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The Role of Shelterbelt in Desertification Control: Local Perspectives, Obsevations and Analysis from Semi-Arid Areas of Katsina State, Northern Nigeria

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Abstract:
Shelterbelt/afforestation is among the approaches adopted by the donor nations and tiers of government for ecosystem restoration in arid and semi-arid areas of northern Nigeria, This study investigate the views of the local people where these shelterbelts are located. Household survey, focus group discussion and transect walk were used in the data collection. Some of the respondents acknowledge the impact of the shelterbelt/afforestation project in ecosystem restoration and minimising the menace of desertification. However, it has been observed that this project contributed to the reduction in plant biodiversity due to natural ecosystem replacement with exotic species; disruption of natural biological process and decrease in soil moisture as result of increasing water consumption by the new tree species. It is concluded that to successfully reduce the impact of desertification in the area environmental planners must determine which vegetation a given environment can sustain naturally.

Keywords: *Desertification, afforestation /shelterbelt, sahel and sudan savannah, Katsina state, northern Nigeria*

1. Introduction

Desertification and drought are the two leading environmental hazard in savannah (grassland) region of Nigeria since the major drought (1913-14, 1931-14, 1942-43. 1972 -73, and 1983-84) of the 20th centaury which compelled international development agencies and donor nations to give priority to development programmes in arid and semi-arid areas of Africa because of fraility and fragility of these ecosystem (Adeghbehin et al., 1990, Oladipo 1993).

Keay (1959) in Otegbeye (2004) classified Nigeria into rainforest and savannah and further subdivide the latter into five ecological zone, southern gunea, northern guinea savannah, sudan and sahel savannah and transition zone called derived savannah.

The savannah region lies within 6 27o to 14o N and longitude 2 44o and 14 42oE, and covers 849,496 square kilometres or 86% of the country's land area and contain over 60% of its population and it is considered as a "grain basket" of Nigeria, producing large proportion of the main staple diet of the population such as sorghum maize millet cowpea and wheat. (Adeghbehin ,1990). The Sudan and Sahel savannnah ecological zones are more susceptible to the hazard of desertification particularly north of latitudenb12oN which is the transition belt between the humid areas to the south and the Sahara desert in the north. (Oladipo, 1993). The problem of desertification in the Sudan and Sahel savannah have been attributed to physical characteristics of the soil, nature of the vegetation, topography of the area, inherent extreme climate variability and disruption in the ecological system caused by poor land management in the form of over grazing, deforestation, over cultivation and generally unsustainable environmental management.(Abdulrashid, 2012). In many areas of savanna region, vegetation and soil sustainable yield threshold has been increasingly threaten (Oladipo, 1993)

The natural vegetation in large parts of savannah areas have been adversely affected by exploitation of forest for domestic and other use. Over 80% of the household in the savanna region of Nigeria depend on wood as source of fuel and fuel wood account for about 90% of forest removal in Nigeria (Adegbehin, 1990). Firewood demand in arid and semi-arid areas of Nigeria is about 2.5 times the sustainable yield of the removing forest in the country, an estimated 404 species of 112 families are threatened with extinction (Mijindadi and Adegbehin, 199). There is also evidence of problems of invasive species, overgrazing in marginal areas, salinization, soil erosion, accumulation of liquid and solid waste materials, increasing severity of floods and dust storms, degradation of forest resources and landscapes, water and air pollution.

Even though, the spatial extent and progression of desertification in Nigeria is subjective and contentious as in other parts of the world. But it is claimed that Nigeria is losing more than 350 000 square meters or 0.6 kilometres of productive lands to desertification per annum.

Tiers of government in Nigeria have responded in different ways to the hazard of desertification to minimise its impact. A variety of adaptive strategies has evolved over the years and became part of the socio-economic framework of the communities. Among the ecological restoration programme introduced was shelterbelt/afforestation scheme in the 1950s. Shelterbelt involves the planting of rows of trees at right angle to wind direction, adjacent to a farmland and on its wind-ward side. (Adegbhin et al., 1990). The shelterbelt act as a wind break for the farmland, reducing wind speed, the rate of evapo-transpiration and wind erosion between the belts and also aided to settle the small sand dunes that had formed (Onyewotu & Stigter, 1995). Apart from topsoil protection and increasing soil organic matter, shelterbelt help in improving the soil structure, sequestering carbon, assisting in nutrient cycling, providing wild life habitat, improving landscape aesthetic quality and enhances crops yield in sheltered areas.

