

**COLLEGE OF HUMANITIES
SCHOOL OF SOCIAL SCIENCES**

**ECONOMIC TREES AND SUSTAINABLE RURAL LIVELIHOODS IN NORTH-
WESTERN KATSINA STATE, NIGERIA**

BY

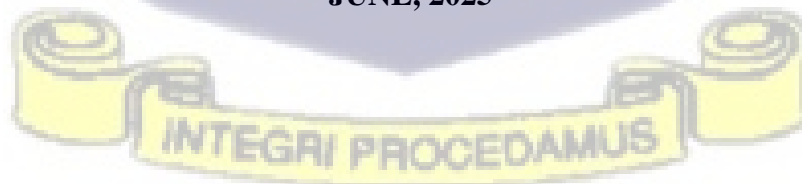
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**This thesis is submitted to the university of Ghana, Legon in partial fulfillment of the
requirement for the award of PHD in GEOGRAPHY Degree**

DEPARTMENT OF GEOGRAPHY

JUNE, 2025



DECLARATION

I declare that this work has been entirely conducted by me produced from research undertaken under the guidance of my supervisors and that it has not been considered or published elsewhere and also that all references cited have been acknowledged properly.



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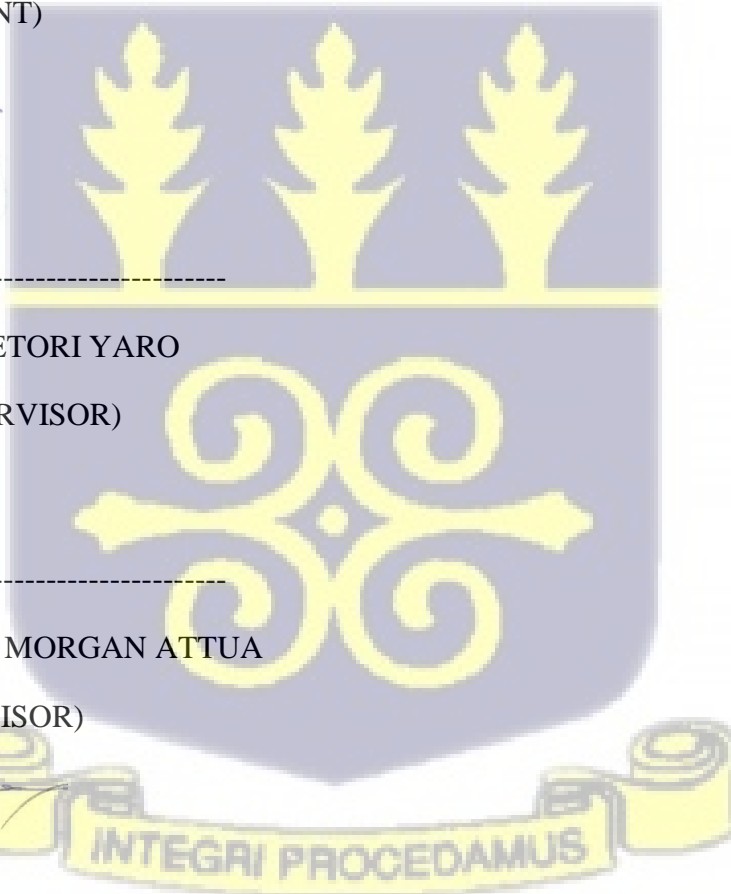
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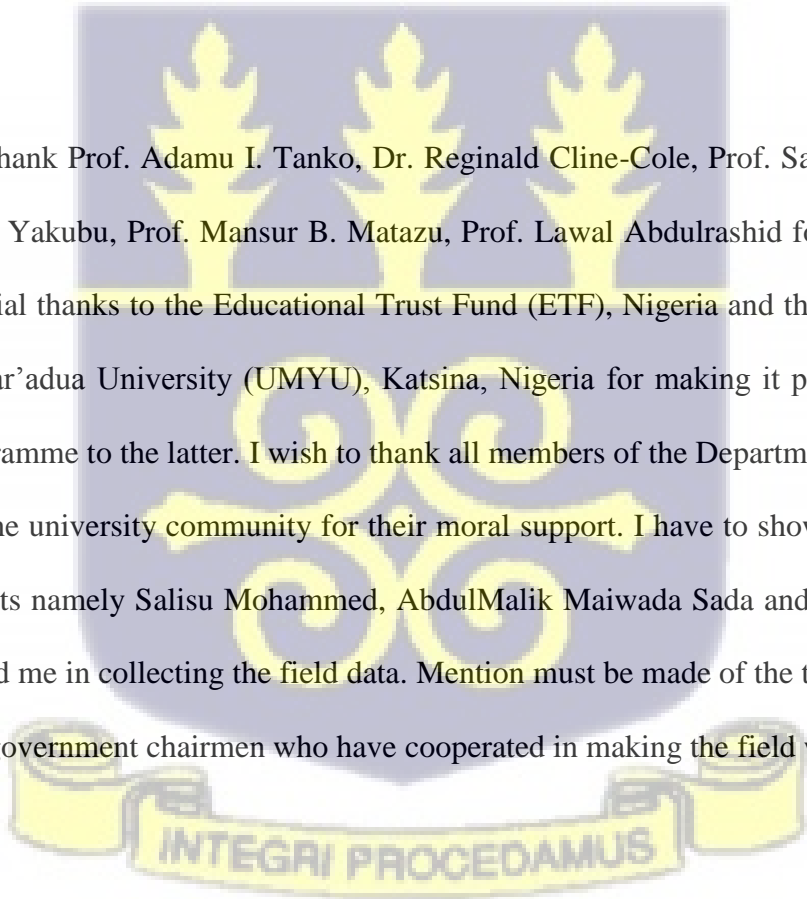
DEDICATION

This work is dedicated to my late parents, my family and the late Prof. Danjuma Abubakar Maiwada who have played a major role in making me reach this far.



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ABSTRACT

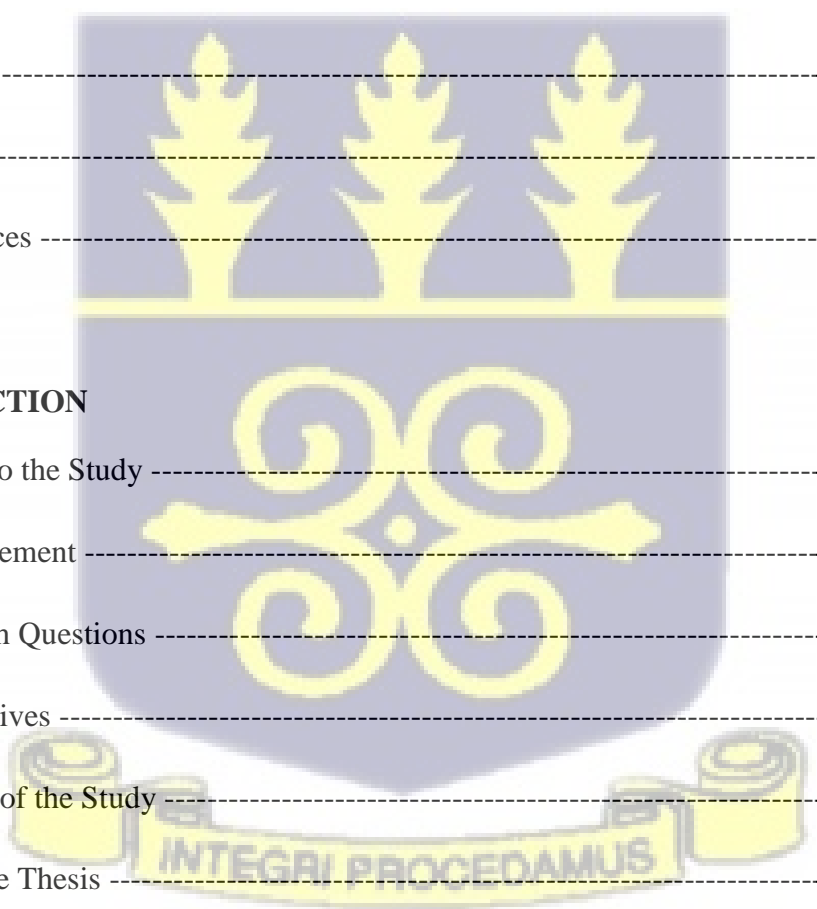
This thesis investigates the role of the six major economic tree species in sustaining the livelihoods of 18 rural communities living in northwestern Katsina State, Nigeria. Tree species include *Anogeissus leiocarpus*, *Balanites aegyptiaca*, *Faidherbia albida*, *Khaya senegalensis*, *Parkia biglobosa* and *Vitellaria paradoxa*. The study basically argues that these trees underpin livelihoods of the rural communities. Its objectives was to explain the observed spatial variation in tree distribution including frequency, density and girth class distributions of the trees. The work also explored the selected tree access patterns and governance regimes. Other objectives considered by the study include the contribution of these trees to the livelihoods of rural households including the local methods and capacities to conserve them. The study combined multiple research methods to gather and analyze primary data. Ecological data on frequency, density, girth class and spatial distribution was collected on 335 individual trees belonging to the six selected economic tree species. Socio-economic data was also gathered on 345 households using structured questionnaires complimented by qualitative interviews using focus group discussions and key informants interviews. Major empirical findings suggest that the spatial distribution pattern of the trees assumed a clumped pattern. Density of the trees though generally low varies considerably among the communities. Population structure of most of the trees depicts an unsustainable position consisting predominantly of *Anogeissus leiocarpus* and *Balanites aegyptiaca* which fall within the moderate to mature girth classes. Trees availability trend demonstrates that more trees are disappearing. There is also protection offered to valuable tree species like *Parkia biglobosa* and *Vitellaria paradoxa* in the cultivated fields, as opposed to uncultivated areas. Private access dominates tenure of the economic trees by the smallholders. The trees contributed significantly to sustainable livelihoods of the communities through the provision of products used notably for food, medicine and fuelwood. Institutions particular

indigenous knowledge plays an important role in governing the management of the trees. Vulnerable tree species because of their decreased population should as a matter of urgency be protected from further decrease and in situ conservation applied as a measure for revamping their occurrence. There should be improvement in the selected tree seedlings distribution system to smallholders to encourage planting. The state should also collaborate with the smallholders whose indigenous knowledge in tree management can enhance the appropriateness and success of policy and programmes, ecosystems and especially afforestation.



TABLE OF CONTENTS

	PAGE
Declaration -----	ii
Dedication -----	iii
Acknowledgements -----	iv
Abstract -----	vi
Table of Contents -----	viii
List of Figures -----	xiii
List of Tables -----	xiv
List of Plates -----	xv
List of Appendices -----	xvi
 1.0 INTRODUCTION	
1.1 Background to the Study -----	1
1.2 Problem Statement -----	4
1.3 Key Research Questions -----	8
1.4 Study Objectives -----	9
1.5 Significance of the Study -----	9
1.6 Outline of the Thesis -----	11



2.0 LITERATURE REVIEW AND CONCEPTUAL FRAMEWORK

2.1 Introduction -----	13
2.2 Spatial Distribution and Growth of Trees -----	13
2.2.1 Ecological Factors Affecting Tree Distribution -----	14
2.2.2 Anthropogenic Factors Affecting Tree Distribution -----	15
2.3 Vegetation Degradation in Africa -----	16
2.4 Role of Local Knowledge in Managing Trees -----	19
2.5 Uses of Trees -----	21
2.5.1 Edible Use of Trees -----	22
2.5.2 Fuel wood Use of Trees -----	23
2.5.3 Medicinal Use of Trees -----	25
2.5.4 Other Non-Timber Use of Trees -----	26
2.5.5 Ecosystem Services Provision of Trees -----	28
2.6 Role of Institutions in the Management of Trees -----	30
2.7 Major Threats to Trees -----	35
2.8 Climate Change and Trees -----	38
2.9 Conservation and Management of Trees -----	39
2.10 Sustainable Livelihoods Framework -----	42



3.0 THE STUDY AREA AND THE METHODOLOGY

3.1 Introduction -----	48
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3.2 Geographical Locations -----	48
3.3 Choice of the Study Area -----	51
3.4 Weather and Climate -----	52
3.5 Geology and Soils -----	54
3.6 Vegetation -----	56
3.7 Relief and Drainage -----	59
3.8 Socio-Economic Settings -----	61
3.9 Selected Trees and Justification -----	63
3.9.1 <i>Anogeissus lieocarpus</i> (African Birch) -----	63
3.9.2 <i>Balanites aegyptiaca</i> (Desert Date) -----	65
3.9.3 <i>Faidherbia albida</i> (Winter Thorn) -----	67
3.9.4 <i>Khaya senegalensis</i> (African Mahogany) -----	69
3.9.5 <i>Parkia biglobosa</i> (African Locust Bean) -----	71
3.9.6 <i>Vitellaria paradoxa</i> (Shea Butter) -----	73
3.10 Types and Sources of Data -----	75
3.11 Instruments and Tools for Data Collection and Analysis -----	75
3.12 Methodology for Reconnaissance Survey -----	76
3.13 Sampling Methods for the Surveys -----	77
3.14 Methods for Quantitative Approach -----	79
3.14.1 The Questionnaire Survey -----	80
3.14.2 The Scientific Tree Measurements -----	81

3.15 Methods for Qualitative Approach -----	90
3.15.1 The Focus Group Discussion-- -----	90
3.15.2 The Individual Interviews -----	91
3.16 Statistical Analysis of Data -----	92
3.17 Challenges of Data Collection -----	93

4.0 ANALYSIS OF THE SELECTED ECONOMIC TREES: FREQUENCY, SPATIAL DISTRIBUTIONS, DENSITIES AND GIRTH

4.1 Introduction -----	94
4.2 Frequency of Selected Trees -----	94
4.3 Spatial Distribution of Selected Trees -----	99
4.4 Density of Selected Trees -----	117
4.5 Perceptions of Availability of the Selected Trees -----	121
4.5.1 Perceptions of Selected Trees Current Availability Compared to the Past 10-20 Years -	124
4.6 Girth Class Distribution of Selected Trees -----	125
4.6.1 Selected Tree Species GBH in Land Use Regimes -----	129
4.7 Composition of Selected Tree Species in Land Use Regimes -----	130
4.8 Chapter Conclusion -----	131



5.0 TREES AND SUSTAINABLE LIVELIHOODS

5.1 Introduction -----	134
5.2 Demographic Profile of the Study Communities -----	134

5.3 Social Profile of the Study Communities	136
5.4 Ownership of Household Assets	138
5.5 Livelihoods of the Households	140
5.6 Uses of Selected Trees in the Communities	142
5.6.1 Edible Use of the Selected Trees	144
5.6.2 Fuel Wood Use of the Selected Trees	146
5.6.3 Medicinal Use of the Selected Trees	147
5.6.4 Other Uses of the Selected Trees	148
5.7 Sustainability of Selected Trees and Uses/Livelihoods	153
5.8 Chapter Conclusion	158
 6.0 TREE GOVERNANCE: THE ROLE OF LOCAL AND STATE INSTITUTIONS	
6.1 Introduction	160
6.2 Access Rights to the Selected Trees by Households	160
6.3 Types of Land Tenure by Households	164
6.4 Occurrence of Indigenous Practices that Protect Trees	165
6.4.1 Indigenous Strategies of Protecting Trees	166
6.5 Role of State Institutions in Woodland Preservation	169
6.5.1 State Institutions and Roles Ascribed to them by Law	170
6.5.2 Strategies Implemented Since Colonial Times on Tree Sustainability	171
6.5.3 Perceived Effectiveness of Strategies of State Institutions	173
6.6 Views of Local People on How to Increase Tree Population in Communities	174

6.7 Chapter Conclusion ----- 176

7.0 SUMMARY OF KEY FINDINGS, CONCLUSION AND RECOMMENDATIONS

7.1 INTRODUCTION -----177

7.2 SUMMARY OF KEY FINDINGS ----- 177

7.2.1 Spatial Distribution, Density, and Availability of Trees ----- 177

7.2.2 Trees and Sustainable Livelihoods ----- 178

7.2.3 Governance of Tree Resources ----- 178

7.3 CONCLUSION ----- 179

7.4 RECOMMENDATIONS ----- 180

References ----- 183

Appendices ----- 203



LIST OF FIGURES

Figure 1: Global Forest Loss Map ----- 36

Figure 2: Sustainable Livelihoods Framework ----- 46

Figure 3: Map of Katsina State showing the three Study Administrative Units ----- 49

Figure 4: The Selected Study Sites/Communities ----- 50

Figure 5: Geology of the Study Area ----- 55

Figure 6: Vegetation of the Study Area ----- 57

Figure 7: The Study Area Showing Relief and Drainage ----- 60

Figure 8: Tree Points to Show Spatial Distribution of Selected Trees in Study Area -----	99
Figure 9: Comparative Distribution of Tree Densities among the Communities -----	121
Figure 10: Girth Class Profiles Showing Population Structure of the Selected Trees -----	126
Figure 11: Uses of Selected Trees by Communities -----	143
Figure 12: Comparison of Selected Tree Use Categories in all Localities -----	151

LIST OF TABLES

Table 1: Extent of Land Degradation due to Deforestation and de-vegetation in Africa -----	17
Table 2: Administrative Units, their Population, Surface Area and the Communities Selected of Each One -----	51
Table 3: Tools Used for Data Collection and Analysis -----	76
Table 4: Sampling Profile among Study Communities -----	79
Table 5: Distribution of Administered Questionnaire in the Administrative Units -----	80
Table 6: Distribution of Sample Plots in the Three Administrative Units -----	82
Table 7: Percentage Frequency of the Selected Trees in all Sample Plots -----	95
Table 8: Chi-Square Descriptive Statistics -----	96
Table 9: Chi-Square Test Statistics -----	96
Table 10: Relative Frequency of the Selected Tree Species in the Study Area -----	98
Table 11: Distribution of Selected Tree Densities in all Quadrats around the Communities ---	119
Table 12: Perceptions of Availability of Selected Trees -----	122
Table 13: Perceived Changes in Tree Densities Compared to the Past 10-20 -----	124

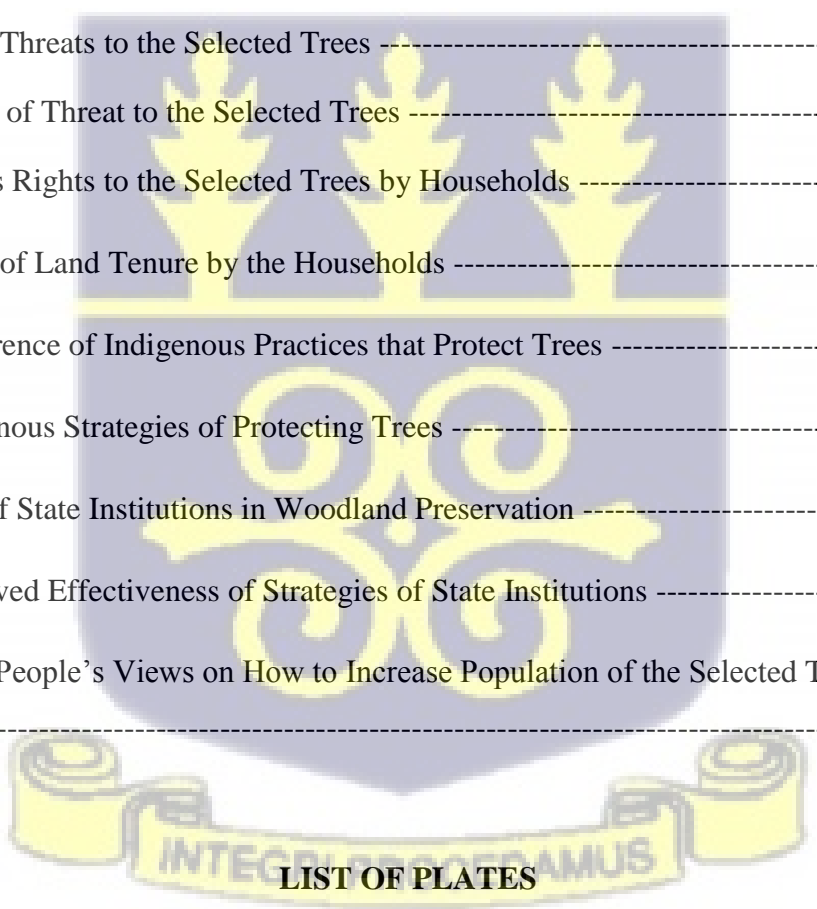
Table 14: Growth Characteristics of the Selected Trees in the Study Communities -----	129
Table 15: Selected Trees GBH across Land Use Regimes in the Study Area -----	130
Table 16: Composition of Selected Tree Species in the Land Use Regimes -----	131
Table 17: Demographic Profile of the Study Communities -----	135
Table 18: Social Profile of the Study Communities -----	137
Table 19: Ownership of Household Assets by Households -----	139
Table 20: Major Sources of Cash Income by Households -----	140
Table 21: Consumptive and Non-Consumptive Use Categories of Selected Trees -----	144
Table 22: Major Threats to the Selected Trees -----	154
Table 23: Levels of Threat to the Selected Trees -----	156
Table 24: Access Rights to the Selected Trees by Households -----	162
Table 25: Types of Land Tenure by the Households -----	164
Table 26: Occurrence of Indigenous Practices that Protect Trees -----	166
Table 27: Indigenous Strategies of Protecting Trees -----	167
Table 28: Role of State Institutions in Woodland Preservation -----	169
Table 29: Perceived Effectiveness of Strategies of State Institutions -----	173
Table 30: Local People’s Views on How to Increase Population of the Selected Trees in Communities -----	175
	
Plate 3:1 <i>Anogeissus leiocarpus</i> Tree -----	64
Plate 3:2 <i>Balanites aegyptiaca</i> Tree -----	66

Plate 3:3 <i>Faidherbia albida</i> Tree	68
Plate 3:4 <i>Khaya senegalensis</i> Tree	70
Plate 3:5 <i>Parkia biglobosa</i> Tree	72
Plate 3:6 <i>Vitellaria paradoxa</i> Tree	74
Plate 3:7 Taking Records of Tree Girth Reading at 1.37m above Ground	88
Plate 3:8 <i>Parkia biglobosa</i> Tree with Forked Stem Close to Ground Treated as Individuals ---	89
Plate 5:1 Bark Harvesting of <i>Faidherbia albida</i> Tree. The Bark of the Tree is highly Patronized for Traditional Medicine	152
Plate 5:2 <i>Parkia biglobosa</i> Tree in a Community Threatened by Wood Rot or Dead Stem Caused by Wood Decay Fungi	157

LIST OF APPENDICES

Appendix 1: Household Head Questionnaire	203
Appendix 2: Focus Group Discussion Checklist	210
Appendix 3: Tree Use Category Tables	211
Appendix 4: Tree Inventory Form	217
Appendix 5: Chi-Square Analysis of Tree Frequency Distribution	218



CHAPTER ONE

INTRODUCTION

1.1 Background to the Study

Tree management is an age-old strategy adopted by rural people as it contributes in enhancing their livelihood needs (Nowrotzki, Hunter, and Dickinson, 2012; Haglund *et. al.* 2011; Regmi and Garforth, 2010). Trees are a vital component of the global natural ecosystem because of the role they play in the preservation of ecological balance that is so important to natural resource-based livelihoods. There is a dynamic relationship between trees and the people's livelihoods, particularly as regard to non-farm income generating opportunities among the poor in the drylands.

This relationship can also be seen from the point of view of environment-livelihood nexus whereby people in the process of finding alternative livelihood strategies to increase their income alter the environment. Pichler (2011) argued that people in their quest for deriving resources as a result of pursuit of different livelihoods from nature physically modify it. In the course of dependence on the environment, the growing human population puts pressure on the land, which they rely upon as an incentive to protect them, and it eventually loses its natural resilience, thereby threatening the fragile dryland ecological balance.

Trees, whether they exist in off-farm or on-farm situations, contribute immensely toward livelihood improvement. German *et al.* (2006) strengthen this point by stating that rural livelihoods are being improved when trees are combined with crops in smallholder agroforestry systems, thereby preventing environmental degradation. Moore (2008) further noted that farmers

for generations have left trees standing on their farms deliberately. They do this with a view to conserving these important trees, even as other associated trees have decreased due to expansion of agriculture and fuelwood extraction. Trees with high socio-economic value to people are usually the ones left standing on farms, as a way of conserving them when forest areas are converted into farming systems (Mullan *et al.* 2018; Kakai *et al.* 2011; Bounkougou, 2009; Mercer, Frey, and Cabbage, 2014).

There have been worldwide declines in the diversity of tree species as a result of deforestation activities and other human actions. Though losses of tree diversity may have only small impacts on an ecosystem in the short term, they may reduce its capacity to recover or adjust to changing environments in the future. Tree diversity losses also affect services that regulate ecosystem processes, such as climate, floods, disease, and water quality. In drylands, land use changes affect biodiversity harmfully. Bounkougou (2009) also noted that the most serious direct threat to biodiversity in drylands is land use changes from degradation of environment. He went ahead to state that losses of biodiversity in drylands make them more vulnerable to further degradation as well as also undermining their environmental health.

Despite claims of increasing tree or biodiversity losses, some researchers believe that dryland biodiversity is being preserved and improved. Mortimore (2009, p.74) argued that “the biodiversity of dry land ecosystems is greater than commonly supposed and valued by the local communities”. However others like UNDDD (2011) and El-Siddiq (2003) argued that some level of biodiversity has improved over time but these are based mainly on tree planting in agroforestry systems. According to them, these accomplishments in drylands are due to the local

people's efforts and project interventions. These indigenous agroforestry trees also form an integral part of the traditional farming system of the savanna parklands in Nigeria and elsewhere. Regmi (2003) in the same vein maintained that households sustain different types of trees due to their values, and this practice enhances biodiversity conservation.

Different economic trees are used in diverse places to improve human livelihoods mostly through the collection of timber and use of non-timber forest products (NTFPs) in both drylands and forest regions. This has been documented by Oldekop, *et al.* (2020); Widianingsih, Thielade, and Pouliot, (2016); Brack, (2018). They affirm the importance of timber and non-timber forest products for the livelihoods of particularly poor forest dwellers. The benefits of non-timber forest products (NTFPs) harvested from trees, according to Belcher (2003), are more likely to affect the poor people and that its development serves to reduce poverty and encourage conservation. He went further to state that significant numbers of poor people living in rural and urban areas rely on these NTFPs as sources of cash income and as raw materials for home-based industries. These timber and non-timber forest products also serve as livelihoods diversification to rural poor especially in sub-Saharan Africa. Livelihoods diversification according to Rubiyanto and Hirota (2021) increases income sources through diversification of assets and activities in rural households.

The focus on poverty reduction particularly in Nigeria and other developing countries has always been on agricultural production. Little attention is paid to the value of trees to supporting non-farm livelihoods and also in providing direct and indirect services to rural people. This study located in northwestern Katsina State, Nigeria is therefore aimed at investigating the state of the

six major economic trees, their governance and their role in achieving sustainable livelihoods of the rural population. These tree species include *Anogeissus leiocarpus* (DC.) Guill. & Perr. (African Birch), *Balanites aegyptiaca* (L.) Delile, (Desert Date), *Faidherbia albida* (Delile) A. Chev. (Winter Thorn), *Khaya senegalensis* (Desr.) A. Juss. (African Mahogany), *Parkia biglobosa* (Jacq.) R. Br. Ex Don. (African Locust Bean), and *Vitellaria paradoxa* C.F. Gaertn (Shea Butter). The local communities rely on these selected trees to serve as a livelihood diversification strategy apart from agricultural activities.

1.2 Problem Statement

A nexus between rural livelihoods, trees and deforestation is one of the biggest ecological problems in the world today, especially as it affects the use and management of trees and other woody plants. Richerzhagen (2011) supported this view by suggesting that the most critical problem that is now challenging the global environment, apart from climate change, is biodiversity depletion. This problem could be particularly grave in dryland ecosystems such as in sub-Saharan Africa, whereby in some areas, increasing pressure on vegetation and other natural resources is posing serious threat to the growth of vegetation, particularly trees. In some of these places including the study area, land degradation is already a serious problem. Effeh (2000) shared this view in stating that northern Katsina State is an area believed to be threatened seriously by land degradation which also includes that of vegetation.

The Institute for Agricultural Research (IAR) Zaria, Nigeria (1998) emphasized that in Katsina state, deforestation is being caused partly by a number of factors which include expansion of human settlements, indiscriminate exploitation of fuelwood, and conversion of forests to

farmlands and settlements. Elsewhere in the same agro-ecological zone, Kuppers (1998) cited in Hof *et al.* (2003, p. 7) in a study of Zamfara forest reserve in Nigeria maintained that “the species composition of the herbaceous and woody vegetation and the low rejuvenation of ligneous species due to browse and lopping are signals for the degradation of the natural vegetation”. Livelihoods activities in such areas continue to be sustained despite the occurrence of deforestation and land degradation.

Tree resources form an integral part of the livelihood security of the rural poor in the growth of viable income-generating enterprises particularly those that are based on natural resources. CGIAR (2011) strengthened this point, by revealing from a survey of 9000 households from disadvantaged rural communities in developing countries that 20-25% of their annual income is contributed by forest products. The World Bank (2001; cited by El-Siddiq, 2003) reported that 1.6 billion people worldwide have their livelihoods dependent on forest resources. In the same vein, Chigwenya and Chirisa (2007, p. 19) argued that “more than 90% of the world’s 1.2 billion poor depend on forest resources for livelihoods”.

This shows the role of tree products harvested from the natural environment in providing benefits to so many local people who depend on it for livelihood sustenance. The selected economic trees including *Anogeissus leiocarpus* (African Birch), *Balanites aegyptiaca* (Desert Date), *Faidherbia albida* (Winter thorn), *Khaya senegalensis* (African Mahogany), *Parkia biglobosa* (African locust Bean) and *Vitellaria paradoxa* (Shea Butter), through their use and management, could play a very important role in bringing livelihood security and facilitating rural economic development for rural communities living in the study area. Such trees were selected in view of

the fact that most of them are prevalent and widespread in the region. The population or availability of some of these selected trees could however threaten livelihoods in the study area. This particularly refers to *Khaya senegalensis* as the tree has been declared vulnerable specie according to the IUCN Red List. Odihi (2003) also added that agrarian changes and increased demand for fuelwood are seriously threatening the sustainability of parkland systems in Nigeria.

Heavy reliance on the environment in dry lands in the face of growing human population and deteriorating economic base threatens the existence of the trees and therefore opportunities for tree-based livelihoods that offer supplementary cash income through harvesting of timber and non-timber forest products (NTFPs). The linkage between tree diversity, livelihoods, and local knowledge is well established. This is also the concern of political ecology where Escobar (1998, p. 55) sees biodiversity from a discursive perspective which according to him opens up “a new relation between nature and society in the contexts of science, cultures, and economies”.

Previous studies in the study area and neighboring environment in the Sahel have focused attention mainly on the ethnobotanical or uses of trees and other woody plants NTFPs and its contribution to overall livelihoods. Ayatunde *et al.* (2009) studied the uses and knowledge of local herbaceous and woody species by the agropastoralists in South-western Niger. They discovered that of the 87 herbaceous plant species included in the survey, 81 were considered useful, while all 36 woody plant species were considered useful by the respondents. Buyinza *et al.* (2015) assessed the indigenous tree species use values and their conservation in Kyoga plains in Uganda. Their findings show that communities in Uganda generally valued a particular tree species for at least more than one favored use. Lykke, Kristensen, and Ganaba (2004) in their

study of valuation of local use and dynamics of 56 woody species in the Sahel have also emphasized the relative importance of these plant species in the livelihoods of local communities.

However, in another study conducted by Lawal (2012) in northern Katsina State, some tree species, including *Khaya senegalensis* and *Vitellaria paradoxa* in parts of the study area, have significantly become depleted due to decline in rainfall and fuelwood harvesting in addition to agricultural extensification. He further stated that thirty years ago most of these tree species were the dominant vegetation of the area. However, according to him, a few others such as *Faidherbia albida* have actually increased in density at some localities, due mainly to the deliberate protection given them and their income generation potentials. In all of these places, plant degradation particularly that of trees and other woody plants reduces the possibilities of further improving rural livelihoods.

Many other studies including the aforementioned ones fail to address the trees governance and accesses with respect to their use and management as well. The livelihoods role of trees is impacted by institutional arrangements for access to the trees. Laird *et al.* (2011) in Woldeamanuel, (2011 p. 4) emphasized that “NTFPs use is characterized by a diversity of institutional arrangements regarding access to the resources and markets at both local and national level”. What else need to be known further are the institutional provisions surrounding the access to the selected tree use and management. This has therefore served as the gap in knowledge for the study.

Knowledge generated from this study seeks to improve and deepen our understanding of the tree-livelihood dynamics and opportunities for sustaining livelihoods. This study adds to the literature on sustainable rural livelihoods in the Sudano-Sahelian zone of West Africa. It contributes to the discussion on the role of local and state institutions in the governance of tree resources and the promotion of sustainable economic growth and social development in Nigeria.

1.3 Key Research Questions

The research in particular raised and answered the following questions:

1. What are the frequencies, spatial distributions, densities as well as girth classes of the selected economic trees (*Anogeissus leiocarpus*, *Balanites aegyptiaca*, *Faidherbia albida*, *Khaya senegalensis*, *Parkia biglobosa*, and *Vitellaria paradoxa*)?
2. What are the forms of access rights and control over the use of the selected economic trees and the opportunities and constraints associated with them?
3. What relative contributions do the selected economic trees make to rural livelihood portfolios in the study area?
4. What are the indigenous knowledge and capacities that support the conservation of the selected economic trees in the study area?
5. What is the role of the major local and national institutions in governing the management of tree resource use?



1.4 Study Objectives

The study investigated the spatial and physical attributes of six economic trees, the governance regimes, and their contribution to the livelihoods of rural households. The following sets of objectives were investigated:

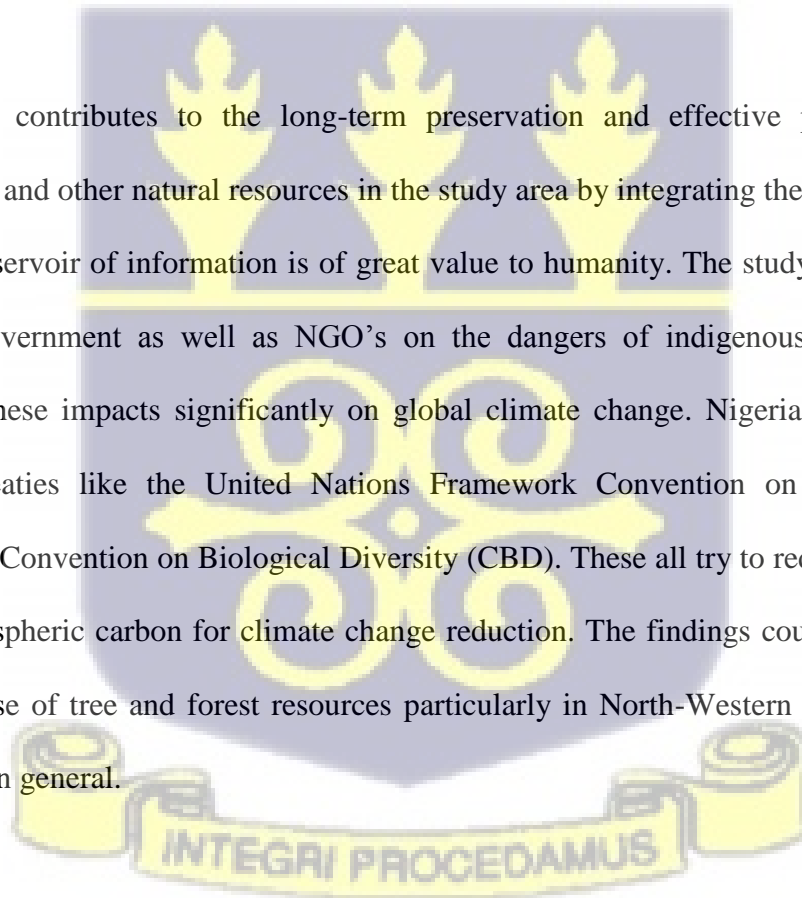
1. To determine the frequencies, spatial distributions, densities, and girth classes of the six selected economic trees (*Anogeissus leiocarpus*, *Balanites aegyptiaca*, *Faidherbia albida*, *Khaya senegalensis*, *Parkia biglobosa*, and *Vitellaria paradoxa*).
2. To ascertain and analyze the forms of access rights and control over the use of the selected economic trees and the opportunities and constraints associated with them.
3. To determine the relative contributions of the selected economic trees in sustaining rural livelihood portfolios in the study area.
4. To evaluate the indigenous knowledge on the selected economic trees and ascertain the local methods and capacities to conserve them.
5. To examine the role of major local and national institutions in governing the management of tree resource use.

1.5 Significance of the Study

Wiersum and Shackleton (2003; cited by Ros-Tonen and Wiersum, 2003) affirmed that natural resource exploitation that includes the gathering of NTFPs still may play a significant role within diversified livelihood activities. The study which explored how timber and non-timber forest products (NTFPs) and direct use values of the six selected economic trees underpin livelihoods activities of the rural people in northwestern Katsina State, Nigeria is significant from both theory and practical perspectives.

The study adds to existing knowledge and theory by adding to the literature on sustainable natural resource-based rural livelihoods with examples from the Sahelian zone of West Africa relating to the selected economic trees. The study also helps to provide inputs for the refinement of government policies. In terms of practical development, many existing government development programmes, policies, and interventions might benefit as findings of the study could be used as baseline data to guide rural development planning. It could still be useful for implementing policies to support the best management and conservation practices particularly those with regards to tree restoration, agroforestry and agrosilvipastoralism activities, for national benefits and food security.

The study also contributes to the long-term preservation and effective protection of the indigenous trees and other natural resources in the study area by integrating the local community, because their reservoir of information is of great value to humanity. The study would hopefully sensitize the government as well as NGO's on the dangers of indigenous trees and forest destruction as these impacts significantly on global climate change. Nigeria is a signatory to international treaties like the United Nations Framework Convention on Climate Change (UNFCCC) and Convention on Biological Diversity (CBD). These all try to reduce deforestation and hence atmospheric carbon for climate change reduction. The findings could also contribute to sustainable use of tree and forest resources particularly in North-Western Katsina State and other dry lands in general.



1.6 Outline of the Thesis

The general chapters outline and organizational structure or layout of this thesis is presented in this section. The thesis comprises seven chapters and what each of them contains from one to seven is introduced as follows.

Chapter 1 as discussed above served as introduction and explores the background to the research which sets the tone of the work, problem statement, and further set out research questions, objectives and significance of the study.

Chapter 2 reviews the literature and discusses the conceptual framework which develops the theoretical underpinnings or foundation of the study and it discusses related literature on the study context like vegetation degradation in Africa, uses of trees and their institutional arrangements.

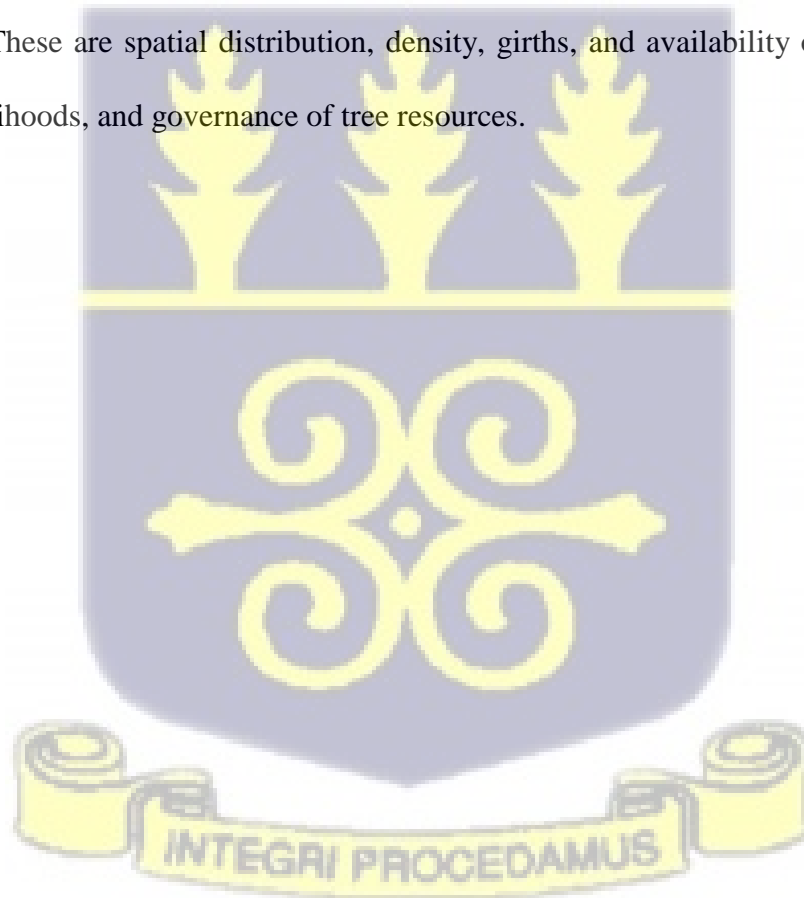
Chapter 3 provides the study area and the methodology and it comprise three main sections which are the study area, selected trees and justification, and methodology that includes data collection, sampling, research methods and statistical analysis.

Chapter 4 is on the ecological discussion of the selected economic trees and it deals with the findings of the ecological survey considered in chapter 3 on spatial distribution, frequency, density, girth class distribution and trees availability trend.

Chapter 5 presents the communities social and demographic profiles, livelihoods of the households, uses of the selected trees in the communities, sustainability of the selected trees and use/livelihoods, ownership of various household assets, and major threats to the selected trees.

Chapter 6 examines the role of local and state institutions that comprise five main sections which are indigenous practices that protect trees, access rights and tree tenure, state institutions and woodland preservation, and views of local people on how to increase tree population.

Chapter 7 presents the summary of the key findings, conclusions and recommendations in three main sections. These are spatial distribution, density, girths, and availability of trees, trees and sustainable livelihoods, and governance of tree resources.



CHAPTER TWO

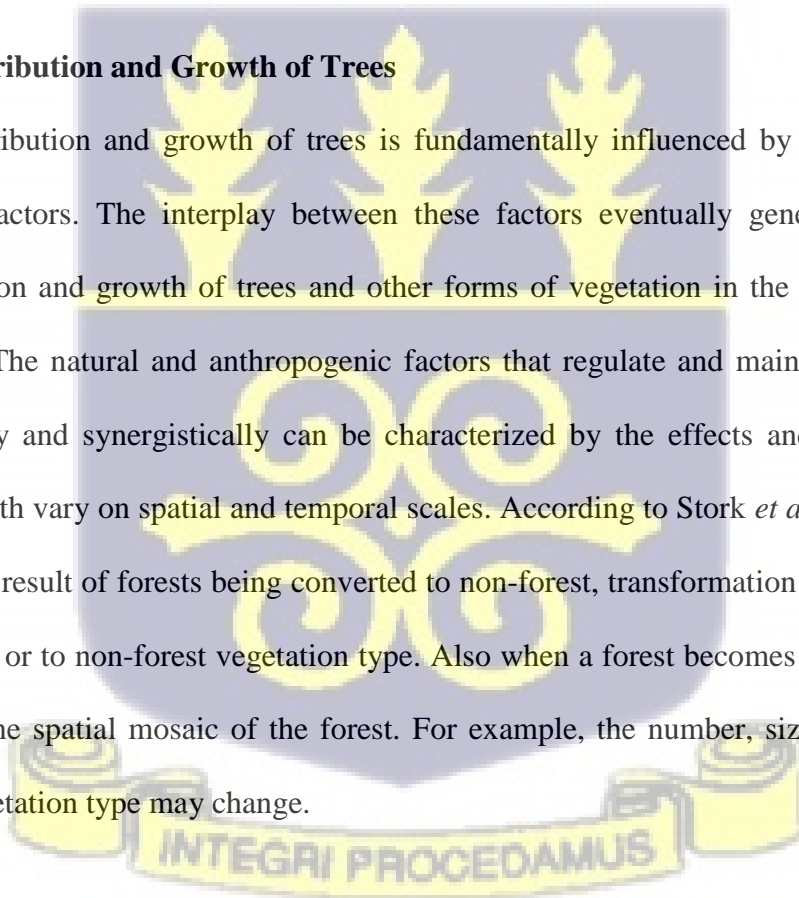
LITERATURE REVIEW AND CONCEPTUAL FRAMEWORK

2.1 Introduction

This chapter presents the literature review and constructs a conceptual framework for the eventual analysis. Themes assessed include livelihood-society relationships; the role played by trees; the role of institutions; biodiversity debates; access to tree resources, and the role of local knowledge in their utilization. It also assessed the conceptual framework on which the work is rooted to provide guidance and focus to the research.

2.2 Spatial Distribution and Growth of Trees

The spatial distribution and growth of trees is fundamentally influenced by a combination of environmental factors. The interplay between these factors eventually generates the current spatial distribution and growth of trees and other forms of vegetation in the dry lands and the world at large. The natural and anthropogenic factors that regulate and maintain tree diversity both individually and synergistically can be characterized by the effects and response of the system which both vary on spatial and temporal scales. According to Stork *et al.* (1997), changes could occur as a result of forests being converted to non-forest, transformation of one forest type to another forest or to non-forest vegetation type. Also when a forest becomes fragmented, there is a change in the spatial mosaic of the forest. For example, the number, size and/or shape of patches of a vegetation type may change.



2.2.1 Ecological Factors Affecting Tree Distribution

Environmental factors that affect the spatial distribution and growth of trees are climate including light, temperature, water and humidity, topography, and soil condition. Gholinejad, Farajollahi and Pauzesh (2012) also supported the view that the occurrence of different vegetation groups in an area is determined by interplay of different ecological factors. Climate through its factors that include rainfall, temperature is the most important aspect that affects tree growth and distribution. Emanuel, Shugart and Stevevson (1985) remarked that the linkage between vegetation and climate parameters is integrated into nearly all systems of climatic classification.

