Sustainable Agriculture Research; Vol. 4, No. 4; 2015
ISSN 1927-050X E-ISSN 1927-0518
Published by Canadian Center of Science and Education

Clipped Cowpea (*Vigna unguiculata* (L.) Walp) Fodder Management: A Potential for Soil Organic Matter Enrichment in Degraded Savannah Soils of Nigeria

Banake E. Sambo[1] & Ehiabhi C. Odion[2]

[1] Department of Crop Science, Federal University Dutse, P.M.B.7156, Jigawa State, Nigeria

[2] Department of Agronomy, Institute for Agricultural Research, Ahmadu Bello University, P.M.B.1044, Samaru, Zaria, Nigeria

Correspondence: Banake E. Sambo, Department of Crop Science, Federal University Dutse, P.M.B.7156, Jigawa State, Nigeria. Tel: 234-802-330-8577. E-mail: banelisam@yahoo.com

Received: May 4, 2015 Accepted: July 15, 2015 Online Published: August 21, 2015

doi:10.5539/sar.v4n4p17 URL: http://dx.doi.org/10.5539/sar.v4n4p17

Abstract

Severe nutrient depletion of the soils of the savannah tropics of Africa over the years has made it difficult to improve the productivity of varieties of crops using cultural practices alone. But interestingly, it has been observed that when a cowpea (*Vigna unguiculata* (L.) Walp) crop is cut (clipped) before senescence; it can regenerate after defoliation (provided there is enough soil moisture). And when the clipped organic fodder is added and/or ploughed back into the soil, it enriches the soil organic matter (SOM) content that in turn enhances crop productivity. Thus, this study was carried out with the objective of determining the influence of intra-row spacing, clipping height and time on the productivity of cowpea and SOM; at the Institute for Agricultural Research, Ahmadu Bello University, Samaru, Zaria, Nigeria; during the 2002-2005 wet seasons. The experimental lay out was a Randomized Complete Block Design (RCBD), replicated three times. The collected data was analyzed statistically using the analysis of variance test (ANOVA); and the means separation was done using the Duncan Multiple Range Test (DMRT). Results showed that the textural class of the experimental site soil was loam silt; with a conducive pH of (6.6 in 2002 and 5.5 in 2005), for crop growth. The soil organic carbon content (SOC), nitrogen (N) and cation exchange capacity (CEC) were very low (0.30 g kg^{-1}, 0.88 g kg^{-1} and 4.90 respectively) in 2002. These increased to 10.37 g kg^{-1}, 2.2 g kg^{-1} and 11.10 respectively in 2005. Total rainfall in 2002 was 1007.9mm and 871.5mm in 2005. Mean air temperature, relative humidity and sunshine hours in 2002 ranged between 21.0-31.5 °C, 16.0-90.6 and 4.5-8.5 respectively; while mean air temperature and relative humidity ranged between 24.7-32.0 °C and 40.5-85.3% respectively in 2005. Total harvested clipped fodder yield was 15t ha^{-1}; and this was added to the soil; and it effectively increased SOM content by about 42%. Consequently, it was concluded that the adoption of this innovative clipping management technology, holds great potential of improving soil pH, increasing soil CEC, SOM and crop productivity generally, for the low technology, resource poor, and subsistence farmers in the region. Without doubt, overcoming SOM decline is a major component in the development of more sustainable agro-systems.

Keywords: Clipping, fodder, production, potential, nutrient, depletion, soil organic matter, sustainability

1. Introduction

The cowpea (*Vigna unguiculata* (L.) Walp) crop is prominent in the farming systems of the semi-arid tropics, where they are grown mainly for both fodder (haulm) and for their mature seeds (Onwueme & Sinha, 1991; Odion & Singh, 2005b).

Generally, cowpea in the northern guinea savannah zone is sown in mid-July (Onwueme & Sinha, 1991), where its productivity has been variedly reported to be dependent on the time of planting, amount and distribution of rainfall. Cowpea requires a moderate amount of rainfall for good production. If rainfall is too heavy, the plant tends to be leafy and produce few pods. Cowpea is reported to be grown successfully on a wide variety of soils provided they are well drained; though light sandy loam soils are more suitable than heavy soils (Onwueme, 1979, Onwueme & Sinha, 1991). The crop is also, sometimes grown on poor acid soils for soil improvement (Onwueme & Sinha, 1991).

