INTERNATIONAL JOURNAL OF ADVANCED BIOLOGICAL RESEARCH

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# RESIDUAL EFFECTS OF ORGANIC MANURE AND INORGANIC FERTILIZER ON MAIZE GRAIN WEIGHT AND SOME SOIL PROPERTIES IN ASABA AREA OF DELTA STATE.

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**ABSTRACT**
This study was carried out in the Teaching and Research Farm of Delta State University, Asaba Campus from March 2008 to December 2009 to evaluate the effects of previously applied amendments on maize grain weight and some soil properties. The experiment was carried out in a Randomized Complete Block Design (RCBD) replicated three times in a factorial layout. Four different rates of poultry dropping, cattle dung and NPK 20:10:10 fertilizers were applied to maize varieties sown at 75cm x 15cm and the residual effects of the amendments on some soil properties were investigated. The results indicated that hybrid maize variety 9022-13 was superior with grain weight of 1.24 $tha^{-1}$ and that plants sown on plots where 450kg $ha^{-1}$of NPK 20:10:10 had the highest grain weight (1.56$tha^{-1}$). Bulk density of plots treated with poultry manure was highest (1.35 $Mg/m^2$), followed by plots treated with cattle dung (1.34 $Mg/m^2$). Plots treated with inorganic fertilizer had the lowest bulk density (1.32 $Mg/m^2$). Also, plots treated with 30$tha^{-1}$ of organic manure had the highest bulk density (1.37 $Mg/m^2$), while the control plots had the lowest (1.30 $Mg/m^2$). The exchangeable cations (Ca, Mg, K, and Na) increased with higher rates of manure/inorganic fertilizer ($P<0.05$). The interaction results showed that pH, organic C,N, C/N and all exchangeable cations were increased by the rates of application of organic manure/inorganic fertilizer and they were significantly ($P<0.05$) different from each other. Based on this study, it is recommended that (i) Farmers who prefer mineral fertilizer should apply 450 $kgh^{a-1}$ of NPK 20:10:10 to promote the release of exchangeable cations that increase maize yield (ii) Farmers who practice organic agriculture in Asaba agro-ecological zone should apply 30$tha^{-1}$ of poultry manure to enhance maize yield.

**KEYWORDS**: Residual effects, organic manure, inorganic fertilizer soil properties, Asaba Delta State.

## INTRODUCTION

One of the members of the cereal family that has added great value to man and animals is Maize (*Zea mays L*). It ranks third following wheat and rice in world production (F.A.O, 2002). Widely grown in the humid tropics and sub-Saharan Africa, the crop is source of food and livelihood for millions of people today (Agbato, 20003). It is consumed roasted, baked, fried, boiled or fermented in Nigeria. In developed countries, maize is source of such industrial products as corn oil, syrup, corn flour, sugar, brewers' grit and alcohol (Dutt, 2005). As an energy supplement in livestock feed, maize is cherished by various species of animals, including poultry, cattle, pigs, goats and rabbits (DIPA, 2006). The numerous uses of maize notwithstanding, yield in Africa has continuously declined to as low as 1t/ha due to such factors as rapid reduction in soil fertility, negligence of soil amendment materials and failure to identify high yielding varieties compatible to each agro-ecological zone (Olakojo, 1993, Kim, 1997, DIPA, 2006).

Tolera *et al*. (1999) suggested that breeders should select maize varieties that combine high grain yield and desirable store characteristics because of large differences that exist between cultivars. Odeleye and Odeleye (2001) reported that maize varieties differ in their growth characters, yield and its components, and therefore suggested that breeders must select most promising combiners in their breeding programmes. Sonetra (2002) suggested that subsistence farmers should apply organic manure directly to the soil as a natural means of recycling nutrients in order to improve soil fertility and yield of crops. Manures and fertilizers are the life wire of improved technology contributing about 50 to 60% increase in productivity of food grains in many parts of the world, irrespective of soil and agro-ecological zone (DIPA, 2006). Reijnties *et al.* (1992) and Adepetu (1997) remarked that the downward trend in food production should prompt farmers to amend the soil with different materials in order to enhance growth and yield of crops. Several organic materials such as cattle dung, poultry dropping, pig dung and refuse compost have been recommended to subsistence farmers in West Africa as soil amendments for increasing crop yield (Sobulo and Babalola, 1992; Ismail *et al.,* 1999; Olayinka, 1996 and Olayinka *et al.,* 1998). Zougmore *et al*., (2006) reported that poultry dropping and cattle dung increased root growth of maize and the crop extracted soil water more efficiently for increased grain yield.

Municipal wastes were reported to have reduced soil temperature, increased soil water, nutrient status and the yield of maize in temperate soils (Movahedi *et al.,* 2000). Cattle dung has been reported to contain 0.3 – 0.4 % N, 0.1 – 0.2 % P and 0.1 – 0.3 % K (Subedi and Gurung, 1991). According to Adekunle *et al.,* (2005) cattle dung applied at the rate of 10 t/ha to cowpea resulted to increased plant height, leaf area, pod number, pod weight as well as improved soil structure in a mixed farming system. Stefan (2003) indicated that fresh poultry dropping contain 70% water, 1.4% N, 1.1% $P_2O_5$ and 0.5% $K_2O$ while dried poultry manure contains 13% water, 3.6% N, 3.5% $P_2O_5$ and 1.6% $K_2O$. Ayodele (1993) reported that inorganic fertilizers are known to influence the quantity and yield of maize.

At present, there are no recommended standards with respect to varietal selection, rates of appropriate organic manure and mineral fertilizer which interplay to influence soil properties, and grain weight of maize in Asaba area of Delta State. Against this background, the broad objective of this study, therefore, was to identify variety of maize most suited or adapted to Asaba area and the appropriate fertilizer types and rates for the variety, and the effects of soil amendments on some soil properties. The specific objectives were to identify the best variety of maize for Asaba area, determine the residual effects of NPK 20:10:10 mineral fertilizer, poultry manure, cow dung on maize grain weight and to determine the effects of mentioned amendments on soil physico-chemical properties.