Climate nurtures vegetation which ensures that trees grow in the first instance before the impact of all other environmental factors. Climate changes though in part caused due to anthropogenic effects as currently experienced also plays an important role in the growth and distribution of trees and other forms of vegetation. Trisura, Alkemade, and Arets (2009) supported the argument that climate change can considerably influence distribution of plant species and composition of the ecosystem which threatens global biological diversity. The relative effect of each of the climatic parameters on vegetation varies in different parts of the world. In tropical dryland climates rainfall is the most important activity affecting tree growth and distribution.

Topography affects tree growth and distribution indirectly through its influence on rainfall, temperature and soil characteristics. Topography, as a parameter, has the ability to influence to a large extent, the range as well as distribution of vegetation including trees and other woody plants within tropical forests (Faqua, Cabrera and Gonzalez, 2013). The effect of elevation on

plant growth and development is best seen on hilly and mountainous regions where changes in vegetation are observed with increased ascent.

Edaphic factor through its physical and chemical and biological properties directly affect tree growth and development but this is not so pronounced as in the above mentioned parameters. Clark, Cark and Read (1998, p. 102) added that “there is much less information on the effects of edaphic factors on plant species distribution where the gradient is less extreme”. Not all plants need soil to grow as in epiphytes and hydrophytes but most plants including trees that are terrestrial need soil to live because their roots are anchored to the soil.

2.2.2 Anthropogenic Factors Affecting Tree Distribution

Apart from the environmental factors that affect the spatial distribution and growth of trees discussed above, anthropogenic effects increasingly influence this distribution through agriculture, urbanization and industrial development. Other human activities include constructions and mineral exploitation and other forms of deforestation. These human activities have affected the composition and distribution of tree species. Extensive areas of once forests have been cleared while in some areas new tree species have been introduced. Exotic and invasive species of trees have replaced naturalized ones in afforestation programmes especially in arid regions. Such human activities are capable of causing land degradation in a particular place. Human activities have profound influence on the degradation trends and patterns in drylands (Reynolds *et al*, 2007) in Ravi *et al*. (2010 p. 237).

2.3 Vegetation Degradation in Africa

Diverse plant and animal life constitute the earth's biodiversity which includes diversity within species, diversity between species, and diversity between ecosystems. Modification or changes through human interference could lead to direct loss of assemblages of tree species. These have an effect on the ecosystem processes that generate and maintain biodiversity which could thus lead to vegetation degradation. Worldwide, land degradation has been defined as a loss or reduction in the productivity of the land or soil as a result of human activities. A broad variety of land conditions according to Gibbs and Salmon (2015) are however used to refer to land degradation which include desertification, encroachment of invasive species, soil erosion, compaction and salinization.

Although lack of reliable data on land degradation in Africa exist (Gibbs and Salmon, 2015; Tully *et al.*, 2015; Kigomo, 2003), land degradation is still a serious problem in Africa. Kigomo (2003) stated that Africa is the most degraded continent in the world. He went ahead to add that, the activities of man such as animal grazing, agricultural extensification, overexploitation of resources, and deforestation in order of their importance, have degraded a total of 340 million hectares of woody vegetation in African drylands (Table 1).

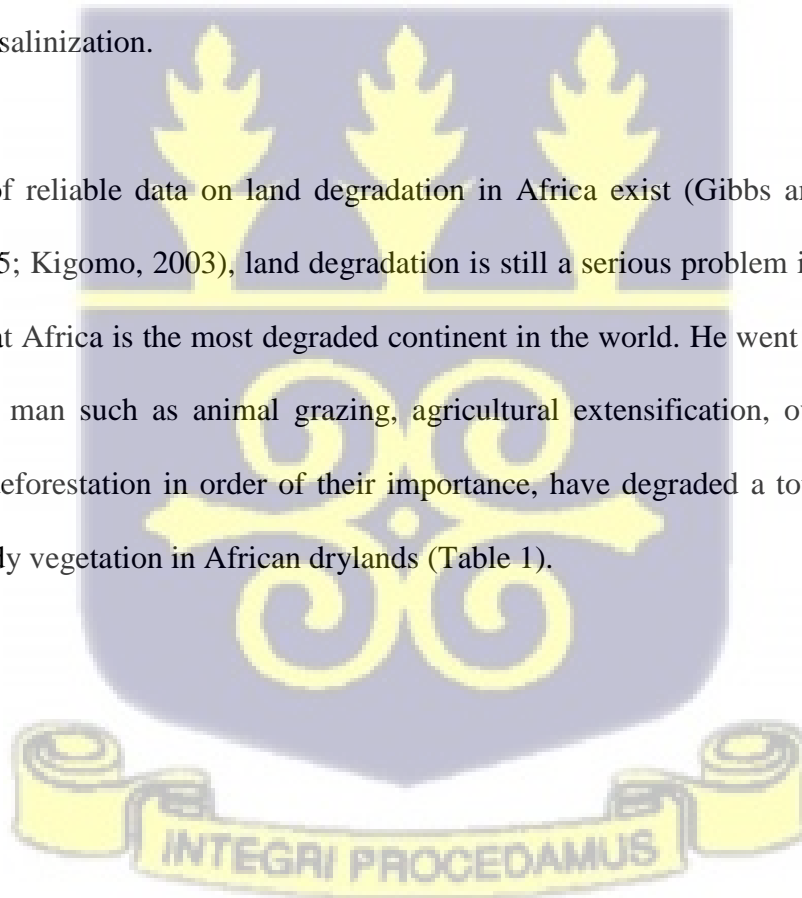


Table 1: Extent of land Degradation due to Deforestation and de-vegetation in Africa (million ha)

Factor	Aridity Zones			Total
	Arid	Semi-arid	Dry sub-humid	
Overgrazing	119.9	61.9	12.6	194.4
Agricultural activity	11.1	33.8	15.5	60.4
Over exploitation	42.0	11.7	1.8	55.5
Deforestation	3.9	7.6	10.5	22.0
Total	176.9	115.0	40.4	332.3

Source: World Atlas of Desertification (1997) in Kigomo, (2003)

For quite some time, debate has been raging over the relationship between man, society and environmental change such as vegetation degradation. While some argue that the environment is being degraded by rural people putting pressure on land in order to eke out a living, others believed that land degradation is not as serious as is being portrayed. Warren and Agnew (1988) in Dahlberg, (1994) stated that the debate on land degradation and other environmental changes is characterized by disagreements and confusion about the causes, extent, and severity of changes that affect the land.

In the past, the assumption had been that inappropriate human activities were causing serious land degradation and desertification in Africa. These beliefs include the Brundtland Commissions work and the neo-Malthusian perspective who according to Leach and Mearns (1996) conveyed the impression of the earth having a fixed natural resource base. According to these arguments, prolonged degradation of dryland areas continues to affect the productivity and genetic diversity of forest, woodland and bush land resources (Mengistu *et al.*, 2005 p.260).

However, recent research studies and literature have questioned the generalizations on land degradation in sub-Saharan Africa. Many of such literature have argued that these evaluations of environmental change are either framed up, exaggerated or even false. Leach and Mearns (1996), Tiffen, Mortimore and Gichuki (1994) in a study in Machakos district in Kenya believed that there is environmental recovery and adjustment of resource dependent poor people in the face of the environmental crisis. They believed that population density and poverty did not necessarily lead to land degradation. New ideas about land degradation are now emerging from studies on dryland areas in Africa and other parts of the world. Dahlberg (1994) suggested that “new ideas concerning the dynamics of semi-arid environments have been inspired by studies of indigenous ecological knowledge, as well as a re-evaluation of local land use systems”.

Environmental changes particularly with regards to land degradation in Africa and elsewhere have serious implications for sustenance of livelihoods. Trees, apart from the environmental services that they provide, are also very useful for sustaining rural livelihoods particularly those that are natural resource-based and of non-farm category. Results from a study in Namibia have shown that the people obtain substantial economic benefits from their natural ecosystems as a result of tree biodiversity alone (Naidoo *et al.*, 2011). The dependence on tree products by the rural dwellers is seen as a form of livelihood diversification mechanism to sustain or revamp income generation through the harvesting of wood for selling as firewood as well as non-timber forest products (NTFPs) like fruits, leaves, seeds and sap. Some of these products also serve as food supplements in times of need. Bloomer (2009) sees livelihoods as the diverse forms of livelihood strategies employed by the different levels of rural dwellers so as to sustain them.

2.4 Role of Local Knowledge in Managing Trees

Indigenous knowledge has been given various definitions. Beckford and Barker (2007, p. 118) define it as “dynamic and complex bodies of know-how, practices and skills that are developed and sustained by peoples/communities with shared histories and experiences”. They also define it as “knowledge which is developed and used over time by local people and is influenced by environmental and socio-economic realities”. Indigenous knowledge of biodiversity has existed over several millennia although Bounkougou (2009) argues that there has not been proper documentation of indigenous knowledge about biodiversity in drylands. Each society or culture has its own unique way of representing its experiences and perception of its own natural environment.

Bodeker (2005) is also of the view that local people living in rural communities are frequently well-informed about the recognition and ecology of plant and animal species among others. Warburton and Martin (1999) maintained that local people make important observations regarding their surroundings including the know-how to adapt to their own environment. Indigenous knowledge is very important to the livelihoods of so many rural dwellers in providing increased food production that help to feed the population, sustain economic growth and reduce poverty. Twarog (2004) believed that indigenous knowledge of biodiversity particularly in developing countries like India enhance food and livelihood security of rural people which helps them achieve self-reliance, sustainable growth and development. They went ahead to recognize the importance of this knowledge in the lives of much of the world’s population and in the conservation of biodiversity.

Howard (2003) argued that women are the most knowledgeable people about local plants in the domestic or wild form. She further stated that they mostly engage in local conservation and management of many useful plants including trees. In a study of local people in rural Limpopo Province, Banda (2005) found that an indigenous knowledge system is greatly used in the conservation and management of trees and other plants there. According to him this includes plant uses, soil types and natural habitats.

Despite the importance of indigenous knowledge in the conservation of trees, other researchers hold different views. Beckford and Barker (2007, p. 125) cited (Kalland, 2000) when arguing that “one of the criticisms of local traditional knowledge and its perceived value is that it tends to be highly contextual and its relevance or usefulness outside the spatial locales where they were created is in doubt”. In the same vein, Rist and Dahdouh-Guebas (2006) noted that indigenous knowledge has been repeatedly rejected and considered as unscientific not capable of meeting the necessary rapid economic development of the modern times.

Indigenous and scientific knowledge should be seen as complementing one another towards improving the involvement of local and indigenous peoples in tree conservation and management. In the same vein, Ann (2004) stated that scientific developments including the local knowledge of the people have helped in the utilization of both traditional and introduced plant varieties. Despite the importance of science and indigenous knowledge in helping local communities to exploit trees and other forms of vegetation, the implementation is not without problems as perceived by some researchers.

People in different parts of the world use indigenous knowledge to conserve and maintain trees. Gadgil, Berkes and Folke (1993) stated that the Kayapo Indians of southern Amazon forest of Brazil enhance biodiversity through the creation of forest islands called *apete*. This according to them has helped tremendously in curbing plant diversity loss in the Amazon using their local knowledge of trees. Nelson *et al.* (2010) have also stated those small scale farmers in Peru plant crops on different types of terrain and this has been acknowledged long ago in agro-ecology as a critical strategy they adopt in order to spread risk by making use of their local and indigenous knowledge. Dovie, Witkowski and Shacleton (2008, p. 311) posited that “indigenous knowledge has not been properly examined in terms of its utility to support biodiversity conservation”. This important store of knowledge must however be conserved and maintained. Gadgil, Berkes and Folke (1993) also maintained that it is important to conserve indigenous knowledge and in doing so consideration should be given to the local people’s community-based resource management systems.

2.5 Uses of Trees

There are two main benefits of trees to human beings. These are direct use (tangible) and provision of ecosystem services (intangible). Trees have direct economic benefits and they are used by people that live in or near them to provide some livelihoods. Ecosystem services that ensure the maintenance of life are also provided by these woody plants and these include exchange of gases in the atmosphere and soil formation which are very important for both man, animals, and the plants themselves.

2.5.1 Edible Use of Trees

Mapongmetsem, Kapchie and Tefemba (2012) cited Kalaba *et al.* (2009) as saying that food insecurity is a characteristic feature that rural households in sub-Saharan African countries have to endure. This necessitates people to make use of certain trees and plants as food supplements apart from the food grown on the farms. The use of trees and other plant resources for food is an obvious activity throughout the world. Taylor, Green and Stout (1997) claimed that 95% of food eaten by human beings is derived from only 30 out of the 250,000 recognized higher plant species including trees.

Harris and Mohammed (2003) also in a study identified 67 wild foods, including fruits and nuts which come from 53 species of plants that play an important role in the livelihood of people in Dagaceri village in northeastern Nigeria. They went ahead to state that these help to enhance the nutritional value of their meals as well as being used during food scarcity periods especially before the annual harvests. Legwaila *et al.* (2011) also testified that indigenous food plants are used for food and source of income between cropping seasons among rural households in many African farming systems. Some of the important trees used for food in African drylands that include some of the selected tree species are; *Vitellaria paradoxa* (Shea butter tree), *Adansonia digitata* (Baobab), *Parkia biglobosa* (African Locust Bean), and *Balanites aegyptiaca* (Desert Date).

Vitellaria paradoxa or shea butter tree is highly utilized for food in West Africa even though it also has a number of other important uses. Moore (2008) supported this point by stating that *V. paradoxa* is used extensively for its nutritious fruit which is eaten as well as for its wood used as

firewood and for medicinal purposes. The kernel of the fruit contains fat from which shea butter is obtained and this has a wide range of uses to local communities. Dianda, Bayala, and Ouedraogo (2009) added that the tree because of its kernel that contains fat is favored by farmers who sell it locally and internationally to generate substantial wealth that enhances their livelihoods. Moore (2008) cited Pulsen (1981) who said that the most important oil crop in Africa after palm oil is produced by the shea butter tree. He further stated that Ghana being the largest producer of shea nuts in the world produces 650,000 tons of the products annually.

Another tree *Pakia biglobosa* or African locust Bean tree is also widely used as food in West Africa. Koura *et al.* (2011) in a study of *Parkia biglobosa* in northern Benin revealed that of all the parts of the tree, its seeds are used the most by people especially for food. He further stated that the tree is widely used by local communities in drylands of Africa for its multi-purpose advantage. In Nigeria a food condiment known as - *Daudawa* is also made from the seeds of the tree.

2.5.2 Fuel wood Use of Trees

Mortimore (2009) argued that the most important use of wood in drylands is for fuel which is followed by construction and craft timber. A substantial number of people living in the drylands of the world use trees in particular as fuel wood largely for domestic purposes such as cooking. Most of the fuel wood is obtained from the natural tree stocks. UNEP (2009) stated that due to the high cost of fossil fuels such as petroleum, kerosene, and natural gas, more than 80% of the people depend on wood and charcoal in their homes for cooking and heating purposes.

O'Brien, O'Keefe and Rose (2007, p. 606) added that "2.4 billion people rely on traditional fuels such as wood, charcoal or dung as their principal source of energy for cooking and heating". They also stated that as a result of this, several women in India and sub-Saharan Africa daily spend from two to seven hours gathering fuel wood for cooking and also carrying 20 kilograms of fuel wood over an average of five kilometers distance. CGIAR (2011) also stated that over 90% of Africa's wood products are used as fuel and are derived from its forest and woodlands. The trees *Anogeissus leiocarpus* and *Acacia senegal* are extensively used for fuel wood in sub-Saharan Africa.

Because of the consequences of the over-exploitation of fuel wood on the natural environment as well as the need to make progress towards achieving the Millennium Development Goals (MDGs) for improving energy particularly in the developing countries, certain fundamental issues have to be addressed. Foremost among them is the problem of poverty which is why O'Brien, O'Keefe and Rose (2007) emphasized on the linkage between the problems of poverty and energy where each one cannot be resolved without tackling the other. In another dimension, Mahiri and Howorth (2001) argued that the fuel wood crisis in Kenya is largely as a result of poverty rather than environmental degradation. In another dimension, Sambo (2005) sees the energy crisis in Nigeria as due to high population growth leading to excessive fuel wood usage, little technical effectiveness of local stove and inadequate patronage of other means of cooking.

Another way of reducing the current fuelwood shortage, especially in the drylands, is in agroforestry practices where trees are allowed to grow on farms alongside crops and then used by the people to support their fuelwood needs at the same time making use of other non wood

products (NTFPs). This has proved successful in some parts of the world. A research carried out in Pakistan among farmers by Hussain *et al.* (2012) showed that growing trees on farms by the farmers have succeeded in helping them in meeting their fuelwood supplies as well as increasing income. Grainger (1999) cited in Matsika, Erasmus and Twain (2013) observed that unless high demand threatens available dead wood supplies, the favored fuelwood extraction consists of deadwood materials over live woody parts which when cut over time could lead to degradation of woodlands. In the same vein, significant studies in the Sahel in the early 1990s concluded that, “it has been a grave error to think that fuelwood has come from the exploitation of the natural savanna when, in the great majority of cases, it comes from deadwood in areas cleared for agriculture” (Catinot and Bonkungo, 1985) from Forley *et al.*, 1997).

2.5.3 Medicinal Use of Trees

Another major use of trees and other plant resources in drylands is in traditional medicines that are used for treating several illnesses common in drylands. There are so many indigenous trees in Africa that are used traditionally in the treatment of diseases. Mann (2012) maintained that the biodiversity of Nigeria contains abundant plants with medicinal value. WHO estimates that 80% of the world’s population uses plant medicines for their primary health care needs (Howard, 2003, p. 9).

Dutfield (2004) added that the world trade in medicinal plant resources and their products now runs into billions of dollars a year showing that herbal medicine is rapidly being acknowledged worldwide. UNESCO (1998); Ampofo (1997) in Atawodi, Adekunle and Bala (2011) maintained that the United Nations have supported countries to consider the use of safe and reliable herbal

medicine as part of their health care systems. UNEP (2009) have stated that an estimated USD 65,000 million worth of traditional medicine products was marketed in the world in 2004.

Many trees and other plants used for this purpose in sub-Saharan Africa and elsewhere include *Khaya senegalensis* and *Vitellaria paradoxa*. Others such as *Balanites aegyptiaca* according to Elfeel (2010) has all of its parts including roots, seeds, fruits and bark used in one way or the other for medicinal use in the treatment of different ailments. A research conducted by Atawodi, Adekunle and Bala (2011) at Samaru-Zaria in Nigeria revealed that the stem bark extracts of *Anogeissus leiocarpus* brings about some therapeutic effects on liver injury. Mann (2012) supported this point by stating that the tree's stem bark extract has antimicrobial potentials that can be used in the treatment of infectious diseases.

In another research conducted by Ognatan *et al.* (2011) at Bogou and Goumou-kope regions in Togo, *Parkia biglobosa* fermented seeds were found to have anti-hypertensive effects on people that consume it a lot. This was done by identifying and comparing two types of populations that consume the seeds and those who do not in the two regions of Togo. In Nigeria, another research conducted by Nwosu *et al.* (2012) at Ahmadu Bello University, Zaria on albino rats reveals that the leaf extracts of *Khaya senegalensis* can be used traditionally in the treatment of diarrhea especially among children.

2.5.4 Other Non-Timber Use of Trees

Although there is an intense debate on the definition and importance of non-timber forest products (NTFPs) in the literature, Belcher (2003) has defined it literally as all those plant

products with the exception of timber that come from forests. He went on to say that the type of definition adopted depends on the user's interests as well as objectives. However in this work, NTFPs are defined as all those products that come from the selected trees found in different landscapes of the study area. The importance of NTFPs varies in diverse communities living in different parts of the world. From livelihoods perspective, NTFPs contribute significantly to income sources. Ros-Tonen and Wiersum (2003) added that in the absence of other income-generating opportunities, NTFPs contribute to peoples' cash requirements. It has also been reported by Pandey, Tripathy and Kumar, (2016) that an estimated 275 million poor rural people in India derive at least part of their subsistence and cash livelihoods from dependence on NTFPs.

Apart from extraction of timber from some tree plants, harvesting of non-timber forest products (NTFPs) is gaining increased patronage. These non-wood products include fruits and seeds, gums, sap /latex, barks, leaves and foliage. Increased diversity of trees in particular encourages collection of these products because different trees have different non-wood products that are needed by different rural communities. Despite claims by Whitemore (1998) that recently timber has over-taken these minor forest products in terms of commercial value, NTFPs are still in the rural economy of developing countries. In the same vein, Shakleton et al. (2005) added that non-timber forest products (NTFPs) in developing countries are being increasingly marketed by people in the rural areas for earning their livelihoods. Some people preferred trees that are used for their minor products in sub-Saharan Africa which include *Borassus aethiopum* (construction) and *Vitellaria paradoxa* (fodder).

2.5.5 Ecosystem Services Provision of Trees

Apart from the direct economic benefits of tree resources that are discussed above, the other important use is in the provision of ecosystem services which are themselves relevant to the livelihoods of the rural communities. Ecosystem is a localized group of interdependent organisms together with the environment they inhabit and depend on. Ecosystem services are the benefits obtained by people from ecosystems. These include the benefits obtained from the different diversity of flora such as trees, providing services (e.g. food, clean water, timber, fiber, and genetic resources); regulating services (e.g. the regulation of micro-climate, flood control, watershed protection, disease, and water regulation); cultural services (e.g. recreational, aesthetic, and spiritual benefits); Supporting services such as, soil formation and fertility enhancement, nutrient cycling). These benefits ensure that the natural ecosystem which is the life support system on which the rural poor depend for their livelihood continue to function for the survival of not just people but all other forms of life.

Jose (2009) asserted that as part of a multifunctional working landscape, ecosystem services, along with environmental benefits as well as economic supplies are increasingly regarded as agroforestry provisions. The diversity of flora plays an important role in the way our ecosystems function and in the services they provide. Species composition matters as much or more than species richness when it comes to ecosystem services since the functioning of an ecosystem, and thus its ability to provide services to humans, is strongly influenced by the ecological characteristics of the most abundant species, not by the number of species (Millennium Assessment, 2005). The local loss of essential species can also disrupt services provided by an

ecosystem for a long time. Changes in the interactions between floral species can also lead to negative impacts on the ecosystem process.

Trees particularly in agroforestry systems have played a very important role in biodiversity preservation and climate change mitigation. The protection provided to them by smallholders makes sure that their genetic variability is enhanced. In many regions of the world, scientists and policy makers have observed that agroforestry continues to play a very important role in biodiversity conservation (Jose, 2009). These agroforestry trees also increase the amount of carbon sequestered from the atmosphere thereby helping to reduce the concentration of carbon dioxide (CO₂) there. In this way the tendency of climate change occurring is greatly minimized. Sharrow and Ismail (2004), Kirby and Potyin, (2007) in (Jose, 2009) explained that in agroforestry systems the inclusion of trees or shrubs as compared to fields of single crops or pasture increase the quantity of carbon sequestered from the atmosphere. The carbon stored by these trees could be traded in carbon credit markets.

However human exploitation of trees and other plant resources brings with it some negative impacts especially when it is done without considerations of sustainability. The land then loses its natural resilience and becomes susceptible to degradation processes with its attendant detrimental consequences for tree depletion. Egoh *et al.* (2012) added that the significance and degradation of ecosystem services to human beings have been highlighted by the Millennium Ecosystem Assessment (MA). Komwihangilo, Goromela and Bwire (1995) also highlighted that in different farming systems the frequent use of woody plant species including trees has its own

beneficial effects as well as some depressing consequences to the land. These threats to trees will continue to increase if serious conservation measures are not put in place.

2.6 Role of Institutions in the Management of Trees

A major concern of the connection between society and nature is institutions and key decision makers or actors. These are important in the creation of natural resource dependent livelihoods like the tree-based ones. Institutions according to Agrawal and Perrin (2008) are “humanly created formal and informal mechanisms that shape social and individual expectations, interactions, and behavior”. These institutions can be global, national or local such as bureaucratic government units, corporate, and business organizations. One of such is the land tenure system which prescribes who has access to what land on which livelihoods can depend. In any case, these institutions influence, to a large extent, livelihood activities in so many ways. Institutions whether they are governmental or non-governmental should be capable of helping in sustaining small holder livelihoods as well as improving rural economic growth. However, CGIAR (2011) have observed that these forest institutions rather than helping the rural people have concentrated their attention in policing areas and collecting revenue from them.

Olson *et al.* (2004) gave an example of the influence of national governments institutional policy on land tenure regulations as in making modifications in traditional land tenure arrangements that can lead to alteration of rights over land. The ownership of trees and forest is very crucial to their management and conservation which any serious governments must address. CGIAR (2011) have stressed that the lack of clarity over resource rights is one of the most important governance failures that affect sustainable management of forests and trees. These and other

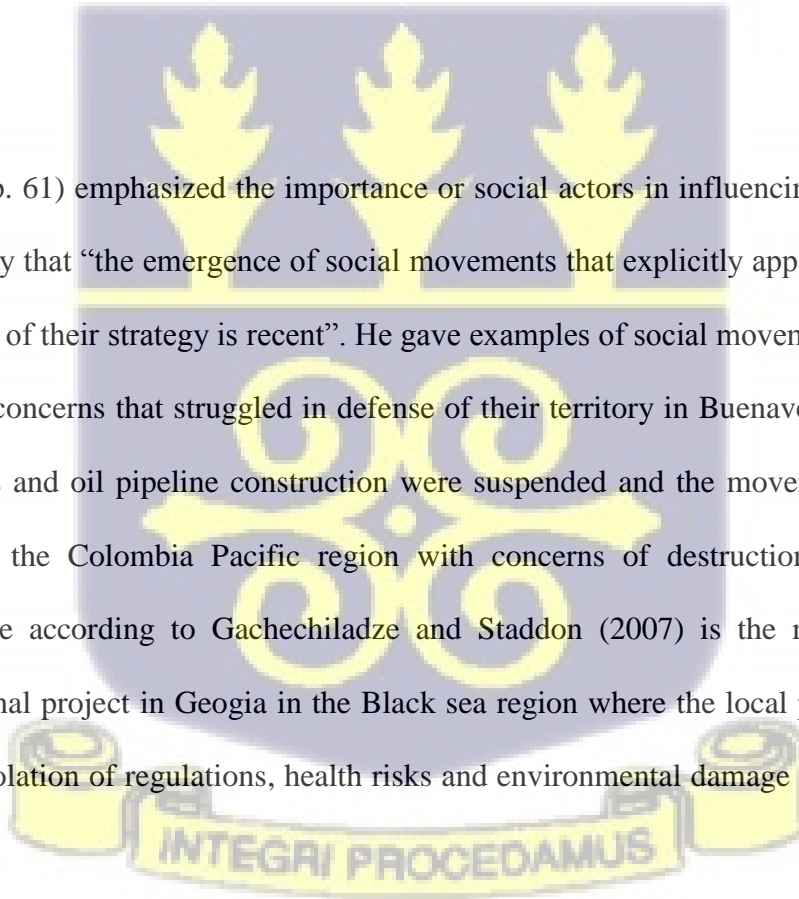
institutions like the global ones give different forms of input or interventions which through the local policy makers is used to impact on rural livelihoods.

Such local institutions according to Agrawal and Perrin (2008, p. 4) “shape the acquisition and distribution of these interventions in fundamental ways, thereby affecting the degree of success of such interventions”. On the whole, the influence of government development policies and programmes in developing countries is not getting down to the local communities. This affects even conservation activities such as land restoration and rehabilitation. Blaike (1989) supported this by saying that in most of the developing countries, state policies in conservation programmes have achieved little success. This therefore calls for increased participation of rural communities in land management activities. Unfortunately, this also requires institutional and policy reforms to be able to become realizable.

Some countries like India and Pakistan according to Shahbaz, Mbeyale and Haller (2008, p. 641) have achieved success in this participatory or bottom up approach but added that in this case “the major obstacles are that the state actors are not willing to fully devolve power; and the responsibility-as delegated by the state-of newly created institutions demands forest protection rather than defining management rights”. The governance of trees and forests needs to be improved and strengthened to be able to accommodate the local community’s participation in development programmes and activities. Traditionally, in most developing countries, the state regulates ownership and access to natural resources including trees and forests.

Arts and Visseren-Hamakers (2012) stressed that modern forest governance largely involves three forms that consist of decentralization, participation and marketization. They further maintained that decentralization brings politics closer to the local communities; participation involves the communities themselves in conservation and local management of trees and forest resources. Marketization involves market-based mechanisms or initiatives that help consumers and produces the management of forests which include Reducing Emissions from Deforestation and Forest Degradation (REDD). This is an international mechanism that provides incentives to developing countries to decrease deforestation and forest degradation by engaging in carbon trading that is supposed to bring in money to finance REDD activities in mitigating climate change.

Escobar (1998, p. 61) emphasized the importance of social actors in influencing livelihoods. He went ahead to say that “the emergence of social movements that explicitly appeal to biodiversity discourse as part of their strategy is recent”. He gave examples of social movement organizations with ecological concerns that struggled in defense of their territory in Buenaventura where gold mining activities and oil pipeline construction were suspended and the movement of the black communities of the Colombia Pacific region with concerns of destruction of biodiversity. Another example according to Gachechiladze and Staddon (2007) is the reconsideration of Kulevi oil terminal project in Georgia in the Black sea region where the local people and NGOs fought due to violation of regulations, health risks and environmental damage in the wetlands of the region.



In the Niger delta region of Nigeria which has vast wetland ecology, there are frequent conflicts between the local inhabitants and the oil companies over important issues such as environmental concerns. Oyefusi (2007) contended that most of these conflicts have to do with compensation for damaged environment from oil spills/operations and land ownership and compensation for land appropriation. These conflicts have forced the Nigerian government and the oil companies to soft pedal on some issues such as sharing of oil revenues. Oil spills have contributed significantly to the degradation of vegetation of the region which consists largely of mangrove swamps and pockets of high forest.

Access to land and its resources particularly tree resources is another concern of political ecology perspectives which affect rural livelihoods. Fabusoro *et al.* (2008) cited Scandizzo (2000) who define access as the right to enter a defined physical area and enjoy subtractive or non-subtractive benefits. Yaro (2008, p. 12) added that “for any man or woman to interact with nature, access qualifications are needed from hierarchical social organizations whose relations are based on power”. Accessibility to land and its resources is therefore very important to achieving sustainable livelihoods in drylands. Clay, Alcorn and Butler (2000) strengthen this point by stating that resource tenure including that of trees has been identified by the local people as a critical element in their quest for survival.

There are different types of access to land. Mohammed (1994) in a study identified three types of access to vegetation resources in most part of northern Nigeria which include private access, common access and open or free access. Land access and rights help in shaping livelihoods and playing an important role in conservation activities in most parts of the world including the dry

lands of sub-Saharan Africa. Recognition of the ownership of forests including improving its governance according to Ozinga (2012) is necessary for the achievement of reduction in forest depletion by any government policy or programme to succeed.

Local communities and smallholders other than the state have an important role to play in forest management activities. Community-based forest management (CBFM) has gained increased popularity and wide acceptance worldwide (Molnar *et al.*, 2011; Mendoza and Prabhu, 2005). The rights of the local communities to own forests were appropriated by the state later in the past. Before this time forests were claimed by smallholders. Molnar *et al.* (2011) added that in the historical past local communities and indigenous peoples fundamentally possess forest lands. The recognition of the rights of the community is essential in forest management activities in the world as this benefits them significantly. That is why Molnar *et al.* (2011 p. X) stated that “when tenure and rights are recognized at the community and smallholder level, communities and smallholders are empowered to create and grow a range of forest-based livelihood and enterprise activities to improve their quality of life and raise their incomes”.

Molnar *et al.* (2011) have observed that a number of countries have achieved different success stories and lessons learned in CBFM. They specifically mentioned countries like Mexico and Bolivia and Honduras as taking the lead in CBFM experiment. Despite these achievements of CBFM, Mendoza and Prabhu, (2005) stated that these participatory methods have often been criticized as not planned and unsystematic as well as not having the required thoroughness.

2.7 Major Threats to Trees

Tree depletion is a great challenge in drylands and its impacts are already evident. A significant number of people in these areas depend locally on the natural ecosystems for diverse subsistence means of livelihood such as food, fuelwood, poles for housing and fodder thereby making trees face immense pressure. In addition to this, the unique climate of dryland areas makes the trees vulnerable to this threat. These undermine the stability of the environment hence making it prone to degradation. Matta and Kerr (2007) added that livelihoods in the rural areas of many developing countries become impeded due to degradation of natural resources. Biggs et al. (2008) also quoted Lawton and May (1995) and Anderson (2001) as saying that the current rate of loss of biodiversity is quite drastic and even surpasses the loss experienced in the fossil record.

The key drivers of tree depletion in drylands include deforestation, agriculture and land degradation. Bounkougou (2009) equally identified the causes responsible for the loss of biodiversity in drylands as fragmentation, degradation or entire loss of habitat, overexploitation, pollution, introduction of non-native (alien or exotic) species and climate change. The destruction of the natural vegetation including that of trees is one of the most important factors which aggravate biodiversity loss. The rate at which trees are being destroyed in the world is alarming despite efforts by many countries to replant the forest areas (Figure 1).

CGIAR (2011) quoted FAO (2010) in identifying that yearly, about 16 million hectares of tree cover and natural forests equivalent to the size of England vanish as a result of human activities. Boafo (2013) also cited (FAO, 2010 and CIFOR 2005) in stating that about 3.4 million hectares

of forests were removed every year in Africa. As a result of this destruction, many important tree species are fast disappearing and some of them have become scarce or threatened. Byakagaba *et al.* (2011) strengthens this point by saying that the World Conservation Union considers *Vitellaria paradoxa* tree one of the threatened tree species.

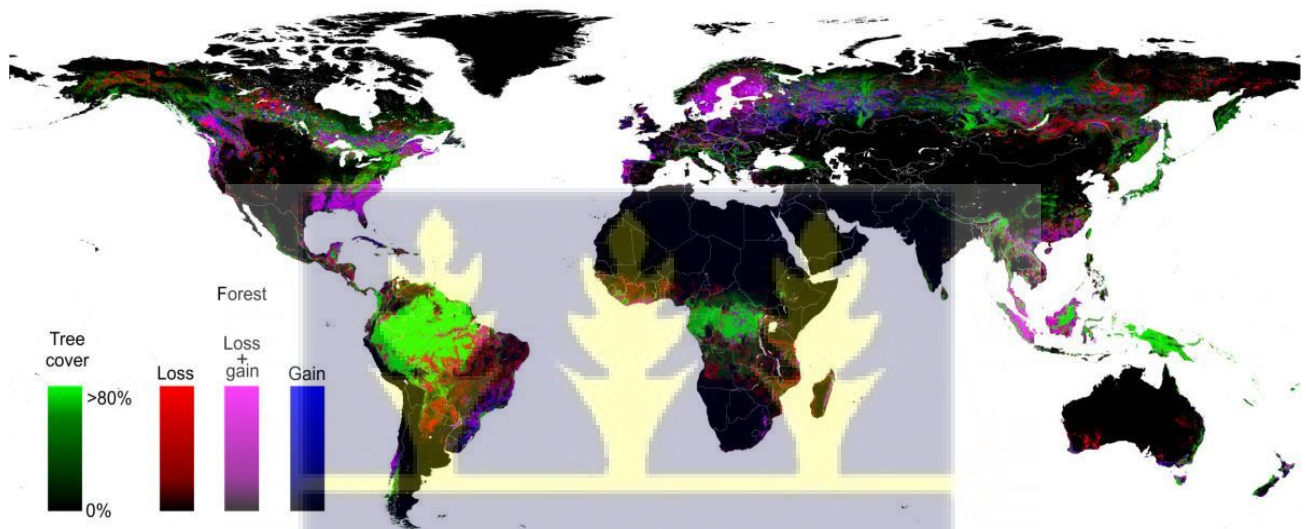


Figure 1: Global Forest Loss Map (University of Maryland, 2013)

Daniel and Edward (1998) cited in Gabriel and Ayuba (2006) maintained that in Nigeria, the clearing of land for the purpose of farming activities to increase food production is among the most important factors responsible for plant diversity loss. Jama and Zeila (2005) also attributed habitat loss and fragmentation as among the most important causes of loss of important dryland biodiversity. Hanski (2011) agreeing in the same vein maintains that habitat loss has so much genetic as well as evolutionary consequences that it leaves so many species to gradually decline and goes extinct.

Forest fires or wildfires are caused mainly due to human activities such as in agricultural development practices, bush burning and in deforestation activities depending on the region. However lightning occurrence can also set wildfires to forests. Generally wild fires affect more areas where the climate and vegetation were drier than in wetter places. In tropical regions the savannah vegetation areas also experience these wildfires which the vegetation has even adapted itself to. Fires have an effect on tree and forest loss. Nasi *et al.* (2002) added that at global level these forest fires produce large amounts of carbon which increase global warming with its attendant biodiversity changes whilst regionally and locally, they also alter hydrological cycle, change biomass stocks and affect plant and animal species functioning. Davies and Unam (1999) in Nas *et al.* (2002) added that forest fires cause significant reduction in photosynthesis activity in plants.

Vadrevu (2009) observed that the loss of biodiversity as a result of fast increase in agricultural activities in many tropical countries which affect forests is alarming. It is apparent that unless changes are made to the ways people treat the natural environment; it will become less capable of supporting the life support system. Green Facts (2006, para. 1) revealed that “across the range of biodiversity measures, current rates of loss exceed those of the historical past by several orders of magnitude and show no indication of slowing”. Salas, Jianchu and Tillman. (2003) added that in contemporary times, the rapid development of global markets as well as untenable and weak development policies constitute some of the most important forces contributing to the loss of cultural and biological diversity in the world. Thus, the development of industrial agricultural activities for instance leads to the substitution of useful indigenous trees for large hectares of crops grown specifically for the markets of the countries of the industrialized world.

2.8 Climate Change and Trees

Climate change is one of the significant causes of tree diversity loss. But, at the same time, the diversity of trees and other plants has an important role in mitigating and adapting to climate change. Climate change is one of the biggest environmental, social and economic threats facing the Earth today. It impacts on biodiversity as a whole and is one of the causes of its loss and exacerbates other pressures. Carbon dioxide emission, through different sources, is a casual factor for global warming, which is the most dreaded problem across the world. Carbon sequestration is a way to mitigate the accumulation of greenhouse gases in the atmosphere released by the burning of fossil fuels and other anthropogenic activities. Various studies have been carried out on how the diversity of trees and other plants can sequester carbon under different scenario.

As the amount of carbon dioxide sequestered by ecosystems is larger than that lost, global terrestrial ecosystems are acting as net sinks of approximately 1.5 GtC per year (IPCC AR4 reported approximately 0.5-1.5GtC). Sequestration at these levels would be equivalent to a 40-70ppm reduction of CO₂ in the atmosphere from anthropogenic emissions by 2100 (Canadell and Raupach, 2008). Tropical forests flora account for large proportion of this CO₂ sink the absence of which would increase the current atmospheric CO₂ concentrations by 10 per cent. The exact processes involved with the oceanic carbon cycle are not well understood. However, it is clear that the ocean acts as a considerable sink. The Intergovernmental Panel on Climate Change 4th Assessment Report (IPCC AR4) maintained that the size of the marine sink is approximately 1.8-2.6 GtC, and has increased by approximately 22 per cent from the 1980s to the 1990s.

2.9 Conservation and Management of Trees

The aim of conservation is to manage or regulate use so that it does not exceed the capacity of the tree species or system to renew itself. A healthy biodiversity provides avenue for maintenance of ecosystems and recovery from unpredictable events. As these ecosystems become degraded and reduce the diversity of flora, we start to lose; the cost of replacing these (if possible) would be extremely expensive. It therefore makes economic and development sense to move towards sustainability. The basic principle of conservation is finding, developing, maintaining and safeguarding managed landscape that include adequate areas to serve as sources of fauna and flora for local people especially those who are vulnerable and marginalized.

The promotion of the conservation of species diversity is one of the goals of the convention on Biological Diversity's (CBD) 2010 target. The implementation of this program seeks to reduce the rate of loss of biological diversity in dry and sub-humid lands by the year 2010. According to this convention, sustainable development, conservation and wise use of plant diversity resources including trees are the key to environmental stability. Jama and Zeila (2005, p. 6) remarked that "biodiversity conservation is an important element in resource management planning". The maintenance of functioning natural ecosystem is vital for the growth of trees and forests which are relevant not just to rural livelihoods but also to the ecosystem services such as water regulation, soil fertility, and improvement of micro-climate. Future natural resource exploitation must be made to incorporate tree diversity concerns that will then ensure that the ecosystem continues to function and services vital to human livelihoods are maintained.

Twarog and Kapoor (2004) emphasized that apart from conserving biodiversity at both species and ecosystem levels, there is the need as well to consider the conservation of genetic diversity at both levels. Households including women play a very important role in tree and other plants diversity management. Horward (2003, p. 1) is of the view that “women predominates in plant biodiversity in their roles as house wives, plant gatherers, home gardeners, herbalists, seed custodians and informal plant breeders”. She went ahead to say that conserving the genetic resources of valuable plants is important and this should be accompanied by understanding the impacts of livelihoods on plant diversity. Thus, conservation of plant biodiversity should be total in such a way that it covers all aspect of plants including trees. Bodeker (2005) however lamented on the fact that too much preference is being given to conservation of trees as well as the forest cover through formulation of forestry policies at the expense of the forest understory and non-timber forest products (NTFPs) that occur at ground level. These are equally important in the functioning of the forest as a whole.

Trees are conserved in an in situ or ex situ condition. Taylor (1997) however maintains that the best way to conserve plants including trees is where they are naturally found. He went ahead to say that the management cost of in situ conservation is capable of maintaining large number of individuals. Afforestation programs need to be intensified by various governments. In northern Nigeria particularly in the Sudano-Sahelian region, afforestation programmes have been set up. These however have to do more with exotic and invasive tree species than naturalized ones to provide shelter belts and conserve the soil.

However, Denslow (2002 p. 1) remarked that “in recent years invasive alien species have gained considerable notoriety as major threats to species and ecosystems”. The most popular tree species used for this purpose is *Azadiracta indica* or neem. Others include Eucalyptus and *Mangifera indica*. Corbera, Kosoy and Tuna (2007) stated that the Kyoto protocol’s Clean Development Mechanism (CDM) which aims to reduce carbon emissions by encouraging funding of reforestation and afforestation activities in developing countries. These processes encourage carbon sequestration or capture and store atmospheric CO₂ in terrestrial ecosystems. All these are designed to reduce global warming and mitigate climate change in the world. Part of this program should also be wind breaks, hedges on field boundaries and protection for regeneration of valuable indigenous species on farmlands such as *Vitellaria paradoxa*, and *Parkia biglobosa* which contribute to household subsistence and income generation through the variety of products obtained from them.

This is supported by El-Siddiq (2003, p. 3) who says that “on-farm tree planting is becoming more appealing because the establishment of parklands, through tree selection and conservation, is becoming difficult as a result of ecological and legislative problems in the dryland areas”. Despite these problems, many of the biodiversity conservation programmes in Africa rely on the demarcation of places as protected areas. This is further buttressed by Pare *et al.* (2009) that many forest management activities within the West African sub region that relates to biodiversity conservation and fuelwood supply take place within government demarcated forest reserves.

Twarog and Kapoor (2004) are of the view that economic development policies and programs developed by countries in the world should take into consideration the prioritization of

conservation of culture in concert with biodiversity. Tacconi (2007, p. 346) concluded everything by stating that “how biodiversity is managed will depend on ecological, social, financial, capacity and historical considerations”.

To sum up lessons from the literature review, some gaps can be identified including how they relate to the research questions and objectives of the study. Aspects such as the livelihood-society relationships, biodiversity debates and access to tree resources ought to have been included. Some of these are related to especially objectives 2, and 3 that talks about forms of access right and control over the use of the selected economic trees and contribution of the economic trees in sustaining rural livelihoods respectively.

2.10 Sustainable Livelihoods Framework

The conceptual approach adopted for this study is the modified version of the sustainable livelihoods framework by Majale (2002) to identify the research variables and their relationships. Malhotra (2002, in Saleh, 2006) reported that in order to explain relationships, a conceptual framework is used. Chambers and Conway (1992) define livelihoods as “comprising the capabilities and material and social assets necessary for a means of living”. There are different livelihood practices most of which depend on the natural environment. These natural resource based livelihoods, including agriculture, depend on the land for their survival. The most prominent livelihood activity is associated with agriculture and livestock rearing that include sedentary farming, transhumance, and nomadic and semi-nomadic pastoralism.

These agriculture based livelihoods increasingly transform and change through the process of livelihoods diversification which according to Ellis (2000) has close association with resilience, flexibility and stability. Murray (2001) cited Bryceson (1999) in supporting the point that in sub-Saharan Africa in 1980s, 40% of the rural household income comes from non-farm enterprises, which grew, to 60-80% in the late 1990s showing significant increase in de-agrarianization among households.

Such diversified livelihoods are non-farm based and are a form of survival strategy adopted by the people for the diversification of their income sources (Nowrotzki, Hunter and Dickinson, 2012; Wang, Yang and Zhang, 2011; Mortimore and Adams, 2001). Accordingly, Mortimore and Manvell (2006) have associated most economically stronger households in drylands to engagement in non-farm livelihood options. A good number of these diversified non-farm livelihoods in drylands are natural resource based associated in one way or the other with plant or tree resources.

The original sustainable livelihoods framework as presented in Majale (2002) investigates the ways (strategies) in which poor people combine and use livelihood assets in the quest to get beneficial livelihood outcomes that meet their own livelihood objectives including the dynamic relationship between them. The Sustainable Livelihoods Framework also tries to explore the linkages between their various assets, vulnerability context within which the people operate structures and processes, livelihoods strategies and outcomes.

Majale (2002) cited UNDP (1999) in stating that the sustainable livelihoods approach unlike other traditional approaches tackle poverty by identifying and addressing the needs of the poor people on what they previously have as assets. Assets or capital are recognized within this approach as natural, physical, human, social, and financial. These are themselves shaped by policies, institutions and processes such as government and the households. The overall goal of this approach is to lead to positive livelihood outcome through increased income and human well-being.

