TREE DENSITY AND DIVERSITY ON SMALLHOLDER FARMS IN KARAYE LOCAL GOVERNMENT KANO STATE

BY

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CERTIFICATION

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APPROVAL PAGE

This dissertation has been prepared in accordance with the regulations governing the preparation and presentation of thesis in the Department of Geography, and therefore had been read and approved by the supervisor as meeting the requirement for the award of M.Sc. Natural Resource Management and Climate change of Bayero University, Kano.

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EXTERNAL EXAMINER DATE

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DEDICATION

To my parents Late Alhaji Usman Ishaq Karaye and Malama Hafsast Mohammad Karaye.

To my guardians Wazirin Karaye Alhaji Musa Mohammad Karaye and Alhaji Umaru Karaye. To my children Hafsat, Aisha and Safiyya.

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ABSTRACT

Scattered trees in general are preserved in Agricultural landscapes in Karaye. A study on this trees species density and diversity on smallholder farms was conducted at Karaye Local government, Kano State with the objectives of assessing tree density and diversity in the study area. Examine the conservation status of trees in the study area, determine the drivers of tree density and diversity change in the study area, and lastly determine the local perception on observed density and diversity changes in the last 10years within the study area. The methodology used was as follows systematic random sampling was employed to sample the smallholder farms and point centred quarter method was used to count the trees, where point at certain intervals are fixed, the tree species are counted and the distance between the points are measured. Interview was employed to obtain responses on observed changes. Twenty nine tree species were found. The density of trees within the study area was found at an average of 2.54 trees per square metre. Fifty farms were studied. Different compositions of trees were identified it was found out that *Parkia biglobosa* is the most dominant tree species with 52 stands and relative frequency of 19.25%}, and the least number of trees species are *Ficus thonongii, Senna occidentalis and Manilkara multiversis* with 2 stands each and a relative frequency of 0.74% each. Furthermore local perception on observed changes on density and diversity of trees revealed that 70% of the respondents agree that number of trees on their farmlands have reduced in the last 10 years, due to cutting down for domestic use, logging for financial gains. 5% of the respondents believe that tree density changes as a result of climate change, while 10% of the respondents do not have any opinion with regards to changes in density of trees.

CHAPTER ONE

1.0 INTRODUCTION

All living organisms depend on vegetation resources directly or indirectly for their survival. Vegetation resources are essentially green and non green plants. Plants as major suppliers of food, fuel, timber, shade etc, need proper protection and management for sustainable environment in addition to human development (Tukur et al 2013). Natural diversity in the ecosystem provides essential economic benefit and serves the society with food, clothing, shelter, fuel and medicine as well as ecological, recreational, cultural and aesthetic values. These play important roles in sustainable development (Zakari, 2015).

Trees are an integral part of land resources that need careful management and sustainability for the use of future generations (Tukur *et al*., 2013). The density and variety of trees are major indicators of the availability of vegetation resources. Tree density is the number of trees per unit area, and it is generally reported as the number of trees per hectare, while tree diversity can be defined as the number of different trees and their relative frequency. Trees are of paramount importance to natural resource management, due to their considerable potential to contribute towards solving environmental problems. They contribute to Nitrogen fixation providing substitute or complementing for chemical fert**i**lizer, This increases small holder income, conserves foreign exchange and improves regional food security. Trees provide food, shelter, building materials, medicine, fodder for animals, fossil fuel, ornament etc. Trees are also essential to environmental balance as they regulate global warming by absorbing carbon dioxide (CO_2) which makes up 0.03% of the atmospheric gasses and releasing Oxygen gas (O_2) which makes up 21% of the total atmospheric gas and which animals use for respiration and is therefore essential to the existence of life. Trees also prevent or reduce

soil erosion and water pollution, When trees are over exploited the natural ecosystem breaks leading to environmental degradation such as wind and water erosion, siltation of the natural ways, desertification, and low discharge of reservoir and soil desiccation. (Tukur, 2010). In addition these are used as boundary markers, windbreaks as well as to provide beauty and shade which are difficult to quantify but are none the less of substantial importance to farm families and for natural resource protection. Another important role played by trees in the environment is the buffering effect it displays against changes in atmospheric conditions especially precipitation. It is an effective conserver of moisture, example *Faidherbia albida* which is the most important forage tree in the Sahel, has multipurpose uses, it is sometimes called "Miracle tree" of the Sahel Its litter is an effective conserver of moisture owing to its considerable control of run-.off, especially storm floods and its canopy offer protection against evaporation. It also redistributes nutrients drawing essential minerals from the subsoil and making them accessible through its leaf fall to other crops. In many countries tree litter is collected in large quantities for compositing and mulching in order to maintain soil fertility (Food and. Agricultural Organization., 2001). When trees are cut down and uprooted the soils within the area become liable to erosion. Trees are mainly cut down for fuel wood and land use. Necessities have made human being to over exploit trees and other resources. This has led to the global recognition of environmental degradation (International Union of Conservation of Natural resources, 1983). However, over one-tenth of the known trees species of the earth are considered to be under threat. (UNEP 1991). Furthermore it also states that deforestation may primarily lead to the extinction of between 5 and 15 of the world's indigenous tree species between 1990 and 2020. The rate of wood consumption

for cooking and for construction of furniture in Northern Nigeria is growing by the day (Malami *et al.,* 2011). The search for fuel wood which was once a simple chore has turned to a full day's labour. Women, children, as wells as men are forced to search further for fuel wood . Thus has undermined the health and well being of the households. There is a general lack of awareness among the population most directly concerned with keeping the woody plant on farms and developing it. The most useful step that can be taken is first of all to protect existing vegetation (trees). This research assesses tree density which is the number of trees per unit area on small holder farms of not more than two and a half hectares within the study area, and tree diversity which is to identify the types of trees found, It aim to highlight current practices of cultivating trees and agricultural crops in intimate combination with one another, which is an ancient practice that farmers have used throughout the world (Ammonun *et al.,* 2009). The system tends to reduce risk increase total productivity, and minimize the risk of total crop failure by growing a variety of crops on the same piece of land. It also highlights the advantage of the system over monoculture This approach can help focus the research process, rather than requiring that, the researcher predicts, which of hundreds of possible tree species and dozens of technologies deserve development and dissemination under different farm conditions and different landscape niches. Farm assessment may highlight the suitability of crops by a farmer (E.g. fuel wood or tree crop) or growth characteristics of a tree that make it suitable or unsuitable for a particular farm, a farmer may like or dislike. E.g. interference with crop production or provision of a boundary marking or socioeconomic, constraint that inhibits the use of a practice. Trees are part of the solution, and therefore the farmers are face with multiple solutions through the integration of crops and trees for multiple benefits in line with choice and suitability, In other words a farmer chooses

trees to be part of his farm output or serve a certain purpose . Farm assessment is very important, since tree products often have multiple uses, new practices frequently involve significant management changes for the farmers and the technology testing period is long. `Furthermore the concept of interaction of actors made possible through the on farm research process itself can strengthen on-farm research among researchers, extension farmers and community groups that would be, unlikely to occur, otherwise particularly when these belong to different social groups. The communication channels opened up through on-farm research which may make possible continued dialogue between groups even after projects are completed. This makes farm assessment a veritable tool for understanding the multiple advantages of growing tree crops on farms

1.1 RESEARCH PROBLEM

Several studies have identified the utility of trees in increasing the overall farm productivity (Rain tree, 1998), fuel wood and construction materials (Amin 2012) erosion control and soil conservation (Amin 2012); socio-economic improvement of rural communities (Ajake, 2008) among others .While forests are still being severely degraded, the number of trees on farms is increasing (Food and Agricultural Organization, 2002) and interestingly, there are many examples where the rise in on-farm tree numbers occurs in areas where population densities are high and farm size is very small. While the adoption of bush-fallow systems, which had hitherto been used to rejuvenate the soil, may no longer be feasible with intensification of food production and the rate of population growth;. The success of cropping on farms largely depends on the use of trees as a fertility contributor since fallow system is less feasible. It has been observed that, the vegetation of Northern Nigeria, which encompasses the study area is

made up of Savanna, which comprises grassland with scattered trees and bushes covering an extensive area (Iguda 2014). The importance of scattered trees on farms cannot be over emphasized; they promote biodiversity, produce oxygen, enrich the soil with humus through the leaf litter and combat greenhouse effect through carbon sequestration. Tree helps conserve energy with their shading and their evapotranspiration effect. They also improve air quality by absorbing polluting gasses and odour together with filtering air particles.

In a study on tree composition and diversity in Oban forest reserve, (Igbinosa et al 2015) used data on tree parameters which include diameter at breast height (DBH),diameters over bark at the base, middle and top mercantile height and total height ,A total of 808 trees were measured base on height and diameter at breast height and 72 species were identified in the study area. The result also portrays that the relative richness of the forest reserve in terms of individual tree species does not correlate well, with the abundance because the abundance of each of the specie was quite low and density poor. Furthermore, (Ajibola et al 2013) studies on Tree species diversity and structure of a Nigerian strict nature reserve investigated Tree species diversity and divide the area into four rectangular plots of 100m by 100m (1ha.), Iidentification and measurement of tree parameters were carried out which include diameter at breast height (DBH) diameters over bark at the base, middle and mercantile top of all trees in the plots. They found 387 tree stems per hectare belonging to 94 tropical hardwood species. The most abundant species and family found were *Celtis zenkeri* of Ulmaceae family which was 41 tree stems altogether. However this research did not obtain the local perception of the populace on the major drivers of changes in tree density and diversity. Also in an analysis of agro forestry practices in Katsina state. Marius (2010), stressed that one of

the greatest challenges facing Nigerians in general and the inhabitants of the Sudano-sahellian regions in particular is that of deforestation or vegetation loss. However these problems exist at all levels on farms, forests and domestic surroundings. The study concluded that the predominant trees found on farms or croplands are multipurpose trees that produce fruits and are used for domestic purposes such as *Parkia biglobosa* .However the study did not attempt to quantify tree density per unit area, neither did it propose to determine the local perception on the observed drivers of density and diversity changes. Also Karthikeyan (2015)conducted a quantitative tree survey investigate tree density, tree specie richness and diversity on a one hectare (100 m by 100m) square plot in India. The result portrayed a density of 517 trees found within a hectare in the study area, Furthermore of the trees found Longanicea family had the largest number of individual, and Also *Azadirachta indica* had the largest share in forest stand and basal area of 8.63 sq m per hectare, while the computed diversity index H was 2.83 and the equitability index was 0.87 which altogether indicate that the study area was moderately diverse. Tijjani (2015) stressed that the diversity of tree dominance and their frequency are very critical elements in improving land productivity in farming ecosystems. Monitoring of biodiversity which entails periodic assessment of occurrence (disturbance) of subset of a plant in sample localities had for long been reorganized as a significant scientific challenge. This research utilised both primary and secondary data available to look at the tree density cover and diversity on smallholder farms through both quantitative and local perception approach to view the drivers of density and diversity changes in the study area.

