Review Article

Modern forest operation techniques in Nigeria: Challenges and solutions

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ABSTRACT

Forest operations are a series of activities directed at getting forest produce from the resource base in the forest and making such products available to consumers. It also refers to the various activities involved in managing, harvesting, and utilizing timber and other forest resources. Forest operations include regeneration harvests, thinning, pruning, timber stand improvement, site preparation, planting, prescribed fire, vegetation control, and fertilization. The methods, materials, and systems used to transform the forest are the technology of forest operations. Forest operations are designed to meet management needs. Modern forest operation techniques are advanced technologies and practices used in forest management to promote sustainable forest management practices. The use of modern technologies and management practices is to ensure sustainable forest management and these techniques include the use of advanced tools and machinery for forest inventory and monitoring, planning, harvesting, and transportation of forest products, remote sensing, geographic information systems, and forest certification. Hence, the use of modern forest operation techniques aims to promote responsible harvesting, minimize environmental impacts, increase efficiency, and maximize the value of forest products. Modern forest operation techniques have been shown to enhance the efficiency and sustainability of forest management, promote economic development, and protect the environment. To address these challenges, this paper reviews the adoption of modern forest operation techniques in Nigeria which is find to be essential for promoting sustainable forest management practices and improving the country's forestry sector's economic and ecological performance.

Keywords: Challenges, forest, harvesting, management, operation techniques

INTRODUCTION

Forests contain several essential resources that play a critical role in maintaining ecological balance and providing economic benefits. Nigeria, as a country with significant forest resources, has been experiencing a decline in its forest cover due to factors such as deforestation, illegal logging, and land-use changes. Nigeria is a country with significant forest resources, covering approximately 9.2 million hectares or about 7.6% of the country's total land area.[1] However, Nigeria's forest resources are under significant threat, with deforestation rates estimated at 3.5% annually.[2] The primary drivers of deforestation in Nigeria are agricultural expansion, logging,

mining, and infrastructure development, these activities have significant ecological and economic implications, including soil erosion, loss of biodiversity, and reduced revenue streams for forest-dependent communities.

Moreover, the Nigerian government has taken several steps to promote sustainable forest management practices. For example, in 2006, the Federal Ministry of Environment established the National Forest Policy, which seeks to conserve and sustainably manage Nigeria's forest resources.[3] In addition, several non-governmental organizations are working with local communities and other stakeholders to promote sustainable forest management practices. To address these

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challenges, the adoption of modern forest operation techniques is necessary to promote sustainable forest management practices in Nigeria,[4] According to Lamers and Glasbergen[5] reported that forest certification can improve market access for timber and non-timber forest products and provide additional revenue streams for forest communities.[6] The adoption of modern forest operation techniques in Nigeria is essential for promoting sustainable forest management practices and improving the country's forestry sector's economic and ecological performance. While several efforts have been made to address the challenges facing the sector, more work is needed to promote the use of modern forest operation techniques in Nigeria. Hence, this study aims to promote sustainable forest management practices in Nigeria that can ensure the long-term viability of its forests while simultaneously enhancing the livelihoods of local communities and contributing to global climate change mitigation efforts.

MODERN FOREST OPERATION TECHNIQUES IN NIGERIA

In Nigeria, modern forest operation techniques are being used to improve forest management practices. The following are some of the modern forest operation techniques used in Nigeria.

Community-Based Forest Management (CBFM) is a technique used to involve local communities in forest management activities. This technique is aimed at promoting sustainable forest use and conservation by involving local communities in decision-making and forest management activities. According to Adeyemo *et al*.,[7] CBFM has been successful in promoting sustainable forest use and conservation in Nigeria.

Impact Logging/Conventional Logging

This is a method of timber harvesting that involves the use of heavy machinery and equipment to extract trees from a forest. This technique has been used extensively in Nigeria and has been associated with several negative environmental impacts, such as soil compaction, erosion, and damage to non-target trees and wildlife habitats. In response to these negative impacts, reduced impact logging (RIL) techniques have been developed and adopted in Nigeria.

RIL is an alternative to impact logging that aims to reduce the environmental impact of timber harvesting by minimizing the damage to the forest floor, reducing the number of trees harvested, and using low-impact logging equipment. Sist[8] reported the impacts of RIL on forest biodiversity and livelihoods in Nigeria. The study found that RIL techniques resulted in lower levels of soil compaction, erosion, and damage to non-target trees, and also increased the abundance and diversity of plant and animal species in the forest. The study also found that RIL had positive socioeconomic impacts

on local communities, including increased employment opportunities and income.