Shelterbelts and parkland trees, in most African communities, are known to have socioeconomic impact on the farmers and reduce the pressure on the forest resources. However, the success or failure of government afforestation programme, such as shelterbelt project, depend largely on the level of farmers participation in the decision making process and their preference (Onyewotu et al., 2003). Northern, Katsina state is among the areas of Nigeria benefited from European Economic Community (now European Union) and Federal Government of Nigeria joint afforestation programme. Under the programme, 85 blocks of shelterbelts (each block being made up of 6 hectres i e 30 metres by 2000 metres) which are expected to protect aboutm 3,400 hectares farmland within 41/2 year period (1987-1992) This study attempt to evaluate the impact of shelterbelt afforestation programme base on the perspectives of the people where this project is located and personal observations of its effects on the local environment

2. Materials and Methods

2.1. Geographical settings of the study area

The study area is located between latitude 12o 52'N and13o 19'N and longitude 7o 16'E and 8o 43'E. Twelve villages selected (Birnin-kukaka, Majigiri, Burdudu, Sawani, Bumbum,Kwangwalam, Faru, Magama, Dankama Gishirawa, Yakubawa and Yadaje) fell within six local government areas of Katsina state, bordering Nigeria and Niger republic. The landscape is underlain by sedimentary rock, dominantly flat with an average height of 300 meters above sea level, with intersection in some parts by hills. Local vegetation adapt to climatic rhythm of long dry season and short wet season. The dominant trees in the area developed long tap roots, thick barks which allow them to withstand the long dry season and bush fires. The vegetation faces various form of abuse, including, cutting, overgrazing and bush fire. The area has unimodal rainfall pattern most which received between May to September, annual average below 700mm.Temperatures are high in most parts of the year, with the mean daily maximum ranging between 27oC to 40oC occur between March and May. The mean minimum ranging between 18oC to 25oC received between November to early February The study area has four different seasons; a cool dry season (December to February), a hot dry season (March to May), a warm wet season (May to September) and a season of low temperature (September to November), (Tomlinson, 2010). The soils are sandy ferruginous type, of latosols group, highly weathered and markedly laterised and slightly acidic due to low organic matter content and phosphorous, its total nitrogen rarely exceed 0.2%.(Abubakar, 2006). The subsistence rainfed farming is the major economic activity in the study area and fragmented farm land form the dominant characteristics of the land use pattern,

2.2. Household survey

Baseline questionnaire with open-ended and closed -ended questions were used to get data on demography, size of land holding, livelihood, farming practices, livestock ownership, constituted the closed-ended questions.(the result of which is not included here). Issues on shelterbelt project were contained in open-ended questions. The respondents were encouraged to give their views and impact of shelterbelt on their environment and the source of livelihood.

2.3. Focus Group Discussion

Series of Focus Group Discussion (FGD) with 8-12 people were held in each village and another with one person selected from each of the twelve villages. The FGD is aimed at weighing and balancing the information derived through questionnaire administration and transect walk with a view of getting a consensus and develops generalization of communities on the impact of afforestation/shelterbelt on the environment and socio-economic well-being of the people living in northern Katsina state. Selections of members of FGD take into consideration, the age, gender, literacy (western or Arabic/Islamic knowledge) and social status of the participants. As Mogotisi et al., (2011) pointed out that these factors affects variation in traditional knowledge in communities.

3. Result and Discussion

3.1. Local views on afforestation/Shelterbelt.

Majority of the respondents' assessments of the impact of afforestation/shelter belt in the twelve villages appeared to be in support of this programme. Some mentioned the impact of the trees planted in reducing destructive power of wind and how it aids deposition of the eroded and transported materials. Others have been observing and recalled how the leaves of the trees break the mechanical force of rain and reduce the erosive power of rain and hit the ground gently and facilitate quick infiltration of rain water and lessen the impact of run off on the soil. Some respondents (18%) mentioned the benefit of increased yield derived

from farm surrounded by trees. The rest of the respondents are of the view that the Azadirachita indica trees actually minimise crop yield close to the trees, due to allelopathic traits of *Azadirachita indica* However, contrary to these views, Onyewotu et al. (1994, 1998) reported that shelterbelts may increase the yields of some crops close to the belts and found that reduced yields close to the belts were caused by competition with the trees for water and nutrients and that yields increased when the tree roots were prune. A small percentage of farmers (about 17%) reported that the trees are harbouring pests and damaging their crops, but no evidence of such claim was found for Eucalyptus in semiarid Sudan by Mohammed et al. (1996).

3.2. Observed Impact of Affaorestation/Shelterbelt on Semi-Arid Landscape of Northern Katsina

Despite increasing afforestation/shelterbelt in most part of the study area as widely publicize during the annual tree planting campaign, such project impact appeared to be insignificant, because the area of degraded land has continue to expand and severity of desertification is increasing throughout the study area. Observations from the transect walk in the sheltered sites indicated that these costly efforts have yielded little success; because it adversely affects natural ecosystem and biodiversity, soil moisture and in some area accelerated desertification.

3.2.1. Loss of Biodiversity

It has been observed, in some parts of the study area particularly in the afforestation/sheltered sites, there is reduction in plants biodiversity due to replacement of natural ecosystem with new exotic species. Because afforestation/shelterbelts in most part of the study area are characterized by total land clearance including destruction of natural vegetation. Hence the overall vegetation cover is found to have negatively affected by afforestation with a net decrease in vegetation cover. (see figure 1). This observation in the study area is similar to the findings of Coa, et al., (2010) in China. They found where grassland is replaced by trees and shrubs, soil erosion increased significantly at the initial stage or where the trees are not given necessary attention to facilitate their quick growth. They noted that initial dense protective cover of annual plant decreased as trees or shrubs increased in grassland and the extent of bare soil surface below the tree also increased.

