe State 2023

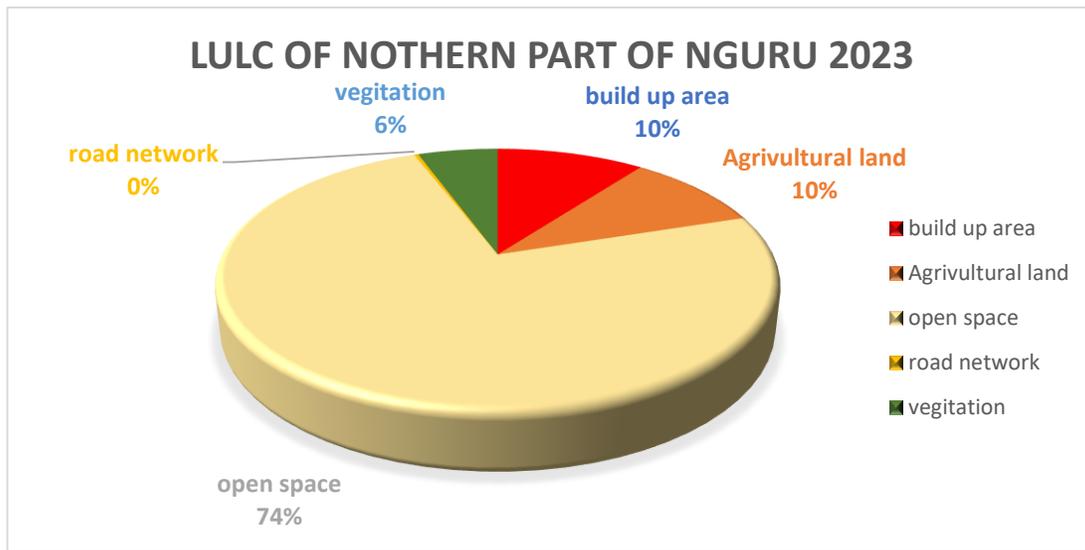


Figure 4.4 Percentage of land use land cover changes for the year 2023

The analysis from figure 4.3 and 4.4 shows that vegetation covers only 6% of the total area then build up area. Cover 10% and farmland also cover 10% then open space cover about 74% of the total area.

From figure 4.1 to figure 4.4 stated that the land use land cover varies, that is from 2015 to 2023. Which shows that the area covers almost 22% of the vegetation in 2015 while around 2023 the vegetation in the area have decrease to 6% which indicate that massive deforestation is taking place in Northern part of Nguru Yobe State. These results are noticed in the study area. The human activities lead to such significant changes, includes but not limited to agricultural and deforestation among others as shown in figure 4.1 while in 2015 its shows less agricultural activities that is only 1% taking pace in the area while in 2023 agricultural land covers almost 10% of the study area. Also, buildings have increase from 4% to 10%. Therefor the analysis shows that, in the near future, there will not be single tree in area of Northern Part of Nguru Yobe State. If agricultural activities and deforestation increase at the same rate as it were as at the time of this research.

### 4.3 Level of Agricultural Productivity

Table 4.1 Respondent Age Group

Age	Number	Percentage %
15-20	0	0%
21-30	2	10%
31-40	5	25%
41-50	7	35%
50 & above	6	30%
Total	20	100%

Table 4.1, shows most of the respondents fall between 41-45 age group which constitute about 35%, follow by does above 50 years old, with 21-30 age groups with constitute the minimum age group respondent with no any respondent between the age group between 15-20.

Table 4.2 Years of experience in the farming activity.

Years	Number	Percentage %
1-2	0	0%
3-4	1	5%
5-6	2	10%
7-8	5	25%
9-10	12	60%
Total	20	100%

From the result shown in table 4. 2, most of the respondent that is 60% have been in to farming 9-10 years back, then 25% of the respondent have been in the farming 7-8 year back, then 10-5 percent of the respondent have been in the farming 3-6 years back, then 1-2 years back no farming activities have been taking place in the study area.

Table 4.3 Yield harvested by the Farmers in 2015 (In Bags).