For this study, the following changes to the framework are made (Figure 2). In the livelihoods asset portfolio category, the selected economic trees (natural capital) are added. At the level of policies, institutions and processes, the indigenous knowledge is added while the vulnerability context has the addition of poverty, climate change, governance, and production pressure. At the livelihoods outcome category, the negative aspect column is added to bring out the trade-offs between livelihood outcomes where in some cases it is hard to measure the relative value of increased well-being or when family members prioritize different livelihood objectives. Yaro (2008 pp. 11) also posited that, “the trade-offs identified under the livelihoods perspectives is adequate warning of the impending danger social inequalities can pose to the realization of sound environmental practices”.

The modified framework is therefore made up of the selected trees as the capital asset and their role in creating livelihood outcomes through the adoption of sound indigenous knowledge management strategies. This could lead to income enhancement and improved livelihoods that are themselves dependent on these selected trees asset. These are also determined by public

sector organizations like the department of forestry that set and implement policy and legislation on these trees which in turn affect people's livelihoods. Other factors such as poverty, poor governance and climate change constraint achievement of positive livelihood outcomes. The Sustainable Livelihoods Framework also tries to explore the linkages between the selected trees as assets, vulnerability context, households and government policy, livelihoods strategies inform of indigenous knowledge and outcomes.



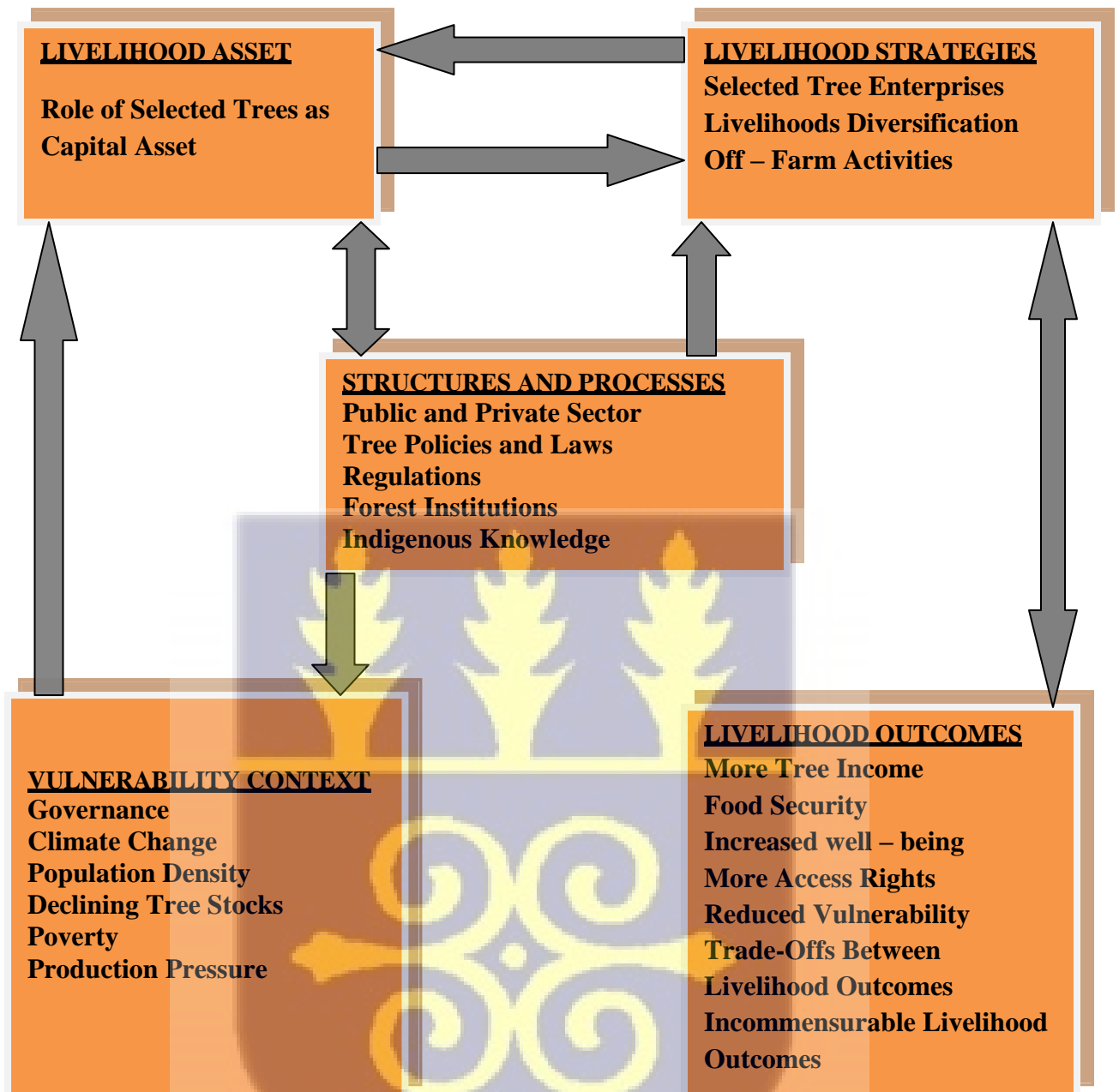


Figure 2: Sustainable Livelihoods Framework (Adapted From Majale, 2002)

The implementation of this framework in this study has served as a useful tool for analyzing how the selected economic trees have impacted on the livelihoods of the poor people living in the various communities of the study area. It is an effective tool for analyzing and understanding the impact of the selected trees on their livelihoods in a useful conceptual base. The Sustainable Livelihoods Framework however does not by itself take into custody certain aspects such as territorial governability, control over access to resources and social struggles though not very relevant in this context. Thus, Ellis (2000) opined that the livelihoods framework however tends to give emphasis to assets and activities while ignoring power relations including different access to resources and livelihood opportunities. The livelihoods framework was therefore modified such that some of these themes were taken into consideration.

Another framework that could have been considered for application for this study is the sustainable livelihoods approach (SLA) developed by Scoones (1998). This framework is also useful for analyzing sustainable livelihoods and how they are achieved through access to a variety of livelihood assets or resources (natural, economic, human and social) in the pursuit of different livelihood strategies. The framework analyses institutional factors that influence livelihood outcomes. Basically, the framework recognizes that people have assets and abilities that can be developed or exploited to improve their livelihood. When applied to this study, the SLA approach can be achieved through supporting poor people to build up their assets which in this case are the selected tree species. People's access to these resources could be increased to enable them achieve livelihood outcomes.

CHAPTER THREE

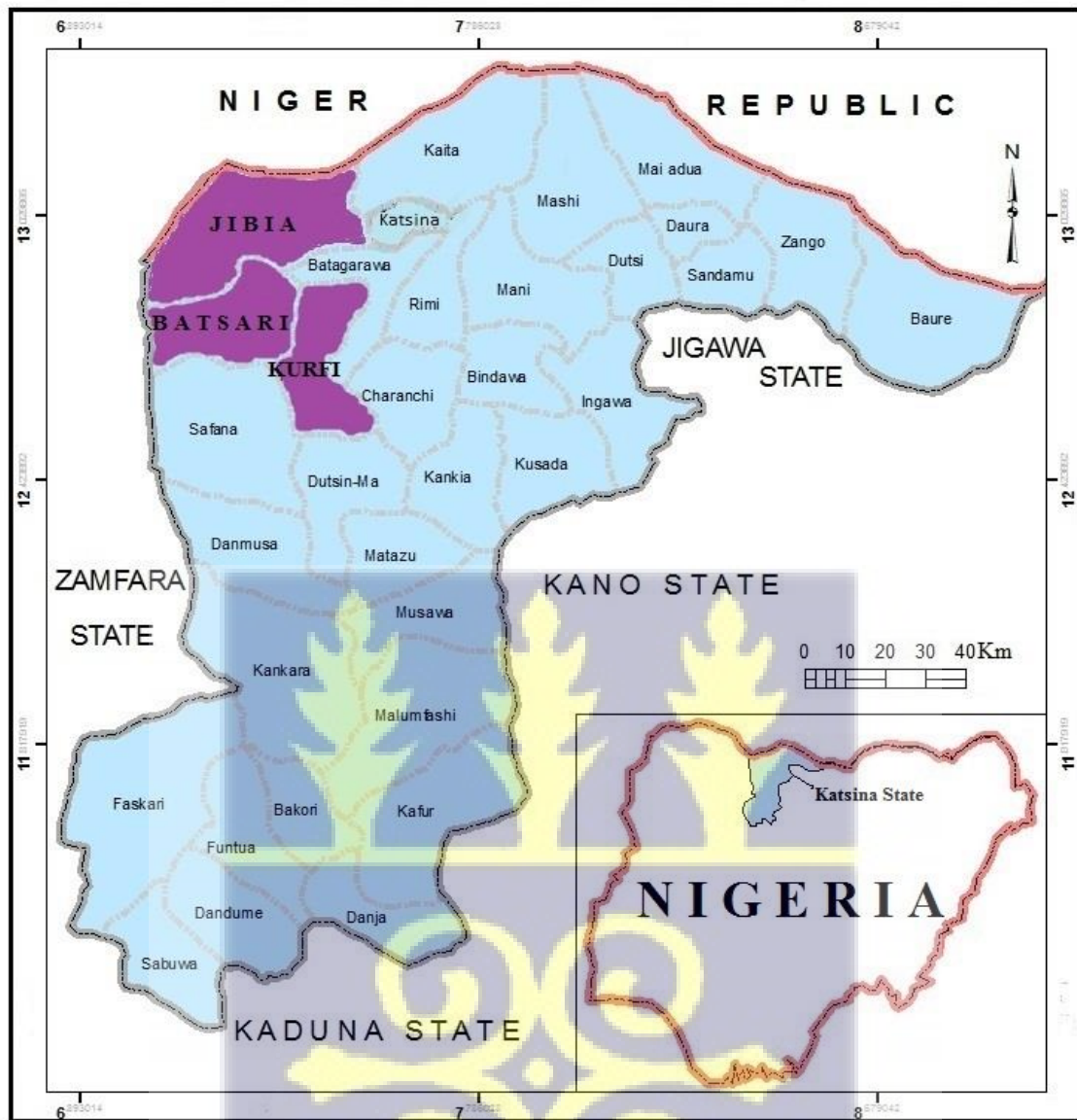
THE STUDY AREA AND THE METHODOLOGY

3.1 Introduction

This chapter describes the study area and the procedure used in conducting the research. It presents the geographical locations and study area, selected trees and justification, types and sources of data, instruments and tools for data collection and analysis, sampling procedures, survey methods/data collection, and data analysis.

3.2 Geographical Locations

The study area spans an agro-ecological landscape with a range of site types encompassing three sampled administrative units or Local Government Areas (Figure 3) that fall within latitudes $12^{\circ} 30'$ North and $13^{\circ} 06'$ North of the equator and longitudes $7^{\circ} 15'$ East and $7^{\circ} 30'$ East of the Greenwich Meridian. These are Batsari, Kurfi and Jibia and within these eighteen communities form the study sites (Figure 4). This Sudano-Sahelian area lying in the northwestern part of Katsina State in the extreme north of Nigeria extends for some 100 km from west to east and 120 km from north to south with a combined population of approximately 496,307 people (NPC, 2006). The cumulative land area of the sampled area is $2,716 \text{ km}^2$ representing about 10 % of the state's total land mass (Table 2). There is proximity of the area to the Sahara desert which is found to the north outside of Nigeria. The biophysical constraints including the unpredictable nature of rainfall make the area to have a fragile ecology.



Source:- NASA/NOAA Spot Image 2012.

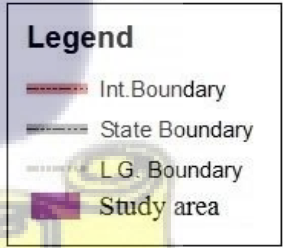


Figure 3: Map of Katsina State showing the three Study Administrative Units

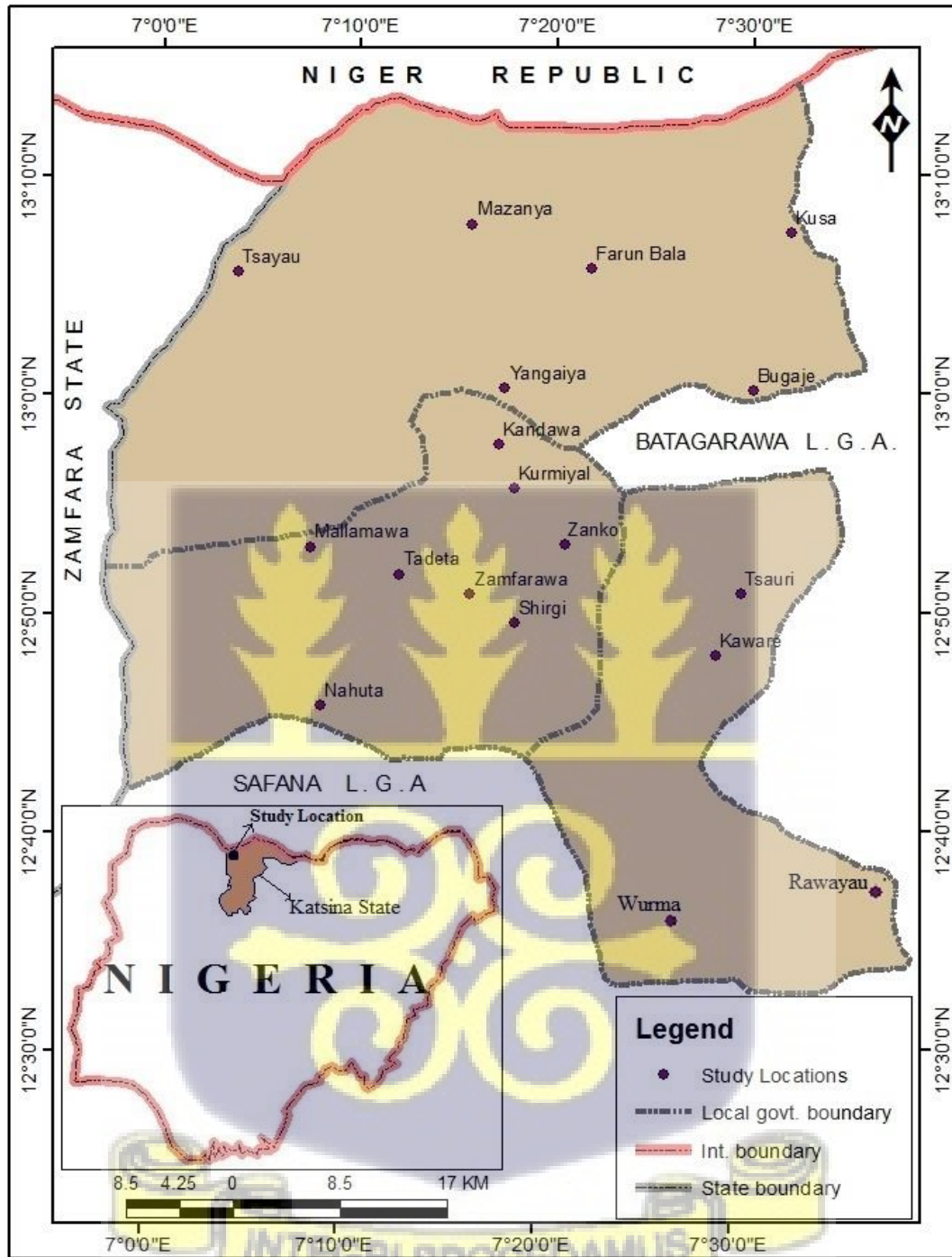


Figure 4: The Selected Study Sites/Communities

Table 2: Administrative Units, their Population, Surface Area and Selected Study Communities

Administrative Units (LGAs)	Population	Area of Land	Selected Communities
Batsari	208,978	1107 km ²	Kandawa, Kurmiyal, Zanko, Mallamawa, Tadeta, Shirgi, Nahuta, Zamfarawa
Jibia	169,748	1037 km ²	Bugaje, Farun-Bala, Mazanya, Yangaiya, Tsayau, Kusa
Kurfi	117,581	572 km ²	Tsauri, Kaware, Wurma, Rawayau

SOURCE: NPC (2006)

3.3 Choice of the Study Area

The three localities of Batsari, Jibia and Kurfi were selected for comparison. The study area selected is not very large since the research design adopted required deeper appreciation than ordinary land mass. The study area especially Bugaje and Kusa communities are closer to the rapidly expanding urban population concentration of Katsina city and its environs. Some of the communities like Mazanya and Tsayau also share boundaries with semi-arid conditions as the Sahara Desert is not very far to the north in neighbouring Niger republic. This has the potential of causing rapid environmental degradation that may threaten the existing vegetation of the study area. This comparison could have the merits of making the study interesting since the researcher will be able to discern the bearing that proximity and exposure to aridity and urbanization has on

the selected trees and livelihoods. The researcher also intends to use Mazanya, Tsauri and Mallamawa communities for the intensive indepth studies.

3.4 Weather and Climate

According to Koppens climatic classification, the study area falls within the *Aw* type of climate characterized by distinct wet and dry seasons. According to Usman et al., (2013) the average annual temperature is 29⁰ C while the average minimum and maximum temperature is 13⁰ C and 38⁰ C in April respectively. Mean annual rainfall according to them is 720mm which falls between June and October. Rainfall varies from less than 700mm in the far north of Mazanya and Kusa communities to about 800mm in the far south around Wurma and Rawayau communities. Rainfall occurs mainly between the months of June to September and occurs annually. The rest of the year is dry. The main influence on the weather of the study area is the two traditions of winds or air masses. The Tropical Maritime Air mass (mT) blows from the sea and moves in a southwesterly direction and is responsible for the shorter rainy season which lasts for only four months. The rainfall is single maxima as in other savanna areas with August experiencing the peak period of the rains that is mostly convectional in nature. The rains coincide with the period when temperatures are warm to hot.

The other air mass known as Tropical Continental (cT) blows from outside the northern part of the country in a northeasterly direction i.e. originating from the Sahara desert and is responsible for the usual dry dusty winds or harmattan. This is the longest season (about eight months) usually beginning from October to May annually. Temperatures during this season are cool from the beginning and end up being very hot in the end just before the onset of rains. These two air

masses meet at the Inter Tropical Discontinuity (ITD) that passes over the study area in an annual cycle causing different weather conditions to prevail. Its passage northwards over the area brings warm moist weather conditions. When it passes over the area to the south, it brings cool dry weather conditions.

Olofin (1987) has identified four seasons in northern part of Katsina State which are generally based on the prevalence of particular element of climate at a point in time and farming activities.

The seasons are:

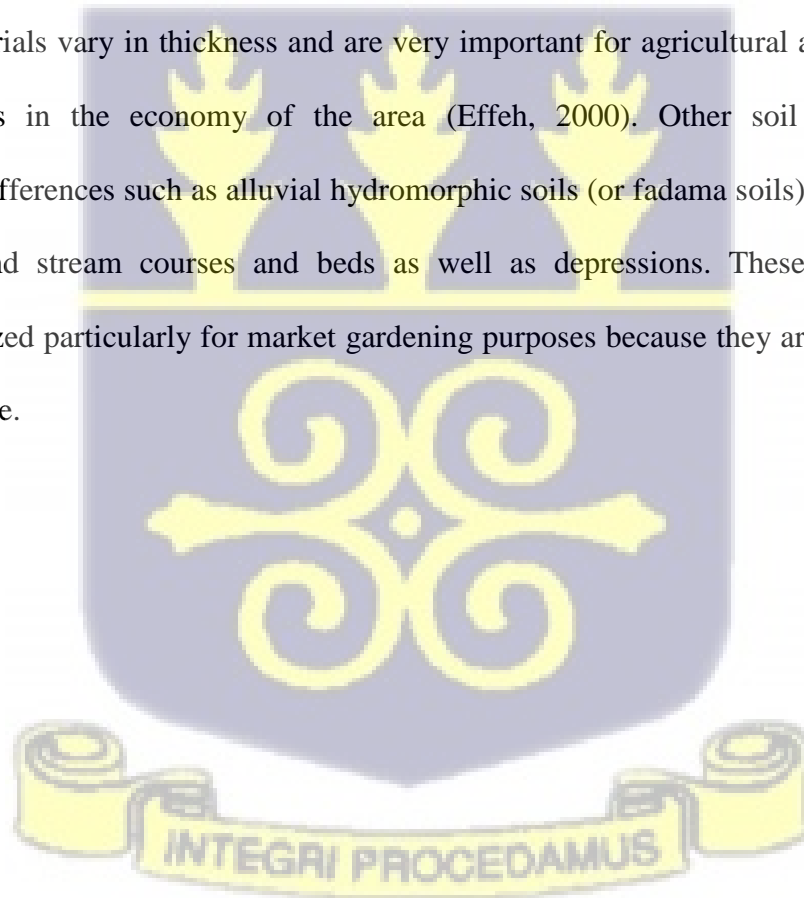
1. The period just before the onset of rains called “Bazara” (March to May)
2. The rainy season proper called “Damina” (June to Sept)
3. The period immediately after the rains called “Kaka” (Sept to Oct)
4. The dry season proper called “Rani” (Nov to Feb)

The climatic factors particularly rainfall and temperature described above play a very important role in the growth and distribution of tree species and other vegetation forms in the world including in the study area. The relevance of climate was echoed by Hamilton (2013, p. 1) that “climate influences broad-scale variations of vegetation, most notably regulating the distribution of world biomes”. All plants including trees needs water to grow in the first place and this is provided by rainfall which vary depending on the location of the place. Thus, trees need more water than other plants like grasses which is why higher rainfall usually generates forest growth. Plants also need certain temperature to grow well. Plants that need higher temperatures are found in tropical regions while those needing lower temperatures grow in temperate climates. The

tropical continental climate of the study area is thus largely responsible for the existence of savannah vegetation in spite of the influence of other environmental factors.

3.5 Geology and Soils

The area is underlain by crystalline basement complex rocks of the Precambrian era which includes granite and undifferentiated metamorphic rocks in most of the west and central areas. The northeastern part covering Kusa and Bugaje communities is however overlain by cretaceous sediments known as Gundumi formations (Figure 5). These underlying rocks are covered with tropical ferruginous soils with sandy drift materials deposited thousands of years ago. These weathered materials vary in thickness and are very important for agricultural activities that play significant roles in the economy of the area (Effeh, 2000). Other soil types related to topographical differences such as alluvial hydromorphic soils (or fadama soils) are found usually around river and stream courses and beds as well as depressions. These soils have been intensively utilized particularly for market gardening purposes because they are usually fertile if water is available.



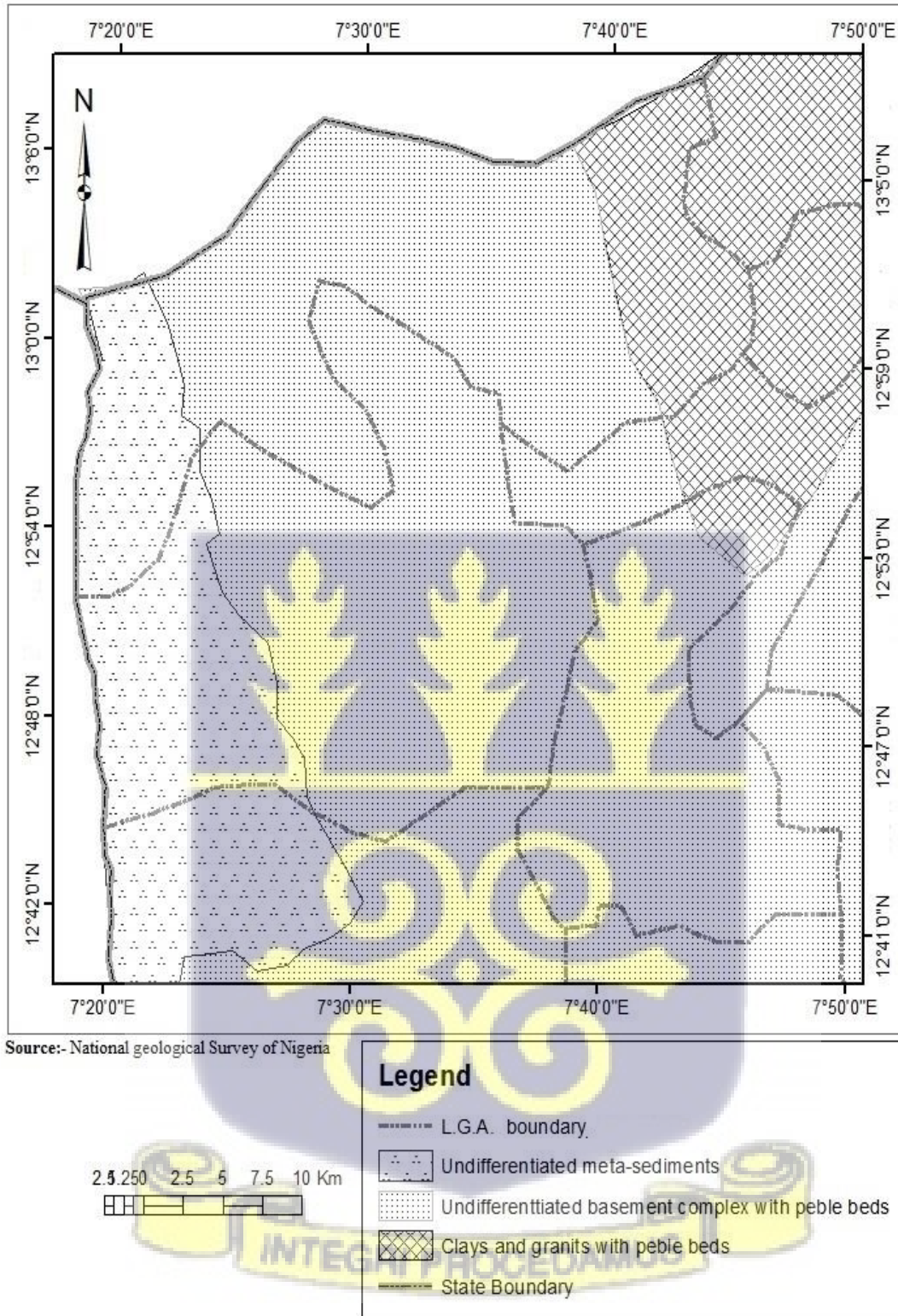


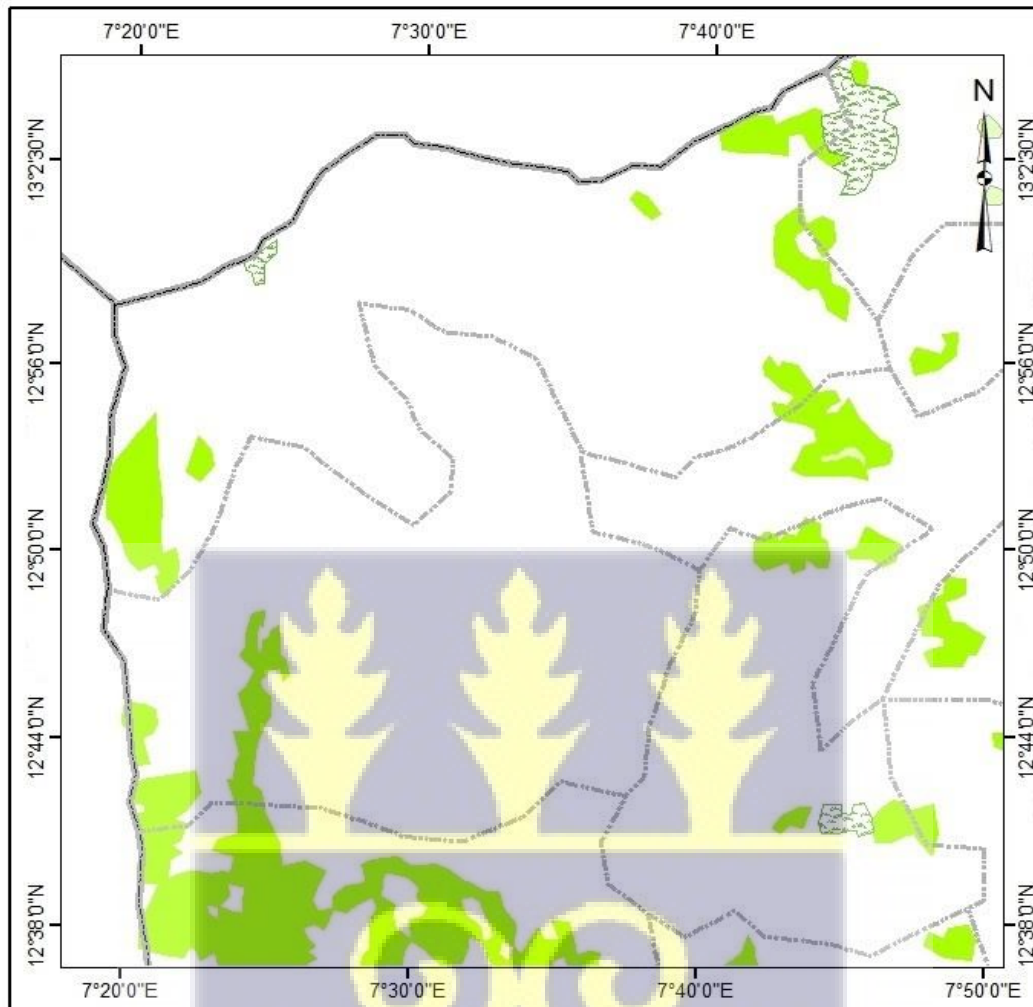
Figure 5: Geology of the Study Area

Soil through its characteristics like nutrient status, texture, depth and composition play an important role in the growth and distribution of vegetation. Few studies of tropical and subtropical forest catenas have generally shown species distributions associated with edaphic conditions (Kahn, 1987; Basnet, 1992; Paulson, 1996 in Clark, Cark and Read 1998, p. 102). However, they also noted that where the environmental gradient is less severe, information on the effects of soil on distribution of plant species is not much.

3.6 Vegetation

The vegetation of the study area falls within the Sudan savannah which is characterized by short grasses and scattered deciduous trees. Patches of savanna woodland vegetation including gallery forests are found particularly in the extreme southwest of Nahuta community in the study area bordering a forest reserve (Figure 6). This vegetation through a combination of fuelwood extraction, annual bush fires, grazing, agriculture and other human interferences, a secondary vegetation or farmed parkland savanna is now found in many places. These together with the relative aridity determine trees and other plant distribution in the area. Agreeing in the same vein, Bounkougou (2009) pointed that relative aridity is a key driving force of biological diversification in the dry lands. As a result of this, a large multiplicity of adaptive traits is found among many of the plants in the study area.

Drought resistant varieties of tree, shrub and grass species are therefore found. Some of the tree species found include *Parkia biglobosa*, *Adansonia digitata*, *Faidherbia albida*, *Khaya senegalensis* and *Anogeissus leiocarpus*. Others are *Vitellaria paradoxa*, *Borassus aethiopum*, *Tamarindus indica*, *Balanites aegyptiaca*, *Vitex doniana* and *Cieba pentandra*. The rest are



Source:- Earthobservatory.nasa.gov/IOTD/view.php

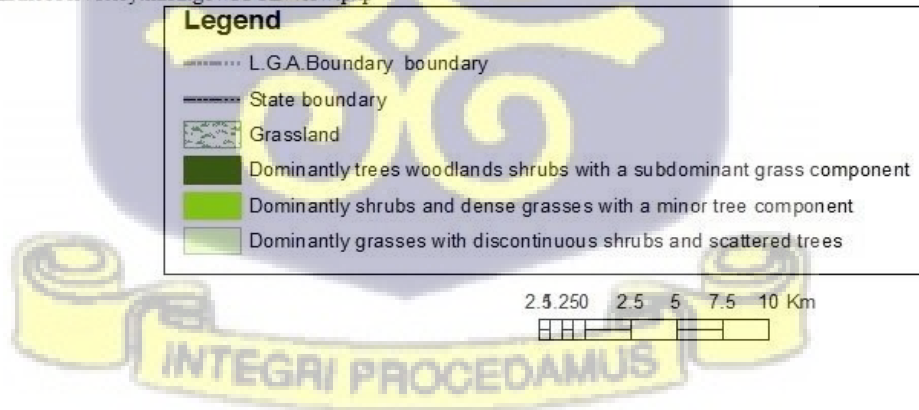


Figure 6: Vegetation of the Study Area

Piliostigma thonningii, *Acacia seyal*, *Bauhinia rufescens*, *Acacia nilotica*, *Ficus thonningii* and *Sclerocarya birrea*. Many shrub and grass species like *Guirra senegalensis* and *Andropogon gayanus* respectively, abound. Exotic tree species introduced which form part of the vegetation of the study area includes *Isobertina doka*, *Mangifera indica* and *Azadirachita indica*.

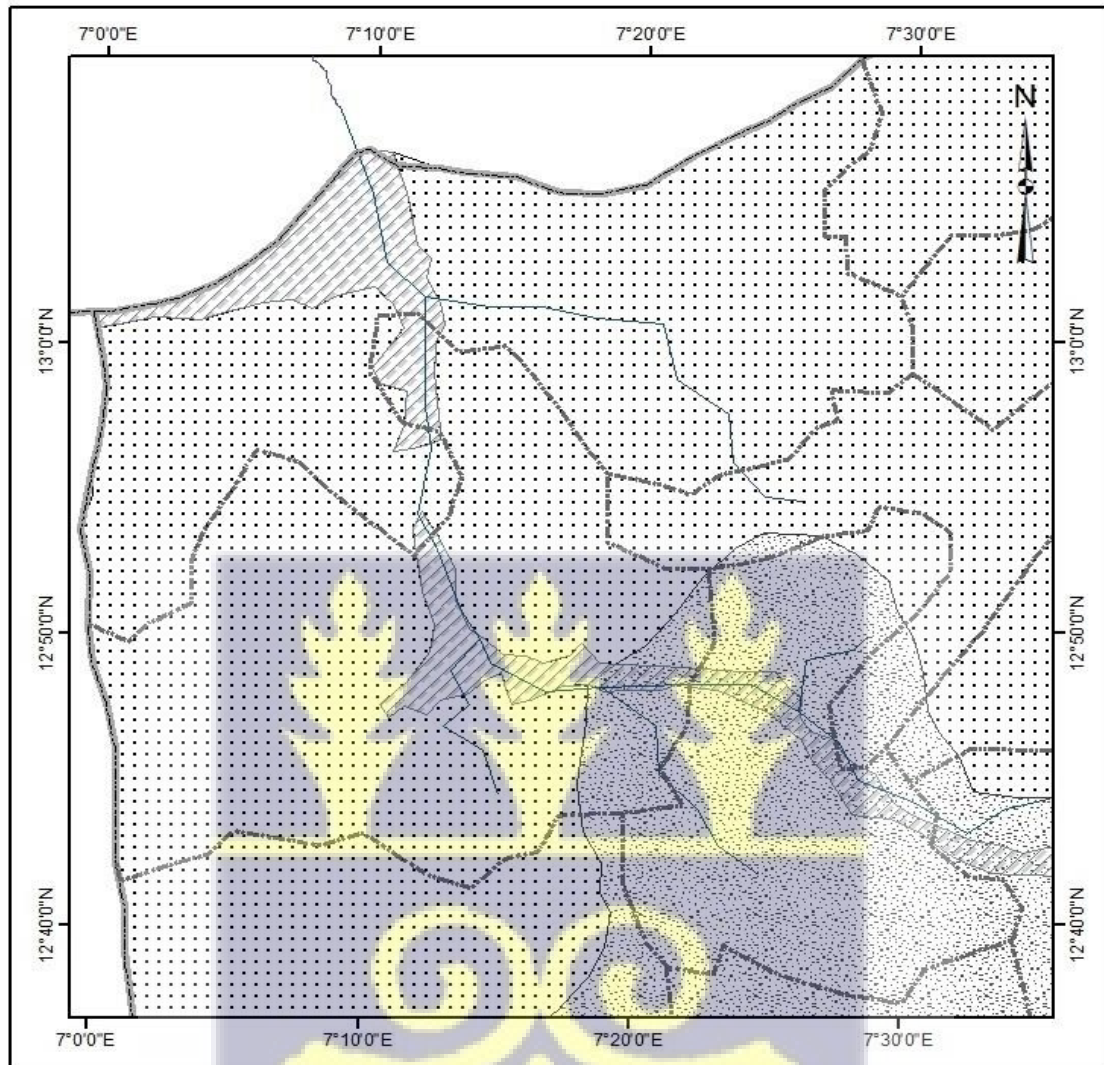
The prevalence of most of the tree species described above have dramatically declined in the area. Lawal (2012) discovered that a lot of these tree species including *V. paradoxa* and *K. senegalensis* have either decreased significantly or have completely disappeared from some of the places. As a result of this, exotic tree species like *A. indica* have actually replaced the natural tree species in most other places. These and other trees found in the area are believed to play a very important role in the livelihoods of the local communities in the provision of food complement, fats and oil production, handicrafts and stocks and forage production. It is because of this that a lot of the trees are able to survive especially in the human agricultural systems.

The vegetation of the study area like in other areas in dry lands of northern Nigeria is being threatened by degradation processes through over exploitation, overgrazing, biodiversity reduction and other human activities. Lawal (2012) citing Mortimore (1989) stated that as a result of these activities, degradation has not only set in, the rate has also accelerated in recent years following a 30% decline in rainfall since 1965 and after the drought of the 1970s. In the same vein, Kigomo (2003) citing FAO (2001) claimed that 340 billion hectares of woody vegetation in African's dryland have become degraded through human activities, such as overgrazing, agricultural expansion, over-exploitation of fuel wood and deforestation.

Vegetation density varies in different parts of the dry lands including the study area. Lawal (2012) in a study conducted in northern Katsina State revealed that tree density vary significantly over small distances. Pullan (1974) in Lawal (2012) suggested that these differences arise in part from the varying attitudes of individual farmers to trees on their farms or from the density and composition of economic trees in the original woodland and from the length of time of cultivation. In the areas close to the villages of Bumbum and Bududu in northern Katsina State, 5-10 and 10-15 trees per hectare are recorded respectively without considering tree size and canopy area. According to him, most of the trees there are exotic species (particularly, *Azadrachita indica*). In another study in Zamfara forest reserve lying to the west of the study area, a comparative analysis of vegetation density between 1962 and 1991 (ARCA, 1995) estimated that 71% to 85% of the vegetation and 50% of the trees had been removed.

3.7 Relief and Drainage

The study area forms part of the high plains of Hausa land and the terrain is generally undulating towards the west, northwest and northeast with occasional outcrops of hills rising above the surrounding plains particularly in the southern and eastern areas (Figure 7). These undulating plains rise up to about 360 meters in the northwest (Effeh, 2000). The area is well drained by several rivers and streams which break up into pools or dry up completely during the dry season. Some of these rivers include, Gada and Tagwai all of which flow towards the northwest. Others are rivers Bunsuru along with other smaller rivers and streams that eventually join the Sokoto-



Source:- Macmilan atlas map 2006.

2.5 250 2.5 5 7.5 10 Km

Legend

- L.G.A. boundary
- ▨ Undulating plains with scattered rock outcrops and hills
- ▤ Nearly level to gently undulating plain with scattered rock outcrops and inselbergs
- ▥ Gently undulating plains with scattered rock outcrops and inselbergs
- State boundary

Figure 7: The Study Area Showing Relief and Drainage

Rima River System to the northwest of the study area which has the lowest relief. The drainage of the area like in most other places is influenced by the topography.

Although the topography of the study area is not very diverse as to significantly affect the growth and distribution of vegetation there, it nevertheless plays a very important role through its influence on soil and microclimates in other places. At a different, higher spatial resolution, topography also influences the distribution of vegetation by creating spatial variations of microclimates, which, in turn, can influence the growth and type of vegetation (Hamilton, 2013, p. 1).

3.8 Socio-Economic Settings

The dominant people in the study area are the Hausas and Fulanis. They live mostly in simple dwellings made from thatch and mud materials derived from the country side. However, other tribal groups from northern and southern Nigeria have settled in the study area. These include Kanuri, Nupes, Igbirras, Yorubas and Igbos. The Hausas are mainly farmers while the Fulanis are pastoralists though many have since adopted a settled life. Agriculture is the most important primary activity pursued in the study area. A combination of tropical climate with moderate to low rainfall and undulating topography makes this possible. Rain-fed agriculture is practiced in much of the area from the onset of rains in May/June when planting takes place to October/November when most crops are harvested. Crops grown usually for subsistence needs include millet, sorghum, beans, maize and sweet potatoes especially in Batsari locality. Groundnut is usually grown for cash but some is converted into groundnut oil for cooking.

Irrigation agriculture is practiced to supplement the rain-fed one especially in Jibia locality where the Jibia dam impounds water from rivers and used to irrigate vast areas using modern irrigation methods. The dry season which begins from November to May usually mark the beginning of the irrigation season. Crops grown include tomatoes, pepper, water melon and onion. Due to the low rainfall in most parts of the area allowing palatable grass species to grow, livestock rearing is an important activity. Ruminants reared include cattle, sheep and goats. The nomadic and semi-nomadic Fulani people do much of the rearing but other people also keep these animals at home. Products derived from them include fresh milk, meat, and skins usually taken to markets in urban areas to sale. There is little industrial activity in the study area. However, the few industries that are there owe their existence mainly to agriculture. These small-scale industries include blacksmithing, local crafts, dying and leather goods.

These socio-economic activities undertaken by people in the study area including developmental projects have no doubt played a major role in influencing growth and distribution of vegetation. These anthropogenic effects are caused largely by agricultural land expansion, fuelwood demand and to some extent industrial activities. A significant part of the vegetation in the study area has now been turned into a land use arrangement noted by Pulsen (1974) and cited by Lawal (2012) as farmed parkland popularly known as agroforestry parkland system. Exotic tree species like *Azadirachita indica* were introduced which form part of the vegetation. Grazing activities of the Fulani herders have also done much to affect the current vegetation compositing in the area particularly with regards to the grass species.

3.9 Selected Trees and Justification

The six selected tree species that comprise *Anogeissus leiocarpus*, *Balanites aegyptiaca*, *Faidherbia albida*, *Parkia biglobosa*, *Khaya senegalensis* and *Vitellaria paradoxa* are presented here. The basis for selecting six economic trees for the study is the fact that most of them are prevalent in the study area apart from being widespread in the region. They also have high potentials for livelihood sustenance in the area.

3.9.1 *Anogeissus leiocarpus* (African Birch)

Known commonly as the African birch or “Marke” in the local Hausa language, *Anogeissus leiocarpus* belongs to the family *Combretaceae*. *Anogeissus leiocarpus* is very widely distributed in Africa. Atawodi *et al.* (2011) have stated that “*Anogeissus leiocarpus* is distributed from the driest areas right up to the margins of the forest zone in Africa”. They further stated that it is found as far west as Senegal and as far to the east as Ethiopia. The tree is also found along seasonal wetlands and along river banks. *A. leiocarpus* can grow to a height of 21 meters high and 1.8-3 meters wide and where found it grows in dense thickets and has also a look that is feathery with birch-like foliage and drooping branches. *Anogeissus leiocarpus* tree is useful among others for fuelwood and medicinal purposes. Arbab (2014, p. 497) cited Rotimi (1988) that “the wood of the tree is used for orudental hygiene in rural communities of Nigeria where the end of the sticks are chewed into fibrous brush which is rubbed against teeth and gum”.

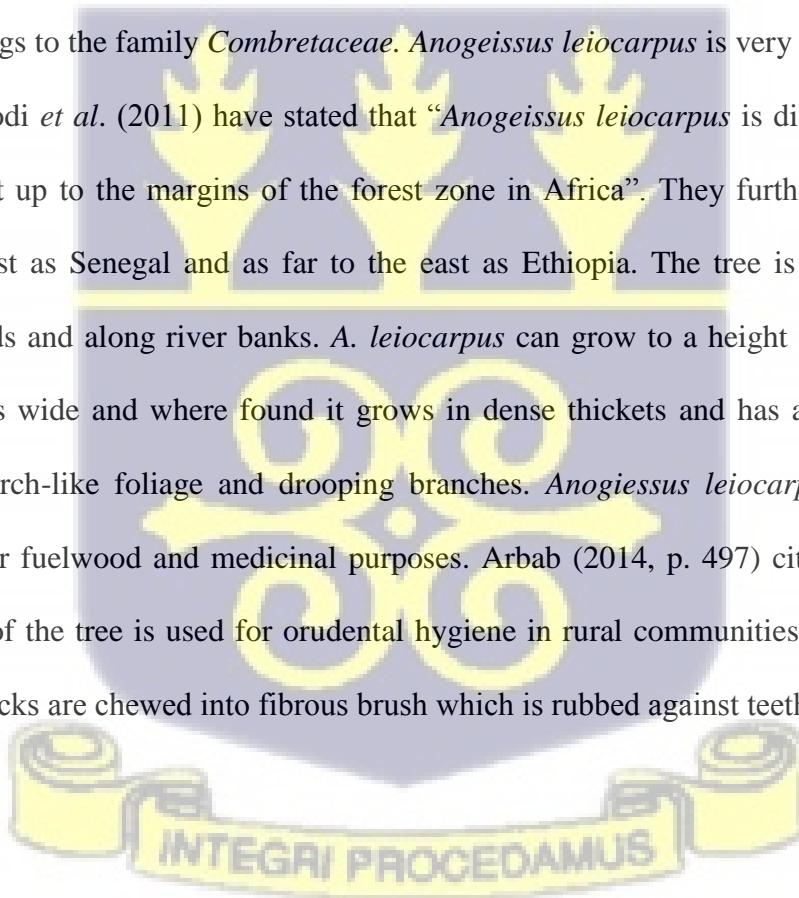




Plate 3:1 *Anogeissus leiocarpus* Tree



3.9.2 *Balanites aegyptiaca* (Desert Date)

Balanites aegyptiaca is known as desert date or “Aduwa” in the local Hausa language and it belongs to the family *Zygophylloceae*. The tree extends to the northern semi-arid regions with extreme conditions such as very low rainfall and high temperatures. It highly tolerates adverse human activities such as bushfires and livestock grazing activities. *Balanites aegyptiaca* is widely distributed in Nigeria’s arid zone and it is a desert plant (Lohlum *et al.*, 2012). Chothani and Vaghasiya (2011) cited in Lohlum *et al.* (2012) says that the tree grows in different kinds of soils and is also found in a variety of habitats. *Balanites aegyptiaca* is a short tree with long thorny twigs found in jumbled bunches and the stem is usually gnarled in shape. Apart from the use of the wood of the tree for making excellent charcoal, *B. aegyptiaca* is utilized for a number of purposes in the African drylands. According to Elfeel and Warrag (2011, p. 287), these include medicine for treatment of stomach pains, diabetes, healing of wounds, jaundice, human and animal food and oils (kornaka).