## MATERIALS AND METHODS

### Site description

The study was carried out in the Teaching and Research Farm of Delta State University, Asaba Campus from March to December 2008 and repeated between March and December, 2009. Asaba is located at latitude 06$^o$14'N and longitude 06$^o$49'N of the equator. It lies in the tropical rainforest zone dominated by mangrove, fresh water, swamps, humid forests and secondary vegetation (NEST, 1991). Its climate is influenced by the movement of the Inter-Tropical Discontinuity (ITD). The ITD is made up of two wind systems namely the moisture-laden South-West monsoon from the Atlantic Ocean and the dry cold North-East trade wind from the Sahara desert. The South-West Trade wind most significantly determines the climate condition of Asaba area of Delta State. Asaba is characterized by raining season between April and October, with annual mean-rainfall of 1500mm and 2000mm maximum. The distribution is bimodal with peak in July and September, coupled with a period of low precipitation in August. Mean temperature is 23.8$^o$C with 37.3$^o$C as maximum. Relative humidity is 77.2%, the mean monthly soil temperature at 100m depth is 20.3 $^o$C, while sunshine stands at 4.8 bars (Meteorological Office, Asaba, 2003).

### Pre-planting soil analysis

Representative surface soils (0-20cm) were sampled with a tubular sampling auger. These soil samples were air-dried at room temperature for 5 days and crushed to pass through a 2mm mesh sieve. Sub-samples from the bulked soil sample were further grounded to pieces to pass through 100mm-mesh sieve for the determination of organic matter. The rest samples were then analyzed to determine the physical and chemical properties of the soil. The analysis was done at Delta State University, Asaba campus.

### Analytical procedure

### Physical properties

**Particle size distribution:** Particle size distribution was analyzed using the Bouyoucos hydrometer method in which 0.5 N Sodium hexameta-phosphate was used as dispersant (Landor, 1991).

**Bulk density**: The bulk density (Bd) was determined by Core-method.

**Particle density**: This was determined by pycometer or specific gravity bottle method as described by Bowles (1992).

### Chemical properties

**Soil pH:** This was determined in soil: water suspension (1:1) using glass electrode pH-meter as described by Mclean (1982).

**Organic carbon:** This was determined using the wet oxidation method of Walkley and Black (Walkley and Black, 1945).

**Total nitrogen:** This was determined using the modified K. Jeldah distillation method as described by Landor (1991).

**Exchangeable cations (EC) and Effective cation exchange capacity (ECEC):** Exchangeable cations were determined by extracting the cations with IN ammonium acetate (IN, NHOAC) as displacing solution, buffered at $pH_7$ as described by Thomas (1986). The extract was then determined electrochemically using atomic absorption spectrophotometry. The effective cation exchange capacity (ECEC) was calculated as the sum of exchangeable bases (Ca, Mg, K and Na) and exchangeable A1 and H expressed in cmo1/kg$^{-1}$ of soil.

**Exchangeable acidity:** This was determined by titration method as described by Juo (1981). The exchangeable $H^+$ and $A1^{++}$ were then expressed in cmo/kg$^{-1}$ of soil

**Available phosphorus:** This was determined by Bray No.1 method as described by Landor (1991).

**Cation exchangeable capacity:** This was determined by neutral $NH_{4-}$ Acetate placement method using the procedure of Anderson and Ingram (1996).

### Experimental design

The study was carried out in Randomized Complete Block Design (RCBD), replicated three times in a factorial layout. The factors were three sources of nutrients:- poultry manure (PM), cattle dung (CD), inorganic fertilizer (NPK 20:10:10). The different rates of PM were 0, 10, 20, 30t/ha, CD were 0, 10, 20, 30t/ha and NPK 20:10:10 were 0, 150, 300, 450kg/ha.

### Agronomic practices

Among the agronomic practices carried out were land preparation / plot layout, planting, application of treatments, weeding.

### Land preparation and plot layout

The land was ploughed and harrowed using tractor. Three blocks (or replicates) consisting of 36 blocks each were laid out, each block measured 2.6m x 2.25m and was separated from one another with a space of 0.5m. Alley pathways of 1m separated one block from another, and the total number of plots laid out in the entire experiment was108.

**Planting**
Maize seeds were sown on the plots at the rate of 1 seed per hole at a depth of 2-3cm, using 75cm x 15cm spacing.

**Procurement and application of organic manure and NPK 20:10:10 fertilizer**
Well-decomposed cattle dung was collected from cattle pen area, while poultry droppings were obtained from the battery cage system of poultry management of Delta State University, Asaba Campus. This organic manure was analyzed to determine their nutrient contents. NPK 20:10:10 fertilizer was obtained from Delta Agricultural Procurement Agency (DAPA), Ibusa. These amendment materials were incorporated into the plots according to the treatment as suggested by Olanikan (2006).

**Weeding:** Weeding was done three times using hoe.

**Data Collection:** Data collected was grain weight of maize at the end of the sixteenth week after harvesting and shelling. This was carried out with a weighing scale. Also, the exchangeable cations (Ca, Mg, K, and Na) were determined in the laboratory using the procedures already described..

**Analysis of soil sample:** Soil samples were collected from each experimental plot and analyzed for their content of N, P, and K.

**Statistical analysis:** Data collected were subjected to analysis of variance (ANOVA) and means were separated with Duncan Multiple Range Test (DMRT) according to Wahua (1999).

## RESULTS

**Soil physico-chemical properties of the experimental site:**
The pre-physico-chemical properties of the experimental site are shown in Table 1. The result showed predominantly sand at the surface and this tends to decrease with depth of profile. Texturally, the soil of the experimental site is classified as sandy loam. The soil is acidic with pH of 6.2 in $H_2O$ and 5.6 in CaCl. The organic matter content and total nitrogen were low with values of 1.22 $gkg^{-1}$ and 0.113 $gkg^{-1}$. The available P was high with value of 26.5 $mgkg^{-1}$. The exchangeable cations (Ca, Mg, Na and K) were equally low in status with values of 2.6$cmolkg^{-1}$ for $Ca^{2+}$ and 0.9 $cmolkg^{-1}$ for $Mg^{2+}$. The value obtained for $Na^+$ was 0.57 $cmolkg^{-1}$, which was moderate while that for $K^+$ was 0.08$cmolkg^{-1}$, which was low. The CEC was 4.15, while ECEC was 5.6$cmolkg^{-1}$, which was generally low. The exchangeable acidity was only trace for $Al^{3+}$ and characteristically low for $H^+$ with a value of 1.4 $cmolkg^{-1}$.

**Nutrient content (%) of organic manure used in the study**
The nutrient content of organic manure (poultry manure and cattle dung) used in the study is shown in Table 31. The values of N, P and K in poultry manure were significantly ($P<0.05$) higher than their values in cattle dung. With respect to N, poultry manure had 1.6% against cattle dung which was 0.4%. Also, poultry manure had 0.6% P while cattle dung had 0.2% P. The values for K were 0.8% in poultry manure, while it was 0.3% in cattle dung.

