

SHORT COMMUNICATION

SILVOPASTORALISM IN SAHEL NIGERIA AS A PANACEA FOR DESERTIFICATION CONTROL AND CONFLICT RESOLUTION: A REVIEW

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ABSTRACT

This paper reviews the practice of silvopastoralism as a panacea for desertification control and conflict resolution in Sahel Nigeria. The contextual use of silvopastoralism in this work has been defined while its benefits, establishment and management techniques as well as its agro ecological requirements with particular reference to the study area have been critically analyzed. A review of available literature has shown that silvopastoralism has the potentials for combating desertification and conflict resolution in Sahel Nigeria despite economic hurdles including poverty, poor infrastructure, inadequate land and gross in availability of planting stocks. Similarly, a number of factors comprising shading, competition and inadequate agroforestry research programs constituted the major technical problems identified. The paper suggests adoption strategies and the prospects of silvopastoralism in Sahel Nigeria and concludes that government can rely totally on silvopastoral system to curtail conflict and environmental degradation ravaging the Sahelian parts of the country.

Key words: silvopastoralism, desertification control and conflict resolution

INTRODUCTION

The Sahelian parts of Nigeria experience climatic variability characterized by short rainy season and unpredictable rainfall pattern (YBSES, 2008). Similarly, considerable increases in meteorological values of temperature and wind speed have been reported in recent years (NIMET, 2014). The resultant effects of these changes are cyclical draught and gradual transformation of Savannah vegetation into Sahel (UNCCD, 1994). Besides climatic variability, the rate of deforestation is alarmingly very high. Consequently, desertification devastates arable land at 0.6 km per annum (FAO, 2009). Thus, the environment is severely degraded making agricultural production an onerous task. This is further aggravated by frequent cases of conflict between arable crop farmers and livestock grazers who migrate seasonally from the north towards the south in search of water and pasture. Lack of grazing reserves, livestock routes (Burtali) and in some instances unauthorized encroachment of such routes as well as wanton destruction of farm produce by the migrating herders were identified as the major causes of conflict between both parties in the region (YBSES, 2008).

The situation is so dire that tens of community settlements, farmstead and infrastructure have been overtaken by the deserts while hundreds of people are being killed annually besides destruction of thousands of crop and livestock products on account of farmer - grazer conflict (Muhammad, 2016).

It is therefore glaring that desertification and arable land user conflict are the major factors militating against economic production of crop and livestock products in Sahel Nigeria. Concerted efforts by government, nongovernmental organizations and other environmental stakeholders to control the situation seem to be temporary.

This paper therefore advocates for silvopastoral system as a panacea for combating desertification and conflict resolution between arable crop farmers and livestock grazers in the region. This can be feasible particularly for the fact that the system allows the production of both trees and pastures simultaneously under the same agro ecology. The former has microclimatic potentials and can therefore modify environmental conditions whereas the latter serves as fodder for livestock.

Silvopastoralism generates a number of definitions. However, the contextual use of the term shall be as put forward by [Wikipedia](#) (2019).

“Silvopastoralism is the practice of integrating trees, forage, and the grazing of domesticated animals in a mutually beneficial way”.

Suffice to state that silvopastoralism has three basic components namely: livestock, forage and trees briefly explained below –

Livestock

Livestock in silvopastoral systems are protected by trees from intense solar radiation and windstorm. Thus, the trees modify environmental conditions needed for higher milk, meat and egg output. In addition, certain tree species can serve as fodder for livestock. Yet, others produce fruit or nuts that are highly palatable to both small and large ruminants including sheep and goats as well as cattle respectively. In some instances, the leaves of some species are good sources of forage that can be produced continuously from coppicing or pollarding operations ([Wikipedia](#), 2019).

