

Review

Climate change and agriculture: The competition for limited resources amidst crop farmers-livestock herding conflict in Nigeria - A review

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ARTICLE INFO

Article history:

Received 18 October 2019

Received in revised form

13 May 2020

Accepted 27 June 2020

Available online 15 July 2020

Handling editor: Jiri Jaromir Klemes

Keywords:

Climate change

Cattle

Agriculture

Food pollution

Environment

Natural resources

ABSTRACT

In Nigeria, there have been clashes between herdsmen and crop farmers. While a lot of people have adjudged it to be solely a religious and political affair, the reality on the ground that cannot be ignored is the fact that the fight for limited resources has led to this conflict. Countless lives, properties and source of livelihoods have been lost because of the competition for limited natural resources. A cow on average contributes between 70 and 120 kg of methane per year, and Nigeria has 20 million of them. Calling for a boycott of beef and increasing prices of beef and beef-based commodities in this part of the world, because of its contribution to climate change is unrealistic as Nigerians still struggle to meet their dietary protein requirement. It is of paramount importance that the focus of the government and all concerned stakeholders shift from just ending the conflicts in addressing the root cause and putting sustainable structures in place for a lasting solution guaranteeing food security. This paper aims to establish the need for concerted efforts towards addressing climate change in the face of geometrically increasing populations and rapidly decreasing finite resources which have induced conflict between farmers and herdsmen over limited and scarce resources.

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1. Introduction

World population review puts Nigeria as the most populated African country and according to the World Bank, it is home to the poorest population in the world. The realities of climate change is felt all around the globe by all and sundry, especially by people who have contributed the least to it (Mendelsohn et al., 2006a, 2006b), Nigeria inclusive. With the unpredictability of climate and rapidly increasing global population, there is an urgent concern for the survival of man and also the carrying capacity of the earth (Daily and Ehrlich, 1992). Agriculture is largely dependent on climate; therefore, climate change has caused a shortage and instability in food supply, there is severe competition for limited resources, even between man and livestock (Lobell et al., 2008). Due to climate change, there has been loss of biodiversity (Harley, 2011) and animal/plant species are going into extinction at an alarming rate (Urban, 2015), while arable lands are also degraded (Ikhuoso, 2015). These have posed a serious threat to food security and resulted in serious competition (Table 1).

Vegetation cover makes up forty percent of the total earth surface (Wang and Fang, 2009). It also makes up seventy percent of arable land for food production. (Conant, 2012). Twenty percent of the planet's soil carbon stock is produced by grasslands Grasslands are able to sequester carbon from the atmosphere into the soil (Reid et al., 2004) and hence, possess the potential to mitigate the effects of climate change (Allard et al., 2007). Nevertheless, sequestration of atmospheric carbon into the soil is affected and determined by various key elements which include animal and grass species, grazing frequency, stocking rate, etc. (Olf et al., 2002; Mcsherry and Ritchie, 2013). Regardless of the fact that soil of grasslands have great ability to store carbon, recent studies have shown that high grazing intensity has led to carbon escaping back into the atmosphere from grasslands where they were sequestered and thereby, these grasslands become sources of harmful greenhouse gas

emissions that contribute to climate change rather than carbon sinks (Janzen, 2006; Ciaes et al., 2010). Grazing frequency can change the soil structure, its function and alter its ability to sequester carbon in the soil (Cui et al., 2005). Grazing intensity can have a huge impact on carbon stocks in grasslands (Cui et al., 2005). Climate change will exacerbate land degradation, natural water source drying and shrinkage, human migration and conflict among settlers, and this calls for meticulous planning of production systems for future livestock rearing. According to FAO (2020), livestock is the single largest land user and hence the need to review the relationship between climate change and livestock and how they affect each other.

2. Study area of Nigeria: vegetative, cattle distributions, and rainfall patterns

Nigeria is an African nation located on the Gulf of Guinea with so many mineral resources, wildlife and natural landmarks. With a population estimate of about 200 million (UNFPA, 2019). Nigeria is situated in West Africa and is the most populous African country. The country is geographically, culturally, and ethnically heterogeneous with about 374 identifiable ethnic groups, which the largest and politically dominant ethnic groups are the Hausa and Fulani of the north, the Yoruba in the Southwest, and Igbo in the Southeast (Antai, 2011).

