THE IMPACT OF LIME AND PHOSPHOROUS FERTILIZER APPLICATIONS ON THE GROWTH OF SOYABEAN (GLYCINE MAX)

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Abstract

A Pot experiment was carried out in year 2004 on "Acid-Sands" of Awka, Kugbo from the Derived Savanna and Akufo soil from the Southern Guinea Savanna Agro-ecological Zones of Nigeria to evaluate the impact of lime and P fertilizer application on the growth of soybean (*Glycine max*). It consisted of four lime treatments (0,2,4, and 6 ton ha $^{-1}$ on three soils combined with three levels (0,30,and 60kg P_2 0_5ha $^{-1}$ applied as SSP. The experiment was laid out in split plot design. There was significant response in the performance of soybean in the limed and P- fertilized treatment compared to the unlimed and unfertilized treatments. Akufo and Kugbo soils performed significantly higher at 4 ton ha $^{-1}$ of lime combined with 60kg P_20_5 ha $^{-1}$ while Awka plants were best at 2 ton ha $^{-1}$ in combination with 60kg P_20_5 ha $^{-1}$. Generally, results reflected appreciable depression in performance when the plants were treated above the optimal lime requirement which resulted in unfavorable soil condition and drastic reduction in plant growth.

Keywords: Acid sands, Amendment, fertility regeneration, fertilizer trial, Tropical soils.

Introduction

"Acid Sands" are acid soils that are found in parts of the tropical humid climates and in areas having underlying geology made up of sedimentary rocks or unconsolidated sediments (Bredenkamp, 1996). These tropical and subtropical agricultural soils formed on coastal plain sands located in the high rainfall regions are strongly acidic, low in base saturation but high in aluminum saturation (Maduakor, 1994). The world distribution of Acid-Sands is related to climate and parent material. In Africa, the occurrence of acid-sands is prevalent in the west, south and central regions particularly Ghana and Nigeria (Piessens *et al*., 2006) In Nigeria, the occurrence covers Lagos, Ogun, Ondo, Edo, Delta, Anambra, Enugu, Oyo, Cross-River, the Federal Capital Territory (FAO, 2004).

Liming has been recognized as the first requirement for effective use of Acid soils in tropical areas (Lelei *et al.*, 2000). The maintenance of satisfactory soil fertility levels in humid regions depends considerably on the judicious use of Lime to balance the losses of calcium and magnesium from the soil. Liming not only maintains the level of exchangeable calcium and magnesium but also provides chemical and physical environment that encourages the growth of common plants (FAO, 2004). The strategy for the soil fertility management of acid soils include decreasing the detrimental effect of acidity and building the fertility status especially that of phosphorus, whereby root conditions below the plough layer will enhance P absorption from the soil solution and ensure optimum utilization of an applied nutrient by plant (Bowen *et al.,* 1999) The supply and availability of phosphorus in acid soils ranges from low to medium in the plough layer of the soil, therefore, these soils will usually need P fertilizer application for optimum yield of most crops as its deficiency will prevent crops from completing their life cycle (Buerkerto *et al*., 2001).

For successful soybean production, large quantities of lime and phosphorus (P) fertilizers may be required (Fageria *et al.,* 1994). Liming improves microbiological activities of acid soils, which in turn increases N fixation by legumes (Giller, 2001; Bala *et al.*, 2001; Kolawole, 2000) and also promotes mineralization of organic materials. However, over liming may reduce crop yield by inducing P and micronutrient deficiencies (Fageria, 1994).

A pot experiment was therefore carried out to investigate and evaluate the impact of lime and P fertilizer application on the optimum performance of Soybean grown on acid sands from the Derived Savanna and Southern Guinea Savanna Zones of Nigeria.

Materials and Methods

The soil samples were collected from three different locations of different pedogenic characteristics namely Akufo (Oxic or Orthic Luvisol), Awka (Typic Paleustults and Haplustults) and Kugbo (colluvium and Nupe sand stone residuum) (Ohiri *et a.,* 1989; Akamigbo, 2002). The soil samples were air-dried and passed through a 2mm sieve to determine particle size by Hydrometer method, soil pH in H_20 and 0.01M $CaCl_2$ by pH meter, Organic carbon by Walkley-Black method, Total N (%) by Kjeldahl method and Available P using the Vanadomolybdate wet digestion, Exchangeable cations by Ammonium acetate (1N NH_40Ac) extraction method at pH 7.0, Exchangeable Acidity and Percentage Aluminum Saturation by titration with IN HCL. Powders of Hydrated lime $Ca(0H)_2$ and lime stone ($CaC0_3$) were obtained from Kano and Anambra States, Agricultural Development Program, respectively, Seed of soybean (*Glycine max*) variety, TGX1440-1E was obtained from the National Cereals Research Institute (NCRI), Badeggi while the Single Super Phosphate (SSP), 18 (% P_20_5 ha $^{-1}$ was obtained from the Soil Science Department, Federal University of Technology, Minna. The trial involved three soils, Akufo, Awka and Kugbo, four rates of $CaC0_3$ (0, 2, 4 and 6 ton ha $^{-1}$) and three levels of P (0, 30 and 60 kg P_20_5 ha^{-1}) applied to each polythene pot containing 2.5 kg soil placed behind the soil laboratory. Five seeds of soybean (TGX 1440-1E) were sown per pot two weeks after liming and

germination test. The plants were then thinned to three plants per pot at 2WAP. The parameters measured include plant height measured at 6 weeks after planting (WAP), shoot biomass weight and the phosphorus content of tissue after 60 days of planting. The plants were carefully uprooted and the shoots were cut at soil level while the roots were carefully washed, rinsed and nodules collected. The shoots and the nodules were oven-dried separately and weighed for dry matter analysis while the shoots (leaves) were ground in a stainless steel grinder and sub-sample analysed for its P content by the Vanadomolybdate yellow method following wet acid digestion. All the relevant data collected were subjected to statistical analysis using statistical analysis software (SAS, 2000). LSD was used to separate the means.

Table 1. Selected Physicochemical Properties of Soils before liming.