In the savanna area, dual purpose cowpea types are sown later in the season and at wider (90 × 30 cm, 75 × 20 cm) spacing's. As a consequence of the short growing season often experienced in the region, the late planting of the dual purpose cowpea often results in its poor vegetative growth with little or no grain production. As a result, it has been difficult to improve the productivity of these varieties using cultural practices alone. However, it has been discovered and observed that if the cowpea plant is cut (clipped) at 7-10 Weeks after Planting (WAP), before senescence, it can regenerate after defoliation (and provided there is enough soil moisture), and produce seeds (Singh, 1993; Odion & Singh, 2005b). The cowpea plant is able to maintain growth and to survive under dry semi-desert soils conditions due to the fact that it is drought resistant and grows deep roots (Singh, Mohan Raj, Dashiell, & Jackai, 1997). Thus, Odion and Singh (2005b), Sambo, Odion, Aliyu, and Labe (2013), concluded that the reproductive growth of the dual-purpose cowpea varieties was enhanced in their trials through clipping management, in spite of the close intra-row spacing under which the crop was grown. Hence, they postulated that it is possible that after clipping, the re-growth from clipped plots behaved like the semi-erect grain type of cowpea that are grown at this closer intra-row spacing's.

Since the cowpea crop when cut at the vegetative growth phase can regenerate provided there is enough soil moisture, thus it is possible to grow cowpea for "green manure" by clipping its foliage and allowing the clipped crop plants to grow to maturity for seeds (Odion & Singh, 2005b). The advantage of this practice, is in the ability of low resources, low input and low technology based farmers to improve on the soil organic matter (SOM) and/or nutrient status of their soils - bearing in mind that most African soils are reported to be typically impoverished and seriously deficient in nutrients - a situation compounded by the more or less permanent agricultural system practiced in the semi-arid tropics which results in severe nutrient depletion in sub-Saharan Africa (Zake, 1993).

But given that a proportionately large amount of available nutrients are retained in the vegetative cover of crops and SOM accumulates on the surface of the soil; the continuous practice of removing and exporting the top vegetative cover of crops from the farmlands, which is a common feature of the farming systems of the semi-arid regions, implies that the fertility of the soil declines rapidly as SOM is not maintained at an appropriate level. However, green manuring, which places, adds and/ or incorporates fresh green non-woody plant, rich in water, sugars, starches, protein and nitrogen into the soil (Kahnt, 1983); as organic fertilizer, could enhance the growth and productivity of crops (Karunairanjan, 1980). The green-manure crop could supply organic matter (OM) as well as additional nitrogen (N) particularly if it is a legume crop, which has the ability to fix atmospheric nitrogen (Patnaik, 2004). It also could protect the soil against erosion and leaching. Usually, green manures are either cut or brought from outside or grown in the field with the intention that they will be ploughed in as manure (Yegna Narayan Aiyer, 1975; Reijntjes, Haverkort, & Waters-Bayer, 1992).

The maintenance of OM is of fundamental importance to the productivity of tropical soils. If soil fertility in the tropics is to be maintained, fertilization must first and foremost be organic. What this means in practical terms is that, a proper management of tropical soils which have only recently come under cultivation must aim to maintain both the structure as well as the content of organic matter. In soils that have been cultivated for a long time, the aim should be to increase the organic mass and to improve their structure (Muller-Samann & Kotschi, 1994).

Thus far, in many tropical cropping systems, little or no agricultural residues are returned to the soil. This is reported to lead to a decline in SOM (Lal, 1986; Bouwman, 1990; Post & Mann, 1990; Woomer & Ingran, 1990); which frequently results in lower crop yields (Lal, 1986); or plant biomass productivity (Woomer & Ingran, 1990).

Recent studies have focused on the effect of green clipped crop materials and placing or incorporating such plant residues into the soil for fertility maintenance and or improvement. Since cowpea can regenerate after defoliation, it might be possible to grow the crop of dual purpose cowpea for both grain and fodder and through clipping management, placement and or incorporation, for fertility maintenance and/or improvement of SOM content (Odion & Singh, 2005a; Odion, Asiribo, Ogunlela, Singh, & Tarawali, 2007).

Cowpea fodder can potentially serve as a source for both soil nutrients and organic matter as well as for other beneficial agricultural purposes which hitherto have been constraints to the improvement and sustainability of crops production in the savanna; and the remedies had been both expensive to the resource poor farmers and have to be gotten from outside the farm. However, the process of ameliorating the negative effects of SOM loss for sustain fertility and crop productivity are now within the farmers' reach and may not be as expensive as the imported technologies (Smalling & Nandwa, 1996; Henao & Baanante, 1999). In the light of the foregone, this study was carried out with the objective of determining the influence of intra-row spacing, clipping height and time on SOM of the dual purpose cowpea (*Vigna unguiculata* (L.) Walp).