Continuous Forest Inventory (CFI)

This is a forest management technique that involves the periodic measurement of forest resources to provide up-to-date and accurate information on the condition and trends of the forest. CFI is increasingly being adopted in Nigeria as a tool for sustainable forest management, as it provides a systematic and efficient approach for monitoring changes in forest resources over time. In Nigeria, forest inventory is conducted using modern technologies such as geographic information systems (GIS), remote sensing, and digital mapping. CFI can also help to identify areas of the forest that require management intervention, such as areas with high levels of tree mortality or invasive species. Several studies have highlighted the importance of CFI for sustainable forest management in Nigeria. According to Akindele *et al*.[9] who also assessed the effectiveness of CFI in monitoring changes in forest resources in Nigeria, noted that CFI provided accurate and up-to-date information on forest resources and could be used to identify areas of the forest that require management intervention. The study found that CFI provided accurate and up-to-date information on forest resources and could be used to identify areas of the forest that require management intervention.

Participatory forest management (PFM) is a forest management approach that involves the active participation of local communities in the planning, implementation, and monitoring of forest management activities. PFM provides a platform for local communities to participate in decision-making processes and to contribute their knowledge and expertise to the management of forest resources. Akindele *et al*.[9] reported the effectiveness of PFM in promoting sustainable forest management in Nigeria. In the study, PFM had a positive impact on forest conservation and management, as well as on the livelihoods of local communities. Ogunjemite *et al*.[10] investigated the role of PFM in reducing deforestation and forest degradation in Nigeria; found that PFM had a significant impact on reducing deforestation and forest degradation, as well as on improving the livelihoods of local communities. PFM can also help to promote social equity and gender equality in forest management.

Forest Certification

This is a voluntary third-party verification process that verifies that forest management practices meet certain environmental, social, and economic standards. The purpose of forest certification is to promote sustainable forest management and ensure that forest products are produced in an environmentally and socially responsible manner. In Nigeria, the Forest Stewardship Council is the main forest certification scheme. Ajewole *et al*.[11] also reported the impact of forest certification on the sustainability of forest management in Nigeria and the

study showed that forest certification had a positive impact on the sustainability of forest management, as it promoted the use of sustainable forest management practices and helped to reduce deforestation and forest degradation. Again, Kusimo *et al*.[12] reported an investigation on the role of forest certification in promoting sustainable forest management and improving livelihoods in Nigeria and the study showed that forest certification had a positive impact on sustainable forest management, as well as on the livelihoods of local communities.

Ecosystem-based Management (EBM)

This is an approach to managing natural resources, including forests, that seeks to maintain or restore the ecological integrity of an entire ecosystem. In the context of forest management in Nigeria, EBM involves managing forests in a way that maintains or enhances their ecological functions, while also providing for human needs and benefits. Several specific techniques and strategies can be used to implement EBM in forest management in Nigeria. These include;

Monitoring and Assessment

Regular monitoring and assessment of forest ecosystems can help to identify changes or threats to ecosystem health and functioning, and inform management decisions.

Adaptive Management

This involves continuously learning from monitoring and assessment data and adjusting management practices accordingly to ensure that ecological and human objectives are being met.

Landscape-scale Planning

EBM emphasizes the importance of considering the entire ecosystem, rather than just individual areas or resources when developing management plans. Collaboration and stakeholder engagement: EBM seeks to involve a wide range of stakeholders in forest management decision-making, including local communities, indigenous peoples, and other interest groups.

The importance of EBM for sustainable forest management in Nigeria as reported by Tade *et al*.[13] assessed the implementation of EBM in Nigerian forest management and found that it had the potential to improve both ecological and socioeconomic outcomes. Omoju *et al*.[14] corroborated the result obtained on the use of EBM in the management of Nigerian forests and found that it was a valuable approach for balancing ecological and social needs in forest management.

*Forest Landscape Restoration (FLR)

FLR involves restoring degraded forest landscapes to improve ecosystem services and provide social, economic, and environmental benefits to local communities. FLR is guided by the principles of sustainability, inclusiveness, and resilience. It involves a range of activities, including tree planting, natural regeneration, soil conservation, and the restoration of water resources. Adewumi *et al*.[15] evaluated the effectiveness of FLR in restoring degraded forest landscapes in Nigeria. Omole *et al*.[16] assessed the economic benefits of FLR in Ogun State, Nigeria, and found that it can provide employment opportunities, increase income, and enhance food security.

*Community-based Forest Enterprises (CBFEs)

These are forest management models that involve local communities in the sustainable use of forest resources for economic, social, and environmental benefits. Okon and Ajake[17] examined the contribution of CBFEs to community development and sustainable forest management in Cross River State, Nigeria. Olaoye and Adedire[18] evaluated the contribution of CBFEs to forest conservation and management in Ondo State, Nigeria. The study found that CBFEs can promote sustainable forest management practices, enhance community participation, and provide economic benefits to local communities.