Forage

Under favorable conditions, well-managed silvopastoral systems can produce as much forage as open-pasture systems. They can also produce quality forage with higher nutritive value compared to non-silvopastoral systems at certain conditions. For instance, higher forage output has been observed in drought conditions in silvopastoral systems compared to open-pasture systems (NSB, 2005). Local grass species that can be incorporated into the program include *Cenchrus biflorus*, *Schoenefeldi gracilis* and *Aristida stipoides*, *lablab cajanus cajan*, etc,

Trees

Modify the local weather, protect animals and enhance their productivity besides provision of timber, fruits and nuts that are compatible with the requirements of the system. Animals on the other hand browse the pasture thus eliminating competition for environmental agents essential for tree growth. Their refuse improves both physical and chemical soil conditions required for higher productivity. Indigenous species suitable for this purpose include *Ziziphus mauritiana*,

Moringa oliefera, *Azadirachta indica*, *Mangifera indica*, *Acacia senegal*, *Acacia nilotica*, *Tamarindus indica*, *Balanite aegyptica*, *Faidherbia albida*, *Annaccadium occidentale*, etc, etc.(Muhammad, 2016)

Evidently, there is a complementary relationship among the three major components of the system. Silvopastoralism utilizes the principles of managed grazing, and it is one of the several distinct forms of agroforestry (World Agroforestry, 2019).

Benefits of Silvopastoral System

The simultaneous integration of trees and pasture produces biological interactions from which multiple benefits can be derived. These benefits among others include diversified sources of income, increased biological production, better water quality and improved habitat for both human and livestock. In addition, it ensures drastic reduction in the cost of tree maintenance. It further enhances nutrient recycling that promotes both physical and biochemical soil activities. Thus, well managed silvopastoralism increases organic matter that serves as the life wire of the soil (NAC, 2006). Above all, it is the most reliable in terms of utility, sustainability and versatility compared to other agroforestry practices (Carter, 2005).

Primarily, silvopastoral system is intended to serve two major purposes viz: provision of livestock feed and sustainable environmental management. For this reason, it can be effectively used to settle mobile grazers on one hand and combat desertification on the other. Generally, properly-managed silvopasture increases overall productivity of arable land with long-term income from production of tree crops, forage, and livestock. It also provides manifold environmental benefits including carbon sequestration, reduction in earth temperature mitigation of climate change as well as runoff, erosion, drought and desertification control ([Wikipedia](#), 2019).

Establishment

Silvopasture can be established by planting trees into existing pasture or by establishing pasture in existing woodland ([Wikipedia](#), 2019). These two establishment methods differ significantly. The former presents several challenges including protecting trees from livestock, waiting for

considerable number of years without income until trees mature and become productive as well as limited land utility for other purposes. The challenges of the latter encompass thinning operation required for infiltration of light which is costly, time consuming and in some cases it may involve heavy machinery. Again, it promotes rapid weed growth that competes both the pasture and the trees. Grazing commences 2 - 3 years when trees are large enough that they cannot be damaged by livestock (NAC, 2006). In other instances, tree tubes and electric fencing protect the young trees and grazing begins immediately. Keith (1977) in NAC (2006) uncovers more technicalities crucial to the success of the system including limiting the number of days animals remain on each site, avoiding compaction and irrigation where competition for water between the pasture and the trees may be a problem.

Management

Trees and shrubs can be regenerated artificially particularly in areas under increasing threats of desertification, drought, erosion and run-off. However, natural regeneration also works well with the system. Planting is normally accomplished in July when rains are well established. Trees are planted in a widely spaced pattern to avoid shading of pasture. Planting can also be accomplished in scattered or in rows across the rangeland to break the wind and to provide shelter for livestock. Young planting stocks are normally fenced to avoid trampling by cattle. Pruning and thinning operations are carried out based on silvicultural requirements of the species.

Agro Ecological Requirements

Can silvopastoralism thrive in Sahel Nigeria? The literature categorically states that the system can be practiced in all ranges of altitudes, soils, temperature, humidity and rainfall regimes (RAGT, 2019). Thus, it is highly versatile and can be used in areas with numerous and varied agro ecological conditions Sahelian parts of Nigeria inclusive.