2. Materials and Methods

Field experiments were carried out on the research farm of the Institute for Agriculture Research, Samaru, Nigeria, during the 2002, 2003, 2004 and 2005 cropping seasons. Samaru (11°.11'N, 07°.38'E and 686m above sea level) is located in the northern Guinea savanna agro-ecology of Nigeria (Keay, 1959). Usually, rainfall becomes established in the region between mid-May and early June and peaks in July/August. Total annual rainfall ranges between 883-1062mm, with an average of 945.20 mm. The dry season starts at about mid-October and extends to the end of April. The mean minimum and maximum temperatures during the rainy seasons range between 14-22 °C and 29-34 °C, respectively. The textural class of the soil of the experimental site was classed loam silt; with a pH of 6.6 in 2002 and o 5.5 in 2005. The soil organic carbon content (SOC), nitrogen (N) and cat-ion exchange capacity (CEC) were very low (0.299 g kg^{-1}, 0.087 g kg^{-1} and 4.90) in 2002. Phosphorus (6.51mg kg^{-1}) and potassium (0.10cmol kg^{-1}) were equally low. The SOC and CEC increased to 10.37, 2.2 and 11.10 in 2005, respectively. Total rainfall in 2002, 2003, 2004 and 2005 was 1007.9mm, 1135.4mm, 1019.0mm and 871.5mm respectively. In 2002, 2003, 2004 and 2005, mean air temperature and relative humidity (RH) ranged, 21.0-31.5 °C and 16.0-90.6%, 23.4-31.2 °C and 16.8-78.4%, 25.9-27.9°C and 60.4-78.4% respectively. While sunshine hours in 2002, 2003, 2004 ranged 4.5-8.5, 5.5-8.1, 5.5-7.5 respectively.

The treatments comprised of three intra-row spacing, 15.0, 30.0 and 45.0cm on ridges 75cm apart; three clipping heights (no clipping control, 12.5cm and 25.0cm); and three clipping periods (64,74 and 84 days after planting – DAP) respectively. Factorial combinations of these treatments were laid out in a Randomized Complete Block Design (RCBD), and replicated three times.

The land was ploughed and harrowed twice at the time of land preparation, before planting, using mechanical power to give a good soil tilt. It was then ridged at 75cm spacing and demarcated into a gross and net plot size of 9.0 m^2 and 4.5 m^2 respectively.

The variety used (Kano 1696/ Sampea 6) is a highly photosensitive dual purpose cowpea, which is usually planted late in the season for fodder as well as grains when possible. It is late maturing (100-120 days), and has a spreading habit; growing vegetative with little grain yield (250-1000 kg ha^{-1}) production. It produces long pods, extra large white seed with black eye, rough seed coat texture and has good palatability.

Fertilizer was applied at the recommended rate of 10 kg N $ha^{-1,}$ 36 kg P_2O_5 ha^{-1} and 20 kg K_2O ha^{-1} (Enwezor, Udo, Usoroh, Ayotade, Adepetu, & Chude, 1989). Weeds were controlled at planting using Gramazone (Paraquat) as a pre and post emergence herbicide; supplemented with manual weeding operations. Post-emergence protection against insect pest and fungal attacks were provided using the insecticides and fungicides as and when necessary.

The fields were planted on 13th July, 17th July, 7th June and 17th June, in 2002, 2003, 2004 and 2005 respectively. The cowpea crop was clipped (harvested) at 64, 74 and 84 days after planting (DAP). The first clipping was done on 15th September, 2002; 19th September, 2003; 10th August, 2004, and 17th August, 2005, respectively. The clipped fodder was placed on the plots to decay and act as a source of organic manure; while the clipped plants were left to grow to maturity alongside the control (unclipped) plots for further yield analysis.

Four plants per plot were sampled for the determination of the following: Total clipped fodder yield: The clipped fodder yield was obtained by weighing and recording the total clipped crop residue (fodder) from each plot, and this was recorded and converted to total fodder yield in tons per hectare (t ha^{-1}) basis.

Soil Organic Matter - SOM: Soil nutrient (status) analysis was undertaken using a 5 g air dry soil. SOM content was calculated according to the procedures as described by (Bray & Kurtz, 1945; Black, 1965; Day, 1965; Bremmer, 1965; International Institute for Tropical Agriculture, 1975; Kundsen, Peterson, & Paratt, 1982).

The data collected was compiled and analyzed statistically using the analysis of variance test (F-test) as described by (Snedecor and Cochran 1967); and the means were compared using the Duncan Multiple Range Test-DMRT (Duncan, 1955).

3. Results

3.1 Harvested Fresh Fodder Yield of Cowpea

In 2002, fresh fodder yield significantly decreased with increasing intra-row spacing from 15 to 45 cm. While in 2005 and the combined analysis for 2002 - 2005, fresh fodder yield was significantly higher at 15cm intra-row spacing than at 30 and 45 cm intra-row spacing; which were statistically the same with each other (Table 1). Clipping height had no significant influence on harvested fresh fodder yield throughout the study period. In all the years, except in 2003, harvested fresh fodder produced from plots clipped at 74 and 84 DAP were statistically the same; but significantly higher than harvested fresh fodder obtained from plots clipped at 64 DAP. In 2003, harvested fresh fodder yield obtained at 64 and 74 DAP were statistically the same; but significantly higher than that produced at 84 DAP.

