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Effective Control and Eradication of Invasive Exotic Plant Species: An Imperative Tool for the Protection of Our Forest Reserves

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Abstract: *Invasive exotic species of plant cause economic and environmental impacts globally. It is unfortunate that Nigerians have varying levels of awareness and priorities for addressing them, practical experience in managing invasive exotic species and to address the issues raised by plant invasion. In forest reserves,exotic species violate the basic objectives of these conservation areas namely to maintain the natural ecosystem. Invasive flora are considered the greatest imminent danger to biodiversity of forest reserves and are adversely affecting the confirmed supply of the useful products supplied by forest. This paper presents various strategies that can be used to manage invasive alien plant species successfully, particularly in forest reserves which should be protected. The paper concluded that invasive exotic species should be controlled and managed efficiently through various means to ensure biodiversity conservation. Recommendations emerging from the study include that forest reserves should be strictly protected and restored to the original form to enchance sustainable development*

Key words: *Alien species, biodiversity, forest reserves, environmental impact, ecosystem and plant invasions.*

I. Introduction

The management of forest reserves is a remarkable legacy of the Nigerian government that has been successfully sustained and taken to greater heights. In Nigeria, the responsibility for forest regulation and management is allocated to the federal, state, and local levels of government in accordance with the System of laws and basic principles of the Country. Be that as it may, the Federal Government has taken the lead and is expressly committed to consolidation and expansion of the forest estate in Nigeria and its management for sustainable yield. Statutory regulation of the forest reserve in Nigeria dates back to the Forestry Ordinance 1901 during the colonial era which marked the inception of forest conservation in the country . The extant legislation are the Federal Forestry Act 1938 (consolidated in 1958 although that law is now dormant) and the respective states' Forest Laws. These laws are largely relics of the colonial era. The Federal Government and state government, under the applicable laws, are duly mandated to demarcate distinctive forest physiognomy as government "forest reserve" and "protected forests". Furthermore under the state Forestry Laws, a Local Government Council is mandated upon approval by the State Governor "to demarcate a large area of land which is designated as forest reserve and should have definite boundaries under the law (FAO,2010) .

The forestry laws are only tangentially relevant for the specific purpose of sustainable forest management in modern times. Indeed, the laws have been criticized as "… archaic… its unsuitability to modern day written requirements and its self-defeatist nature in appearing to unduly protect the interest of forest exploiters to the detriment of forest resources conservation."

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Under the Oyo State Forestry Law 1978 , for example, it is an offence, except with the written approval of the officer in charge for any person in a forest reserve to:

- Take any forest produce
- Uproot, burn, tamper with the exterior covering of the trunk and branches of a tree
- Set fire to any part of a forest or kindle fire without ensuring it does not spread Smoke within the boundaries of the forest reserve
- Pasture cows or permit them to trespass
- Engage in agricultural activities
- Engage in any form of trespass
- Cause any form of obstruction to the water bodies
- Reside or erect any structure
- Hunt or fish
- Damage using any method or destroy forest materials

Nigeria is by its location open to invasion by exotic plant species from several directions. Invasions have assumed great international popularity because of rapid landscape transformations by human influences and by natural forces. The forest reserve which is a protected area is not left out of this scenario. Effective management of the invasive plants species is a means through which the forest reserve can be saved and preserved in order to achieve its initial objectives.

Therefore, this paper intends to review the significance of forest reserve in sustainable development, the historical background of the forest conservation in Nigeria .impacts of invasive exotic plant species in our forests and the various ways of managing invasive exotic plant species with a view to sustaining our natural biodiversity.

II. The Meaning and Significance of Forest Reserves in Sustainable Development

Primary roles of forest consist of the production of timber, non- timber resources and production of water. In the past twenty years, additional roles of the forests have become equally important. Among which are educational and recreational roles, biodiversity conservation, regulating universal climate since forests are accepted globally as reservoirs for CO_2 which is relevant in global warming. Forest is also important for erosion prevention, water shed protection, soil stability and fertility and habitat for animals, serving as a reservoir which can be relied on during unfavourable conditions to improve crop production in order to ensure all round harvest (Longman and Jenik, 1987; FAO, 1997).

Kamugisha *et al.,* (1997) and Kaisha (1993) reported that forests are useful domestically in a number of ways which include traditional uses and for sustenance, example essential needs like water, food, fibre, materials for building and huge income from illegal exploitation of forest resources . Kaisha (1993) observed that forests are socially, economically and environmentally important especially tropical forest which serves as home to at least two thirds of the world's living organisms. He said further that forest plays crucial roles in the resources management of many countries but forest resources are at great risk because of severe exploitations.