3.2.2. Disruption of Natural Ecosystem

It is visible in the study area, in most afforestation sites, the natural biological process that protected the soil from erosion and help in the reduction of evaporation from the soil surface are disrupted by tree-planting. The sites could take years to recover and erosion could intensify and desertification might expand (see figure 1) because "succession from bare ground to a stable climatic climax community can take 20-40 years before succession is complete" (Cao, 2008). This problem to some extent may be responsible for the persistent increase in desertification in the study area.

Figure 1: Complete clearance of natural vegetation for Azadirachta indica plantation accelerated erosion in Magama, Jibia Local Government

It is also observed in the afforestation site, reduce sunlight under the tree canopies and the release of substance into the environment by the *Azadirachta indica* trees suppress the growth of other species. This has adversely affects the growth of under storey vegetation, hence decrease of vegetation cover in the afforestation plots.

3.2.3. Disruption of Soil Moisture Balance and Hydrology

The establishment of shelterbelt with unsuitable species in the study area has led to drastic fall in soil moisture levels and it is unlikely if it can create a stable equilibrium with the available water supply. This may lead to further decrease of soil water. For example, the species chosen for the shelterbelt project (Azadirachta indica and Eucalyptus camadulensis) have low water-use efficiency, because of the high rate of evapo-transpiration by these trees (Adegbehin, et al., 1990).

Groundwater reserves amassed over very long periods could sustain newly planted tree species in the selected sites for the afforestation even when the rainfall is inadequate, that is why afforestation and shelterbelt project of arid and semi-arid areas can be successful at the beginning. But as afforestation continue to expand; trees that cannot adapt to the shortage of moisture will steadily deplete groundwater to compensate for insufficient rainfall, until the remaining water can no longer sustain the trees.(Odihi 2003; Yakubu, 2007; Cao 2008)

Cao (2008) observed in northern China that "the effects of this depletion can be subtle at first, and as a result, people have been fooled by small-scale and short-term results into believing that desertification can be solved by large-scale afforestation. Unfortunately, the effects of increasing depletion of groundwater often become apparent many years later.'' Hence, "policymakers must understand that small-scale or short-term afforestation success does not necessarily support a policy of large-scale tree planting in arid and semi-arid areas" (Cao et al., 2009).

In nine out of the twelve villages visited, villagers reported increasing depth of water table level from 7 metres to more than 15 metres in Bumbum village. But the establishment of the shelterbelt in the area may not be the only responsible factor. Studies in northern China have indicated that when the consumption of rain water by trees planted is greater than the level of consumption by indigenous natural species, increased forest cover (shelterbelt) reduces

the net runoff from a watershed *(Jacson, 2002; Cao, 2007*).

Other research findings in northern China conform to the villages' observation of decrease of water table recharge and increasing water table depth, the study revealed that the runoff from afforestation/shelterbelt plots diminished by an average of 77% (ranging from 57 to 96%) compared with grassland and farmland. Even though this reduced runoff indicate increased retention of rain water and decreased water erosion, the retained water could be used quickly than it can be replace during the rainy season. Hence, the trees decreased the underground water supply and reduces the supply of water to rivers (*Cao,2007*), and as result of this, any soil conservation achieved by tree plantation will gradually offset by more severe wind erosion

It is also observed, some of the sites selected for the shelterbelt are not capable of supporting adequate tree growth. One of the conditions for successful afforestation is suitable site that can support proper tree growth, but not all the sites selected met this basic requirements. Most of the sites used are marginal land with poor quality. The slow growth of *Azadirichta indica* in most of afforestation sites could be attributed to unsuitable site and inappropriate choice of species given the study area environmental constraints and low water availability. Trees are believed to have low water use efficiency than other form of vegetation species such as grasses and shrubs (Adegbehin, 1990; Coa, 2009). Natural vegetation in much of the study area are semi–arid plant communities, well adapted to the environment and have much higher water – use efficiency, than the newly introduced exotic species, and have evolve to use soil water in sustainable way under these environmental conditions.

Conversation with the state forestry officials revealed that the afforestation/shelterbelt techniques that proved to be successful over small scale or short term elsewhere are expanded in large scale without careful consideration of its suitability and sustainability. This indicated that too much attention was given to environmental impact rather than their underlying causes. In other word, the most effective solution to land degradation requires mitigation of the sources of the degradation rather than the treatment of the symptoms. The State Ministry of agriculture should focus in restoration of natural climax rather than afforestation.

4. Conclusion

It also important to emphasize that in reclaiming of degraded land the most appropriate measure to each site should be investigated rather than using the current approach which is base on adopting a single solution (afforestation) for all sites. For instance, land degradation in the study area has been largely attributed to human activities, particularly unsustainable livestock grazing, farming activities, and improper clearance of vegetation. Promoting more sustainable form of these activities should be investigated as a potential alternative wherever afforestation/shelterbelt failed in restoration of the environment. It is a fact that afforestation/shelter belt may have some beneficial effect in reducing desertification; However, the importance of afforestation/shelter belt is overstated

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