Silvopastoralism and Desertification Control

As already highlighted, silvopastoral system integrates trees and pasture on the same piece of land. It is considered one of the many agroforestry practices with high desertification

control potentials (Muhammad, 2016). This is explained by the fact that the tree component of the system performs all physical function including draught, desertification and erosion control (UNCCD, 1994). The utilization of trees in projects and programs of environmental management has long been recognized by the United Nations. This is substantially reflected in its various agreements, treaties and conventions including the Millennium Development Goals (MDGs), the Kyoto Protocol, the Arusha Agreement and more recently the 2015 Paris Convention on Climate Change. The main thrust of these agreements centered on the development of tree plantation for sustainable environmental management. Recent researches corroborate this fact. For instance, in an Investigation of Socioeconomic and Ecological Effects of Agroforestry Practices in the North central Nigeria, Zira (2014) reported significant improvement in biophysical and environmental conditions of farmlands managed under agroforestry technique in southern Kaduna. Specifically, there was significant reduction in temperature and wind speed as well as improved humidity and rainfall pattern. These changes led to increase in vegetative cover and land productivity in the protected areas. This further confirms the more recent findings of Muhammad (2016) who compared *Azadirachta indica* and *Acacia senegal* based on two research variables namely; desertification control and revenue generation in Yobe State, Nigeria. Results further revealed greater modification of both the physical and chemical soil parameters in samples collected under the shelters of both species compared to the values generated from the control sites at the same stages of growth. Thus, trees considerably modify environmental conditions through several mechanisms including albedo of the plantation surface, evapotranspiration, aerodynamic, chemical and aerosol effects as well as interaction with carbon dioxide (Betts, 2006). All these functions can only be performed by trees and their integrated effects significantly control desertification.

Silvopastoralism and Conflict Resolution

As severally reiterated earlier, pastoralism will pave way for sedentary livestock production instead of transhumance involving seasonal migrations. This will automatically eliminate encroachment of

farmlands and concomitant destruction of farm produce. Again, it will check livestock rustling. These two factors – destruction and theft of farm products are the major causes of conflict in the region. This means that proper adoption of silvopastoral system can check the menace of conflict and desertification ravaging the Sahelian parts of the country. In other words, it is a singular land use practice with dual benefits of sustainable environmental management and conflict resolution.

Anticipated Problems

A number of economic and technical problems that could challenge Silvopastoralism in Sahel Nigeria include:

(i) Extreme poverty in the region. The bulk of the population lives below 1 US dollar per day (UNDP, 2008), let alone purchase the required materials or provide the needed collateral to back up loans from private lending agencies.

(ii) Poor infrastructure. Nigerian Sahel is predominantly inhabited by semi-nomads. Therefore, they produce crops and livestock in a system of transhumance which is probably the most sustainable way of utilizing the agricultural potentials of the region. This farming system is characterized by seasonal migrations occasioned principally by lack of water and other social and infrastructural facilities (Wikipedia, 2019).

(iii) Inadequate land. The increasing rate of urbanization, population and food production consumes large expanse of arable land. In addition, the remaining productive land is continuously being degraded by the action of both natural and anthropogenic factors. This creates considerable shortage of land that could have been use in production agriculture including silvopastoralism (YBSES, 2008).

(iv) Poor financial return at the early stage of the program

By their nature, agroforestry practices normally yield long term benefits against the immediate benefits derived from arable crop farming. This couple with high rate of poverty in the region can be another hurdle to their adoption.

(v) Inadequate supply of planting stocks

Although both public and private organizations raise and distribute planting stocks in the region, the quantity produced per annum is grossly inadequate to meet the needs of users. Most often, species raised are not suitable for silvopastoral system but for other physical

functions including afforestation and reforestation projects, sand dune fixation and stabilization programs, re-greening urban and rural settlements, erosion and drought control programs. This could probably be the reason for the high scarcity of planting materials suitable for silvopastoral projects.

Technical Problems to be encountered among others include:

(i) Shading is associated with light demanding species that produce dense and broad canopies. This creates low albedo and consequently, the arable pasture crop is not only deprived of solar radiation but is also subjected to extreme humidity resulting from heat transfer between the trees and the surrounding air (Betts and Ball, 2007).