Majority of the goods and services are derived from the forest reserves. Some of the major products include poles, timber, veneer and fuelwood. Some of these products can be obtained from other areas apart from the reserve which are not strictly managed. The manipulation of forest ecosystems worldwide is increasing tremendously (Abramovitz 1998). FAO (2005) estimated that annually above 10 million hectares of our forests are destroyed between 2000 to 2005. Among the earliest forests annual deforestation rose to 6.26 million ha from 5.41 million ha in the same period with earliest forest, transforming to less biodiverse plantations and succeeding forests. In 1980s demands for forest goods in Nigeria particularly timberland increased because of overpopulation and economic growth. This led to unlawful forest manipulation which put the forest in a bad state in the country (Ezebilo, 2004). The FAO (2005) estimates that Nigeria looses about

600,000 ha of her natural timberland annually through human activities that resulted into destruction of the forest. These human activities result in degeneration and deforestation of forest and forest reserves.

Recently, the Forest reserves have gained ground internationally because of the awareness of the significant roles they play in global development. In Nigeria, conservation of natural vegetation started with the establishment of the first forest reserve in the year 1899 (Eboh and Ujah, 2010). Forest reserves are portion of government land where logging and related activities are not permitted in order to sustain biodiversity that can be missing from other porous sites. It can also be referred to as areas where deforestation is prohibited because of the importance attached to its ecosystems and being habitats for numerous plants and animal species coupled with communities.

Eboh and Ujah (2010) observed that reserves serve as baseline for studying ecological baselines of natural change (background effects) and reaction to induce change (direct and active disturbance). Reserve can be referred to as a no going area to exploitative activities that may alter the physical components of such areas though some reserves are porous. Therefore, a forest reserve is a lawfully protected natural area which is guarded to avoid human interference and is primarily for the conservation of genetic resources and for scientific research (Dunster and Dunster, 1996).

Forest conservation is the judicious use of resources (biotic or abiotic) and activities in the forest in an attempt to restore, enhance, protect and sustain the quality of a desired plant and animal communities, physical conditions, biological processes for present and future generations.

III. Historical background of the forest conservation in Nigeria

In Nigeria, efforts at forest conservation dates back to the early years of 20th century (Aminu- Kano and Marguba 2002; Oyebo 2006). It is acknowledged that private land ownership was not the norm when the colonialists came but that low population densities facilitated demarcation of forests for conservation. These initial steps went so well that forest reservation went up from 970 km^2 in 1907 to 93 420 km^2 in 1970 Oyebo (2006). Then the target was to have 25% of Nigeria's land area under reserves. There were management plans for reserves. Large plantations of exotics were also established from 1960 and by 1988 there were 270,000 ha of such plantations. But problems had started creeping in by the 1930's when tracts of forest were given as concessions to timber companies. The government department of forestry was mainly concerned with inspection of exploitation activities and the collection of fees and revenue. The Land Use Act 1977 vested ownership of lands in state governments who saw forests as good sources of revenue.

The reservation of land for timberland purposes came into inception during colonian times. Attempts to expand the forest reserve have been unsuccessful (World Bank, 1990) The colonial objectives of forest management in Nigeria use to maximize the annual production of wood, mostly, timber and generate revenue on a sustainable basis (Oyebo, 2006). Strategies to achieve these objectives were the conversion of the natural forest to even–aged exotic and indigenous tree plantations with a management based on felling cycles. The *Taungya* system initiated in aid of this still survives to date. Oyebo,2006 states that there are 1,160 forest reserves covering 10,572,702 ha. Aminu – Kano and Marguba (2002) gives the proportions of each of the six geographical zones covered by reserves and when summed up, gives a total of 99,991.92 km^2, a figure that converts to 10.99% of our land area.

Majority of the goods and services are derived from the forest reserves. Some of the major products include poles, timber, veneer and fuelwood. Some of these products can be obtained from other areas apart from the reserve which are not strictly managed. Conservation areas in Nigeria include National Parks, Games and Wildlife Sanctuaries, Proposed Game Reserve/Wildlife Sanctuaries and Strict Nature Reserves (SNR). Wood demands far outstrip supply and Ojo (1994) projected an 80-100millions deficit by 2010. The biodiversity of these forests both protected (forest reserves) and unprotected are currently under threat from invasion by invasive species which could adversely affect the products and services from these forests. The establishment and spread of alien plants in forest ecosystems have not been widely considered until recently (wagner *et al* 2017).