Table 1. Harvested fresh fodder yield (t ha^{-1}) as influenced by intra-row spacing, clipping management and time treatments of dual purpose cowpea, at Samaru, Zaria, Nigeria

Harvested Fresh Fodder Yield (t ha^{-1})					
Treatment	**2002**	**2003**	**2004**	**2005**	**Combined 2002-2005**
Intra-row spacing(cm)					
15	39.53a	1.19	12.75	19.03a	18.13a
30	26.55b	1.17	12.95	11.81b	13.12b
45	15.72c	1.03	12.67	12.98b	10.60b
SE ±	2.90	0.17	0.86	1.97	0.93
Clipping height (cm)					
0 (Control-unclipped)	-	-	-	-	-
12.5	26.93	1.29	12.83	16.48	14.38
25.0	27.60	0.98	12.74	12.74	13.52
SE ±	2.90	0.17	0.86	1.97	0.93
Clipping time (DAP)					
64	17.64b	0.78b	11.45	9.33b	9.80b
74	33.66a	0.98b	13.10	19.50a	16.81a
84	30.49a	1.64a	13.80	15.00a	15.23a
SE ±	2.90	0.17	0.86	1.97	0.93
Interaction					
I*H	NS	**	NS	NS	NS

Means followed by different letter (s) are significantly different at ≤ = 0.05; using Duncan's Multiple Range Test (DMRT). ** = Highly significant. NS = Not Significant.

The interaction of treatments on fresh fodder yield was significant in all the years investigated, except the combined analysis for 2002-2005. Clipping height and clipping time interaction on fresh fodder yield was significant in 2004 (Table 2). At 64 DAP, plants clipped at 25.0 cm height produced significantly higher fresh fodder yield than plants clipped at 12.5cm height and the control plots. Similarly, plants clipped at 12.5 cm, recorded significantly higher fresh fodder yield than those of the control plots. But at 74 DAP, fresh fodder yield of plants clipped at 12.5 cm and the control plants were statistically similar; but significantly higher than those clipped at 25.0 cm height. While at 84 DAP, clipping height did not significantly affect the amount of fresh fodder produced. The highest mean harvested fresh fodder yield was recorded when crop plants were clipped at 74 DAP and at 12.5 cm clipping height.

Table 2. Interaction of clipping height and time on fresh fodder yield (t ha^{-1}) of dual purpose cowpea, in 2004, at Samaru, Zaria, Nigeria

	Clipping height (cm)		
	Control (unclipped)	**12.5**	**25.0**
Clipping time (DAP)			
64	11.45bc	8.43d	14.47a
74	13.10abc	16.10a	10.11d
84	13.82ab	13.95ab	13.64abc
SE± 1.49			

Means followed by different letter (s) are significantly different at ≤ = 0.05; using Duncan's Multiple Range Test (DMRT).

3.3 Soil Organic Matter (SOM) Content

In 2004, 2005 and the combined analysis for 2002-2005, SOM content consistently, significantly increased with increase in intra-row spacing from 15 to 45 cm. While, in 2003, SOM obtained at 15cm and 30cm intra-row spacing were statistically similar, but significantly higher than the SOM contents obtained at 45cm intra-row spacing. The influence of clipping height on the SOM content was significant in 2003, 2004, 2005 and the combined analysis for 2002-2005; where the SOM content of plots clipped at 12.5 and 25 cm heights were statistically the same, but significantly higher than the SOM content of the control plots. Clipping time had a significant effect on SOM content only in 2002; where the SOM content of plots clipped at 74 and 84 DAP were statistically at par; but significantly higher than for plots clipped at 64 DAP. There was a significant interaction of the treatments on SOM content in 2003, 2004, 2005 and the combined analysis for 2002-2005 (Table 3).

Table 3. Percent soil organic matter (SOM) content as influenced by intra-row spacing, clipping management and time treatment of dual purpose cowpea at Samaru, Zaria, Nigeria

	Soil Organic Matter (SOM) content (%)				
Treatment	**2002**	**2003**	**2004**	**2005**	**Combined 2002-2005**
Intra-row spacing (cm)					
15	0.527	1.607a	1.488a	1.672a	1.323a
30	0.514	1.602a	1.459b	1.593b	1.292b
45	0.511	1.200b	1.046c	1.509c	1.066c
SE ±	0.009	0.004	0.005	0.011	0.004
Clipping height (cm)					
0 (Control-unclipped)	0.503	0.866b	0.830b	1.155b	0.838b
12.5	0.520	1.773a	1.582a	1.807a	1.420a
25	0.528	1.769a	1.581a	1.812a	1.422a
SE ±	0.009	0.004	0.005	0.011	0.004
Clipping time (DAP)					
64	0.503	1.461b	1.329	1.578	1.217
74	0.516	1.472a	1.331	1.598	1.229
84	0.532	1.475a	1.333	1.698	1.259
SE ±	0.009	0.004	0.005	0.011	0.004
Interaction					
I*H	NS	**	**	**	**

Means followed by different letter (s) are significantly different at ≤ = 0.05; using Duncan's Multiple Range Test (DMRT). ** = Highly significant. NS = Not Significant.