**TABLE 1.** Physico-chemical properties of experimental site

| Soil Property | | Value | Interpretation |
|---|---|---|---|
| Particle Size Distribution (%) | | | |
| | Coarse sand | 38 | |
| | Fine sand | 41 | |
| | Silt | 9 | |
| | Clay | 12 | |
| | Texture | ____ | Sandy loam |
| | $H_2O$ | 6.2 | Acidic |
| pH | CaCl | 5.6 | Acidic |
| Organic | Carbon $gkg^{-1}$ | 0.71 | |
| Organic | Matter $gkg^{-1}$ | 1.22 | Very low |
| Total | Nitrogen $gkg^{-1}$ | 0.113 | Low |
| Available | P (ppm) | 26.5 | |
| Exchangeable bases ($cmol/kg^{-1}$) | | | |
| | $Na^+$ | 0.57 | Moderate |
| | $K^+$ | 0.08 | Very low |
| | $Ca^{2+}$ | 2.60 | Low |
| | $Mg^{2+}$ | 0.90 | Low |
| Cation Exchange Capacity | | 4.15 | |
| Exchangeable acidity ($cmol/kg^{-1}$) | | | |
| | $Al^{3+}$ | Trace | |
| | $H^+$ | 1.4 | |
| Effective cation Exchangeable capacity ($Cmol/kg^{-1}$) | | 5.6 | |

**TABLE 2.** Nutrient (%) of Organic Manure used ion the Study

| | Nutrient Content (%) | | |
|---|---|---|---|
| Parameter | N | P | K |
| PM | $1.6_a$ | $0.6_a$ | $0.8_a$ |
| CD | $0.4_b$ | $0.2_b$ | $0.3_b$ |

*Legend: PM = Poultry Manure, CD = Cattle Dung, N = Nitrogen, P = Phosphorus*

**Residual effects of treatment application on grain weight ($tha^{-1}$) of maize**

Figure 1 shows the response of grain weight of maize to residual effects of organic manure and inorganic fertilizer. With respect to variety, hybrid maize 9022-13 had the highest grain weight of 1.24 t/ha, followed by open-pollinated variety $BR9922\text{-}DMRSF_2$ with 0.68 t/ha. Agbor local variety had the lowest grain weight of 0.53 t/ha. The order of superiority in grain weight of maize based on variety was $9022\text{-}13 > BR9922\text{-}DMRSF_2 >$ Agbor local. Plants that received inorganic fertilizer NPK 20:10:10 had the highest grain weight of 1.01 t/ha, followed by plants that received poultry manure with grain weight of 0.86 t/ha. Plants that received cattle dung had the lowest number of grain weight (0.58 t/ha). The order of superiority in grain weight of maize based on nutrient sources was Inorganic Fertilizer>Poultry Manure>Cattle Dung. Plants that received higher rates of organic manure or inorganic fertilizer obtained higher grain weight than plants that received lower rates. With respect to rate of organic manure, the order of superiority in grain weight of maize in $tha^{-1}$ was 30>20>10>0 while the order of superiority in grain weight of maize based on rate of inorganic fertilizer in kg/ha was 450>300>150>0.

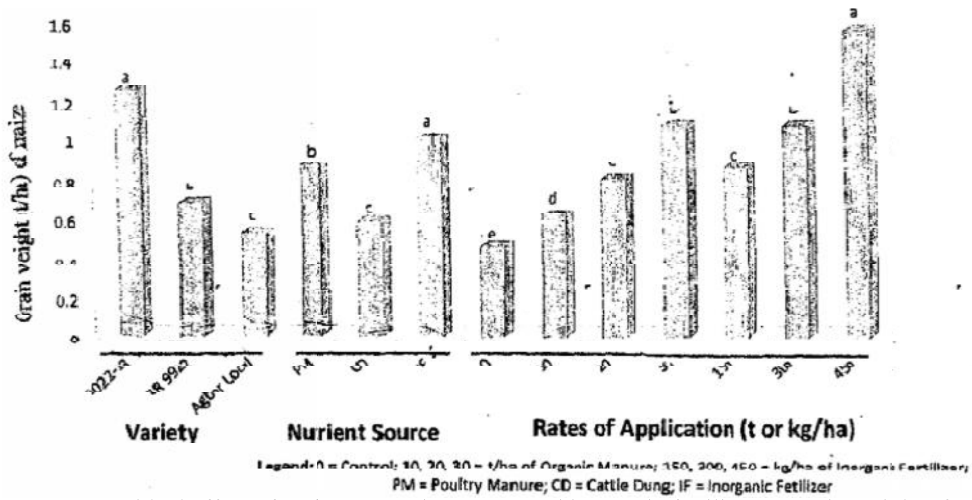


**FIGURE 1:** Residual effect of variety, organic manure and inorganic fertilizer on grain weight of maize

**TABLE 3**. Effects of interaction of variety, residual organic manure and inorganic fertilizer on grain weight of maize

| Variety | Nutrient Source | Rate | Grain Weight ($tha^{-1}$) |
|---|---|---|---|
| | | 0 | 1.0 |
| 9022-13 | | 10 | 1.1 |
| | PM | 20 | 1.3 |
| | | 30 | 1.7 |
| | | Mean | 1.3 |
| | | 0 | 0.6 |
| | | 10 | 0.8 |
| | | 20 | 1.0 |
| | CD | 30 | 1.2 |
| | | Mean | 0.9 |
| | | 0 | 1.0 |
| | | 150 | 1.4 |
| | | 300 | 1.6 |
| | IF | 450 | 2.2 |
| | | Mean | 1.6 |
| | | 0 | 0.3 |
| BR9922 | | 10 | 0.5 |
| | PM | 20 | 0.7 |
| | | 30 | 1.0 |
| | | Mean | 0.6 |
| | | 0 | 0.2 |
| | | 10 | 0.4 |
| | CD | 20 | 0.5 |
| | | 30 | 0.8 |

| | | | |
|---|---|---|---|
| | | Mean | 0.5 |
| | | 0 | 0.4 |
| | | 150 | 0.8 |
| | IF | 300 | 1.1 |
| | | 450 | 1.3 |
| | | Mean | 0.9 |
| | | 0 | 0.2 |
| | | 10 | 0.6 |
| Agbor | PM | 20 | 0.8 |
| Local | | 30 | 1.0 |
| | | Mean | 0.7 |
| | | 0 | 0.1 |
| | | 10 | 0.3 |
| | CD | 20 | 0.5 |
| | | 30 | 0.6 |
| | | Mean | 0.4 |
| | | 0 | 0.1 |
| | | 150 | 0.4 |
| | IF | 300 | 0.5 |
| | | 450 | 1.2 |
| | | Mean | 10.1 |
| Variety | | | * |
| Manure type | | | * |
| Rate | | | * |
| Variety x manure type | | | * |
| Variety x rate | | | * |
| Manure type x rate | | | Ns |
| Variety x manure type x rate | | | Ns |