IV. Invasive exotic plant species and their impacts

Invasive alien species are considered as a major source of danger to global biodiversity (Vitousek *et al.,* 1997; Sala *et al.,* 2000) as they change general make up and performance of local ecosystems (Chapin *et al.,* 2000; Richardson *et al.,* 2000; Levine *et al.,* 2003).They also constitute serious economic and malfunction problems (Davis, 2003). In addition, biological invasions have negative socio-economic and human health impact (Shakleton *et al* 2018, Potgeiter *et al* 2019, Roy *et al* 2019.). These invasive alien species have acquired significant infamy as constituting danger to indigenous ecosystem (Kunwar, 2003). A few of the species have rapid growth and keep into check the growth of other indigenous species. Consequently there is a drastic reduction in the floral diversity of the country in the process of introducing exotic species could alter the community indigenous composition and the disappearance of indigenous species, ecosystem operates and services. Reaser *et al*., 2007; Spotswood, Meyer, & Bartolome, 2012 ; Rojas-Sandoval, Melendez-Ackerman, &Angeles-Alcazar, 2016;). These exotic invasive plants significantly interest conservators, experts in ecology, forestry and science as well as stakeholders for their negative impacts in biology, ecology and socio-economy globally. They are causing massive destruction to biological diversity and the cherished natural agricultural systems that can sustain man. Health effects are becoming more critical and the destruction to nature is often not reversible. The effects are aggravated by globally change, critical disturbance of different kinds to species and ecosystems.

Chemical impacts include the release of allelochemicals which impact the regeneration of neighboring tree seedling directly (Rusterholz *et al* 2018) Chemical impacts also include the ability of alien plants to alter chemical and biochemical soil properties, which in turn can cause changes in the native species richness above and below the ground (Rusterholz *et al* 2018).Structural impacts refers to alien plants causing changes in the structural biotype characteristics of native environment ,nutrient or water cycles disturbance regime or natural succession (Campagnaro,*et al* 2018). Iincreasing connection globally with increment in business, export of goods have brought huge benefits to many people. It has however triggered the spread of invasive exotic species with massive undesirable impacts. This global problem requires international cooperation to eke out government actions, economic and public sectors as well as organization at national and local levels.

Species that are newly stabilized in a new ecosystem because of human interference are referred to as alien, exotic, introduced, foreign, non-indigenous and non-native species (Morse *et al.,* 1995, Morin, 1995) or even bioterrorists (Meyerson and Reaser, 2003) 5000 alien plant species have been estimated to be found in the United States' natural environment, compared with about 17,000 indigenous plants species (Morse *et al.,* 1995, Morin, 1995). Anthropogenic activities are known facilitators for the spread and establishment of invasive species (Kuffer *et al*., 2010; Reaser *et al*., 2007; Richardson & Pysek, 2012).

The extent of existence and availability of invasive species can also be determined by vectors that facilitate their scattering (Mortensen *et al*., 2009; Von der Lippe & Kowarik, 2012). Apart from being an indirect indicator of economic development, the presence of created road can play important roles as pathways for the dissemination of invasive species and by providing particularly propitious habitats (open and disturbed) for their establishment (Pauchard & Alaback, 2004; Sharma & Raghubanshi, 2009; Jolly *et al*., 2011; Vakhlamova, Rusterholz, Kanibolotskaya, & Baur,2016,.kerri *et al* 2016).Since the forest road system is well developed ,the risk of forest roads functioning as pathway for invasion should not be underestimated (Woziwola *et al* 2018) ,

Many exotic species cover minute areas and appear not to spread. Others have become thoroughly tangled in indigenous ecosystems and can be regarded as being naturalized.. Those that continue to extend quickly and speedily are referred to as invasive. Naturalized species producing numerous offspring's and atgraet distances from the parent plants were classified as invasive. (Pysek *et al.,* 2004).

'Native plant' refers to plants endemic (indigenous) or naturalized to a given area in geologic time. Among which are plants that have grown, occur naturally or existed for some years in an area (e.g trees, flowers, grasses and other plants (Theodoropoulos & Calkins, 1990) .The rapid spread of few invasive alien species in forest was mediated by the positive socio-economic effects of potentially invasive plant species in urban and rural areas.(Vaz *et al* .,2018,Castro-Diez *et al*., 2019).Therefore,several policies ,risk

assessment,and legislation are now in place to regulate the spread of invasive alien species in forest ecosystem(Potzelberger et. al., 2020)**)**

V. Effective Management Strategies

Management of exotic species has become a matter of great local and global concern

The best control option that can be used in managing invasive alien plant species can be determined by a factors among which are; knowledge of the potential destruction of the invasive plant, relative frequency of the plant species, description of the site, cost of the control method, environmental influence of the plant species.