The above image (Fig. 1) is a satellite image showing where Nigeria is located on the globe. Nigeria is located between latitude 4N and 14N of the equator and between longitude 2E and 15E of the Greenwich Meridian. The total land area of Nigeria is approximately 923,768 square kilometers.

Nigeria has a wide range of vegetation types and they reveal past and present climatic changes (Igbawua et al., 2016) and the vegetation has been under threat (FAO, 2012). The land terrain ranges from southern coastal swamps to tropical forests, open woodlands, grassland and semi-desert in the far north. Below is the map of Nigeria showing the vegetative cover.

Rainy seasons when the country experiences its highest precipitation is about 1,780 mm annually. In the northern parts of the country, it is mostly dry and dusty all year round and this determines the kind of vegetation found in the region. The northern region of Nigeria is predominantly short grass and marginal savanna as shown in Fig. 2 above. The climate and weather conditions of the north vary from that of the south. Cattle rearing is system practiced majorly in northern Nigeria where rainfall is low (Olutoyin et al., 2017).

Estimation of cattle population in Nigeria ranges between 10 and 15 million. Sub-humid region of the country has about 4.5 million heads with the mean cattle density of about 15 per km² and approximately 45% of the National herd could be readily found in the sub-humid zone of the country (Lawal-Adebawale, 2012).

2.1. Methodology

This paper is a review and investigation into the role of climate change in the current conflict between farmers and herdsmen in northern Nigeria. Data from secondary sources were used, these were sourced from Global Administrative Areas database (GADM), Food and Agriculture Organization of the United Nations 2017 (FAOSTAT) and other related research works.

3. Climate change and agriculture: the issue and problems

In recent times, human activities and farming practices have constituted a major factor accelerating climate change in Africa.

Table 1

Primary forest loss and tree cover loss: Nigeria. Annual loss of primary forest cover and tree cover for Nigeria by year. All area figures are in hectares (ha).

Year	Primary forest	Tree cover
2001		43,540
2002	6132	32,411
2003	1830	13,406
2004	3055	14,672
2005	1922	14,672
2006	3458	26,220
2007	2753	24,630
2008	4090	27,541
2009	3924	25,350
2010	6781	32,867
2011	7403	54,011
2012	6062	35,068
2013	6385	43,546
2014	9928	68,819
2015	5318	41,020
2016	12,336	72,372
2017	17,389	171,538
2018	15,183	120,143
Primary loss 2002–2018	113,948	
Tree cover loss 2001–2018		818,286
Primary loss/Total tree cover loss	13.9%	
Percent loss 2001–2018	6.0%	
Loss/year (2001/2–2010)	3771.59	25,531
Loss/year (2011–2018)	10,000.49	75,815

Source: Mongabay (2020)/Tree cover loss: Hansen/UMD/Google/USGS/NASA via Global Forest Watch. Administrative boundaries: Global Administrative Areas database (GADM), version 3.6.



Fig. 1. GIS Screenshot showing location of Nigeria on the World Map.

Activities such as burning of vegetation cover, deforestation and overgrazing have led to increased carbon emissions into the atmosphere and also affects the local weather and climate systems in the concerned regions through moisture fluxes and energy change (Ngaira, 2003; O'Brien and Daigh, 2019). Loss of vegetation cover through bush burning and rapid deforestation are likely to lead to increased droughts, and this is the leading cause of the frequent droughts in the Sahel areas of Sub-Saharan Africa (Ichoku et al., 2016). According to UNEP (1989), it was forecasted that evaporation rate would go up and the aggregate rainfall will drastically be reduce by 7–11% per year (UNEP, 1989) leading to warmer weather in the tropics. The climate change will cause a shift in the equilibrium of nature affecting the ecosystems, with consequences such as rapid desertification, loss of forest areas and droughts as a result of diminishing water and natural reserves. The tropics would inadvertently become very dry and will be difficult to practice weather/climate-dependent agriculture.