Legend: * = significant at 0.05 level of probability, ns = not significant

**Residual effects of treatment application on grain weight ($tha^{-1}$) of maize**

Figure 1 shows the response of grain weight of maize to residual effects of organic manure and inorganic fertilizer. With respect to variety, hybrid maize 9022-13 had the highest grain weight of 1.24 t/ha, followed by open-pollinated variety BR9922-DMRSF$_2$ with 0.68 t/ha. Agbor local variety had the lowest grain weight of 0.53 t/ha. The order of superiority in grain weight of maize based on variety was 9022-13>BR9922-DMRSF$_2$>Agbor local. Plants that received inorganic fertilizer NPK 20:10:10 had the highest grain weight of 1.01 t/ha, followed by plants that received poultry manure with grain weight of 0.86 t/ha. Plants that received cattle dung had the lowest number of grain weight (0.58 t/ha). The order of superiority in grain weight of maize based on nutrient sources was Inorganic Fertilizer>Poultry Manure>Cattle Dung. Plants that received higher rates of organic manure or inorganic fertilizer obtained higher grain weight than plants that received lower rates. With respect to rate of organic manure, the order of superiority in grain weight of maize in $tha^{-1}$ was 30>20>10>0 while the order of superiority in grain weight of maize based on rate of inorganic fertilizer in kg/ha was 450>300>150>0.

**Residual effect of organic manure and inorganic fertilizer on some soil properties**

The response of some soil properties to organic manure and inorganic fertilizer is shown in Table 4. Bulk density of plots treated with poultry manure were highest (1.35 mg/m$^3$), followed by plots treated with cattle dung (1.34 mg/m$^3$). Plots treated with inorganic fertilizer also had the lowest values with respect to bulk density (1.32 mg/m$^3$). The order was PM>CD>IF.

With respect to rate of application of the amendment, plots treated with organic manure had higher bulk density than plots treated with inorganic fertilizer, except the control plot, which had 1.30 mg/m$^3$, and plots treated with 450kg/ha of inorganic fertilizer, which were 1.33 mg/m$^3$. Plots treated with 30t/ha of organic manure had the highest values based on bulk density (1.37 mg/m$^3$), while the control plots had the lowest values. The effect of interaction of organic manure and inorganic fertilizer on some soil properties (Table 5) indicated that manure type and rate were significantly ($P<0.05$) different, and improved bulk density of soil. Increased level of application of poultry manure and cattle caused a corresponding increase in soil pH, while increased rates of application of NPK 20:10:10 fertilizer led to a gradual reduction in pH. There were significant differences in chemical properties ($P<0.05$) measured. Plots that received higher rates of manure had higher pH than the control plots but the trend was different in plots that received inorganic fertilizer where the pH of the control plot was higher than the pH of plots that received higher rates of fertilizer.

The exchangeable cations (EC) increased with higher rate of manure/fertilizer ($P\leq0.05$). The increase in EC based on rate of application of manure (in tons/ha) to the plots was 30 > 20 > 10 > 0, while that of fertilizer in (kg/ha) was 450 > 300 > 150 > 0. The order of increase of EC based on source of nutrient was IF > PM > CD. The percentage organic carbon, nitrogen and P (ppm) followed the same trend. Plots treated with inorganic fertilizer were superior in their level of nutrients, followed by plots that received poultry manure. Plots treated with cattle dung had lower level of nutrients. The order of superiority with respect to higher organic C, N and P (ppm) was IF > PM > CD while the order of superiority based on rate of application for manure (in tons/ha) was 30 > 20 > 10 > 0. The order of superiority based on rate of fertilizer (in kg/ha) was 450 > 300 > 150 > 0. The C:N ratio increased with increasing rates of manure or fertilizer, though it was highest in unfertilized or control plots. The ratio was widest in plots treated with poultry manure, followed by plots treated with cattle dung. It was lowest in plots treated with inorganic fertilizer. The exchangeable cations (Ca, Mg, K, Na) also increased with increasing rates of manure or fertilizer. Plots treated with inorganic fertilizer had more cations, while plots treated with cattle dung had the lowest level of cations. The order was IF > PM > CD. The interaction result (Table 3) indicated that apart from manure type * rate, $p^H$, organic C, N, C/N and all exchangeable cations were significantly ($p<0.05$) different and were affected by organic manure/ inorganic fertilizer and their rates of application.

**TABLE 4.** Residual effects of organic manure and inorganic fertilizer on some soil properties

| | | Bulk density | pH | Organic C(%) | N(%) | C/N | Exchangeable Bases | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Ca | Mg | K | Na | P |
| | | ($Mg/m^3$) | | | | | Cmol $kg^{-1}$ | | | | |
| **Treatment** | | | | | | | | | | | |
| PM | | $1.35_a$ | 5.84a | $1.26_b$ | $0.043_c$ | $29.3_a$ | $2.55_b$ | $0.42_a$ | $0.61_b$ | $0.35_b$ | $0.33_b$ |
| CD | | $1.34_b$ | 5.66b | $1.07_c$ | $0.045_b$ | $23.7_b$ | $2.42_c$ | $0.38_c$ | $0.15_c$ | $0.28_c$ | $0.15_c$ |
| IF | | $1.32_c$ | 5.56c | $1.32_a$ | $0.057_a$ | $23.2_{cb}$ | $2.56_a$ | $0.40_c$ | $0.67_a$ | $0.39_a$ | $0.34_a$ |
| **Rates of application (tons kg/ha)** | | | | | | | | | | | |
| | 0 | $1.30_f$ | $5.59_e$ | $0.70_g$ | $0.013_g$ | $54.6_a$ | $2.31_g$ | $0.26_g$ | $0.03_g$ | $0.26_g$ | $0.24_f$ |
| manure ($tha^{-1}$) | 10 | $1.34_c$ | $5.67_c$ | $1.17_f$ | $0.053_f$ | $22.1_d$ | $2.34_f$ | $0.28_f$ | $0.46_f$ | $0.30_f$ | $0.23_g$ |
| | 20 | $1.35_b$ | $5.76_b$ | $1.36_d$ | $0.055_e$ | $24.7_c$ | $2.55_d$ | $0.37_d$ | $0.50_e$ | $0.32_e$ | $0.25_e$ |
| | 30 | $1.37_a$ | $6.03_a$ | $1.45_c$ | $0.056_d$ | $25.8_b$ | $2.75_c$ | $0.65_b$ | $0.53_d$ | $0.38_b$ | $0.28_d$ |
| IF ($kgha^{-1}$) | 150 | $1.31_e$ | $5.65_d$ | $1.32_e$ | $0.063_c$ | $20.9_g$ | $2.36_e$ | $0.30_e$ | $0.83_c$ | $0.35_d$ | $0.33_c$ |
| | 350 | $1.34_c$ | $5.46_f$ | $1.54_b$ | $0.072_b$ | $21.4_f$ | $2.77_b$ | $0.44_c$ | $0.85_b$ | $0.36_c$ | $0.35_b$ |
| | 450 | $1.33_d$ | $5.44_g$ | $1.72_a$ | $0.080_a$ | $21.5_e$ | $2.80_a$ | $0.70_a$ | $0.70_a$ | $0.44_a$ | $0.38_a$ |

