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Impacts of Deforestation on the Spread of *Mastomys natalensis* in Nigeria

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ABSTRACT

Lassa fever is an acute viral disease that is endemic in West African countries of Nigeria, Liberia, Sierra Leone and Guinea. Since the first case was reported in Lassa town Nigeria in 1969, Mali 2009, Ghana in late 2011 and serological evidences of the virus was reported in Togo and Benin in 2014 the virus has assumed an endemic proportion in West Africa. Deforestation which is the deliberate disruption of the natural forest ecosystem has been implicated as a major cause of the virus holding to the fact that the natural habitats of the rodent host have been tampered and hence they seek refuge in human homes. Most research work have been centered on the epidemiology ,hygiene and mode of transmission of the zoonotic virus without critical consideration of habitat destruction of this rodents that negate their relocation to human homes in search of food and alternative shelter. This review article aims to raise awareness on the urgent need to control deforestation acts in order to prevent further outbreak of Lassa fever.

Keywords: Deforestation, Desertification, *Mastomys natalensis*, Habitat destruction, Biodiversity, Lassa fever

1. INTRODUCTION

Lassa fever is an acute immunosuppressive and multi systemic viral disease characterized by severe morbidity and high mortality especially during epidemic outbreak among patients

(McCormick et al 1970, Gunther & Lenz 2004, WHO 2016). Lassa virus was first discovered in 1969 in a small town of Lassa in Borno state Northeast Nigeria (Frame JD 1970). Various investigations have reported that Lassa virus is probably transmitted by contact with excretions or secretions including faeces and urine of infected *Mastomys* rats accessing food items and water inside human residence and other centers with human activities (WHO 2016, Frame JD 1970, McCormick 1987). Human to Human transmission of the epidemic has been established in health care institution in Africa (Monath et al 1973). Population explosion, large scale deforestation, industrial and other social facility establishment deprives the *Mastomys* rodents of their natural habitat hence contributing to the increased cases of Lassa fever in West Africa (Sogoba et al 2017, Gonzalez et al 1983). The government's efforts to address the issue of deforestation in Nigeria have not yielded any result, this is evidentry from the rate of desertification experienced in the northern part of the country, for instance community nutrition is sometimes linked to fuel wood availability and cost, others depend directly on forest for their livelihood (Nigeria Environmental Study Group 1992). In 2000 the forest cover was estimated at 13.5million hectares compared to 17.5 hectares in 1990 indicating a forest cover of about 2.6% (Food and Agricultural Organization 2001).

Deforestation result from the removal of trees without adequate replacement which leads to reduction in wildlife habitat, biodiversity as well as wood and quality of life. When the habitat of these rodents is destroyed they seek refuge in neighboring structures which has predominantly occupied their space due to population increase, industrialization and agricultural purposes. *Mastomys* rodents breed frequently and produce large numbers of offspring and are numerous in the savannah and forests of West Africa, Central and East Africa, they readily colonize human homes and areas where food is stored, and all this factors contribute to the spread of Lassa virus from infected rodent (Khan et al 2008).