Clipping height and time interaction on SOM was significant in the combined analysis for 2002 - 2005 (Table 4). At 15 cm intra-row spacing, plants clipped at 12.5 cm and 25.0 cm height produced statistically similar, but significantly higher SOM than the control plants. Similarly, plants clipped at 12.5 cm, recorded significantly higher fresh fodder yield than those of the control plots. On the other hand, crops clipped at 15 and 30 cm intra-row spacing produced statistically similar SOM content. However, a further increase in intra-row spacing to 45 cm resulted in a significant reduction in the SOM contents of the plots. Generally, the highest mean SOM content were recorded when crops were clipped at either 12.0 or 25.0 cm and at 15 cm intra-row spacing (Table 4).

Table 4. Interaction of clipping height and intra-row spacing on percent soil organic matter (SOM) content of dual purpose cowpea, combined for 2002 - 2004, at Samaru, Zaria, Nigeria

	Clipping height (cm)		
	Control (unclipped)	**12.5**	**25.0**
Intra-row Spacing (cm)			
15	0.919c	1.52a	1.52a
30	0.875c	1.49a	1.50a
45	0.722d	1.23b	1.23b
SE$\pm$ 0.12			

Means followed by different letter (s) are significantly different at ≤ = 0.05; using Duncan's Multiple Range Test (DMRT).

4. Discussions

4.1 Harvested Fresh Fodder Yield of Cowpea

The favorable growth of cowpea could be attributable to the soil texture, favorable pH, high temperatures and the good amount of rainfall recorded during the period viz. the soil moisture conditions required to support good crop growth; except in 2003, when the harvested fresh fodder yield was remarkably low; largely due to observed excessive flooding of the plots. Because cowpea is reported to be a warm-weather annual crop, capable of withstanding heat better than most other legumes and at the same time, drought-resistant. It is known to be grown successfully on a wide variety of soils provided they are well drained. Moisture deficiency has been noted to have an adverse effect mainly on vegetative growth. (Onwueme, 1979; Onwueme & Sinha, 1991).

The favorable response of cowpea to these climatic and environmental conditions facilitated the production of large amounts of plant biomass. When this green crop material was clipped and the harvested material added to the soil (green manuring), which is primarily a form or method of biological soil fertility maintenance, it proved to be beneficial in improving the soil physical and chemical properties of the soils and eventually becoming a source of SOM enrichment and nutrients supply (Lee & Wani, 1988; Lal, Wilson, & Okigbo, 1979; Mulongoy & Akobundu, 1990; IITA, 1992). Indeed, this was clearly shown in the improvements brought about in the soil CEC during the period. Without a doubt, the gain in SOM has been found to have considerable impact on the buffering capacity and nutrient content of the soil viz. improving the soil CEC by about a third. Certainly the soil CEC is reportedly a chemical property important to soil fertility; accordingly, soils with high CEC can sustain intensive, continuous cultivation; while those with low CEC would undergo rapid physical and chemical degradation (Chude, Amapu, Malgwi, & Ano, 2002).

Harvested fresh fodder yield of the dual purpose cowpea was highest at 15cm intra-row spacing (Table 1). Definitely, if rapid production of the green crop biomass is desired (i.e. when yield is the product of growth of vegetative material), then denser sowing is preferable, as higher yield per area is achieved, as rapidly as possible, through greater population pressures; for maximum radiation interception. (Gardner, Pearce, & Mitchell, 1985; Muller-Samann & Kotschi, 1994).

Clipping management practices have been reported to be more common with grasses and forage legumes (Chapparo & Sollenberger, 1991). In the present study, the adoption and application of this clipping management practice showed that it facilitated the production of large amounts (15t ha^{-1}) of plant material (green fresh fodder) on-farm; which can be put to various uses. The observed high increase in fresh fodder yield (62%) at 74 DAP, has been reported to coincide with the period of the crops maximum vegetative growth (Musa, 1990).

4.2 Soil Organic Matter (SOM) Content

Soil organic matter (SOM) content decreased with increasing intra-row spacing and adoption of clipping treatment over the control (Table 3 and 4). Indeed, this could be attributed to the high volume of added plant organic material obtained at high plant densities; and is in conformity with the findings of Murthy and Hirekerur (2004), which highlighted that the vegetation determines the quantities and quality of organic material added each year. In addition, Adams, Bamford, and Early (1998) reported that most SOM is concentrated on the top soil because most of the roots occur in the zone and the plant residues tend to be added to the surface, forming the leaf litter layer. In this study, SOM content added on clipped plots increased by about 41%. Indeed, this result is supported by the findings of Jones (1971), who in a study in the dry savanna climate of Samaru, Nigeria, reported that the C-content of a sandy loam (Alfisol) was improved from 0.45% to 0.67% in 9 years; signifying a 66% increase.

