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# Comparative Assessment of Four Crop Species for Soil Fertility Maintenance, Weed Suppression and Sustainable crop yield in *Manihot esculentus* (Cassava) based Cropping Systems.

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**ABSTRACT:** The effects of the four crops species (*Telfairia occidentalis*, *Vigna unquiculata*, *Arachis hypogea and Citrullus vulgaries)* on soil fertility, weed suppression and sustainable crop yield were compared. Highest root yield of *Manihot esculentus* (30.2tlha and 33.1tlha) was recorded from *Arachis hypogea* intercrop. The lowest weed biomass (71.3g/m$^3$ and 68.3g/m$^2$ for 2005 and 2006) was obtained from *Teifairia* intercrop (unstaked). Land economy was improved by intercropping. The nitrogen and organic matter contribution to the soil from the crop species based on means from the two seasons were in the following order, *Arachis hypogea*> *Vigna unquiculata* > *Telfairia* > *Citrullus vulgaris*. While intercropping improved the soil nutrient status, solecrops reduced it significantly.

**KEYWORDS:** Comparative Assessment, Species, Soil Fertility Maintenance, Weeds Suppression, Sustainable Crop Yield, Cassava.

## INTRODUCTION

*Manihot esculentus* (cassava) is one of the major carbohydrate staple food crops in Nigeria, especially from the rainforest to the guinea savanna agro-ecological zones of the country *(Willey 1979).* It is also used for industrial starch, ethanol and in the production of cassava powder, (garri) and Chips/Pellets, which is the primary area of nation's focus. *(Ngumen 2007).*

In Nigeria, cassava production has moved from small-scale enterprise to medium and large scale production enterprise with a lot of emphasis on export (Fresco 1993). The Federal Government, lately has realized the potentials of export of cassava products particularly cassava chips. Since then, there have been series of activities with government forming committees and action plans having outlined how much Nigeria is capable of making from cassava products. Thus, the crop (cassava) is among the national priority crops in the current Agricultural Development Policy of Nigeria on which the Federal Government has projected to attain self-sufficiency on the short-run (FMAWARRD, 1988).

Meanwhile the Federal Government is sponsoring individual farmers, Agricultural Institutions or companies for large scale production of cassava. *(Anyaegbu, 2008).* Unfortunately, the major problems facing the farmers in cassava production is soil fertility maintenance *(Ononoiwu 1990)* and weed infestation.

Intercropping of cassava with legumes has been reported to alleviate weed problem in cassava fields. *(Zuofa et al 1992)*. However, little work has been done in this area. *Zuofa et al (1992)* found 13% reduction in weediness in cassava intercropped with maize and a further reduction of between 16 and 40% by intercropping with low-growing smoother crops such as *Arachis hypogea*, *Vigna unquiculata* or *Citrullus vulgaris*.

There has been reports *(Norman 1976, Richards 2005)* on the contributions of legumes to soil nitrogen but not much has been done to compare their individual importance with other low growing or cover-crops in improving cassava yield, and controlling weed problems in cassava-based cropping systems.

This study therefore was designed to evaluate the individual contributions of *Arachis hypogea* (groundnut), *Vigna unquiculata* (cowpea), *Telfairia occidentalis* (Uguh) and *Citrullus vulgaries* (melon) to soil fertility, weed suppression and crop yield of cassava in cassava intercrop conditions.

## MATERIALS AND METHODS

The trials were conducted on an Ultisol, at the Teaching and Research Farm of Imo State Polytechnic, Imo State, Nigeria, in 2005 and 2006 cropping seasons. The institution is located in the rainforest belt with total annual rainfall of between 2000 and 2500mm.

The site was in a two year fallow period prior to the commencement of the experiment. In 2005 the area was cleared and ploughed using tractor. In 2006, clearing was restricted to individual plots. After clearing a plot, the debris or left over of the given crop and weed biomass were spread evenly in the plot and allowed to decompose prior to planting.