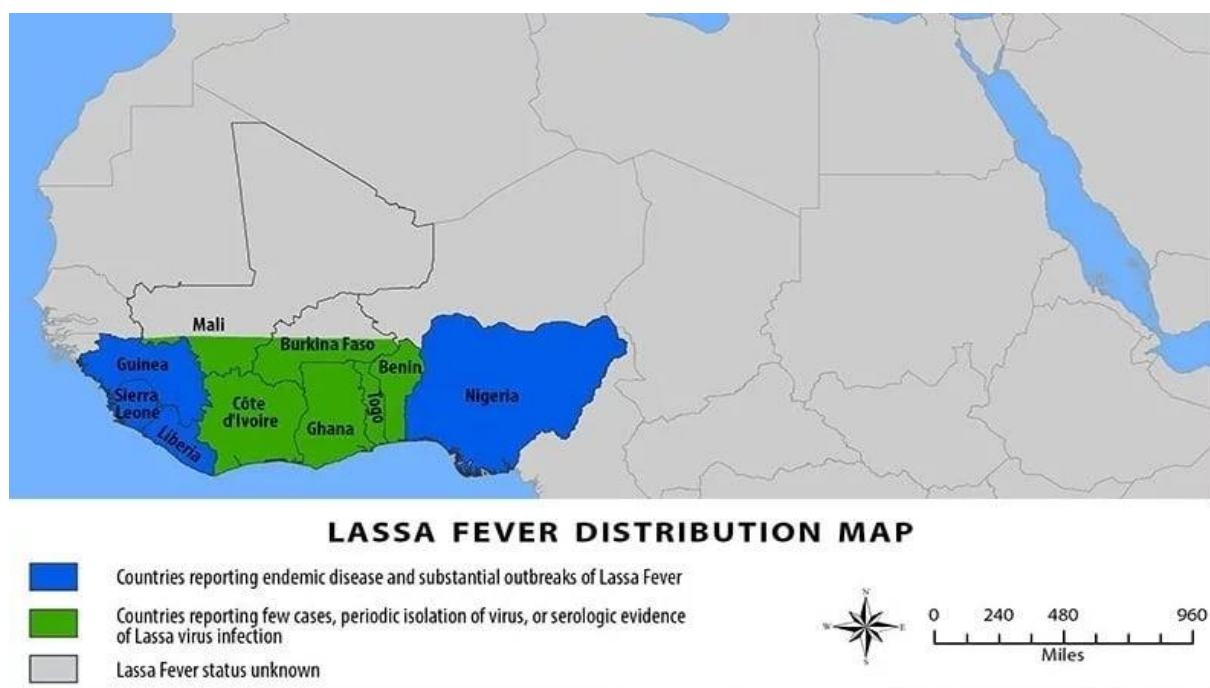


Fig. 1. Lassa fever Distribution in Africa

Source: Google Search

2. DESERTIFICATION A PREDETERMINING FACTOR OF DEFORESTATION: HEALTH TREND

Desertification is land degradation in arid, Semi – Arid and humid areas resulting from various factors including climatic variations and human activities (United Nation Convection to Combat Desertification 1997). Food and Agricultural Organization (FAO), the World Meteorological Organization (WMO) and U.N.E.S.C.O confirmed that about 15% of Nigeria land is prone to desertification (Emordi EE 2013). It has been estimated that between 50 and 75% of states Bauchi, Borno, Gombe, Jigawa, Kano, Katsina, Kebbi, Sokoto, Yobe and Zamfara in Nigeria are being affected by varying degrees of desertification. Deforestation is the conversion of forested areas to non-forested land (Olagunju 2015a). Nigeria is regarded as the world's highest deforested country and has lost about 55.7% of its primary forest from 1990 to 2010, Nigeria nearly halved its amount of primary forest cover with an annual deforestation rate of 3.6% between 2000 and 2010 (FAO 2010). This alarming situation prompted FAO to posit that the forest in Nigeria will disappear by 2020 if the current rate of forest depletion continues unchecked (Onyeanus & Otegbeye 2012).