Means with the same letters(s) under the same column are not significantly different ($P \leq 0.05$) using Duncan Multiple Range Test (DMRT).

**TABLE 5**. Effects of interaction or organic manure and inorganic fertilizer on some soil properties

| Nutrient Source | Rate | Bulk density | pH | C | N | C/N | Ca | Mg | K | Na | P |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0 | 1.32 | 5.64 | 0/72 | 0.013 | 55.4 | 2.32 | 0.27 | 0.03 | 0.26 | 0.30 |
| | 10 | 1.35 | 5.70 | 1.20 | 0.052 | 23.1 | 2.35 | 0.29 | 0.76 | 0.34 | 0.32 |
| PM | 20 | 1.36 | 5.82 | 1.52 | 0.054 | 27.9 | 2.75 | 0.38 | 0.81 | 0.36 | 0.33 |
| | 30 | 1.38 | 6.20 | 1.64 | 0.055 | 29.8 | 2.78 | 0.66 | 0.85 | 0.43 | 0.35 |
| | Mean | 1.4 | 5.8 | 1.3 | 0.04 | 34.1 | 2.6 | 0.4 | 0.60 | 0.30 | 0.30 |
| | 0 | 1.31 | 5.45 | 0.71 | 0.013 | 54.6 | 2.30 | 0.26 | 0.02 | 0.25 | 0.10 |
| | 10 | 1.33 | 5.65 | 1.14 | 0.054 | 21.1 | 2.32 | 0.27 | 0.16 | 0.26 | 0.13 |
| | 20 | 1.34 | 5.70 | 1.20 | 0.056 | 21.4 | 2.36 | 0.36 | 0.19 | 0.27 | 0.16 |
| CD | 30 | 1.36 | 5.85 | 1.30 | 0.058 | 21.7 | 2.73 | 0.64 | 0.21 | 0.34 | 0.20 |
| | Mean | 1.30 | 5.70 | 1.10 | 0.050 | 29.7 | 2.30 | 0.40 | 0.10 | 0.30 | 0.10 |
| | 0 | 1.30 | 5.68 | 0.70 | 0.013 | 53.8 | 2.31 | 0.26 | 0.04 | 0.27 | 0.31 |
| | 150 | 1.32 | 5.65 | 1.32 | 0.063 | 20.9 | 2.36 | 0.30 | 0.83 | 0.35 | 0.33 |
| IF | 300 | 1.33 | 5.46 | 1.54 | 0.072 | 21.4 | 2.77 | 0.44 | 0.85 | 0.36 | 0.35 |
| | 450 | 1.34 | 5.44 | 1.72 | 0.080 | 21.5 | 2.80 | 0.70 | 0.96 | 0.44 | 0.38 |
| | Mean | 1.3 | 5.6 | 1.3 | 0.1 | 29.2 | 2.6 | 0.4 | 0.7 | 0.4 | 0.3 |
| Manure Type | | * | * | * | * | * | * | * | * | * | * |
| Rate | | * | * | * | * | * | * | * | * | * | * |
| Manur type x Rate | | ns | ns | ns | * | * | ns | Ns | ns | Ns | ns |

Legend: * = significant at 0.05 level of probability, ns = not significant

**DISCUSSION**

**Physico-chemical properties of the experimental site**

The sandy loam texture of the experimental site may be attributed to the parent material (PM) from which the soil was formed and the climate of the area. The soil might be formed from sandstone and quartz parent materials. These impart sandy texture to the soils. The high sand content of the soil could be attributed to high content of quartz in the parent material (Brady and Weil, 1999).

The weakly acid nature of the soil of the area may be traced to the marked leaching of exchangeable bases resulting from the high rainfall associated with the environment and the dissociation of strong and functional group in the organic matter. This is in harmony with the findings of Esu (2001). The low organic matter status of the experimental site could be attributed to the rapid decomposition of organic matter due to high solar radiation and moisture, these favour optimum microbial activities in the soil. It could also be attributed to the annual seasonal bush burning which tend to deplete organic matter accumulation in the soil (Landor, 1991). The low level of total nitrogen could be possibly due to low organic matter content of the soil which contributes about 90-95% of soil nitrogen (Amalu, 2001). It could also be attributed to leaching of nitrate by torrential rainfall prevalent in the environment (Olatunyi, 2007). The high level of Phosphorus may be attributed to either of these reasons: (i) History of land use and cultural practices associated with the land use (that is, cropping of crops that do not take much P nutrient from the soil and the application of P organic or inorganic fertilizers (Nnaji, 2002 and 2008). (ii) The parent material from which the soil was formed may be rich in P minerals (Brady, 2002, Nnaji, 2002). (iii) The soil may not be highly acidic as to cause high level of P fixation (Brady, 2002, Isirimah, 2003 and Omokri, 2007). The low values of exchangeable cation may be attributed to the leaching of bases from the solum due to the high rainfall characteristics of the area. The low cation exchange capacity could be attributed to the PM from which the soil was formed, and low organic matter (OM) content of the soil. The PM from which the soil was formed may be poor in basic nutrients. FMANR (1990) noted that soils of the study area were dominated by Fe oxide and kaolinites. These clay minerals are low in basic cations (Brady, 2004). The exchangeable acidity was low possibly because of leaching of basic cations by torrential rainfall. The results generally are in harmony with the findings of Osaretin *et al*. (2006), Olatunji *et al.* (2007) and the results of soil fertility evaluation in the region. It is also consistent with the findings of FMANR (1990) which reported that most soils of the Southern Nigeria are poor in nutrients due to intense rainfall, soil erosion, and nutrient depletion through leaching and continuous cultivation of land without adequate application of fertilizer or other amendments.