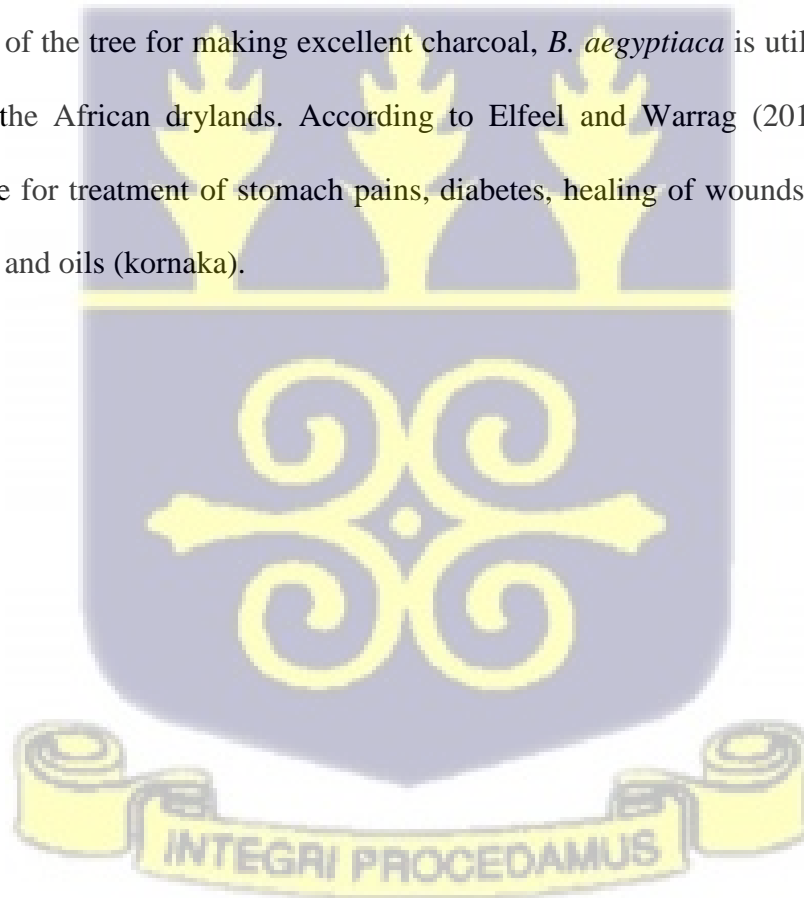




Plate 3:2 *Balanites aegyptiaca* Tree



3.9.3 *Faidherbia albida* (Winter Thorn)

Popularly recognized as Winter Thorn, Apple-ring or Ana tree, *Faidherbia albida* is known as “Gawo” in the local Hausa language and it belongs to the family *Leguminosae*. This tree can reach up to 18 meters in height and about 3.7 meters wide. Its crown is also relatively wide and tends to spread out. *Faidherbia albida* is a peculiar tree in the sense that it sheds its leaves when rains are approaching and then regains them in the dry season. The tree has thorny twigs and can be found growing in clusters. *F. albida* being legume fixes nitrogen into the soil and crops grown in association with them stands to benefit. The tree is highly tolerant to drought. A research conducted by Gitonga (2012) at Kenyatta University in Kenya revealed that *F. albida* fixes a lot of nitrogen in the soil. Among the uses of the tree is that it is very popular in land fertility management. Le Hauerou (n.d, p. 1) cited Charreau and Vidal (1965); Dancette and Poulain (1969); Radwanski and Wickens (1967) who have argued that “it has been shown that millet yields under *Faidherbia* are, on average, 2.5 times more than any other tree.”

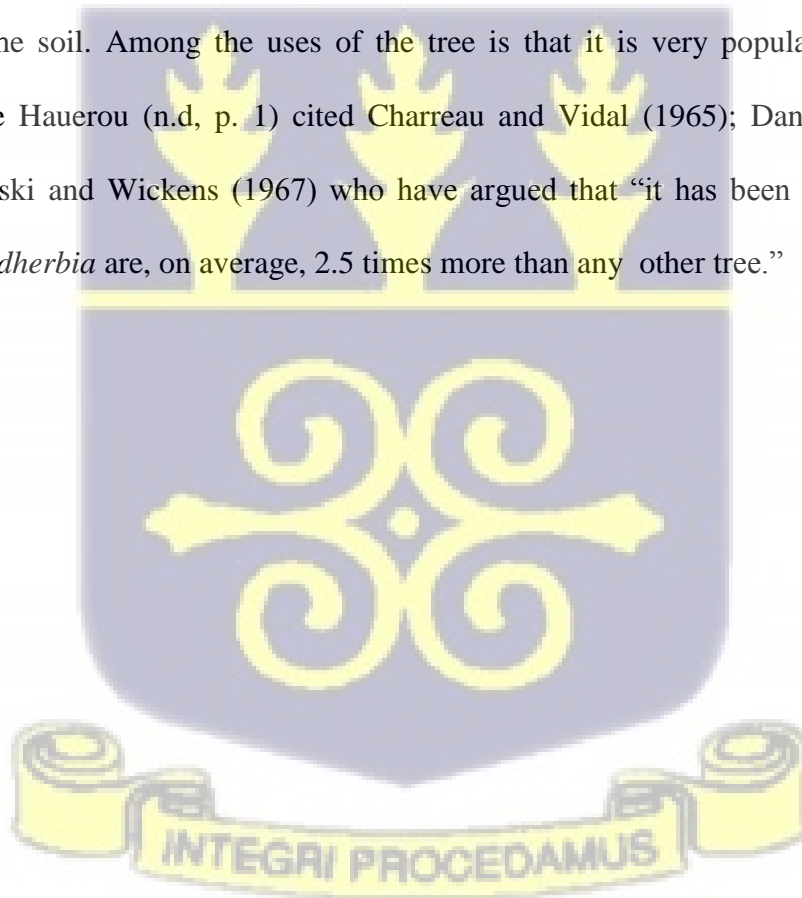




Plate 3:3 *Faidherbia albida* Tree

3.9.4 *Khaya senegalensis* (African Mahogany)

Khaya senegalensis is commonly called African mahogany or dry zone Mahogany and in the local Hausa language it is known as “Madachi”. It belongs to the family *Meliaceae*. This tree is indigenous to a number of African countries that include Nigeria and many other West African countries. IUCN Red List considers it a vulnerable species as little regeneration takes place once disturbance occurs. *Khaya senegalensis* is a relatively small tree and can reach up to 18 meters high and 1.8-2.4 meters wide. It is a very important multi-purpose tree but it is best known for its timber and medicinal uses. The timber of *K. senegalensis* according to Arnold (2004) due to its good qualities in grain and colour is so much valued by its users. Nwosu *et al.* (2012) have also stated that the tree is being used so much for its medicinal values. Mayell (1986) in Sule *et al.* (2008) also testifies that the seeds and leaves of *K. senegalensis* are used in the treatment of fever and headache while the roots are used in treating mental illness, syphilis and leprosy.

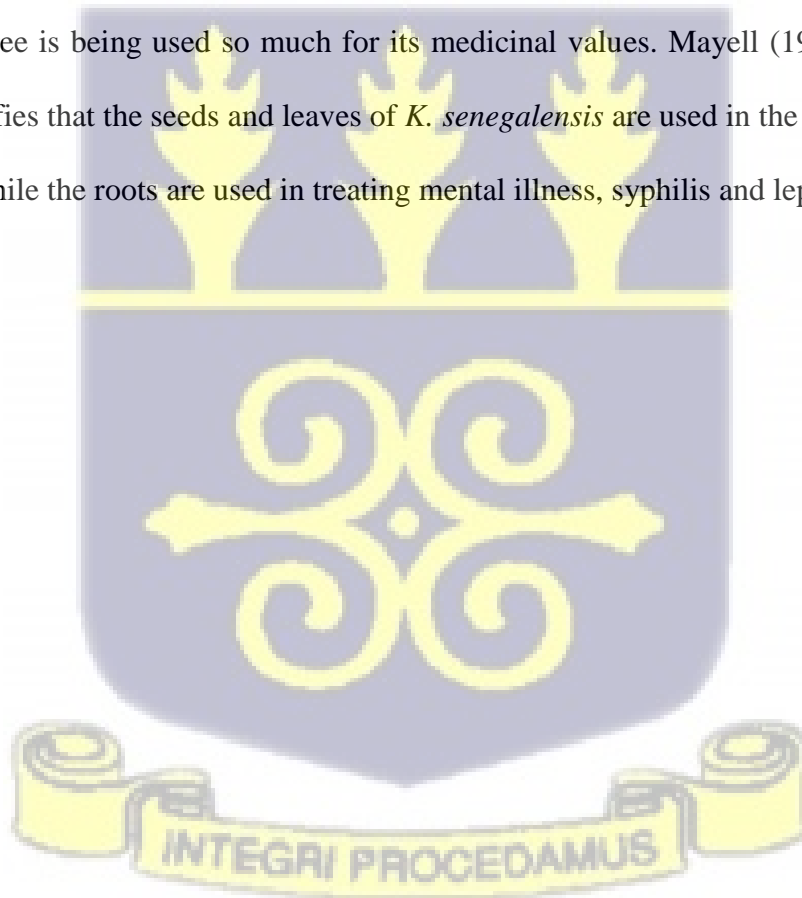




Plate 3:4 *Khaya senegalensis* Tree

3.9.5 *Parkia biglobosa* (African Locust Bean)

Parkia biglobosa is popularly known as African locust bean tree and “Dorowa” in the local Hausa language. The tree belongs to the *Fabaceae-Mimosaceae* family and can grow up to a height of 15-18 meters and 3 meters wide. *P. biglobosa* has a wide spreading crown and the seeds are embedded in a pulp that has a yellow colour and it has a multi-purpose use. Ouedraogo *et al.* (2012) argued that the tree has an extensive multi-purpose use in Africa’s Sudano-Sahelian zone. *Parkia biglobosa* is however most famous for its fruit and seeds. The fermented seeds of *Parkia biglobosa* are extensively used throughout Nigeria and other parts of West Africa for seasoning soups (Teklehaimanat, 2004; Ajaiyeoba, 2002). Kaura *et al.*, (2011, p. 1) also cited Djakpo (2005) who added that “The pulp of the fruit pods is rich in sucrose and the seeds are rich in carbohydrates, proteins and lipids, thus constituting an important source of energy”.





Plate 3:5 *Parkia biglobosa* Tree



3.9.6 *Vitellaria paradoxa* (Shea Butter)

Vitellaria paradoxa is also known as shea butter tree and “Kadanya” or “Kadai” in the local Hausa language. The shea tree belongs to the family *Sapotaceae*. Moore (2008) asserted that *Vitellaria paradoxa* specie has wide geographical distribution and is very versatile. Byakagaba *et al* (2011) cited Maranz, Zeev, and Bishnu (2004) saying that the tree is common to the Savanna lands of Africa north of the Equator. On average, the tree has a height of about 9 meters and 1-1.5 meters in width. *Vitellaria paradoxa* has a spreading crown and drooping lower branches. The fruits when ripe contain chestnut-brown kernels that contain oil of which the tree is famous. Okiror *et al.* (2012, p. 1) cited Lamien *et al.* (2007) who noted that “The fruit pulp can be eaten by both humans and animals, while the butter extracted from the seed kernel has remarkable importance for traditional food security, manufacturing of body care products, pharmaceuticals, and the confectionery industry”.

Shea tree because of its importance is mostly managed on farms. A survey conducted by Okiror *et al.* (2012) in 80 selected households in the Amuria district of eastern Uganda revealed that the Shea tree is cultivated mainly on farms through natural regeneration by 93% of the households in the area. Effort must be made to conserve *V. paradoxa* as it is under threat from human pressures. Byakagaba *et al.* (2011) support the World Conservation Union in declaring the tree as a threatened species.

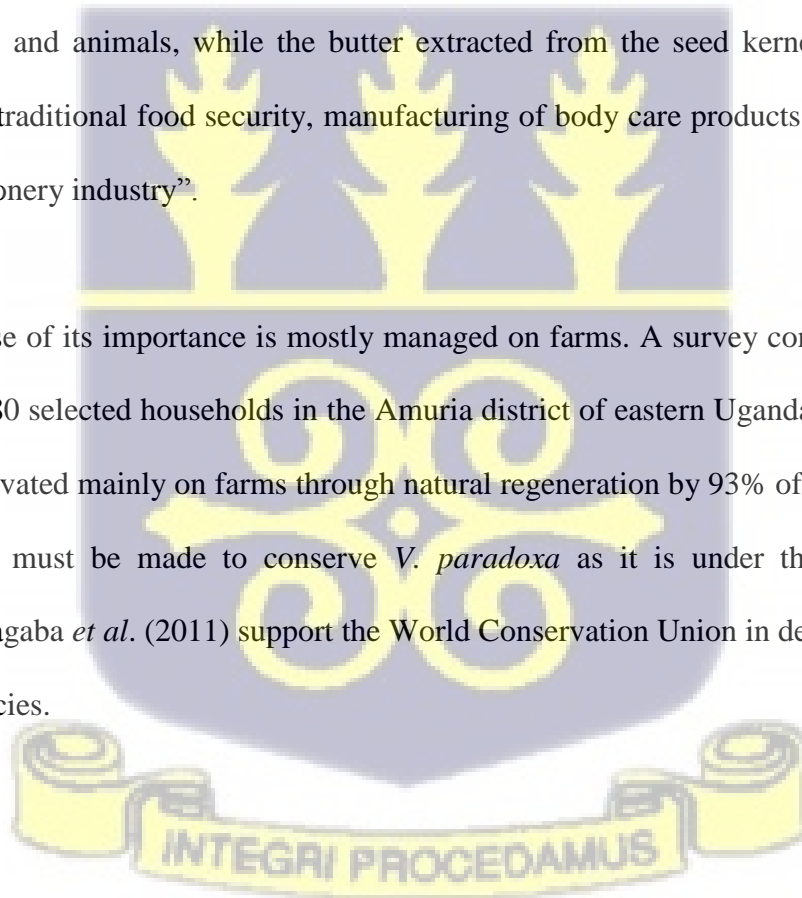




Plate 3:6 *Vitellaria paradoxa* Tree

3.10 Types and Sources of Data

Two main sources of data namely primary and secondary sources were identified and explored so as to realize the stated objectives of this study. Firstly, the primary source of data was the information obtained on the selected tree species identified, their diameter at breast height (DBH) and frequency records through direct field observation measurements using Global Positioning System (GPS) and measuring tape. The second aspect of primary source of data was obtained on the selected communities through questionnaire administration, focus group discussion and key informant interviews. The secondary data used apart from internet and library research materials include topographical (1:150,000) and administrative maps of the three administrative units and 2006 National Population Commission (NPC) locality Enumeration Areas (EA) lists.

3.11 Instruments and Tools for Data Collection and Analysis

Research instruments and materials used comprise questionnaire, interview schedules, locality lists, maps (topographic and administrative) and specialized forms designed to record the field data on tree parameters measurement as well as the respondents. These include tree use category forms, tree inventory forms and focus group discussions checklist. The main tools used for data collection and analysis are presented in Table 3.



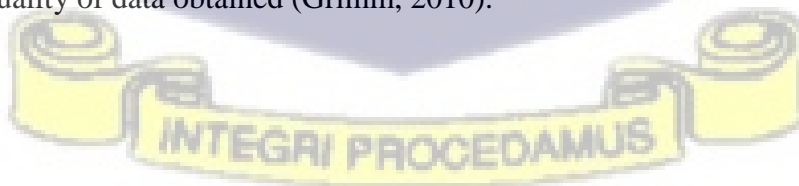
Table 3: Tools Used for Data Collection and Analysis

TOOL	PURPOSE
GARMIN 60 GPS	For point location on the ground and mapping
TAPE (100 m)	For measurement of distance and tree DBH
SONY DIGITAL CAMERA	For taking terrestrial photographs and trees
SPSS	For statistical analysis of questionnaire
RANGING POLES	For marking points and setting out straight lines on ground.
ARCGIS 10.2 SOFTWARE	For map analysis including digitization

Source: Field Work, 2012

3.12 Methodology for Reconnaissance Survey

A reconnaissance survey was conducted to get the researcher familiarize with the study area and to provide insight into how to organize the actual fieldwork in March, 2012. Information about the pattern of vegetation, its aerial coverage as well as the people's socio-economic background and land use activities were ascertained. This was followed by a pre-testing of a hundred questionnaires administered to one hundred respondents in the study area to standardize the test. This helped to considerably minimize all kinds of errors associated with survey research as well as improve the quality of data obtained (Grimm, 2010).



3.13 Sampling Methods for the Surveys

A multi-stage sampling design was used in this study and this is in view of the fact that there are separate components which must be considered separately, and in stages. These include the three administrative areas, the rural communities and the households. In the first stage, the study area was selected purposely represent the entire geographical area covering the three administrative units or local government areas of Batsari, Jibia, and Kurfi.

The second stage involved the application of stratified random sampling method to stratify the study area and select the eighteen (18) rural communities. The stratification was done by dividing the study area into administrative regions of strata which formed the basis of stratifying the survey area. Each stratum signifies one of the three administrative regions or local government areas. Thus Batsari, Jibia, and Kurfi served as the three strata. This was done to ensure homogeneity.

Stratified sampling method based on proportional sampling scheme was then applied to select the eighteen (18) rural communities. Each administrative unit or local government area was accorded certain number of communities according to its population size. Each region's percentage of the three regions total population was multiplied with 18 communities to get its share of number of communities. Thus Batsari (42.1% of 18) was allocated 8 communities while Jibia (34.2% of 18) and Kurfi (23.7% of 18) were allocated 6 and 4 communities respectively. The actual survey communities from within each stratum were selected to ensure that they were fairly spread over each administrative region.

The third stage involved households sampling which was undertaken through systematic random sampling method with random start of the first household and subsequent ones at an interval of every 5th household. This ensured that, as much as possible, a fair representation of the households in each community was achieved. Here households were selected from each of the selected rural communities proportionally depending on their population sizes. In all, three hundred and forty five households from the eighteen rural communities were selected. Each of the selected household heads was identified and interviewed and in this case male or female household head served as the respondent.

The sample frame for the household surveys is the Katsina State Census Enumeration Area (EA) register of 2006 which is the most recent census conducted in Nigeria by the National Population Commission. It was from this that the population and hence sample sizes for the survey communities were drawn. United Nations (2005) have added that for conducting household surveys, census enumeration areas are the principal source of sampling frames. At the time of the survey, the community level population figures were not aggregated. The researcher therefore has used the Enumeration Areas (EA) population data of each of the eighteen rural communities to establish their total population.

Consequently, each community's total number of households was determined on the basis of relating its total population with the average number of persons per household for Katsina State to get the total number of households required for this survey. Nearly three percent (2.5 %) of each study communities' households which was based on convenience represent the total sample size of three hundred and forty-five (345) respondents or eligible household heads required for

this survey (Table 4). These were therefore randomly selected for the interview schedule to obtain quantitative data for the study. The size of the sample must take account of competing needs so that cost and precision are optimally balanced (United Nations, 2005 p. 27).

Table 4: Sampling Profile among Study Communities

BATSARI		JIBIA		KURFI	
Communities	Sample Size	Communities	Sample Size	Communities	Sample Size
Shirgi	19	Bugaje	13	Wurma	41
Zanko	14	Mazanya	22	Tsauri	40
Kurmiyal	11	Yangayya	6	Kaware	19
Zamfarawa	19	Farun Bala	6	Rawayau	45
Nahuta	16	Tsayau	4	—	—
Tadeta	13	Kusa	6	—	—
Mallamawa	11	—	—	—	—
Kandawa	40	—	—	—	—
Total	143		57		145

SOURCE: Field Work, (2012)

3.14 Methods for Quantitative Approach

This survey segment entails collecting quantitative data. Two methods were employed for collecting data for realizing some objectives of the study. These were the questionnaire survey and tree feature measurements. The objectives covered under this survey include access right and control over trees, trees and sustainable livelihoods, indigenous knowledge of trees conservation

and tree governance. The other objective was to determine the frequency, spatial distribution, density, and girth classes of the selected trees.

3.14.1 The Questionnaire Survey

Household sample surveys have become a key source of data on social phenomena in the last 60-70 years (United Nations, 2005, p. 32). This study therefore made use of household as the unit of data collection through questionnaire interview. The respondent who in this case was the household head makes important decisions that affect communities including those on the selected tree species. In all, three hundred and forty five questionnaires were administered in all the communities (Table 5). Every one of the households was visited and in each the household head or their representative formed the basis for the questionnaire interview. In this way all the households were covered for the 345 interviews conducted. The questions were interpreted in the local language when it was deemed necessary.

Table 5: Distribution of Administered Questionnaire in the Administrative Units

Administrative units (LGAs)	Number of Questionnaires
Batsari	143
Kurfi	145
Jibia	57
Total	345

SOURCE: Field Work (2012).

The questions (both open ended and close ended) covered several topics that are linked to the dynamics of household's rural livelihood activities and selected economic trees uses (see appendix 1). The questionnaire consists of several themes presented in the following modules:

- *demographic and socio-economic information*
- *household access to the selected trees and livelihood activities*
- *household ownership of assets and income sources*
- *household local awareness and people's perceptions*
- *indigenous knowledge of conserving the selected trees*
- *threats to the selected trees*
- *Institutions and governance*

The researcher who also participated in such interviews was occasionally contacted on problems relating to the questionnaire interview. The data obtained using this method was used in the final analyses to come up with answers to the research questions and objectives of the study. The merits of this method of data collection according to Mathers, Fox and Hunn (2007) include its cheapness and quickness if the sample is big and widely dispersed.

3.14.2 The Scientific Tree Measurements

Quadrat sampling method using line transects was used to establish sample plots in the survey area. This is because according to Cox (1990: cited in Fidelibus and Mac Aller 1993 p. 1), "sampling with quadrats (plots of a standard size) can be used for most plant communities". Fifty four quadrats (54) each of dimension 100m by 100m, were established in total - three in each of the 18 rural communities. The quadrats were thus distributed in the three administrative regions

based on the number of communities in each (Table 6). The rationale for choosing this number of quadrats is because of the size of the area (2,716 km²) as well as cost consideration and convenience. Strahlgren *et al.* (1997, p. 1064) also added that “only a small portion of any landscape can be sampled for vascular plant diversity because of constraints of cost (salaries, travel time between sites, etc.)”. Kindt and Coe (2005) have argued that the issue of choosing a standard or common sample size in any place is not hard and fast.

The fifty-four sample plots or quadrats (100 m x 100 m) were established from each of the eighteen (18) communities using measuring tape and ranging poles. For the inventory, single transects were laid across cultivated and uncultivated fields and made to run from each of the communities. Three sample plots were placed at intervals of 300m positions along each transect on both sides with the help of measuring tape and poles (Adopted from McGregor, 1991). According to Fidelibus and Mac Aller (1993 p. 1), “quadrats can be established randomly, regularly, or subjectively within a study site”.

Table 6: Distribution of Sample Plots in the Three Administrative Units

Administrative units (LGAs)	Number of Sample Plots
Batsari	24
Kurfi	12
Jibia	18
Total	54

Source: Field Work, 2012

In each quadrat, data on the selected tree species were recorded on a Special Form designed for that purpose (See Appendix 6). In each quadrat, data was collected on frequency, density, and girth of trees. Also, ground control points were taken with GPS to explain spatial distribution of trees. Each of the four attributes measured are explained subsequently.

The method that was adopted for the inventory of the selected trees in terms of frequency, density, girth class and spatial distributions was direct observation and measurements. This method of data collection according to the United Nations, (2005) is the best and usually more objective. This is the ecological survey segment which involved actual data collection/measurements in the field. Actual field data collection took place between April and June, 2012.

Ground inventory regarding the attributes of the six selected economic trees was conducted in both the cultivated farmlands and the natural tree/woodland vegetation of the study area. The rationale for selecting these methods in this case was to obtain field data/information that addressed the objective that deals with the determination of frequency, spatial distribution, density and girth class distribution of the selected economic trees. The data obtained using these methods on the four variables investigated are explained below:

In quantifying tree frequency, the individual member of each of the selected economic tree species within the sample plots or quadrats was simply counted and the frequency of occurrence of the tree stands recorded. Percentage frequency which relates the number of times a particular selected tree species appears in the sample plots with the total sample plot number was also

computed. Relative frequency or distribution of individual selected tree species in the study area was determined as the frequency of occurrence of each tree as it relates to all the other species.

Both of these parameters were calculated from the formulae:

$$\text{Percentage frequency} = \frac{\text{Number of sample plots with a particular tree species}}{\text{Total nos. of all sample plots}} \times 100$$

$$\text{Relative frequency} = \frac{\text{Frequency for each tree species}}{\text{Total frequency for all species}} \times 100$$

A particular tree once identified by its vernacular name which is later converted to the scientific and common names is counted and then recorded on the Tree Inventory Form. This was done for all the fifty four sample plots. Saplings and seedlings which are young trees of the selected economic trees once identified were also counted and recorded with a view to obtaining information on the selected trees regeneration capacities. The entire field data concerning the selected tree's inventory were entered into the fifty-four Tree Inventory Forms distributed in sample plots close to the eighteen communities of the study area (See Appendix 1). From these forms, frequency, density, girth class and spatial distribution were determined.

In order to determine the spatial distribution of each tree species of interest, individual stands of the selected economic trees within each sample plot was located using GPS in terms of its latitude and longitude coordinates and this was recorded on the Tree Inventory Form. The data for the selected trees within each sample plot was explored with the help of chloropleth mapping

technique to explain the spatial distribution pattern. The tree coordinates data generated from this activity was then used to map the distribution of these selected trees using ARCGIS 10.2.

Tree density was computed for each of the fifty four sample plots. Individuals of each of the selected trees were simply counted by a research assistant and another records the information. Care was however taken not to count already counted selected trees. Each sample plot was given an identification code to distinguish it from the rest. This was done until all the sample plots were covered. It is assumed that the density of any plot gives an indication of the extent of human exploitation of the selected trees through clearance or deforestation in that plot which was later compared with the density of other sample plots in different localities of the study area. In order to calculate the selected trees density in each sample plot, the following formula from Kershaw (1975) was employed:

$$D = \frac{\text{number of a particular species}}{\text{Area (hectare)}}$$

Where D = species density.

The girth at breast height (GBH) i.e. 1.37m or 4.5 ft from the ground of individual trees of the selected tree species within each sample plot or quadrat was directly measured in the field by the research team using the 100 meter measuring tape. One of the research assistants who carried out the GBH measurement calibrated 1.37m and marked it on his body from the ground. At this height, the measuring tape was wrapped around the tree stem and the diameter is measured (in meters) and recorded on the Tree Inventory Form until all other trees in the sample plots in the

study area were covered. This is with a view to the researcher defining the trees diameter into four girth classes, small (GBH<1m), moderate (GBH 1-1.99m), big (GBH 2-2.99m) and very big (GBH >3m). The basis for this was that the trees comprise wide ranging diameters. This categorization of the trees according to GBH and the distribution pattern explains tree stand structure (Omeja, Obua and Cunningham, 2004).

Certain assumptions were made in the estimation of GBH of some of the few individuals of the selected tree species measured with irregular stems such as trees with buttresses, multiple stems or no clear trunk. For trees with buttresses like *Parkia biglobosa*, the GBH was measured just above the buttresses (Omeja, Obua and Cunningham, 2004). Trees with gnarled stems like *Balanites aegyptiaca* have their GBH determined from 3 girth readings of each individual of species which is then averaged to get GBH (Attua, 2003). The ones with forked or multiple stems closed to ground were treated as separate stems if they forked at below 1.3m (Timber Measurement Manual, 1999).

From the DBH measurements (converted into centimeters), the basal area or the cross-sectional area of a tree trunk at breast height per selected tree species was computed as the average of the sum of the basal area values for each individual selected tree expressed in square meters. Basal area is a function of the number of trees and the sizes of trees. It also gives an indication of site occupancy and forecast future development of a selected tree stand. Basal area (BA) was determined from the following metric formula from Larsen (2014):

$$BA = \frac{\pi}{4 \times 10000} \times DBH^2$$

$$BA = 0.00007854 \times DBH^2$$

Where:

BA = basal area per tree in square meters.

DBH = diameter at breast height in centimeters.

π is the constant = 3.1415





Plate 3:7 Taking Records of Tree Girth at 1.37 m above Ground





Plate 3:8 *Parkia biglobosa* Tree with Forked Stem close to Ground Treated as Individuals



3.15 Methods for Qualitative Approach

Two methods were employed for collecting data for complementing some objectives of the study which include access right and control over trees, trees and sustainable livelihoods, indigenous knowledge of trees conservation and tree governance. These are a combination of the use of individual interview and Focus Group Discussions (FGD). Murray (2001) has asserted that livelihoods research is best achieved through a combination of several methods. This method for collecting qualitative data was conducted in the following ways:

3.15.1 The Focus Group Discussion

The focus groups for collecting community level data were also selected purposely based on participants ages and specialized knowledge of the selected trees in the study area. The study area is also not very diverse (see study area in earlier section) in terms of its culture and biogeography hence the limited number of the focus groups selected. Three focus groups, consisting of ten participants each, were set up in three communities of Tsauri, Mazanya and Mallamawa area each representing one administrative region. These communities were also selected because they harbor famous people with specialized knowledge of the selected trees including some famous herbalists.

This was done to complement the household level data collected through the questionnaire survey. The focus groups were composed such that each of them had a mixture of different stakeholders comprising village/community elders and people with expert knowledge. Such people include fuel wood sellers, herbalists, and local forest officials. A focus group contained at least four village elders and one each of the expert people.

This method was selected to complement the questionnaire survey in getting different perspectives on the selected economic trees. This according to Banda (2005) is to have a rich exploration of ideas and knowledge from so many perceptions. Each focus group session lasted for at least an hour so as to allow for a full discussion and providing a clear picture specifically on the six selected economic trees. The three specific themes that served as the key questions constituted the key checklist questions (see Appendix 4). The major themes are outlined as follows:

What is the use and importance of the selected economic trees?

How does the selected economic trees availability vary locally?

What is the local conservation status of the selected economic trees?

Tree use category tables were also used to address the theme on use and importance of specific selected trees (See Appendix 5).

3.15.2 The Individual Interviews

The rationale for selecting this method was to obtain useful information that was not captured in the questionnaire and also to compare it with the locally held views obtained from the questionnaire survey. The people selected for the individual interviews (key informants) include the Director and other professionals working with the Katsina State Department of Forestry which now controls all forestry activities in the state. Others selected were some community leaders and members of some NGOs. The main advantage of personal interview method is that the respondents can be persuaded to answer questions and can explain the objectives of the

survey including greater potential for collecting statistical information on conceptually difficult items which are likely to elicit ambiguous responses (United Nations, 2004).

The information obtained from such institutions includes valuable insights on official statements about tree resource issues, tree tenure and tree governance. It is interesting to note that the state has benefitted in the past from some global institutional interventions on sponsored afforestation programmes such as EU and the World Bank. Useful information that was not captured in the questionnaire was obtained in this way. This is the last of the socio-economic data survey and indeed the whole data collection exercise.

3.16 Statistical Analysis of Data

Two data sets whose analyses are different were generated. The first data set involved quantitative data generated from the three hundred and forty five (345) respondents in the communities. It was analyzed and interpreted in line with the objectives of the study. Excel (version 2010) and Statistical Package for Social Sciences (SPSS version 19.0) were used for the statistical analyses.

Another data set generated from the fifty four (54) quadrats (sample plots) regarding the 335 individuals of the selected tree species was also analyzed in line with the objectives of the study. Chloropleth mapping was also done to be able to explain the observed spatial variation in selected tree species' distribution patterns. The software used in prosecuting this mapping was ARCGIS 10.2.

In the analysis of quantitative data, both descriptive and inferential statistical techniques were used for analyzing the data gathered for this research work. Descriptive statistics like frequency tables and graphic data displays, percentages and percentage frequency tables for some household and selected trees data have been employed. Chi-Square analysis was employed to find significance in observed distributions of percentage frequencies of the selected tree species in all sample plots.

The qualitative data generated from focus group discussions and key informant interviews was analyzed using thematic coding method as well as organizing answers by questions. In the former, comments that relate to specific themes were grouped together while in the latter; comments are recorded as answers to particular questions. In this way, the data was categorized and assigned codes and at the end these categories were summarized and used in the discussion.

3.17 Challenges of Data Collection

In the course of conducting the research, some challenges were encountered as in every other study of this kind. However, the researcher tried as much as possible to reduce these problems to the barest minimum. An unforeseen event like flood had affected some of the selected communities which were not thus sampled in time. At one time, our vehicle's tire was destroyed in trying to reach a community. Other challenges encountered include uncooperative manner of some of the respondents during the individual interviews. Despite these challenges however, the quality of the research has not been significantly compromised.

CHAPTER FOUR

ANALYSIS OF THE SELECTED ECONOMIC TREES: FREQUENCY, SPATIAL DISTRIBUTIONS, DENSITIES AND GIRTH

4.1 Introduction

This chapter describes the field data generated through field measurements of the selected economic tree species inventoried in the quadrats around the selected rural communities. The analysis and discussion of the results address the following research question: What are the frequencies and densities as well as girth class and spatial distributions of the selected trees?

4.2 Frequency of Selected Trees

Result of the inventory shows that a total of 335 trees, belonging to five of the selected economic tree species were included in the samples. Table 7 shows the percentage frequency of the tree species in all sample plots in the study area. It also indicates the number of individuals of the trees in all sample plots around the communities. Among the tree species, *A. leiocarpus* has the highest average percentage frequency of almost seventy percent (69.4%) followed by *B. aegyptiaca* with nearly fifty three percent (52.8%). The former tree is also the most frequently found tree in neighboring Kano Close Settled Zone in Nigeria (Cline-Cole *et al.*, 1990).



Table 7: Percentage Frequency of the Selected Trees in all Sample Plots

Selected Tree Species	Common Name	Batsari		Jibia		Kurfi		Average Percentage Frequency
		Freq	%	Freq	%	Freq	%	
<i>A. leiocarpus</i> (Marke)	African Birch	18	75.0	15	83.3	6	50.0	69.4
<i>B. aegyptiaca</i> (Aduwa)	Desert Date	12	50.0	15	83.3	3	25.0	52.8
<i>F. albida</i> (Gawo)	Winter Thorn	4	16.7	5	27.8	1	8.3	17.6
<i>P. biglobosa</i> (Dorowa)	African Locust Bean	14	58.3	2	11.1	9	75.0	48.1
<i>V. paradoxa</i> (Kadanya)	Shea Butter Tree	0	0	1	5.6	4	33.3	13.0
Total Sample Plots		24	Total	18	Total	12	Total	54

Source: Field Work, 2012

The frequency of observed distribution in the above table regarding the selected trees was computed using chi-squared analysis (Table 8). *Anogeissus leiocarpus* and *Balanites aegyptiaca* have the highest frequencies among the selected trees in the study area. They were followed by *Parkia biglobosa* and the least were *Vitellaria paradoxa* and *Acacia albida*. Three (3) cells (100.0%) have expected frequencies less than 5. The minimum expected cell frequency is 1.0 (Table 9). The various selected trees computed frequencies are shown in Appendix 5.



Table 8: Chi-Square Descriptive Statistics

Selected Tree Species	N	Mean	Std. Deviation	Minimum	Maximum
<i>A. leiocarpus</i> (Marke)	3	69.4333	17.33388	50.00	83.30
<i>A. leiocarpus</i> (Marke)	3	52.7667	29.24830	25.00	83.30
<i>F. albida</i> (Gawo)	3	17.6000	9.78110	8.30	27.80
<i>P. biglobosa</i> (Dorowa)	3	48.1333	33.14096	11.10	75.00
<i>V. paradoxa</i> (Kadanya)	3	12.9667	17.83040	.00	33.30

Source: Field Survey, 2012

Table 9: Chi-Square Test Statistics

	<i>V. paradoxa</i> (Kadanya)	<i>A. leiocarpus</i> (Marke)	<i>F. albida</i> (Gawo)	<i>P. biglobosa</i> (Dorowa)	<i>V. paradoxa</i> (Kadanya)
Chi-Square	.000 ^a	.000 ^a	.000 ^a	.000 ^a	.000 ^a
Df	2	2	2	2	2
Asymp. Sig.	1.000	1.000	1.000	1.000	1.000

Source: Field Survey, 2012

The least frequent tree species were *Faidherbia albida* and *Vitellaria paradoxa*. *V. paradoxa* individuals were found in very few of the sample plots indicating small spread. *B. aegyptiaca* due to its natural ability to tolerate dry conditions such as in Jibia which is the driest of the three regions has high percentage occurrence. The same tree species however has small spread in

Kurfi locality due to higher rainfall conditions that are not very suitable for its growth. *B. aegyptiaca* also has a relatively high ability for natural regeneration from seedlings in the area. The most frequent tree is also one of the most preferred and exploited by the respondents particularly for fuelwood.

Table 10 which indicate the relative frequency of the selected tree species reveals that almost half of the total trees listed in the area belong to the most frequent and abundant tree species *Anogeissus leiocarpus*. It is found topping all the other species in the three localities. This is followed by *Parkia biglobosa* and *Balanites aegyptiaca* respectively. However, *P. biglobosa* is less prevalent in Jibia while *B. aegyptiaca* has high occurrence there probably due to the drier weather condition which the trees prefer. The least frequent and abundant tree species however were *Faidherbia albida* and *Vitellaria paradoxa*. The latter tree species is very restricted as most of it was found in Kurfi locality with very small percentage in Jibia where the drier condition could be the reason for its scarcity because the tree needs higher moisture than others.

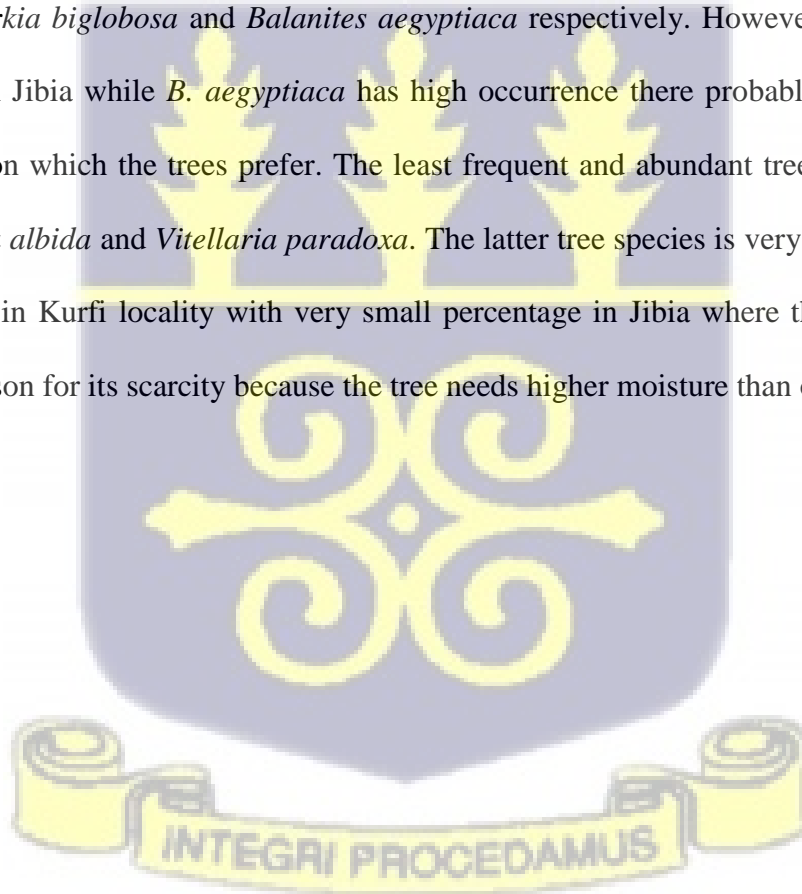


Table 10: Relative Frequency of the Selected Tree Species in the Study Area

Selected Tree Species	Common Name	Batsari		Jibia		Kurfi		Average Relative Frequency
		Freq	%	Freq	%	Freq	%	
<i>A. leiocarpus</i> (Marke)	African Birch	83	55.3	58	48.7	20	30.3	44.8
<i>B. aegyptiaca</i> (Aduwa)	Desert Date	19	12.7	49	41.2	6	9.1	21
<i>F. albida</i> (Gawo)	Winter Thorn	8	5.3	9	7.6	1	1.5	4.8
<i>P. biglobosa</i> (Dorowa)	African Locust Bean	40	26.7	2	1.7	35	53.0	27.1
<i>V. paradoxa</i> (Kadanya)	Shea Butter Tree	0	0	1	0.8	4	6.1	2.3
Total Selected Trees		150	100	119	100	66	100	100

Source: Field Survey, 2012

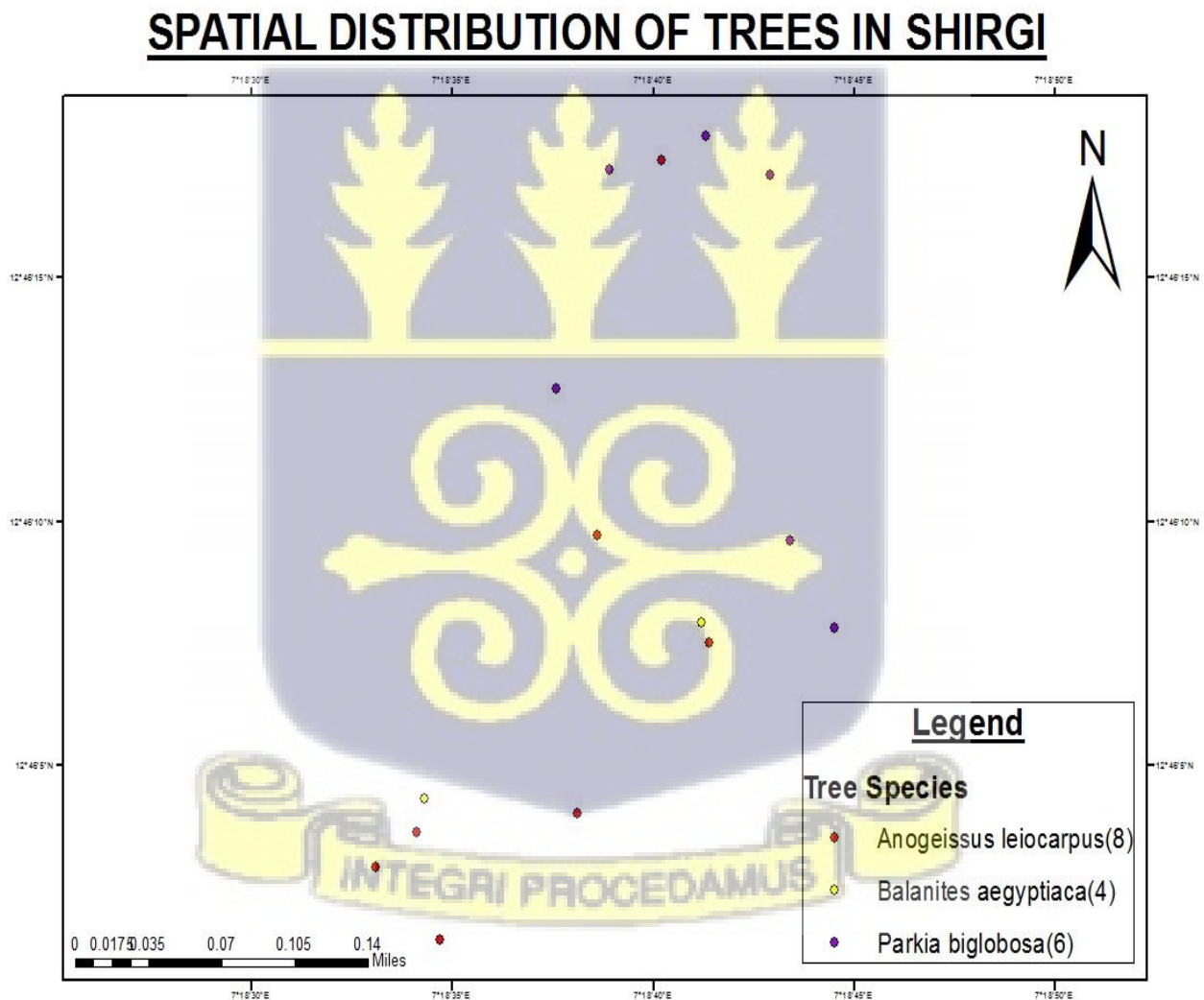
It is not surprising that *A. leiocarpus* tops the other selected tree species in terms of percentage frequency and relative frequency. Maiwada (2000) revealed in a study in a forest reserve close to the study area that *A. leiocarpus* is also among the most widespread tree species. *Khaya senegalensis* was not included in the samples probably because of intense pressure from felling by the people due to its multiple uses. This is not surprising as the tree also belongs to the vulnerable category according to the IUCN Red List of Threatened Species (World Conservation Monitoring Centre, 1998).