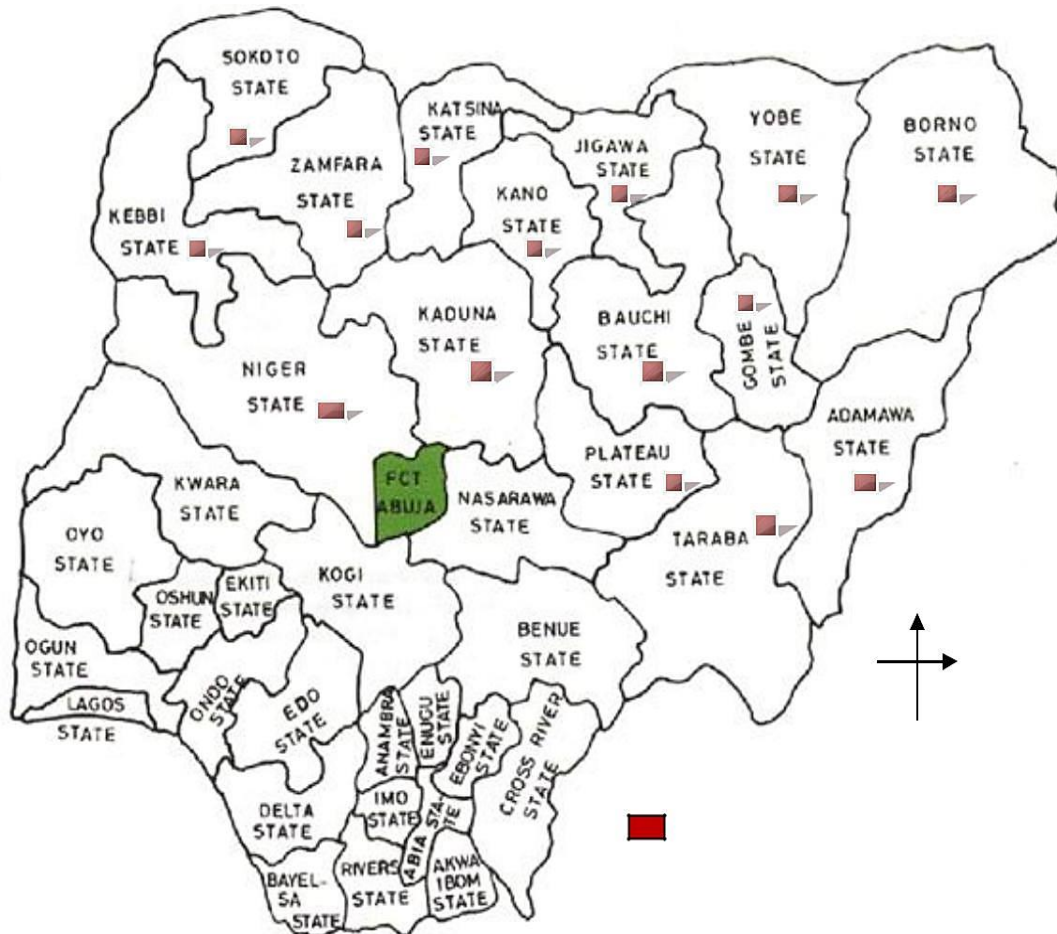


Fig. 2. Map of Nigeria showing the desertification frontline states.

Nigeria's wide biodiversity of 899 species of birds, 274 species of mammals, 154 reptiles, 53 amphibians and 4,715 species of higher plants will also be strongly affected by the negative impacts of deforestation all due to poaching by local mass and habitat destruction (Khan et al 2008).

The current state of Nigerian environment has been allowed by the State Department of forestry who have not implemented any Forest Management policies in effort to curb deforestation since the 1970s (Emordi EE 2013). Deforestation has been noted to exact negative health effects on human apart from Zoonotic transmitted diseases like Lassa fever, for instance heat wave can cause heat exhaustion, cardiovascular diseases etc. Higher UV ray exposure could suppress the immune response to infection of the host, in animals, high UVR exposure has been shown to decrease host resistance to viruses such as influenza and cytomegalovirus, parasites such as malaria and other infections such as *Listeria monocytogenes* and *Trichinella spiralis* (Patz 1996). It has also been proved that excessive exposure to sunlight can cause skin disease and cancer (Cunningham & Cunningham 2006). Skin cancer develops on body arrears of Agricultural laborers and farmers mostly exposed to sun e.g. hand, neck and face (McMichael & Githeko 2001).

3. HABITAT DESTRUCTION AND LOSS OF BIODIVERSITY A PROMOTER OF EMERGING DISEASE-LASSA FEVER TREND

Diversity is measure of the amount of variability in the species composition of a community (Don-Pedro 2009). Nigeria dry lands contains a large number of species of plants and animals that are important to humankind as a whole but are threatened as a result of deforestation practices occurring in the area.

Environmental threats to human health at global and regional levels include –Climate change, Ozone layer depletion, changes in ecosystem due to loss of biodiversity, land degradation, urbanization and stress on food producing systems (WHO 2017). In the tropics where there is high biodiversity ,ecological changes is greatest making this regions potential hotspots for the emergence of new pathogens affecting human, wildlife and domestic animal health (Jones et al 2008, Lambin & Meyfroidt 2011).

Land use changes occur mostly in many low – income countries that contain tropical forests (Lambin & Meyfroidt 2011). Land use changes such as deforestation, extreme livestock intensification (i.e. food production) without proper biosecurity have contributed greatly to spread of infectious diseases (Daszak et al. 2001, Machalaba et al. 2015).

The Structure and functioning of ecosystems and pattern of species distribution and biodiversity have been significantly altered by simultaneous expansion of agriculture and urbanization (Gibbs et al 2009).

Urbanization has been responsible for the decline in wildlife species availability due to their inability to adapt to the new environment (Mackenstedt et al 2015). Anthropogenic driven land use has been discovered to be highly correlated with the emergence of Zoonotic diseases (Patz et al. 2004).

By providing higher landscape suitable for rodent host reservoir and increasing human to host contact rates, Climate change and human population growth are predicted to be the most important drivers of Lassa fever Virus in western Africa by 2070 (Redding et al. 2016).