Climate change will negatively affect food security in Africa. For instance, in Egypt where most of the land is desert and the entire nation depends on the Nile river for irrigating farmlands which comprises four percent of arable land for food production (Jackson, 1989). This implies that if hypothetically the Nile River dries up, automatically there will be no food for people in Egypt, hence leading to an inevitable emigration of people from this country to

temperate regions capable to sustain human existence. According to Ngaira (2007), climate change will have significant negative impact on water use and its availability to people on the continent bringing to an abrupt end major irrigation systems across the continents as water sources will eventually dry up. Already, many regions in Africa are suffering from various forms of water scarcity ranging from those approaching physical water scarcity in southern Africa, those already experiencing physical limitations in northern Africa and some part of southern Africa and those with economic water scarcity across western Africa, middle Africa and eastern Africa (Comprehensive Assessment of Water Management in Agriculture CAWMA, 2007). The impacts of climate change might lead to insecurity challenges and conflicts within countries on the continent as the competition for scarce resources intensifies; competition for land, water etc. and coastal regions might also be submerged because of increasing sea levels and constant flooding (Ngaira, 2007).

With the impact of climate change severely felt in the agricultural sector of developing nations (Pearce et al., 1996; Tol, 2002; Mendelsohn et al., 2006a, 2006b), in the long run, climate change will have enough power to alter the directions of the general growth and economic development of these developing countries. Irrigation portends to be a potent tool to mitigate the impacts of climate change on crop yield and ultimately securing income levels

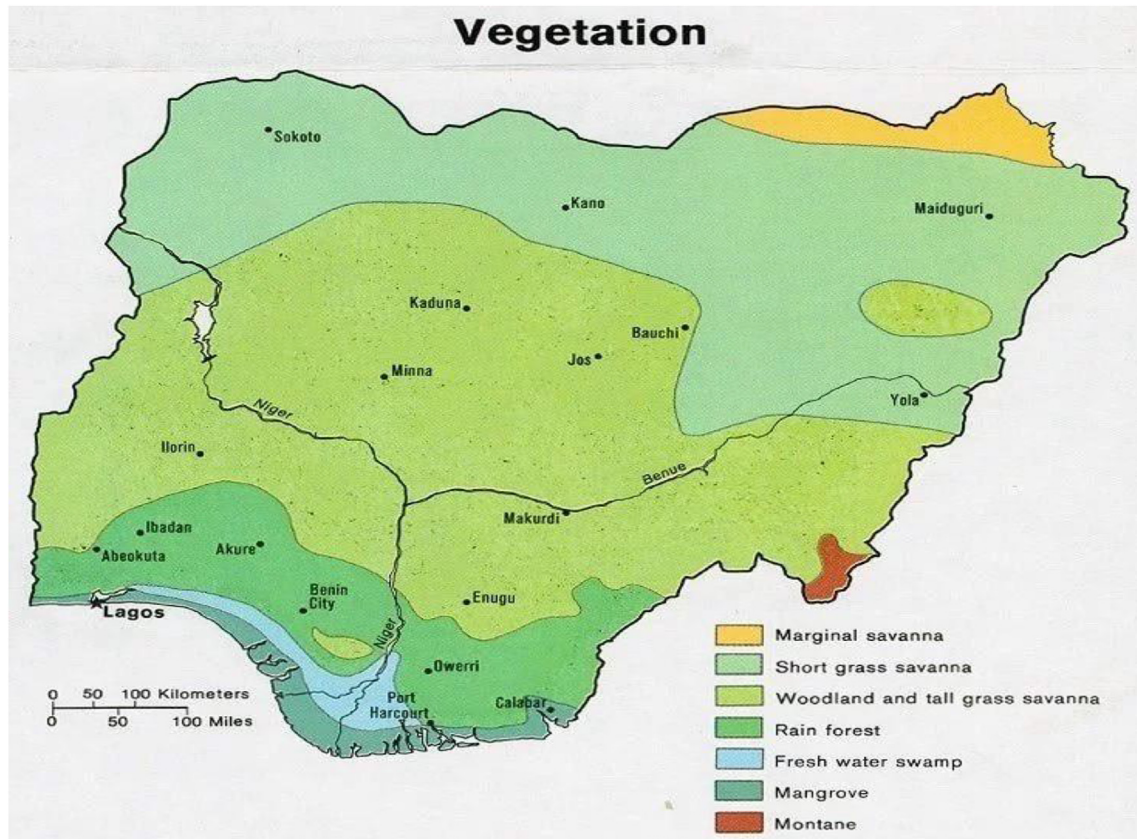


Fig. 2. Map of Nigeria showing vegetation.