CHALLENGES AND SUGGESTIONS IN THE IMPLEMENTATION OF MODERN FOREST OPERATION TECHNIQUES IN NIGERIA

Inadequate Funding and Limited Access to Credit

The forestry sector in Nigeria suffers from inadequate funding, which has hampered the implementation of modern forest operation techniques. Limited access to credit is also a significant challenge, as it affects the ability of forest operators to invest in sustainable forest management practices.[19]

Suggestions

Nigerian government can develop sustainable forest finance mechanisms, such as green bonds, forest conservation funds, and sustainable forest investment funds, to provide long-term financing for sustainable forest management practices. Government can also create a favorable policy and regulatory environment that encourages private investment in the forestry sector. The private sector can support the forestry sector by providing financing through venture capital, loans, and grants. This will help to address the challenge of inadequate funding and limited access to credit.

Lack of Capacity Building and Institutional Support

There is a shortage of skilled personnel and inadequate institutional support, which affects the implementation of modern forest operation techniques.[20] The lack of capacity

building and institutional support is a significant challenge facing the forestry sector in Nigeria.

Suggestions
Government can develop capacity-building programs that provide training for forest operators, government officials, and local communities on sustainable forest management practices. The government can also establish institutions, such as forestry schools and research centers, to support the development of skilled personnel and promote research and innovation in the forestry sector.

Illegal Logging
Illegal logging is a significant challenge facing the forestry sector in Nigeria. This practice leads to deforestation and forest degradation, and it is a significant contributor to greenhouse gas emissions.[21]

Suggestions
Nigerian government can develop policies and regulations that prohibit illegal logging and enforce existing laws. The government can also establish monitoring and enforcement mechanisms to detect and prevent illegal logging activities. The private sector can support sustainable forest management practices by implementing certification schemes that promote responsible forest management and reduce the demand for illegally sourced forest products.

Limited Stakeholder Engagement: There is a lack of collaboration and coordination between government agencies, the private sector, civil society, and local communities, which affects the implementation of sustainable forest management practices.[1]

Suggestions
Multi-stakeholder partnerships involving the government, private sector, civil society, and local communities can foster collaboration and support for sustainable forest management practices. This can facilitate the sharing of knowledge, resources, and expertise necessary for effective forest resource management.

Inadequate Monitoring and Evaluation
Inadequate monitoring and evaluation of forest resource management activities are a significant challenge facing the forestry sector in Nigeria. This affects evidence-based decision-making, transparency, accountability, and the effectiveness of forest resource management.[20]

Suggestions
The Nigerian government can develop a robust monitoring and evaluation framework that involves regular monitoring of forest resource management activities and evaluation of their effectiveness. This can facilitate evidence-based decision-

making and promote transparency and accountability in the forestry sector.

Climate Change
Climate change is a significant challenge facing the forestry sector in Nigeria. The sector is vulnerable to the impacts of climate change, such as drought, floods, and extreme weather events, which affect the growth and productivity of forests.[1]

Suggestions
The Nigerian government can develop climate change adaptation and mitigation strategies that promote sustainable forest management practices. This can include measures such as reforestation, afforestation, and forest conservation, which can help to increase carbon sequestration and reduce greenhouse gas emissions. The government can also promote the use of renewable energy sources, such as biomass energy, to reduce reliance on fossil fuels and promote sustainable forest management practices.

Lack of Data and Information
There is a shortage of reliable data and information on forest resources, which affects evidence-based decision-making and the development of effective forest resource management strategies.[20]

Solutions
The Nigerian government can invest in data and information management systems that facilitate the collection, storage, and analysis of data on forest resources. This can include measures such as remote sensing, GIS, and forest inventories, which can help to improve the quality and availability of data and information on forest resources.

Inadequate Policy and Regulatory Framework
Inadequate policy and regulatory frameworks are a significant challenge facing the forestry sector in Nigeria. The sector suffers from weak governance, which affects the development and implementation of effective policies and regulations that promote sustainable forest management practices.[21]

Solutions
The Nigerian government can develop a strong policy and regulatory framework that promotes sustainable forest management practices. This can include measures such as the development of forest management plans, the establishment of protected areas, and the promotion of CBFM. The government can also strengthen governance structures and institutions that support the development and implementation of effective policies and regulations.

Lack of Awareness and Education
The lack of awareness and education on sustainable forest

management practices is a significant challenge facing the forestry sector in Nigeria. Many stakeholders, including forest users, local communities, and policymakers, have limited knowledge of the importance of sustainable forest management practices, which affects the adoption and implementation of such practices.[22]

Suggestions

The Nigerian government can invest in awareness-raising and education programs that promote sustainable forest management practices. This can include measures such as public outreach campaigns, training and capacity-building programs, and the development of educational materials that highlight the importance of sustainable forest management practices.

