POTENTIAL OF BAMBOO IN RESTORATION OF DEGRADED FORESTLAND IN NIGERIA: A REVIEW

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ABSTRACT
Forest as a diverse biological system faced with critical degradation condition due to increasing over exploitation, fragmentation, climate change and other environmental problems that are mostly caused by human activities. This is creating threat that the world must be concerned now and years to come. Bamboo is one of multifunctional, fast growing and a renewable plant that can be considered in landscape reclamation and restoration of degraded forest. This paper reviewed the status of Nigeria forest with the causes of forest loss such as deforestation which is currently at alarming rate, fuel wood exploitation, timber exploitation, overgrazing and encroachment. The paper examined the consequences of forest degradation which include destruction of micro environment, lowering of water table, climate change, flooding and drought. Furthermore, the potential of bamboo as green gold in forest restoration was discussed. This is because bamboo is a fast growing plant and the biological characteristics made the plant to be excellent in soil function restoration. Other socioeconomic benefits of bamboo as contained in this article include provision of ecosystem services, erosion control, enhancement of livelihood and food security. This paper recommends a policy formulation that will enhance scientific and holistic approach to the research, cultivation, management and processing of bamboo products for economic development.

Keywords: *Bamboo; restoration; degraded; forest land; Nigeria*

INTRODUCTION

Forestry is vital to human existence. From time being it has attracted much attention. This is because a wide range of resources are extracted from forest with many ecosystem services supporting human survival. Forests are important as storage of carbon, for production of oxygen vital for human existence on earth. It helps in the regulation of hydrological cycle, water purification, habitat for wildlife and reduction of global warming. It also helps in reducing pollution and absorbing toxic gases as well as soil conservation (Saka-rasaq, 2019). Forest is a source of wood mainly used by mankind in various forms for constructional works, as basic raw materials, for pulp and paper production, particle board making, plywood manufacturing, veneer production, furniture making, as industrial raw materials, as fuel in industries and home and a host of other products. Forest also have added value of conservation for scenic purposes, prevention of erosion, reduction of pollution, provide food and habitat for wildlife, prevention of many environmental problems and stabilization of climate. One of the services afforded by forests is the regulation of the world's climate through carbon storage and sequestration (IPCC, 2001).
Nigeria has an estimated land area of 923,768 km². This was once covered by extensive forests. According to an estimate, as at 1897, Nigeria had 60 million hectares of forests and woodlands (Oguntala, 1993). There is an enormous diverse of plant species which according to NEST (1991) are about 4614, out of which 255 are endemic. Unfortunately, we have taken these forests for granted because they were found everywhere and we have the notion that it will always be there to meet our needs. However, recent evidences point to the fact that our interaction with the forests through unsustainable exploitation of its resources, negative attitude towards its wanton destruction for other uses is creating a number of serious environmental problems. A larger proportion of Nigerian forests either reserved or not had been degraded.

The end results of the degraded and destruction of forest ecosystem includes land degradation, drought, desertification, destructive gully erosion, flood, climate change, depletion of ozone layer and biological diversity amongst other environmental problems threatening the existence of mankind. There is, no doubt, nexus between presence of forests and prevention of ecological problems. Many research scientists and stakeholders whose research efforts and mission focused on environmental protection, amelioration of degraded environments and conservation of forest resources for sustainable development is deeply concern about the high rate of degradation and wanton destruction of vegetation in Nigeria. It is therefore important to harness sustainable option to halt the present escalating rate of forest land degradation. This could be supported with policy strategy for recovering Nigeria forest land only for environmental protection but for sustainable national development.
It is necessary to restore the status of Nigeria forestland. This is because majority of household particularly the rural population gain their livelihood through proper productivity of land (CSA, 2015). One of the options of land restoration is the use of bamboo. Bamboo is imperative for re-establishing degraded landscapes that deteriorated by mining activities (INBAR, 2015). The plant has potential for sustaining forest resources, maintaining land degradation and economically supporting rural communities' livelihood. Despite the potential of bamboo in landscape restoration, less attention is given and there is limited knowledge on the part of communities around forestland towards management and cultivation of bamboo. This paper therefore discussed the concept of ecological restoration with a view to examine the potential of bamboo as a green gold in the restoration of degraded forest land in Nigeria.