for reducing vulnerability of farmers, unlike those which are rain-dependent. Nevertheless, it is very crucial to take note of the fact that irrigation is subjected to the availability of water, therefore, as climate changes it reduces the availability of water and increases the demand for it; water will become scarce hence limiting the capacity of farmers to irrigate their land. In this situation, the farmer will ultimately will be forced to continue to depend on the rain-fed system for crop production. For regions whose crop production relies on irrigation, it is of paramount importance that watershed management analysis be also conducted to ascertain the availability of water supplies for crucial irrigation periods. There needs to be more studies and investigation on climate change and water availability (Strzepek et al., 1996; Hurd et al., 1999; Howitt and Pieneer, 2006; Lund et al., 2006).

4. Effects of climate change on food security

Climate change is a major challenge to humanity because it exerts stress on the environment (UNEP, 2010) and affects water, land and other natural resources availability as well as agriculture productivity. Of the effects of climate change on human activities, its impact on agriculture will be devastating in pastoralist and agro-pastoral production systems in developing countries. Climate change will have several impacts on arid and semi-arid rangelands which covers 70% of the African continent (Galvin et al., 2001) and this will affect millions of crop farmers and pastoralist communities that depend on natural resources for a living (Adhikari et al., 2015). Climate change greatly affects local or global natural resources, and if not properly managed, it could cause flooding, drought and conflict among resource users. Already, climate change is causing water shortage by the shrinkage of lake Chad basin which the

pastoralist depend on and this forces them toward the southern part of the country in search of pasture and water (Oli et al., 2018; Njoku, 2018). Furthermore, climate change effects on agriculture include more erratic and decreased rainfalls, prolonged drought and increased ambient temperature, cattle death and diseases outbreaks such as contagious bovine pleuropneumonia and tick-borne diseases (Kimaro et al., 2018) and increased heat stress which would be reflected in lower animal fertility (Nardone et al., 2010; Kima et al., 2015). Climate change would increase conflicts over resources such as land and water between pastoralists societies and crop farmers (FAO, 2012; Kima et al., 2015), loss of lives and displacement of both farmers and herdsmen, and reduced domestic animal productivity (Musa et al., 2014). For pastoralists, their low-input livestock productivity depends on natural vegetation and water resources. These climate-driven perturbations include drought and prolonged dry seasons, which causes scarcity of forage and water, resulting in cattle starvation and malnutrition, weight loss, death, reduction of meat and milk yield and low price of cattle due to poor body condition.

5. Relationship between climate change, limited resources and the conflict in Nigeria

The relationship between climate change and farmer-herdsmen crisis is associated with water scarcity, illegal land encroachment, livestock feeding etc. Cattle rearing is a global trade carried out to provide food (protein), generate income and it has far-reaching economic and environmental impacts. About 26% of earth's land base are pastures for raising livestock (FAO, 2003), and cattle grazing is carried out in large scale in several parts of the world and even it constitutes a land management technique (Fleischner,

1994). An investigation into livestock farming in Africa revealed that revenues from subsistence farming will rise with increase climate warming and it will drop for commercial scale farming. The study further revealed that small scale livestock farmers are able to easily decide to breed and raise different animals to cope with the increased warming, it is not the same for large-scale livestock farmers who are specialized and are more vulnerable to warmer climate. Among developing countries, the vulnerability to the effects and impacts of climate change is less for small scale farmers than for commercial-scale livestock farmers (Mendelsohn, 2008).

Cattle grazing has created a prolonged public disagreement and arguments between landowners, pastoralists and environmentalists who are fighting to put an end to degrading land use systems (Craine et al., 2010) and climate change have added a new twist to this land use and management controversy. Cattle grazing has a major impact on the biological and physical properties of soil (Gerlanc and Kaufman, 2003). To reach a common ground between pastoralists and environmentalist, the relationship between grazing regimes and climate change must be explored and investigated.