Listed below are the preventive and control methods that can be adopted in controlling and eradicating invasive alien plant species.

- **Prevention and Early detection**:-obstruction of actions, early detection and eradication of the invasive alien species of plant is the most less expensive and efficient means of invasive plant management. Measures for early detection include forest maintenance and restoration (nobis *et al* 2017) coupled with sensitizing the forest management about the risk of plant invasion (Laube *et al* 2018) It is necessary that vegetative reproductive parts of invasive alien plants are not introduced into new areas. Practice that disturb the soil and facilitate the scattering of weeds should be avoided. Establishing the identity of invasive plants before their arrival is important for preventing destruction to native biological diversity. After introduction, control of established species may not positively after the cherished ecosystem functions because invasive species, in addition to other facilitators of global change, may have already changed and manipulated biotic interactions (Schlaepfer *et al*. 2011).

Many nursery professional will not encourage customers from planting popular invasive species but are often ignorant about which species are problematic (Burt *et al*. 2007). Relationship between invasive plant managers and the horticulture industry need to be fortified to improve better spreading of that information (D'Antonio *et al*.2004).

Other measures that should be taken include:

- Ensuring vehicles, equipment, goods and services are free from invasive alien plant species
- Treating new infestation as quickly as possible to prevent further spread
- Sensitizing citizens about the environmental impact of invasive alien plant species (Rupp *et al* 2017).
- Restricting movement of invasive alien plant species from roadways, railways and waterways etc
- Minimizing disturbance on the sites as invasion does not take place in natural areas but disturbed sites

VI. Eradication Measure

- **Mechanical Approach:** This is usually done by mowing or carrying out mechanical cutting/Felling of the invasive plant to reduce the rate of seed production. It involves clearing the plants before seedling stage. Plant should be cut severally to the ground level especially during the growing season. Also general management of the area enhances regeneration of native tree species.
- **Chemical Approach:** Invasive alien plant species can be treated with various herbicides, the kind of herbicide and method of application varies depending on the specific exotic species and environmental factors. Large infestation and infestation close to aquatic environment may be difficult to control by chemical mean. Chemical control does not require much labour though a lot of precautions must be observed to reduce effects on other plants in the surrounding. Some of the chemical that can be used are Glyphosate (The active ingredient in Roundup™ and Rodeo™) and Triclopyr (The active ingredient in Brush-BGone™ and Garlon™).
- **Biological Approach:** This method involves using living organism to limit the amount of seed that can be produced by an invasive plant species. The method is effective in large infestation that are near aquatic

environment. At times, one biological control agent can bring an invasive plant under control or at times, a combined agents are needed to ensure effective control of the plants. Biological controls can also take the forms of is the bioherbicide method which involves native, naturally occurring pathogens put into practical use in a manner that can cause death or serious destruction damage to the target species. Moreover, native pathogen are subject to natural controls, impacts beyond the target species are not likely the pathogen or bioagent are mostly Fungi, a reason that accounts for why the bioherbicides are sometimes called mycoherbicides.

- **Manual Approach:** This can be described as hand-pulling , digging out and manual removal of the entire plant prior to seed collection (Rupp *et al* 2017). This method works well for dealing with one plant or insignificant infestation that can be completely destroyed with little labor. This method is effective when invasive plants are on loose soil or shallow rooted. This method is not suitable for exotic plants that reproduce by roots and rhizomes.
- **Silvicultural Approach:** This method involves activities like adopting methods like continuous tree cover and longer rotation periods appropriately to promote shadier conditions in the forest environment. Forest pathways, that can be facilitates introduction of alien plants should avoided, hence no thinning activity in the forest.

VII. CONCLUSION AND RECOMMENDATIONS

Sustainable forest management can enhance environmental quality that is capable of helping Nigeria to achieve sustainable development.Though Nigeria is still far below the mark,our forest reserves should be strictly protected and restored to the original state by ensuring that the biological diversity of these areas is not altered. Moreover, a dynamic, natural and ecologically based approach to this is through effective control and eradication exotic of invasive alien plant species. In order to sustain our biodiversity in Nigeria, there is a dire need to increase the protected areas particularly the areas of conservation. It is recommended that the Nigerian Government needs to pursue workable policies that would ensure the sustenance of these vital resources.

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