Parameter	Akufo	Kugbo	Akwa
Sand	65	70	85
Silt	23	20	3
Clay	12	10	12
pH (0.1MCaC1$_2$)	4.7	4.8	4.7
Organic Carbon (%)	0.8	0.60	0.9
Total N (5)	0.05	0.04	0.03
K' (cmol kg^{-1})	0.10	0.33	0.12
Na^+ (cmol kg^{-1})	0.04	0.31	0.10
Ca^+ (cmol kg^{-1})	0.30	2.0	0.52
Ma^+ (cmol kg^{-1})	0.16	0.32	0.30
Exchange acidity (cmol kg^{-1})	5.4	7.04	5.80
Effective C.E.C (cmol kg^{-1})	5.64	10.0	6.84
Base Saturation (%)	23	30.0	15
Al saturation (%)	77	70	85

Results and Discussion

Growth component of soybean as affected by lime and P levels

Table 2: Plant height (cm) of soyabean plant at 8WAP as affected by lime rate and phosphorus level in Akufo soils

	Lime Rate (t ha^{-1})				
	0	2	4	6	
P level					Means
0kg $P_20_5ha^{-1}$	11.7	20.8	23.9	18.3	18.68
30kg $P_20_5ha^{-1}$	14.1	25.6	30.4	18.1	22.05
60kg $P_20_5ha^{-1}$	19.9	32.7	33.7	21.4	26.93
Means	16.23	26.37	29.33	19.27	

$LSD_{.05}$ (main effect of P fert.) = 3.6

$LSD_{.05}$ (main effect of lime rate) = 3.6

$LSD_{.05}$ (subplot effects for same P level) = 3.0

$LSD_{.05}$ (subplot effect for diff. P level) = 7.8

Table 3: Plant height (cm) of soyabean plant at 8WAP as affected by lime rate and phosphorus level in Kugbo soils

	Lime Rate (t ha^{-1})				
	0	2	4	6	
P level					Means
0kg $P_20_5ha^{-1}$	19.2	21.2	24.4	19.6	21.1
30kg $P_20_5ha^{-1}$	17.3	24.7	27.1	24.0	23.28
60kg $P_20_5ha^{-1}$	18.8	28.0	33.7	28.4	27.23
Means	18.43	24.53	28.4	24.0	

$LSD_{.05}$ (main effect of P fert.) = 4.6

$LSD_{.05}$ (main effect of lime rate) = 3.4

$LSD_{.05}$ (subplot effects for same P level) = 7.1

$LSD_{.05}$ (subplot effect for diff. P level) = 9.4

Table 4: Plant height (cm) of soyabean plant at 8WAP as affected by lime rate and phosphorus level in Awka soils

	Lime Rate (t ha^{-1})				
	0	2	4	6	
P level					Means
0kg $P_20_5ha^{-1}$	18.4	28.0	23.7	20.6	22.66
30kg $P_20_5ha^{-1}$	15.0	32.2	24.5	22.2	23.43
60kg $P_20_5ha^{-1}$	21.8	33.3	29.4	29.3	28.45
Means	18.4	31.7	25.87	23.97	

$LSD._{05}$ (main effect of P fert.) = NS

$LSD._{05}$ (main effect of lime rate) = 3.5

$LSD._{05}$ (subplot effects for same P level) = 6.1

$LSD._{05}$ (subplot effect for diff. P level) = NS

Plant height differed in response to treatments across the soils (Table 2 -4). The increase in height of plants when supplied with a combination of lime and phosphorus regardless of soil, may be attributed to the effect of liming on P nutrition of plants. Several workers (Johnson *et al.*, 1982) have reported that liming reduced fixation of P and AL, Fe and Mn toxicity to soybean plants thereby making P available and also Ca and Mg. The amount of lime required to combine with a given level of P in order to improve height varied with soils. Akufo and Kugbo soils gave their highest response when supplied with 4 ton ha^{-l} lime and 60 kg P_20_5 ha^{-l} while Awka plants were tallest when fertilized with 2 ton ha^{-l} lime and 60 kg P_20_5 ha^{-l} (Table 3 and 4). This is an indication that these soils averagely needed liming not more than 3 ton ha^{-1} when external P fertilization up to 60 kg P_20_5 ha^{-l} was required. When P was not required, however, Awka soils would need liming up to 4 ton ha^{-l} to increase height beyond that due to 30kg P_20_5 ha^{-l} application implying that more lime would be required to improve plant uptake of soil P better than the applied P. Mamaril *et al*. (1991) explained that lime treatments improve crop performance with time. Kamprath (1973) recorded satisfactory growth at pH 6.5 as a result of the absorption of $P0_4$ and Molybdate.

Table 5: Shoot biomass (ton^{-1}) of soyabean plant as affected by lime rate and phosphorus level in Akufo soils

	Lime Rate (t ha^{-1})				
	0	2	4	6	
P level					Means
0kg $P_20_5ha^{-1}$	26	52	65	32.5	43.9
30kg $P_20_5ha^{-1}$	26	45.5	66	45.5	45.5
60kg $P_20_5ha^{-1}$	45.5	91	156	58.5	87.8
Means	32.5	62.8	95.3	45.5	

$LSD._{05}$ (main effect of P fert.) = NS

$LSD._{05}$ (main effect of lime rate) = 32.5

$LSD._{05}$ (subplot effects for same P level) = 52

$LSD._{05}$ (subplot effect for diff. P level) = NS

Table 6: Shoot biomass (ton^{-1}) of soyabean plant as affected by lime rate and phosphorus level in Kugbo soils

	Lime Rate (t ha^{-1})				
	0	2	4	6	
P level					Means
0kg $P_20_5ha^{-1}$	32.5	71.5	71.5	58.3	58.5
30kg $P_20_5ha^{-1}$	45.5	97.5	123.5	58.5	81.25
60kg $P_20_5ha^{-1}$	58.5	104	136.5	65	91.0
Means	45.5	91	110.5	60.5	

$LSD._{05}$ (main effect of P fert.) = NS

$LSD._{05}$ (main effect of lime rate) = 13

$LSD._{05}$ (subplot effects for same P level) = 19.5

$LSD._{05}$ (subplot effect for diff. P level) = 58.5

Table 7: Shoot biomass (ton^{-1}) of soyabean plant as affected by lime rate and phosphorus level in Akwa soils

	Lime Rate (t ha^{-1})				
	0	2	4	6	
P level					Means
0kg P_20_5ha^{-1}	26	52	58.5	39	43.0
30kg P_20_5ha^{-1}	26	84.5	57	52	54.9
60kg P_20_5ha^{-1}	52	104	91	58.5	76.4
Means	43	80.2	69	49.8	

$LSD._{05}$ (main effect of P fert.) = NS

$LSD._{05}$ (main effect of lime rate) = 13

$LSD._{05}$ (subplot effects for same P level) = 26

$LSD._{05}$ (subplot effect for diff. P level) = NS

In this study, the weight of shoots varied because of treatment (Table 5-7). Liming up to 4 ton ha^{-1} combined with 60kg P_20_5 ha^{-l} maximized weight of Akufo and Kugbo plants (Table 5 and 6) expressing improvement in growth as a result of availability of nutrients and their improved uptake. Sanginga *et al*. (2000) and Osunde *et al*. (2006) reported increased weight of cowpea tops at various rates of P applied. This response to lime of calcium source could probably be because the soil was enriched with calcium (Fageria, 1994). The availability of calcium to plants would however depend on uptake of calcium which is a function of the growth of new roots (Favaretto *et al*., 2006). More calcium in the lime was therefore taken by the new roots formed as a result of P application (Favaretto *et al*., 2006). This probably explained why shoots were heavier when P was increased at a particular lime rate for example shoot response at 6 tons ha^{-1} lime as P increased from 0 to 60kg P_20_5 ha^{-l} regardless of soil type (Table 5 -7). The shoot biomass of 26 ton ha^{-1} recorded by Awka soils at 0 ton ha^{-1} lime without P compared to value of 26 ton ha^{-1} when 30 kg P_20_5 ha^{-1} was applied (Table 7) revealed that these plants were P-efficient under 0 ton ha^{-1} lime (Baligar *et al*., 2001). The shoot biomass of Akufo plants limed up to 0 ton ha^{-1} and 4 ton ha^{-1} at 0 kg P_20_5 ha^{-1} did not change when P was applied up to 30 kg P_20_5 ha^{-l} (Table 6) probably because the additional level of P was low and therefore more was needed.