According to Mongabay (2006), deforestation and reduction of vegetation cover have increased since the end of the 1990s by approximately 79.1%. Between 1990 and 2005, Nigeria lost 39.2% of its vegetative cover (forest and woodland). Mongabay also indicates that on average 409,700 ha of forest are lost per year in Nigeria.

According to the FAO (2009), the world has 1.468 billion head of cattle and Nigeria ranks 14th in global cattle population with 20 million heads of cattle making up 1.36% of the total global cattle population; livestock is the world's largest user of land resources. Cattle over the years have played a significant role in supplying the protein dietary requirement for man and only recently have there been calls to boycott beef because of its contributions to climate change and turn to other sustainable and eco-friendly choices to meet people's protein requirement.

5.1. Cattle grazing effects on climate methane

Methane is a greenhouse gas like CO₂, but the negative effect of methane on climate is 23 times higher than that of carbon dioxide (Howarth et al., 2011). Of all organic gases in the atmosphere, methane is the most abundant and this gas in the atmosphere has risen at about 12 ppb/yr in the past ten years (IPCC, 1995). Due to methane's radiative forcing characteristics, it affects the hydroxyl radicals and carbon-monoxide concentrations and ozone chemistry (Raynaud et al., 1988). There are two ways in which cattle release methane into the atmosphere; enteric fermentation and manure with enteric fermentation which contributes to climate change

(Stackhouse-Lawson et al., 2015). Methane is the by-product of the digestive activity that occurs in the rumen of cattle, it is known as enteric fermentation.

Cattle rearing and grazing are a major source of concern when it comes to climate change because of the amount of emission these animals contribute to climate change. They contribute more greenhouse gases than pigs, chicken, poultry and small ruminants, with their global estimate put at 2495 Million Tonnes of Carbon as shown in Fig. 3 above. The effect of methane as a greenhouse gas in its contribution to climate change is 25 times that of carbon dioxide. A cow does on average produce 70–120 kg of methane per year (EPA, 2017), and Nigeria has 20 million of them.

5.2. Carbon sequestration

Overgrazing has several adverse effects on plant communities (Milchunas and Lauenroth, 1993). Additional consequences of overgrazing are reduced species diversity, proliferation of unpalatable species, soil erosion, and soil quality degradation (Schlesinger et al., 1990; Milchunas and Lauenroth, 1993). Soil carbon is a result of the balance between inputs from primary production and outputs through decomposition. Soil carbon may reduce if inputs decline as a result of decreased net primary production due to overgrazing. Therefore, grazing is a vital human-controlled factor affecting grassland production which can deplete soil carbon (Ojima et al., 1993). Rehabilitation of degraded lands due to overgrazing can potentially sequester atmospheric carbon (Dlamini et al., 2014).

Overgrazing is also not totally in line with land degradation, important to note is that overgrazing can aid and increase ecosystem carbon stocks (wood thickening), while it can also lead to a decrease in soil carbon stocks (soil degradation). Grazing management can affect the levels of carbon stocks by upsetting the balance between the amount of carbon sequestered in the soil and the amount that leaves it (Mcsherry and Ritchie, 2013). The adoption of more efficient livestock management systems that involves improved animal feeding including dietary supplements will have a positive impact on food security by increasing productivity, the quality of beef produced and also carbon stocks in the soil (Conant et al., 2002).

The frequency of cattle grazing should be controlled to improve carbon sequestration in the soil. Noteworthy is the fact that methane emission, grazing frequency and growth of vegetation cover are all connected. Carbon sequestration should be taken into consideration alongside greenhouse gas emissions whenever the role of livestock contributions to climate change is analyzed. (FAO,