No. of Farmers	Maize	Guinea cone	Millet	Bambara nut	Total
1	20	10	15	8	53
2	16	7	8	10	41
3	30	12	10	13	65
4	0	25	20	3	48
5	12	8	5	0	25
6	5	17	6	19	47
7	30	0	0	0	30
8	0	30	10	0	40
9	22	10	21	10	63
10	10	18	6	0	34
11	0	18	0	9	27
12	10	10	5	9	34
13	3	20	18	0	41
14	20	0	19	7	46
15	18	0	7	9	34
16	15	13	10	5	43
17	0	0	18	10	28
18	10	9	6	2	27
19	0	0	0	19	19
20	10	5	5	6	26
<b>Total</b>	<b>231</b>	<b>212</b>	<b>189</b>	<b>139</b>	<b>771</b>

**Table 4.4: Agricultural Produce in 2015**

Agricultural yield	Total number of yields	Percentage %
Maize	231	30%
Guinea cone	212	27%
Millet	189	25%
Bambara nut	139	18%
Total	771	100%

The Table shows that about 30% of the agricultural productivity in Northern part of Nguru Yobe State is maize, then follow by guinea cone which is 27%, then millet 25% and Bambara nut 18% which is minimal in production. This indicate that maize is the predominant agricultural produce in the study area as at 2015.

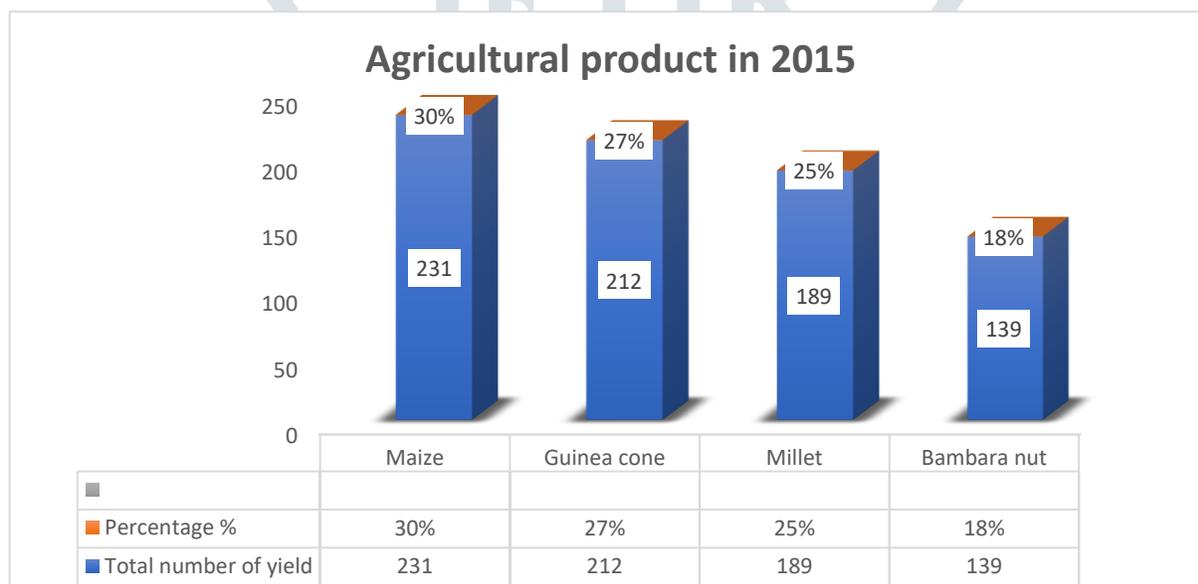


Figure 4.5: Bar graph showing the total percentage of agricultural yield around 2015

**Table 4.5:** Yield harvested by the Farmers in 2023 In Bags.

Number of farmers	Maize	Guinea cone	Millet	Bambara nut	Total
1	0	12	0	10	22
2	10	10	0	5	25
3	5	13	12	8	38
4	0	10	13	0	23
5	0	20	0	0	20
6	8	13	9	3	33
7	10	5	5	0	20
8	0	14	3	5	22
9	10	13	16	8	47
10	0	0	0	0	0
11	3	4	20	2	29
12	0	0	0	0	0
13	6	7	10	5	28
14	0	0	0	0	0
15	5	3	2	1	11
16	0	10	10	2	22
17	0	0	10	5	15
18	5	3	0	0	8
19	0	0	0	0	0
20	5	10	10	2	27
Total	67	147	120	56	390

**Table 4.6:** Agricultural Produce in 2023

Agricultural yield	Total number of yields	Percentage %
Maize	67	17%
Guinea cone	147	38%
Millet	120	31%
Bambara nut	56	14%
Total	390	100%

The Table 4.6 shows that the percentage of the agricultural product in 2020, which shows that the major crop which is produce is Guinea cone which is 38% and millet 31% the followed by maize 17% and last one is Bambara nut which is only 14%. This indicate that Guinea cone is the predominant agricultural produce in the study area as at 2023.