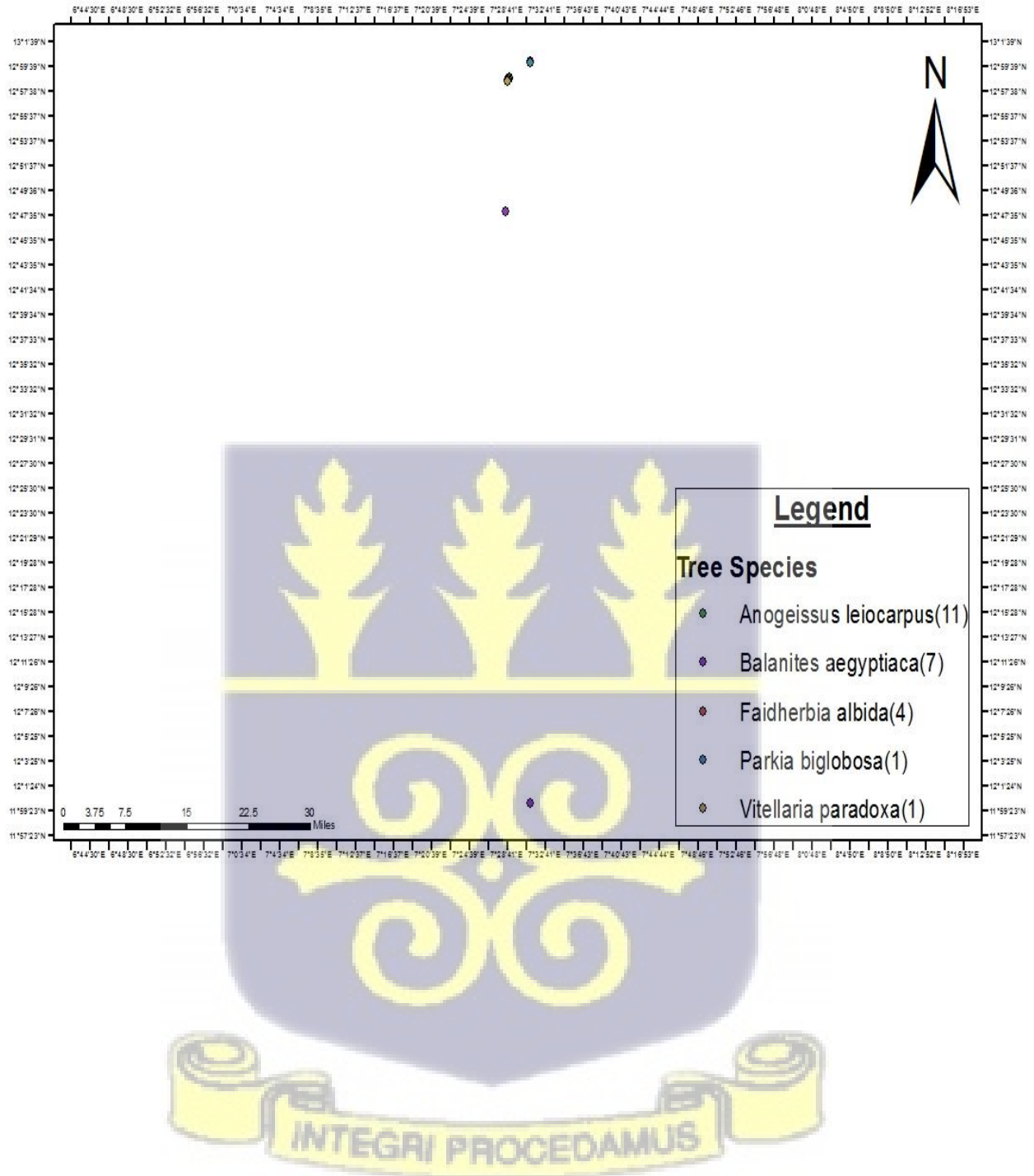
4.3 Spatial Distribution of Selected Trees

In order to represent the spatial distribution of the selected trees, mapping was employed. Figure 8 displayed the tree points (coloured) in maps to show spatial distribution pattern of trees in the study area.

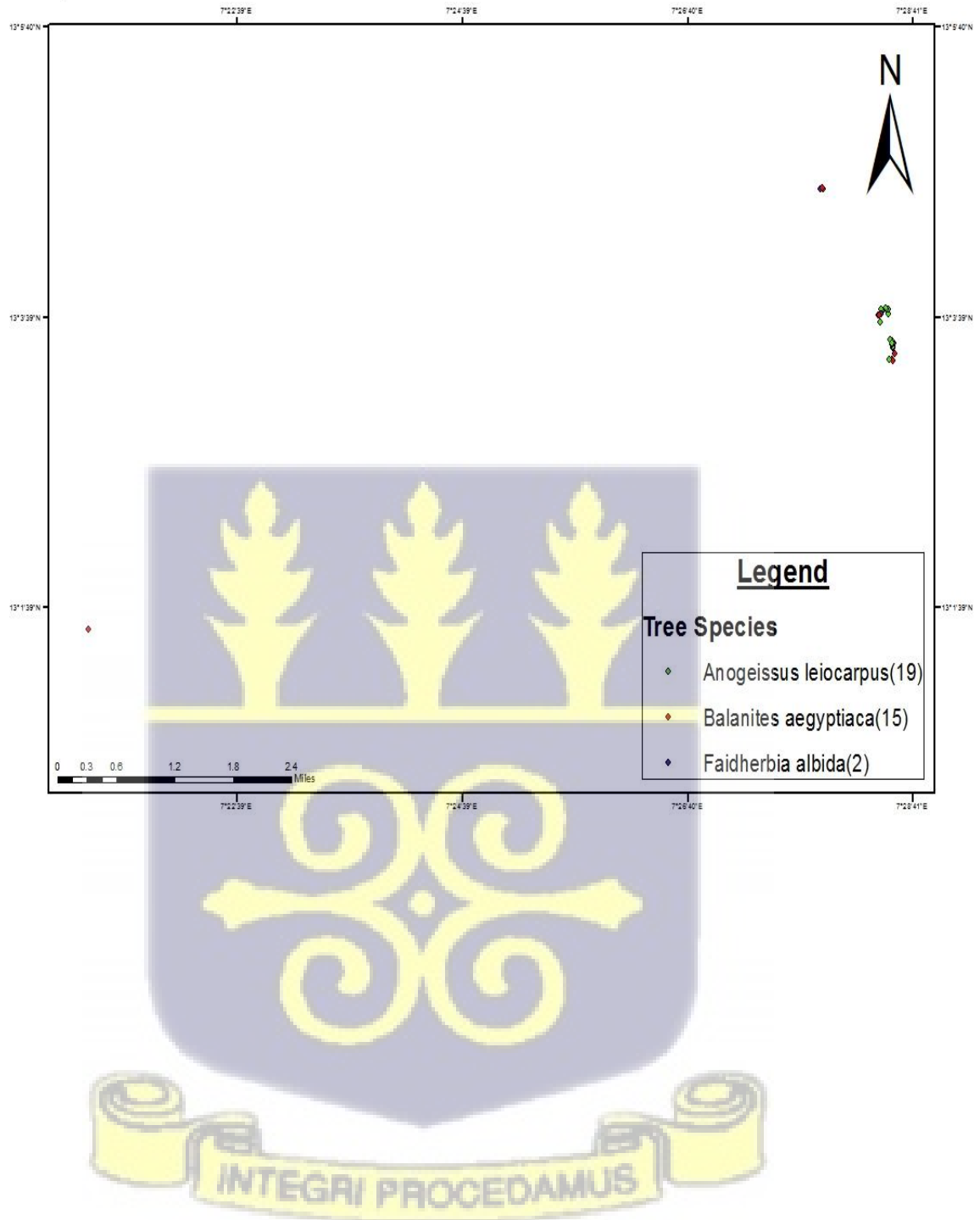
Figure 8: Tree Points to Show Spatial Distribution of Selected Trees in Study Area



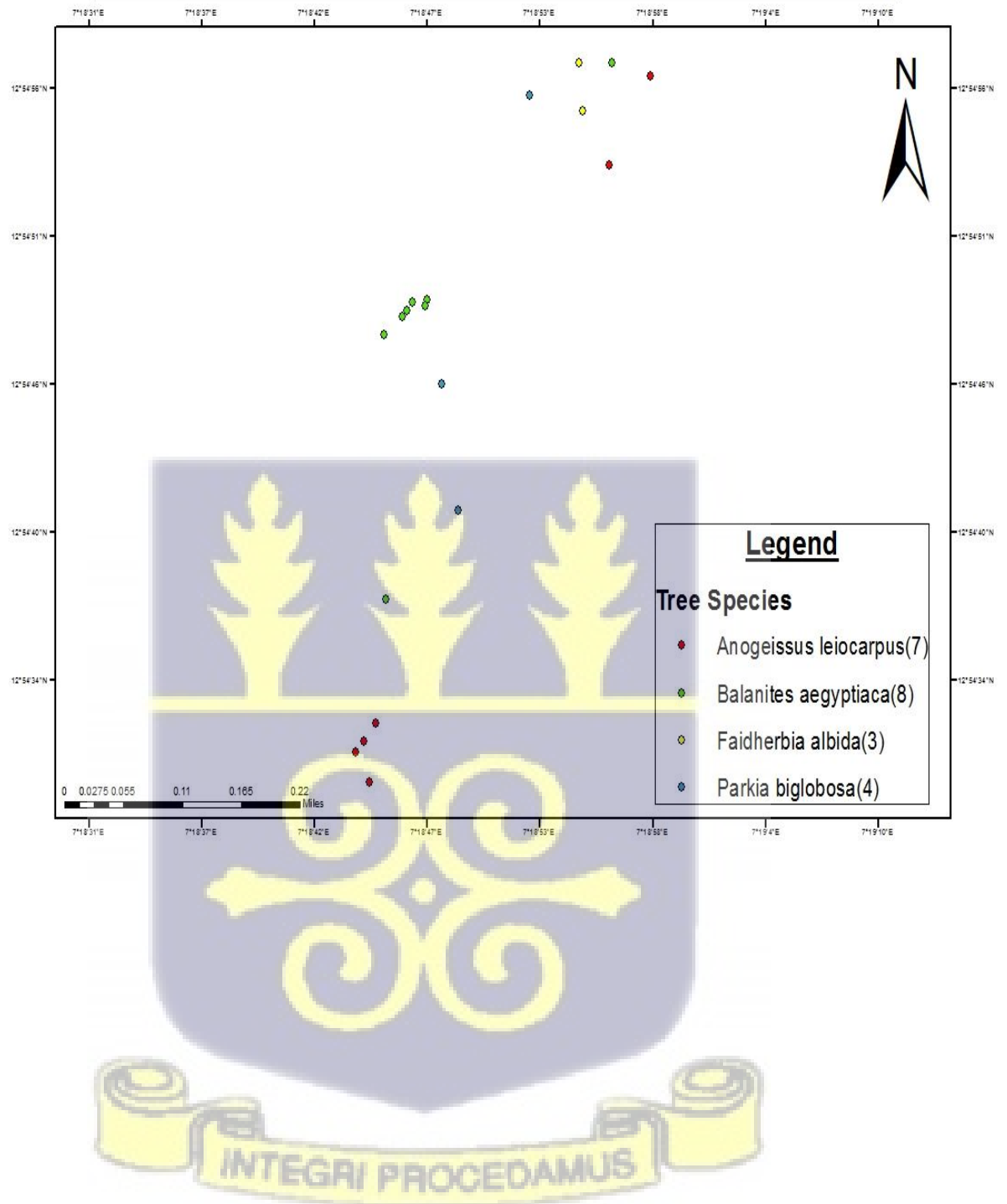
SPATIAL DISTRIBUTION OF TREES IN BUGAJE



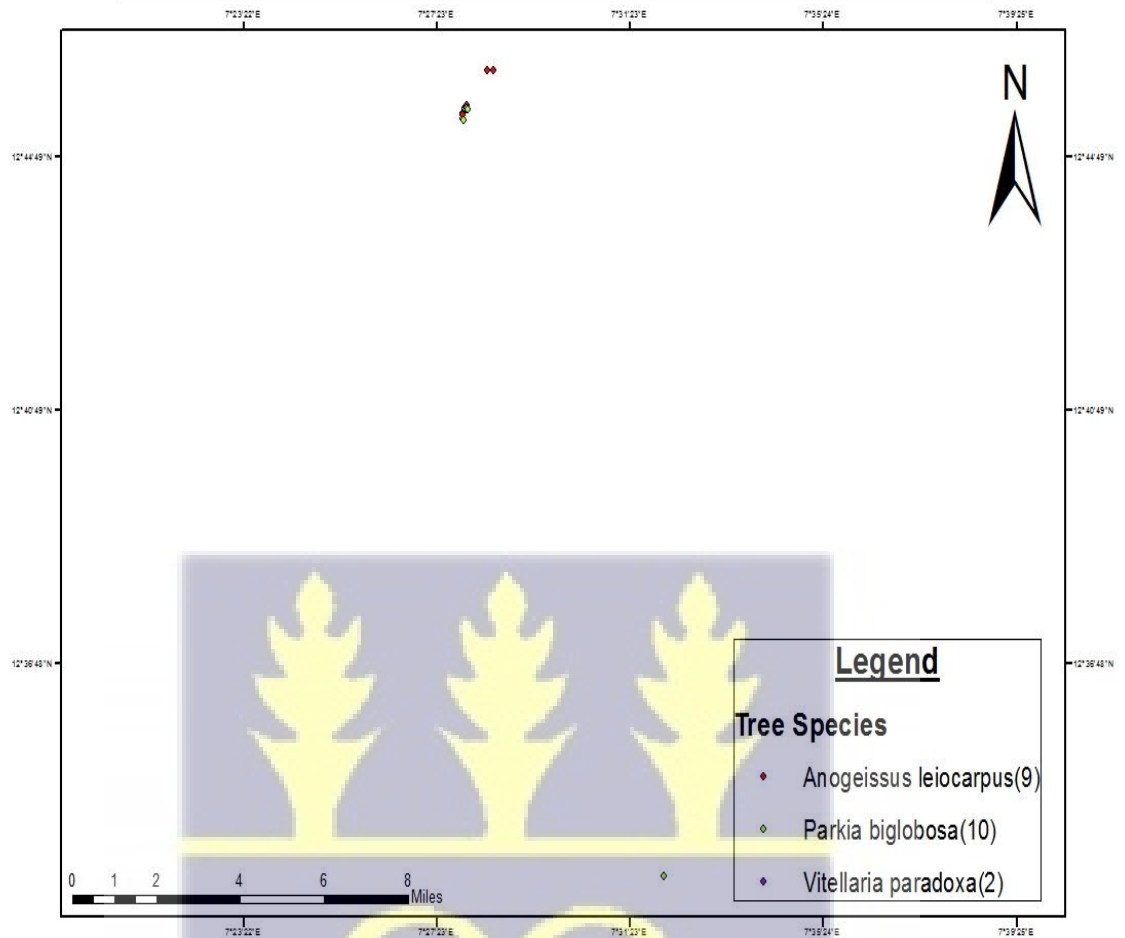
SPATIAL DISTRIBUTION OF TREES IN FARUN-BALA



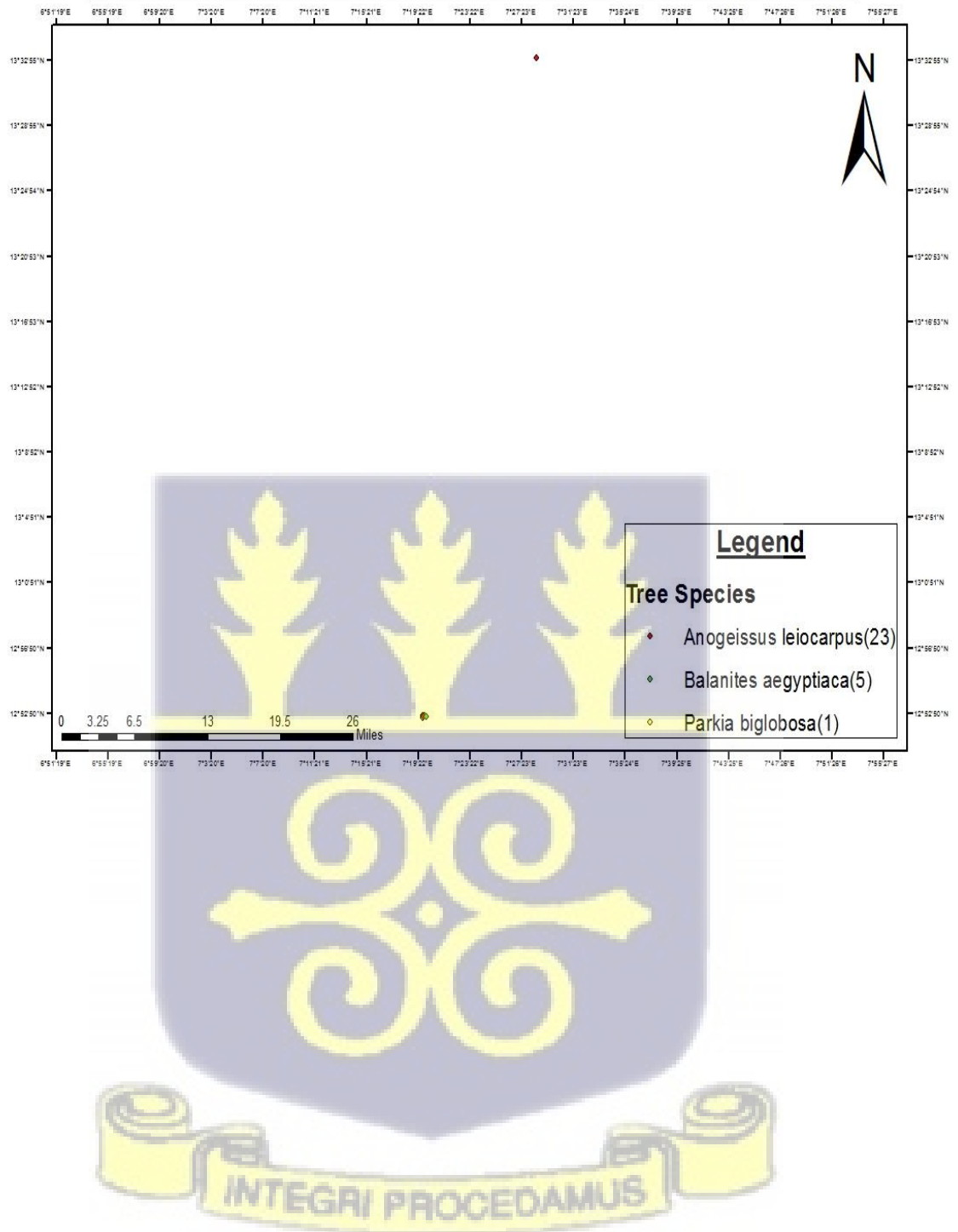
SPATIAL DISTRIBUTION OF TREES IN KANDAWA



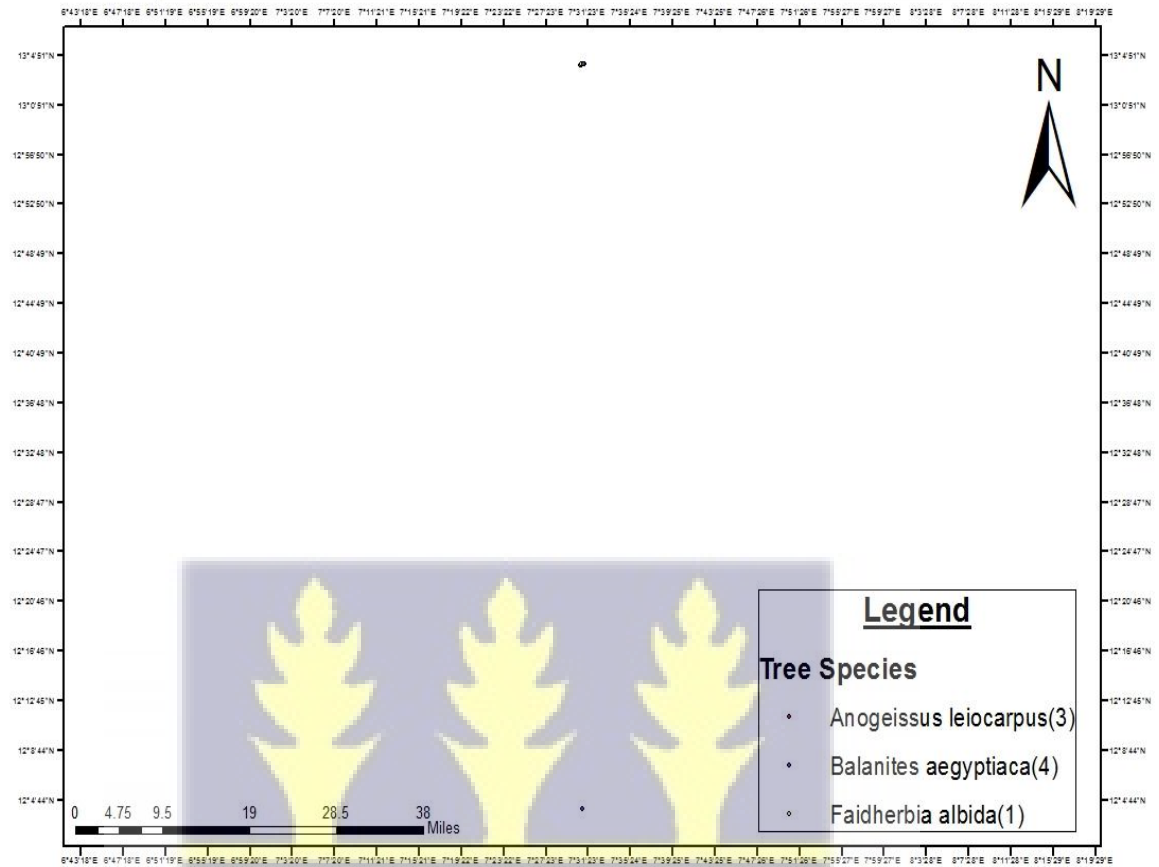
SPATIAL DISTRIBUTION OF TREES IN KAWARE



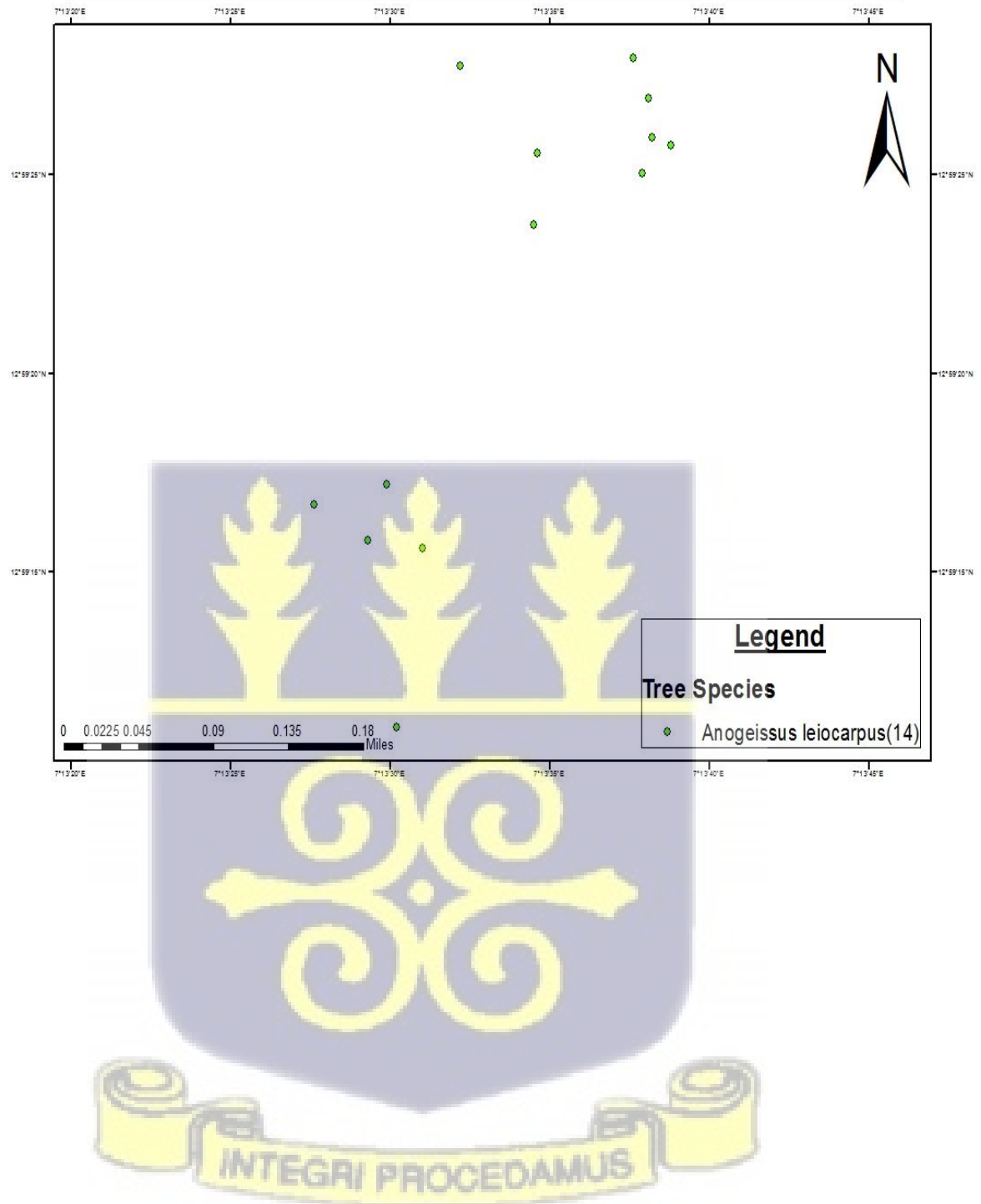
SPATIAL DISTRIBUTION OF TREES IN KURMIYAL



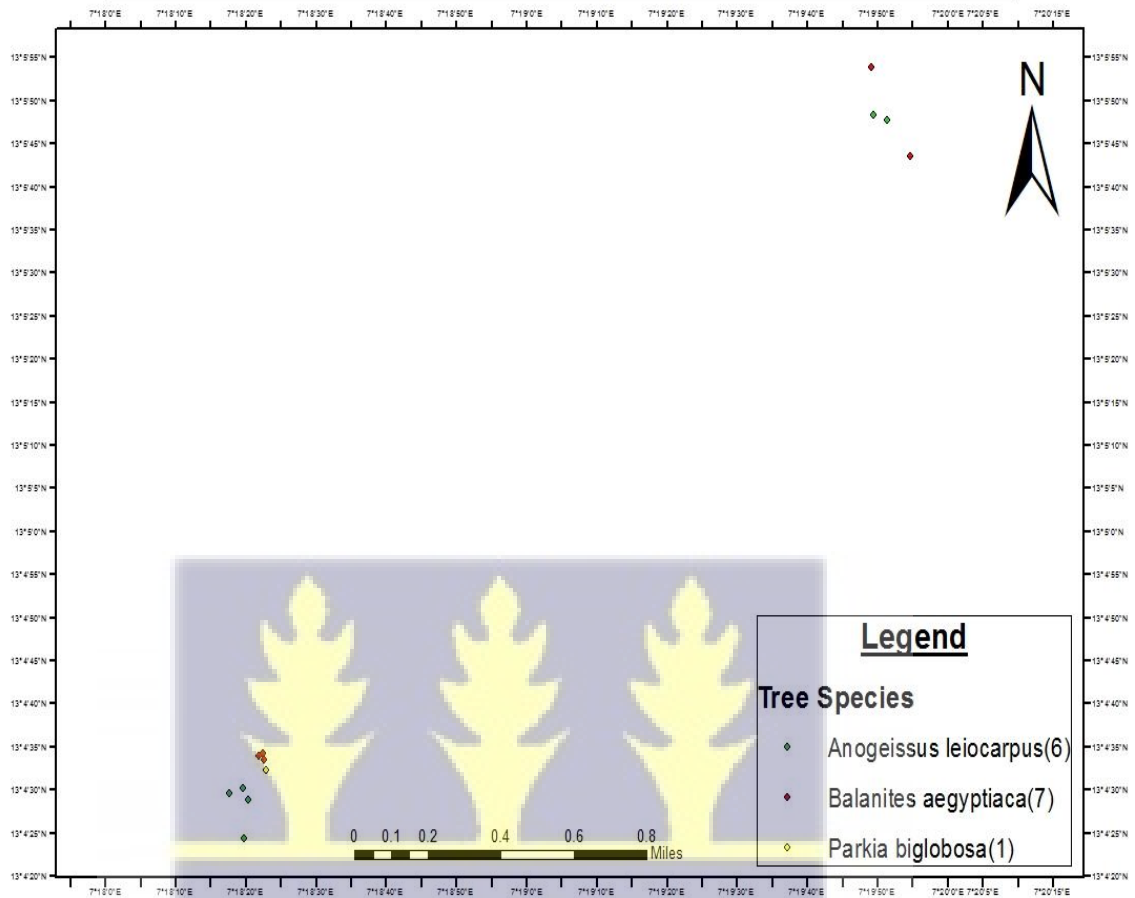
SPATIAL DISTRIBUTION OF TREES IN KUSA



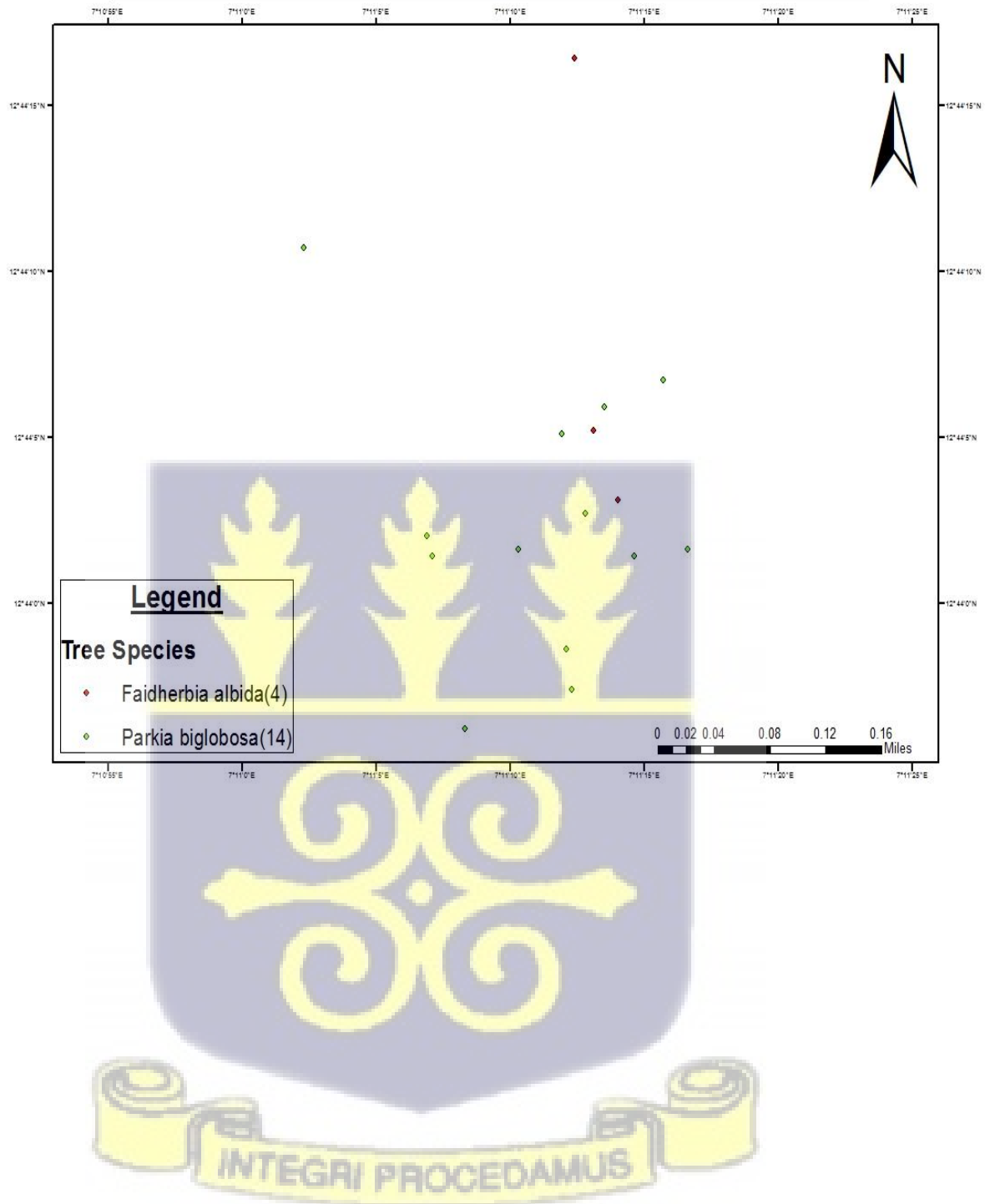
SPATIAL DISTRIBUTION OF TREES IN MALLAMAWA



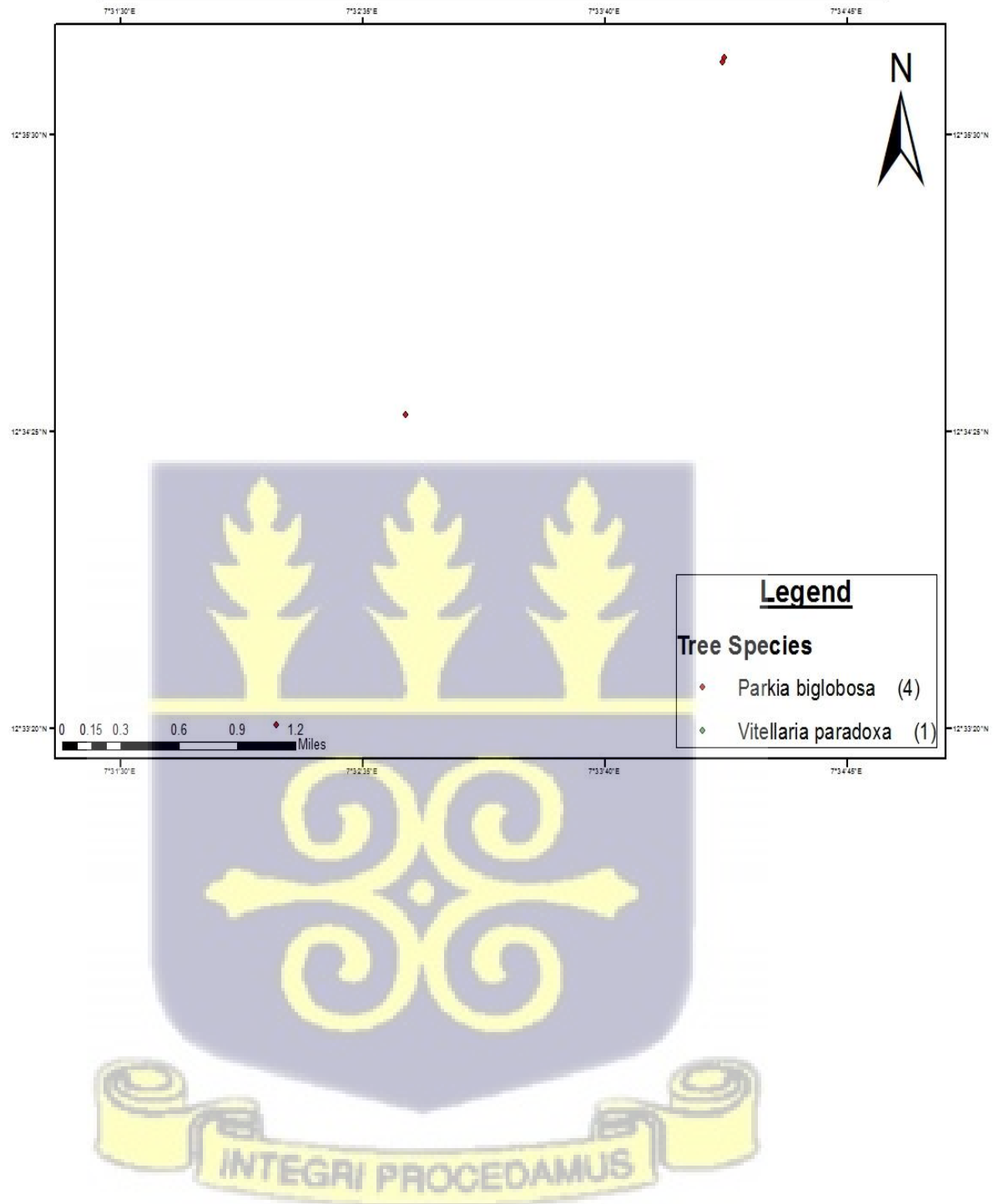
SPATIAL DISTRIBUTION OF TREES IN MAZANYA



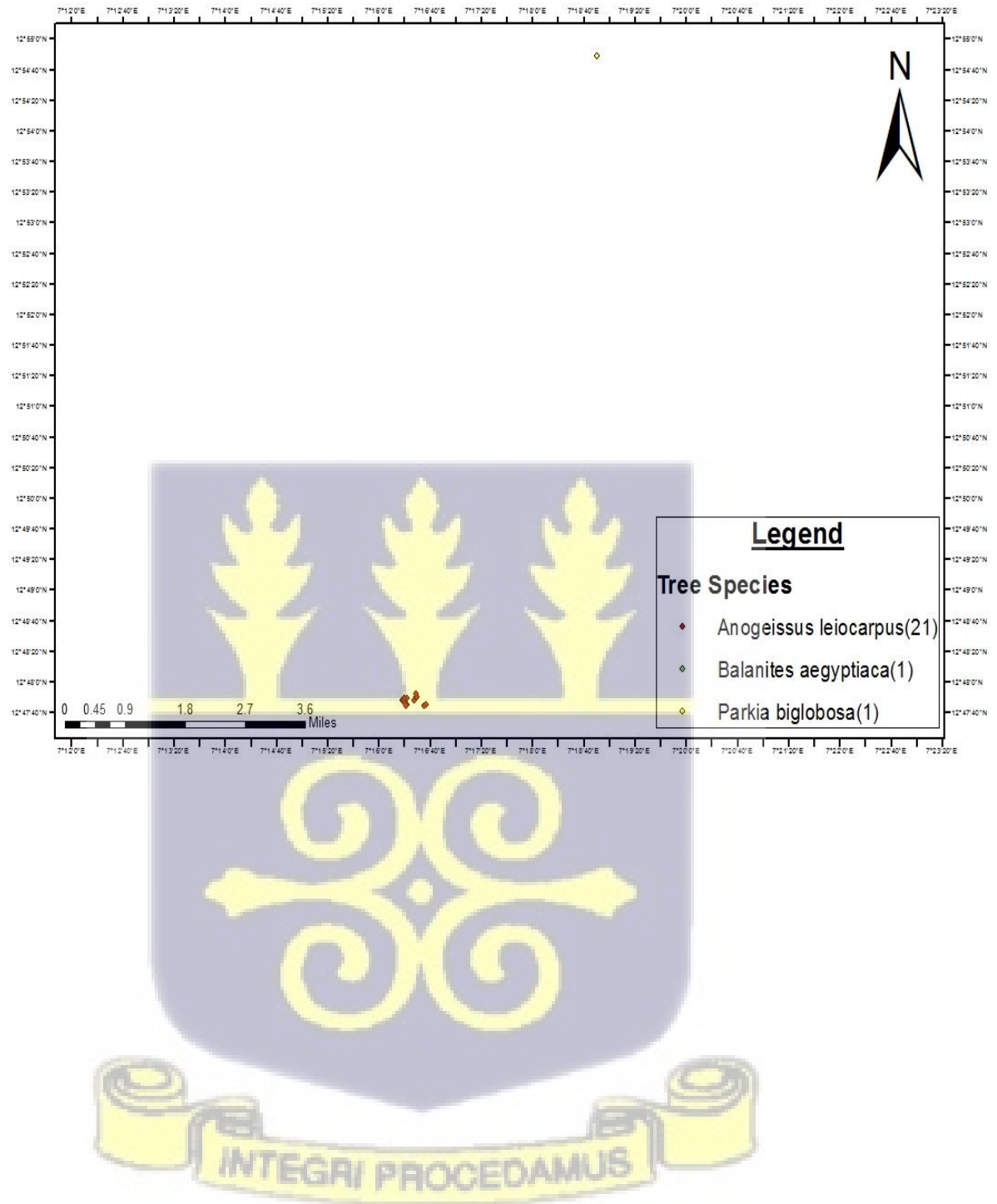
SPATIAL DISTRIBUTION OF TREES IN NAHUTA



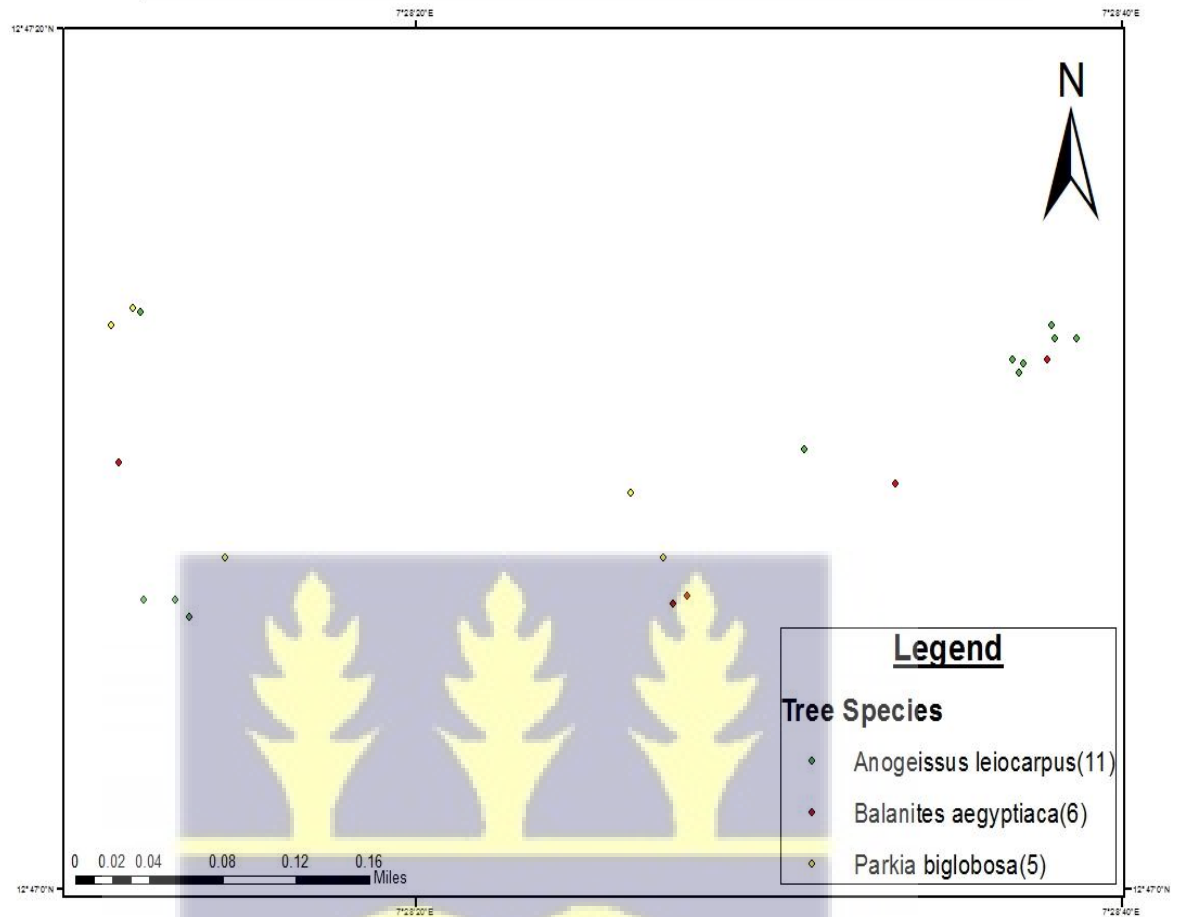
SPATIAL DISTRIBUTION OF TREES IN RAWAYAU