**Residual effect of treatment application on grain weight of maize**

Hybrid variety 9022-13 had the highest grain weight among the varieties evaluated. This may be attributed to the special traits credited to hybrids, including high yield, diseases resistance and ability to adapt to environmental stresses. This is consistent with the findings of Iken and Anusa (2004) who reported that the high yielding advantages and special traits of hybrid maize appear to be sufficiently large enough to attract the attention of farmers. It is also consistent with the findings of Kim (1997) and Olakojo (1998) who reported that hybrid maize varieties have yield advantages of 25% and 50% over the best open-pollinated varieties. Plants that received inorganic fertilizer NPK 20:10:10 obtained higher cob weight than plants that received organic manure including plants in the control plot probably because the nutrients in organic manure slowly became available for plant's use compared to rapid release of nutrient from inorganic fertilizer. This is in harmony with the findings of Hera (1996) who reported that nutrients in organic manure slowly become available for plants' use though it could sustain yield over an extended period of time. It is also consistent with the findings of Abiola and Aiyelaagbe (2005) who reported that inorganic fertilizer performed better than organic manure because inorganic fertilizer made their minerals easily available for plants' use. It is also similar to the findings of Ayoola and Makinde (2008) who reported that plants received NPK 20:10:10 fertilizer had higher cob weight than their unfertilized counterparts. Plants that received higher rates of organic manure or inorganic fertilizer obtained higher cob weight than plants that received lower rates probably because lower rates of soil amendments attract poor response from maize plants. This is similar to the findings of Olarewaju and Isma (1990), and Ayodele (1993) who reported that the degree of crop response to fertilizer is depend on the type of fertilizer, amount applied, method and time of its application.

**Residual effects of organic manure and inorganic fertilizer on some soil properties**

Plots treated with poultry manure had higher values with respect to percentage clay, silt, bulk density than plots treated with cattle dung or inorganic fertilizer. This could be attributed to such special qualities of poultry manure as improvement of physical, chemical and biological conditions of the soil with respect to enhancing good water holding capacity, water infiltration, CEC, bulk density and stable aggregates. This is in harmony with the findings of Egerszegi (1990), Rose *et al.* (1995), and Dutt (2005) who reported that the use of organic amendment (poultry manure) improves the physical, chemical and biological conditions of the soil, widens the C:N ratio in soil, results in formation of stable aggregates which could resist erosion. It is also consistent with the findings of Girma and Emdale (1995) who reported that application of organic manure increases water holding capacity and soil structure. It is also in harmony with the finding of Zhang *et al.* (2006) who reported the poultry droppings increased water retention, and varied bulk density and porosity.

Plots treated with higher rates of organic manure or inorganic fertilizer obtained higher values with respect to percentage clay, silt bulk density, than plots treated with lower rates of the nutrient sources. This could be attributed to the increased amount of nutrients and organic matter, which improves soil physical properties. This is similar to the findings of Rose *et al.* (1996) who reported that the continuous application of large amount of manure increases the amount of plant nutrients and organic matter in the soil, which generally improves soil physical properties. It is also consistent with the findings of Gopinath *et al.* (2008) who reported that higher rates of organic manure enhanced microbial activities of degydrogenase β–glucosidase urease and phosphatase better than their mineral fertilizer counterparts. The increase in soil pH due to corresponding increase in the rates of poultry manure and cattle dung could be attributed to increased microbial activity during the process of decomposition and organic matter formation. This could have led to the release of more exchangeable cations or bases that reduces the soil acidity towards neutrality. This is similar to the findings of Nel *et al.* (1996), Odiete *et al.* (1999) and Ibiawuchi *et al,* (2007) who reported that all the plots treated with poultry manure and / or inorganic fertilizer had high residue of N,P,K , Ca and Mg with an increase in pH from 5.65 to 5.71. It is also consistent with the findings of Nnaji *et al.* (2005), who reported cation release from decay of organic amendments. The decline in pH of plots treated with increasing rates of inorganic fertilizer could be attributed to their rapid rates of release of nutrient, which are immediately used up by plants, leading to poor accumulation of exchangeable bases ($Ca^{2+}$, $K^+$, $Mg^{2+}$, $Na^+$) that neutralizes soil acidity. It could also be attributed to increased levels of N and P in response to increased level of inorganic fertilizer. This is also similar to the findings of Ibeawuchi *et al.* (2007) who reported increased N and P levels due to a reduction in soil pH towards increased acidity. It is also similar to the findings of Gopinath *et al.* (2008) who reported increased levels of N and P in plots treated with inorganic fertilizer than in plots treated with organic manure. The observed increase in C, N and P contents in plots that received organic manure in the present study could be attributed to the continued application of manure over two years and its residual effects which could last for several years after discontinuation. These observations regarding the persistence of elevated nutrient levels in previously manured plots are in agreement with the report of Sharpley *et al.* (1993), Sharpley and Smith (1995). The consistent increase in C: N ratio due to corresponding increase in the levels organic manure and inorganic fertilizer could be attributed to improvement in physical, chemical and biological conditions of the soil such as good water holding capacity, water infiltration, CEC, bulk density and stable aggregates. This is in harmony with the findings of Rose *et al.* (1995), and Dutt (2005) who reported that the use of organic amendments improves the physical, chemical and biological conditions of the soil, widens the C : N ratio in soil, results in formation of stable aggregates which could resist erosion. Exchangeable cations increased with increasing rates of manure or fertilizer possibly because the various nutrient sources released their nutrients elements to compliment already existing levels sin the soil. This is similar to the findings of Jackson *et al.* (1999), Ayola and Makinde (2008) who reported that poultry manure and cattle dung increase the water soluble and exchangeable cations (Ca, Mg, NPK) which enhance crop yield.