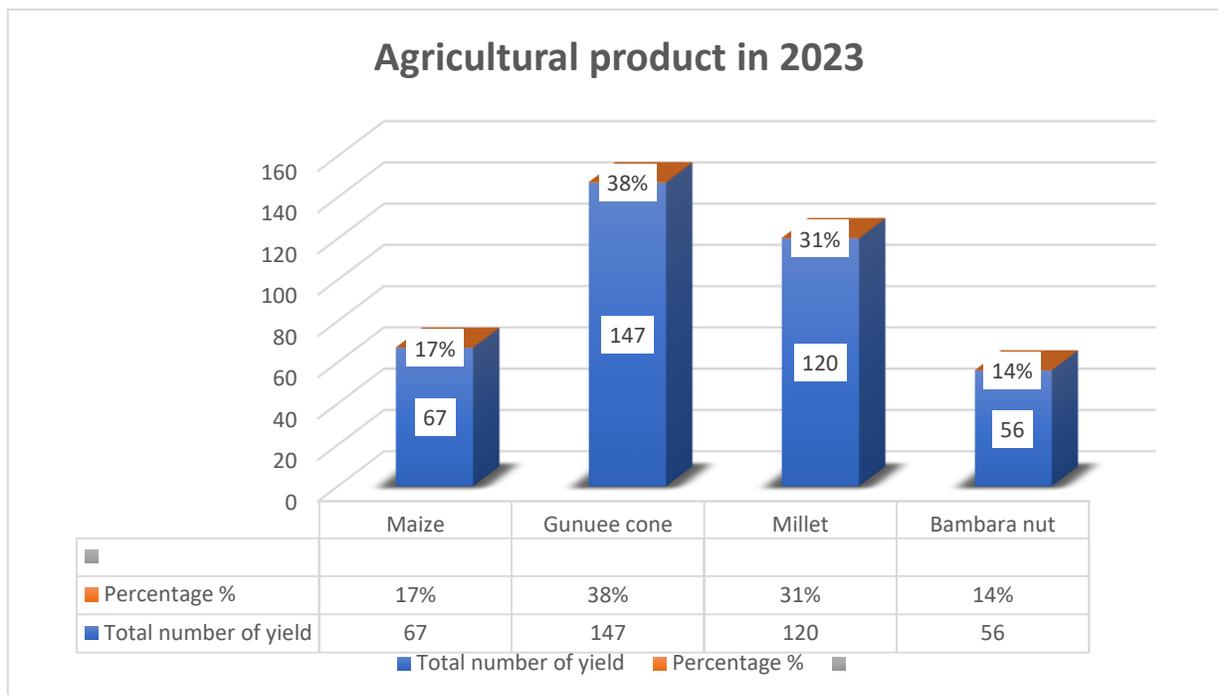


Figure 4.6: Bar graph showing the Total Percentage of Agricultural Yield in 2023

Table 4.7: Yield harvested in year 2015 and 2023

Name of yield	Year 2015	Percentage	Year 2023	Percentage
Maize	231	30%	67	17%
Guinea cone	212	27%	147	38%
Millet	189	25%	120	31%
Bambara nut	56	18%	139	14%