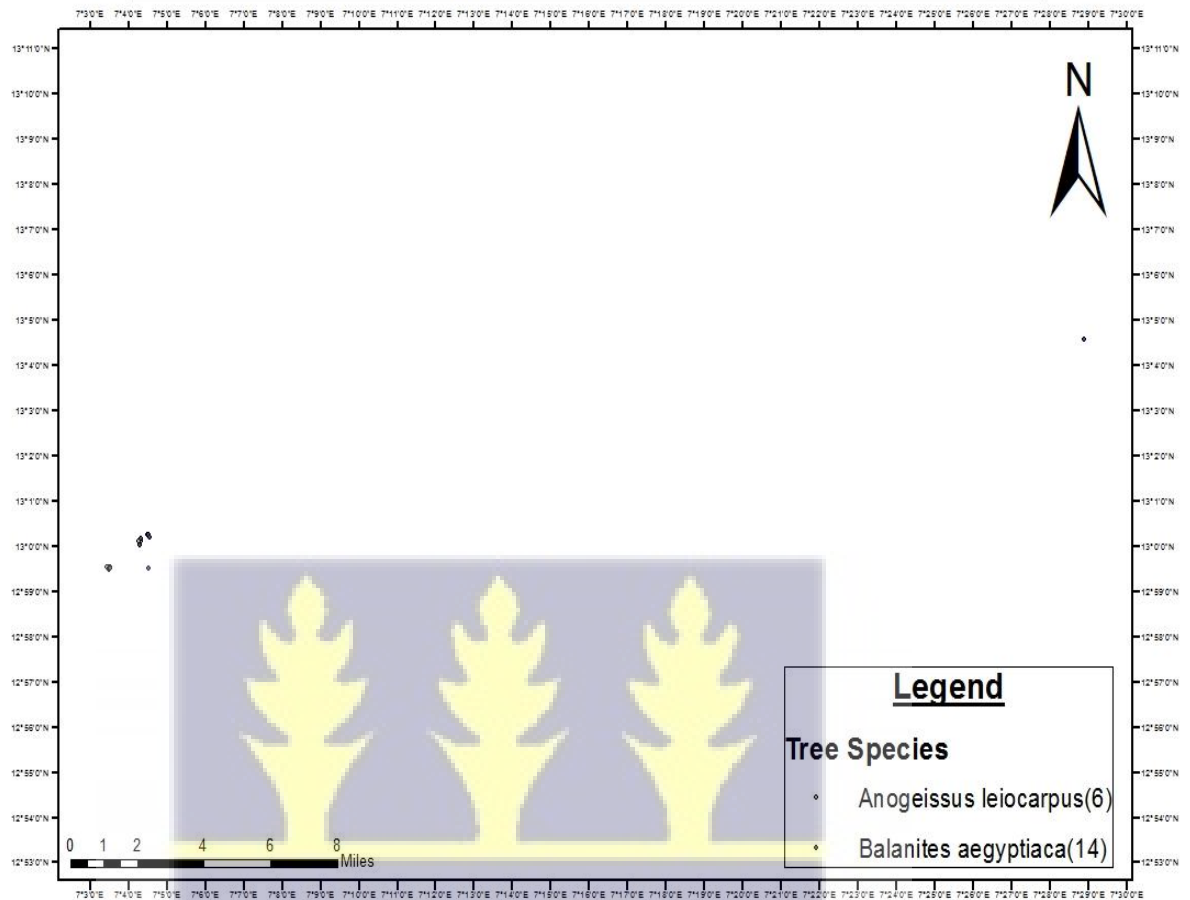
SPATIAL DISTRIBUTION OF TREES IN TADETA



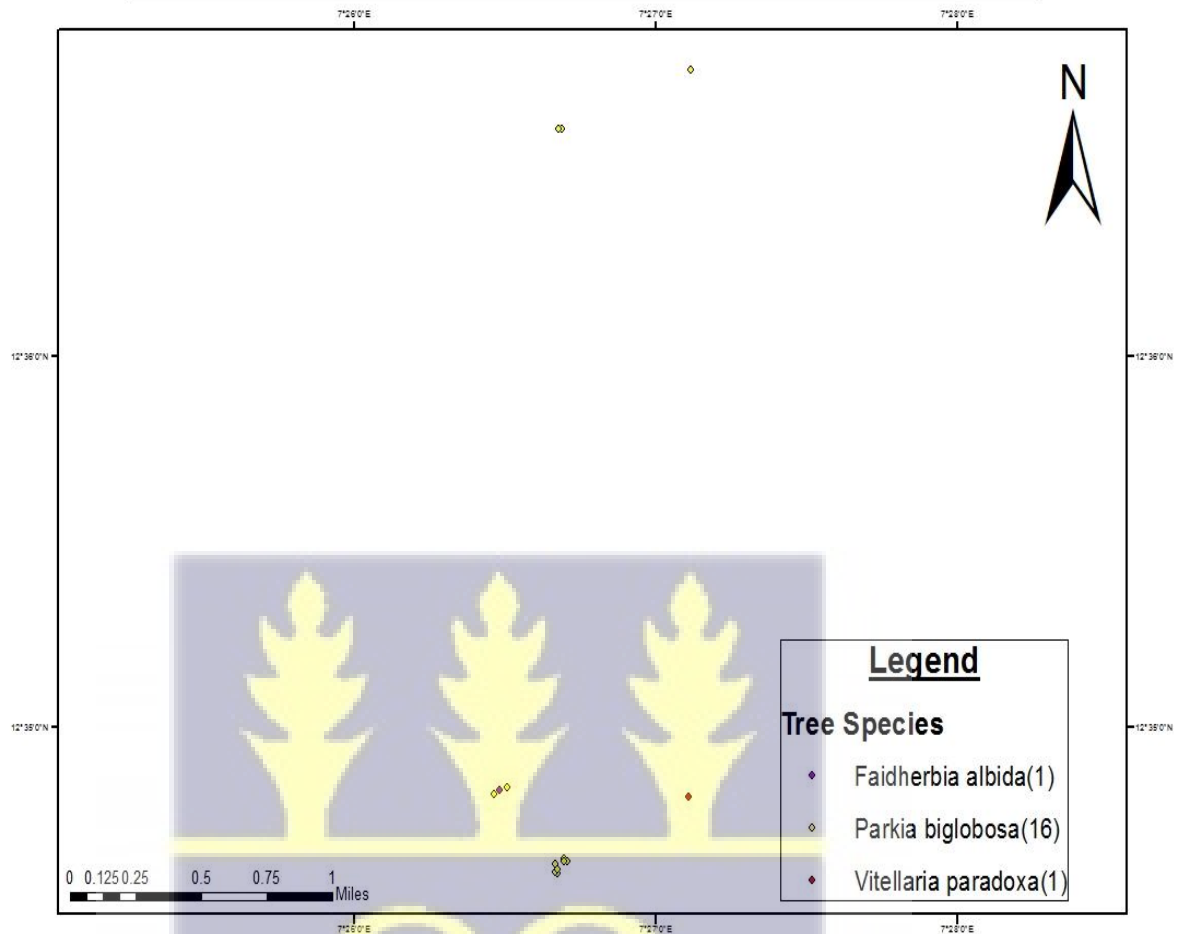
SPATIAL DISTRIBUTION OF TREES IN TSAURI



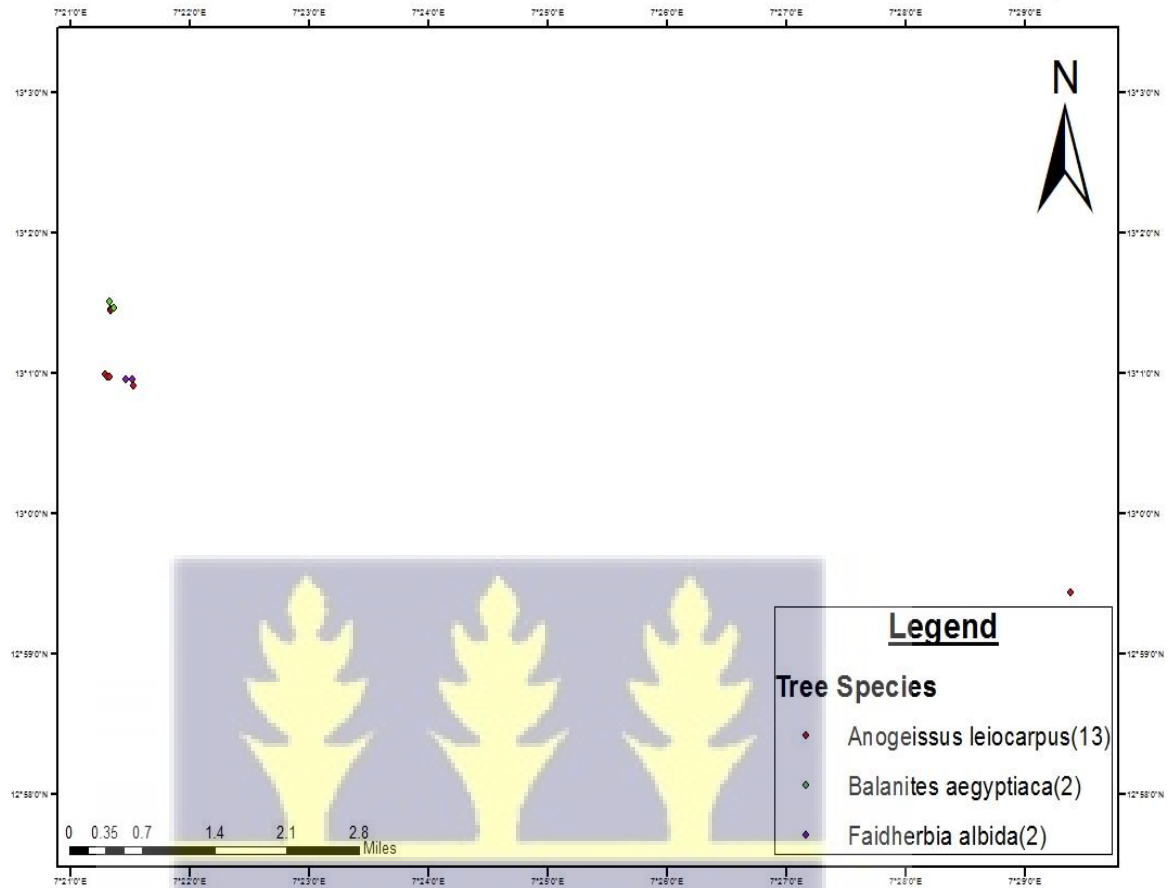
SPATIAL DISTRIBUTION OF TREES IN TSAYAU



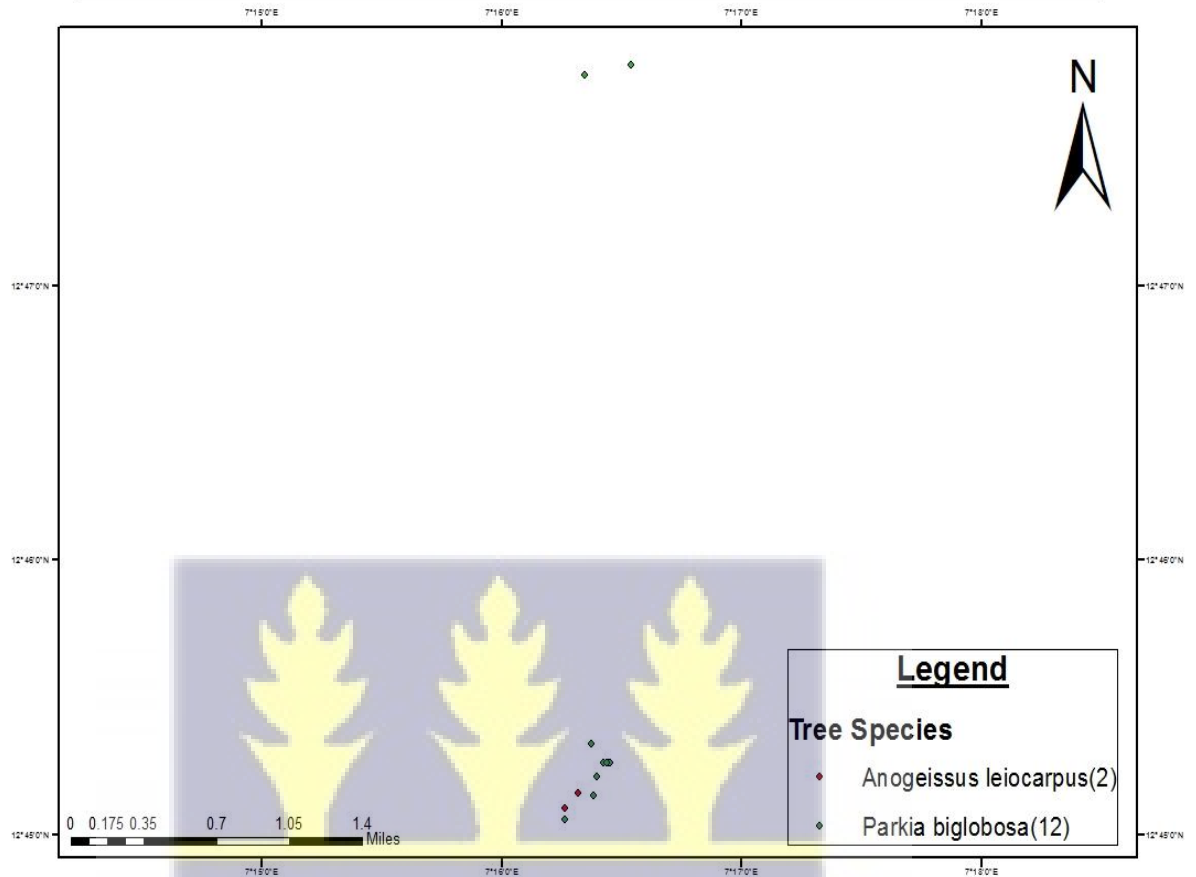
SPATIAL DISTRIBUTION OF TREES IN WURMA



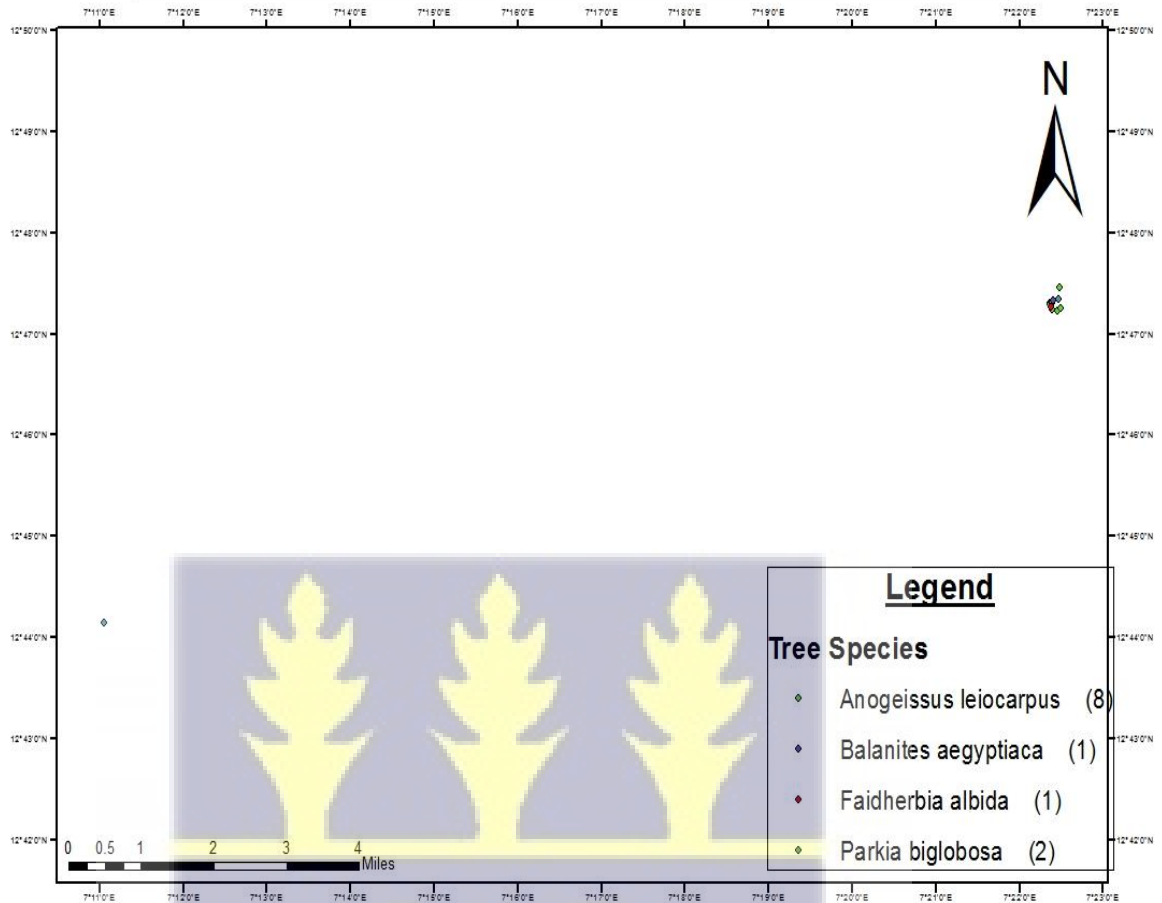
SPATIAL DISTRIBUTION OF TREES IN YANGAIYA



SPATIAL DISTRIBUTION OF TREES IN ZAMFARAWA



SPATIAL DISTRIBUTION OF TREES IN ZANKO



They represent the geographical region where individuals of a particular selected tree species can be found near the rural communities in the study area. Two types of tree distributions have been identified in the study area. These are random and clump pattern of distributions.

Most of the selected tree species exhibit clumped distribution with the exception of *Vitellaria paradoxa* which has random pattern. This is corroborated by Couteron and Kokou (1997) in a study of woody vegetation patterns in semi-arid savannas of Gondo plain in Burkina Faso which revealed that clumped spatial distributions were identified for most of the species including *A. leiocarpus*. It is worthwhile to note that there is no uniform or regular distribution in the study area as this type of pattern has to do more with human influences such as farming and agricultural practices including reforestation activities.

Colgan *et al.* (2012) cited Skarpe (1992); Scholes and Archer (1997) have suggested that “in savannas the spatial pattern of woody plants is driven by climate, topography, soils, competition, herbivory, and fire over a wide range of scales”. In the same vein, Gholinejad, Farajollahi and Fauzesh (2012) also supported the view that plant groups in a particular place are determined by the combined influence of a whole range of ecological factors that include climate, topography, soil and biotic parameters.

4.4 Density of Selected Trees

Table 11 illustrates the distribution of selected tree densities in all quadrats around the rural communities in the study area. It shows that the density of the selected trees varies considerably

from place to place within the study area. The quadrats with the highest density of the selected trees was FAR 1 with 18 trees per hectare followed by KUR 1 with 15 trees per hectare and TAD 2/FAR 2 with 14 trees each per hectare. The quadrat with the lowest density of the selected trees was MAL 1 followed by RAW 3 where no trees were included in the samples. Generally, average tree densities were low at 6-7 selected trees per hectare. Ahmed (2000) in a study of 33 tree species in neighboring Kano State involving Rimin Gado and Rimaye villages revealed also a low density of below 21 trees per hectare.

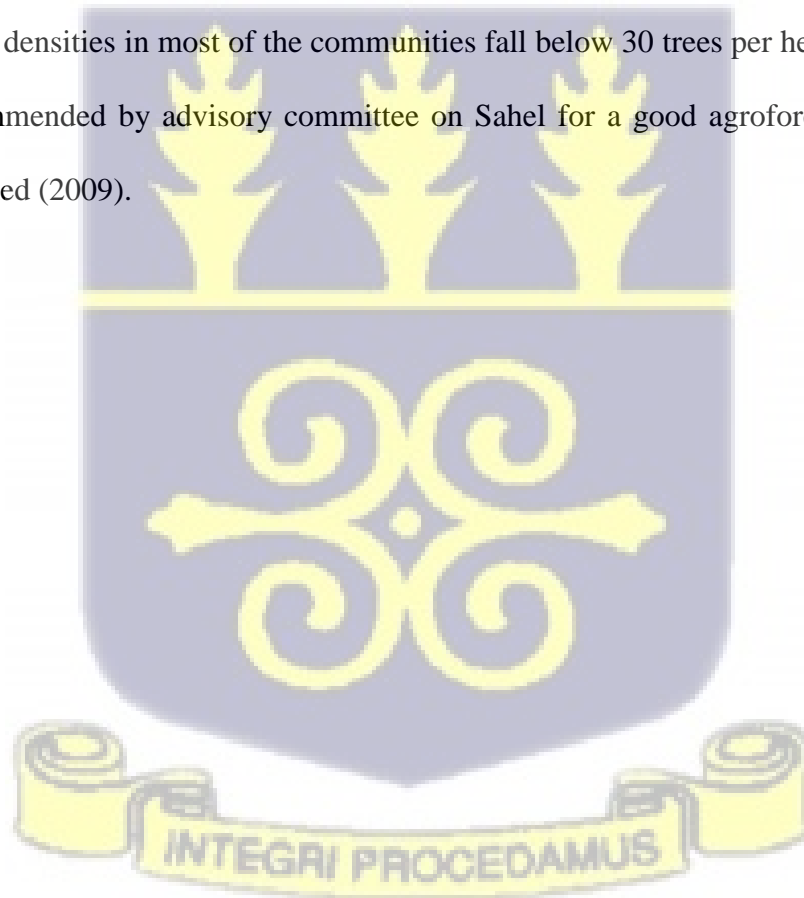


Table 11: Distribution of Selected Tree Densities in all Quadrats around the Communities

Communities	Distribution of Tree Densities in Quadrats (Stems ha ⁻¹)						Total Trees
	Quadrat ID Code	Trees Density	Quadrat ID Code	Trees Density	Quadrat ID Code	Trees Density	
Nahuta	NAH 1	7	NAH 2	9	NAH 3	2	18
Shirgi	SHIR 1	6	SHIR 2	5	SHIR 3	7	18
Zamfarawa	ZAMF 1	5	ZAMF 2	7	ZAMF 3	2	14
Kurmiyel	KUR 1	15	KUR 2	10	KUR 3	4	29
Tadeta	TAD 1	6	TAD 2	14	TAD 3	3	23
Zanko	ZAN 1	9	ZAN 2	2	ZAN 3	1	12
Kandawa	KAN 1	6	KAN 2	9	KAN 3	7	22
Mallamawa	MAL 1	0	MAL 2	8	MAL 3	6	14
Kusa	KUS 1	3	KUS 2	3	KUS 3	2	8
Bugaje	BUG 1	8	BUG 2	11	BUG 3	5	24
Tsayau	TSA 1	6	TSA 2	10	TSA 3	4	20
Yangayya	YAN 1	4	YAN 2	3	YAN 3	10	17
Mazanya	MAZ 1	9	MAZ 2	2	MAZ 3	3	14
Farun-Bala	FAR 1	18	FAR 2	14	FAR 3	4	36
Tsauri	TSAU 1	6	TSAU 2	8	TSAU 3	8	22
Wurma	WUR 1	3	WUR 2	13	WUR 3	2	18
Rawayau	RAW 1	2	RAW 2	3	RAW 3	0	5
Kaware	KAW 1	8	KAW 2	11	KAW 3	2	21
Total Trees in All Quadrats	-	-	-	-	-	-	335

Source: Field Work, 2012

In terms of differences in distribution of density between the communities as shown in Figure 13, Farun-Bala has the highest with 36 trees followed by Kurmiyel and Bugaje with 29 and 24 trees respectively. The communities with the lowest density of the selected trees were Rawayau with 5 trees and Kusa with 8 trees. It is worthwhile to note that there is a diversity of the selected trees densities among the rural communities. The respondents during the focus group discussion also corroborated this by saying that there is great local variability in the availability of these trees in the area. This is important because it relates to livelihoods in the area. There is thus more conservation of these selected trees in some places than others and differences in extensification, use values are also found in the various communities. Result from the tables in above show that the selected tree densities in most of the communities fall below 30 trees per hectare which is the minimum recommended by advisory committee on Sahel for a good agroforestry practice and reported in Ahmed (2009).



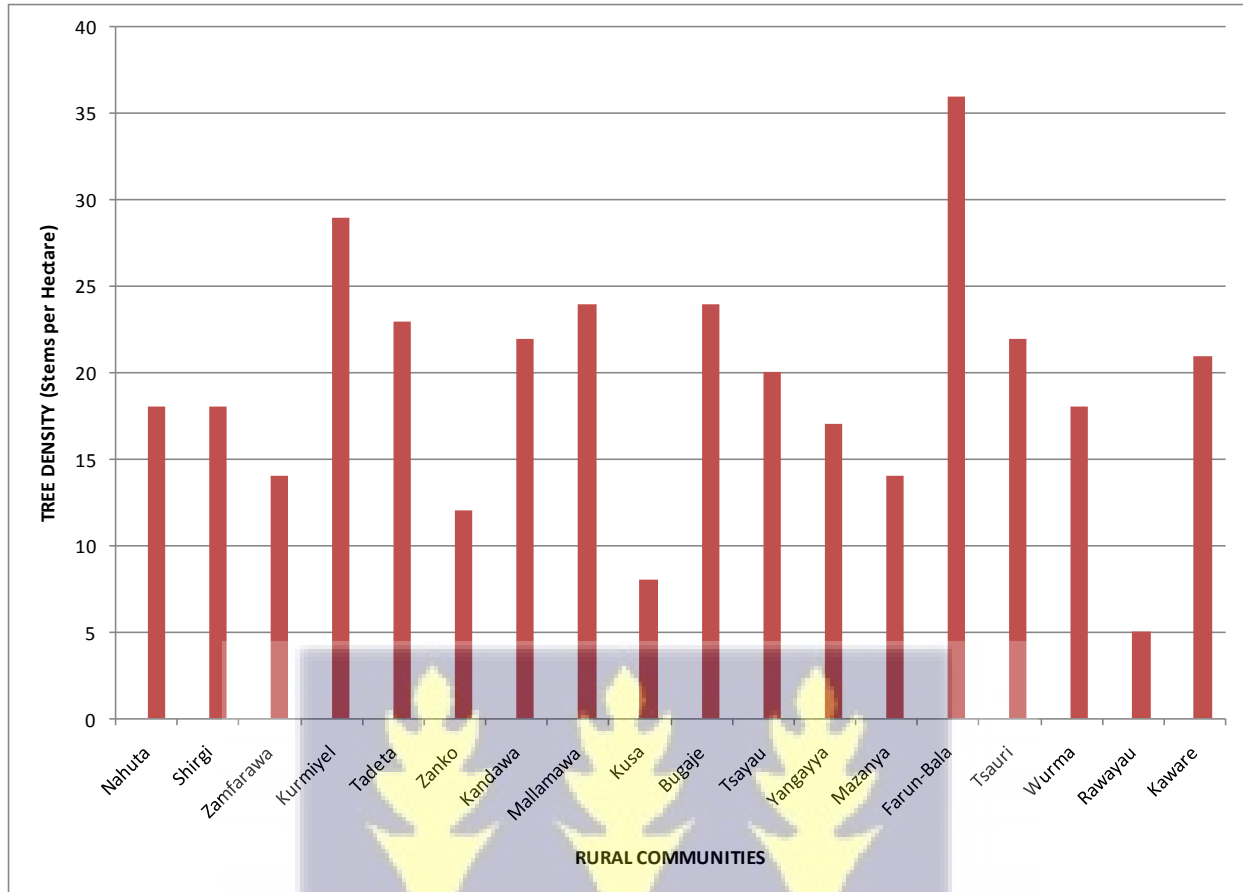


Figure 9: Comparative Distribution of Tree Densities among the Communities

Having used scientific measures to show selected tree densities data around the communities, comparison will thus be made with the data on people’s perceptions on the availability of such trees so as to draw useful conclusions in the subsequent section.

4.5 Perceptions of Availability of Selected Trees

Table 12 represents percentage distribution of local perceptions of availability of selected trees in the rural communities where the selected trees were categorized into increasing, common (normal), rare and decreasing availability trends. It shows that almost fifty five percent (54.7%) of the respondents have observed decreasing in availability of the selected trees. Nearly eighteen

percent (18.4) believed that the trees are becoming rare. While only about thirteen percent (12.6%) are of the view that the trees are increasing, almost (14.4%) believed that the trees are common or widespread. This does not apply to the study area on a local scale only as similar trends occur in many other drylands elsewhere in Africa.

Table 12: Perception of Availability of Selected Trees

Selected Trees	Increasing		Common		Rare		Decreasing	
	Freq	%	Freq	%	Freq	%	Freq	%
<i>A. lieocarpus</i> (Marke)	50	14.7	93	27.3	22	6.5	175	51.5
<i>B. aegyptiaca</i> (Aduwa)	81	23.8	75	22.0	22.1	6.5	162	47.6
<i>F. albida</i> (Gawo)	49	14.4	39	11.5	66	19.4	186	54.7
<i>K. senegalensis</i> (Madachi)	7	2.1	0	0	157	46.2	176	51.7
<i>P. biglobosa</i> (Dorowa)	53	15.6	77	22.6	25	7.4	185	54.4
<i>V. paradoxa</i> (Kadanya)	16	4.7	12	3.5	82	24.1	230	67.7
Average Percent Availability		12.6		14.4		18.4		54.6

Source: Field Work, 2012

This finding corroborates other findings especially in the Sahelian and sub-Saharan zones of Africa. A research conducted by Smith (2010) in 4 villages in the Koula and Lanfiela districts of northern Tominian district in Mali revealed that a lot of the indigenous trees found there

particularly *V. paradoxa* and *P. biglobosa* have severely diminished. In the same vein, Wezel and Lykke (2006) in a study in parts of West Africa including Burkina Faso, Niger and Senegal also revealed that woody plant species in the Sahelian zone of West Africa have seriously been decreasing as well as disappearing. Furthermore, a study by Sop and Oldeland (2011) of 20 villages in sub-Sahel of Burkina Faso among Fulani, Mossi and Samo ethnic groups revealed that 90% of species were declining. Such species according to them include *Parkia biglobosa*, *Anogeissus lieocarpus* and *Vitellaria paradoxa*.

Cline-Cole *et al.* (1990) have also revealed from a study in Kano Close Settled Zone in northern Nigeria that there is a perceived decrease in tree cover from 1977-1982 according to 89% of wood cutters sampled. However, they further stated that the cause of this might be due to exploitation activities or drought which is still unclear. During the focus group interview, three elderly persons from Tsauri and Mazanya communities have indicated that some of the selected trees have died and are still dying naturally by themselves which they attribute to changes in climatic conditions. One Kalla from Mazanya community emphasized that, – Not further away from my farm, a *Parkia biglobosa* tree died within a couple of years due to what he thinks was as a result of climate change.

Some of the selected tree species like *B. aegyptiaca* and *K. senegalensis* have the highest percentage of increasing availability of nearly twenty four percent (23.8%) and rarest availability trees with almost two percent (46.2%) respectively. This is probably because of the high natural regeneration capacity of the former in the area and the selective felling in the later. Sop and

Oldeland (2011) have also listed *B. aegyptiaca* as one of the species reported by the local people to be increasing in abundance. *V. paradoxa* has the highest percentage decrease of the entire selected tree species apparently due to its scarcity particularly in Jibia locality. Decreasing pattern of selected trees and other woody plants are mainly due to increasing population pressure and this is capable of undermining livelihoods that are dependent on these trees. However during the focus group discussion, a few of the villagers have observed an increase in the availability of *B. aegyptiaca* in their places.

4.5.1 Perception of Selected Trees' Current Availability Compared to the Past 10-20 Years

Table 13 represents percentage distribution of the respondent's perception of the selected trees current availability compared to the past 10-20 years. It shows that the selected trees have decreased in numbers as observed by nearly eighty two percent (81.6%) of the respondents compared to these past years particularly those in Jibia locality. About eighteen percent (18.4%) of them however have observed an increase in the selected trees over the years especially in Batsari and Kurfi localities.

Table 13: Perceived Changes in Tree Densities Compared to Past 10-20 Years

Tree Availability in Past 10-20 Years	Batsari		Jibia		Kurfi		Average Percent
	Freq	%	Freq	%	Freq	%	
Tree Numbers Have Increased	33	23.9	6	10.5	30	20.7	18.4
Tree Numbers Have Decreased	105	76.1	51	89.5	115	79.3	81.6
Total	138	100	57	100	145	100	100

Source: Field Survey, 2012

Such knowledge of availability trend and changes in the selected trees occurrence compared to the past is thus from the point of view of human assessment or local knowledge of the rural communities living in these localities. It is worth noting that this knowledge from the people's perceptions of these trees has thus strongly correlated with the scientific findings on tree densities discussed in earlier section. Those findings suggested very low tree densities in most communities while these other ones also depicted a trend showing decreased tree numbers around the communities.

4.6 Girth Class Distribution of Selected Trees

Figure 10 represent the Girth Class profile showing population structure of the selected trees in the study area. Generally, the graph indicates that there is higher frequency of more mature stems than less mature stems in trees like *P. biglobosa* and *V. paradoxa* where the girths range from 2m to more than 3m. In *B. aegyptiaca* and *F. albida* trees however, there is higher frequency of smaller stems including seedlings and saplings than mature stems with girths between less than 1m and 1.99m. This outcome is contrary to Shackleton (2000); Luoga *et al.*, (2004); Mlambo & Huizing, (2004); cited by Shackleton, Guthrie and Main (2005p. 282) that “the high density of small stems is also a result of the high capacity of savanna trees to regrow after chopping via coppice stems”.



Anogeissus leiocarpus is the only tree that has higher frequency of moderate stems (1m to 2.99m). However, a study of size-class distribution of *A. lieocarpus* by Hennenberg (2005) in Comoe National Park in northern Ivory Coast reveals that there are high densities of smaller

diameter classes and lower densities of large diameter classes. Although most of the selected trees regenerate naturally rather than planted, assisted regeneration management practices like coppicing is employed to encourage shoot/tree regrowth and to provide wood or other NTFPs.

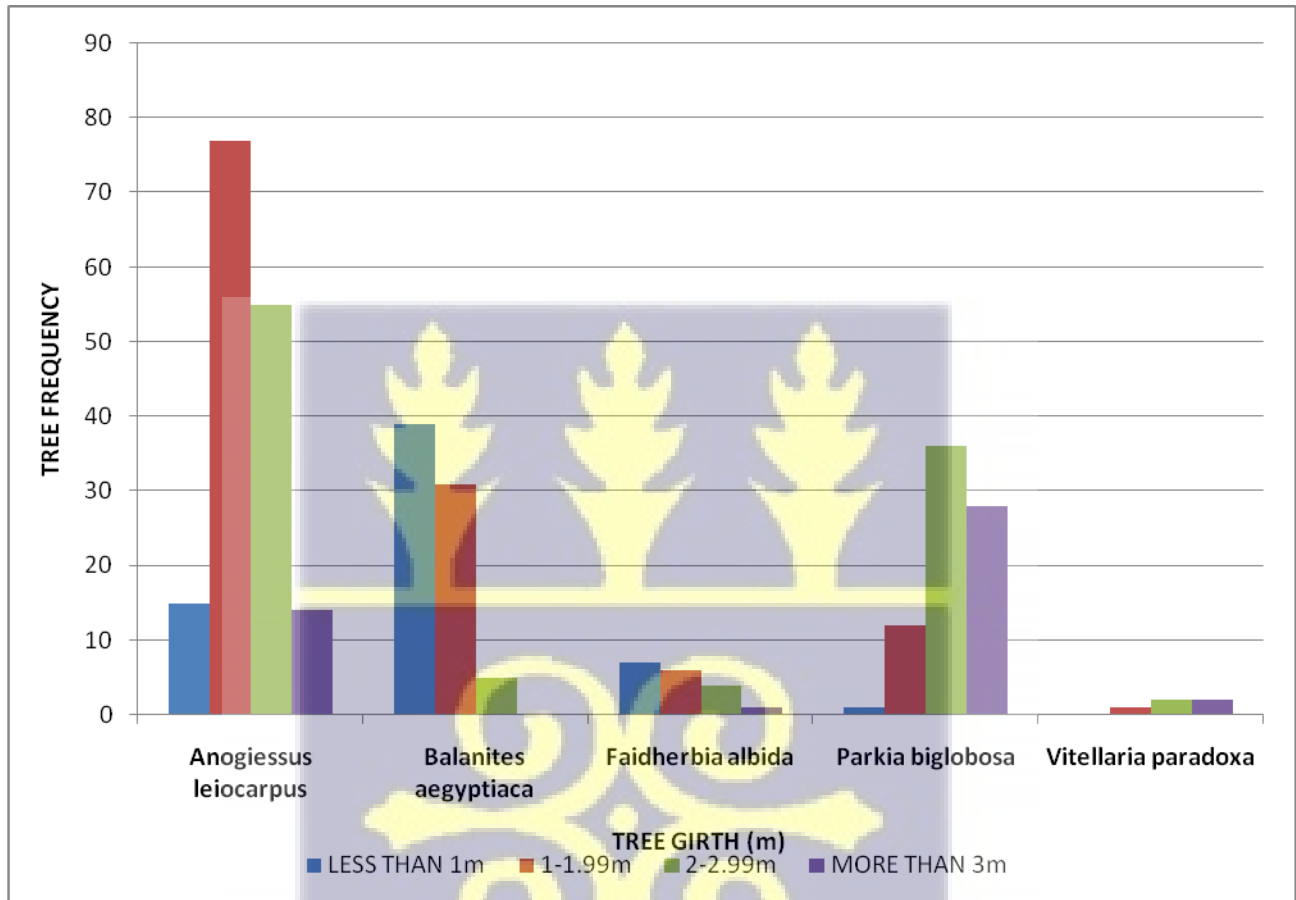


Figure 10: Girth Class Profiles Showing Population Structure of the Selected Trees

Figure 10 explains the population structure according to girth of tree species which varies and followed three patterns namely a normal distribution, inverted J-shape and J-shaped patterns. *A. leiocarpus* followed almost a normal distribution curve with trees belonging to moderate GBH classes suggesting a fairly stable population. A reverse J-shaped curve for *B. aegyptiaca* and *F. albida* exist according to Lemenih (2011) signifies a normal and stable population of these

species. This suggests that the population of these species is more stable and capable of regenerating to mature trees under favorable conditions. This observation about *B. aegyptiaca* is corroborated by previous finding which also reported increase in abundance and a stable population as perceived by the local communities. Lemenih (2011, p. 33) in a study of *Boswellia papyrifera* species in Ethiopia strengthen this point by saying that “under normal regeneration conditions, the population structure should show an inverted J-shape, with a higher density of lower diameter classes than of higher diameter classes”.

The curves for *P. biglobosa* and to some extent *V. paradoxa* depict a J-shaped pattern indicating more trees with bigger GBH than smaller GBH indicating an unstable population since there is fewer smaller GBH and recruitments which regenerates to become mature trees. This means that these tree species have more tendency of becoming scarce in the event of depletion. Such patterns possibly indicate the influence of human disturbances on the ecology of the tree species’ regeneration capacity (Worku, 2006) from Lemenih, 2011)

A J-shaped curve exists for *P. biglobosa* and *V. paradoxa* tree species and depicts an unstable population as there were very few trees in the smaller GBH Class. *V. paradoxa* tree seeds are reportedly difficult to germinate (Asente *et al.*, 2012 in Muhammad *et al.*, 2020). However, an experiment conducted at Gombe State University in Nigeria by Muhammad *et al.* (2020), reveal that fruit pulp of *V. paradoxa* prevented germination and that different seed treatments can significantly improve germination rate. This situation was not normal as evidence shows that a lot of the existing mature trees were ageing and under pressure from bark harvesting and lopping.

However, the fact that they are in the majority means that intensive harvesting is not taking place and that regeneration also was not actively occurring. The implication is that the population might be threatened which could undermine the long-term sustainability of wood-based enterprises in the localities. Such a situation could deny the people from getting livelihoods from the selected economic trees hence threatening their livelihoods sustainability.

Table 14 portrays the growth characteristics of the selected trees in the study communities. It shows the percent distribution of basal area (BA) for each of the selected tree species. The tree *Anogeissus lieocarpus* has almost fifty percent (44.9%) of the total basal area followed by *Parkia biglobosa* with about forty two percent (41.9%). The least basal area is occupied by *Vitellaria paradoxa* and *Faidherbia albida* with about four percent (3.7%) and almost four percent (3.8%) respectively. A point worth noting here is that the selected trees numbers and sizes or GBH corresponds with their basal areas. Hence those selected trees with larger numbers and bigger GBH like *A. lieocarpus* and *P. biglobosa* have the highest basal areas while those with smaller numbers and GBH such as *V. paradoxa* and *F. albida* have the least basal areas. Vest, (n.d) added that the basal area of tree stand is a function of both their number and size.

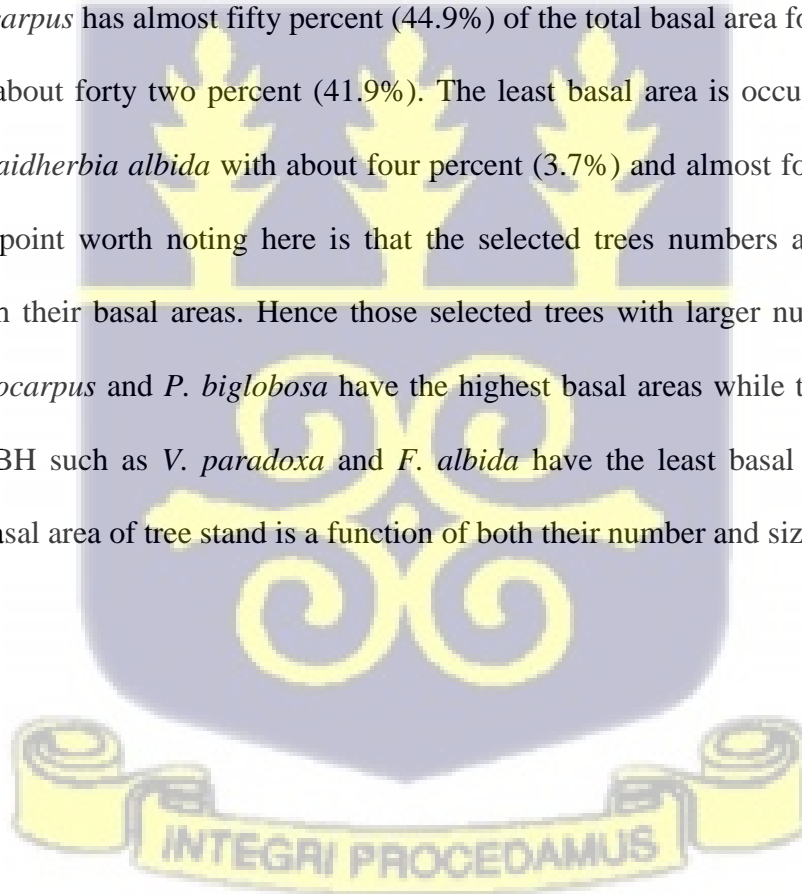


Table 14: Growth Characteristics of the selected Trees in the Study Communities

Selected Tree Species	Common Names	Number of Trees	Total GBH (Meters)	Total BA M ²	Average Percent
<i>A. leiocarpus</i> (Marke)	African Birch	161	310.53	552.09	44.9
<i>B. aegyptiaca</i> (Aduwa)	Desert Date	74	70.99	70.57	5.7
<i>F. albida</i> (Gawo)	Winter Thorn	18	26	47.16	3.8
<i>P. biglobosa</i> (Dorowa)	African Locust Bean	77	212.42	515.94	41.9
<i>V. paradoxa</i> (Kadanya)	Shea Butter	5	15.8	45.20	3.7
Total		335	635.74	1230.96	100.0

Source: Field Work, 2012

4.6.1 Selected Tree Species GBH in Land Use Regimes

Table 15 reveals the distribution of selected trees GBH across the land use regimes in the study area. It is worthwhile to note that within most of the selected trees, the average GBH in the cultivated lands is more than that in the uncultivated land with the exception of *Balanites aegyptiaca* and *Parkia biglobosa* which is almost similar. This variation in tree GBH among the two land use regimes could be attributed to greater importance and protection of the trees given in the cultivated lands than in uncultivated lands by the small holders.



Table 15: Selected Tree's GBH across Land Use Regimes in the Study Area

SELECTED TREE SPECIES	CULTIVATED LAND			UNCULTIVATED LAND		
	Total GBH(m)	Number of Trees	Average GBH	Total GBH (m)	Number of Trees	Average GBH
<i>A. leiocarpus</i> (Gawo)	275.73	142	1.94	32.4	19	1.70
<i>B. aegyptiaca</i> (Aduwa)	45.79	55	0.83	21.15	19	1.11
<i>F. albida</i> (Gawo)	18.54	14	1.32	2.46	4	0.61
<i>P. biglobosa</i> (Dorowa)	146.53	57	2.57	59.09	20	2.95
<i>V. paradoxa</i> (Kadanya)	13.90	4	3.47	0.90	1	0.90
Total Selected Trees	500.49	272	1.84	116	63	1.84

Source: Field Work, 2012

4.7 Composition of Selected Tree Species in Land Use Regimes

Table 16 presents the composition of selected tree species in land use regimes in the study area. The major land use regimes included in the samples were cultivated lands and uncultivated lands which make up 81.5% and 18.5% of the total sample plots respectively. The distribution of the latter in the area is low because of the nature of samples taken. Another explanation might probably be due to existence of limited uncultivated lands closer to Katsina Metropolis not very far from some of the selected study sites. It is worthwhile to note that there is a clear or marked difference in the number of selected tree species in these two major land use management types.

Table 16: Composition of Selected Tree Species in the Land Use Regimes

Land Use management Before Taking Samples	Number of Sample Plots	Number of Selected Tree Species
Cultivated (fallow Land)	2	4
Cultivated	10	3
Cultivated	21	2
Cultivated	9	1
Cultivated	2	0
Uncultivated	4	1
Uncultivated	6	2
Total Sample Plots	54	-

Source: Field Work, 2012

Among the sample plots in the study area, two of them in the cultivated land category contain four different selected tree species each. In the uncultivated land management category, no such sample plots contain as many number of selected tree species. From the table 14 above, there is thus more selected tree species diversity in the cultivated lands than in uncultivated lands. This pattern could probably be as a result of greater protection and more secured tenure in the cultivated lands thereby leading to more preservation of the tree species than in the uncultivated lands.

4.8 Chapter Conclusion

This chapter has presented major assertions and conclusions drawn that have answered the main question addressed in it. It reveals the most frequent and least frequent selected tree species is *A. leiocarpus* and *V. paradoxa* respectively. This is an indication of the most abundant and lacking/scarce selected tree species in the study area. The spatial distribution of most of the selected trees around the communities assumed a clumped pattern. The population structure of

the selected trees varies with the type of specie. It varies from a fairly stable population of *A. lieocarpus* and *B. aegyptiaca* to an unstable population of *P. biglobosa* and *V. paradoxa*. These parameters studied were affected mostly if not wholly by significant “natural” variation in tree species distribution pattern as it relates to the habitat requirements of the selected trees. There is also better preservation of key tree species in cultivated area than uncultivated areas.

The density of the selected trees within the communities is generally low and it varies considerably from one community to the other. For instance, it is 36 trees per hectare in Farun Bala which is the highest, 29 in Kurmiyel and 5 in Rawayau with the least trees per hectare. This suggests that there are more trees in particular places. This is because the communities have realized the importance of maintaining these trees in providing uses to them which sustain their livelihoods as analyzed in chapter 6. A study conducted by Herrmann, Wickhorst and Marsh (2013) in west central agricultural region of Senegal revealed that that pockets of dense tree cover and areas where trees are practically absent exist within the farmed parkland system. They further stated that “areas where *Faidherbia albida* field tree cover was maintained or increased might indicate success stories of good land management practices by rural communities”.

The local perceptions on trees availability trend suggest that many of these selected trees are experiencing decrease while some are increasing in abundance around the communities. Useful trees like *Khaya senegalensis*, *Vitellaria paradoxa* and *Parkia biglobosa* are unfortunately the ones most affected by this disappearance probably due to disturbance and overexploitation. One

of the most affected trees in terms of increasing in abundance is *Balanites aegyptiaca* and is not as important as the aforementioned trees.