CONCEPT OF ECOLOGICAL RESTORATION

Ecological restoration according to the Society for Ecological was define as an activity that initiates or accelerates the recovery of an ecosystem with respect to its health, integrity and sustainability" (SER, 2014). The progression of an ecosystem is usually from a simple level of organization (this involves dominance of few pioneer species) to a more complex community (i.e. many interdependent species) over time. Based on the extent and severity of the disturbance, restoration always includes initiating, assisting, or accelerating ecological successional processes.

Ecological restoration is an approach that can reverse the trend of land degradation and loss of biodiversity (MEA, 2005). This approach is necessary for a development that ensures sustainability and improvement in conservation efforts that is rising more pronounce in recent tie(Hobbs *et al*., 2011; Roberts *et al*., 2009). This is reflected in the increasing role of restoring ecosystem at all levels of environmental policy and in the process of ensuring ecosystem services (Bullock *et al*., 2011). The process requires effective strategies that consist of collaborative efforts of different specialists from relevant discipline (Aradottir, 2013). Ecological restoration is concerned has to do with the process of recovering the degraded ecosystems and attempts to restore their historical development trajectories by establishing and enhancing ecological processes (SER, 2004). The strategies of these disciplines include appropriate efforts with a view of restoring and reflecting this difference. Restoration process is positive when the ecosystems have high resilient and changes in management of their degraded state are sufficient for natural recovery to take place (Holl and Aide, 2011).

Forest restoration is the process that involve improvement of health, productivity, and array of life of a forest. Forest restoration is concerned with efforts of protecting remnant vegetation (fire prevention, cattle exclusion etc.) or more active interventions to accelerate natural regeneration as well as tree planting and/or sowing seeds (direct seeding) of species characteristic of the target ecosystem (FAO, 2016). Planted tree species (or encouraged to establish) include those that are typical of, or provide a critical ecological function in, the target ecosystem.

Plate 1: Degraded Forestland
Source: worldwildlife.org

FOREST LOSS AND LAND DEGRADATION IN NIGERIA

Forest and land degradation is a serious problem worldwide. It occurs in many counties. It has been reported that larger part of world's land is degraded. According to Abadega and Abawaji (2021), about 25% of the total land has been degraded globally. Currently, degradation of land is one of the world's most pressing issues and even it will worsen if immediate action is not taken. Land degradation is one of ecological problems affecting the livelihood of people, food security and increasing risk of disease. Worldwide, 3.2 billion people have been affected by land degradation, the impact of the degradation is especially severed for smallholder farmers who heavily depend on natural resources. Mostly land degradation occurs through human-induced livelihood activity and rarely by natural processes (Abadega and Abawaji, 2021).

Loss of forest cover is presently a major problem in the tropical region and indeed in Nigeria. According to Kio (2000), between 1964 and 1984, forests and woodlands were diminished by 26% while croplands and permanent pastures increased by 5% and 9% respectively. About 300,000 hectares of closed forests were cleared each year between 1981 and 1985 (WRI, 1987). The Forest Resources Survey by FORMECU (1996-1998) revealed that the forest cover of the country decreased by about 20% over the preceding 18 years, that is, 1978 and 1996. Indeed, the total forest estate which stood at the 10 percent of the country's land area in 1976 is now less than 6 percent (Bada, 1996). It has been reported that Nigeria has the highest rate of deforestation in the world. This is according to the Food and Agriculture Organization of the United Nations (FAO, 2010). The estimate by FAO showed that the rate of deforestation in Nigeria between 1990 and 2010. It was also revealed that Nigeria lost an average of 409,650 hectares or 2.38% per year. In total, between 1990 and 2010, Nigeria lost 47.5% of its forest cover or around 8,193,000 hectares. The annual rate of deforestation in Nigeria is 3.5%, approximately 350,000-400,000 hectares

per year. The greatest concern is mainly in respect of the significant loss of the high forest productive areas in the rain forest and derived Savanna losses.