The initial nutrient status of the soil was determined. Soil samples (o-15cm) and (15-30cm) were randomly collected from each plot and used for the determination of NPK and organic matter. The post soil analysis was also carried out to determine the contribution of each crop in the nutrient status of the soil at the end of the cropping seasons.

An improved cassava variety TMS 419 obtained from IITA Onne, River State Nigeria was intercropped with *Vigna unquilata* (TVX 3236), *Arachis hypogea*(erect type), *Citrullus vulgaris* (Local) and *Telfairia occidentalis*. The four treatment combinations evaluated with sole cassava treatment as control were Cassava/Cowpea, Cassava/Groundnut, Cassava/Melon and Cassava/*Telfairia*.

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These were laid out in randomized complete Block Design with 3 replications. A total of 15 plots were used in the trial and each plot measured 3m x 4m with 0.5m pathway.

Cassava was planted at 1m x 1m, giving a population of 10,000 stands per hectare while the component crops were planted at 50cm x 50cm with 2 seeds per hole giving a population of 80,000lha. Herbicides and fertilizers were not applied. The first and only weeding done with hoe was carried out 3 weeks after planting.

Weeds in each plot were sampled at the end of the trial in $1m^2$. They were dried under shade for 2 weeks. Cassava was harvested 11 months after planting. The leaves of *Telfairia occidenlalis* were harvested at 2 weeks intervals. The dried pods of the legumes harvested were shelled and the grains were further dried and weighed.

Analysis of variance was carried out to access treatment effects. Means were compared by LSD at 5% level of significance. Land Equivalent Ratio (LER) was calculated after *Willey and Osiru (1972).*

## RESULTS AND DISCUSSION

Fresh root yield:- The root yield of cassava was influenced significantly ($p>0.05$) by different crop combinations (table 1).

The highest root yield of cassava was recorded from *Arachis hypogea* intercrop. Thus intercropping cassava with *Arachis hypogea* significantly ($p>0.05$) produced the highest cassava root yield among the other crop combinations evaluated during the two cropping seasons.

This same observation was made by *Nguyen et al (2001)* in Vietnam that intercropping cassava with peanut was able to maintain cassava yields, while cassava and peanut planted at the same time *(Tran and Nguyen, 2001)* and in two rows intercrops were considered the best system. High root yield was also recorded in *cassava/vigna unquiculata* intercrop and cassava/*Telfairia* system. The cassava root yield in cowpea intercrop may be attributed to cowpea's ability to improve the nitrogen economy of the soil. The *Telfairia* crop, unstaked, effectively reduced weed growth and may have contributed to high root yield of cassava in the system.

Generally intercropping with the cover crops improved cassava root yield more than in sole cassava. These observations may be attributed to the ability of the crops to suppress weeds (Table 4) apart from the legume property of groundnut and cowpea.

While the cassava root yield in the intercrop plots remained steadily high in the two cropping seasons, the cassava sole crop yield decreased drastically ($p>0.05$) in 2006 (table 2). This phenomenon indicates that intercropping cassava with legumes or cover crops ensures yield sustainability. *IITA (1975), Fagbamiye (1997)* and *Ikeorgu (1984)* had reported that *Citrullus vulgaris* improved the yield of companion crops by conserving soil moisture and reducing high noon temperature, thereby making the environment more conducive for plant growth and development.

### Land Use Productivity

The total land equivalent rations of the cassava and the various crops as contained in Table 3, were all above 1.0, indicating that higher productivity per unit area was achieved by intercropping than by sole cropping. The highest LER of 1.48 was obtained by intercropping cassava with *Arachis hypogea* (groundnut) depicting 48% yield advantage in growing those crops together. This agrees with observation of *Ikeorgu et al (1992)* that intercropping cassava and legumes is more advantageous in terms of land economy and productivity. *Njoku et al (2007)* recorded 160% yield advantage in growing sweet potato with Okra over their sole crop yields. *Asiegbu and Uzo (1984)* obtained similar results in okra/Cowpea intercropping. However the superiority of cassava/groundnut intercrops was probably due to higher nodulation and therefore higher Nitrogen contribution, (Table 6).

