



## Mitigation of Land Degradation for Agricultural Space Using Agroforestry System in Chikum Local Government Area, Kaduna State, Nigeria

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**ABSTRACT:** This study investigate the use of agricultural land space for agroforestry system in order to mitigate farmers-herders conflicts and land degradation in Chikum local government area of Kaduna State, Nigeria, using data obtained from field inspection and unstructured interview administered to 200 farmers through snow – ball sampling techniques. The data analysed reveals that farmland categorisation into five groups namely: very small (<1/2 ha; 27%), small (1/2 – 5ha; 56%), medium (5.1 – 10ha; 6.5%), large (10.1 – 50 ha; 9.5%) and very large (> 50 ha; 1%), while the main crops grown are maize and rice and the main trees are cashew and mangoes, and sheep, goats, pigs and poultry dominate the animals. Data categorization revealed that all sizes of agricultural space can adopt agroforestry irrespective of the main goal of the farmers and as a result, the space allocated for crops ranges from 30 to 90%, animals from 1 to 20% and trees from 5 to 65% given room for a lot of flexibility to accommodate the farmers and herders main goal. This was possible because of the availability and adoption of fast growing economy trees and animals that occupies little space for growth and development like snails, poultry and rabbit. This study therefore proposed more enlightenment on agroforestry because of its benefits to the farmers, herders and the environment.

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### INTRODUCTION

For a long time, crop farming and animal husbandry has been the occupation of man around the globe and mostly including Nigeria. This has giving rise to competition for space due to increase in population of both man and animals. But issues around ownership, accessibility and land administration have complicated these challenges. Recently, there are so many problems associated with farming and animal husbandry in Nigeria (Iro, 2017). The problems vary across the country in scope, scale and trend. While in the southern part of Nigeria and urban areas, it is land scarcity, while in the north and rural areas it is more of poor and dwindling pasture resources (Moretimore and Wilson, 1965; Awogbade, 1980).

The introduction of grazing reserves neither solves the problems because the location of such reserves are on impoverished land (Goldschmidt, 1980), which consequently results to inferior fodder with very low-protein component and hardly enough to sustain grazers year round. This eventually led to migration of nomads to places they do not normally go to and the depletion of trees by cutting down tree leaves and branches and animals eating anything green (de st Croix, 1945).

These problems have led to so many socio-economic challenges in the country. Famous among them is the now frequent farmers-herders clashes resulting to loss of lives and property across the length and breadth of the country (Adewuyi and Mustapha, 2017). It has also threatened the general peace and tranquility in most part of the country prompting some states government to come up with new regulations on animal husbandry. Already Benue, Ekiti and Taraba states has banned open grazing by all animals and encourage interested stakeholders to embraced ranching (Hunkuyi, 2017 and Premium, 2017).

Other problems are the lack of economic empowerment of both the farmers and herders which has resulted in both of the groups becoming more desperate in controlling and monopolizing any available resources in this case vegetation and water. This has also led to land degradation in the forms of erosion, depletion of vegetation, loss of biodiversity and lack of sustenance of ecosystem services, just to mention a few ( Adewuyi and Olofin, 2014; Adewuyi and Mustapha, 2017). To solve these problems, FAO (2015) and Adewuyi (2011) have advocated the adoption of agroforestry system of agriculture to alleviate these problems but with no specific details on

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its adoption on the farm in terms of land use planning. There is also the need to adapt it to different ecological zones of the country to take care of their peculiarities such as types of soil, characteristics of rainfall, vegetation cover, terrain and drainage, land use, size of land available, economic base and level of development and population density. So as to, avoid environmental and social problems due to wrong application of the techniques. Consequently, this study attempted land use planning of agricultural space for agroforestry system in the Guinea savannah region of Nigeria, using Chikum Local Government Area as a study area.

