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USE of *Faidherbia albida* for Soil Improvement in Small Holder Farming System of Gezawa Local Government Area of Kano State, Nigeria

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Abstract: Soil fertility depletion has been described as one of the major biophysical root cause of declining per capita food production. The study was carried out to investigate the use of *Faidherbia albida* as soil quality improvement practice in small holder farming system of Gezawa local government of Kano state. The population of *F. Albida* trees in the four villages selected for the study was obtained through questionnaire survey; this is to assess the potentials and current uses of the tree in both forestry and agricultural systems in the area. For soil quality assessment, 10 composite soil samples collected at the depth of 0-20 cm were analyzed for physical, chemical and fertility related indices. The analytical result revealed an increase in all the parameters tested except sand which decreased when compared to earlier work in the area. The questionnaire interviews involved farmers and foresters and the results showed that there was significant decrease in the population of the tree over the years. It was also found that the tree had been regarded as an important agro forestry species and helps in the improvement of soil fertility and subsequently crop yield, reduction of heat stress and the provision of fodder for livestock feeding.

Keywords: *Faidherbia albida*, gezawa, soil improvement practices, smallholder farming system

INTRODUCTION

Soil Stalinisation is a global problem that is estimated to affect 6.5% of the Earths soil surface (Ceverry and Bourrie, 1998). Despite the increasing global per capital food production there has been an alarming decline in food production in the African continent over the past 25 years (Bationo *et al*., 2003). Soil fertility depletion has been described as one of the major biophysical root cause of declining per capita food production (Bationo *et al*., 2003).

Faidherbia albida, leguminous tree is distributed throughout the semi arid lands of Africa. It is an important agro-silvo-pastoral tree species in sahelian Africa, due to its unique reverse phenology of shedding leaves during the rainy season at the time of higher microbial activities in the soil and when such litter decompose, they improve the soil structure, stability and permeability, thus providing micro environment favourable for crops (Adamu and Garba, 2009). The retained leaves in the dry season provide shade and green fodder (especially pods) rich in protein and carbohydrate for livestock and also mulch which reduces evaporation thus, conserving the available soil moisture. *Faidherbia albida* has a remarkable capacity for recycling nutrient from underground to the surface due to its very deep root system (Le Houerou, 1980). *Faidherbia albida* does not compete with inter-planted crops for soil nutrients as it enters a period of physiological rest during the normal crop growing season (ICRAF, 1989). The tree also stabilises sand dunes and prevent soil erosion (Dancetta and Paulain, 1969). In addition increase in yield from crops grown below the tree has been attributed to increase in fertility due to nitrogen fixation, dung from livestock browsing and falling leaves and pods (Radwanski and Wickens, 1969). It is also used for timber, fuel wood, medicinal purposes and the seeds are food for human (Wickens, 1969). However, a range of proportion have been identified which make tree species suited to soil improvement (Essiet, 1995a, b, c). For many purposes, high biomass production, nitrogen fixation; a combination of feeder roots with tap root and litter with high nutrient content are suitable as reported by Essiet (1990).

Semi arid West Africa is one of the front lines of desertification. UNCCD (1994), defined desertification /land degradation as “human induced”, serious aspects of desertification are caused through daily activities, such as crop cultivation and other land activities that are under-taken by local farmers to maintain basic needs and to improve livelihood. However, over application of commercial fertilizers may also reduce farm profits, create a risk of soil degradation and cause environmental pollution (Tisdale *et al*., 1985).

In northern Nigeria problems of soil degradation have attained an important level, with very low nutrient and low organic matter content. This problem is increasing the farmers concern over their continued use of these soils for agriculture that results in low yields due to the low fertility. To grow crops these soils have to be improved. This study therefore focuses on the effect of *Faidherbia albida* on yield and quality of soil properties for improving crop production and conserving natural resources.