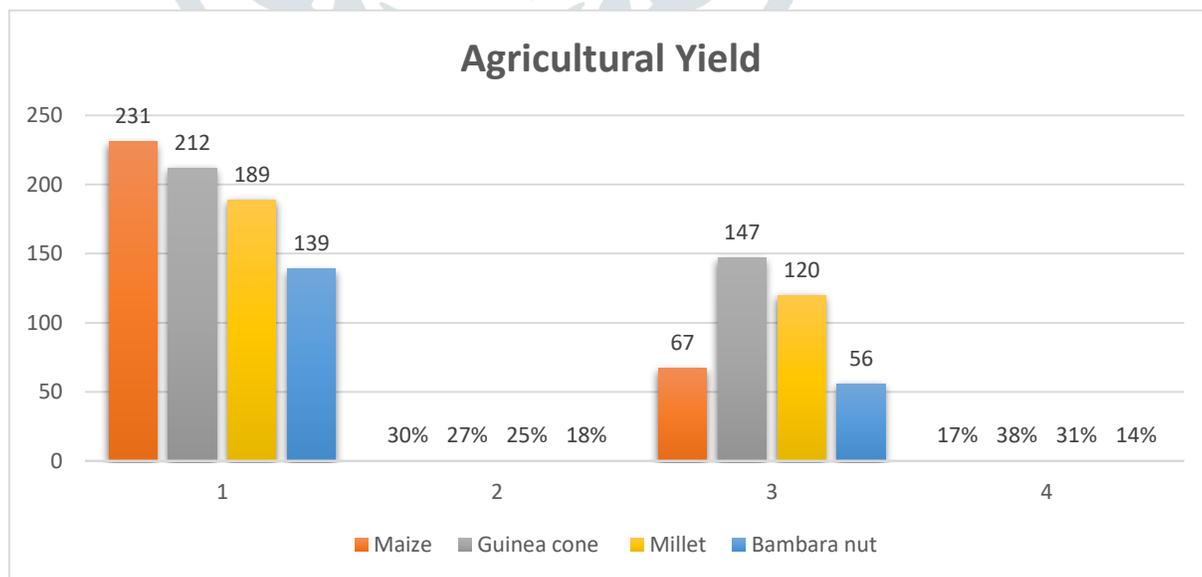


Figure 7 Multiple Bar graph showing the Total Yield Harvested in 2015 and 2023

From the result shown in figure 7, in the year 2015 there is abundant agricultural productivity in Northern part of Nguru town while in 2023 the agricultural yield has reduced. This is due to the fertility of the natural soil. That is around 2015 the soil is more fertile, while around 2023 the agricultural product has reduced which also means the fertility of the soil in the study area was reduced. Also, it was found in the

year 2015, maize is the major yield which is produce in the area, while in the year 2023, Guinea cone and millet are the major yield which is produce in the study area. Therefore, this comes as a result of the massive deforestation that is taking place in the area of Nguru Yobe State

#### 4.4 Courses of Deforestation in Northern part of Nguru Yobe State

##### a. Deforestation for Agricultural activities

The primary driver of deforestation in Northern part of Nguru, Yobe State, is the conversion of forested areas into agricultural land to meet the growing demand for food. Before farming, individuals clear land by cutting down trees to create space for planting crops. As a result, forested regions are increasingly transformed into agricultural land.

##### b. Deforestation for construction of buildings

Construction of new buildings is also one of the factors that lead to deforestation in Northern part of Nguru Yobe State. People do engage in cutting down a tree in other to build a house or a small-scale industry. Therefore, places that are covered by trees also have been transformed in to buildings.

##### c. Deforestation for fuel wood

Deforestation in the study area occurs partly due to local domestic needs and the export of firewood for commercial purposes. Residents cut down trees for firewood and other household uses, contributing to the loss of forest cover.

#### IV DISCUSSION

The findings of this study reveal a significant correlation between deforestation and agricultural productivity in Northern part of Nguru, Yobe State. The analysis indicates that the loss of forest cover, primarily due to agricultural expansion and domestic use of wood, has adversely affected soil quality and water retention, leading to decreased crop yields. These results align with global research highlighting the detrimental effects of deforestation on agricultural systems, particularly in semi-arid regions.

#### V. CONCLUSION

The study highlights the critical need for sustainable land management practices in Northern part of Nguru, Yobe State, due to ongoing deforestation driven by agricultural expansion and domestic firewood use. The loss of forest cover negatively impacts soil quality, water retention, and crop yields, threatening the livelihoods of local agricultural communities. Implementing reforestation initiatives and promoting agroforestry can restore forest cover, enhance biodiversity, and improve soil health while providing additional income sources. To ensure the long-term sustainability of agriculture in the region, it is essential to address the root causes of deforestation. This involves educating local communities about sustainable practices, offering alternatives to firewood, and developing policies that balance agricultural needs with environmental conservation. Engaging local farmers in decision-making and fostering community-led initiatives are vital for achieving sustainability. By prioritizing these strategies, Northern Nguru can mitigate the adverse effects of deforestation and secure a sustainable future for its agricultural landscape.

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