### Weed Biomass

The weed biomass as affected by the selected cover crops in cassava intercrop is presented in table 4. *Telfairia occidentalis* intercropped with cassava had the lowest weed biomass ($71.36g/m^2$) in 2005 and $68.3g/m^2$ in 2006. Intercropped cassava had significantly ($p>0.05$) lower weeds than sole cassava. However, the effectiveness of *Telfairia* in reducing weed growth may be attributed to its high biomass. Cowpea, groundnut and melon, were equally effective in controlling weed growth in cassava farm. *Akobundu (1987)* attributed the efficiency of intercropping cassava/legumes to reduced weed pressure.

### Soil Nutrient

Intercropping cassava with the selected crops significantly ($p>0.05$) improved Nitrogen status of the soil when compared with sole cassava, (Table 6). Intercropping cassava with *Arachis Hypogea* gave the highest nitrogen contribution in soil for the two cropping seasons. This is followed by cassava/cowpea intercrop. The effectiveness of *Arachis Hypogea* and *Vigna unquiculata* (cowpea) in contributing nitrogen in cassava intercrop could be attributed to their nodulation property. Several workers showed that good growth of legumes improved its nodulation which ultimately improve the nitrogen economy, *(Das and Mathur 1981).* The soil analysis also showed that both phosphorus and potassium were actively utilized by cassava and the companion crops, hence the drop at the end of the season. Organic matter contribution showed the same trend as nitrogen. The rating of soil organic matter by *Asadu (1991)* showed that organic matter content of soil of 2-3% is the optimum requirement for crops. In this trials, the highest organic matter content of 2.5 in 2005 and 2.58 in 2006 were obtained from groundnut/cassava intercrop.

The result of the soil analyses had shown that intercropping cassava with the selected crops improved soil nutrient availability. This improvement was progressive with the cropping seasons. Thus, intercropping plays significant roles in sustaining soil fertility for improved crop yields.

## CONCLUSION

The root yield of cassava was significantly improved by intercropping with the selected cover crops, though the highest root yield was recorded in cassava/groundnut intercrops for the two growing seasons, 2005 and 2006. This result showed that the selected cover crops are compatible with cassava and are capable of sustaining cassava production especially now that cost of fertilizer is relatively high. Intercropping cassava with the selected crops has been seen to improve land economy. Compared with sole crop cassava, intercropping cassava with the selected crops significantly reduced weed growth. The comparative evaluation has shown that cassava/groundnut intercrop appeared to be more effective in improving N and Organic matter (OM) content of the soil and the yield of cassava more than other companion crops in the cassava intercrop.

**Table 1: Pre-Planting Soil Physico-Chemical Properties at The Face 0 15cm At The Experimental Site 2005.**

| **Properties** | **Value** |
|---|---|
| Sand (%) | 80.0 |
| Silt (%) | 3.0 |
| Clay (%) | 12.0 |
| pH ($H_2o$) | 4.5 |
| Org. matter | 0.61 |
| Total N (%) | 0.31 |
| Avail.P (ppm) | 5.08 |
| Exch. K (cmol/kg) | 0.09 |
| $Mg^{2+}$ (Cmol/kg) | 0.64 |

**Table 2. Performance of Cassava in Intercrop with the selected cover crops in 2005 and 2006.**

| **Treatments** | **Mean Fresh Root yield of cassava** | |
|---|---|---|
| | **2005** | **2006** |
| *Cassava /Telfairia* | 22.8 | 24.2 |
| Cassava /cowpea | 27. 3 | 28. 1 |
| Cassava /Groundnut | 30. 2 | 33. 1 |
| Cassava / Melon | 20. 5 | 22.5 |
| Sole Cassava | 16. 6 | 19.10 |
| LSD (p>0.05) | 1.5 1 | 1.08] |