MATERIALS AND METHODS

Study area: Gezawa Local Government geographically lies between 12.22º N and 12.33º S and between 10º O and 10.05º E, (Fig. 1). It is located about 37 km from the northern part of Kano city (state capital) and with population of 282,328 comprising of 138,948 females and 143,380 males. The local government occupies an area of 477 km^2 which comprise of one district of 59 towns and villages, (Garba, 2008). Gezawa has a population of 14,192 inhabitants and average rainfall for the area is 842 mm. Gezawa local government is bordered with Gabasawa local government to the east, Nassarawa local government to the west and north and Warawa local government to south (Asma, 1997). The fertility status of the agricultural soils in the area is marginal as common with most savannah soils, (Table 1).

Field observations and measurements: The study was conducted in four major villages of Gezawa Local government area, after a reconnaissance survey to identify farmlands with at least 2-3 F. albida trees. The villages were Gezawa, Gidan Tsamia, Ketawa and Sararin Gezawa (Fig. 1). The study was conducted in 2010 as a follow up to an earlier study. The researcher undertook series of visits to the four selected villages with a view to enumerate the F. albida existing trees.

The farms that were found to have at least two trees were selected as study sites. The use of F. albida

Table 1: Mean soil physical and chemical properties of the study area in 1995

Soil properties	Control	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6
PH	5.7	6.1	6.3	5.9	6.0	6.0	5.8
Organic carbon (%)	0.6	0.7	0.4	0.7	0.5	0.3	0.5
Total P (ppm)	219.0	219.0	65.0	278.0	281.0	259.0	156.0
Available P (ppm)	1.6	4.9	3.6	2.7	4.3	0.9	1.8
Total nitrogen (%)	0.0 3	0.01	0.01	0.01	0.03	0.04	0.02
Sodium (meq/100 g)	0.2	0.2	0.2	0.2	0.2	0.1	0.1
Total K (ppm)	2.2	3.1	3.8	2.1	3.8	2.4	3.0
Potassium (meq/100 g)	0.1	0.1	0.2	0.1	0.1	0.1	0.05
Calcium (meq/100 g)	1.0	1.3	1.3	0.9	1.1	0.9	0.8
Exch Mg (meq/100 g)	0.5	0.5	0.6	0.6	0.6	0.4	0.3
C E .C (meq/100 g)	2.7	3.8	3.2	2.8	2.9	2.1	2.3
Sand (%)	86.0	84.7	83.3	83.8	83.1	88.5	82.5
Silt (%)	15.6	13.4	14.7	13.4	14.5	10.0	15.2
Clay (%)	3.8	1.9	2.0	2.8	2.4	1.5	2.0
AWHC (%)	16.8	15.6	16.8	16.8	15.0	14.0	13.9