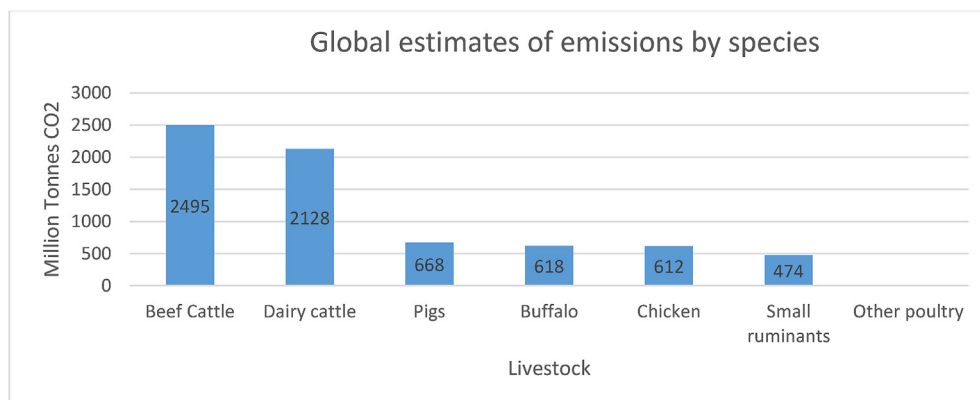


Fig. 3. Global estimates of emissions by species. Source: GLEAM (FAO, 2018).

2009). The chart below (Fig. 4) shows the inter-relationship between cattle and climate change.

6. Herdsmen and farmers conflict in Nigeria from a different perspective

Recently, in Nigeria there have been several cases of clashes between herdsmen and crop farmers (Bello, 2013), for instance, in March 2003, more than 100 people were killed in clashes between ethnic groups living next to Fulani herdsmen due to competition for limited forage resources in north-eastern Nigeria. While a lot of people have adjudged it to be solely a religious and political affair, the reality is the fact that the fight for limited resources has created this conflict (Brown et al., 2007). Countless lives, properties and source of livelihoods have been lost because of the competition for limited resources. If nothing is done to mitigate the effects of climate change, things will get worse and degenerate into a more extended conflict, even between nations (Brown et al., 2007).

Agriculture in Nigeria is majorly rain-fed and due to the effects of climate change, seasons have been irregular and unpredictable (Ateador, 2014). This has adversely affected food production for

both man and animals and is gradually creating a severe food security challenge for a nation whose population is geometrically increasing. If the impact of climate change is not mitigated quickly, the conflict due to competition for scarce and limited resources might spiral out of control (Odoh and Chilaka, 2012).

The competition for limited resources between farmers and herdsmen is a complex one, and this is a result of the struggle over ownership of land, water and other resources. This tussle is hinged on certain factors that border on reciprocity and flexibility. The most important resource for livestock farmers is the land but it is not solely their property (Sandford and Habtu, 2000; Thebaud and Batterbury, 2001; Nori et al., 2005). A practice of herdsmen is to wander from region to region seeking pasture for their cattle even in harsh and treacherous conditions, they live at the mercy of nature hoping to secure their animals. The increase and growth of the livelihood of herdsmen depend on the condition of their herd and grazing ecosystem which symbiotically depends on the availability of forage, watering points and several other ecological, socio-economic and safety conditions (Abbass, 2014).

As resources continue to diminish year by year, tensions mount and this can often lead to conflicts between livestock producers who need these natural resources. The rate at which the vegetative and forest cover is diminishing calls for urgent action.

7. Triggers/causes of conflicts

Pastoralist-crop farmers' conflict is the most predominant type of resource use conflict (Pasquale et al., 2007). The competition for resources among farmers and pastoralist have already caused losses of lives, properties, crop in various countries in sub-Saharan Africa, such as Nigeria, Namibia, Ghana, Kenya etc.; there are several causes of the conflict between herdsmen and farmers with various fractions claiming several causes of hostility. Climate change has caused migration with other associated factors such as freshwater scarcity, but importantly, struggle arises from access to sources of water rather than water scarcity itself (Audu, 2013), damage to harvested crops, destruction of farmlands, uncontrolled grazing, pollution of community water source from the herdsmen, assault on non-Fulani women by herders, violation of laws/tradition, while herdsmen report that animal rustling, blocking of water source and stock routes, commercialization of crop residues, harassment of herdsmen by host communities (Musa et al., 2014; Dimelu et al., 2016; Ukamaka et al., 2017) are the major effect of migration of herdsmen to the south caused by climate change.