1.2 RESEARCH QUESTIONS

- What is the density and diversity of on-farm tree species in the study area?
- What is the conservation status of tree species in the study area?
- What are the drivers of tree density and diversity change in the study area?
- What are the local perception of the observed changes in density and diversity of trees in the study?

1.3 AIM AND OBJECTIVES

Aim

The aim of this study is to assess tree density and diversity of smallholder farms in Karaye Local government Kano State with a view to provide recommendations to farmers concerned.

Objectives

Objectives for the study are to:

1. Assess tree density and diversity in the study area.
2. To examine the conservation status of trees in the study area,
3. To determine the drivers of tree density and diversity change in the study area.
4. To determine the local perception on observed density and diversity changes in the study area.

1.4 THE STUDY AREA

1.4.1 GEOGRAPHICAL LOCATION AND EXTENT

The study area Karaye Local government is positioned at the south western part of Kano state.. It is located between latitudes $11^0\,37^0$N and $11^0\,45^0$N and longitudes $7^0 51^0$E and $8^0\,10^1$E with an area of about 341sq km bordering Katsina State to the southeast, Rogo local government to the south and Kabo to the Northwest (Figure1) Abubakar (2010). The local government has an estimated population of 153,828 people (Kano state government 2015), Karaye main town is surrounded by wall known as {Ganuwa) .Challawa Goje dam one of the most important dams in northern Nigeria, is situated at Karaye local government.

1.4.2 GEOLOGY AND RELIEF

The geology of Karaye Local Government is mainly the pre-Cambrian rock of the basement complex, which comprises of gneisis, amphibolites, marbles and the older granites (Musapha *et al.,* 2014). The geological structure influences the relief as well as landforms, which are relatively flat, with some undulation around the challawa gorge dam. The relief of Karaye is of the western high plain, these high plains are areas of low relief, usually less than 20m and areas of grouped hills, where the hill may rise higher than 10m above the plains.

1.4.3 CLIMATE

The climate of the area is a hot sub humid tropical climate, coded Aw by Koppen. Rainfall is the most critical element (Olofin et al 2002) with a mean annual rainfall of

800 to 1000mm (Olofin, 2002). The temperature in the region is generally high throughout the year, with mean monthly temperature 24.9°C (Olofin, 2002). The mean monthly rainfall attains it highest value (273.85mm) in August and drops rapidly to its lowest 24.85mm in October. Four seasons are identified as follows

Damina (wet season) This began from July to September and few days of October, The month with the highest rainfall is August.

Kaka (Harvesting season) , This began from late September or early /October

Bazara (Dry season), this begin from the months of March and ends in the month of July It is characterised by high temperatures.

Rani This began from the Month of November and ends in the month of March , it is characterized by diurnal temperature changes ,dust and poor visibility.

1.4.4 DRAINAGE AND HYDROLOGY

The drainage and hydrology of the area is part of the drainage system, as the zone of high surface water discharge and retention which is largely basement complex structure as stated earlier. The climate of the region controls the amount of water that is available both on the surface and at subsurface at any given time within a water year (Olofin, 1984; Mustapha *et al.,* 2014).

The hydrogeology of the region is to a large extent controlled by geologic settings, climatic condition and human activities. The surface situation, which is directly governed by the underlying geology, has its infiltration, evaporation, run off and other flow components as the major factors responsible for the groundwater, recharge and

development in the regional hydrologic environment Mustapha *et al.,* 2014). Karaye local government has 2 major dams, which include ;

1. Challawa gorge dam
2. Kusalla dam

1 Challawa Gorge Dam

The Challawa –gorge dam is located in Karaye Local government Area of Kano state,

1. It is about 90km southwest of Kano city with a catchment size of about 3,860km^2. The dam was built on Challawa river in Challawa village a tributary of the Kano river. ,which is the tributary of Hadeja river in the Sudan Savannah ecological zone of Kano state (EAO/NSPES 2005, Daya *et al.,* 2015).

2. KUSALLA DAM

Kusalla dam is located in Kusalla village latitude 10^0 2N and 11^0 0 N and longitude between 11^0 42E and 12^0 42 E. The dam was impounded in 1969 and commissioned in 1970 it has two major River kunkun and River Makugara, It covers about 200 hectares of land with about 17.3 million cubic metres water capacity.

1.4.5 SOILS AND VEGETATION

Karaye Soil being within the zone of basement complex is being influenced by topography and wind drift materials from the desert, which is what shapes the aggregate of the soil structure within the Kano region (Olofin, 1987). The lower and the upper course have distinct characteristics. The lower course contains more of loamy sand, than heavy or light loamy soils.

1.4.6 AGRICULTURE

The study area is one of the most important agriculture sites in Kano state, which produces food and cash crop such as sorghum rice, millet, groundnut and wheat.

1.4.7 THE PEOPLE AND ECONOMY

Karaye is inhabited predominantly by Hausa, Fulani, and a minor intrusion of Kanuri. There is also the presence of Igbo, Yoruba and other tribes in a small portion of the area. However the major language spoken is Hausa. In terms of religion, the inhabitants are predominantly Muslims with a small minority of Christians and traditionalists.

The richest socio-cultural structure of the people is Durbah conducted by the Emir of Karaye . The durbar is celebrated twice a year .The Emir and his Council which include Wazirin Karaye , Galadima ,and other title holders gather in Karaye to mount on horses displaying the rich cultural heritage of the domain, other cultural displays include Fulani cultural dance, horse race, praise singing and marriage celebrations

A large expanse of fertile soil near the Challawa gorge dam support a high rate of, of production of vegetables in the area which is being transported and sold in the western part of the country. These have earned the youth around Challawa gorge dam, a high income. Crops and economic trees that are found in the area are planted in farms and most household compounds such as mango, guava, and pawpaw. The plant species covering the area are put a variety of uses, such as medicinal, grazing, fuel and energy. In addition, the Fulani's rear a variety of animals such as sheep, goats, guinea fowl, chicken and cattle for domestic consumption and commercial purposes, The settlement pattern in Karaye is a mixed form, comprising both dispersed and nucleated respectively.

The former is largely found in the suburb, while the latter is more active within Karaye town. There are three major roads linking Karaye to other towns which includes'

1. Gwarzo ---- Karaye road
2. Karaye ----- Rogo
3. Karaye ----- Kiru to Zaria

While the fourth is under construction linking Karaye to Kabo to Kano town

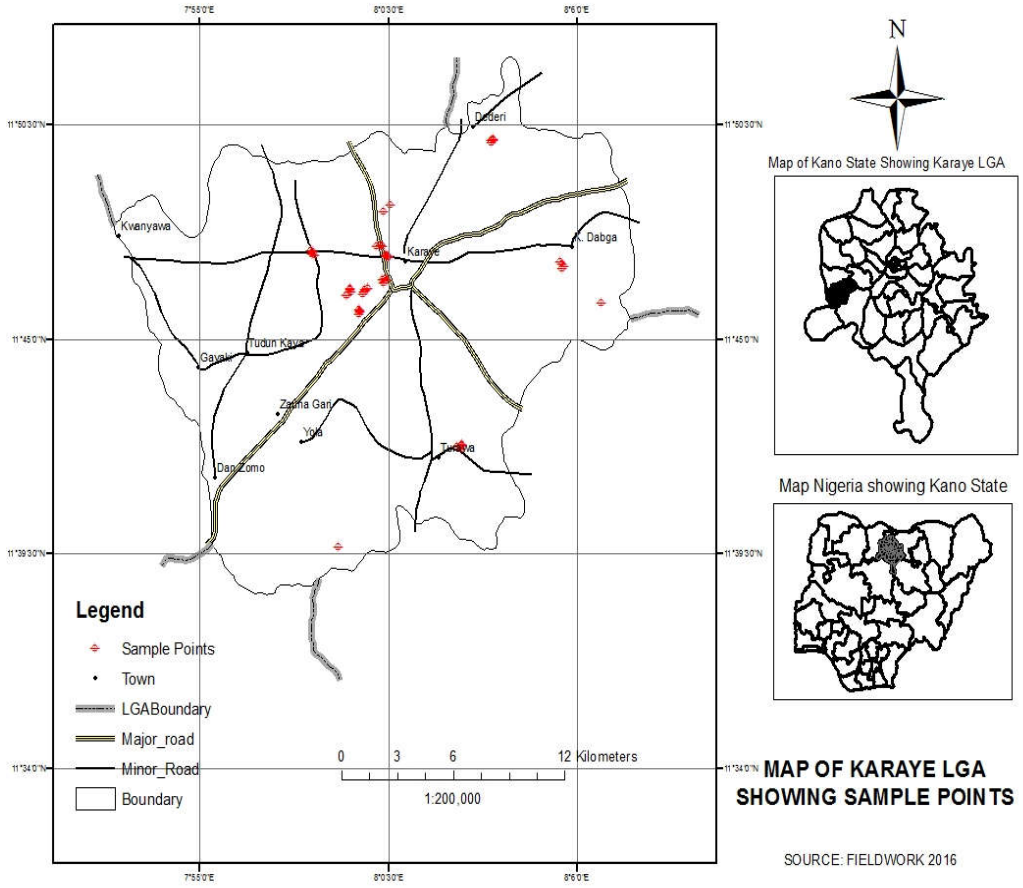

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Fig 1: Map of Karaye Local Government showing sample points