Table 8: Nodule dry weight(g plant-^{1}) of soybean plant as affected by lime rate and phosphorus level in Akufo soil

	Lime Rate (t ha^{-1})				
	0	2	4	6	
P level					Means
0kg P_20_5ha^{-1}	0.03	0.13	0.24	0.04	0.11
30kg P_20_5ha^{-1}	0.11	0.34	0.25	0.10	0.20
60kg P_20_5ha^{-1}	0.06	0.23	0.53	0.14	0.25
Means	0.08	0.23	0.34	0.09	

$LSD._{05}$ (main effect of P fert.) = NS

$LSD._{05}$ (main effect of lime rate) = 0.2

$LSD._{05}$ (subplot effects for same P level) = 0.04

$LSD._{05}$ (subplot effect for diff. P level) = NS

Table 9: Nodule dry weight(g plant-^{1}) of soybean plant as affected by lime rate and phosphorus level in Kugbo soil

	Lime Rate (t ha^{-1})				
	0	2	4	6	
P level					Means
0kg P_20_5ha^{-1}	0.11	0.13	0.07	0.04	0.11
30kg P_20_5ha^{-1}	0.04	0.15	0.24	0.04	0.12
60kg P_20_5ha^{-1}	0.10	0.15	0.34	0.09	0.15
Means	0.08	0.14	0.25	0.06	

$LSD._{05}$ (main effect of P fert.) = 0.10

$LSD._{05}$ (main effect of lime rate) = 0.06

$LSD._{05}$ (subplot effects for same P level) = 0.09

$LSD._{05}$ (subplot effect for diff. P level) = 0.2

Nodulation of soybeans as affected by lime and P levels

Nodulation described as nodule dry weight increased with P application. 6 ton ha^{-1} lime however depressed nodulation due to over liming. Fageria *et al.* 1994 reported that over liming resulted to unavailability or precipitation of P as insoluble $CaP0_4^-$.

Several other workers have reported the role P plays in nodulation. According to Osunde *et al*. (2006), nodules of legumes are strong sinks for P and short supply of P was found to reduce nodulation. The response of soybean to P in acid soils would undoubtedly depend on adequate liming. Physiologically, nodule number and weight depends on the assimilate partitioning to nodules which has been reported to be a function of P and Ca availability and also the activity of microorganisms (Osunde *et al.,* 2006). Growth was depressed due to a short supply of P, when lime of calcium source was inadequate.

Tissue P Content of soybeans as affected by lime and P levels

Table 10: Nodule dry weight(g plant-^{1}) of soybean plant as affected by lime rate and phosphorus level in Awka soil

	Lime Rate (t ha^{-1})				
	0	2	4	6	
P level					Means
0kg $P_20_5ha^{-1}$	0.03	0.17	0.12	0.05	0.05
30kg $P_20_5ha^{-1}$	0.04	0.15	0.10	0.03	0.08
60kg $P_20_5ha^{-1}$	0.05	0.43	0.19	0.10	0.19
Means	0.04	0.25	0.14	0.06	

$LSD._{05}$ (main effect of P fert.) = 0.9

$LSD._{05}$ (main effect of lime rate) = 0.05

$LSD._{05}$ (subplot effects for same P level) = 0.09

$LSD._{05}$ (subplot effect for diff. P level) = 0.001

Liming and P fertilization increased P content of tissue (Table 10 and 11). This may either be due to higher absorption of P by the roots or due to increased root proliferation. The increase in P content of Kugbo plants with P applied under 0 ton ha^{-1} and 2 ton ha^{-1} lime respectively (Table 12) might be as a result of increased root proliferation. This is consistent with the report of Osunde (1993) that P fertilizer Increased root growth, hence reduced the need for Arbuscular Mycorrhiza Infection (AMF).

Table 11: Phosphorus content of tissue (kg ha-^{1}) of soybean plant as affected by lime rate and phosphorus level in Akufo soil

	Lime Rate (t ha^{-1})				
	0	2	4	6	
P level					Means
0kg $P_20_5ha^{-1}$	23.3	33.3	36.7	26.7	30.00
30kg $P_20_5ha^{-1}$	23.3	30.0	26.7	33.3	28.33
60kg $P_20_5ha^{-1}$	26.7	30.0	23.3	23.3	25.83
Means	24.40	31.00	28.90	27.77	

$LSD._{05}$ (main effect of P fert.) = NS

$LSD._{05}$ (main effect of lime rate) = NS

$LSD._{05}$ (subplot effects for same P level) = NS

$LSD._{05}$ (subplot effect for diff. P level) = NS

Table 12: Phosphorus content of tissue (kg ha-^{1}) of soybean plant as affected by lime rate and phosphorus level in Kugbo soil

	Lime Rate (t ha^{-1})				
	0	2	4	6	
P level					Means
0kg $P_20_5ha^{-1}$	20.0	23.3	43.3	33.3	29.98
30kg $P_20_5ha^{-1}$	33.3	26.7	26.7	26.7	28.35
60kg $P_20_5ha^{-1}$	36.7	36.7	30.0	23.3	31.68
Means	30.00	28.9	33.3	27.77	

$LSD._{05}$ (main effect of P fert.) = NS

$LSD._{05}$ (main effect of lime rate) = NS

$LSD._{05}$ (subplot effects for same P level) = 14.7

$LSD._{05}$ (subplot effect for diff. P level) = NS

Table 13: Phosphorus content of tissue (kg ha-^{1}) of soybean plant as affected by lime rate and phosphorus level in Akwa soil

	Lime Rate (t ha^{-1})				
	0	2	4	6	
P level					Means
0kg $P_20_5ha^{-1}$	23.3	30.0	33.3	26.7	28.33
30kg $P_20_5ha^{-1}$	23.3	36.7	36.7	23.3	27.45
60kg $P_20_5ha^{-1}$	23.3	30.0	20.0	20.0	23.33
Means	23.3	30.0	33.3	26.7	

$LSD._{05}$ (main effect of P fert.) = NS

$LSD._{05}$ (main effect of lime rate) = 7.8

$LSD._{05}$ (subplot effects for same P level) = NS

$LSD._{05}$ (subplot effect for diff. P level) = 11.9

Conclusion

Soybean plants exhibited differences in growth, tissue P concentration and nodulation across soils. The growth and development of plants on Kugbo and Akufo soils were better averagely at any combination of P under 4 ton ha^{-l} lime. Similar trend was observed for Awka soils at any combination of P under 2 ton ha^{-1} lime. The application of 60kg P_20_5 ha^{-1} however, gave the best response with little sacrifice in lime. Over liming resulted in depressions observed on growth and development. Awka soils would need liming up to 4 ton ha^{-1} to increase height beyond that due to 30 kg P_20_5 ha^{-1} application implying that more lime would be required to improve plant uptake of soil P better than the applied P. The tropical soil literature is full of reports citing lack of response or negative response when tropical soils are limed. This has created the generalized idea that liming does not work in the tropics. Against this background, our reports have shown that soybeans responded to liming by improving growth and yield components. Liming should therefore be encouraged in the tropics for the cultivation of soybean on acid sands.