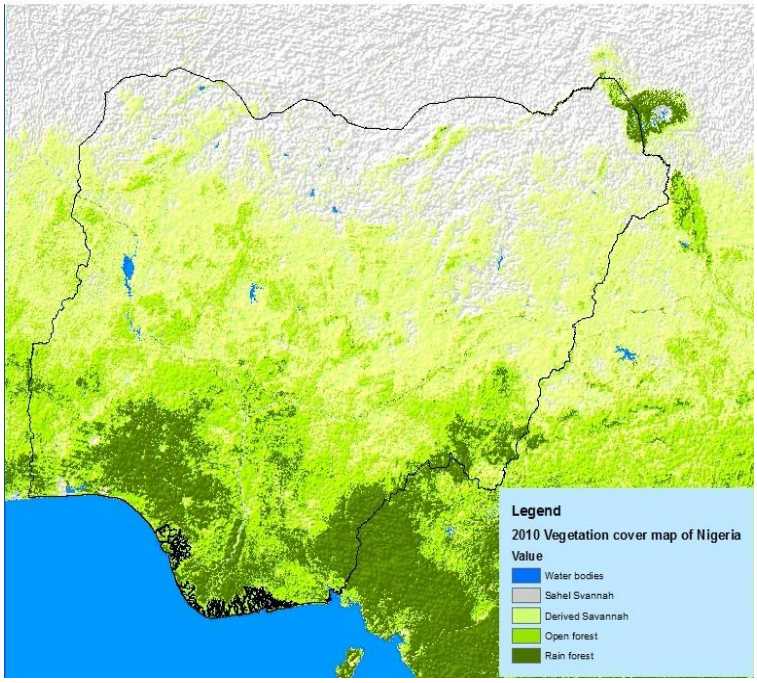

Figure 1: Nigeria Forest cover as at 2010
Source: FRIN Annual Report, 2016

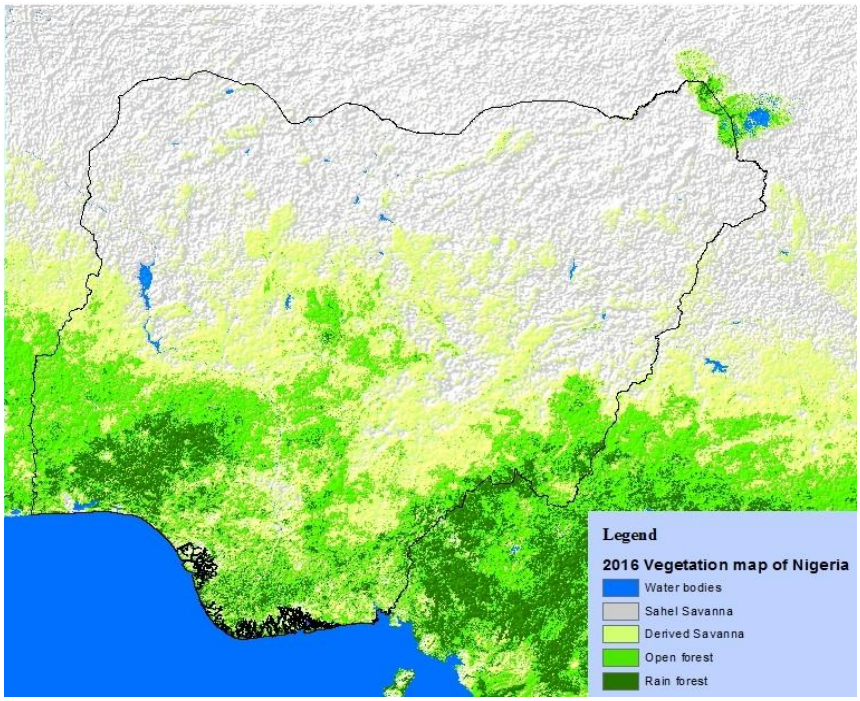

Figure 2: Nigeria Forest cover as at 2016
Source: FRIN Annual Report, 2016

CAUSES OF DECREASING FOREST COVER IN NIGERIA

In Nigeria, forest degradation is caused by population pressure, habitat degradation, over exploitation, change in land use, pollution and lack of emphasis on conservation (Adekunle, 2005).Causes or factors leading to reducing forest covers in Nigeria are summarized by several authors to include:

- **Deforestation**: The current rate of which deforestation is going on in Nigeria is becoming alarming. The forest reserves intended to be land under forest are been clear felled for agricultural purposes as a result of the availability of fertile land under forest cover.
- **Exploitation for fuel wood**: Till the present time, direct combustion of wood is used for heat supply households and rural industries. More than 80% of Nigerian population depends on firewood and charcoal as domestic source of energy. Adekunle (2005) noted that fuel wood is the only affordable energy source for the rural people who constituted about 77% of Nigerian population. In Nigeria, consumption of fuel wood, rose from 60.3million m^3 in 1980 through 90.75million m^3 in 1994 to 97.6 million m^3 in 2000 and has been predicted to rise 110.619 million m^3 by 2010. At this rate of consumption, if regeneration is not stepped up, reduction in forest cover will continue and its adverse effect on environment is imminent.
- **Timber exploitation:** In Nigeria large areas of natural forests are being exploited for tree species such as Mahogany, *Nauclea diderichii* (Opepe), *Terminalia ivorensis* (Odigbo), *Terminalia superba* (Afara), *Triplochiton scleroxylon* (Obeche) and other known timber species in International market. Indiscriminate logging and illegal harvesting of these tree species and others and continued to pose serious threats to the country's forest cover.