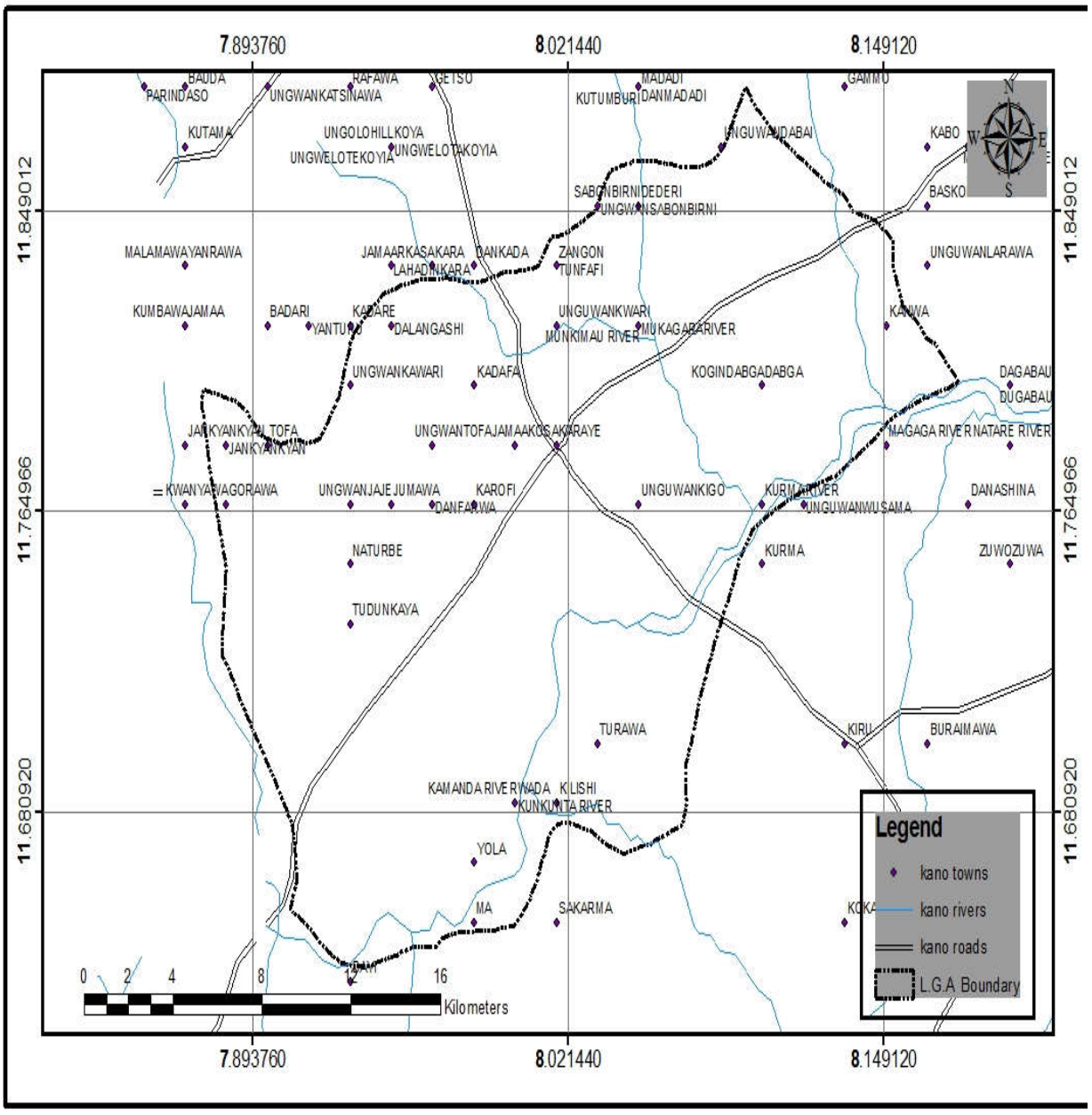

Fig 2: Map of KarayeLocal Government, Kano state

CHAPTER TWO

LITERATURE REVIEW

Increasing frequency of cultivating without technological change may be expected to result to a downward trend in bio-productivity and soil fertility.(Mortimor1995) However, smallholder agriculture faces many challenges including low productivity, high dependence on rainfall, insecurity of the traditional land tenure system and environmental degradation due to unsustainable agricultural practices. As a result of these challenges, smallholder agriculture remains at low productivity. and This has led to high incidence of poverty among rural smallholder farmers (Opio, 2011). In Nigeria agro forestry technologies have been trailed at research stations since 1980, and also on farms since 1984 in collaboration with farmers((Franzel et al. 2002). Inorganic fertilizer is a quick method for replenishing nutrients and other trace elements; however, it is too expensive for most of the rural farmer's. Therefore agro forestry technologies offer an alternative solution to resources constraints. Smallholder farmers, who in the absence of inorganic fertilizers would otherwise grow crops without addressing nutrient requirements and harvest little or nothing for storage (Jamala et al.,2013). (Raintree *et al.,* 1992) pointed out that Agro forestry is a collective name for land use systems and technologies where woody perennials, (tree, shrubs, palms, bamboos etc) are deliberately used on the same land management units as agricultural crops. The most important single factor affecting run-off and erosion is vegetative cover, including trees which provide most effective protection. The canopy of the trees and shrubs together with herbaceous ground cover break the impact of rainfall. The tree litter also reduces raindrop impact, improves soil structure by adding organic matter as it decomposes,

impedes water movement and acts as a filter through which water is slowly transmitted to the soil.

Nair (1993) pointed out that the presence of woody perennials in agro forestry systems may affect several bio physical and bio-chemical processes that determine the health of the soil substrates. The impacts of trees on soil include amelioration of erosion, primarily through surface litter cover and understory vegetation maintenance or increase of organic matter and diversity through continuous degeneration of roots and decomposition of litter, nitrogen fixation, enhancement of physical properties such as soil structure, porosity and moisture retention due to the extensive root system and the canopy cover and enhanced efficiency of nutrient use because the tree-root system can intercept, absorb and recycle nutrients in the soil that would otherwise be lost through leaching (Sanchez, 1987).(Mortimore *et al* 1990)) analyzed soil samples in Tumbau to view changes of soil nutrients and fertility over time and they concluded that maintenance of soil fertility was a prime objective of small holder management and that the farming system of the Kano close settled zone from the evidence of their study was sustainable in the short and medium term (30 years). However, the long term maintenance can also be achieved through planting of trees on crop farmlands.

Bangrawa *et al* (1992) also pointed out that the choice of tree species is the most important factor to be considered in agro forestry practices. Trees such as Baobab (*Adansonia digitata*) are thoroughly widely grown throughout Sub Saharan Africa. Its exceptionally nutritious fruit has the potential to play an important role in family nutrition and food security in marginalized rural communities. The fruit pulp is of high nutritional value, especially regarding Calcium and Vitamin C (Stadlymanr *et al*., 2013).

Other edible parts of the baobab such as the leaves, young roots and oil from the seeds also provide valuable nutrients and are eaten regularly. In addition, baobab parts are processed by local communities into diverse products such as juice, sweets and snacks (Gebauer *et al*., 2014). It also provides a variety of medicines, bark for making ropes and baskets, and materials for tools and handicrafts (Wickens *et al.,* 2008). On the other hand Foronglbackhch,(1992) stated that the choice of tree species be made after careful consideration of their adaptability for growth and benefit for rural populace. In another study Tully *et al* (1973) found that leguminous species such as *Faidherbia albida* "the forage tree of the Savanna" cause a considerable improvement on crop yields. The farm preference of forest trees would definitely be due to the potentials and adaptability to the land area.

In Nigeria, natural fallows have been a common practice among small holder farmers for restoring soil fertility. However, with rapid population increase and land use pressure these fallows have been reduced to below the minimum threshold required for the system to sustain itself. Reversat (1995) pointed out that poor soils are usually devoted to a forestation which is assumed to enhanced their fertility. Trees improve soil organic matter status and increase soil nutrient content either by nutrient absorption in the deep layers of soil and release in litter fall, or by increasing the retention of nutrient input in relation to increased exchange capacity (Kellman 1979). Traditionally small holder farmers in West Africa have improved soil fertility through fallowing of land, or the use of manure and small amounts of fertilizer. However, it is feared that these methods may not be sufficient to maintain soil fertility in the light of recent population increase as pointed out by (Harris 1998). Agro forestry practices particularly planting trees on farm

plant maintain and increase the soil fertility. In fact agro forestry practice offers an alternative solution to resource – constrained small holder farmers, who in the absence

of inorganic fertilizers would otherwise grow crops without addressing nutrient requirements and harvest little or nothing for storage (Jamala *et al*., 2013). In a separate studies conducted by (Peterson et al 1999, Kwesiga et al 2003) found that lack of planting materials (seed and seedlings) is another factor that constrains establishment of agro forestry, (Gledwin et al 2002 , Keil et al 2005) established that the probability of adoption increases, when farmers perceive low soil fertility as their current problem. In most cases however, even when low crop productivity is observed, farmers have been known to continue cultivating same plots. Alternatives such as agro forestry that allow intensive management of already cultivated areas for resource poor farmers offer best solution. Tree regeneration processes can be influenced by various environmental factors, such as soil moisture, temperature, micro scale disturbance, canopy cover, wind direction and speed as well as slope gradients (Yanamoto, 2000, Ceccan et al ,2006, Viera et al, 2006). Biotic factors, such as herb ivory and intra/inter-specific competition for water nutrient and space can also influence seedling or tree dynamics (Nagamatsi et al 2001, Picard and et al 2002, Denbele et al, 2006).