(ii) Competition for water and nutrients is a serious problem in Sahel Nigeria due acute water shortage fueled by desertification. Lack of critical assessment of water requirements of both species can negatively influence the choice of desirable tree/ pasture combination.

(iii) Inadequate agroforestry research programs deprive indigenous people; public and private organizations from direct access to knowledge, innovations, techniques and technologies as well as improved agroforestry practices that can promote multiple land use programs and improved security of life and property.

Strategies for Adoption of Silvopastoral system in Sahel Nigeria

A number of strategies may be crucial to the successful adoption of silvopastoral system in the region. These include:

(i) Awareness creation

Adoption of any change programs requires proper understanding of the concomitant benefits and problems that go with it. Though the technique has been in use in the United Kingdom since 1970s (NSB, 2005), there is no evidence of its widespread usage in the Sahel and sub-Saharan Africa. This therefore stresses the need for greater awareness creation among all the stakeholders of the program. To achieve this, full involvement of extension service is inevitable. For it is the link between farmers and policy makers, research, marketing and credit institutions. All these stakeholders need information for their respective functions and

decision making. It is the duty of the extension service to generate and disseminate the required information. Thus, to be effective and efficient, extension services in the region need to be revitalized.

(ii) Selection of desirable tree and pasture combination

The selection criteria should consider the needs of the species, the environment and the users. For instance, the selection of the tree species must answer the three universal questions of plantation forestry --- Which species? Where and Why? Alternatively, the existing local species can be assessed based on these three objective inquiries. This allows the selection of species with highest physical, social and economic potentials. The grass or the fodder species can also be selected based on their strengths, weaknesses, opportunities and possible threats. The aim here is to select desirable tree and grass combination with positive physical and socioeconomic impacts on communities ravaged by conflict and desertification. In this regard, Wilkinson and Elevitch (2012) suggest appropriate selection criteria as follows:

“When choosing a species for a particular purpose, consider the multiple uses and functions the specie can provide. For example, while there may be many species that are wind-strong enough to suit your needs for windbreak, one should also inquire about other species that are wind strong and have other uses for your farm enterprise.”

The purpose here is desertification control and conflict resolution. The question asked is this: which tree species has the highest microclimatic potential? Can it also serve as forage for livestock? Can it resist climatic variability prevailing in Sahel Nigeria? Which pasture species can provide adequate and highly nutritive livestock feed despite the unfavorable conditions of the Sahel? Are there economic and ecological problems associated with large scale utilization of both the trees and the pasture? Answers to all these queries are deliberate attempt to avoid negative development at later stage. For example, the Australian experience with *Leucaena Leucocephala* is a lesson that serves as proper guide in large-scale utilization of any tree species (PIESR, 2002). Though it has fast growth rate and highly palatable, it was later

discovered that it is among 100 world`s worst invaders and that once it gets established, it becomes difficult to eradicate rendering extensive areas inaccessible and unusable.

(iii) Reclamation/Re-establishment of grazing reserves

The designated grazing reserves created since 1970s need to be reclaimed from degradation and encroachment. Degraded reserves can be reclaimed through efficient environmental management program such as reforestation and re-greening projects. However, encroached reserves that have been converted into farmlands or used in infrastructural development cannot be easily reclaimed. In such cases, it is advisable and more appropriate to enact laws that could pave ways for the creation and management of new grazing reserves.

(iv) Provision of infrastructure

Rural areas are the major sites for all forms of agricultural activities in Sahel Nigeria. In spite of their crucial positions however, most of them are devoid of modern conveniences of life due to the imbalance pattern of development (Osuala, 2001 and NPC, 2005). Absence of social and infrastructural facilities such as schools, hospitals, electricity, pipe-born water and roads has been responsible for rural-urban drift. The mass exodus of able bodied men and women considerably reduces the size of labor force that could have been used in silvopastoralism. Thus, successful silvopastoral program in Sahel Nigeria would require provision and maintenance of such facilities at the door-steps of the rural populace.