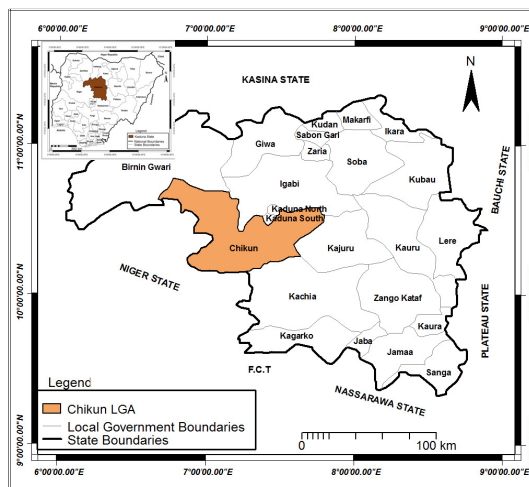
## MATERIALS AND METHODS

**Study Area:** The area of focus within the guinea savannah ecological zone is Chikum L.G.A. of Kaduna state and to be specific two wards; Kakau and Gwagwada along the Kaduna – Abuja Expressway axis for easy access and availability of various sizes of farm size and very dynamic agricultural practice (Figures 1). The LGA is located between Latitude  $9^{\circ}56'59''$  N and  $10^{\circ}53'44''$  N and Longitude  $6^{\circ}48'16''$  E and  $7^{\circ}48'30''$  E, with an average elevation of 625m above mean sea level. The area is approximately 4690.1km<sup>2</sup> in size and parts of it constitutes Kaduna metropolis, which makes the study area to be partly urban, peri-urban and rural in nature. As a result, the area is diverse in composition, population density and economic activities, which gave rise to dynamic pressure on the natural resources of the area. The relief is flat and rolling in most places except for few places along Kajuru axis that is rocky. The area is drained by River Kaduna and its tributaries.

The area belongs to the Tropical Savannah climate (Aw) with mean annual temperature of 25.5°C with the warmest month in April with 28.7°C and coolest month of December with 23°C. The mean annual rainfall for the year is 1200mm while the month with highest precipitation is August with up to 80 days of precipitation in a year and an average of 10 hours of sunshine per day (Climate data, 2017).

The area also belong to the crystalline basement complex of the northern Nigeria and the soil is mainly made up of Ferruginous tropical soil that are generally well drained and mostly sandy-loam and loamy soils in plains while in the valleys there are deposits of hydromorphic soils that are rich in mineral content and therefore support the high agricultural productivity in the area which is the main land use and occupation of the area. The study area is located in the Guinea Savannah where grasses are dominant with scattered

trees and woody shrubs with fringe forest along the water ways (river).



**Fig 1:** Kaduna State showing Chikum Local Government Area.

*Source: Kaduna State Ministry of Land and Country Planning (2015)*

Agriculture which is the steady occupation has modify the land use and cover, which is now dominated by crops such as rice, maize, guinea corn, groundnuts, millet, beans, yam, cassava, cocoa yam, sugar cane, soya beans, potatoes and fruits such as mango, banana, oranges, guava are common while the vegetables found in the area are spinach, tomatoes, pepper and onions. Many are found to also rear animals such as cows, sheep, goats, pigs and assorted poultry birds at different scale. The population as at 2006 was 372,272 people and 79,451 households and now estimated to be 518,077 people and 110,564 households base on a growth rate of 3.05% as recommended by the National Population Commission for the area which translates to a population density of 110.46 persons per km<sup>2</sup>.

**Methods:** The study depends on field inspection of existing agricultural practices and how agricultural space is utilized. A Snow-ball sampling technique was used to sample 200 farmlands so as to cover different categories of farm sizes. Farm labourers and commercial tractor owner/operators provided information and sometimes access to the medium to the very large scale farm. At the farm, a detail note was taken on the sizes of farm space, the crops they grow and the animals they keep (if any), which among the crop, trees and animals have the higher priority and the purpose of engaging in crop, animal production and tree planting. Also data on the types of crop grown, animal kept and trees planted was documented. This information gathered were collated and analysed to arrive at the priority of the farmers and herders, which constitute the data used in estimating space required

for different agricultural land uses on the farm. Tapes, GPS, camera was very handy during the field inspection which was carried out in July, 2017.