## CONCLUSION AND RECOMMENDATIONS

The study was carried out to evaluate the residual effects of previously applied organic manure and inorganic fertilizer on grain weight of maize and some soil properties in Asaba area of Delta State. It was a factorial experiment carried out in a Randomized Complete Block Design (RCBD) with three replicates. The results showed that hybrid maize variety 9022-13 was superior in grain weight. It also indicated that bulk density of plots treated with poultry manure was highest, while exchangeable cations (Ca, Mg, K and Na) increased with higher rates of organic manure/inorganic fertilizer based on the study, it was recommended that (i) farmers in Asaba area of Delta State sow hybrid variety 9022-13 for increased grain weight (ii) farmers who prefer mineral fertilizer should apply 450 $kg/ha^{-1}$ of NPK 20:10:10 (iii) farmers who practice organic agriculture should apply $30tha^{-1}$ of poultry dropping to enhance maize yield.

## REFERENCES

Abiola I.O. and Aiyeaagbe I. O. (2005) Comparative investigation on the influence of organic and inorganic fertilizers on the growth of *Passifola edulis var (flavicarpa). In Horstson Abstracts 2005 23rd Annual conference on September 16-22 at* Port Harcourt River State. 37.

Adekunle, I.O., Akirinade, O.E. and Azeaz, J.O. (2005) Influence of combined application of cattle manure and NPK fertilizer on soil chemical properties, growth and yield of Okra *(Abelmoschus esculentum)* in Alfisol. *Proceedings of the 29th Annual Conference of the Soil Science Society of Nigeria, December 6-10, 2004, University of Agriculture, Abeokuta, Nigeria*. Pp. 143-146.

Adepetu, J. A. (1997) Soil and Nigeria food security. Inaugural Lecture series 119, Obafemi Awolowo University, Ile-Ife. Nigeria p.19.

Agbato, S.O. (2003) Principles and Practices of crop production. Odumatt press publisher, Oyo, pp. 57-62.

Akintoye, H. A. and Olufolaji, A.O. (2005) Effect of different levels of organic mineral fertilizer on the growth and yield of Cayenne pepper grown in South Western Nigeria. In HORSTON Abstracts 2005 of 23rd Annual conference held on September 16-22 at Rivers State p. 35.

Aliyu, L. and Olarewaju, J. D. (1996) Response of pepper *(Capsicum annum L)* to fertilizers: growth, yield and yield components as affected by nitrogen and phosphorus levels. *In proceedings of 14th HORTSON conference, Ago-Iwoye, 1-4 April, 1996* pp 5, 82-87

Ayodele, O. J. (1993) Further yield responses of tomatoes *(Lycopersicum esculentum)* to fertilizer application *Research Bulletin* No. 16. national Horticultural Research Institute, Ibadan, Nigeria.

Ayoola, O.T. and Makinde, E.A. (2008) Performance of green maize and soil nutrients changes with fortified cattle dung. *African Journal of Plant Science.* 2 (3), pp 019-022.

Brady, C. and Weils, R.R. (1999) Nature and properties of Soil Twelfth Edition, Prentice Hall, New Delhi pp 74 – 114.

DIPA (2006) Handbook of Agriculture: facts and figures for farmers, students and all interested in farming. Directorate of Information and Publications of Agriculture. *Indian Council of Agricultural Research,* New Delhi, p. 435.

Dutt, S. (2005) A Handbook of Agriculture. ABD Publishers, India. Pp 116-118.

Egerszegi, E. (1990) Effect of sewage sludge and compost applied to the soil on some physical and chemical properties. *Journal of Environmental Quality* Vol. 15:122-127.

FAO (2003) Fertilizer and the future. *IFA/FAO Agriculture Conference on Global food security and the role of Sustainability Fertilization.* Rome, Italy. 16th-20th March, 2003, pp 1-2.

FMANR (1990) Literature review of soil fertility. Investigation in Nigeria (in five volume) 3(2) 102-106.

Girma,T. and Endaele (1995) Influence of Manuring of certain soil Physical Properties in Middle Awash of Ethiopia. Commun. *Soil Science Plant Annal* 26: 15654-1569.

Gopinath, K. A., Supradip, S., Mina, B. L., Pamde, H., Kundu, S. and Gupta, H.S. (2008) Influence of Organic Amendments on Growth, Yield and Quality of Wheat and on Soil Properties during Transition to Organic Production. *Journal of Nutrient Cycling in Agroecosystem.* Springer, Netherland, http://www. sprngerlink.com/ content/a241607223w64748.

Hera, C. (1996) Role of inorganic fertilizer and their management practices. Khiwer Academic Publishers. *Fertilizer Resources* 43:63-81.

Ibeawuchi, I. I., Opara, F.A., Tom, C.T. and Obiefuna, J.C. (2007) Graded replacement of inorganic with organic manure for sustainable maize production in Owerri Imo State, Nigeria. *Life Science Journal* 4 (2):82-87 (ISSN:1097-8135).

Iken, J. E. and Anusa, A. (2004) Maize Research and Production in Nigeria. *African Journal of Biotechnology*. 3(6): 302-307.

Iken, J.E., Anusa, A. and Obaloju, V.O. (2001) Nutrient Composition and Weight Evaluation of some Newly Developed maize Varieties in Nigeria. *Journal of Food Technology, Kenya.* 7:25-28.

Isirimah, N.O., Dickson, A.A. and Igwe, C. (2003) Introductory soil Chemistry and Biology for Agriculture and Biotechnology. Asia International Publishers Limited, Port-Harcourt, Nigeria. Pp 103.

Ismail, A.S., El-Schaay, A.S., Salehu, S.A., and Abdel-Wahab, A.F. (1999) Effect of application of mineral and organic amendment of nodulation of cowpea growth and certain chemical properties of calcareous soil. *Ann. Agric. Sci.* (Special Ed) pp. 23-39.

Jackson, H. (1999) Land disposal of broiler litter changes in soil potassium, calcium and magnesium. *Journal of Environment Quality* 4:202-206.

Kim, S. K. (1997) Achievement, challenges and future direction of hybrid maize research and product in B. Badu-Apraku, Akoroda M.O., Oedraw M. and Quin F.M(eds). *Proceedings of Required Maize Workshop May 99-june 2, 1995. IITA Cotonou,* Benin Republic.

Landor, J.R. (1991) Brooker tropical soil manual. A handbook for soil survey in the tropics and subtropics. Longman Group. England. 106-144.

Meteorological Office Asaba (2003) Weather Characteristics of Delta State of Nigeria. Unpublished Vol. 2 p 2-21.