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Rural Transformation: An Imperative for Nigeria's Development

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Abstract
Rural transformation forms a very key and significant component of Nigeria's overall developmental process. There can be no national development in the absence of rural development. Transformation of the rural sector holds the key to sustainable socio-economic development in Nigeria. This paper examines Nigeria's attempts at rural transformation. It illuminates factors militating against rural transformation in Nigeria. The paper posits that for overall national development to be appreciable and sustainable, the rural sector ought to be accorded priority attention by government. The paper concludes by proferring recommendations aimed at enhancing rural development in Nigeria.

Key words: Rural, transformation, imperative, development.

Introduction

The central position occupied by the rural sector in the overall developmental process of Nigeria as it is the case in most developing countries is self-evident. This is especially with regard to food production, labour force and population dynamics. At present, about 75 percent of Africa's population live and work in the rural areas. The overwhelming rural base of the economy of African countries is also obvious in the high proportion of the working population engaged in farming and cognate activities. In Nigeria, for example, in 1980, agriculture accounted for about two-thirds of the total gainful employment (mainly self-employment) in the economy. As Adepoju (1982) rightly points out, even in the context of the (short-lived) oil boom, rural economic activities still constituted and seem likely to continue to form the mainstay of the Nigerian economy. It was clearly indicated in the Third National Development Plan (NDP) 1975-1980, that the rural sector would continue to generate the bulk of employment opportunities, meet the food requirements and raw material inputs for processing industries and export to enhance foreign exchange (forex) earnings in the country.

Yet, despite its centrality to the economy of Nigeria, the rural sector has not

been accorded the attention it appropriately deserves. In this perspective Ukwu (1987) asserted that "rural development as a specific national policy is a latecomer in our national planning experience. In his view, in practical terms, development has so far been unjustifiably urban-biased, with the rural areas being remembered only during elections and perhaps in terms of food production to feed the bourgeoning or rapidly expanding urban population. Corroborating this view, Emeghara (2006) avers that available evidence depicts that efforts made thus far to meaningfully effect rural develop in Nigeria have been grossly inadequate, unbalanced, patchy and unintegrated.

He further states that the ugly result is that the living conditions of rural dwellers have further deteriorated rather than improved.

In this regard, some scholars aptly observed that the glaring manifestations of the above situation include: general poverty trap, low productivity especially of labour, under-utilized and/or unutilized natural resources, high level of illiteracy, ignorance, disease and malnutrition, Chambers (1983); Lele and Nyako (1991); and Ijere (1992). Others are near absence of socio-economic and physical infrastructure (like all – season roads, potable water, electricity, good schools, health centres, (etc) and political powerlessness, gullibility and high level of general vulnerability. Hence, the quest for sustainable rural development through increased agricultural productivity and improvement of the living condition of the ruralites is now the focus of considerable attention. However, as Idode (1989) observes, a great disparity exists between the promulgated goals of rural development and actual results of implementation efforts.

In view of the critical importance and cardinal role of the rural sector in Nigeria's economy as clearly and adequately highlighted above, rural development and transformation should be truly made an integral part of her overall developmental process. To this end, development experts and planners have stressed that if development in Nigeria is to take place and become self - sustaining, it will have to start in the rural areas in general and the agricultural sector in particular. They have further noted that the transformation of the rural sector holds the key to economic development in Nigeria as in most other developing nations. The imperative of self-sustaining and effective rural development is further emphasized by Todaro (1977), who once asserted that "there can no national development without rural development. He further opined that "the core problems of widespread poverty, growing inequality, rapid population growth and rising unemployment, all find their origins in the stagnation and often retrogression of economic life in the rural areas. Consequently, the rural areas should be meaningfully transformed and provided with socio-economic and physical amenities such as good roads, safe, clean and potable water, electricity, cottage/agro-allied industries, modern health centres, improved housing and recreational facilities and modern agricultural facilities, amongst others. Such a measure will certainly and drastically reduce the current acute rural poverty by significantly increasing both rural income and output levels. This in turn would result in marked improvement in the standard of living of rural dwellers. All these will ultimately lessen the present unwholesome socio-economic disparity between the urban and rural areas.

This paper focused on the imperative of rural transformation in Nigeria's overall developmental process. In this way, it fills the lacuna in literature and provides a guide for policy options towards improving rural development in Nigeria.

Nigeria's Attempts at Rural Transformation

Since the 1970s, successive governments in Nigeria had recognized the urgent and great need to appreciably improve agricultural and rural development in the country. As a result, several radical and far-reaching measures have been introduced, resulting in the formulation of a myriad of policies and adoption of well-articulated strategies and programmes ostensibly aimed at achieving the above desired goal necessary for sustainable national transformation. Yet, this has remained largely unaccomplished as Nigeria continues to be increasingly a food-dependent country, with food import bills rising astronomically. Also, the living conditions of her preponderant rural population have deteriorated with manifestations of widespread poverty, malnutrition, hunger, disease and ignorance. These measures/programmes include inter alia the following:

- creation of the Federal Ministry of Agricultural and Rural Development, National Accelerated Food Production Programme (NAFPP) and the Nigerian Agricultural and Co-operative Bank (NACB) now called the Nigerian Agricultural, Co-operative and Rural Development Bank (NACRD), all in 1973;
- establishment of World Bank-Assisted Agricultural Development Projects (ADPs) in 1975, first at Gusau, Gombe and Funtua and later at Lafia, Bida, Ilorin, Oyo, Jalingo, Ayangba, etc.;
- introduction of the Integrated Rural Development (IRD) Schemes, which led to the launching of the River Basin and Rural Development Authorities (RBRDAs), Operation Feed the Nation (OFN) and the Green Revolution Programme (GRP) in 1976, 1978 and 1980 respectively;
- introduction of the Structural Adjustment Programme (SAP), which resulted in the establishment of the National Directorate of Employment (NDE) and the Directorate for Food, Roads and Rural Infrastructure (DFRRI) now called Directorate for Rural Development (DRD), all in 1986;
- establishment of the Better Life for Rural Women Programme (BLRWP) and the Family Economic Advancement Programme (FEAP), which later became the Family Support Programme (FSP) in 1987 and 1998, respectively;
- establishment of the now defunct Nigerian Agricultural Land Development Authority (NALDA) in 1992;
- introduction of National Poverty Alleviation/Eradication Programme (NAPEP) in 1999;
- launching of the National Special Programme for Food Security (NSPFS) and the Root and Tuber Expansion Project (RTEP) in 2000 and 2001 respectively;
- introduction of the Local Empowerment and Environment Management Project (LEEMP), now called Community and Social Development Project (CSDP) in 2002 and
- introduction of the FGN/IFAD-Assisted Rural Finance Institution Building Programme (RUFIN) in 2009.