Studies conducted by (Mousa, et al,2000, Mortimore, 2001) re-stated that though natural woodland is becoming scarce, tree densities are now rising on farms. They further state that farmers actively manage the selective preservation of trees and the harvest of branches on fields. The trend now is to preserve more shoots until they are matured to full tree (Mousa, 2000). Although in many area in West Africa forest ecosystems especially trees are subject to common disturbances (e.g agricultural clearing, wood

extraction and grazing) which are exacerbated by human population growth (Artwell et al, 2000. Weld et al, 2006, Morton 2007), Annual rate of deforestation is still on the increase due to high demand or huge demand for source of fuel wood around Kano Metropolis (Usman, 2013). Rural communities generally use more fuel wood than any other forest products (Mortimore, 1967) The strong dependence of rural households on forests for cropland, grazing and fuel wood together with demands from cities for wood energy is exacerbating pressure on the forests(Pere, 2008) . Also a separate study by a team in Bayero University concluded that 'two principal processes effecting change in woodland are the extension of the cultivated area and wood cutting for fuel and construction through increasing aridity (Mortimore *et al,* 2000), many multipurpose trees are well known and others are being identified for their potential use as fuel wood. Trees such as *Laucearina leucocephala* which is frequently grown in lines associated with food crops provide fuel wood from its branches (ICRAF 2000). Also a wood tree *Prosopis africana* (kirya) provide the most valued wood from its trunk and branches in some parts of the country.

2.1 THE USE OF FUEL WOOD, AS AN ALTERNATIVE FOR DOMESTIC ENERGY

Between 1962 and the early 1980s the urban population of Kano increased from a quarter of a million to about a million, according to unofficial estimates. The increasing population has led a number of observers to predict the elimination of trees, in time, from the Kano Close-Settled Zone, the immediate hinterland of Metropolitan Kano. Indeed (Eckholm et al. 1984, p. 28) state that "over the last 25 years commercial wood demands have led to severe deforestation and the collapse of a sustainable agricultural

system, now farmlands within a 40 km radius of the city (of Kano) have been largely stripped of trees".

Smallholders who live in the tropical dry lands are unable to escape from the impacts of fundamental properties of their ecosystems, they are dry, and their rainfall is unreliable (Mortimore *et al.,* 2000). The easy accessibility of fuel wood in the environment makes it prone to extraction. However, sustainable management of natural resources, trees inclusive, is a condition for enhancing incomes based on primary production in view of the land, and bio – productive resources are becoming or have long been scarce. Various food production systems have been adopted by farmers in the sub-Saharan Savannah to produce crops (Odion *et al.,* 2007). Mixing crops and trees on farms is one such a system. The system of smallholder can be extensive i.e. with the adoption of very little improved production practices and maintenance of soil fertility with bush fallow or it can also be intensive i.e with adoption of improved technologies such as seeds or seedlings for trees, fertilizers, pesticides as well as seed dressing chemicals. Trees, shrubs and specially crops have historically played a vital role in dry land agriculture in developing countries (Hulse 1996, Von Maydell, 1990). Trees are preserved on farms because they are valued for goods and services, such as fuel wood, construction material, fodder, medicines, cosmetics, enhancing soil fertility and shade (Leakey, 2001). In the dry land of West Asia, and North Africa trees have long been domesticated and orchards (e.g. olive, citrus pistachio) are ubiquitous, sheep and goats are grazed between trees. Trees are highly regarded by African farmers as well. Tree density increased in the surrounding of Kano from 1972 to 1985 as farmers protected and planted trees to meet the demands of the growing fuel wood market (Cline-Cole *et al* 1988, Winslow *et al.,*

2004). Valuable trees species can be domesticated through farmer participatory selection for desirable traits used as fuel wood (Leakey 2003, Mulas *et al.,* 1999, Winslow et al., 2004). Some examples of dry land trees and shrubs valued by farmers and holding potential for increasing application are from the genera *Acacia* (wattle, gum Arabic ana tree), *Azadirachita* (Neem), *Boscia ceratonia* (carob tree, lust beean *cyanops* (cluster beean) *Eucalyptus,* herbiscus (Roselle bisap). *Mangipera (*Mango) , Moringa *Olea,* (olive), *Parkia* (locus bean), *Pistacia* (pistachio), Phoemix (date palm) Scleroccarya (M*anulla)*, Tamarindus (*tamarind)* vtella (shea butter), Warburgia (Pepperbark tree and Ziziphus (apple of the Sahel). (Winslow *et al.,* 2004). The domestication of the above trees are by far of paramount importance within the dry lands, However, coupled with the need for energy, the demand for fuel wood has been on steady increased by the increasing population and rapid urbanization despite the existing felling of trees (control Edict) in various states of the Federation.

2.12 TREE SPECIES DOMINANCE

Tree species dominance is simply an expression of the space trees occupy in given area. It is also seen as the degree to which a tree is more numerous than its competitors .For example in a study on vegetation composition and conservation of north-western dry lands Danjuma (2016) portray the dominance of *Caesalpiniaceae* and *Minosaceae* families in the study area. Also another study on the assessment of tree density and diversity on smallholder farmed parkland Agro forestry systems in Daura, (Saminu 2011) identified 52 species of *Vitex doniana* along 7 transects in all, *Vitex doniana* is the dominant species in the study, Furthermore in a study on density, species' richness and diversity of trees in a sacred grove tropical dry deciduous forest Dhamapuri district in

India ,(Karthikeyan2015) recorded 517 trees and also identified *Strychnos nux-vomica* as the most represented tree species with almost 70 stands.

2.2 SPECIES DIVERSITY

Species diversity can be explained in terms of the differences between species, ranging from common annual herbs, trees, to bacteria of deep ocean trenches and their arrangement into classifications reflecting their ancestral relationships and Smallholders who live in the tropical dry lands are unable to escape from the impacts of fundamental Properties of their ecosystems, they are dry, and their rainfall is unreliable (Mortimore et al, 2000). Trees on farms can result from three processes: (A) retention of trees that were present before farms were established, (B) tolerance (and protection) of natural tree regeneration after farms were established, or (C) active planting by farmers of selected trees in preferred locations. Many agricultural landscapes include trees derived from more than one of these processes. Trees are any woody perennial growing in agro forestry land use systems, or forest remnants. Typically after an initial period of deforestation, trees on farms are remnants of previous vegetation, followed by a gradual loss of trees and , ultimately leading up to a phase of deliberate tree establishment by farmers The set of trees that ends up being present on farms depends greatly on the interaction of ecological and social-economic-cultural processes. Tree diversity in terms of species and functions on farms, gives way explore potential implications of changes in tree diversity for biodiversity conservation, provision of ecosystem services and human livelihoods. Mixing crops and trees on farms is one of such a system. The system of smallholder can be extensive i.e. with the adoption of very little improved production practices and maintenance of soil fertility with bush fallow or it can also be intensive i.e.

with adoption of improved technologies such as a seeds or seedlings for trees, fertilizers, pesticides as well as seed dressing chemicals.. The natural environment in the savanna ecosystem is characterized by a combination of trees and grasses in different proportions. Farmers in the West African savannas maintain valuable trees, which also resist periodical fires in and around their fields giving rise to distinct park like landscape (ICRAF,2000). Scattered trees on farmland/pasture and bush fallowing are the common traditional agro forestry practices in the savanna ecosystem of Nigeria (Usman et al, 2010). Traditionally farmers grow crops under scattered trees of different species and incorporate animal production with no special technique, species type or density per unit area .Farmers can also increase tree diversity using anthropogenic sources of indigenous or exotic planting material (planted or grafted), which are usually produced in on-farm or off-farm tree nurseries At this point, the gene pool from which on-farm trees are derived depends on the characteristics of tree seed and seedling markets and supply systems, and/or social net- works in which tree is passed on. Some examples of dry land trees and shrubs valued by farmers and holding potential for increasing application are from the genera *Acacia* (Wattle, gum Arabic ana tree), *Azadirachita* (neem), *Bosciaceratonia* (Carob tree, locust bean *cyanops (cluster bean) Eucalyptus,* Hisbiscus (Roselle bisap). *Mangifer*a (mango), *Moringa*, *Olea* (olive), Parkia (locus bean), Pistacia (pistachio), Phoemix (date palm) Scleroccarya (manulla), *Tamarindu*s (tamarind) *vtellaria* (Shea butter), *Warburgia* (pepperbark tree and *Ziziphus (*apple of the Sahel). Winslow *et al.,(* 2004). The domestication of the above trees are by far of paramount importance within the dry lands, However, coupled with the need for energy, the demand for fuel wood has been on steady increase by the increasing population and rapid urbanization despite the

existing felling of trees (control Edict) in various states of the federation., as a result of the demand for fuel wood.