Compared to the past, these trees have generally decreased in abundance according to the respondents. This corroborates finding of availability from elsewhere in the drylands of Africa (Sop and Oldeland, 2011; Smith, 2010). In west central Senegal also, a comparison of current tree cover with historic cover along a transect shows a slight overall decrease in tree cover from an average of 6.53% to 5.75% over the past four decades; however, this decrease is not uniform in space and there are areas where tree cover has remained stable or even increased dramatically in some locations (Herrmann, Wickhorst and Marsh, 2013 p.4915).

It is also interesting to note that some of the communities like Farun-Bala and Bugaje that are situated closest to the semi-arid and urbanization conditions respectively, as stated in chapter 3, have some of the highest tree densities in the study area as a whole. This finding has gone contrary to the neo-Malthusian debates on land degradation in drylands. Dahlberg (1994) emphasized that new ideas emerging from studies in traditional knowledge and local land use systems have suggested that these are more appropriate to the local conditions in reducing the effect of land degradation in drylands.



CHAPTER FIVE

TREES AND SUSTAINABLE LIVELIHOODS

5.1 Introduction

This chapter deals with themes on socio-demographic characteristics, livelihoods and economic value of the selected trees among the communities in the study area. It also addresses the following research question: What relative contributions do the selected trees make to rural livelihood portfolios in the study area? It was mainly on the human, social, financial, physical and natural capitals of the people that motivate them to interact and access their sources of livelihoods. Comparison was also made between the localities to get the geographical variations in the information generated.

5.2 Demographic Profile of the Study Communities

Table 17 shows the percentage distribution of demographic profile of the study communities. It shows that ninety three percent (93%) of the sampled households were headed by males. This is because of the religious and cultural backgrounds of the respondents where the responsibility of heading a household is vested on the males. The remaining seven percent (7%) consists of divorced and widowed females. Predominant male-headed households lead to domination of access to the use of trees. In this situation women often become marginalized in terms of ownership and usage rights of natural resources such as trees. Chileshe (2005) added that gender dimensions are very essential when considered in land and rural livelihoods matters in Africa.

Table 17: Demographic Profile of the Study Communities

Sex	Batsari		Jibia		Kurfi		Average Percent
	Freq	%	Freq	%	Freq	%	
Male-headed	128	92.8	53	93	135	93.1	93.0
Female-headed	10	7.2	4	7.0	10	6.9	7.0
Total	138	100	57	100	145	100	100
Age Structure (In years)							
1-15	3	2.2	0	0	1	0.7	1.0
16-30	22	15.9	7	12.3	28	19.3	15.8
31-45	52	37.7	31	54.4	51	35.2	42.4
46-60	41	29.7	16	28.0	38	26.2	28.0
61-75	18	13.0	2	3.5	24	16.6	11.0
More than 75	2	1.4	1	1.8	3	2.1	1.8
Total	138	100	57	100	145	100	100
Marital Status							
Married	127	92.0	52	91.2	129	89.0	90.7
Single	11	8.0	5	8.8	16	11.0	9.3
Total	138	100	57	100	145	100	100

Source: Field Work, 2012

The age group 31-45 years leads all other groups in terms of number of respondents which is followed by age group 46-60 years. The former group has potentials of a dynamic population. Banda, (2005) is also of the view that 20-45year is the most active age group of both men and women. The least age groups were the 1-15year and over 70 years. Jibia locality has the highest proportion of 31-45 year olds with none for 1-15 year's age groups.

Nearly ninety one percent (90.7%) of the household heads were married followed by the single household heads. Out of these, a lot of them were polygamists. Marital status here has implications on the selected trees use and management in that married household heads could have greater use of the selected trees due to greater responsibility in providing to the relatively

bigger family needs that include fuel wood and other non-timber forest products (NTFPs) such as leaves, fruits and seeds. The distribution of these demographic characteristics is almost the same for all the localities in the study area.

5.3 Social Profile of the Study Communities

Table 18 reveals the percentage distribution of the number of members of households, their level of formal education and membership in associations. It shows that some of the households have 6-10 members followed by others with 11-15 members and 16-20 members. Together, these make up about seventy percent (70%) of the total households in the area. A few of the households have more than 30 members and less than 6 members. In the extended family system, many household members contribute to the household production. Jibia and Kurfi localities have the highest proportion of households with 11-15 members which has the largest number of members of households in the study area. Bigger household size in the area potentially means more demand for tree products to prevent poverty intensification. Coomes, Takasaki and Rhemtull (2011) added that these poverty traps represent dependency by people towards accumulation of important assets such as tree stocks for the sake of households' future wellbeing.

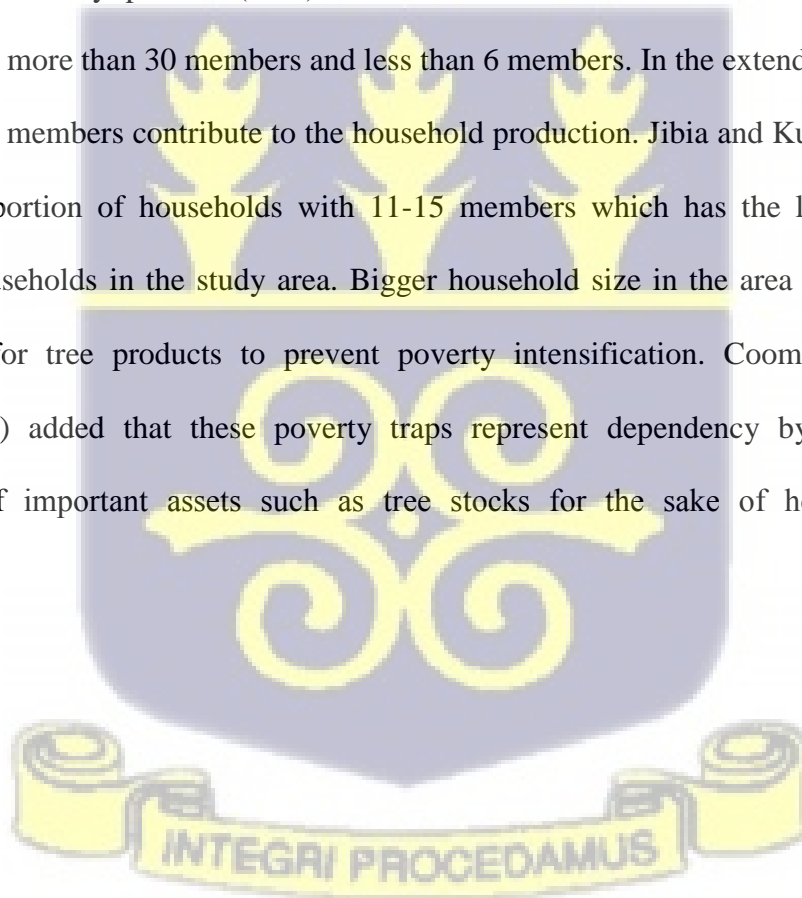


Table 18: Social Profile of the Study Communities

Number of People Living in Households	Batsari		Jibia		Kurfi		Average Percent
	Freq	%	Freq	%	Freq	%	
0-5	10	7.3	5	8.8	16	11.0	9.0
6-10	33	23.9	16	28.0	37	25.5	25.8
11-15	34	24.6	19	33.3	47	32.4	30.1
16-20	38	27.5	7	12.3	25	17.2	19.0
21-25	13	9.4	4	7.0	11	7.6	8.0
26-30	8	5.8	3	5.3	5	3.5	4.9
More than 30	2	1.5	3	5.3	4	2.8	3.2
Total	138	100	57	100	145	100	100
Level of Formal Education							
Primary School	37	26.8	15	26.3	30	20.7	24.5
Secondary School	14	10.2	8	14.1	23	15.8	13.4
Tertiary School	9	6.5	4	7.0	22	15.2	9.6
Not Attended Formal School	78	56.5	30	52.6	70	48.3	52.5
Total	138	100	57	100	145	100	100
Membership in Associations							
Trade Unions	27	19.6	11	19.3	19	13.1	17.3
School Committees	9	6.5	3	5.3	18	12.4	8.0
Government Organization	4	2.9	2	3.5	16	11.0	5.8
Politics	14	10.1	6	10.5	13	9.0	9.9
No Membership at all	58	42.1	14	24.6	51	35.2	34.0
2 or More Associations	14	10.1	0	0	17	11.7	7.3
Other Associations	12	8.7	21	36.8	11	7.6	17.7
Total	138	100	57	100	145	100	100

Source: Field Work, 2012

Almost fifty three percent (52.5%) of the respondents have had no formal education at all while some have not been educated beyond primary school level. About thirteen percent (13.4%) and ten percent (9.6%) of them have never attended secondary school or have even received tertiary education respectively. The literacy level of the household heads is thus low but comparatively, Kurfi locality seems to be better off as it has the lowest and highest proportions of uneducated respondents and tertiary school attendants respectively. The less educated people are, the more they depend on the environmental resources like trees to earn their livelihoods.

Thirty four percent (34%) of the respondents have no membership in any association or group. While some of them are members of relevant craft guilds and have joined various trade unions, others are into politics and school committees. Other associations patronized by the respondents include barbers, blacksmiths, and builders associate and a few that deal with natural resources management like farmers and herbalist groups. Almost forty two percent (42.1%) of respondents in Batsari locality do not join these groups compared to Kurfi and Jibia localities. Although membership in associations could not be directly linked to trees, it however serves as social capital for the household.

5.4 Ownership of Household Assets

Table 19 illustrates the percentage distribution of respondents owning various assets in their households in the study area. These are items that form an important physical capital component of household's productive activities and help towards the achievement of livelihood goals of the rural communities in the area. The most important assets are farmlands which were owned by about ninety six percent (96.1%) of the respondents followed by radio and livestock in all the localities. This is not surprising as the most important primary livelihood activities in this Sudano-Sahelian region are agriculture and livestock rearing practiced predominantly by the Hausa and Fulani ethnic groups.

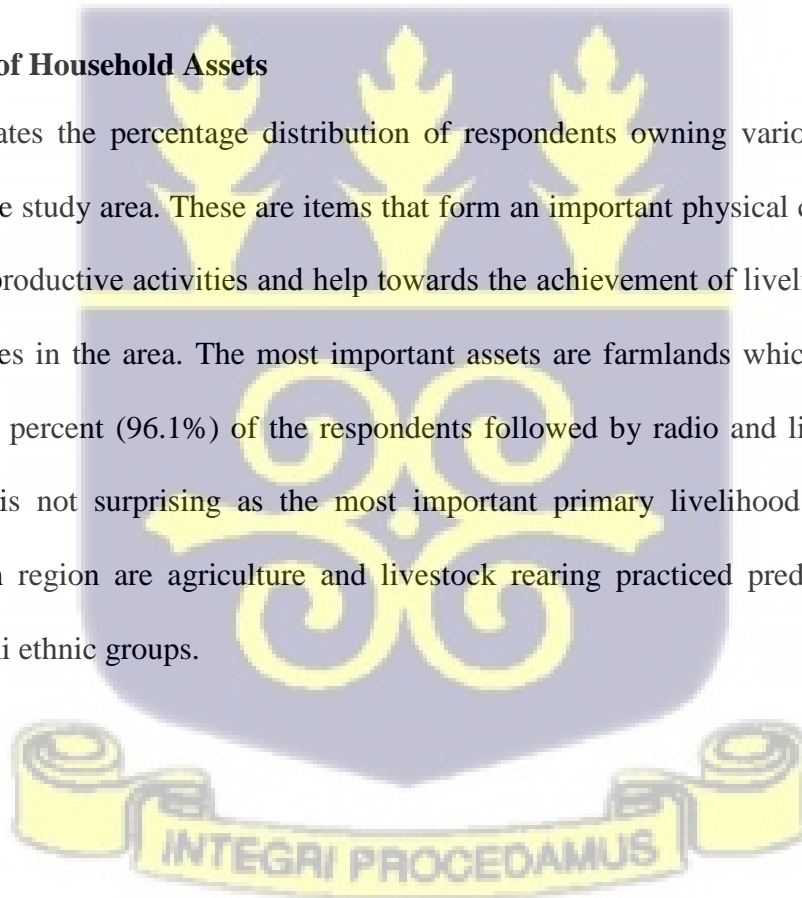


Table 19: Ownership of Household Assets by Households

Various Household Assets Owned	Batsari		Jibia		Kurfi		Average Percent
	Freq	%	Freq	%	Freq	%	
Sewing Machine	30	21.7	11	19.3	25	17.3	19.4
Livestock	63	45.7	46	80.7	75	51.7	59.4
Bicycle	69	50.0	21	36.9	49	33.8	40.2
Farmland	135	97.8	54	94.7	139	95.9	96.1
Motorcycle	11	8.0	10	17.6	51	35.2	20.2
Poultry	98	71.0	24	42.1	69	47.6	53.6
Beehive	4	2.9	1	1.8	5	3.5	2.7
Television	31	22.5	4	7.0	13	9.0	12.8
Transistor Radio	80	58.0	44	77.2	93	64.1	66.4
Refrigerator	6	4.3	2	3.5	10	6.9	4.9
Bucket	85	61.6	37	64.9	71	49.0	58.5
Bed	51	37.0	32	56.1	60	41.4	44.8
Other Houses	10	7.3	8	14.0	18	12.4	11.2
Plot of Land	10	7.3	13	22.8	10	6.9	12.3
Pressing Iron	30	21.7	23	40.4	60	41.4	34.5
Cart	44	31.9	9	15.8	24	16.6	21.4
Generator	0	0	0	0	1	0.7	0.2
Mobile Phone	0	0	0	0	9	6.2	2.1

Source: Field Work, 2012

Wezel and Lykke (2006) added that agriculture or livestock rearing remain the most important land use activity in the West African drylands including the Sahel. Whilst the Hausas are mainly cultivators, the Fulani's are essentially nomadic or semi-nomadic who have now largely become settled and keep cattle, sheep and goats. The highest proportion of livestock and transistor radio set owners is found in Jibia locality where almost eighty one percent (80.7%) and about seventy seven (77.2) respectively own these types of assets compared to Batsari and Kurfi localities. Generators and mobile phones have the least patronage in the study area as only Kurfi locality has very few respondents owning them probably because the later is a relatively new innovation.

5.5 Livelihoods of the Households

Table 19 portrays the percentage distribution of respondent's major income sources by households in the study area. It shows what the households do to earn a living because these sales generate cash which sustain these households. It also shows the major household's financial capital inflows in the localities derived from sales associated with crop, tree, livestock, and off-farm enterprises.

Table 20: Major Sources of Cash Income by Households

Sources of Cash Income	Batsari		Jibia		Kurfi		Average Percent
	Freq	%	Freq	%	Freq	%	
Sale of food crops	21	15.2	9	15.7	25	17.3	16
Sale of Firewood	11	7.9	7	12.3	11	7.6	9.3
Sale of Livestock	20	14.5	7	12.3	10	6.9	11.2
Sale of Cash Crops	9	6.5	5	8.8	13	8.9	8
Business Income	11	7.9	5	8.8	9	6.3	7.7
Traditional Medicines	8	5.8	4	7	5	3.5	5.4
Cash Remittances	12	8.7	6	10.5	13	8.9	9.4
Wage Income	10	7.3	4	7	17	11.7	8.7
Sale of Honey	5	3.6	0	0	0	0	1.2
Sale of Poultry	12	8.7	3	5.3	18	12.4	8.8
Sale of Fruits	12	8.7	2	3.5	11	7.6	6.6
Sale of Crafts	7	5.2	2	3.5	13	8.9	5.9
Migrant Labor	0	0	3	5.3	0	0	1.8
Total	138	100	57	100	145	100	100

Source: Field Work, 2012

The major source of income to the respondents is through the sales of farm products. Both food and cash crops were sold by sixteen percent (16%) and eight percent (8%) of them respectively. Such crops include millet, sorghum, beans, sweet potato and groundnuts sold to get some cash income despite the subsistent condition of many farmers in the area. It should be noted that sale

of farm products is almost equally important in all the localities. The other major source of livelihood apart from farming is from the sale of livestock and livestock products like milk and meat by about eleven percent (11.2%) of the respondents.

Livelihoods associated with selected trees products are also very important. These include sale of firewood particularly in Jibia locality where nearly twelve percent (12.3%) of the respondents practice it. Traditional medicines are also sold from the parts of some of the selected trees like barks, roots and leaves. Business income is another livelihood activity in the area especially in Jibia locality that also shares an international border with Niger Republic to the north.

Off-farm enterprises like sale of fruits, poultry, crafts and migrant labour particularly in Jibia locality is practiced by about five percent (5.3%) of the respondents. Some of the respondents also receive cash remittances from brothers and other close associates. Nearly nine percent (8.7%) receive wage incomes like teaching. Another tree product enterprise is the sale of honey but this is not very important as it was only found in Batsari locality.

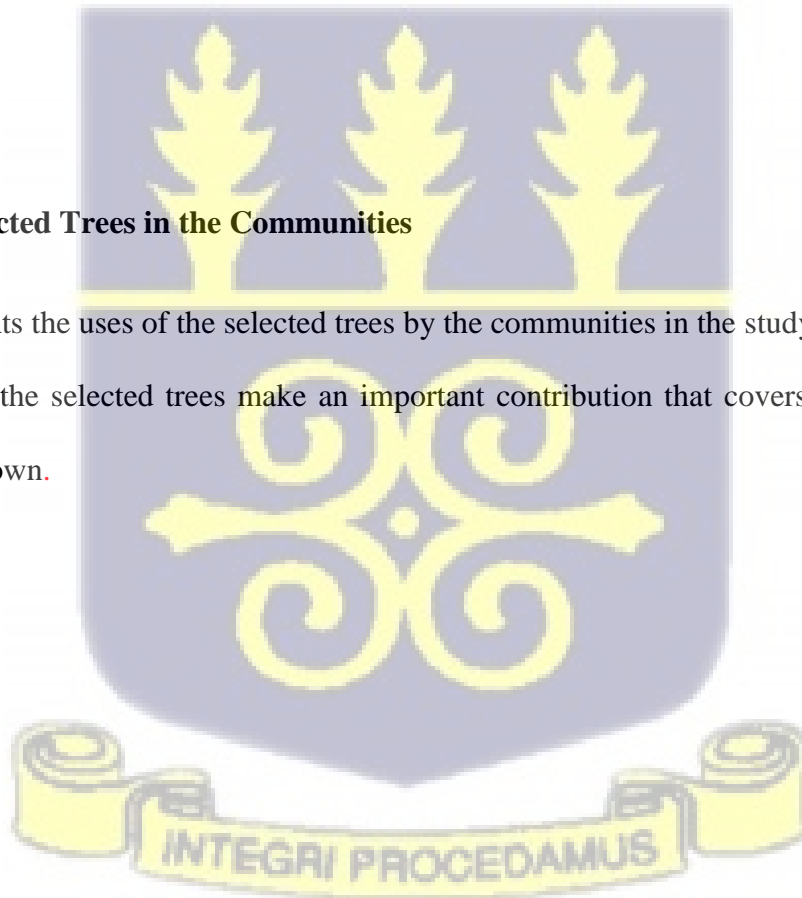
A point worth noting is that many households have significant off-farm income generating activities in the study area suggesting some level of livelihood diversification away from agriculture. Crop sales remain the most important enterprise. Others like sale of tree products including firewood, traditional medicine and fruits, off-farm or non-agricultural enterprises are significant. These represent a kind of '*productive bricolage*' survival strategy these rural households adopt in order to diversify incomes or combining reliance on multiple sources of

income to improve livelihoods. This corroborates findings from studies in Fandou Beri village in South-Western Niger (Batterbury, 2001), Romwe and Mutanga villages in Chivi District of Masvingo Province in South-Eastern Zimbabwe (Campbell et al., 2002) and 8 rural communities in five districts in northern Ghana (Marchetta, 2011).

It is interesting to note that the livelihoods of the communities discussed above can be linked to the uses of the trees as discussed in the ensuing section. These livelihoods include sales of food substances like firewood, traditional medicines, fruits and honey that are directly related to the selected trees.

5.6 Uses of Selected Trees in the Communities

Figure 11 presents the uses of the selected trees by the communities in the study area. The survey established that the selected trees make an important contribution that covers the different use categories as shown.



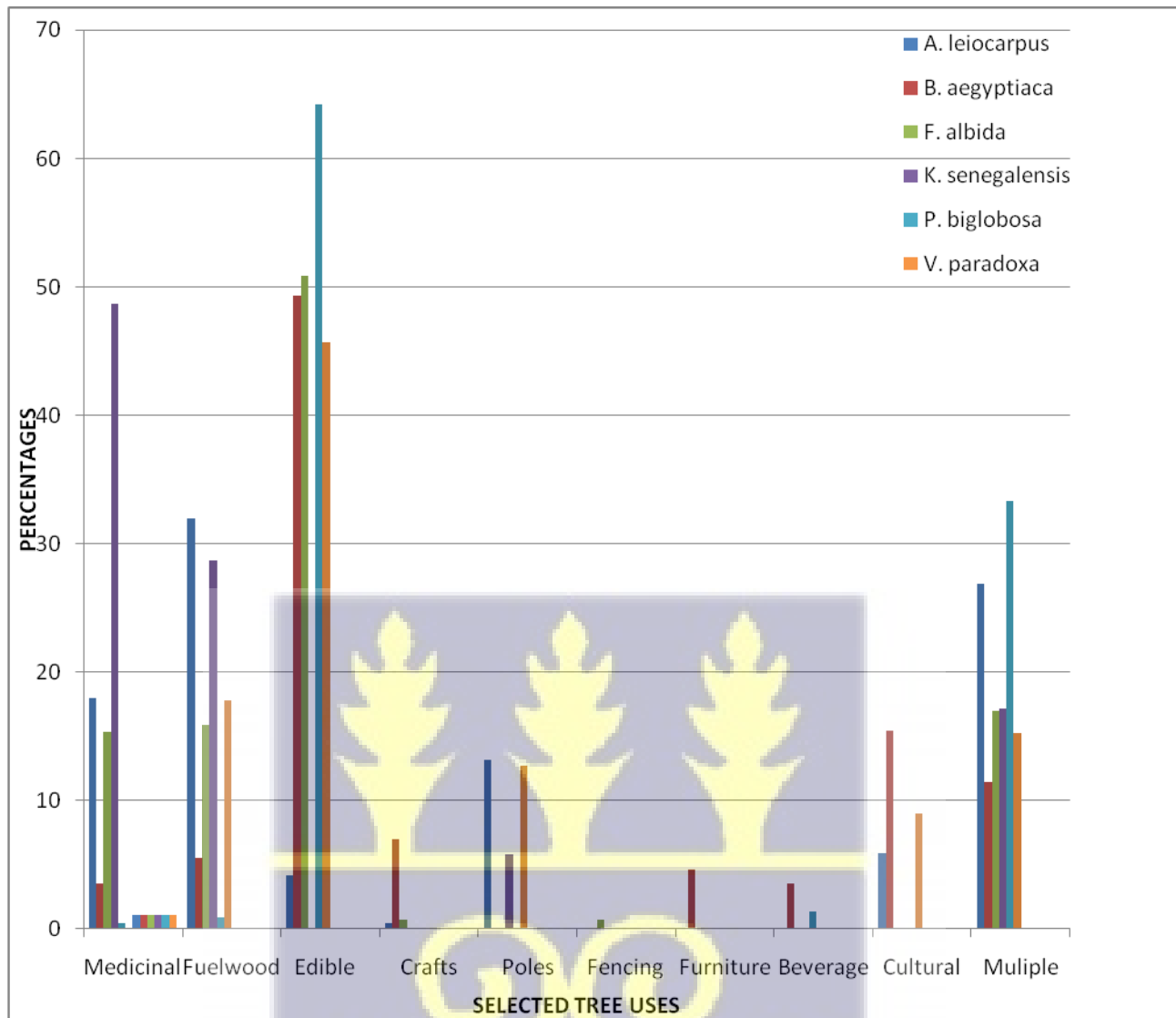


Figure 11: Uses of Selected Trees by Communities

The uses of the selected trees include both consumables and non-consumables (Table 20). The selected trees have different ranges of use by the respondents starting with *Balanites aegyptiaca* topping the list which spans all the use categories including medicinal, fuelwood, edible poles, local crafts, fencing, furniture, beverage and cultural uses. This is followed by *Anogiessus leiocarpus* with same uses as the former tree except for fencing, furniture and beverage. Others like *F. albida*, *P. biglobosa* and *V. paradoxa* are useful for medicine, fuelwood, food and cultural

activities. *Khaya senegalensis* with least number of uses is being used for medicine, fuelwood and pole making according to the survey. This could be due to its limited occurrence in the study area. A point worth noting is that all the selected tree species have multiple uses represented by the percentages of respondents that use them in 3 or more ways.

Table 21: Consumptive and Non-Consumptive Use Categories of Selected Trees

Consumptive Use of Selected Trees	Non-Consumptive Use of Selected Trees
Edible	Fuelwood
Beverage	Medicinal
Medicinal	Local crafts
–	Poles
–	Fencing
–	Furniture
–	Cultural

Source: Field Work, 2012

5.6.1 Edible Uses of the Selected Trees

Figure 10 shows that the most diversified use of the selected tree species in the study area is for edible purposes. All the selected tree species except *K. senegalensis* were used as food to supplement existing food crops being cultivated by the smallholders. Sop and Oldeland (2011), Legwaila *et al.* (2011) and Harris and Mohammed (2003) have also noted that several rural people in African farming systems depend on indigenous food plants including trees for food.

The tree mostly used for this purpose is *P. biglobosa* as about sixty four percent (64.2%) of the respondents use it for food. It is famous for its seeds which when dried are fermented to make a black strong-smelling nutritious food condiment popularly known as - daudawa. This according to many participants of the indepth interview is used to prepare traditional soups and stews and the pulp is sometimes eaten raw and when dried its powder is made into different kinds of foods and drinks.

The other most important tree used as food is *V. paradoxa*. Nearly forty six percent (45.6%) of the respondents use it as food. It is usually used to make shea butter which is derived from the seeds of the tree. This creamy substance is rich in vitamin A and is used mostly by poor households as oil for food. The fruit pulp is the one that is mostly eaten by the respondents as food. The fruit seed and leaves of *B. aegyptiaca* were also used for food by almost fifty percent (49.3%) of the respondents. About the leaves of this tree, one respondent during the indepth interview puts it that -we make a delicious food substance from it.

Honey is also obtained from such trees as some of them like *F. albida*, *P. biglobosa* and *V. paradoxa* are melliferous plants as they are harvested by domesticated bees which collect substances to make into honey. Some of the respondents during the indepth interview mentioned that they collect honey particularly from *V. paradoxa* tree. A tree best known for raising livestock is *F. albida* as its seed pod is fed to them and which they prefer so much. It is widely used for this purpose in northern Nigeria as a whole where the tree is found. The animals used to rest under the tree to wait for the seed pods to fall to the ground for them to feed on it hence the Hausa proverb *jiran gawon shanu* meaning “awaiting of seed pods of the tree by livestock”.

5.6.2 Fuelwood Use of the Selected Trees

The second most important use of the selected economic trees in the study area according to Figure 10 is fuelwood gathering from both living and dead trees. All the selected trees are used for this purpose in the communities. Kuntashula and Mafongoya (2004) added that in Africa, fuel wood is a very essential energy supply for many of the local people. Part of the tree for instance its branches are cut/logged or whole trees felled to obtain fuel wood. The wood of *A. leiocarpus* tree is widely used for fuelwood by about thirty two percent (31.9%) of the respondents. Another tree part involved in this type of use are branches that are lopped as wood fuel especially in *P. biglobosa*. During the indepth interview, members of the communities attested that selected trees particularly *K. senegalensis* and *B. aegyptiaca* provide good-quality fuel wood used in the communities for cooking food.

A bye-product of fuelwood that is also used for cooking and heating purposes is charcoal even though it is produced in small quantities. High-quality charcoal is produced particularly from the wood of *B. aegyptiaca* and to a lesser extent *A. leiocarpus*. The effect of charcoal production on the selected trees is therefore selective and not very detrimental due to their protection. However, a survey in Togo by Kouami, Yaovi and Honan (2009) among 310 charcoal producers from 4 production areas of the country revealed that only some selected woody species were affected by charcoal production through depletion. They identified 158 woody species where only 34 were regularly exploited for charcoal production.

Stacks of firewood were seen here and there in the study area where fuelwood is sold to the rural communities mainly for cooking purposes but it is also obtained from their farms. The specific

livelihood activity that relates to this use value in the area is fuelwood selling by retailers and distributors who earn a living from it. It noteworthy that as these trees particularly *A. leiocarpus* are being unsustainably exploited, this livelihood activity will decline and people have to travel far to get it.

5.6.3 Medicinal Use of the Selected Trees

Figure 10 above shows that almost all the selected trees are used for medicinal purposes in the study area with the exception of *Vitellaria paradoxa*. The most important tree widely used for making traditional medicines in this case is *K. senegalensis* where almost forty nine percent (48.6%) of the respondents use it for that purpose. The other selected trees used for the same purpose by almost eighteen percent (17.9%) and about fifteen percent (15.3) of the respondents include *A. leiocarpus* and *F. albida* respectively. The tree parts utilized were mostly leaves, barks, roots extract and wood. Traditional herbal practitioners in the communities use these tree parts to make herbal medicines for the treatment of different types of ailments including those of livestock.

The indepth interview participants have provided useful information on some illnesses treated by such trees in the area. The leaves of *A. leiocarpus* are used in the treatment of cough, yellow fever, and in livestock for expelling worms while those of *P. biglobosa* are also used to treat diarrhea and poison effects. The bark of *V. paradoxa* is used to treat dog bite in the area. Its shea butter is used to make different kinds of ointments including skin ointment to treat inflammations on the body. The use of the selected trees for this purpose is however becoming vulnerable as some of them particularly *K. senegalensis* and *V. paradoxa* according to the study are already

under threat in the study area. The livelihood activity that directly relates to this use value in the area is sale of traditional medicine by herbalists that use products from these trees to increase income generation. This business has however declined as some of the trees mostly used for this purpose have significantly decreased.

Traditional medicines provide the people opportunities to cure some of their illnesses at the local level. This is because health facilities are lacking or are located very far away from them in major urban centers. Another reason is the alternative cost of western medicine which many of the people finds difficult to purchase in view of the relatively high level of poverty there. As most of them lack formal education according to Table 16 above, many of them would find it difficult to appreciate western medicine. For these reasons, traditional medicines are patronized more and support to help their illnesses and help enhance livelihoods of people who sell them.

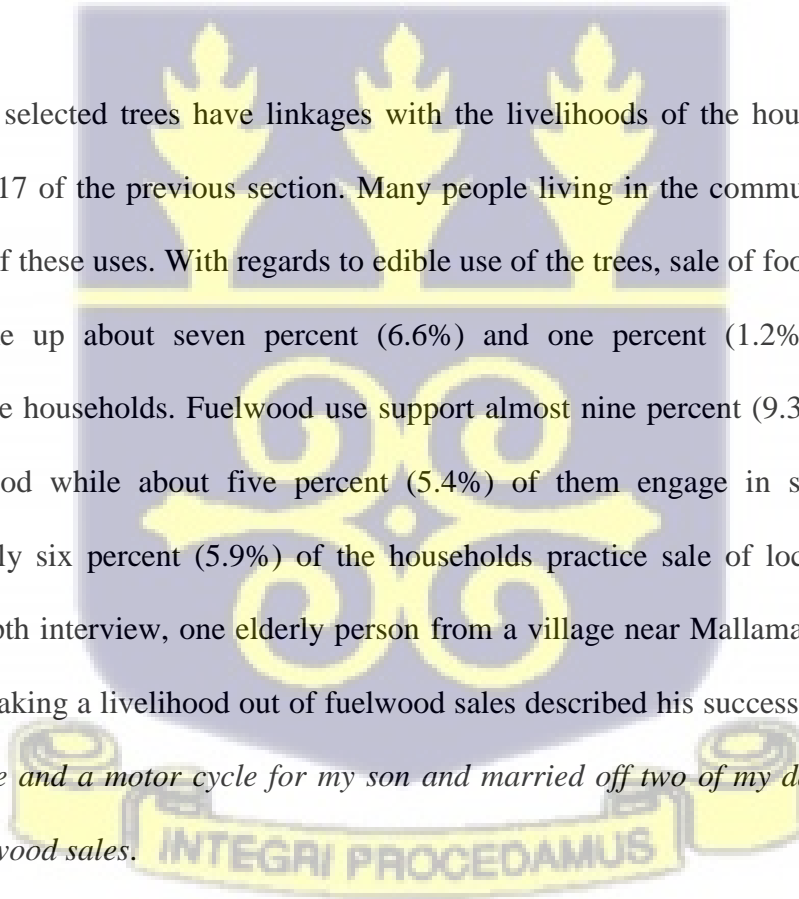
5.6.4 Other Uses of the Selected Trees

Figure 11 indicates that some uses of trees by the respondents such as for making fences, poles, local crafts, and cultural products are not very popular and only affect specific trees. The trees *A. lieocarpus*, *V. paradoxa* and *K. senegalensis* branches are still being used to make poles by about thirteen percent (13.1%), or nearly thirteen percent (12.6%), and almost six percent (5.7%) of the respondents. Such trees are mostly used for building roofs of houses, huts or temporary sheds that are common in these rural communities. The branches of *A. lieocarpus* are particularly used for this purpose as they are durable. The trees used mainly for making cultural products are *B. aegyptiaca* and *A. lieocarpus* and about fifteen percent (15.4%) and almost six percent (5.8%) of the respondents do so. Their woods are used to make carvings into hoes, wooden slates, mortar, different tool handles and agricultural implements. Traditional furniture is

made from the wood of *B. aegyptiaca* in the area. These products are sold in the market by the people in the communities to improve livelihoods.

B. aegyptiaca and *P. biglobosa* trees are used in the communities for making beverages by nearly four percent (3.5%) and about one percent (1.3%) of the respondents. The fruits/seeds of such trees are utilized for this purpose. The only tree used for fencing purposes is *F. albida* which is also used in the area for soil fertilization as suggested by the focus group participants. They also suggested that the powder of *P. biglobosa* seeds is used in building where it is mixed with earth materials to make it hard and durable.

The uses of the selected trees have linkages with the livelihoods of the households as shown earlier in Table 17 of the previous section. Many people living in the communities are making livelihoods out of these uses. With regards to edible use of the trees, sale of food items like fruits and honey make up about seven percent (6.6%) and one percent (1.2%) respectively of livelihoods of the households. Fuelwood use support almost nine percent (9.3%) of households that sell fuelwood while about five percent (5.4%) of them engage in sale of traditional medicines. Nearly six percent (5.9%) of the households practice sale of local craft products. During the indepth interview, one elderly person from a village near Mallamawa community in the study area making a livelihood out of fuelwood sales described his success story as follows - *I bought a house and a motor cycle for my son and married off two of my daughters from the proceeds of fuelwood sales.*



The use of the selected trees in the area has limited variation in its geographical distribution. Consequently, the forms of use of the selected trees in the three localities were compared in Figure 12. It represents the proportion of categories of uses of the selected trees for each locality in the study area.



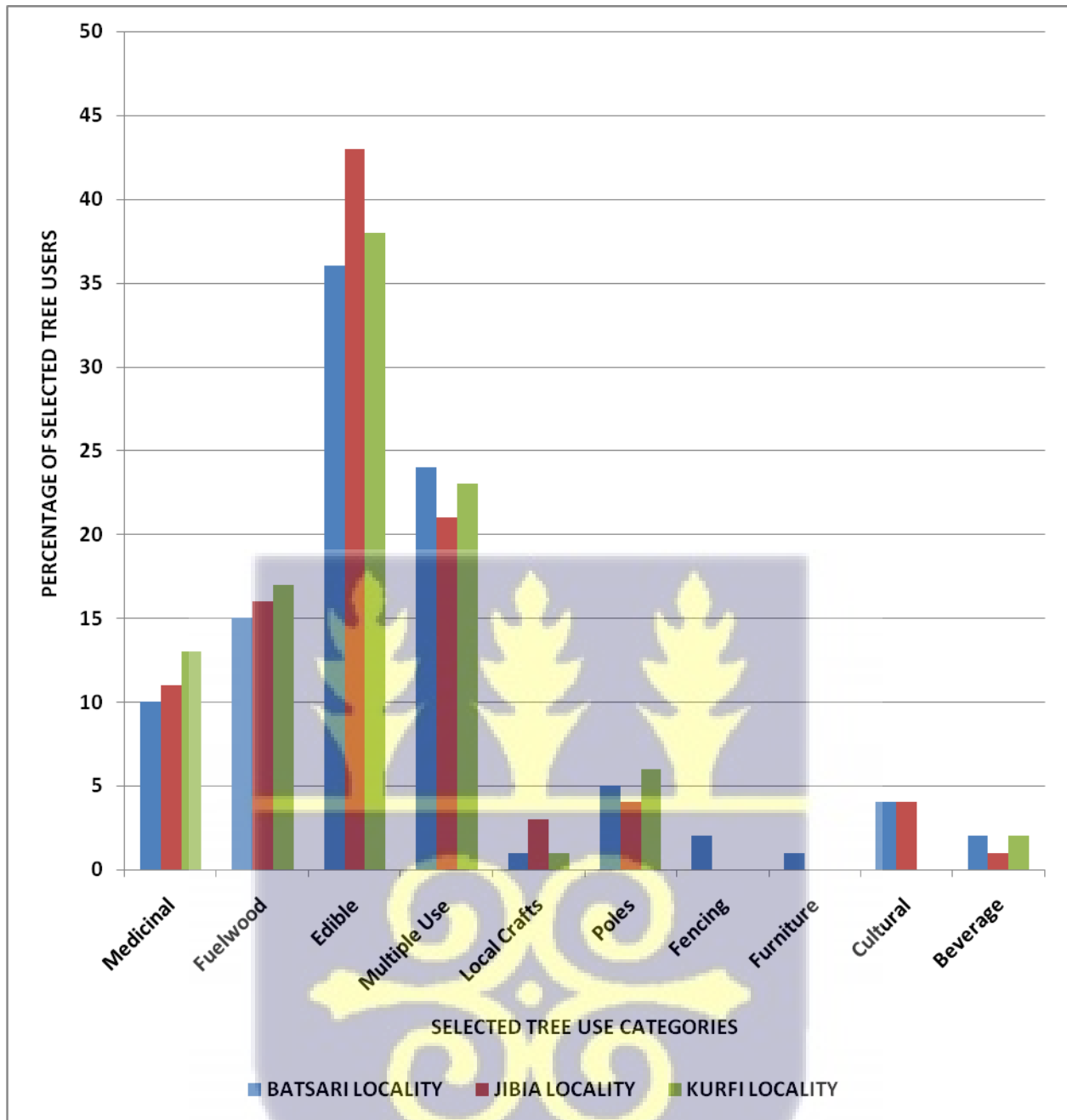


Figure 12: Comparison of Selected Tree Use Categories in all Localities





Plate 5:1 Bark Harvesting of *Faidherbia albida* Tree. The Bark of the Tree is highly Patronized for Traditional Medicine



5.7 Sustainability of Selected Trees and Use/Livelihoods

There is a nexus between some livelihood activities and sustainability of the selected trees in the area. This is because some livelihoods are dependent on, for instance, the sale of firewood, use as traditional medicine, harvesting of fruits, making of crafts, and harvesting of honey. This means that to some extent, where these trees decline in availability, the livelihoods attached to them decrease in importance. Conversely, where these trees are available, the associated livelihoods are sustained..

During the indepth interview, some of the participants attested to the fact that in many of the communities in the study area, some of the selected trees are very rare to find while others have almost disappeared. According to them, tree species like *Vitellaria paradoxa* and *Khaya senegalensis* belong to this category of very rare tree species. This view was also echoed in the results of the survey in Chapter 4 on availability trend of the selected trees. They noted that, already, shea butter production which is associated with the *V. paradoxa* tree has dropped in significance owing to the reduced availability of this tree in many communities.

The rest of the selected tree species like *A. lieocarpus*, *B. aegyptiaca* and *P. biglobosa* are however abundant and are being conserved mostly on farms. Those found in open access areas, however, were mostly felled and used as fuelwood. However, the selected trees face a number of threats that could affect their sustainability in the study area. Table 22 depicts the percentage distribution of the major threats to the selected trees according to the respondents in the study area.

Table 22: Major Threats to the Selected Trees

Major threats to the Selected Trees	Batsari		Jibia		Kurfi		Average Percent
	Freq	%	Freq	%	Freq	%	
Climate Change	7	6.7	10	19.7	5	4.4	10.3
Reduced Rainfall	11	10.5	6	11.8	10	8.7	10.3
Population Increase	0	0	9	17.6	0	0	5.9
Fuelwood Gathering	68	64.7	17	33.3	83	72.2	56.7
Desertification	14	13.3	9	17.6	15	13	14.6
Poverty	5	4.8	0	0	2	1.7	2.2
Total	105	100	51	100	115	100	100

Source: Field Work, 2012

It shows that fuelwood gathering was rated the highest by nearly fifty seven percent (56.7%) of the respondents as posing threat to the selected trees in the area. This seem to have corroborated CGIAR (2011) study that revealed that more than 90% of all the wood cut from Africa’s forest and woodland areas are used as fuel wood. It is however less important in Jibia locality than in others where about thirty three percent (33.3%) of the respondents stated so and this probably may be due to its less tree cover. Such fuelwood resources used are mostly from secondary woodland on fallows, agricultural fields, unreserved forests and other open access areas. However, some researchers have argued that there are now changes in fuelwood collection strategies in many areas that pose less threat to vegetation in drylands than portrayed (Matsika, Erasmus and Twine, 2013; Foley *et al.*, 1997; Cline-Cole *et al.*, 1987).

Desertification is the second most important threat to selected trees according to about fifteen percent (14.6%) of the respondents. They believe that the desert is encroaching and the land is becoming drier. Another threat affecting the trees according to almost ten percent (10.3%) of the respondents was attributed to climate change and reduced rainfall. Research conducted by Salim, Chen and Gong (2008) in Sudan using spatial analysis methods on the relationship between rainfall and NDVI between 1982 and 1993 revealed that the relationship is strong and positive even though it is not a simple linear one.

Other less important threats according to the respondents are population increase and poverty. According to them, more people mean more destruction of vegetation to establish farmlands and settlements. This has however gone contrary to the context of the debate generated by a study conducted by Tiffen, Mortimore and Gichuki (1994) in Machakos district of Kenya which revealed that the people have not degraded their environment in spite of poverty and climatic challenges. Poverty also as they say drives the people to depend on more on vegetation for sustenance. Matsika, Erasmus and Twine (2013, p.723) have also stated that “poverty is linked to environmental degradation and is inextricably linked to the use and the unsustainability of fuelwood use across rural landscapes”. However, FAO (2010) believed that poverty seem to promote easier strategies of coping among people.

The respondents were also solicited to state the level of such threats affecting the trees around the communities. Table 27 illustrates the percentage distribution of the levels of threats to the selected trees in the study area. Thirty three percent (33%) of the respondents were of the view

that there is a high risk of threat to the selected trees in the area whilst about fifty two percent (52.4%) especially in Jibia locality believe that there is moderate threat in the form of desertification, fuelwood gathering and climate change to the selected trees in the area.

Table 23: Levels of Threats to the Selected Trees

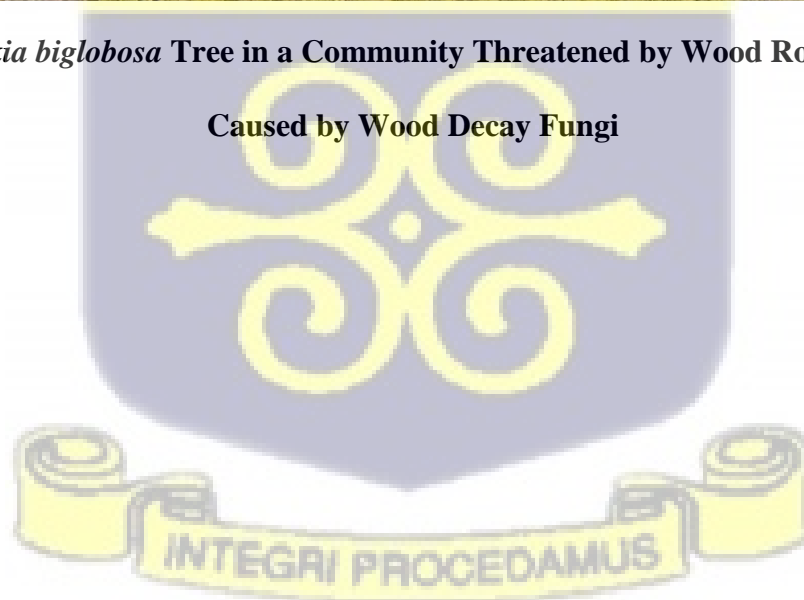
Extent of Threat to Selected Trees	Batsari		Jibia		Kurfi		Average Percent
	Freq	%	Freq	%	Freq	%	
High	39	37.1	12	23.5	44	38.3	33
Moderate	43	41	38	74.5	48	41.7	52.4
Low	12	11.4	1	2	13	11.3	8.2
No Idea	11	10.5	0	0	10	8.7	6.4
Total	105	100	51	100	115	100	100

Source: Field Work, 2012

Overall, the high average percent (52.4%) of moderate threats might probably be due to the protection being given to these trees which are mostly found in an on-farm situation and also largely privately owned by the respondents. Regmi (2003) emphasized that many households retain different trees due to their particular use and this helps in conserving biodiversity. Because of the importance of the selected trees around them, they would do more to reduce the level of threats and sustain them. There is not much difference in the geographical variation of the major threats between the localities.



**Plate 5:2 *Parkia biglobosa* Tree in a Community Threatened by Wood Rot or Dead Stem
Caused by Wood Decay Fungi**



5.8 Chapter Conclusion

The main idea analyzed in this chapter was the role and contribution of selected trees in the livelihoods of the rural communities in the study area. The trees comprising *A. lieocarpus*, *B. aegyptiaca*, *F. albida*, *P. biglobosa* and *V. paradoxa* were found to contribute so much to the livelihood of the respondents mostly through their varied non-timber and other uses. Such major uses include medicinal, food, local crafts and fuelwood. Trees like *A. lieocarpus* and *P. biglobosa* which were the most used in the communities have so many uses of which the most important is for food. This study corroborates other studies such as Ros-Tonen and Wiersum (2003), Kalaba *et al.* (2008) and Hugland *et al.* (2011) on contribution of trees and woody plants to livelihood. The sustainability of selected trees like *V. paradoxa* and *K. senegalensis* in the communities were also found to be threatened by disturbance and over exploitation thereby affecting associated livelihoods.