The table above reveals the loss/year of primary forest and tree cover from 2001 to 2010 as 3771.59 ha and 25,531 ha, respectively, which will triple in the next decade (2011–2018) with 10,000.49 ha lost in primary forest and 75,815 ha lost in tree cover. This rapid loss of tree cover and primary forest amidst the rising needs for these natural resources by the geometrically increasing population is a major issue of concern. The loss of tree and vegetation cover exposes the land to environmental hazards and degradation which invariably reduces food output and land productivity. The competition for limited and scarce might lead to conflicts.

8. Possible solutions

When livestock quantities exceed the capacity of available land and water, migration to other places is unavoidable and this will lead to conflict between immigrant and residents. Constant conflict over land and water resources between herdsmen and farmers will have negative effects on food production and animal yield if there is no government intervention. This intervention must pacify both the aggrieved and aggressor for a lasting peaceful solution. Several attempts have been made in the past by the government of Nigeria

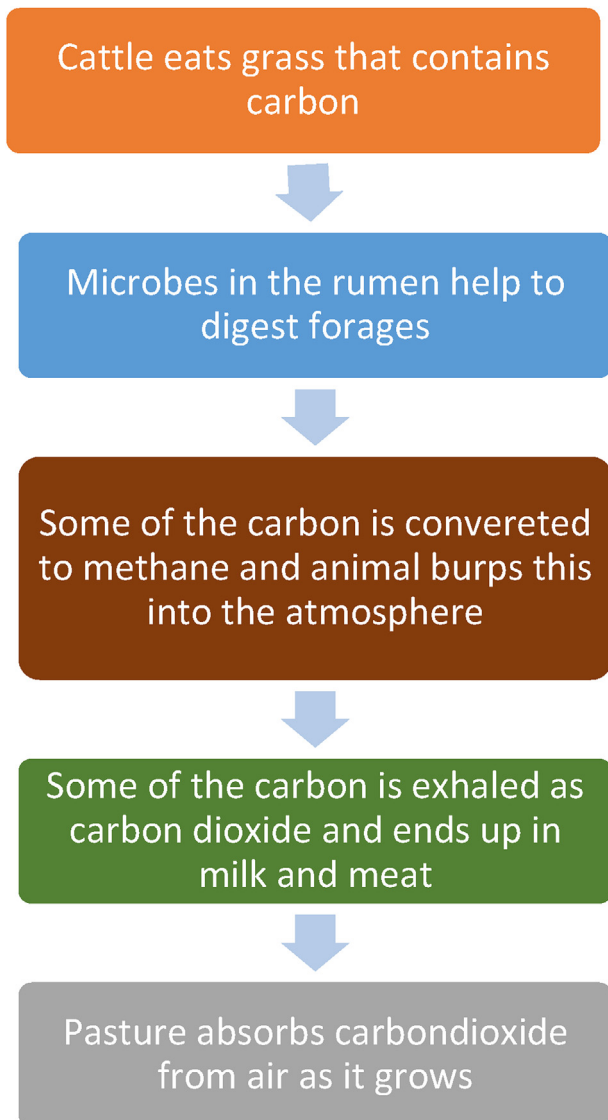


Fig. 4. Interrelationship of grazing and climate change.

but there has always been conflict of interest that is associated with religion, tribe, part ownership of the stock and this is why many times the interventions have failed or have met with stiff resistance. For instance, to find a solution, recently, the federal government of Nigeria tried to create a settlement across the country in each state as a grazing reserve for Fulani herdsmen, known as RUGA (rural grazing area). However, citizens resisted the move due to previous history of Fulani being unscrupulous and treacherous such that they claim a foothold when given a toehold such as recorded in northern Nigeria and Ilorin in Nigeria, as well as other livestock farmers who protested that the federal government has not given them such support. Furthermore, the cause of resistance was the political undertone associated with it. As such to avoid migration, government created *grazing reserves*, cultivating fodder crops in suitable areas, ranch land, digging more wells, dams and water in states that are predominantly Fulani so that they don't travel long distances and would avoid cultural trespass (Hou, 2005; Shang et al., 2012; Ubelejit, 2016; Tanimu and Akujuru, 2018).