2.2 DENSITY AND DIVERSITY IN THE DRYLANDS

Knowing and understanding the ecology of trees on farmlands is essential for formulating important strategies for trees conservation and management. Protection of trees on farms from further damage and extension of tree area through sustainable management, are important tasks because only the trees can provide sources of environmental and social services, Such services are to a larger extent derived from Forests reserves. Forest reserves are areas of forest designated by the government for the protection of trees growing or planted for the purpose of their ecological benefits among others (Usman et al 2010). However due to rapid urbanization forests reserves are gradually being taken away by farmers into nearby farms. Therefore trees are also endangered. The need to quantify and protect tree species from wearing away of the forest reserve is a task that must be done. This research therefore intends to investigate tree density and diversity on farmlands in Karaye with the view to determine the density and diversity of trees on farmlands. (Egodawatta *et al* 2014) compares the types and density of tree species in home gardens of inherited and settled lands in close proximity of Anuradhapura city, Sri Lanka. Mean harvestable tree density was 54.5 trees/ac in inherited lands compared to 40.3 trees/ac in settled lands. Certain tree species are more abundant in one than the other. Exotic timber tree flora represented approximately 30% of total tree population in settled compared to 16% on inherited lands. Ahmad (2002) carried out tree species diversity and soil status of Kogo Forest Reserve and determine tree species composition, richness and evenness, relative density through the process of

point cantered quarter method and found out a total of 249 tree stands belonging to 29 different tree species distributed within 25 genera and into 16 families. Family *Caesalpiniaceae* had the highest number of six species in five genera, followed by *Mimosaceae* with four species belonging to four different genera. (Rad et al. 2009) compared plant species diversity with different plant communities in deciduous forests north of Tehran, where they established 152 sample plots. From these plots, 104 species were recorded in different layers including 12 trees, 9 shrubs and 83 herbs. Yusuf (2013) carried out a study on vegetation change in Bebeji Local Government of Kano State using multi-date Spot 4 imageries of 1998, 2003, 2008, 2011 and 2012. The result indicated that there are about four vegetation cover types in the area with 72 different species inventoried. Causes of the change were fuel wood extraction, cultivation and overgrazing are the main drivers in the area.

2.3 EXCESS FUEL WOOD EXTRACTION PATHWAY TO DEGREDATION IN THE DRYLANDS

The risk of drought and consequent crop failures along with financial constraints discourage the poor or the smallholder's from investing in their lands (fertilizer, organic matter, fallows etc,). Without inputs the soils are mined' of their native fertility and protective cover (e.g trees being removed for firewood). As those lands become non productive, the poor expand onto additional, often more marginal lauds in order to meet basic needs, impoverishing those soils as well. In this way they are relentlessly mine until the soil resource is exhausted. (Buresh *et al.,* 1997, Batino *et al.,* 1998: Cleaver and Schierber 1994: Eswaran *et al*., 2001; Gruhn *et al.,* 2000; Matlon 1987; Sanchez *et al*., 1997; sander 1996, Stooevogel and Smaling 1990; Vander Pol 1992; World Bank

FAO1996; Winslow *et al.,* 2004). Also (Batino et a1999) considered land degradation as a threat to the basis of many farming communities and their livelihood. In this respect a holistic approach is needed to arrest such threat to a sustainable form through space and time

2.4 PLANTING OF TREES ENHANCE SOIL FERTILITY IN THE DRYLANDS

Low soil fertility is common in the dry land (Winslow *et al.,* 2004) Dry hot conditions limit vegetative growth, resulting in low soil organic matter content, compared to wetter environments (Bationo *et al.,* 2001). Human activities exacerbate this problem. Vegetation is often removed for fuel, feed and construction purposes instead of recycling into the soil. This drives organic matter and nutrient contents even lower, depressing productivity further. Soils that are low in organic matter are less effective in retaining nutrients in plant-available forms and are more susceptible to compaction and erosion. It has been on record that fertilizer can increase dry land productivity significantly when rainfall is adequate. However, this will not be economically and environmentally sustainable, over the long term (Sanders *et al.,* 1996). This is because of low organic matter and low cation exchange capacity. However, soil fertility can be modified by man's intervention towards improving it, soil productivity is a function of soil fertility status (Keller, 1982). Furthermore, this is attributed to the productive ability of the soil to hold water, to support yields, which depends on the organic matter found in the soil. Organic matter on farms includes higher percentage of leaf lifter from trees, and shrubs and the crop residue. Therefore tree planting on farms can be regarded as a solution to nutrients depletion of soils on farms, especially in rural Nigeria, where farmers form the primary system actors. There is ample evidence that farmers form a significant if not the

most significant players in the tree planting industry. In a separate study of wood fuel, in Kano, it has been observed that on farmed parkland, evidence was found of a significant increase in tree density from 1972 to 1985. Furthermore cultivation is the dominant form of land use, and widely spaced trees of similar age and size are maintained by farmers for economic purpose (Mortimore *et al.,* 1988). Also a separate study on the dry land case study of local natural resource management in the Maradi – Kano region of Niger and Nigeria pointed out that long fallows are now an exception, under annual cultivation, nutrient stocks and the amount of soil organic matter in the surface layer diminish and yields fall, farmers try to obtain organic manure or purchase inorganic fertilizers for application in micro-doses. Therefore success in fertilization depends on economic resources (livestock or cash) (Mortimore *et al.,*1988). However, farm incomes are most often supplemented by the sale of a variety of tree products for medicinal, constructional and fuel purpose. Mohammed (1997) found out that, there were more than two hundred and twenty one (221) useful plants in the semi-arid Northeastern Nigeria. The most common plant species found in the area among others include *Acacia Spp., Euphorbia Spp., Hibiscus Spp., Ficus spp., Combretum spp., and Ziziphus spp.* The plants have various uses to the villagers. Several parts of the trees such as barks, branches, pods, roots, wood, gum, seeds, leaves etc, were used for different purposes, like medicinal, cultural, fodder, human food, timber, agricultural, fuel wood, shade, soil protection and improvement etc. A lot are being sold to gain money for either use on farm, or for buying food. Tree density patterns are shaped by variety of abiotic and biotic factors (Ahmed 2015).However different environments respond positively or negatively to a particular tree species ,therefore tree distribution is a function of the environment coupled with other factors that are at interplay.

2.5 SMALL FARMS, PRODUCTIVITY, AND AGROBIODIVERSITY

Smallholders have been considered unproductive and inefficient because of their isolation in rural areas, an use of simple technology, (Jake, 2011). It is evident that most smallholders utilize the scarce land available to them and optimize per unit area production. Smallholders in contrast to the larger farms that utilize modern production techniques for the purpose of marketable surpluses for export or domestic consumption, are composed of small farming units whose output is just sufficient to support the immediate family's consumption needs and possibly sell whatever surplus there iss (Biggs, 1997; Jake, 2011).

In addition, however, several detailed studies and historical reviews have shown agricultural booms (both in cash crop and food production) based on smallholder agriculture. Colonial agriculture in Africa was largely based on smallholders; cocoa in Ivory coast and Ghana, groundnut in Nigeria, Senegal and Gambia, oil palm in Nigeria and tea and coffee in Kenya and Zimbabwe, (Jake, 2011).

Smallholders obtain a living from trees and therefore farmers and other rural dwellers have keen interest in trees conservation. For instance, Danjuma (2010) revealed that in the Maradi-Katsina area farmers' conservation efforts are the foundation of any management regime.

Furthermore, in maintaining agro biodiversity, indigenous technique is of high significant, as pointed out by (Danjuma,2013). Thus indigenous knowledge should not be alienated from the trees management regime because such, techniques evolvedfrom, and reflect a society's intimate understanding of its ecological and social environment, through constant use and domestication of resources.

A study on relevance of agro forestry to appropriate land management, pointed out that tree densities in the North-western part of the Kano region are about 12 – 21 tree per hectare with an average of 13 trees per hectare. About one third of the trees are made up of saplings and the most frequent species are *Combretum bilderam*, *Fieldehbea albida, Balamite aegyptiaca* .These species have higher frequency of sapling and furthermore show active regenerating in Karaye, which shows an average density of 18 trees per hectare (Karaye, 1995; Ahmed, 1997).

In the same study, an in- depth study of vegetation show that the Kano region is lightly dominated by the composition of *F. albida* and *B. aegyptiaca*. The research, employed Point Centred Quarter method as field work and questionnaire survey and interviews to gather and analyze the collected data.

CHAPTER THREE

RESEARCH METHODOLOGY

3.0 TYPES OF DATA

Both quantitative and qualitative data were used for the study. The quantitative data are the current inventory of trees within the study area, scores, and tabulations from the field as a result of the study while, qualitative data type includes the attributes i.e measurements, and knowledge gained as a result of the field work.

3.1 SOURCES OF DATA

The sources of the data are the smallholder farms of Karaye Local government, Kano state. Average size of the farms in the study area is estimated at 0.3ha (Essiet, 1990).

Direct field surveys which were carried out on the sampled smallholder farms produced the primary data. Also a checklist was prepared which was used in conducting interviews with the farmers; Secondary data was obtained from books, unpublished theses, journal articles, working papers, bulletins and reports from local and international organizations.

3.2 RECONNAISSANCE

Reconnaissance survey was the first major activity undertaken in the course of the study and was carried out to familiarize with the study area and gain a general overview of the environment. Local communities in the study area ,and their surroundings were visited. The outcome of the survey include identification and sensitization of some key community leaders on the objective of the study, a general overview and acquisition of any viable information available on the environment of the study area.

3.2.1 Data Collection Procedures for Trees

Various attributes on vegetation includes composition, density, diversity and relative density were collected for trees within the study area.

3.3 COMPOSITION

Tree species were recorded, common/local (specifying local name and scientific name) for all species, were also identified , the dominant tree species were identified, and the tree which is not known .a herbarium was asked as well as the local farmers and other land users for further knowledge (Mortimore et al., 2006,)

3.4 MEASUREMENT OF VARIABLES

In general, diversity refers to the number of categories that can be differentiated, and to the proportions (or relative abundances) of the number of objects in each category. Density is the number of individual plants or plant units per unit area. Density is a highly quantitative and precise measure, but is only applicable where individual plants or plant units are distinguishable (Danjuma, 2012).The density of trees within the study area was obtained through physically counting the number of trees and species were identified. The density was calculated by getting the individual number of trees on farms relating such numbers to a hectare.