## RESULTS AND DISCUSSION

*Categories of Agricultural Space:* From the field inspection embarked upon and the summary presented in tables 1 and 2, most of the farms in the area belong to the categories of very small and small farms. They jointly constitute 83% and have the characteristics of small sizes, different shapes and mostly subsidence in nature and worked upon mostly by couples and in some cases with their children. They hardly engage labourers, animals or tractors, which further explains why they are very small in sizes. Those that utilized labourers, animals and tractors are workers and business owners from the metropolis, since fund to pay for such services is not a challenge. The sizes also explains the absent of animals and intentionally planted trees on the farms. Consequently, they produced mainly cash crop for food and income which are dominated by rice, maize, beans, groundnuts and guinea corn mixed with some vegetables.

The next category of farm space is the medium size farms which constituted 6.5% of the farms surveyed. They are not as many as the very small, small and large farms. They are mostly monocropping, and in this case cereal such as rice and maize dominate. They employed animals, human labourers and tractors to provide services on the farm because the size of the farms has gone beyond what a couple and their children can physically handle on their own. They are mainly traditional farmers with some economic clout to pay for services rendered while some of them have their own animals and tractors. Land is also not a challenge, consequently, they have up to four of medium size farms scattered around the study area and they are used to produce different crops suitable to the sites and are also used for crop rotation techniques. So, different farm site are dedicated to different crops in a farming season. Some of them likewise have gardens close to their resident for fruits such as mangoes, guava; trees like palm and coconut and vegetables. The animals are mostly kept directly of by their wives, which include cows, goats, sheep, duck and domestic fowls such as chicken and duck.

**Table 1:** Categorizations of farm sizes

S/No.	Farm Category	Farm Size (ha)	Number	%
1	Very small	<½	54	27
2	Small	½ - 5	112	56
3	Medium	5.1 - 10	13	6.5
4	Large	10.1 - 50	19	9.5
5	Very large	>50	02	01

After the medium size farms are the large farms that accounted for 9.5% of the farms in the area. They are farms with commercial goal and are owned mostly by retired federal and state officials. They use tractors and other machineries to cultivate maize and rice. They do not cultivate trees neither do they keep animals on the farms though some of them have interest in poultry at other locations in the metropolis.

The last category of farm land sizes is the very large farms, which are two in numbers. Their size which is over 50ha explains the reason they are not many. The two farms integrate maize cultivation with animal husbandry. The maize is produced to supplement the feeds of the animals which in this case are cows and poultry. The cows produce milk for yoghurt, meat and other dairy products while the poultry is mainly for chicken which lay eggs for consumption in Kaduna and Federal Capital Abuja. They sale excess to food processing companies both in Kaduna and all across the country. This warrant full mechanization of their processes for optimum production. The two farms have no trees or forestry components at all therefore they are short of being classified as agroforestry.

### *Best Crops, Trees and Animals for the Area*

From the characterization of the farm sizes, the crop grown, and the characteristics of the guinea savannah in terms of rainfall (volume, on-set, duration etc), the types and quality of the soil and the socio-economic aspiration of the farmers, cereals such as maize, rice, sorghum, millet, and tubers like yam and cassava, leguminous like beans remain the best crops for the area.

These crops provide the farmers with food, income from sales and feeds for their animals from farm residue (Adewuyi and Olofin, 2017). The animals for now are mainly herbivorous such as cows, sheep, goats, pigs, with chicken dominating the birds. The climatic and ecological characteristics of the area support their growth and development at large scale because of abundant grains, grasses, trees and farm residuals. But the scope of the animals can be expanded to include grass cutter, bush rat, rabbit, snails, fisheries and guinea fowl.

The benefits of some of these animals include smaller space required to integrate them into the farms. For instance a small fish pond of 60m<sup>3</sup> (5m\*6m\*2m) well-constructed can take 2,000 cat fish fingerlings from hatch to full growth. Same space can take hundreds of snail, rabbit, chicken and guinea fowl. Therefore irrespective of the size of the farm when the scope of the animals adopted is broadened, they can be integrated into the farming system.