4.3 Soil Organic Matter, Soil Fertility, Organic Agriculture and Sustainability

Many agricultural farmlands in the savannah are degraded due to various factors ranging from intensive weathering, high rainfall, temperature and decomposition rates, soil erosion, leaching, deterioration of the soil structure – low organic matter content (SOM), low CEC, and low moisture retention capacity of soils, resulting in low soil fertility.

Organic manure (OM) often includes wastes from both plants and animals whether composted or fresh but intended for use in farming. It is often brought into the field to improve the soils physical, chemical and biological properties, so as to enhance crop performance. Organic matter plays a key role in soils and the significance of organic mass in tropical soils is greater than any other soil characteristics apart from moisture (Asadu, Ezeaku, & Nnaji, 2004). Thus, the maintenance of organic matter is of fundamental importance to the productivity of tropical soils. If soil fertility in the tropics is to be maintained, fertilization must first and foremost be organic. What this means in practical terms is that, a proper management of tropical soils must aim to maintain both the structure as well as the content of organic matter; and for soils that have been cultivated for a long time, the aim should be to increase the organic mass and to improve structure (Muller-Samann & Kotschi, 1994). Without a doubt, organic farming avoids or largely excludes the use of synthetic fertilizers and pesticides and as far as possible promotes the purposeful maintenance and replenishment of soil fertility; as in crop rotation, crop residues and animal manures to supply plant nutrients, and to control weeds, insects and other pests (Wikipedia, 2005).

Yet in many tropical cropping systems, little or no agricultural residues are returned to the soil leading to a decline in soil organic matter (Lal, 1986; Bouwman, 1990; Post & Mann, 1990; Woomer & Ingran, 1990); and lower crop yields (Lal, 1986), or plant biomass productivity (Woomer & Ingran, 1990). It is therefore clear that if soil fertility in the tropics is to be sustained, then, the amount of soil organic matter will need to be maintained at the level of economic yields and not degraded through cultural practices.

5. Conclusion

It can be concluded that, cowpea possesses a great potential for improving soil organic matter (SOM) in degraded tropical soils; provided appropriate cultural and management practices which could lead to improvements in the soil pH and CEC (physical and chemical conditions) are adopted. In this regard, for the low technology, resource poor, and subsistence farmers of the region, the adoption of this innovative clipping management technology enhanced the production of large amounts of green plant biomass (fodder) on-farm/ in-situ; which could be put to various uses: it could be incorporated into the soil as organic (green) manure for improving the soil organic matter (SOM) status. Certainly, in the savannah tropics where most soils are inherently low in soil nutrient content/fertility amongst other diverse challenges militating against boosting crop productivity - overcoming soil organic matter (SOM) decline is a major component in the development of more sustainable agro-systems; which encompasses the successful management of resources for agriculture to satisfy human needs, while maintaining or enhancing the quality of the environment and conserving natural resources in a sustainable manner.

References

Adams, C. F., Bamford, K. M., & Early, M. P. (1998). *Principles of Horticulture* (3rd ed.) Butterworth-Heinmann, London, U.K.

Asadu, C. L. A., Ezeaku, P. I., & Nnaji, G. U. (2004). The Soils of Sub-Saharan African and Management Needs for Sustainable Farming. In M. A. Badejo, & A. O. Togun (Eds.), *Strategies and Indices of Sustainable Agriculture in the Tropics* (Vol.2, pp. 1-27), Ibadan, Nigeria: College Press and Publishers Ltd.

Black, C. A. (1965). Methods of Soil Analysis. 11 Chemical and Microbial Properties (p. 1578). Madison, Wisconsin, American Society of Agronomy.

Bouwman, A. F. (1990). Exchange of Green House Gases Between Terrestrial Ecosystems and the Atmosphere. In P. L. Woomer & Swift, M. J. (Eds.), The Biological Management Tropical Soil Fertility. John Wiley and Sons, USA. A Co-Publication with the Tropical Soil Biology and Fertility Programme (TSBF) and Sayce Publishing (U.K).

Bray, R. H., & Kurtz, L. T. (1945). Determination of Total Organic and Available Forms of P in soil. *Soil Science,* *59*, 39-45. http://dx.doi.org/10.1097/00010694-194501000-00006

Bremmer, J. M. (1965). Total Nitrogen. In C. A. Black (Ed.), Methods of Soil Analysis (Part 2, pp. 511-576). American Society of Agronomy.