(v) Motivational incentives

The pastoralist in the region should be motivated to adopt silvopastoral programs through a number of incentives including stipend when they grow species with high economic and physical potentials. For instance, *Acacia senegal* can be cultivated alongside various pasture species for a number of reasons

► It is one of the most popular nitrogen fixing trees and can therefore improve the impoverished sand of the Sahel (FACT NET, 2001).

► It has product of high market value (Acacia Market Report, 2006).

►It is drought resistant and effective for desertification control

Thus, when sufficient number of planting stocks are raised and distributed to the grazers at the climax of growing season, they would be encouraged to plant and manage them at strategic locations across the grazing reserves.

(vi) Funding silvopastoral researches in various universities and research institutes including Universities of Agriculture in Abeokuta and Makurdi, Gum Arabic Research Institute Jawa, Lake Chad Research Institutes Maiduguri, International Institute for Tropical Agriculture Ibadan [IITA], etc.

(vii) Re-establishment of marketing and commodity boards earlier abolished to purchase crop and livestock products directly from both farmers and grazers respectively at rates that can guarantee increased future production (Adegeye & Dittoh, 2005).

Prospects of silvopastoralism in Sahel Nigeria

The prospects of silvopastoralism in the Nigerian Sahel are manifold.

First; the region is free from tsetse flies and trypanosomiasis that constitute a bottle neck to production of livestock at economic scale. With silvopastoralism, the herders would save the energy, time and resources they expend in seasonal migrations. In other words, sedentary agriculture would replace transhumance, while the other inputs can be invested intensively into improved management. This guarantees higher productivity of the livestock enterprise. Furthermore, the system

would automatically resolve the incessant farmer-grazer conflict since migrations – the principal causes of the conflict are illuminated. Second; the monthly ecological funds allocated to the states can be used to finance the program besides funds received from donor and collaborative agencies including World Bank and relevant agencies of the United Nations such as Food and Agriculture Organization (FAO), United Nations Environmental Protection (UNEP) as well as Nongovernmental Organizations (NGOs). In addition, various agencies of government can collaborate and provide the much needed social and infrastructural facilities.

Third; the National Animal Production Research Institute (NAPRI) can be mandated to

extend scientific methods, techniques and technologies of livestock production and management to the settled grazers. Here, training and visit system can be fully exploited particularly in areas of feeding, housing and health care. Similarly, the Forest Research Institute of Nigeria (FRIN) can in collaboration with relevant agencies, undertake research in critical aspects of silvopastoralism in particular and multiple land use practices in general.

Four; the national legislature can significantly promote silvopastoralism by enacting objective and result oriented environmental laws. Existing laws need to be updated to make them more responsive to the challenges of the operating environment.

Five; public and private lending institutions can mobilize funds needed for all feasible silvopastoral projects without interest and collateral. This can trigger the nomads to seek and experiment supervised credit scheme that has been tried and found successful in many countries of the world.

Six; public empowerment programs such as **N-power, trader-moni, market moni and farmer-moni** as well as motivational incentives can be extended to the rural areas to promote greater participation and widespread acceptability of the program.

CONCLUSION

One of the greatest failures and embarrassments in the Nigeria's efforts towards desertification control and conflict resolution is the fact that as the world prepares to celebrate global sustainable environmental management and conflict resolution, the country is still grappling with crude techniques and technologies of land use practices that are highly inefficient in achieving the desired objectives. The same technique was used successfully in the United Kingdom to promote timber production and wildlife conservation. Nigeria can equally domesticate the practice to suit its physical, social and economic peculiarities. The task at the moment is to look inwards and exploit the potentials of our available resources. This paper provides an opportunity to reactivate multiple land use practices in Nigeria. The program requires active support and participation of all environmental stakeholders including crop and animal scientist, engineers, lawmakers, public and private financial institutions, research institutes, environmental associations as well as

extension specialists which Nigeria can produce. If Nigeria therefore does not review its land use regulations, the national objectives of stable and productive environment will ever remain an unaccomplished dream.