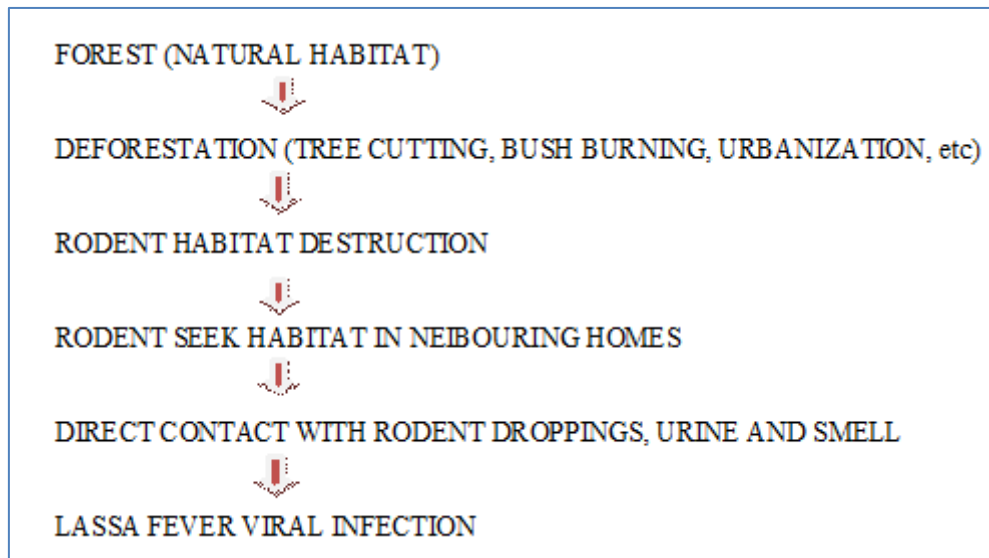


Fig. 3. Flow Chart of Habitat Destruction as a Cause of Mastomys Rodent Spread in Nigeria.

Biodiversity loss poses a significant threat to humanity. The global encroachment by humans into natural habitats drives habitat loss and fragmentation, leading to declines in species richness (Hadad et al. 2015). Human population density strongly correlates with the risk of emergence for all major classes of emerging infectious disease (Weiss & McMichael 2004). Lassa fever has been found to fall under this category. Human encroachment into species-rich habitats may simultaneously decrease biodiversity and increase exposure of people to novel microbes (Karesh et al. 2012). Recent advances have linked anthropogenic land conversion to multi-host models for pathogen transmission between species in intact and degraded habitats quantifying the changing infection risk across altered landscapes for multi-host pathogens (Faust et al. 2018).

4. CAUSATIVE FACTORS OF DEFORESTATION THAT PROMOTES SPREAD OF MASTOMYS NATALENSIS: LASSA FEVER TREND

Nigeria is located approximately between latitudes 4° and 14° north of the equator and between longitudes 2° 2' and 14° 30' east of the Greenwich Meridian. To the north, it is bordered by the Republics of Niger and Chad, to the east by the Republic of Cameroon, to the south by the Atlantic Ocean and to the West by the Republic of Benin. Nigeria National Bureau of Statistics estimated that the country has an approximate total surface area of 909,890 km² (National Bureau of Statistics 2010). The current Lassa fever outbreak in Nigeria shows an increasing trend in the number of cases and deaths in recent weeks. This is the largest outbreak ever reported in Nigeria. From 1 January to 11 March 2018, 1386 suspected cases and 114 deaths have been reported across 19 states, 365 cases have been classified as confirmed and 9 as probable (Case Fatality Rate = 24%).

A National Lassa Fever Emergency Operations Centre (NEOC) was activated on 22 January to coordinate response activities in collaboration with WHOM and other partners

(ALIMA). WHO supports the outbreak response mainly in enhanced surveillance, contact tracing, strengthening of diagnostic capacity and risk communication.

The reports of confirmed cases in different parts of the country and porous borders with neighbouring countries indicate a high risk of spread.

Deforestation is affected by: Competitions between humans and other species for the remaining ecological niches on land and in coastal region, this factor is substantially demonstrated by the conversion of forest land to other uses such as agriculture, infrastructure, urban development, industrial site and other anthropological uses. Failure in the working of the economic systems to reflect the true value of the environment, many functions of tropical forest are not marketed and as such are ignored in decision making (Pearce & Brown 1994).

Notwithstanding the above scenarios the following factors have been noted to contribute substantially to the endemic spread of *Mastomys* rodent as a result of deforestation in Nigeria.

4. 1. Agricultural activities

About 60% of the clearing of tropical forests is for agricultural settlement (Myers & Mittermeter 2000). The fact that more than 80% of the Nigeria populace are into farming explains the concern of environmentalists on agricultural induce deforestation in the country. Agriculture practices requires that the site is prepared through bush burning and felling of trees leading to deforestation, the slash and burn activity in tropical forests which is utilized during shifting cultivation has led to the permanent destruction of the rainforest (Nwobosh 1982).