Chaparro, C. J., & Sollenberger, L. E. (1991). Productivity and Persistence of Moth Elephangrass under Clipping Management (p. 141). Agronomy Abstracts. 1991, Annual Meeting.

Day, P. L. (1965). Particle Fractionation and Particle Size Analysis. In C. A. Black (Ed.), Method of Soil Analysis part 1. Physical and Mineralogical Properties (pp. 545-567). American Society of Agronomy.

Chude, V. O., Amapu, I. Y., Malgwi, W. B., & Ano, D. A. (2002). Train-the-Trainers Workshop on Interpretation of Soil Test Data and Fertilizer Recommendations for State ADP Facilitators (Crops) Engaged in SPFS Projects. PCU/IAR/NRCRI: 21-22 and 28-29th August, 2002.

Duncan, D. B. (1955). Multiple Range and Multiple F-tests. *Biometrics, 11*, 1-42. http://dx.doi.org/10.2307/3001478

Enwezor, W. O., Udo, E. J., Usoroh, N. J., Ayotade, K. A., Adepetu, J. A., Chude, V. O., & Udegbe, C. I. (1989). Fertilizer Use and Management Practices for Crops in Nigeria (pp. 1-168). Fertilizer Procurement and Distribution Division of the Federal Ministry of Agriculture, Water Resource, Rural Development. Lagos, Nigeria.

Gardner, F. P., Pearce, R. B., & Mitchell, R. L. (1985). Physiology of Crop Plants (pp. 76-97). AMES, IOWA, U.S.A: Iowa State University Press. http://dx.doi.org/10.1104/pp.77.3.540

Henao, J., & Baanante, C. (1999). Nutrient Depletion in the Agricultural Soils of Africa 2020 Vision Brief 62. Washington D.C. International Food Policy Research Institute.

International Institute for Tropical Agriculture. (1975). Selected Method for Soil and Plant Analysis (p. 44). International Institute for Tropical Agriculture (IITA), Ibadan, Nigeria. Annual Report.

International Institute for Tropical Agriculture. (1992). Sustainable Food Production in Sub-Saharan Africa 1. IITA contributions. International Institute for Tropical Agriculture - IITA, Ibadan Nigeria.

Jones, M. J. (1971). The Maintenance of Soil Organic Matter under Continuous Cultivation at Samaru, Nigeria. *Journal of Agricultural Science, 77*, 473-482. http://dx.doi.org/10.1017/S0021859600064558

Kahnt, G. (1983). Grundungung, Z.verb. Auflage. DLG-varlag, Frankfurt/M. P. In K. M. Muller-Samann & J. Kotschi (Eds.), Sustaining Growth: Soil Fertility Management in Tropical Small Holdings. CTA/GTZ-Weikersheims Margraf

Karunairanjan, R. D. (1980). Grundungung In den Tropen. *IFOAM, 35*, 18-21.

Keay, R. W. J. (1959). *An Outline of Nigerian Vegetation*. (3rd ed.) Government Printer, Lagos. In B. T. Kang, I.O. Akobundu, V. M. Manyong, R. J. Carsky, N. Sanginga & E. A. Kueneman (Eds.), Moist Savannas of Africa; Potentials and Constraints for Crop Production (pp. 31-48). Proceedings of an IITA/FAO Workshop held from 19-23 September, Cotonou, Republic of Benin.

Kundsen, D., Peterson, G. A., & Paratt, P. F. (1982). Lithium, Sodium and Potassium. In Pagered, A. L. (Ed.), Method of Soil Analysis (pp. 225-246). American Society of Agronomy.

Lal, R. (1986). Soil Surface Management in the Tropics for Intensive Land Use and High Sustained Productivity. In P. L. Woomer & M. J. Swift (Eds.), The Biological Management of Tropical Soil Fertility. John Wiley & Sons, U.S.A. A Co. Publication with the Tropical Soil Biology and Fertility Programme (TSBF) and Sayce Publishing (U.K.).

Lal, R., Wilson, G. F., & Okigbo, B. N. (1979). Changes in Properties of an Alfisol Produced by Various Grasses and Legume Crop Covers. *Soil Science, 127*(6), 377-382. http://dx.doi.org/10.1097/00010694-197906000-00009

Lee, K. K., & Wani, S. P. (1988). Soil Fertility and Fertilizer Management in Semi arid Tropical India. Colloguium on Soil Fertility and Fertilizer Management in Semi arid Tropical India. Proceedings held 10/17-18/88, in Hyderabad, India. IFDC-Nlabama, U.S.A.

Mulongoy, K., & Akobundu, I. O. (1990). Agronomic and Economic Benefit of Nitrogen Contributed by Legume in Live-Mulch and Alley Cropping Systems. In International Institute for Tropical Agriculture: Sustainable Food Production in Sub-Saharan Africa 1. IITA's Contributions. IITA, Ibadan, Nigeria. http://dx.doi.org/10.1007/978-1-4684-6432-0_54

Muller-Samann, K. M., & Kotschi, J. (1994). Sustaining Growth. Soil Fertility Management in Tropical Small Holding.CTA; GTZ-Weikersheim: Margra; Germany.