3.5 SAMPLING

The research made use of systematic random sampling to gather data. Quadrats of 30m by 30m were used. Fifty sample plots, were selected at random and points were fixed at

intervals whereby trees species were inventoried.10(ten) locations were selected from different angles of the study area, these places include;

1. Magajin gari
2. Magaji Haji
3. Daura
4. Yola
5. Tudun kaya
6. Kwanyawa
7. Kurugu
8. Yan medi
9. Kafin dabga
10. Turawa

3.5.1 DATA INSTRUMENTS

One of the important data instruments used for collection of data is formal interview with an open ended question, Formal interview was adopted because the respondents are rural populace who are more conversant with formal dialogue. The interview essentially deals with questions on the drivers of tree density and diversity and management strategies of on farm trees.

3.6 TOOLS

1. GPS (Global positioning system) – (Hand held type)
2. Ranging poles
3. Camera
4. Measuring tape
5. Arc G I S software9.3

6. Quadrat

3.7 DATA ANALYSIS

Data obtained from field work are presented in table ,percentages were computed and analyzed using Shannon Weiner index.

Shannon – Weiner (1949) diversity index was employed to determine the diversity of plant species in the sample plots,

$H' = - \Sigma pi \ln pi$

Where:

Pi = proportion of each species = ni/N

Ni = number of individual of each species

N = Total number of individuals in the plot.

3.8 Species density

Equitability of plant species was calculated as $J = H'/Hmax = - \Sigma piln pi /ln$ Species Density in this study refers to the total number of individual trees in a sampled area. However the research identify species density (SD) within every quadrate using the formula below.

$$SD = \frac{\text{Total number of species in quadrat}}{\text{Area the quadrat of}}$$

Species frequency which is the number of times a species was encountered was determined and expressed in percentages Species frequency was quantified as a number of times a species was encountered divided by the total number of the specie,

CHAPTER FOUR

RESULT AND DISCUSSION

4.1 INVENTORY OF TREE SPECIES IN THE STUDY AREA

Twenty nine (29) different plant species were identified in the study area. Their local and botanical names were also recorded. (Table 4.1)

In the work of Yusuf (2013) on farmed parkland vegetation changes density and composition in the southern part of Kano, 50 tree and shrub species were found in the average of 30km^2 of the farmed parkland (Yusuf, 2013).

Table 4.1: List of Identified Trees in the Study Area

S/N	Trees (Botanical)	Local Name
1	*Azadirachta indica*	Maina
2	*Mangifera indica*	Mangoro
3	*Parkia biglobosa*	Dorawa
4	*Ziziphus spinachristi*	Kurna
5	*Guiera senegalensis*	Sabara
6	*Celtix integrifolia*	Zuwo
7	*Psidium guajava*	Goba
8	*Tamarindus indica*	Tsamiya
9	*Annogeisus leocarpus*	Marke
10	*Acacia sieberana*	Farar kaya
11	*Diospyros mespilliformis*	Kanya
12	*Combretum glutinosum*	Kattakara
13	*Balemites aegyptiaca*	Aduwa
14	*Acacia farnesiana*	Kandili
15	*Acacia nilotica*	Bagaruwa
16	*Citrus lemon*	Lemon tsami
17	*Gossypium spp*	Gwanda
18	*Vitex doniana*	Dinya
19	*Celosia argentea*	Rimi
20	*Ficus politia*	Durumi
21	*Catinoregan nolitica*	Kwamarya
22	*Manilkara multiversis*	Kadanya
23	*Senna occidentalis*	Maganfari
24	*Faidherbia albida*	Gawo
25	*Acacia senegalensis*	Dakwara
26	*Englerina gabonensis*	Kauci
27	*Acacia polycantila*	Karo
28	*Ficus thonongii*	Cediya
29	*Adansonia digitata*	Kuka

4.2 TREE DENSITY IN THE STUDY ARE[1]

Table 4.2.1 below shows that at Magajin gari a total 23 trees were identified within five (5) quadrats (Table 4.2), The highest density per square metre in all the quadrates is highest at Magaji Hajji .

A total of 253 tree stands were encountered within the ten (10) randomly sampled small holder farms.

Table 4.2.1 LOCATION OF MAGAJIN GARI

Quadrats	No. of Trees per Quadrat	Density (square metre)
1	5	0.05
2	5	0.05
3	4	0.04
4	5	0.05
5	4	0.04
Total	**23** Average tree density is 2.3square metre	

Source field work 2016

Table 4.2.1 shows that, the total density of trees found in Magajin Gari is 23trees in 5 quadrats and the average density is 2.3 trees s per square metre and quadrat 1,2 and 4 has the highest number of trees, ie 5 trees, while quadrat 3 and 5 have 4 trees each

Table 4.2.2 Location of Magaji Hajji Smallholder farm

Location	No of tree per Quadrat	Density (square metre)
1	3	0.05
2	6	0.01
3	5	0.08
4	4	0.06
5	4	0..06
Total	**22** Average tree density 2.2 square metre	

Source fieldwork 2016

In Magaji Hajji five quadrants were established. The total number of trees are 22 while the average tree density is 2.2 trees per square metres. Quadrat 2 has the highest number of trees while quadrant 1 has the lowest number of trees.

Fig. 4.2.3: Location of Daura Smallholder Farms

Location	Daura No. of trees (quadrat)	Density per metre square
1	9	0.015
2	9	0.015
3	10	0.016
4	3	0.05
5	7	0.01
Total	**38** Average tree density is 3.8square metre	

Source fieldwork 2016

The total number of trees found in Daura is 38 trees. Within the five quadrats, the average density per square metre is 3.8treeswith quadrat 3 having the highest number of trees while quadrant 4 has the lowest number of trees

Fig. 4.2.4 Location of Yola Smallholder Farms

Location quadrant	Yola No. of Trees (quadrat)	Density of trees(square metre)
1	5	0.008
2	6	0.01
3	5	0.008
4	5	0.008
5	5	0.008
Total	**26** Average tree density is 2.6squaremetre	

Source field work 2016

Yola is the next locations were the total number of trees found was 26 while the average tree density found per hectare was 2.6 trees per square metres. Quadrat 2 has the highest number of trees while the other quadrats, have the same number of trees.

Table. 4.2.5 Location of Tudun Kaya Smallholder Farms

Quadrats	No of trees (quadrat)	Density of trees(square metre)
1	3	0.05
2	7	0.01
3	10	0.01
4	9	0.01
5	5	0..008
Total	**34** Average tree density per square metre is 3.4 trees	

Source field work 2016

In Tudun kaya the total number of trees found was 34. The average density of trees found was 3.4 trees, and quadrat 3 has the highest number of trees.

Table 4.2.6 Location of Kwanyawa Smallholder Farms

Quadrat	No of trees (quadrat)	Density of trees per square metre
1	2	0.003
2	2	0.003
3	4	0.006
4	3	0.005
5	3	0.005
Total	**15** Average density of trees per square metre is 1.5 trees	

Source field work 2016

In Kwanyawa the total number of trees found on smallholder farms sampled was 15 and the average density was 1.5square metre. Quadrat 3 has the highest number of trees and the lowest number of trees was found on quadrats 1 and 2

Table 4.2.7 Location of Kurugu Smallholder Farms

Location Quadrat	Kurugu No. of trees per quadrat	Density of trees per square metre
1	7	0.01
2	5	0.008
3	4	0.006
4	5	0.008
5	5	0.008
Total	**26** Average tree density per square metre is 2.6 trees	

Source Field work, 2016

In Kurugu the total number of trees found was 26 and the average tree density per square metre is 2.6.

Fig. 4.2.8 Location of Yan Medi Smallholder Farms

Location Quadrat	Yan Medi No. of trees (quadrat)	Density per square metre
1	6	0.01
2	4	0.006
3	5	0.008
4	4	0.006
5	6	0.01
Total	**25** Average tree density per square metre is 2.5trees	

Source fieldwork 2016

At Yan Medi, the total number of trees found was 25 with an average density of 2.5 trees per square metre quadrat 5 has the highest number of trees while quadrat 2 has the lowest number of trees.

Table 4.2.9 Location of Kafin Dabga Smallholder Farms

Location Quadrat	Kafin Dabga No. of trees (quadrat)	Density of trees per square metre
1	5	0.008
2	7	0..01
3	8	0.01
4	1	0.001
5	2	0..003
Total	**23** Average tree density per square metre is 2.3	

Sourec fieldwork 2016

At Kafin Dabga smallholder farms the total number of trees found was 23 and the average density of trees per square metres is 2.3. Quadrat 3 has the highest number of trees while quadrat 4 has the lowest number of trees.

Table 4.2.10 Location of Turawa Smallholder Farms

Location Quadrat	Turawa No. of trees (quadrat)	Density of trees per square metre
1	3	0.005
2	8	0.013
3	5	0.008
4	4	0.006
5 **Total**	2 **22** Average tree density per square metre is 2.2	

Source Field work, 2016

The last location is Turawa small holder farms were the total trees found was 22 and the average density of trees found per square metre was 2.2 The quadrat that has the highest number of trees was quadrat 2 and the lowest was quadrat 5.