4. 2. Urbanization

Clearing the forest is a pre-requisite for expansion of cities and towns for the establishment of infrastructures necessary to support growing population (Sands 2005), for instance, the 60 million hectares of land in Nigeria in 1897 declined to 9.6 million hectares after 100 years this represents a loss of 50 million hectares in 100years (Carty 1992). Ajaokuta steel plant and the Federal capital territory claimed 18, 390 hectares of Ajaokuta forest reserve in old Kwara State and 27,330 hectares respectively (Carty 1992). All this deforestation acts contributes to the spread of Lassa fever as a result of rodent habitat encroachment. Yellow fever outbreaks occurred for instance in both Congo and Brazil in 2016 and 2017, respectively, and in both instances the virus shifted from forested areas to urban populations, raising concerns about effective public health response and sufficient vaccine reserves (Dyer 2017, Ortiz-martinez 2017). The outbreak in Congo was associated with high population mobility and low vaccination coverage (Otshudiema et al. 2017). In Brazil, the outbreak was likely driven by anthropogenic deforestation and forest fragmentation (Ribeiro & Antunes 2009, Ortiz-martinez 2017, Rosseto et al. 2017)|.

4. 3. Bush burning

Fires a major tool in clearing the forest for agricultural purposes, if adequately used can be a positive tool in agriculture and forest management but if not used effectively can be a major cause of deforestation (Row et al. 1992). Farmers and hunters do set fire to forest in order to have a cleared land as well as fresh shoots for their animals respectively. During this process rodents and other animals are quitted from their habitat hence exposing humans to Lassa fever and other zoonotic infections. Slash and burn practice in agriculture and fire-hunting is a major cause of deforestation in Nigeria.

4. 4. Overgrazing

Overgrazing is more common in drier areas of the tropics where pastures degraded by overgrazing are subject to soil erosion. Overgrazing is also most common in areas that depend on extrinsic system of animal husbandry. It is a well established fact that over grazing leads to a gradual change in vegetation from derived Savannah to Sudan Savannah as the animals feed on tree seedling especially in the dry season when there is little grass to sustain them (NEST 1992).

Random grazing practiced in Akwanga area of Nasarawa State by Fulani nomads where grasses are set on fire to enable new ones grow for their cattle to feed on make sprouting of other plants difficult, this practice has led to the extinction of various plants (Aliyu et al. 2014). This practice has further promoted the process of deforestation and hence the spread of Mastomys rodents.

Table 1. Anthropogenic factors responsible for the spread of infectious diseases in Nigeria.

DRIVERS	ROUTE OF TRANSMISSION	EMERGENCE OF DISEASE
Land use activities	Contact with contaminated Excretions.	Increased incidence of hantavirus due to agricultural activities
Deforestation and Urbanization	Contact with Rodents urine and droppings.	Lassa Fever transmission due to contact with Rodent urine and Droppings
Consumption of Bush Meat	Contact with Wildlife meat or blood.	Ebola virus transmission due to wild animal meat or blood

5. MODE OF TRANSMISSION OF LASSA FEVER

The outbreaks of Lassa fever in endemic areas are mainly fuelled by activities or factors that encourage increased contact between man and rodent. They include deforestation, rodent hunting, bush burning, and agricultural activities such as rice cultivation that provide food supplies for rodents (Richmond et al. 2003)

West African Rural dwellers are at risk of Lassa fever infection because of proximity to animal reservoir, grains drying practice by road sides or outside homes and unprotected grain storage within homes. Factors such as this are known to facilitate increased rodent-man contact or contamination of food sources by infected rodent secretions (Ogoina 2013). Humans can also get infected when infected rat secretions (excreta or urine) make contact with non-intact skin (e.g. through cuts or sores) or liquid contaminated by infected secretions or by ingestion of food as well as by inhalation of aerosolized viral particles (Richmond et al. 2003).

Human to human transmission of Lassa fever has been reported in hospital settings following contact with infected blood, urine, and other body secretions of patients with Lassa fever or through contact with contaminated hospital equipments, including reused needles. Sexual transmission risk has also been reported since the virus is excreted in semen for up to three months after recovery from an acute illness (Richmond et al. 2003).

6. CONCLUSION

Deforestation is progressing more rapidly particularly in the tropics; the health implications associated with deforestation cannot be overemphasized. Spread of *Mastomys* rodent, the host of Lassa fever keep increasing due to various deforestation activities ranging from expansive agricultural practices, bush burning, fuel wood cutting, urbanization etc. It is imperative that the government implement more sustainable afforestation policies; this will ensure that the rodent's natural habitat is sustained. Also more agroforestry practices should be encouraged, this will ensure food supply availability for the rodent hence keeping them from searching for food in nearby homes and ultimately prevents Lassa fever infections.

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