REFERENCES

- Acacia Market Report (2006, May 18). Grade 1 Acacia senegal. Article 102. Retrieved August 22, 2006, from: <http://www.agricproducts.com/whatsnews/news-2000-03-acacia-market-report.html>.
- Adegeye, A.J. & Dittoh, J.S. (2005). Essentials of Agricultural Economics. Impact Publishers (Nig.).Ltd, Ibadan, Nigeria.
- Betts, R.A. (2006). Forces and feedbacks by land ecosystem changes on climate change. J. Phys. IV France, 139, 123-146, doi: 10.1051/jp4:2006139009.
- Betts, A.K. and Ball, J.H. (2007). Albedo over the boreal forest. J. Geophys. Res., 102, 28901-28910, doi: 10.1029/96JD03876.
- Carter, M. (2005). Agro forestry: An article on Agro forestry accessed via net library @ <File://E:/Agroforestry Overview.htm> on 18/09/2006
- Food and Agriculture Organization (FAO) (2009). An Economic Analysis of the Value of Shelterbelts to Northern Nigeria's agricultural production. FAO forestry development paper No 18 Rome.
- Forest, Farm and Community Tree Network (Fact Net)(2001). *Acacia senegal*. Retrieved May 26, 2004 from: <http://www.winrock.org/farm/factnet/aetPub/FACTSH-acacia senegal.html>
- Muhammad. K. (2016). Comparative Analysis of Neem (*Azadirachta indica*) and Gum Arabic (*Acacia senegal*) for Desertification Control and Revenue Generation in Yobe State, Nigeria. An unpublished PhD thesis submitted to the Department of Forestry & Wildlife Management, Modibbo Adama University of Technology Yola, Adamawa State, Nigeria.
- National School of Biology, University of Leeds (2005). Agroforestry Experiment-AF2 Silvoarable with Poplar.
- National Planning Commission (NPC)(2001). Federal Republic of Nigeria: Development Cooperation 1998/1999 Report. Abuja, Nigeria.
- National Agro forestry Centre (NAC, 2006). Agroforestry practices: accessed via Net Library @ <File://E:/Agroforestry Overview.htm> on 18/09/2006.
- National Meteorological Agency of Nigeria (NIMET) (2014). Summary of meteorological Records of Weather Variables from 1999 - 2013 retrieved from Nguru coordinating office, Yobe state, Nigeria.
- Osuala, E.O. (2001) Foundations of Vocational Education: A Behavioural Objective Approach. Centaur Press Limited, Calabar, Nigeria.
- Pacific Island Ecosystem at Risk (PIER). (2002). *Leucaena leucocephala*. Retrieved July 09, 2006, from: <http://www.hear.org/pier/species/leucaena-leucocephala.htm>.
- Rwanda Agroforestry Guidance Tool (RAGT) (2019). Silvopastoralism at <http://worldagroforestry.org/agt/rwanda/agroforestry-practices-in-rwanda/es-silvopastoralism>
- United Nations Convention to Combat Desertification (UNCCD) (1999a). Desertification: Causes and Effects. Retrieved March 8, 2016, from: <http://www.unccd.int/en/about-the-convention/Pages/Text-Part-I.aspx>
- United Nation Development Programme (2008). Millennium Development Goals accessed @ <http://www.undp/mdg/goal1>. Shtml.
- Wilkinson, K. and Elevitch, C. (2012). Multipurpose Trees. Retrieved December 31, 2012, from: ejournal of Agroforestry @ www.Overstory Online No. 16
- Wikipedia (2019). Silvopastoralism @ <https://en.wikipedia.org/wiki/Silvopasture>
- World Agroforestry (2019). *Eastern Savannah – Silvopastoralism* accessed @ <http://worldagroforestry.org/agt/rwanda/agroforestry-practices-in-rwanda/es-silvopastoralism> on 22/06/2019 at 7:07 pm.
- Yobe State Economic Submit (YBSES) (2008). The Yobe Environment: Problems and Proposed Intervention. Spectrum Books Limited Ibadan, Nigeria.
- Zira, B.D. (2014). Socioeconomic and Ecological Effects of Agroforestry Practices in Southern Kaduna, Nigeria. Unpublished PhD thesis, Modibbo Adama University of Technology, Yola, Adamawa State, Nigeria.