- **Overgrazing**: Intensification of herding activities lead to deforestation through overgrazing. The inadequate and non- provision of range levels for nomadic in Nigeria, has led to uncontrolled grazing and browsing of the forest covers. The livestock practice in Nigeria is nomadic in nature. Vast numbers of livestock, especially cattle, goats, sheep and camel roam and browse on forest covers on daily basis searching for fodder. When overgrazing occurs trees and shrubs destroyed, the land is eroded and trampled upon which automatically reduces its productivities capacities.
- **Construction**: Forest land is always cleared of the rich vegetation for construction of roads, public and private buildings, dams and provision of infrastructure. All these activities contribute to the reduction in forest cover of the nation.
- **Encroachments**: Despite the fact that Nigeria is not able to meet 25% of the landed area to be under forest cover as recommended by FAO, Nigeria forest covers are being destroyed to make way for other forms of land use such as farming, housing estate and roads. The high fertility of the forest lands as well as land hunger is the major factors which encourage land clearing of Nigeria's forest cover.

EFFECT OF FOREST DEGRADATION IN NIGERIA

Forest and land degradation cause soil erosion, and watershed destabilization resulting in flooding and drought. They reduce biodiversity (the range habitat species and genetic types). It contributes to regional and global climatic imbalances. According to Adedire (2002) the implications of reduction on forest cover include decrease in the amount of precipitation, increased in the amount of surface temperature and the alteration of local hydrology. Reduction in forest covers, has led to the increasing atmospheric concentration of carbon dioxide (Co_2), since the trees require for sequestration have been drastically reduced or completely lost. The consequences of reduction in forest cover include:

- ✓ **Soil erosion by rain and wind**: Forest cover destruction or reduction accelerates soil erosion case by rainfall, wind and sea waves. Deforestation in southern Nigeria with heavy rainfall resulted in the increase in amount of top soil removed every year and the incidence of gully erosion.
- ✓ **Destruction of micro-environment:** Excessive logging or removal of forest destroys the micro environment together with the habitats for flora and fauna. Climax trees and the animals that are often thriving under the canopies are destroyed when forests are excessively exploited.
- ✓ **Lowering of the water table:** The destruction of forests covers in Nigeria has led to the disappearance of springs, streams, rivers and lakes or total reduction in the sizes of many water bodies.
- ✓ **Changes in ecosystem:** A large proportion of the part of Nigeria, that was earlier classified as rainforest at the beginning of the 20th century now has the ecosystem of derived savanna woodlands as a result of excessive logging and bush burning.
- ✓ **Flooding and drought**: One of the functions of forest covers is to absorb and store great amount of water quickly when there are heavy rainfalls. When forests are cut down, the regulation of the flow of water is hindered which also leads to alternating periods of flood and drought in the affected areas.
- ✓ **Climate change:** It is commonly belief that global warming is being caused largely due to excessive reduction in forest covers and increase in greenhouse gasses like carbon-dioxide into the atmosphere. The effect of forest cover reduction is not limited to declining in number of rainy days and total volume of rain fall, but also increases surface run-off and reduce evapo-transpiration rate. The cumulative effect leads to reduction in amount of water available for atmospheric circulation.

BAMBOO: A GREEN GOLD AND CHAMPION IN DEGRADED FOREST LAND RESTORATION

Bamboo is an important plant in land restoration projects. The root system is long which can reach down deep that can draw up essential nutrients where other plants species find its difficult to assess, so they can grow on poor soil or on steep slopes. Bamboo offers important ecosystem services, making it an important plant for agro forestry (Akwada and Akinlabi, 2016). The reasons why bamboo is an excellent tool in degraded land restoration are discussed as flows.

Biological characteristics

Bamboo is basically a perennial grass with woody culms from rhizomes. The surface area of bamboo root is usually dense with a large network of rhizomes which form a mat-like structure that prevent seepage of soil water and provide good protection during sheet and gully erosion for soil conservation (Stapleton, 1994). Most of the bamboo species found in the tropics and sub tropics have sympodial/pachymorph type rhizomes (clumpforming). They have short and thick rhizomes. They cluster together. Large bamboo species under two genera (Bambusa and Dendrocalamus), and other smaller ones (Thamnocalamus and Drepanostachyum) fall in this category (Jackson, 1994). The rhizomes of amphipodial bamboos exhibit both running (leptomorph) and clumping (pachymorph) habits such as in Melocanna species. Monopodial bamboo has thin and longrhizomes such as species of Phyllostachys which run parallel to the ground, and produce isolated shoots at an interval of up to 3 m (Gautam *et al.*, 2018).

Fast growing plant

The growth rate of bamboo is approximately 121 cm in 24 hrs, hence, it is one of the fastest growth plant on earth (Adhikari, 2008). Depending on the species and other associated factors i.e. the prevailing edaphic and climatic factors, bamboo matures within 4—5 years (Yigardu *et al.*, 2016). Due to its nature in terms of growth rate, it is acting as remedial materials for reducing land degradation through fast recovery.

Ability to restore soil function

Gautam *et al*. (2018) in their study reported that besides ecological and economical values of bamboo, it is taken as biological measures for soil conservation due to its silvicultural characteristics. Bamboo produces evergreen leaves with dense foliage, it also produce numerous culms. This made it to have capacity for rainfall interception and a thick layer of litter that could maintain a microclimate in the understory for the retention of soil moisture, increased water holding capacity of the layer thereby enhances the soil infiltration properties and reduces surface flow and peak run off. Furthermore, the leaves, branches and stems from bamboo enhance the nutrient circulation and preserve soil fertility.