Factors Militating Against Rural Transformation in Nigeria

Nigeria has had to grapple with a catalogue of problems and constraints in her attempt at rural development and transformation. Unequivocally, these constraints have tended to impede rather than enhance her quest for sustainable socio-economic growth and development. These obstacles are multifarious and range from economic, political, social to technical issues. On a general note, the most prominent of the impediments are those associated with poor/faulty policy measures, insufficient involvement/participation of local beneficiaries in rural development projects/programmes, inadequate and unreliable statistical/planning data and poor funding. Others are politicization of appointments to man rural development projects/programmes, rural- urban migration, emergence of oil and corruption. These issues are discussed in turn below.

Poor/Faulty Policy Measures has proved to be one of the most serious problems confronting meaningful agricultural and rural development in Nigeria. As Idachaba (2000) opines, undesirable agricultural policies were at the centre of Nigeria's agricultural decline during the period of the 1940s to the 1990s. He further states that harsh policy environment, design and implementation of unworkable agricultural policies were said to have also contributed immensely to poor agricultural and rural development. He lamented that farmers and policy consumers were not properly involved in the design of new policies; instead faceless bureaucrats, policy analysts in the academia and private consultants mainly formulate and design policies. All these, he argues, have resulted in poorly formulated policies that were either poorly implemented or sabotaged.

Closely related to the issue of faulty policy measures is that of insufficient involvement/participation of the local beneficiaries in rural development projects/programmes. It has been observed that more often than not the rural population for which the development is meant is left out of the development process. This stems from what some development planners and experts have referred to as "the confusion about the philosophy of rural development in Nigeria".

Accordingly, Ijere (1981) posits that "rural development projects in Nigeria are more of a response to the needs of the urban political economy than a response to the yearnings and aspirations of the rural people". He further affirms that the projects command national attention in direct proportion to the increasing severity of the problems of the urban political economy that they are implicitly meant to solve. He also contends that the level of integration of rural development projects is directly proportional to the "root" problems of the urban economy as perceived by the urban elite and their planners.

Adequate statistical data are sine qua non for proper planning, policy formulation, monitoring, evaluation as well as impact assessment of agricultural and rural development projects. Conversely, paucity or complete absence of reliable data makes planning, policy formulation, monitoring, evaluation and impact assessment of agricultural and rural development projects pretty difficult and unrealistic as they may be based on false or wrong premise. At present in Nigeria, there appears to be absence of reliable database necessary for meaningful agricultural and rural development. The resultant effect of this state of affairs is frequent abandonment or failure of certain projects or programmes especially

hydrological projects or programmes mid-stream.

One of the most worrisome impediments facing agricultural and rural development in Nigeria is improper funding. Most agricultural and rural development projects/programmes have failed or become incapacitated to achieve their laudable objectives due to poor funding both in quantum and release pattern. Experience has shown that there is often untimely release of usually inadequate funds for projects and programmes. According to Anyanwu et al (1997) activities of such agricultural and rural development projects and programmes as the RBRDAs, NDE, ADPs, GRP, etc. have been bedevilled by shortage of funds.

Corruption has been identified as the bane of development efforts in Nigeria as in many other African and Asian countries. The magnitude of corruption in Nigeria is so much that it appears as if it is institutionalized and permissible. Corruption is a serious hindrance to Nigeria's socio-economic and political progress. This is because there is a strong negative nexus between levels of corruption and economic growth and development thereby making it pretty difficult for Nigeria to develop fast. In Nigeria, corruption retards economic growth, whittles down economic efficiency and development, notwithstanding availability of abundant material and human resources. In the words of Shafritz et al (2007), corruption is the unauthorized use of public office for private gain.

As it relates to agricultural and rural development in Nigeria, there is ample evidence of reckless financial spending, fraud, forgery, embezzlement, misappropriation/diversion of public funds and/or costly/expensive possessions and other forms of corruption in the management of projects and programmes. For instance, the vast majority of board members and top officials of parastatals of rural development like the RBRDAs and NDE have seen their appointments as an opportunity to feather their nests. As a result, they have viewed these parastatals as conduits for siphoning public funds into private pockets, Ezeani (2006). All these lead to unnecessary high costs of running projects / programmes.

Due to frequent change in political leadership of Nigeria, each government usually appoints its own men irrespective of their qualifications and suitability. By so doing, set goals of agricultural and rural development programmes are hardly, if ever achieved. This results in abandonment of projects/programmes mid-way for political reasons.

Closely allied to the above, is the issue of use of political/social consideration rather than technical/economic viability in project/programme choice and location.

Rural-urban flight of youths is another great difficulty to effective agricultural and rural development in Nigeria. The cankerworm is consequent upon the general economic stagnation of the outlying rural areas and the near absence of socio-economic and physical amenities there. In other words, rural-urban drift is owing to poor state of rural infrastructure which makes the rural environment unattractive to the younger generation. Mass migration of able -bodied young men and women from the rural to urban centres is unhealthy for Nigeria. This is because it leaves behind a very weak, unproductive, uneducated and ageing population in the rural areas. This in turn leads to shortage in local food production, sharp decline in agricultural exports and consequent massive importation of food into the country.

The advent of petroleum in Nigeria in 1957 and the subsequent upsurge in oil revenue since the 1970s brought about the dismal performance of the agricultural and rural sectors. This is as a result of serious

and utter neglect of the sector by government. As Ijere (1992) succinctly notes, the effect of the oil boom was too devastating to agricultural and rural development as most projects and programmes failed to realize their set objectives. This is despite huge amount of resources committed by government into them.

Other problems facing agricultural and rural development in Nigeria include lack of appropriate technology to curtail the drudgery in agricultural production and processing activities, inadequate availability of inputs particularly improved seeds, seedlings, fertilizers, agro-chemicals, fingerlings, credit, farm machinery, etc, and weak agricultural extension delivery service. This leads to ineffective dissemination of modern farming techniques and poor feedback mechanism for research to respond to farmers' needs.

Conclusion

In this study, the author has made good efforts to highlight the imperative of rural transformation in Nigeria's quest for sustainable development. Also, he has been able to demonstrate that multiplicity of problems confront rural transformation in Nigeria. It is the author's fervent view and belief that for meaningful and sustainable development to be possible in Nigeria, the rural sector ought to be accorded priority attention. In order to make this possible, the researcher proffers the following recommendations:

- Making sure that agricultural and rural development policies are fully and religiously implemented.
- Ensuring adequate and active involvement/participation of local beneficiaries in rural development projects and programmes.
- Giving the communities the opportunity to prioritize or choose projects and programmes according to their felt needs, instead of imposing projects or programmes on them.
- Improvement of funding of projects and programmes by increasing budgetary allocation.
- Combating corruption headlong through creation of more jobs with better remuneration, effective public enlightenment, entrenchment of good governance and increasing the constitution powers of anti-graft institutions like the Economic and Financial Crimes Commission (EFCC) and Independent Corruption Practices and Other Related Offenses Commission (ICPC)
- Finally, ensuring timely supply of inputs especially fertilizers, agro-chemicals, improved seeds and seedlings, credit and extension services at the affordable prices to farmers.