Cattle and small ruminants number in western Africa had increased by over 155 million post millennium with cattle increasing by over 31 million (FAO, 2017). This increase in number leads to more demand for forages and more pressure on land and forages due to fast encroaching desertification. Such farmers can adopt the method of buying feeds, seeking other grazing resources (either reserved rangeland during dry season), housing livestock to protect animals from poor health (Hou et al., 2012) include selling livestock, buying feeds, buying fodder. In Nigeria, the rainy season is between April and October, therefore farmers can have large number of stock in this period due to availability of pasture, but when the dry season approaches (November to March) farmers can sell off old and non-productive livestock so that they can maintain a balanced herd that they can better care instead of keeping unnecessarily large numbers. Farmers could also sell off young animals, especially heifers, to get cash during the dry season (Liu and Wang, 2012; Ducrotoy et al., 2016). Shrinking livestock herds is necessary to maintain the balance between grass and animals on grasslands (Otterman, 1974). In southwestern Nigeria, cattle seller keep their animal in kraal without grazing. These farmers buy grass for these cattle daily to feed them. This could also be an option that can be explored by herdsmen. There is also a need for herdsmen to increase the use of crop residues, making and storing more hay and silage, or use of concentrate feed. There is also a need to build forage production bases with irrigation and actively adjusting the beef industry structure (Liu and Wang, 2012). This will enable herdsmen to store forages during the rainy season when the regrowth is faster.

Due to increasing environmental temperature in the future, herdsmen need to start rearing camels as a complement to their cattle, especially during the dry seasons. Camels have adaptive capacity to deal with harsh environmental conditions as they can tolerate dehydration, thriving for many days without water (Kagunyu and Wanjohi, 2014). However, there could occur diseases such as trypanosomiasis, camel pox, Rift Valley fever, pneumonia and ectoparasites (Kagunyu and Wanjohi, 2014). Small ruminants account for more than 50% of the global ruminant population and over half of these small ruminant reside in arid regions. Their CH₄ emission is lower than cattle (FAO, 2016; Monteiro et al., 2018). Furthermore, their abundance in arid zones and lower CH₄ emission intensity per kg of the final product (Adegbeye et al., 2020) shows that are hardy and environmentally friendly. This adaptable characteristic with lower greenhouse gas emission could make small ruminant rearing an alternative to large ruminant farming whose meat is still in demand (Adegbeye et al., 2020). Already, the small ruminant population is higher than cattle in Africa and its subregions. So, there is a need to diversify and improve yield derive

from diverse ruminants. Therefore, switching to small ruminants could be advantageous to reduce losses during the long drought season, because these animals have high fecundity and are hardy and resilient to drought.

9. Conclusions

It is time for more appropriate agricultural production practices for sustainable food production characterized by economically beneficial, environmentally friendly and socially fair agriculture for providing the nutritional needs for the vastly increasing global population. Some the ways to achieve sustainable agriculture are:

- Biocontrol and crop rotation to ensure pest control instead of excessive use of pesticides.
- Conservative tillage should be engaged to maintain physical properties of the soil such as aeration, water retention capacity, nutrient availability etc.
- Increased efficiency using practices with reduced inputs (e.g. fertilizers, water, pesticides) and improve crop productivity.

The efforts towards addressing the climate change-induced conflict between farmers and herdsmen over limited and scarce resources must be intensified. It is of paramount importance that the focus of the government and concerned stakeholders shift from just ending the conflicts to address the root cause and implementing proactive policies to improve structural development in agricultural systems to produce food for future generations.

Government should come up with policies that ensure the peaceful co-existence of crop farmers and herdsmen. Areas that have been set apart for grassland should be well protected from woody plant invasion and encroachment. In the absence of peace and security, there cannot be any form of development and growth. Also, the government should ensure that it is sincere with the campaign for reforestation all around the country, especially in drought-prone areas of Northern Nigeria.

Calling for a boycott of meat and increasing prices of beef and beef-based commodities in this part of the world because of its contribution to climate change is unrealistic as Nigerians still struggle to meet their dietary protein requirements. Individuals should make better food choices to help mitigate climate change. Sustainable livestock management should be adopted in order to solve this conflict, in such a way that more jobs are created poverty is reduced, food security is ensured, and the environment is protected to ensure availability of resources for future generations.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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