**Table 2:** Other farm characteristics of the area

Variables	Item	Number	%
<b>Priority among agroforestry components</b>	Crops	193	96.5
	Trees	5	2.5
	Animals	2	1
<b>Purpose of farming</b>	Income only	34	17
	Food only	90	45
	Animal only	Nil	Nil
	Income and food	63	31.5
	Food and animals	11	5.5
	Income and animals	2	1
<b>Main crops grown</b>	Maize	103	51.5
	Rice	66	33
	Guinea	19	9.5
	Corn		
	Millet	1	0.5
	Yam	10	5
<b>Trees planted</b>	Cassava	1	0.5
	Palm	7	10.6
	Mango	13	19.7
	Oranges	5	7.6
	Cashew	21	31.
	Guava	3	4.5
	others	17	25.7
<b>Main animals kept</b>	No accurate details were available by farmers because they do not know the specifics off head. However, the following animals are kept by most of the farmers at different scale: cow, goats, sheep, pigs, local fowls – ducks, chicken and modern poultry		

The other benefits is the diversification of income in terms of timing since some of these animals may generate proceeds off the farm harvest season which can also reduce the impacts of crop failure due to climate change or pest invasion thereby reducing the effects of the devastation on farmers. While the waste produced from all the components of agroforestry are beneficiary to each other and facilitate nutrient exchange (Adewuyi and Olofin, 2017).

Forestry or tree planting by farmers is nearly absent in the area. The reason is not far fetch, tree canopy obstruct sunshine which is the source of energy for plant growth. However, this challenge can be overcome by planting modern improved species of trees that get mature and produce fruits very quickly without casting big shadows on crops. As a result, such trees will perform their ecological functions in climate change mitigation as well as holding the soil together,

soil nourishment, wind breaker etc, generate income and also fuel wood for farmers' domestic energy for cooking. Other benefit is that they serve as feeds to animals on the farms. The survey revealed that the following trees can be adopted for the area; mangoes, oranges, grapes, lemons, palm tree, coconuts, cashew, guava, paw-paw and bananas.

*Animals, Crops and Trees Combinations on Farm Space:* Before now, it has being very difficult to model very small and small farm spaces because of the understanding on agroforestry that involves trees that are mostly big and animals such as big cows grazing on the farmland. But with improvement in science and technology, these categories of farm land that accounted for most of the farm space can now benefit from the concept of agroforestry. Therefore for these categories of farms, two approaches can be adopted; the first is where all the components are on the farm while the second is where some of the components are on the farms while the others are at the farmer's resident or alternative sites.

Where the farmer choose to have every component of agroforestry on the same farm, trees plants such as oranges, mangoes, pineapple, paw-paw, cashew can be adopted and plant on the farm to demarcate farm boundaries, along water channels if there is any or to mark areas designated for the use of animals and tracks for vehicle. For the animal component, one or two corners of the farm can be used for snail, fish pond or for keeping goats, sheep, rabbit or grasscutter as the case may be while the rest of the space can be dedicated to crops. However, where the second option is adopted, the crops and the trees may be on the farm while the animal component may be at the farmer's resident or any other alternative site. In this case, poultry, goats, sheep and snail are the best choice of animals because of the space they required. For the tree component, the trees and their location, the first option will serve for it too.

For the medium, large and very large scale farms, space is not a problem and consequently an elaborate planning of the land scape can be done for all the components to be on the same farm without any hindering the other. However, the major focus of the farming activities will determine the space and priority for each of the component. So also are the methods of crop farming as well as if the animals will be ranch or cage in a restricted location on the farm. Another important factor taking into consideration is the shape of the farmland and the terrain. But the bigger the farm the lesser the effect they will have on the landscape distribution among the components.

A proposed criterion for modeling farm space allocation is presented in table 3. The farm size are presented in ranges to accommodate different dynamics in focus of the farmers and the style of application of crop planting, animals adopted and style of husbandry and the level of mechanization. However, in any case except for the situation where the main focus is forestry, the space for crop planting takes most of the landscape. It can occupy as much as 90% when the focus of the farmer is crop and animal husbandry and it can be reduced to 30% when it is for forestry.