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THE EFFECTIVENESS OF AGRICULTURAL EXTENSION PACKAGES IN AGRICULTURAL FOOD SECURITY IN NWANGELE, OF IMO STATE.

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ABSTRACT

The study analyzed the effectiveness of agricultural extension packages in agricultural food security in Nwangele Imo State. The multistage sampling technique was used in selecting respondents for the study. Semi-structured questionnaire was used to collect data from 60 randomly selected farmers from the chosen 6 villages out of the 3 communities randomly selected. Data analysis was achieved using simple descriptive statistics such as percentages, frequency tables, mean and cost returns analysis, from the result obtained the mean age of respondents was 40 years. Results also revealed that 58% of the farmers were males, 55% had secondary school education, 62% were farmers, while 75% of the farmers were faced with lack of capital because of high interest rate charged. Farmers agreed that extension innovation packages increase agricultural production. This may not lead to sustainable agricultural production in the area. There is the need to empower the respondents farming activities to achieve food security in the study area by both Government and non-government organization.
Key words: Agriculture, Extension Food Security, and effectiveness.

INTRODUCTION

Agriculture has been the main source of food and raw materials for the ever-increasing population in Nigeria. Haque, et al. (2001) attributed the rate of growth in food production in the country, which was put at 2.5% per annum compared with the alarming rate of population growth of about 5% to the low level of agricultural mechanization in the country. Agriculture in Nigeria as in most other developing country is dominated by small farm producers (Oladeebo, 2004). Without the right to food the protection of other human rights becomes mockery for those who must spend all their energy merly to maintain life it self (FAO/WHO 1992; PCCU, 1996; USDA, 1999; Roberts, 2001) Thus, Nnadi and Akwiwu (2006) maintained that all of the inventions of men, no alternative has been found to food. Extension packages generally regarded as the foremost food security and poverty alleviation for Nigeria and entire sub-Saharan Africa (SSA) because of its special attribute which include ability to contribute greater yield even at extreme stress condition (Beeching et al 2000; Awah, and Tumauleh, 2001).

In recent times food security issues have become more serious than ever. The first Millennium Development Goal is having hunger and extreme poverty by 2015. About 6 years to the target date hunger and poverty is still prevalent. The situation is very precarious even now. Id21 insight (2006) reported that without adequate extension packages in development practices the international food policy research (IFPRI) predicts that globally by 2015, 600 million people will suffer from hunger, 900 million people will live in absolute poverty 128 million pre-school children will be malnourished, Babatunde et al (2007) reported that among the

developmental problems, facing Nigeria, food insecurity ranks topmost.

According to him, the level of food insecurity has continued to rise steadily since 1980's. The necessity of ending poverty is no longer just a moral imperative, but a survivability imperative (FAO 1996; Diouf, 2001; Johnson. 2001) – because food and agriculture are central the poverty issue. The goal of eradication of hunger will be achieved if there is availability and accessibility of food as well as its utilization and these can be achieved if there are adequate extension packages extended to the farmers.

The World Bank (2001) identified three pillars under food security, these are food availability, food accessibility and food utilization. This refers from concept that food security is not just a production issue. The following research question is asked to seek solution to the problem of food security.

a. What are the extension packages extended to the study area by government agencies
b. How relevant are they to the people in the area
c. Does the introduction of the packages bring about changes in Agricultural production?

OBJECTIVES OF THE STUDY

The major objective of the study was to determine the effectiveness of agricultural extension packages in agricultural food security. Other specific objectives are to

a. Determine the socio-economic characteristics of the farmers
b. Identify the relevance of extension packages in agricultural food security.
c. Determine the major causes of food insecurity
d. Identify the major constraints to agricultural production

MATERIALS AND METHODS

The study was conducted in Nwangele Local Government Area of Imo State. The study population comprised of rural farm households from where a sample size was selected. Generally about 80% of the people engage in agriculture. Agricultural development project (ADP) (IMO ADP, 2009) the study area is located under Orlu Agricultural zones. Stratified random sampling techniques was used in selecting the respondents. Out of seven communities in the L.G.A, three were randomly selected namely Abba, Amaigbo and Abajah Two villages were randomly selected from each of the three communities making a total of 6 villages. 10 farmers were randomly selected from each village. This gave a total of 60 respondents. The major instrument used for the study was, the questionnaire items which consisted of both open and fixed choice questions. They were administered as face-to-face interview to all respondents to ensure uniformity in the interpretation of concepts, and to create room for possible clarification, where necessary. Data generated were analyzed using descriptive statistics such as frequency percentages and mean as well as cost and return analysis of farmers to determine the farmers profitability and output, was achieved through the determination of net farm income (NFI) which was determined by subtracting the total cost (TC). Total Cost = (Total Variable Cost) + (Total Fixed Cost) from the total revenue (Eze and Onebiri 2005).

RESULTS AND DISCUSSION

Table 1 showed that 33 percent of the farmers were between the age of 31-40 years and 6 percent were with the age of 61 and above. This indicates that majority of the farmers are in their active stage of life, and may have a good perception of the various extension activities and services available to them. Younger farmers are more adventurous while according to Onuoha and Nnadi (1999), older farmers are so conservative that they treat any new thing with skepticism and indifference. The resultant effect according to Orebiyi, et al (2002) is that, there will be a decrease in agricultural productivity in the long run hence the ageing farmers can no longer perform. The results also shows that the average age of farmers was found to be 40.9 years. The results also reveals that majority of the farmers were male. Majority of the respondents 55% had secondary school education while 62% of farmers concentrated on farming alone as the only source of income and channeled 100% of their resources to farming. Hence this suggests that the area is an agricultural base.

Table 2: Revealed that lack of capital rank highest in the table as the major constraint followed by high interest rate charged. Thus there is need to check – mate these factors so as to encourage farmers to fully adopt new technologies and packages disseminated to them.

Table 3: Shows that 58%, 25% and 17% of the farmers indicated extension packages as very important, and not important respectively. 17% were against the plan either because of the cost of the packages or the adoption of new plan.

Table 4: Indicates that the bone of contention of food security is lack of capital which is 75%, lack of capital can lead to poor storage facility 41%, poor processing 33%, soil infertility and low accessibility to land 50% and 12% respectively. The poor storage facilities will make high number of agricultural products mainly perishables to be damaged due to there is no processing machine to turn the raw product into durable goods through processing, all these attributed to lack of capital. Finally 16% of the farmers were faced with the problem of poor management due to high illiteracy level of farmers.