Adopted from Essiet (1995); Mean of 40 samples per site

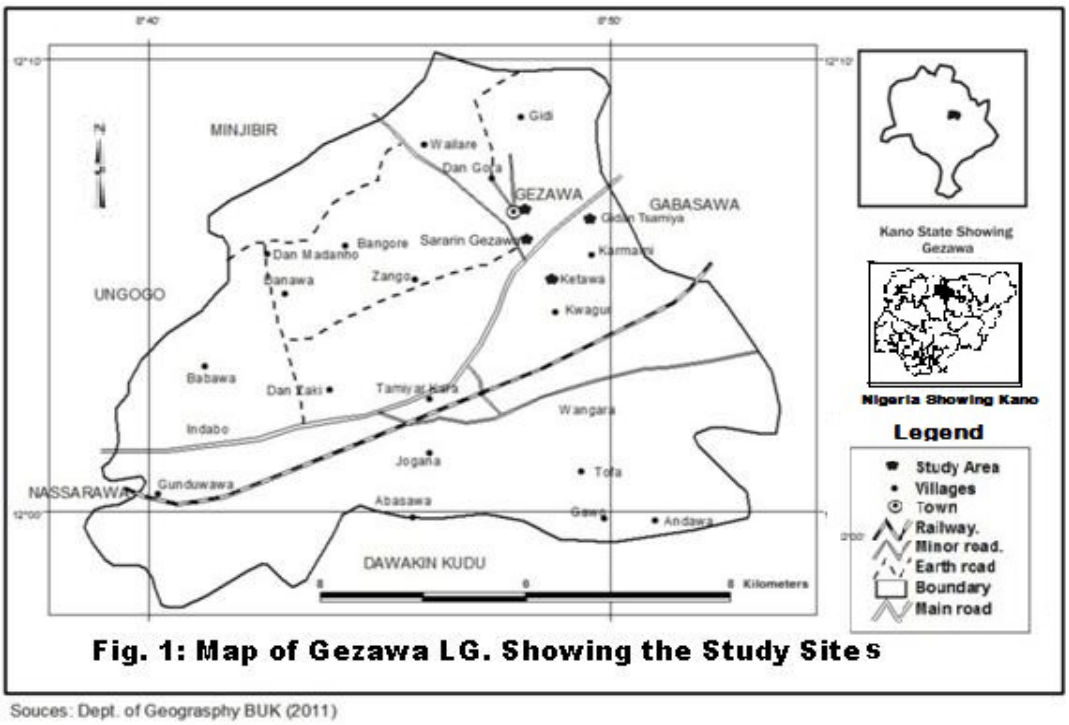

Fig. 1: Map of Gezawa LG. showing the study sites

tree was described through the interview with farmers and field observations. The crop yield was determined through questionnaire and field measurements and observations to ascertain what the farmers gave as their yields over the years. Questions relating quantity/amounts of their harvests in tonnes or number of bundles (dami) or donkey loads were asked and documented.

LABORATORY ANALYSIS OF SOILS

A total of 10 composites soil samples were collected from the four selected sites with at least 2-3 *F. Albida* trees and analysed for soil physical, chemical and fertility related parameters using standard laboratory procedures. The depth of the sampling is 0-20 cm because all the crops grown in the selected sites are shallow rooted.

Soil samples collected for analysis are randomly selected at positions around the plots having *F. albida* trees. The parameters tested included; soil P^H, organic carbon, available phosphorous, CEC, exchangeable bases (sodium, potassium, calcium and magnesium), total nitrogen and particle size distribution analysis.

Organic carbon was determined using the Walkley and Black (1934) method. Phosphorus (P) content determination was done using the colorimeter (CECIL CE 373) method using the sodium hydrogen carbonate extraction. The determination was according to the Bray and Kurtz (1945) method. The determination of exchangeable bases was done with flame photometer (JENWAY PFP7) after extraction using ammonium acetate extraction technique. The CEC was determined using the ammonium acetate saturation method as outlined by Hesse (1971).

The total nitrogen was determined using the kjeldal Digestion method. P^H was determined using the 1:2.5 soil water ratios. The particle size distribution was determined using the hydrometer method.

Statistical techniques: The mean values were compared with the set of values suggested as low, medium and high by Landon (1991). Analysis of Variance (ANOVA) method (Gregory, 1963) was used as the statistical tool. The analysis was used to determine whether there was significant difference/ variation between sites having *F. Albida* trees.

Interview schedules: In the second stage of sampling a stratified random sampling technique was used in the selection of respondents' farmers from the four villages for interview. Twenty five farmers were purposively selected from each site for the interview.

RESULTS AND DISCUSSION

The ranges of values for soils that do not have *Faidherbia albida* in their farm are presented in Table 1. While range of values of soil with *Faidherbia albida* are presented in Table 2. The organic carbon values for plots with *F. albida* ranged from 1.25 to 2.35%, while the nitrogen values ranged from 0.15-0.25%.

The results indicated that the *F. albida* enhanced soil quality and increased soil fertility as supported by Le Houerou (1980). As shown in Table 2, soil pH, nutrient distribution and other soil quality parameters were found to be very high in the *F. albida* plots even though, there was significant difference in the results which was due to the numbers of *F. albida* present in each of the sites.