**Table 3:** Proposed land Space Allocation for Agroforestry

Main Focus of Farming	Allocation of component space in %		
	Crop	Animals	Tree
Crops e.g Maize, rice etc	88 – 90	1 – 2	8 - 11
Animals Poultry, snails and rabbit	82 – 90	5 – 10	5 - 8
Cows, goats, sheep and pigs	60 – 75	15 – 20	5 - 25
Trees	30 – 40	5 – 10	50 - 65

Trees seem to be the most generous in terms of accommodation of other components of agroforestry particularly when they are well planned. For instance, most trees can accommodate crops and grasses to grow as food and fodders for animals, allows snail to grow on them, construct series of fish pond without disturbing the trees and there production. That is the reason why on table 3, as much as 50% of the space can be used for crops and animals simultaneously with the trees.

As expected, the characteristics of the farm sizes and the components of the agricultural practices are very dynamic and generally at small scale which agreed with most of the other parts of sub- Sahara region (Kalema *et al.*, 2015). The farming practiced are mostly subsistence with very poor conservation practices which subject the farms to all forms of degradation ranging from soil erosion, deforestation to nutrient depletion that is already resulting into low crop yield (Adewuyi, 2016). Consequently, agroforestry proposed for adoption by farmers and herders as well as land scape modeling for agricultural space is very timely.

Improvement in agricultural practices has made agroforestry techniques to be possible to be integrated by all sizes of agricultural space, which brings hope for improved land conservation which will help in the mitigation of land degradation by all farmers but in particular very small and small farm holders and herders who are known to care less about the state of the environment and its conservation (Adewuyi, 2011).

In all the cases, when the focus is on animal husbandry with restricted movement, the maximum space allocated to them is 20%. This is justified because the movement is restricted either in cages or ranch area per time and also because of the need to produce enough crops and trees branches to feed the animals. However, when the focus is on smaller animals like birds, fish in ponds, snails, rabbit, etc, additional space can be allocated to crops because they do not required too much space to have a lot of them.

Therefore the ability to improve the scope of the practice of agroforestry to cover new species of economic trees and animals that required smaller space has further accommodate farmers with smaller farm space. As a result, faster growing trees and smaller trees in terms of height, girth with nutritious leaves and fruit can now be easily adopted into the farming system to improve the soil, served as wind breaker, fodders for animals, fuel wood, food and economic empowerment for the farmers. When this land use planning is adopted it will fulfill the suggestion of Adewuyi (2015) on how to improve fuel wood supply, mitigated the effects of unsteady power supply and standard of living of the general populace. It will likewise reduce land degradation as postulated by Liu *et al.*, (2014); Mohawesh *et al.*, (2015) and Muñoz-Rojas *et al.*, (2015).

Similarly, fisheries, snails, poultry and rabbit has expanded the scope of animals that can be integrated on farms particularly very small and small farms categories without much effects on the space normally reserved for crops while the medium, large and very large farms have space to play around with. This make the case a win-win situation for all the components of agroforestry and making the farmers to be more food and economically secure and at the same time gives room to a more sustainable environment for all. Likewise, herders will have the opportunities to keep their animals in a cage or ranch, feed their family and ultimately reduce the ever present tension which normally results to conflicts between them and farmers that destroys life and properties.

*Conclusion:* This study has revealed that no matter the size, shape and location of farmlands and the goals of the farmer, agroforestry system of agriculture can be adopted for practice in Nigeria. This will help to achieved the much awaited and expected environmental protection by both farmers and herders, reduce if not eliminate farmers and herders conflicts, improved vegetation cover, water regime and provide income to farmers year round from different components of the farm produce. Improved and fast growing economic trees and smaller animals such as fish, assorted birds, rabbits, goats and sheep just to mention a few encourages agroforestry either to be practiced fully or partly on the farms with the other components at the farmers resident or other locations.

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