Table 5: Cost and return analysis

This is used to determine the profitability of crops produce among farmers. The cost and return analysis of farmers in the study area (Rice, Beans, Maize, Cassava, Yam). The total cost of production is 30, 535.31/farmers. Cost of labour attracted the highest cost about 46%. This attributed to the high migration pressure from rural to urban area thereby causing labour scarcity. More so, there is high depreciation of equipment of about 15.3% of total cost is accounted on depreciation. The total revenue is N55.900/farmers. Rice yield the highest return about 32% of the income was obtained from rice. Cassava also generated high return about 26% of the total return. The net revenue of the production is N25,364.69/Farmers. This indicates that for every 1.00 input invested, 83 kobo gain is made.

CONCLUSIONS

The study has shown that the major constraint faced by farmers is lack of capital, where available with high interest rate charged. Which in turn will affect access to storage and processing machines as well as low accessibility of land. Though the net farm income is not so wonderful due to the fact that these farmers are faced with some problems in their farming activities all things being equal.

To reduce the problems faced by farmers, government should subsidize farm input, all the extension packages, provide credit

facilities to farmers and the interest rate should be reasonable enough and reduce food crisis in the study area.

Agricultural infrastructural facilities such as processing materials, storage facilities, good roads, water and electricity should be made available to reduce the rate of migration, cost of distribution and transportation.

Table 1: Personal characteristics of the respondents (n-60)

Age (Years)	Frequency	Percentage
21-30	14	23
31-40	19	33
41-50	11	18
51-60	12	20
61 above	4	06
Gender		
Male	35	32
Female	25	42
Education		
Primary	14	23
Secondary	33	55
Tertiary	13	22
Occupation		
Farming	37	62
Non-farming	7	12
Both of item	16	26

Average age = 40 years

Source: Field survey data 2010

Table 2: Problems encountered by farmers.

Problem	frequency	percentage
High Interest rate	40	67
Lack of capital	55	91
High cost of transportation	30	50
Far distance	20	33
Poor storage facilities	30	50

* Multiple Responses

Source: Field Survey Data 2010

Table 3: Relevance/importance of extension packages

Relevance	Frequency	Percentage
Very important	35	58
Important	15	25
Not important	10	17

Source: Field Survey Data 2010

Table 4: The major cause of food insecurity

Causes	Frequency	Percentage
Lack of capital	45	75
Soil infertility	25	50
Poor storage facility	20	41
Poor processing facility	15	33
Poor Management Practices	10	16
Accessibility to land	10	12

*Multiple response

Source: Field survey data 2010

Table 5: Cost and Return Analysis

Cost (N)	Items	Amount	Percentage %
Fixed cost			
1	Rent on land	3,808.33	12.47
2	Depreciation	4,673.33	15.31
3	Interest on capital	83.33	0.27
Total Fixed Cost		8,564.99	28.05
Variable Cost			
	Labour	14,191.67	46.48
	Harvest	3,633.33	11.90
	Transportation	1,788.33	5.86
	Storage	904.16	2.96
	Planting materials	1,452.83	4.75
Total variable cost		21,970.32	71.96
Total cost	TC=TFC+TVC	30,535.31	100.00
Revenue			
	Rice	18,000	32.20
	Beans	6,500	11.63
	Maize	10,900	19.50
	Cassava	15,000	26.83
	Yam	5,500	9.84
Total revenue		55,900	100.00
Gross margin	TR-TVC	33,929.63	
Net revenue	GM-TFC	25,364.69	.83

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PHYTO-PATHOLOGICAL APPROACH TO HOST PLANT RESISTANCE TO TIKKA DISEASE OF GROUNDNUT

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ABSTRACT

A study on the screening technique for host plant resistance Tikka disease of groundnut in South-Eastern Nigeria was conducted at the School of Agriculture and Agricultural Technology research Plot of Federal University of Technology Owerri in 2005 and 2006. Three Planting depths (3, 7, and 11) cm and four planting densities (444,444; 250,000; 160,000 and 111,111 plants/ha respectively, were variously combined on P1274/19 variety of groundnut in February, March and April to find the effect of time of planting on Tikka disease severity, percentage defoliation and nodulation. Analysis of variance indicated a significant difference in months and planting density on Tikka disease severity in 2005 and 2006. Time of planting significantly lower Tikka disease severity 0.81, 0.96 and lower percentage defoliation 76.23%, 76.76% at 1% probability level in 2005 and 2006, respectively. This is in comparison with those planted in March 1.14, 1.38 and 84.48%, 84.48% disease severity and percentage defoliation while April recorded highest 1.45. 1.62 And 87.5%, 88.2% disease severity and percentage defoliation in 2005 and 2006, respectively. Planting density 1,000,000 plants/ha recorded highest Tikka disease severity 1.60, 1.88 while 250,000 plants/ha recorded the lowest disease 0.58 and 0.61. However, planting depth was not significant on Tikka disease severity and percentage defoliation Investigation revealed that nodulation of groundnut was highly significant on month, planting density, depth as well as depth and month interaction. April recorded lowest nodulation 9.48, 9.73 while March had the highest 11.65, 11.62 in 2005 and 2006, respectively. 250,000 plants/ha recorded highest nodulation 13.00, 13.19 while 62,500 plants/ha recorded the lowest 9.35, 9.44 in 2005 and 2006, respectively. There is a direct relationship in plant depth. The microorganisms associated with Tikka disease were *Cercospora arachidicola , Phaeoisariopsis personata* and *Aspergillus spp* and *Strachlidium.*

INTRODUCTION

Groundnut (*Arachis hypogeae* L) is a leguminous oil-seed crop which is rich in fats and protein. It is mostly grown in the savannah areas of Nigeria with little cultivation done in the forest areas of the south. This is as a result of high incidence and severity of diseases. Tikka disease is often known as leafspot disease. It is of kinds namely, early leafspot caused by *Cercospora arachidicola* Hori and Late leafspot caused by *Phaeoisariopsis personata* (Berk and Curt). They are the major foliar diseases reducing groundnut yield wherever they are grown. The early leafspot is potentially more devastating disease because it produces many more spores than the late leafspot. Yield losses

from the two leafspots have been estimated at 15-50 % under no spread conditions. (Smith, 1994).

In addition to carbohydrate, human diet must contain fats and protein. Fats however, are often in short supply which resulted to its deficiency in the diet of our indigenous people. Ahmed and Young, (1982) observed that one hundred grains of raw groundnut seed provide about 570 kilocalories of dietary energy. The unsaturated fatty acids, oleic and linoleic comprise about 80% of the total, and the fatty saturated palmitic acid contributes 10%. (Harkness, *et.al.*,1976; Cobb and Johnson, 1973). Therefore, any effort to ensure the mass production of the crop will solve the problem of deficiency of these nutrients in the human and animal diet.

There is dearth of information as to the suitable time of planting this variety in the zone with respect to appropriate plant density as well as plant depth for groundnut production for reduced Tikka disease. Related trials have been reported on Sesame (Adeyemo and Ogunwolu, 1996; Ihejirika, and Nwufo, 2001). Cowpea variety (Anzaku *et,al.,* 2005). More so, the call for self sufficiency in food production today requires that not only land areas be brought under arable land use, but also that low input technologies affordable by resources poor farmers be used. The planting of leguminous crops like groundnut, that supply cheap nitrogen, use of planting density as well as planting depth and use of appropriate planting period are such low input technologies needed in the agricultural sector to suppress the severity of leafspot disease of groundnut and obtain high yield as well. IITA, (1986). Also, ageing is an irreversible process and can not be stopped, but its rate can be manipulated. Abdul-Baki and Anderson, (1995). The stage at which the seed is harvested determines seed viability, storability, size, shape and uniformity by Pullock and Roos, (1995). Estimates as large as 240 kg N/ha have been reported to be fixed by groundnut, representing 80% of the plants total nitrogen. Dart and Krantz, (1977), Weaver, (1974).