Due to extensive rhizome system Bamboo, It is a very good as it holds the soil together which help to reduce erosion, particularly in areas prone to high amounts of run off like steep slopes, river banks or degraded lands. As a result, the root system creates an effective mechanism for watershed protection, stitching the soil together along fragile river banks, deforested areas and in places prone to earthquakes and mud slides. Unlike in most trees, proper harvesting does not kill bamboo plants, so the top soil is held in place. The arrangement of rooting system is usually spread with uniquely shaped leaves, and dense litter floor, the sum of stem flow rate and canopy intercept of bamboo is 25%, which means that bamboo greatly reduces run off, preventing massive erosion and keeping up twice as much water in the watershed (Pandey and Shyamasundar, 2008; BF, 2010).

]Bamboo and climate change mitigation

The impact of climate change is fast becoming global reality. It is already affecting patterns of production and consumption activities, including international trade (Akwada, and Akinlabi, 2016). One of the major causes of climate change is deforestation which accounts for almost 20% of all anthropogenic emissions (ITTO, 2005). Carbon sequestration potential of bamboo is very high (RMRDC, 2004). It grows both in the forest and plantations (INBAR 2009). Bamboo is an important plant in reduction of global climate change effects. It could be efficient that any other plant in sequestration of carbon (Akwada and Akinlabi, 2016). The growth potential of bamboo contributes to high energy production of oxygen more than equivalent stand of trees. The growth of bamboo has significant implication in reducing atmospheric carbon dioxide being the fastest growing canopy that releases 35% more oxygen than equivalent stands of trees and sequester up to 12 tonnes of carbon dioxide from the air per hectare per year in a year (EBF, 2001). Advancing bamboo cultivation has advantage in green house gas emission reduction.

Other socioeconomic benefit of bamboo

Bamboo provides a great number of benefits for people on global basis. Majority of rural population in sub tropics and tropics live in bamboo houses. They build their agricultural infrastructures and tools from bamboo and sleep on bamboo mats. Nearly all areas of livelihood such as transportation, storage, medicine and food depend on bamboo (Ogunwusi, 2012). Bamboo can help provide food security for both human and livestock. The shoots of many species are edible and nutritious and they are a common ingredient in many dishes, whilst bamboo leaves are common source of fodder for livestock and feed for fish INBAR (2009).

Bamboo has been reported to provide shelter when properly managed (Jalan, 2008). In terms of house material provision, bamboo has been described as a poor man material for rural dwellers that depends on it for the building of their houses, bridges,

etc. In recent years, new designs and production technologies coupled with shifts in perception have made the construction of modern high quality houses that combine safety, durability and aesthetics from bamboo products possible and affordable (Jalan, 2008; Pandey, 2008). Bamboo can help reduce deforestation by replacing trees as a source of bio fuel (EBF, 2001). Bamboo is used as industrial raw material in a variety of sectors. Bamboo is used in the pharmaceutical, cosmetics, construction, wood, pulp and paper, textile industries, etc. In these industries, bamboo has largely replaced some of the traditional raw materials Ogunwusi (2011).

CONCLUSION AND RECOMMENDATIONS

Bamboo is a golden gold with distinguishable biological characteristics that makes it a valuable tool for land restoration activities. This characteristic includes the root system network of fibrous rhizomes and roots that can control erosion, flood and landslides. It is a resilient plant that can survive on marginal land. Planting bamboo can help speed up conversion of degraded lands into productive and economically viable systems. Bamboo can be grown as a pioneering plant in soil damaged by poor agricultural management techniques. Based on the excellent environmental and economic benefits of bamboo as well as potential role in forest degradation restoration, this paper recommends inclusion of bamboo in forest plantation establishment programme and policy formulation that will enhance scientific and holistic approach to the research, cultivation, management and processing of bamboo products for economic development.

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