4.3 TREE SPECIES DIVERSITY

Tree species	Local Name	Number	Pi	Ln Pi	-(Pi)*lnPi
Azadirachta indica	Darbejiya	25	0.098	-2.322	-0.227
Mangifera indica	Mangwaro	25	0.098	-2.322	-0.227
Parkia biglobosa	Dorawa	52	0.205	-1.5847	-0.324
Ziziphus spinachrist	Kurna	07	0.027	-3.611	-0.097
Guiera senegalensis	Sabara	03	0.011	-4.509	-0.049
Celtix integrifolia	Zuwo	03	0.011	-4.509	-0.049
Psidium guajava	Goba	02	0.007	-4.961	-0.034
Tamarindus indica	Tsamiya	22	0.086	-2.453	-0.210
Annogeisus leocarpus	Marke	04	0.015	-4.199	-0.062
Acacia sieberiana	Farar kaya	07	0.027	-3.611	-0.097
Diospyros mespilliformis	Kanya	12	0.047	-3.057	-0.143
Combretum glutinosum	Kattakara	03	0.011	-4.509	-0.049
Balanites aegyptiaca	Aduwa	04	0.015	-4.199	-0.062
Acacia farnesiana	Kandili	03	0.011	-4.509	-0.049
Acacia nilotica	Bagaruwa	04	0.015	-4.199	-0.062
Citrus lemon	Lemon tsami	04	0.015	-4.199	-0.062
Gossypium spp	Gwanda	02	0.007	-4.961	-0.034
Vitex doniana	Dinya	08	0.031	-3.473	-0.107
Celosia argentea	Rimi	04	0.015	-4.199	-0.062
Ficus politia	Durumi	03	0.011	-4.509	-0.049
Catinoregan nolitica	Kwamarya	03	0.011	-4.509	-0.049
Manilkara multiversis	Kadanya	02	0.007	-4.961	-0.034
Senna occidentalis	Maganfari	02	0.007	-4.961	-0.034
Faidherbia albida	Gawo	03	0.011	-4.509	-0.049
Acacia senegalensis	Dakwara	03	0.011	-4.509	-0.049
Englerina gabonensis	Kauci	04	0.015	-4.199	-0.063
Acacia polycantila	Karo	03	0.011	-4.509	-0.063
Ficus thonongii	Cediya	02	0.007	-4.961	-0.034
Adansonia digitata	Kuka	33	0.130	-2.040	0.265
TOTAL		**253**			

Source Fieldwork 2016

H = -Σ pi lin pi = 2.695

J = H/Hax = 0.488

Table 4.3 shows the diversité of tree species in the study area .The diversity of all tree species calculated as H is 2.743 and the equitability index which is J is 0.488. This

agrees with the result of Ahmad(2012) Tree species diversity and soil status of kogo forest reserve in north-western Nigeria,were the species diversity index was found to be 2.63 which is described as moderate because it lies within the general limits of 1.5-3.5 (Kent and Coker, 1992). The species that has the highest number of stands is *Parkia biglobosa* with 52 stands , followed by *Azadirachta indica and Mangifera indica* with 25 stands each. The fourth tree species was *Tamarindus indica* with *22* stands , The least represented was *Psidium guajava, Gossypium spp, Manilkara multiversis, Senna occidentalis and Ficus thonnongi* The distribution of tree species are shown in Table 4.4 it shows that Parkia biglobosa has the highest percentage of 19.25 followed by Mangifera indica and Azadirachta indica with 11.11 percent each , while a number of species have a lowest percentage of 1.11 percent ,these species include *Senna occidentalis, Manilkara multiversis, Gossypium spp ,Psidium guajava.*

Table 4.4 FREQUENCY AND RELATIVE DENSITY

LOCAL NAMES	BOTANICAL NAMES	FREQUENCY	RELATIVE DENSITY
Maina	*Azadirachta indica*	25	9.88
Mangwaro	*Mangiifera indica*	25	9.88
Dorawa	*Parkia biglobosa*	52	20.55
Kuka	*Adansonia digitata*	33	13.04
Tsamiya	*Tamarindus indica*	22	8.69
Marke	*Annogeisus leocarpus*	04	1.581
Kurna	*Ziziphus spina-christi*	07	2.766
Farar kaya	*Acacia sieberana*	07	2.766
Karo	*Acacia polycantila*	03	1.185
Sabara	*Guiera Senegalensi*	03	1.185
Kanya	*Diospyros mespilliformis*	12	4.743
Kattakara	*Combretum glutinosum*	03	1.185
Aduwa	*Balamites aegyptiaca*	04	1.581
Kauci	*Englerina gabonensis*	04	1.581
Dakwara	*Acacia senegalensis*	03	1.185
Gawo	*Faidhebia albida*	03	1.185
Kandili	*Acacia Farnesiana*	03	1.185
Bagaruwa	*Acacia nilotica*	04	1.581
Rimi	*Celosia argentia*	04	1.581
Lemon tsami	*Citrus lemon*	04	1.581
Gwanda	*Gossypium spp*	02	0.790
Cediya	*Ficus thonongii*	02	0.790
Dinya	*Vitex doniana*	08	3.162
Goba	*Psidium guajava*	02	0.790
Durumi	*Ficus polita*	03	1.185
Kadanya	*Manilkara multiversis*	02	0.790
Kwamarya	*Catinoregan Nilotica*	03	1.185
Majanfari	*Senna Occidentalis*	02	0.790
Zuwo	*Celtix Integrifolia*	03	1.185
Total		253	

Source Fieldwork 2016

4.5 CONSERVATION STATUS OF TREES IN THE STUDY AREA

The pattern of frequency distribution indicates its conservation status and also portrays the higher percentage of tree species that are being regenerated or are less exploited for fuel wood, staple animal fodder and other medicinal uses.

High frequency of *Parkia biglobosa* (20.55%),*Mangifera indica*,(9.88%) and *Azadirachta indica*(9.88%) are probably due to less use of *Parkia biglobosa* as fuel wood and high regeneration of *Azadirachta indica* and *Mangifera indica* for fuel wood and fruits provision as well which is being sold for income generation. This can also be as a result of selective management and certain characteristics that favour the above species to flourish..*Azadirachta indica* has been termed as an invasive species of tree which releases phytotoxins that prevent other tree species . This result agree with the work of Yusuf (2013) were the research noted that the most dominant tree species found were *Parkia biglobosa* (Dorawa) (111.5 per km^2), *Anogeissus leiocarpus* (91.7 per km^2), *Adansonia digitata* (Kuka) (87.8 per km^2) and *Diospyros mespiliformis* (Kanya) (56.2 per km).However, the less frequency of *Gossypium* ,*Ficus thonnogii* and *Semm occidentalis*(0.790%) may not be unconnected to over exploitation which leads to its low occurrence during the study

4.6 Drivers of Vegetation Change in the study area

Human exploitation are causing declining in biodiversity worldwide; losses of plants and other species are taking place at a rate far higher than the natural background rate of extinction .(Ahmad 2012). According to (Smeins *et al.* 1997), woody plants have always increased and decreased with fluctuations in climate over the past 20,000 years.

4.6.1 Deforestation

Harvesting and unregulated exploitation of forest products have been major factors to changes in species composition and distribution of forest vegetation (Colombo *et al.*, 1998), especially in the tropics where there is high dependence on non-timber forest products for various use values including health care delivery. The driving force behind deforestation in the study area is largely cutting down of trees for domestic use and clearing for residential development.

4.6.2 Bush Burning

Bush burning is still a cultural practice in most of the third world countries. Shift cultivators or encroachers refers to people who have moved into, and established small-scale farming activities in the forests in order to sustain themselves and their families, and in time shift to other areas. They are landless peasants who have followed roads into forested areas. They cause additional damage to the composition and structure of the forests and are currently being blamed for 60% of tropical forest vegetation loss (Apade, 2003).Their had been evidences from interviews that burnig farms after clearing is a traditional norm in the study area.

4.6.3 Fuel wood Extraction

FAO estimated that 1.5 billion of the 2 billion people worldwide who rely on fuelwood for cooking and heating are overcutting forests. This problem is worst in drier regions of the tropics (FAO, 2007). Wood is the major source of fuel for domestic cooking for nearly half of the world's population and as they are removed, the forest vegetatively undergoes alteration. In some parts of West Africa, availability of fuelwood is an essential element in community welfare (Nwoboshi, 2002). According to FAO (2007) more than 90% of the trees cut in Africa were burnt as firewood. Cline-Cole (1994) observed that the fuel wood - human needs relation does impede forest conservation/protection, and gradually alters the composition of forests vegetation. Farmlands in Turawa ,Kwanyawa ,Kafin Dabga are highly affected by fuel wood extraction even to the extent of killing trees.

4.6.4 Logging

Logging roads are used by landless farmers to gain access to forest areas, which process involved the destruction of vast area of forest vegetation. Apart from domestic fuel demand in Africa, Fairhead and Leach (1997) reported that the highest cause of forest and tree depletion in the region, resulting to vast changes in vegetation composition is timber export to the Western countries. It is evident that along Parts of Gunshi forest their is high rate of logging activities taking place.

4.7 TREE MANAGEMENT

Table 4.5, below shows the respondents views on illegal felling of trees in the study area . 80% of the respondents have the view that trees on farmland should not be cut down indiscriminately due to the importance attached to them which include wind brake and erosion control.10% are of the view that trees should be cut down for domestic purpose due to absence of alternative to domestic energy ,while 10% are of the view that trees are cut down due government non enforcement of environmental laws.