The communities rely on them as important sources of cash inflow from the sale of their products including non-timber from the selected trees and other off-farm enterprises which greatly help in sustaining livelihoods and increasing diversification away from agriculture. Kangawale *et al.* (2008) studied the Lake Victoria basin in Tanzania, Kenya and Uganda and revealed that there is increasing population pressure and livelihoods diversification there. The respondents also have varied household assets which form part of their livelihood support. Coomes, Takasaki and Rhemtull (2011) added that poverty traps represent dependency by people towards accumulation of important assets such as tree stocks for the sake of households' future wellbeing.

Most of the respondents have suggested that there is an existential threat to the selected trees in the study area. Bongers (2010) agreeing in the same vein suggested that the livelihoods of the rural dwellers particularly in developing countries which depend so much on the natural environment, is being threatened by myriad of environmental changes. Foremost among such threats are fuelwood gathering, desertification and climate change and population increase. However, emerging consensus and changing views on environmental change and land degradation are showing that there is environmental recovery and adaptive capacity from such threats (Tiffen, Mortimore and Gichuki, 1994; Dahlberg, 1994; Mortimore and Turner, 2005).



CHAPTER SIX

TREE GOVERNANCE: THE ROLE OF LOCAL AND STATE INSTITUTIONS

6.1 Introduction

This chapter deals with local and state institution's role in the governance of trees. It addresses research questions as: what is the indigenous knowledge and capacities that support the conservation of the selected economic trees in the study area? What are the forms of access rights and control over the use of the selected trees and the opportunities and constraints associated with them? What is the role of the major local and national institutions in the management of tree resource use?

6.2 Access Rights to the Selected Trees by Households

Table 24 presents the percentage distribution of access rights to the selected trees by the respondents in the study area. It shows that generally almost seventy eight percent (77.7%) of the selected trees species including *Anogeissus leiocarpus*, *Balanites aegyptiaca*, *Faidherbia albida*, *Parkia biglobosa* and *Vitellaria paradoxa* fall in the private access category where they are vested in individuals who have usufruct rights over the trees. This is particularly agreed by (86.2%) each of the respondents practicing private access on *A. leiocarpus* and *P. biglobosa* tree species.

Access is generally defined as the ability, the opportunity or the right to acquire something at will which could be determined by historical, cultural, political, social, economic or environmental factors (Mohammed, 1994). The selected trees in private access are more often used than those found in other access categories. For any member of the community to use the trees within the private access category they have to seek permission from their owner. In the open access category, every member whether from within the communities or outside could make use of the trees without seeking permission from somebody. Community or village heads need to give permission to members outside their community if they want to use these trees in common access category. However the utilization of the trees is free to the community members only.

Okiro *et al.* (2012) in a study in Amuria district in Uganda revealed that shea trees were mainly managed in an on-farm basis. Only about twenty one percent (21.1%) of these trees fall in the open access category. The least category involving communal membership was common access whose occurrence in the area could be described as negligible. Trees such as *F. albida* and *K.senegalensis* with about two percent (2.2%) and nearly three percent (2.9%) are associated with this case. Private access is therefore dominant for all the selected tree species followed by open access and then common access. It is worth noting that common access category is not even found among selected tree species like *V. paradoxa* and *B. aegyptiaca* in the study area. There is thus a high security of tenure of the selected economic trees in the area.

Table 24: Access Rights to the Selected Trees by Households

Selected Trees	Private Access		Open Access		Common Access	
	Freq	%	Freq	%	Freq	%
<i>Anogeissus leiocarpus</i> (Marke)	251	86.2	38	13.1	2	0.7
<i>Balanites aegyptiaca</i> (Aduwa)	156	77.6	45	22.4	0	0
<i>Faidherbia albida</i> (Gawo)	135	73.8	44	24.0	4	2.2
<i>Khaya senegalensis</i> (Madachi)	22	62.9	12	34.2	1	2.9
<i>Parkia biglobosa</i> (Dorowa)	207	86.2	30	12.5	3	1.3
<i>Vitellaria paradoxa</i> (Kadanya)	63	79.7	16	20.3	0	0
Average Percent of Accesses		77.7		21.1		1.2

Source: Field Work, 2012

Teklehaimanat (2004) cited Leakey *et al.* (2005) who stated that the increasing establishment of trees in cultivated lands brought about by human pressure is due to secure tree tenure regime.

Common access of some of the selected trees according to the findings was not found among *B. aegyptiaca* and *V. paradoxa* recordings. This suggests that community ownership of these tree stocks is not very important in the area. The issue of land rights is very important as noted by Neef and Schwarzmeier (2001) that the management of deforestation can be associated with land rights. This could have implications on the livelihood and security of the people.

Nearly ninety eight percent (97.8%) of the respondents in all the localities haven't ever encountered any restriction on the open access of the selected trees. This is because tree tenure is often unclear in the open access category where there is usually lack of ownership and control and rules are not effectively enforced. Thus only a few of them have ever encountered restrictions on the open access for the selected trees in the area. The rural communities in the absence of sufficient security of tenure continue to exploit these selected trees for meeting their livelihoods needs with potentials for over-use and degradation.

A type of restriction practiced in the study area is competition or contestation with other selected tree users. This has the potential to cause degradation since nobody has control over exploitation of the tree resources. A situation whereby everyone has their claim to the use of common tree resource could bring about conflicts between the individuals themselves and the community or society as a whole. This is consistent with the debate on common access resources where according to Hardin, (1968), common access resource exploitation ends up in tragedy in which every rational individual tends to pursue their own interest and over stretch the carrying capacity of the land thereby affecting the life of everybody in the society. According to him, such tragedy

connotes individuals increasing exploitation without limit in a world with limited resources which consequently brings ruin (degradation). In the context of the study communities, however, private access dominates and this reduces the chances of “the tragedy of the commons” happening.

6.3 Type of Land Tenure by Households

Table 25 below portrays the percentage distribution of types of land tenure by the respondents in the study area. Farmlands are another source of physical capital to the respondents in the area and its access is therefore of fundamental importance towards achieving livelihood objectives. It shows that about eighty six percent (86.3%) of all the types of land tenure in the localities is individual private land. This is followed by rented land with almost seven percent (6.7%) particularly in Jibia locality and public land especially in Kurfi locality. The least tenure category practiced by the respondents is common land where only about one percent (1.4%) of the respondents practices it.

Table 25: Types of Land Tenure by Households

Land Tenure Category	Batsari		Jibia		Kurfi		Average Percent
	Freq	%	Freq	%	Freq	%	
Family Land	8	5.9	2	3.7	10	7.2	5.6
Private Ownership	120	88.9	46	85.2	118	84.9	86.3
Rented Land	6	4.5	5	9.3	9	6.5	6.7
Common Land	1	0.7	1	1.8	2	1.4	1.4
Total	135	100	54	100	139	100	100

Source: Field Work, 2012

There is thus high security of tenure to land holdings in the area and this is in line with the earlier findings about access that most of the selected trees were in the private access category. This is because land tenure has much in common with tree tenure in the area as in most other parts of northern Nigeria. Neef and Schwarzmeier (2001) supported this point by stating that land tenure system defines tree tenure with similar rights structure. This arrangement is however different in some societies in the world where the two are not regarded as one unit. Although in this study, tree tenure and land tenure are regarded as same, there are however differences between the two in some instances. Neef and Schwarzmeier (2001) stated that on the same plot of land, an individual might have the right to use it for growing crops while at same time the community is allowed to use the trees.

6.4 Occurrence of Indigenous Practices that Protect Trees

Table 26 presents the percentage distribution of the respondents that employ indigenous practices in the management of the trees. It shows that about seventy eight percent (77.7%) of them practice indigenous knowledge in the preservation of the selected trees, while the rest constituting about twenty two percent (22.3%), just allow the trees to grow on their own without doing anything to them.

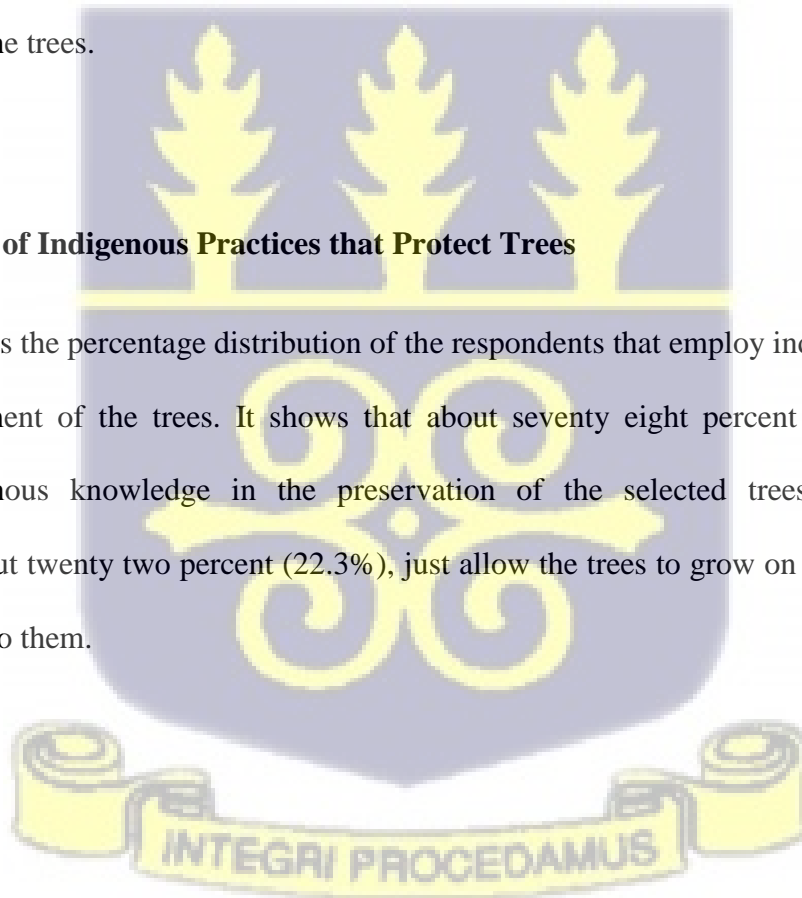


Table 26: Occurrence of Indigenous Practices that Protect Trees

Occurrence of Indigenous Practices in Trees Governance	Batsari		Jibia		Kurfi		Average Percent
	Freq	%	Freq	%	Freq	%	
Yes	97	70.3	46	80.7	119	82.1	77.7
No	41	29.7	11	19.3	26	17.9	22.3
Total	138	100	57	100	145	100	100

Source: Field Work, 2012

In all the localities, the trend is almost the same but in Kurfi locality it is slightly higher with about eighty two percent (82.1%). This demonstrates that a high number of community members consciously take measures to protect the trees, which is a reflection of their uses as discussed in the previous chapter. This has been established from other studies, such as Etongo *et al.*, (2016) in Southern Burkina, by Buyinza *et al.*, (2015) in Uganda and by Segnon *et al.*, (2015) in Benin.

6.4.1 Indigenous Strategies of Protecting Trees

Table 27 indicates the percentage distribution of indigenous strategies of protecting the selected trees in the study area.

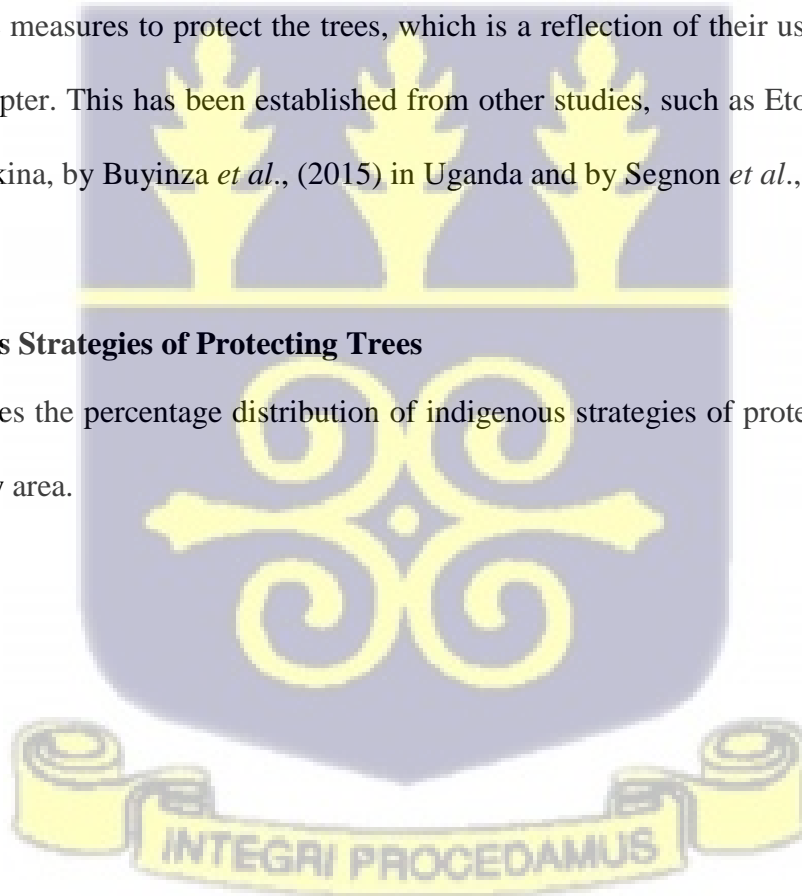


Table 27: Indigenous Strategies of Protecting Trees

Indigenous Strategies of Protecting Trees	Batsari		Jibia		Kurfi		Average Percent
	Freq	%	Freq	%	Freq	%	
Fencing	31	31.9	17	37.0	45	37.8	35.5
Pruning	20	20.6	14	30.4	43	36.1	29.0
Weeding	7	7.2	1	2.2	13	10.9	6.8
Watering	5	5.2	1	2.2	0	0	2.5
Cutting Older Parts	8	8.2	3	6.5	0	0	4.9
Fertilizer Addition at Roots	5	5.2	1	2.2	7	5.9	4.4
Creating Depression at Roots	9	9.3	3	6.5	11	9.3	8.4
Multiple Methods	12	12.4	6	13	0	0	8.5
Total	97	100	46	100	119	100	100

Source: Field Work, 2012

About thirty six percent (35.5%) of the respondents practice fencing to protect the selected trees especially when they are young. A lot of the villagers during the indepth interview also mentioned using this method to protect trees. The farm owners use different materials such as wire and thorny plant materials to fence them and protect them from destruction by keeping away grazing animals and people during clearing of fields. Some of the trees around houses are also fenced for the same purpose. Selected tree such as *Faidherbia albida* which supply nitrogen to farms is usually fenced.

A major strategy which twenty nine percent (29%) of the respondents practice is pruning of the tree tops and crowns and this enhances fast growth and increases yield. The indepth interviews also suggested many villagers practicing this strategy. It is also done to reduce massive tree

crowns as the shade could even harm the interspaced crops. Pruning can also be conducted if the farmer is interested in getting early harvest for desired products such as fuelwood (Mutua *et al.*, 2014 p. 43). Both farmers and other land owners practice this strategy to protect trees including those around homesteads. Trees selected that are pruned include *Anogeissus lieocarpus*, *Vitellaria paradoxa* and *Khaya senegalensis*.

Other less important strategies practiced by about eight percent (8.4%) and almost three percent (2.5%) of the respondents in the study area are creation of depression watering at root zones of these trees to allow water to settle and allowing watering respectively. These are practiced by both farm owners and in homesteads. The young trees or seedlings of these trees are the ones that benefit from these strategies especially when planted during the dry season. Few among the indepth interviewees in the villages also mentioned practicing this strategy. Selected tree species that receive this practice include: *Faidherbia albida*. In a study in the Meskan district in Ethiopia, Bongers (2010) revealed that, 85% of the respondents practice fencing and opening up of the soil around root zones.

Multiple methods constituting a combination of more than one strategy are however being used by about nine percent (8.5%) of the respondents to conserve these trees. However some geographical variations were found in the strategies adopted by the respondents between the three localities like cutting of older parts and multiple methods which were not practiced in Kurfi locality. This combination of diverse knowledge represents adaptive strategy and indigenous self-determination by the local communities to achieve livelihood sustainability. Other local

institutions relevant to the governance and management of tree resources in the study area are described in the two subsequent sections.

6.5 Role of State Institutions in Woodland Preservation

Table 28 displays the percentage distribution of the role of state institutions in woodland preservation in the study area. It shows that almost seventy two percent (71.8) of the respondents believed that there is no state institutional role in that regard. According to them they were not being assisted with the selected trees seedlings especially in Jibia locality. However many of them said they receive state institution assistance mostly with the provision of exotic tree seedlings. Almost twenty eight percent (28.2%) of the respondents were of the belief that state institutions were and are still relevant in woodland preservation. Owino (2009) also maintained that in most countries, the major problem with public forest administration continue to be their weak capacity to implement forest governance effectively.

Table 28: Role of State Institutions in Woodland Preservation

Participation of State Institutions in Woodland Preservation	Batsari		Jibia		Kurfi		Average Percent
	Freq	%	Freq	%	Freq	%	
Yes	49	35.5	8	14	51	35.2	28.2
No	89	64.5	49	86	94	64.8	71.8
Total	138	100	57	100	145	100	100

Source: Field Work, 2012

Rules and laws are developed by organizations and agencies that do change as a result of changes in governments and administrative structure over time. Such organizations and agencies enforce the rules and laws that govern trees. They employ different measures in the discharge of their functions at different levels of governance as discussed in the following section:

6.5.1 State Institutions and Roles Ascribed to them by Law

At state level, the autonomous Department of Forestry under the state governor's office oversees all forestry matters and uses the Katsina State's Forestry Laws of 1990 as a policy tool through which the states forests/trees are governed. Other organizations and agencies in the state according to Mohammed and Danjuma (2014) that provide assistance in this regard include Ministry of Agriculture, Ministry of Environment, Katsina State Agriculture and Rural Development Agency (KTARDA) and Katsina State Afforestation Programmes Unit (KTAPU). However the local governments compared to the state have some limited control in the decision-making process in their own areas. According to the many respondents, trees seedlings were being supplied to them by the state through the local governments where in many instances the traditional rulers help in this regard.

At the national level, the organizations relevant to the management of forests/trees including the selected trees mostly play an indirect role in this regard. The policy scale is provided for by the Federal Department of Forestry which sits under the Federal Ministry of Environment. Others like the Agricultural Development Project (ADPs) and National Fadama Scheme now have an umbrella under each of them that deals with agro-forestry matters. These institutions also

influence the forestry decisions and policies considered at the state level. The national land use act of 1978 has vested all lands in the powers of the state governor which has implications on tree governance in the state.

6.5.2 Strategies Implemented Since Colonial Times on Tree Sustainability

The British Colonial Administration since after the amalgamation of northern and southern protectorates of Nigeria in 1914 to form one single country had come up with some idea to conserve the vegetation. Akpan-Ebe (2017) maintained that the colonial administration created forest reserves in the country in the early 20th century and this was done in good faith to conserve the trees and also ensure their sustainable use. This strategy was maintained for a long time now and is still being practiced in Nigeria to maintain tree sustainability. Despite the importance of this strategy in conservation of forests in Nigeria, there are problems that emanate as a result of alienation of local communities in the process of conserving these forested areas. In recent times, the question of ownership of these forests whereby the government hold it in trust for the people and exclude them at the same time from the management of the forest reserves is the major problem in the conservation of these areas (Akpan-Ebe, 2017).

Another strategy known as the Great Green Wall for the Sahara and Sahel initiative was conceived by the African Union in 2011 and adopted by partner countries including Nigeria. This initiative implemented by Nigeria in 2013 seeks to erect a wall of trees across the Sahel to tackle desertification and land degradation. It supports the efforts of the local communities to improve their food security and livelihoods. One of the main objectives of the Great Green Wall

strategy is to serve as catalyst for rural development that could lead to the improvement of the living conditions of the affected communities in the Sahel Saharan Region of Africa (Annual Report of National Agency for Great Green Wall, 2014 p. 5). Part of the study area (Jibia Locality) is among the local governments selected for this project.

Despite the establishment of such organizations and agencies through which forests and woodlands are governed in the state, the forestry sector still struggles to stand firmly to implement and come up with sound rules, laws and policies to preserve forests and woodlands. Mohammed and Danjuma (2014 p. 250) emphasized that “various attempts have been made by successive administrations in Katsina to ensure the efficient management of her forest resources”. They went ahead however to state that bad governance accumulated over the years has made these programmes misplaced. To strengthen this point, Agea, Obua and Fungo (2009) argued that sustainable forest management in many countries suffers setbacks due to problems of uncertain government policies. Pursuance of colonial policies without meaningful reform and over centralization of forest administration are responsible for most of such problems. Colonial policies have been pursued in many countries in the world with little changes due to occasional occurrence of problems (Owino, 2009).

Ensuring the participation of a diversity of actors can improve the governance process towards sustainable forestry with its attendant consequences on people’s livelihood security. This calls for a more stake holder participation or collaborative forest management that will ensure partnerships between the rural communities in the area and the relevant government agencies. By so doing care must be taken to address areas of emerging conflicts between the different actors

involved. Ostrom (1990 p. 1) sums it up by asserting that, “What one can observe in the world, however, is that neither the state nor the market is uniformly successful in enabling individuals to sustain long-term, productive use of natural resource systems”.

6.5.3 Perceived Effectiveness of Strategies of State Institutions

Table 29 presents the percentage distribution of the effectiveness of strategies of state institutions according to households in the study area. It shows that among the respondents that believed in institutional role in trees governance and management, twenty three percent (23%) indicated that it was high while about thirty nine percent (39.2%) viewed it as moderate. Others still believe that it is low. This is important because, Woldeamanuel (2011) emphasized that effective institutions at different levels of government generate good forest resource governance.

Table 29: Perceived Effectiveness of Strategies of State Institutions

Effectiveness of Strategies of Institutions	Batsari		Jibia		Kurfi		Average Percent
	Freq	%	Freq	%	Freq	%	
High	9	18.4	2	25	13	25.5	23
Moderate	23	46.9	3	37.5	17	33.3	39.2
Low	17	34.7	3	37.5	20	39.2	37.1
No Idea	0	0	0	0	1	1.2	0.7
Total	49	100	8	100	51	100	100

Source: Field Work, 2012

This gives a rough measure of the efficiency or equity of state institutions on the management of trees and woodlands as perceived by the respondents. A point worth noting is that, the extent of institutional role in governing and managing trees leaves much to be desired and this has

implications on woodland preservation. Broekhoven *et al.* (2012) added that in view of the myriad and intricate problems facing the sustenance of forest areas, many countries do not have capacity to tackle them. FAO (2010) has also added that, a serious challenge facing sub-Saharan Africa countries is establishing and maintaining good practices. The respondents believed that the outcome of this is seen in the way more of the seedlings of other trees are being provided at the expense of the selected trees and this could have implications on the sustenance of their livelihoods.

6.6 Views of Local People on How to Increase Tree Population in Communities

Table 30 illustrates the local people's views on how government could increase tree populations in the study area. Almost fifty two percent (51.5%) of the respondents are of the view that provision of more seedlings of the tree species studied will increase their availability and also maintain local diversity. The Batsari community is topmost in this opinion with nearly sixty-four percent (63.8%) of the respondents saying so. Some of them believe that the existing trees will be better protected by strengthening existing bylaws. Others think that reducing poverty will make people lessen their over-reliance on these trees and hence preserve them. This opinion was expressed more in the Kurfi locality. Some of the respondents in Jibia gave more than one submission to this problem. Although the respondents have very little if any influence in governmental affairs, they could still play very important role if they are allowed to become partners in natural resource development because they have a stake and knowledge in sustaining the selected trees around them.

Table 30: Views of the Local Community on How to Increase Population of the Selected Trees in Communities

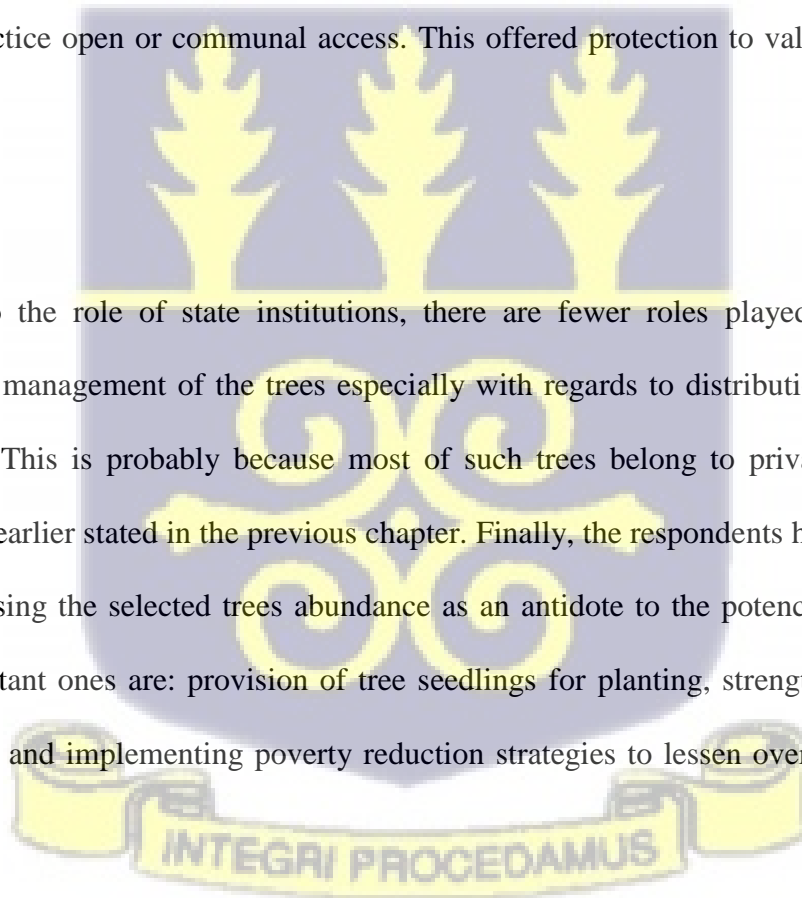
Local Peoples Views on How to Increase Number of Selected Tree Species	Batsari		Jibia		Kurfi		Average Percent
	Freq	%	Freq	%	Freq	%	
Provision of More Tree Seedlings	88	63.8	27	47.4	63	43.4	51.5
Strengthening Bylaws to Protect Trees	13	9.4	6	10.5	24	16.6	12.2
Provision of Alternative Energy to Ease Dependence on Trees	0	0	3	5.3	0	0	1.8
Increased Awareness Campaign on need to Protect Trees	8	5.8	3	5.3	5	3.4	4.8
Reduce Poverty to Lessen Reliance on Trees	7	5.1	3	5.3	14	9.7	6.7
Increased Involvement of Local People in Decision Making and Governance of Trees	0	0	0	0	10	6.9	2.3
Establishing Tree Nurseries in Every Community	5	3.6	1	1.8	10	6.9	4.1
Enact More Bylaws and Policies to Protect Trees	0	0	2	3.5	0	0	1.2
Provision of Employment to People	9	6.5	2	3.5	0	0	3.3
Intensifying Afforestation	0	0	0	0	14	9.7	3.2
Creating Forest Reserves	0	0	0	0	1	0.7	0.2
Provision of Credit Facilities	0	0	0	0	1	0.7	0.2
Multiple Recommendations	0	0	10	17.5	0	0	5.8
No Idea	8	5.8	0	0	3	2.0	2.6
Total	138	100	57	100	145	100	100.

Source: Field Work, 2012

6.7 Chapter Conclusion

Indigenous knowledge is widely critical in the management and conservation of the selected trees through the adoption of diverse local strategies. Such strategies include fencing, pruning of tree crowns, and creation of depression at roots and weeding in the order of decreasing importance. Traditional and indigenous knowledge related to biodiversity is central to elucidating its status and trends and for developing plausible scenarios based on community participation with regard to the way biodiversity is conserved and used (United Nations University, 2013 p. 5). Private access dominates tenure of the selected economic trees by smallholders particularly on *A. lieocarpus* and *P. biglobosa* trees. A negligible number of the respondents practice open or communal access. This offered protection to valuable tree species by cultivation.

With regards to the role of state institutions, there are fewer roles played by them in the governance and management of the trees especially with regards to distribution of the selected trees seedlings. This is probably because most of such trees belong to private control of the smallholders as earlier stated in the previous chapter. Finally, the respondents have come up with views on increasing the selected trees abundance as an antidote to the potency of such threats. The most important ones are: provision of tree seedlings for planting, strengthening bylaws to protect the trees and implementing poverty reduction strategies to lessen over-reliance on such trees.



CHAPTER SEVEN

SUMMARY OF KEY FINDINGS, CONCLUSION AND RECOMMENDATIONS

7.1 INTRODUCTION

The study assessed the role of trees in the livelihoods of rural households which also provides an institutional analysis of their governance and access patterns in the study area. The rest of this study conclusion presents a summary of the key study findings, conclusions and recommendations.

7.2 SUMMARY OF KEY FINDINGS

7.2.1 Spatial Distribution, Density, Girths and Availability of Trees

The study has shown that the most abundant and least abundant of the trees in the study area are *Anogeissus leiocarpus* and *Vitellaria paradoxa* respectively. The population structure of the trees consists of more moderate to mature stems particularly those of *Parkia biglobosa* and *Vitellaria paradoxa*. Saplings of these trees are few in the population thus depicting instability. The distribution of the trees is complex as many of them other than *Vitellaria paradoxa* and *Faidherbia albida* have a broad distribution over the land categories considered. Spatial distribution of the trees in the area is thus not uniform; it mainly depicts a clumped pattern. Cultivation has also provided protection to some valuable tree species in the area as opposed to uncultivated lands. Most of the tree species were also found to be disappearing while a few like *B. aegyptiaca* are actually increasing in abundance according to the perception of the local people.

7.2.2 Trees and Sustainable Livelihoods

The people are poor with low assets, very low level of education, which is the major source of human capital. The high level of vulnerability of the households is important in defining their relationship with trees. The trees contribute significantly in constructing the communities' livelihoods in the study area through their uses which is mainly edible, medicinal, fuelwood and local crafts thus indicating dependency of them on these trees. The sales of NTFPs are also found to contribute to livelihood diversification in the study area alongside other off-farm enterprises. This makes the people to protect the trees further because of this benefit.

7.2.3 Governance of Tree Resources

There is dynamism of local strategies of conservation and management of the trees in the study area as demonstrated by the smallholders' indigenous knowledge and capabilities in the rural communities. Major local strategies practiced in the study area range are fencing and pruning of tree crowns. It is worth noting that fencing to protect especially the younger trees is the most important practice among the communities in the study area.

Tenure arrangements of the selected trees in relation to their use values have shown that strategies of the trees acquisition increasingly focus on cultivated fields rather than common lands thus private access dominates tenure of the trees by smallholders in the area. An open access situation with regard to the selected tree rights does not exist significantly in the study area. The trees found in the cultivation systems have a secure tenure thus minimizing the risk of depletion over the time. Access right is very important in making the communities to achieve

livelihoods objectives from the trees. State institutional role in the management of the trees particularly with regards to the distribution of such seedlings in the study area has been modest. Furthermore, since there is a trend towards privatization of these trees in the study area, and government institutions could play little role in this respect.

7.3 CONCLUSION

The findings show that the population of selected trees found in the study area is unstable and their densities near the communities vary considerably. It also indicates that the smallholders derive so many benefits from the use of products from the selected trees that are found mostly under private ownership within the communities. These people use local knowledge in the management and conservation of the trees.

In view of the fact that the greater part of the people living in the study area and other drylands rely on their local environment to eke out a living, I argue that smallholders' traditional land management practices and indigenous knowledge must be given fair share in the management of these trees. The existing adaptive capacities of these people including knowledge of agrobiodiversity management, environmental change, and other opportunities that are more suitable to smallholder farming systems, must be protected and promoted to enhance their livelihoods.



Tree management requires concerted two-pronged approach. In the first instance, the local people or smallholders must be considered in the scheme of things as far as tree management is

concerned. Moreover, governmental institutions must be seen to put in place sound policies and other development initiatives in that regard. Foreign agencies and other development partners must also be included. It is a shared responsibility for both of these stake holders to come together for the betterment of tree management.

The thesis has contributed knowledge on the state of trees availability, their contribution to livelihoods and the role of local and state institutions in governance of the selected trees in the study area towards achieving sustainable rural livelihoods. These findings are also very crucial for better policy directions, research and development that could engender environmental-friendly tree management practices that are resilient and more sustainable.

7.4 RECOMMENDATIONS

The study proposes the following recommendations:

- The least frequent and denser selected tree species in the area that are in the IUCN red list of endangered species like *Vitellaria paradoxa* and *Khaya senegalensis* should be considered as high profile species and then inventoried and then given extra protection to prevent them from further depletion in the communities. This has become necessary so as to save the smallholders livelihood activities dependent on such trees from extinction. As part of conserving them, effort should be made to also increase their propagation. Careful implementation could increase their population and prevent them from further depletion.
- In view of the dominance of more mature stems of the selected trees in the area, there is the need by state government and other NGOs in collaboration with traditional

institutions to improve the selected tree seedlings distribution system to smallholders. This measure should be implemented to encourage planting of these trees. This could provide a more stable population of such trees in future as there would be younger trees to replace the more matured ones around the communities. Farmer managed regeneration could also be promoted by the smallholders to enhance vegetative regeneration.

- The state government should use the smallholders' indigenous knowledge and capabilities and work with them to improve on vegetation and afforestation interventions and other environmental management practices particularly for biodiversity conservation in the state. This measure is important because it integrates and engages the local communities in policy development and land management decisions. When this measure is implemented, the role of these communities in the state's development framework could be strengthened.
- Since private access dominates the tenure of the selected trees by smallholders in the area, more efforts should be made by the state government to make further tenure reforms in clarifying tree use rights particularly with regards to open and common access property. This is important as access rights underpin rural livelihood activities in the communities. Implementing this measure could change the tide and make these communities have more security of tenure especially in tree-based livelihoods portfolios.
- As most of the selected trees found on the cultivation fields were owned by the smallholders, efforts must be made by the state government or local institutions to promote tree protection and diversity on farmers plots.
- Trees on uncultivated lands should be protected and governed by instituting appropriate laws to encourage conservation of diversity of such trees. This is because these are the

lands under the direct control of the state. Increasing the diversity of trees in these lands could help the livelihoods of these rural communities.

- The state government should create more poverty reduction programmes for people to diversify livelihoods away from natural resource-based activities that use trees. This will complement the existing ones that are also provided by the federal government of Nigeria.



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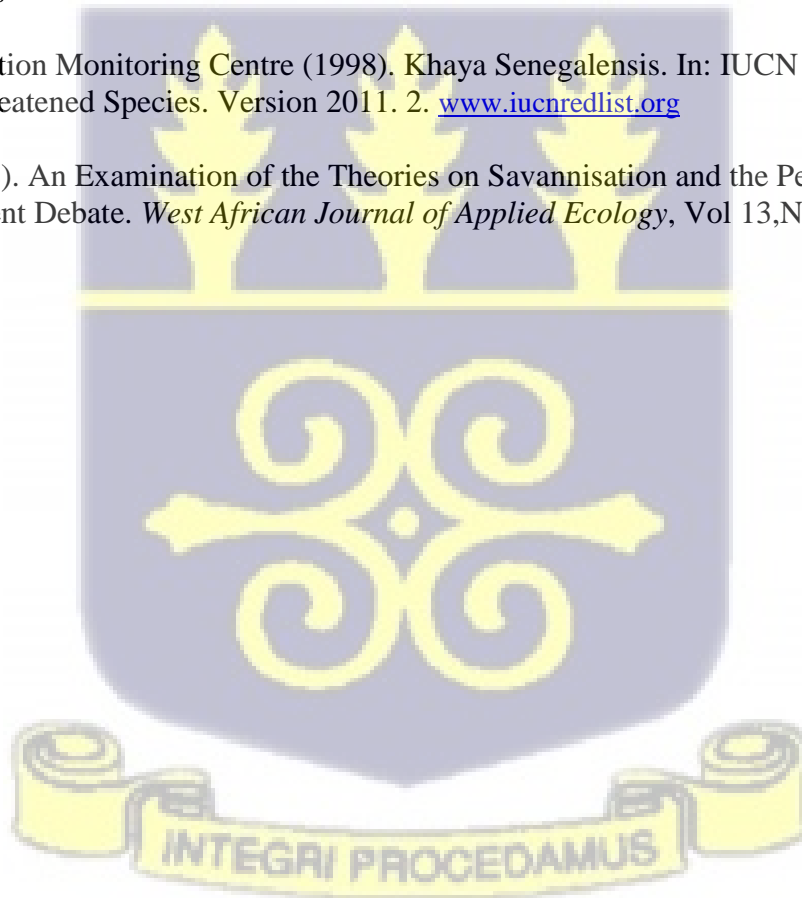
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APPENDIX 1

HOUSEHOLD HEAD QUESTIONNAIRE

Questionnaire number ----- Location -----

Date of interview ----- Sign -----

SECTION A: SOCIO-DEMOGRAPHIC CHARACTERISTICS

1. Age of household head -----

2. Sex of household head Male-headed ----- Female-headed -----

3. Marital status of household head Single ----- Married -----

4. Place of birth -----

5. How many people live in your household?

 Wife/Wives ----- Children ----- Brothers/Sisters ----- Others -----

6. What is your formal education status? Tick as appropriate

Education Status	Tick
Primary School	
Secondary School	
Tertiary Institution (specify type)	
Not attended Formal School	

7. Do you have membership with local community association? Tick as appropriate.

Membership Type	Tick
Affiliation in NGOs	
Trade Unions	
School Committees	
Government Organisation	
Politics	
Others (Please specify)	

No Membership at all	
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SECTION B: HOUSEHOLD ACCESS TO THE SELECTED TREES AND LIVELIHOOD ACTIVITIES.

8. What are your access rights to the selected trees? Tick as appropriate.

Selected Tree Species	Private Access	Open Access	Common Access
<i>Anogeissus leiocarpus</i> (Marke)			
<i>Balanites aegyptiaca</i> (Aduwa)			
<i>Faidherbia albida</i> (Gawo)			
<i>Khaya senegalensis</i> (Madachi)			
<i>Parkia biglobosa</i> (Dorowa)			
<i>Vitellaria paradoxa</i> (Kadanya)			

9. Do you encounter any restriction to the open access of the selected trees in the community?

Yes ----- No -----

10. If yes, list some of these restrictions.

11. What do you use the selected trees for? (Tick use from 1 to 9) and insert tree parts utilized from (A to I)



Selected Tree Species	1	2	3	4	5	6	7	8	9
<i>Anogeissus leiocarpus</i> (Marke)									
<i>Balanites aegyptiaca</i> (Aduwa)									
<i>Faidherbia albida</i> (Gawo)									
<i>Khaya senegalensis</i> (Madachi)									
<i>Parkia clappertonia</i> (Dorowa)									
<i>Vitellaria paradoxa</i> (Kadanya)									

Tree Uses-1=medicinal, 2=fuel wood, 3=edible fruit/seed, 4=craft, 5=housing poles, 6=fencing, 7=furniture, 8=cultural, 9=beverage. **Tree Parts Used**- A=bark, B=leaves, C=wood, D=fruit/seeds, E=roots, F=Flower, G=pods, H=latex, I=others (please specify).

SECTION C: HOUSEHOLD OWNERSHIP OF ASSETS AND INCOME SOURCES

12. Do you possess any of the following assets in your household? Tick as appropriate.

Asset Type	Number of Asset	Asset Type	Number of Asset
Cart		Bucket	
Sewing Machine		House	
Farmland		Radio	
Beehive		Television	
Livestock		Iron	
Poultry		Beds	
Video		Table	
Bicycle		Chair	
Motor cycle		Others (please specify)	

13. If you own land, what is the tenure arrangement to it? Tick as appropriate.

Tenure Category	Tick
Family Land	
Private Ownership	
Rent	
Common	
Others (please specify)	

14. Which are the household's major sources of cash income? Tick as appropriate?

Sources of Cash	Tick	Sources of Cash	Tick
Sale of Firewood		Sale of Food Crops	
Sale of Traditional Medicine		Sale of Cash Crops	
Sale of Fruits		Sale of Vegetables	
Sale of Timber/Poles		Wage Income	
Sale of Honey		Business Income	
Sales of Livestock		Sale of Crafts	
Sale of Wild Meat		Sale of Charcoal	
Sale of Poultry		Cash Remittances	
Sale of Fish		Other Cash earnings	

**SECTION D: HOUSEHOLD LOCAL KNOWLEDGE OF CONSERVING THE
SELECTED TREES.**

15. Do you locally conserve the selected trees?

Yes ----- No -----



16. How do you locally conserve the selected trees? List methods below.

<i>Anogeissus leiocarpus</i> (Marke)	<i>Balanites aegyptiaca</i> (Aduwa)	<i>Faidherbia albida</i> (Gawo)	<i>Khaya senegalensis</i> (Madachi)	<i>Parkia clappertonia</i> (Dorowa)	<i>Vitellaria paradoxa</i> (Kadanya)

17. How would you rate the success of the local methods of conserving the selected trees? Tick as appropriate.

Conservation success rating	Tick
Very successful	
Successful	
Unsuccessful	
No idea	

SECTION E: THREATS TO THE SELECTED TREES

18. Give an indication of the selected tree species vulnerability to overexploitation around the settlement. Tick as appropriate.

Selected Tree Species	Increasing	Common	Rare	Decreasing
<i>Anogeissus leiocarpus</i> (Marke)				
<i>Balanites aegyptiaca</i> (Aduwa)				
<i>Faidherbia albida</i> (Gawo)				
<i>Khaya senegalensis</i> (Madachi)				
<i>Parkia biglobosa</i> (Dorowa)				
<i>Vitellaria paradoxa</i> (Kadanya)				

19. Have you observed an increase or decrease in the availability of the selected trees over the past 10-20 years? Increase ----- Decrease-----

20. Are the trees in the communities undergoing threat? Tick as appropriate.

Yes ----- No -----

21. Which of the following do you consider as major threats to the selected trees around the community. Tick as appropriate.

Threat types	Tick	Threat types	Tick
Fuel wood gathering		Soil erosion	
Farming activities		Reduced rainfall	
Settlements		Plant diseases	
Deforestation		Population increase	
Livestock rearing		Climate change	
Constructions		Desertification	
Drought		Others (specify)	

22. To what extent are the threats affecting the number of selected trees around the community? Tick as appropriate.

Extent of threat	Tick
High	
Moderate	
Low	
No idea	

SECTION F: INSTITUTIONS, LOCAL AWARENESS AND PERCEPTIONS

23. Are governmental institutions involved in selected trees resource management in the area? Tick as appropriate.

Yes----- No-----

24. If yes, give example of categories of institutions/government agencies involved.

25. To what extent are these institutional policies/programmes successful in selected

trees resource management. Tick as appropriate.

Success Level	Tick
High	
Moderate	
Low	
No idea	

26. How would you recommend ways to the government to improve the selected trees availability in the communities?



APPENDIX 2

FOCUS GROUP DISCURSION CHECKLIST

WHAT IS THE USE OF THE SELECTED ECONOMIC TREES?

- List all the uses of the selected trees used by you and tree parts utilized (Tree use category table to be filled for each selected tree species in each focus group discussion).

HOW DOES THE SELECTED ECONOMIC TREES AVAILABILITY VARY LOCALLY?

- How do these selected trees vary locally from one place to another around the community?
- Are these selected trees undergoing decrease or increase?

WHAT IS THE LOCAL CONSERVATION STATUS OF THE SELECTED ECONOMIC TREES?

- How do you conserve the selected trees around the community?
- What do you think are the benefits of using local people's knowledge and management techniques to conserve the selected trees?
- Are there any problem or achievement you had while trying to manage and conserve the selected trees around the community?



APPENDIX 4

TREE INVENTORY FORM

Land Use Class ----- Location of Quadrat-----

Quadrat ID Number ----- Date of Inventory ----- Sign -----

S/N	TREE LOCAL NAME	TREE COMMON NAME	TREE SCIENTIFIC NAME	LATITUDE	LONGITUDE	GBH
Tree Density in Quadrat (converted into hectares)						
Total Number of Tree species in Quadrat						
	<i>1. Anogeissus leiocarpus</i> (Marke)					
	<i>2. Balanites aegyptiaca</i> (Aduwa)					
	<i>3. Faidherbia albida</i> (Gawo)					
	<i>4. Khaya senegalensis</i> (Madachi)					
	<i>5. Parkia biglobosa</i> (Dorowa)					
	<i>6. Vitellaria paradoxa</i> (Kadanya)					
Total Number of Trees in Quadrat						

APPENDIX 5

CHI-SQUARE ANALYSIS OF TREES FREQUENCY DISTRIBUTION

Frequencies

Anogeissus lieocarpus (African Birch)

	Observed N	Expected N	Residual
50	1	1.0	.0
75	1	1.0	.0
83.3	1	1.0	.0
Total	3		

Balanites aegyptiaca (Desert Date)

	Observed N	Expected N	Residual
25	1	1.0	.0
50	1	1.0	.0
83.3	1	1.0	.0
Total	3		

Faidherbia albida (Winter Thorn)

	Observed N	Expected N	Residual
8.3	1	1.0	.0
16.7	1	1.0	.0
27.8	1	1.0	.0
Total	3		

***Parkia biglobosa* (African Locust Bean)**

	Observed N	Expected N	Residual
11.1	1	1.0	.0
58.3	1	1.0	.0
75	1	1.0	.0
Total	3		

***Vitellaria paradoxa* (Shea Butter Tree)**

	Observed N	Expected N	Residual
0	1	1.0	.0
5.6	1	1.0	.0
33.3	1	1.0	.0
Total	3		