This shows the presence of *F. albida* has a high significant effect on the production of seeds without the application of chemical fertilizer. Charreau and Vidal (1965) and Poschen (1986), in their studies carried out in Senegal and Ethiopia respectively, found that yields of crops like millet, groundnut, sorghum and maize cultivated under *F. albida* trees are higher than in the open. On the basis of characteristics, it was found that the improvement was not only in yields, but also the taste or palatability and quality of the products. The result of the soil structure is attributed to the presence of the hoofs of the livestock which break up the soil and allow more water infiltration. Increase in nitrogen contents of the soil is also recorded due to the livestock faeces and urine which are beneficial for plant growth (Adamu and Garba, 2009).

Table 2: Mean values of soil physical, chemical and fertility related indices for plots with *F. albida* trees in four villages of Gezawa LG. A, Kano State

Parameter	Site 1	Site 2	Site 3	Site 4	Landon (1990) evaluation
P^H	6.70	6.56	6.62	6.74	
Organic carbon (%)	2.00	1.75	1.25	2.35	Medium-medium high
Available P (ppm)	45.0	40.0	35.0	55.0	Medium
Total nitrogen (%)	0.20	0.17	0.15	0.25	Medium-medium high
CEC (cmol/kg)	21.0	19.0	15.0	25.0	Medium
Sodium (cmol/kg)	0.20	0.30	0.20	0.14	Low
Potassium (cmol/kg)	0.30	0.20	0.23	0.55	Medium
Calcium (cmol/kg)	5.00	3.55	4.00	5.55	Low
Magnesium (cmol/kg)	2.50	1.55	1.75	2.20	Low-medium
Sand (%)	55.00	60.00	62.00	45.00	
Silt (%)	30.00	26.00	25.00	40.00	
Clay (%)	15.00	14.00	13.00	15.00	

Laboratory analysis (2010)

Table 3: Distribution of crop yield (kg/ha) at Gezawa LG. Area of Kano State

Crops	Crop yield from plots with *F. albida* (kg/ha)	Crop yield from plots without *F. albida* (kg/ha)
Millet	10	5.0
Groundnut	6.0	3.5
Beans	4.5	2.0
Sorghum	2.13	1.6

Field work (2010)

Table 4: Population of *F. albida* trees in the four villages of gezawa LG. Area Kano (2010)

Villages	Population of *F. Albida*
Gezawa	11
Gidan tsamiya	15
Ketawa	25
Sararin gezawa	7
Total	59

Field work (2010)

High soil fertility under *F. albida* trees have been identified in the study site. This has been attributed to nitrogen fixation, the extraction of nutrients from deep soil depths by the tree`s roots and return of the nutrients to the soil from tree litter. Ayuba and Murya (2000) observed that livestock serve as nutrient conducts between the point of grazing and where they rest .This was because as they rest, they drop their faeces and urine as a result raise the nutrient status of such soil, which could account for the higher yield of crops observed under the *F. albida* trees where the livestock rest. *F. albida* is also capable of fixing nitrogen status of the soil. During leaf shedding period of the tree *F. albida* deposits a times much of leaf litter which undergoes a rapid decomposition.

This greatly enriches the topsoil in plant nutrients and organic matter which improves soil moisture condition, porosity, root penetration and entrapment of precipitation.

The partial shading produced by the tree branches coupled with the lead mulch on the ground reduces heat stress and evapo-transpiration, which contributes to early survival of the crops and improve crop yield.

Based on the information obtained from the interviews it was recorded that crop yield on plots with *F. albida* were higher than those without *F. Albida* (Table 3).

Table 4 shows the population of the *F. albida* trees found in the four villages studied. The reasons for the differences and decrease in number of the trees between study sites as revealed by the survey may not be unconnected with the location of the site, poverty level of the people leaving in the sites as well as the awareness of the farmers on the importance of the tree. This was further supported by the forestry officers interviewed during the study.

CONCLUSION

The results and observation from this study indicates that *F. albida* tree is certainly a good substitute for organic fertilizers both in terms of enhanced soil fertility and improved soil quality indices. As indicated, *F. albida* trees are rich organic matter and they improve physical as well as chemical properties of soil under them.

The use of the species should be encouraged and the planting of the tree needs to be introduced in areas where they are not in existence.

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