Murthy, R. S., & Hirekerur, L. R. (2004). Soils. In C. S. Viswanath (Ed.), Handbook of Agriculture. (pp. 20-72). New Delhi: Indian Council of Agricultural Research.

Musa, U. T. (1990). Effect of Seed Size and Phosphorus Level on the Growth and Yield of Cowpea (*Vigna unguiculata* (L.) Walp) varieties. M.Sc. Agronomy Seminar. Department of Agronomy, Ahmadu Bello University, Zaria, Nigeria.

Odion, E. C., & Singh, B. B. (2005a). Production Dual Purpose Cowpea Varieties at Two Clipping Heights in the Sudan Savanna of Nigeria: 1. Fodder Production in Pure Stand. *Journal of Arid Agriculture, 15*, 9-14.

Odion, E. C., & Singh, B. B. (2005b). Production of Dual Purpose Cowpea Varieties at two Clipping Heights in the Sudan Savanna of Nigeria 2. Pod and grain Production in Pure Stand. *Journal of Arid Agriculture, 15*, 15-19.

Odion, E. C., Asiribo, O. E., Ogunlela, V. B., Singh, B. B., & Tarawali, S. A. (2007). Strategies to Improve and Sustain Food Production Capacity in the Savannah: The Role of Leguminous Fodder Crops in Maintaining Soil Fertility and Health. *Journal of Food, Agriculture and Environment, 5*(2), 338-344.

Onwueme, I. C. (1979). Cassell's Tropical Agriculture Series, Book 2 Science (pp. 56-61). Macmillan Publishing Co. Inc. N.Y..

Onwueme, I. C., & Sinha, T. D. (1991). *Field Crop Production in Tropical Africa CTA*, Ede, The Netherlands.

Patnaik, N. (2004). Soil Fertility and Fertilizer Use. In C. S. Viswanath (Ed.), Handbook of Agriculture (pp. 203-247). New Delhi: Indian Council of Agricultural Research.

Post, W. M., & Mann, L. K. (1990). Changes in Soil Organic Carbon and Nitrogen as a Result of Cultivation. In P. L. Woomer & M. J. Swift (Eds.), The Biological Management of Tropical Soil Fertility. John Wiley and Sons, U.S.A. A Co. Publication with the Tropical Soil Biology and Fertility Programme (TSBF) and Sayce Publishing (U.K).

Reijntjes, C., B. Haverkort, B., & Waters-Bayer, A. (1992). Farming for the Future: An Introduction of Low-External-Input. ETC/ILEIA. The Macmillan Press Ltd., London and Basingstoke.

Sambo, B. E., Odion, E. C., Aliyu, L., & Labe, D. A. (2013). Cowpea (*Vina unguiculata* (L.) Walp) clipping management technology 2: A potential for sustained yield and food security in the savannah regions of Nigeria. *Journal of Agricultural and Crop Research, 1*(4), 55-60.

Singh, B. B. (1993). Cowpea Breading. Archival Report 1988-92. Grain legume improvement programme, crop improvement division, IITA, Ibadan, Nigeria.

Singh, B. B., Mohan Raj, D. R., Dashiell, K. E., & Jackai, L. E. N. (1997). Advances in Cowpea Research. Co-publication of International Institute of Tropical Agricultural Sciences (JIRCAS). IITA Ibadan, Nigeria.

Smalling, E. M. A., & Nandwa, S. M. (1996). Soil Fertility in Africa is at Stake (p. 36). Agronomy Abstracts.

Snedecor, G. W., & Cochran, W. G. (1967). *Statistical methods 6th edition*. (p. 456). U.S.A: Iowa State University Press.

Wikipedia. (2005). Organic farming. From Wikipedia, the free encyclopedia. Retrieved from on December 18, 2005, from http://wikipedia.org/organicfarming

Woomer, P. L., & Ingran, J. S. I. (1990). The Biology and Fertility of Soils. TSBF Report 1990, Nairobi Kenya TSBF. John Wiley and Sons, U.S.A. Co Publication with the Tropical Soil Biology and Fertility Programme (TSBF) and Sayce Publishing (U.K).

Yegna Narayan Aiyer, A. K. (1975). *Principles of Crop Husbandry in India*, (5th ed.) The Bangalore Press India.

Zake, J. Y. K. (1993). Overcoming Soil Constraints of Crop Production. In Y. Ahenkorah, E. Ownsan – Bennoah, & G. N. N. Dowuona (Eds.), Sustaining Soil Productivity Intensive African Agriculture: Overcoming Soil Constraints (pp 57-63). Seminar Proceedings, Accra, Ghana.