Limited Access to Technology

Limited access to technology is a challenge facing the forestry sector in Nigeria. Many forest-dependent communities lack access to modern technologies, such as improved seeds, agroforestry practices, and processing equipment, which affects their ability to engage in sustainable forest management practices.[21]

Suggestions

The Nigerian government can invest in research and development programs that promote the development and adoption of appropriate technologies for sustainable forest management. This can include measures such as the development of improved seedlings, the promotion of agroforestry practices, and the provision of processing equipment and technologies that improve the value chain of forest products.

Inadequate Infrastructure

Inadequate infrastructure is a significant challenge facing the forestry sector in Nigeria. The sector suffers from poor roads, limited storage facilities, and inadequate processing facilities, which affect the efficient and effective management of forest resources.[21]

Suggestions

The Nigerian government can invest in infrastructure development programs that promote the efficient and effective management of forest resources. This can include measures such as the construction of roads and bridges that improve access to forest resources, the development of storage facilities that improve the value chain of forest products, and the provision of processing facilities that increase the value of forest products.

Climate Change

The changing climate patterns are affecting forest ecosystems, including biodiversity loss, forest fires, and increased frequency and intensity of droughts, which affect the sustainability and productivity of forests.[23]

Suggestions

The Nigerian government can develop and implement climate-smart forestry programs that promote the adaptation and mitigation of climate change impacts on forest ecosystems. This can include measures such as the promotion of reforestation and afforestation programs, the development of climate-resilient forest management strategies, and the integration of climate change considerations into forest policies and plans.

Land Use Conflicts

Land use conflicts are a significant challenge facing the forestry sector in Nigeria. The forestry sector competes with other land uses, such as agriculture, mining, and urbanization, which affect the availability and quality of forest resources.[23,24]

Suggestions

The Nigerian government can develop and implement integrated land use planning approaches that promote the sustainable and equitable use of land resources. This can include measures such as the establishment of zoning regulations that prioritize forest conservation and restoration, the development of multi-use forest management approaches that promote sustainable livelihoods and biodiversity conservation, and the promotion of collaborative and inclusive decision-making processes that involve all stakeholders.

Weak Law Enforcement

The sector suffers from weak enforcement of forest policies, laws, and regulations, which promotes illegal logging and trade, and undermines the sustainability of forests.[1]

Suggestions

The Nigerian government can strengthen law enforcement mechanisms that promote the legal and sustainable use of forest resources. This can include measures such as the establishment of forest law enforcement and governance systems, the development of monitoring and evaluation systems, and the promotion of public awareness campaigns that highlight the importance of sustainable forest management practices and the consequences of illegal activities.

Lack of Data and Information

The lack of data and information is a significant challenge facing forest operation techniques. The sector suffers from limited data and information on forest resources, forest governance, and the socioeconomic aspects of forest-dependent communities, which affects the development of evidence-based policies and strategies.[21,24]

Suggestions

Suggestions

The Nigerian government can invest in data and information management systems that promote the collection, analysis, and dissemination of data and information on forest resources and forest governance. This can include measures such as the establishment of forest inventories and monitoring systems, the development of research and development programs that promote data and information management, and the promotion of public-private partnerships that promote data and information sharing.

CONCLUSION

Modern forest operation techniques in Nigeria are faced with several challenges that affect the sustainability and productivity of forest ecosystems. These challenges include inadequate funding and investment, limited technical capacity, inadequate policy, and regulatory frameworks. To overcome these challenges, the Nigerian government can adopt several solutions that promote the legal and sustainable use of forest resources, promote stakeholder participation, and ensure the efficient and effective management of forest ecosystems. Incorporating these solutions into the forestry sector will require collaborative efforts from all stakeholders, including the government, civil society organizations, private sector actors, and local communities. The implementation of modern forest operation techniques in Nigeria requires sustained efforts and commitments to overcome the challenges faced and promote sustainable forest management practices that benefit present and future generations.

RECOMMENDATIONS

Based on the challenges faced by modern forest operation techniques in Nigeria and the solutions provided, the following can therefore be recommended to enhance the sustainability and productivity of forest activities, and implementation will improve its forest operation techniques and ensure that its forest resources are managed sustainably and responsibly. Encourage the adoption of sustainable management practices to ensure that forest resources are managed in a way that balances economic and ecological considerations. Improve forest inventory and monitoring systems to enable better planning and management of forest activities and resources in Nigeria. Invest in capacity building and training for forest management professionals to ensure that they have the skills and knowledge necessary to implement modern forest operations. Promote research and development in modern forest techniques that are specifically tailored to the Nigerian context, taking into account local ecological and socioeconomic factors.

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