Movahedi, S.A.R, and Cook, H.F. (2000) Influence of municipal compost on temperature, water, nutrient status and the yield of maize. *In a Temperate Soil. Soil use and Management* 16:3, 215-221.

Mubondeni, T.H., Manga, I. K., Mugwira, L.M. and Chivinge, O.A. (1999) Maize response to method and rate of manure application. African *Crop Science Journal* 7(4):407-413.

Nel, P.C., Bernard, R.O., Steynberg, R.E., De Beer, J.M and Groeneveld, H.T. (1999) Trends in maize grain yields in long-term fertilizer trial. *Elsevier Science B.V, Field Crop Research* 47(1):53-64.

Nest-Nigerian Environment Study Action Team (1991) Nigerian threatened environment: A National Profile, p 288.

Nnaji, G.U. (2008) Fertility status of some soils in Isoko South Local Government Area of Delta State. *Proceedings of the Annual Conference of the Agricultural Society of Nigeria* held n Ebonyi State University, Abakiliki Pp 515-519.

Nnaji, G.U., Asadu and Mbagwu, J.S.C. (2002) Evaluation of the physico-Chemical properties of soils under selected agricultural land utilization types. *Journal of Tropical Agriculture, Food, Environment and Extension* 3:27-33.

Nnaji, G.U., Mbagwu, J.S.C. and Asadu, C.L.A. (2005) Influence of organic manures on cassava yield and some chemical properties of an ultisol Nsukka area of south Eastern Nigeria. *Proceedings of the 29th annual conference of the soil science society of Nigeria 5th-9th December, 2005, Makurdi*, Nigeria.

Odeleye and Odeleye (2001) Evaluation of morphological and agronomic characteristics of two exolic and two adapted varieties of tomato *(Lycopersicom esculentum)* in South West Nigeria. *Proceedings of the 19th Annual Conference of HORTSON.(1):140-145.*

Odiete, T., Ojeniyi, S.O and Akinole, O.M. (1999) Effect of goat dung manure on soil, Okra, amaranthus and maize. *Proceeding of the 25th Annual Conference* held in Benin. *Book of Abstract SSSN.*

Olakojo, S.A., Ogundodede, B. A. and Kogbe J.O.S. (1998) Evaluation of Maize *(Zea mays)* Top crosses in a Rainforest Location. Biose res. Comm 11(2); 141-146.

Olarewaju, J.U. and Isma, F. (1990) Irrigated pepper production as influenced by plant population and nitrogen nutrition at Samand, Nigeria. *Paper presented at 26th Annual conference of Agriculture, Markudi, 2-5 September, 1990.*

Olarewaju, J.U. and Showemimo, F.A. (2003) Response of pepper to nitrogen and phosphorus fertilization in

Northern Nigeria. *In Proceedings of the 21st Annual conference of the Horticultural Society of Nigeria* 2003. November 10-13th pp. 28-30.

Olatunji, U.S.A., Ayuba, A. and Oboh, V.U. (2007) Growth and yield of Okra and Tomato as Affected by pig dung and other organic manures. *Proceedings of the 30th Annual Conference of the soil science society of Nigeria 5-9th December, 2005, Makurdi* Nigeria.

Olayinka, A. (1996) Carbon Mineralization from Poultry Manure Straw Sawdust amended alfisol. *Ife Journal of Agriculture* 1 and 2. (18) 26-36.

Olayinka, A., Adentunyi, A. and Adebayo, A. (1998) Effect of organic amendment on nodulation and nitrogen fixation of cowpea. *Journal of Plant Nutrition* 21 (11): 2455-2464.

Omokri, J.I., Nnaji, G.U. and Uyovbisere, E.O. (2007) Assessment of the physical properties of Orogodo basin and the surrounding soils in in Agbor, Delta State. Proceedings of the 31st Conference of Soil Science Society of Nigeria held on the 13th – 17th November, 2006 at Ahmmadu Bello University, Zaria, Nigeria Pp 358-362.

Osaretin, A.U., Jedeki, F.C. and Odingo, F.M. (2006) Fertility status and classification of some tropical soil cateria. *Tropical soils* 31 (24) 38-52.

Reijnties, C., Hoverkork, B., and Water-Bayer, A. (1992) An introduction to Low External-Input and Sustainable Agriculture. John Wiley and Sons. London. p. 340.

Rose, R. and Diane, L.H. (1996) Managing organic matter in forest nurseries. In Landis, T.D, South, D.B. tech. cords. *National proc. Forest and Conserval Nursery Associations.* Gen. Tech. PNW-GTR. 389, Portland Department of Agriculture, Forest Service, Pacific Northwest station pp. 250-252.

Sharpley, A.N. and Smith, S.J. (1995) Nitrogent and phosphorus forms in soil receiving manure. *Soil Science* 159:253-258.

Sharpley, A.N., Smith, S.J and Bain, W.R. (1993) Nitrogen and fate from long-term poultry litter applications to Oklahoman soils. *Soil Science Society American Journal,* 27:1131-1137.

Smith B.D. (1995) Emergence of Agriculture. Volume 54. *Scientist American Library,* New York.

Sobulo, R.A. and Babalola (1992) Improved organic fertilizer and soil condition. *In Toward Efficiency Fertilizer use in Nigeria. Federal Ministry of Agriculture, Water Resources and Rural Development.* Lagos pp. 90-110.

Sonetra, S., Borin, K and Preston, T.R. (2002)Waste water from rubber processing as fertilizer for water spinach and forage cassava. http.www.utafoundation.org/ utacanbod/ msc99thes/sonintro.htm.

Stefan, T. (2003) Organic Agriculture: Sustainability market policies. CAB Organization for Economic Co-operation and Development p. 95.

Subedi, K. D. and Gurung, G. (1991) Soil fertilizer thrust towards sustainable agriculture: experience of Lumile Regional Agricultural Research centre. *In: Soil Fertility and Erosion Issues in the Middle Mountains of Nepal* pp. 81-82 IDRC, Otawa, Canada.

Tolera, A., Berg, T. and Sundstol, F. (1999) The effect of variety on maize grain and crop residue yield and nutritive value of the Stover. *Journal of Animal feed Science and Technology* 79(3):165-177.

Wahua, T.A.T (1999) Applied statistics for scientific studies. Afrika-Link Books, Nigeria, pp. 250 -287.

Zhang, S., Yang, X., Wiss, M., Grip, H. and Lovdahl, L. (2006) Changes in physical properties of a loess soil in china following two long-term fertilization regimes. *Geoderma* 136 Issue 3-4.