**Table 3: Mixture productivity of the cassava with the various component crops assessed by land equivalent ratio**

| **Cropping system** | **2005** | **2006** |
|---|---|---|
| Cassava /*Telferia* | 1. 25 | 1.21 |
| Cassava /cowpea | 1.33 | 1.38 |
| Cassava / groundnut | 1.48 | 1.47 |
| Cassava / melon | 1.22 | 1.19 |
| Sole cassava | 1.00 | 1.00 |
| LSD (p>0.05) | 0.03 | 0.05 |

**Table 4: Weed Biomass (glm$^2$) as attested by the cassava based cropping system.**

| | Weed biomass (g/m$^2$) 2005 | |
|---|---|---|
| **Copping System** | **2005** | **2006** |
| Cassava / *Telferia* | 71.3 | 68.3 |
| Cassava / Cowpea | 133.3 | 142.2 |
| Cassava / Groundnut | 130 | 128.6 |
| Cassava / Melon | 133.3 | 126.1 |
| Sole cassava | 383.38 | 286.3 |
| LSD (p>0.05) | 21.6 | 18.1 |

**Table 5 component crop yield tha $^{-1}$ as influenced by cassava based cropping systems**

| | **2005** | | | **2006** | | |
|---|---|---|---|---|---|---|
| **Crops** | **intercrop** | **solecrop** | **x±s** | **intercrop** | **solecrop** | **x±s** |
| *Telfairia* | 22.20 | 19.7 | 9±1.6 | 24.1 | 20.4 | 22±2.62 |
| Cowpea | 0.11 | 0.12 | 0.12±0.07 | 0.21 | 0.31 | 0.20±0.02 |
| Groundnut | 0.21 | 0.19 | 0.2±0.014 | 0.31 | 0.21 | 0.21±0.02 |
| Melon | 19.6 | 20.5 | 20.1±0.64 | 16.8 | 18.9 | 17.9±1.48 |

Table 6: Post-harvest soil physico-chemical properties as affected by Cassava based cropping systems in 2005 and 2006

| Cropping systems | $P^H$ | % Total N | aval. $P_{(ppm)}$ | $K^+$ Exch $Mg^{2+}$ | % Exch M | Org | % sand | % silt | % clay |
|---|---|---|---|---|---|---|---|---|---|
| **2005** | | | | | | | | | |
| Cassava / *Telfairia* | 4.95 | 0.38 | 14.15 | 0.07 | 0.92 | 2.26 | 80 | 31 | 2.1 |
| Cassava / cowpea | 5.18 | 0.58 | 16.5 | 0.12 | 1.29 | 2.39 | 80 | 3.1 | 12 |
| Cassava / groundnut | 5.5 | 0.85 | 17.7 | 0.21 | 1.48 | 2.50 | 80 | 3 1 | 2.1 |
| Cassava / melon | 5.09 | 0.42 | 13.9 | 0.21 | 0.81 | 2.27 | 80 | 3 | 12.3 |
| Cassava / sole | 4.48 | 0.21 | 4.8 | 0.08 | 0.99 | 0.58 | 80 | 3 | 12.1 |
| LSDP20.05 | 0.11 | 0.08 | 0.51 | 0.03 | 0.28 | 0.14 | ns | ns | ns |
| **2006** | | | | | | | | | |
| Cassava / *Telfairia* | 4.99 | 0.4 | 15.0 | 0.22 | 1.02 | 2.38 | 80 | 3 | 12.1 |
| Cassava / cowpea | 5.26 | 0.62 | 17.9 | 0.25 | 1.43 | 2.38 | 80 | 3 | 12.1 |
| Cassava / groundnut | 5.69 | 0.85 | 19.2 | 0.31 | 1.41 | 2.68 | 80 | 3.1 | 12 |
| Cassava / melon | 5.10 | 0.42 | 14.6 | 0.23 | 1.10 | 2.25 | 80 | 3 | 12 |
| Cassava / sole | 4.46 | 0.20 | 4.5 | 0.11 | 0.84 | 0.57 | 80 | 3 | 12 |
| LSDP>0.05 | 0.21 | 0.06 | 1.32 | 0.04 | 0.16 | 0.59 | ns | ns | ns |

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