Table 4.5 TREE FELLING IN THE STUDT AREA

	RESPONSES	No Magajingari	No Magaiji Hajji	No Turawa	No Kwanyawa	No' Kafin dabga	
Indiscriminate Felling of trees	NO	08	09	07	06	08	
	YES	02	01	03	02	01	
Total		10	10	10	08	09	

Source Field survey2016

4.8 LOCAL PERCPTION ON OBSERVED CHANGES IN THE STUDY AREA

According to the respondents in the study area, observed changes on density and diversity reveals that tree density changes over time in smallholder farms. 70% of the respondents agree that the number of trees on their farmlands have reduced in the last 10years which is being attributed to cutting down of trees for domestic uses. 10% believe that over time tree density change due to lifespan of the trees because the trees have been there for long and those planted are few due to maximizing space for crop cultivation on farmlands. Furthermore almost 25% believe that the density of trees is largely attributed to the wellbeing of the farmers i.e if tree owners are financially sound, trees will not be cut down .However if otherwise trees will be cut down and sold for financial gains. While 5 % are of the opinion that tree density changes are as a result of climate change and 10% do not have any opinion with regards to the changes in density of trees within the study area. Table 4.6 below shows clearly the opinion of the respondent.

Table 4.6 LOCAL PERCPTION ON OBSERVED CHANGES

	Magaj in Gari	Magaji hajji	**Daura**	**Yola**	**Tudu n kaya**	**Turaw a**	**Kur ugu**	**Yan Medi**	**Kwa nya wa**	**Kafin Dabg a**
Change of density as 9a result of lifespan	2	1	0	1	2	0	0	3	5	2
Cutting of Trees for domestic use	4	5	5	6	4	3	1	2	2	0
Changes as a result of climate change	1	1	2	0	1	4	4	2	0	5
Total	07	07	07	07	07	07	05	07	07	07

4.9 CHANGES ON DIVERSITY OF TREES IN THE STUDY AREA

Table 4.7 below show the respondents opinion on the diversity of tree in the study area , One farmer from each location was interviewed.

Table 4.7 CHANGES ON DIVERSITY OF TREES

	Magajin gari	Magaji Hajji	Daura	Yola	Yan Medi	Kafin Dabga	Kwanyawa	Turawa	Tudunkaya	
Number of trees Specie Presnt	7	5	4	6	5	8	5	4	6	
Types in last 10years	9	5	8	9	4	8	5	7	9	
Percentage change	12.5 decrease	No change	33.3 decrease	20 decrease	11.1 increase	No change	No change	27.2 decrease	20 decrease	

Source Field Survey 2016

Table reveals that, there had been significant changes from the respondents with regards to the diversity of trees in the study area with almost 12.5 % decrease of variety of species found in Magajin gari , while respondent from Magaji Hajji, Kafin Dabga and Kwanyawa reveal that no change has taken place with regard to diversity in the last 10 years . However the only increase in diversity occurred in Yan Medi with a rise of 11.1%.Plate 1 show *Tammarindus indica* species in Kwanyawa.In Kurugu their are

considerable concentration of Baobab trees,(*Adansonia digitata)*Plate 3 shows large number on a certain on farm

Plate 1: showing *Tammarindus* i*ndica* specie in Kwanyawa

Plate 2 showing *Mangifera indica* in Magajin gari

Plate 3 showing *Adansonia digitata* Tree species in Kurugu

Plate 4 showing *Ficus thonnongi* Tree specie in Yola

4.10 DISCUSSIONS

The tree composition of Karaye Small holder farmlands shows that a total of 29 species of trees were recorded. Dangulla (2013) recorded 40 species of trees in Yabo area Sokoto of State.

Also (Zakari, 2015) recorded (98) ninety eight different plant species in Hadeija wetlands. This findings is similar to that of (Amanda *et al* 2011) were a total of 244 tree species are recorded in lowland forest of Madagascar and that of (Ahmad 2012) were a total of 29 tree species were recorded in Kogo forest reserve North western Nigeria.

The overall density of tree species in the study area was found out to be 253 specie(Table 4.4) This shows a low density of tree species in the study area compared to 2684 woody species found in Yabo area (Dangulla ,2012). Also much lower than 3416 trees species found in southern Kano (Yusuf,2013). However much higher than 48 tree found out in four sampled locations in Kano State.(Ezeobi 2015).This can be attributed to climatic condition of the study area.

The diversity index of inventoried species was calculated of all the farms sampled as 2.695 and equitability index of 0.488.This is relatively high compared to that of Ahmad(2012), who found a diversity index of 2.93 in kogo forest reserve, North-western Nigeria.

Also,(Ahmad,2012) found out that Dabagi Forest Reserve recorded a diversity index value of 1.45, which is very low, but even higher in percentage than that of Kumar *et al* (2010), in 3 sites of tropical dry deciduous forest of Western India, in which the shannon-Weiner Index (*H'*) values of 0.67 to 0.79 were recorded. This implies that

climate favours diversity and may be partly responsible for the diversity index obtained at Karaye.

Parkia biglobosa is the species that has the highest number of 52 stands and the relative density of 0.192 and relative frequency of 19.25% showing a highest conservation status in the study. The species with lowest stands are *Manilkara multiversis*, *Senna occidentalis*, and *Ficus thonongii* with 2 stands each, and relative density of `0.74 each, this may probably be due to indiscriminate rate of tree felling and non replacement at certain intervals. The drivers of tree density and diversity were identified to be bush burning, logging and fuel wood extraction. This agrees with the result of Dangulla (2010) of tree diversity and spatial distribution of woody species in Yabo were it identify bush burning, fuel wood extraction and logging as the major drivers of tree density and diversity . However, in terms of local perception on observed changes in density of trees, 70% of the respondents believe that there had been a significant decrease in density of trees in the last 10 years. This can be attributed to the persistent cutting down of trees for domestic energy .This agrees with the study of (Tijjani,2015) on the analysis of trees on farmlands in Watari and Wuroladde villages in Tofa Kano state, were the research identified a decrease in number of trees on farmlands in the last 10 years due to deforestation. Also the study identified a significant reduction of tree density in Watari due to large scale clearing for irrigation purposes.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.0 SUMMARY

The tree composition and distribution in Karaye are not uniform among the farms surveyed. The trees found are not different from the Sudano-Sahellian trees, which portray high drought resistant characteristics. The composition and spatial pattern of species distribution in the area is variable. On the whole, 249 tree species were encountered. The average density of tree species is 2.54 trees per square metres, this can be due to the nature of the climate since the study area is within the dry lands furthermore the conservation status of the species are as follows *Parkia biglobosa* has the highest of 19.25% *Adansonia digitata* is next species with 12.22% the species with the least density per hectare are *Manilkara multiversi*, *Semma occidentalis* and *Psidium guajava,* The dominant species found are *Parkia biglobosa,* 19.25%, *Adansonia digitata* 12.22%,,*Azadirachta indica* 11.11%, and *Mangifera indica* 11.11% .The calculated diversity index of tree species from sampled smallholder farms was found to be 2..695 and the equitability index was calculated as 0.488.

5.1 CONCLUSION

This study has clearly demonstrated that tree species in the study area show variability. Reasons for such variability include the nature and intensity of exploitation; the economic and ecological value of species, species adaptability to environmental conditions and their tolerance to disturbance as well as difference in soil nutrients and

moisture in a given area .In general, the species and actual number of tree stands are high compared to (Ezeobi 2015) where he found out 48 trees in some parts of Kano state. Therefore the research concludes that their exist differences in vegetation within Karaye that occur along different places ranging from Magajin gari along challawa goje which has lower trees due to the large scale clearance opened for Irrigation.

5. 2 RECOMMENDATIONS

Small holder farms in Karaye can achieve significant achievements in economic and nutritional status through modification in their approach to planting and management of different trees, both indigenous and non indigenous. These changes will surely minimize input costs, through reducing the reliance on chemical fertilizer in farms by planting trees that improve soil fertility. Agricultural extension workers need to be provided either from the community or from the government.

By combining Agro ecological restoration with income generation within a participatory integrated rural development program that provides community training and education in a wide range of relevant skills. On farm tree planting becomes a powerful tool to address the cycle of land degradation and social deprivation. The income-generating component adds critical value to agro ecology and may even be an important incentive for farmers to diversify their economic gains through on farm trees. The study recommends the following;

i) There should be effective management of trees in order to guarantee a sustainable future devoid of socio-economic and ecological crisis.

ii) Awareness campaigns and intensive public enlightenment on the values of woody species in particular and biological diversity in general as well as their role in environmental protection and conservation are highly desirable.

iii) In view t of the immense benefit of a holistic survey on trees, it is recommended that the local and community authorities should carry out or sponsor holistic surveys of their local government areas in order to generate the much needed data for planning which will promote the development of sustainable rural communities.

iv) The enforcement of laws that protect vegetation should be implemented and heavy penalties should be imposed on defaulters.

v) Local farmers should be rewarded for effective resource management by the local authorities to ginger farmers on keeping and management of trees.

vi) The adoption of Ecosystem approach will go a long way in maintenance of tree density because it encompasses all the stakeholders in the management of those trees in study area.

vii) The role of traditional institutions should be highly empowered so as to strength farmers ability on tree planting and management.

viii) Further research on the state and conservation status of woody species in particular and biodiversity in general is also recommended

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APPENDIX

CHECKLIST USED TO GUIDE INTERVIEW SCHEDULES WITH FARMERS

1. Give the number of trees on your farm. _____
2. What types of trees can be found on your farmland _____
3. Are these trees of any important to you on your farmland?

   Yes _____ No_____
4. Did you think that trees should be protected from indiscriminate cutting down?

   Yes _____ No_____
5. Can anybody fell/cut trees in any place at anytime in your environment

   Yes _____ No_____
6. Is there any existing law stated by government against illegal felling of trees either by individual or group in your environment.

   Yes _____ No_____
7. What are the human disturbances that reduce the density of the trees on the farmland?
8. How do you conserve trees on farmland _____
9. Are you planting trees in your farmland

   Yes _____ No_____
10. If yes what type of tree do you plant?
11. List the common species of trees found 10 years ago on your farmland.
12. Have the number of tree increased how _____
13. Which tree species has the highest density on your farmland?
14. What local management of trees is in your area?
15. Suggest how you would improve tree density and composition on the farm land?