Hence, the objectives of this research were to determine phytopathological approach to reduce to a minimum, the severity of Tikka disease of groundnut, determine the best planting density as well as the best planting depth to be adopted so as to reduce to a minimum the severity of Tikka disease of groundnut.

MATERIALS AND METHORDS

A two season experiments was conducted in the School of Agriculture and Agricultural Technology research plot of Federal University of Technology, Owerri (FUTO) using a groundnut variety P1274/19 on the area located at $5^{o}29'$N and $7^{o}02'$E in the rain forest belt of South-Eastern Nigeria. The mean annual rainfall is 1700 to 2500 mm which spans early March to October in 2005 and 2006 respectively. The temperature range during the growing season was 21-33.3^{o}C and the vegetation in the zone is divided into four broad types namely, the swamp coastal forest, rain forest, rain forest savannah ectone and the very minor semi montane forest and the grass land (Enwezor, *et.al.*, 1990).

The (3) planting periods investigated upon were 1st February, 1st March and 1st April. Also three (3) planting depths (3, 7 and 11) cm were used as the main plot while the four (4) planting densities (15x15) cm, (20x20) cm, (25x25) cm and (30x30) cm, respectively, giving plant populations of 444,444, 250,000, 160,000 and 111,111 plants/ha respectively. Plant depth form the main plot while the plant population forms the sub-plot and the experiment was replicated four (4) times. Data was collected on the severity of Tikka disease, percentage defoliation and nodulation.

The severity of Tikka disease was estimated using the following visual observation and scoring according to the following format as described by Ford and Hewitt, (1980).

Severity estimation (%)	Scale	Interpretation
0	0	No infection
1 – 20	1	Slight infection
21 - 41	2	Moderate infection
41 – 60	3	Severe infection
61 - 80	4	Very severe infection
81- 100	5	Complete infection

The defoliation was determined by counting abscised and retained leaflets, while Nodulation was obtained by counting nodules number per sampled plant per treatment level and recorded.
The diseased plants were taken to the laboratory. They were cultured, sub-cultured, isolated and the micro-organisms responsible for the disease development were identified using the laboratory manual by Barnette and Hunter, (1998). Data was analyzed using the methods of Steel and Torrie, (1981) as described for the Randomized Split plot experimental design and means separated using Fischers Protected Least Significant Difference (LSD) at 5% probability level.

RESULTS

A two season experiments conducted in 2005 and 2006 showed that time of planting and plant density were significant on Tikka disease severity at 0.01 probability levels. February recorded significantly lower Tikka disease0.81 and 0.96 as well as percentage defoliation 76.23% and 76.76% in 2005 and 2006, respectively. This is in comparison with those planted in March which is 1.14 and 1.38 in 2005 and 2006 and percentage defoliation of 84.48% and 84.48% inh the two seasons investigated. April recorded highest severity of tikka disease 1.45 and 1.62 and percentage defoliation of 87.54% and 88.15% in 2005 and 2006, respectively (Table 2&3).
Plant density was highly significant on the incidence and severity of tikka. 444,444 plants/ha recorded highest incidence and severity of tikka disease 1.60 and 1.88 while 250,000 plants/ha recorded the lowest 0.58 and 0.61, thereby, recording 100% reduction in the severity of tikka disease in comparison with other planting densities in 2005 and 2006, respectively (Table 3).
Tikka disease severity was not significant on plant depth although, 3 cm recorded numerically lower 1.06 and 1.88 while 7cm was highest 1.18 and 1.42 in 2005 and 2006, respectively. (Table 1).
Month and plant depth was highly significant on defoliation in the two seasons investigated. February recorded the lowest percentage defoliation 76.23% and 76.76%, while April recorded highest 87.54% and 88.15%in 2005 and 2006, respectively. 444,444 plants/ha recorded the lowest percentage defoliation 80.14% and 80.67%, followed by 250,000 plants/ha 82.97% and 83.14% while 62,500 plants/ha recorded the highest 84.03% and 84.28% in 2005 and 2006, respectively. However, 7cm recorded the highest percentage defoliation 83.13% and 83.58%, while 3cm recorded the lowest 82.68% and 82.98% in 2005 and 2006, respectively (Table 3).
Interactions were not significant on Tikka severity and percentage defoliation in all the seasons investigated. Tikka disease recorded 100% increase from 4 to 8 weeks after planting and the same increase in 12 weeks of plant age. Tikka severity recorded a linear increase with plant age irrespective of the season investigated. Plant density as well as plant depth recorded similar increase in Tikka disease with plants age irrespective of the season investigated (Table 2).
Investigation revealed that month, density, depth as well as month and depth interaction was highly significant on nodulation at 0.01 probability level.

April recorded lowest nodulation 2.48 and 9.73, followed by those planted in February 11.19 and 11.00 while those planted in March, recorded the highest nodulation 11.65 and 11.62 in 2005 and 2006. 250,000 plants/ha recorded the highest nodulation 13.00 and 13.19 while 62,500 plants/ha recorded lowest nodulation 9.35 and 9.44. Investigation also revealed a direct relation on plant depth and nodulation with 3cm recording highest nodulation 11.67 and 11.56 followed by 7cm with 11.10 and 11.17 while 11cm recorded 9.54 and 9.52 in 2005 and 2006, respectively (Table 3). The microorganisms identified with Tikka disease were *Cercospora arachidicola, Phaeoisariopsis personata*, Mucor, *Strachlidium* and *Aspergillus* species.

DISCUSSION

High Tikka severity and percentage defoliation recorded in February in all the seasons investigated, may be attributed to high organic matter present in the soil for the crop to utilize thereby providing a healthy environment for plant growth and development thus reduce the at which plants will respond to Tikka disease and defoliation, development and spread in crop as suggested by Kanaiyan, (1987).

High defoliation recorded in March and April as well as high disease severity, may be attributed to inherent factors peculiar to this ecological zone of South-Eastern Nigeria, as well as high rainfall and relative humidity characterized by March and April. These, play significant biological effects on soil nutrient and function. It also encourages the activities of soil fauna among which are the earthworms, ants and termites. They exert major influences on the plant as they consume large amount of leaves and litter (Asawalam, 2002). They also cause defoliation as well as predispose the plants to disease infection.

The lower record of Nodulation recorded in February in both seasons, may be attributed to less decomposition of available nutrients due to low rainfall and low relative humidity inherent in February. This may also be attributed to volatilization of soil nutrients or minerals resulting from high temperature. High volatilization and nutrient fixation increases as temperature decreases thus, nodulation decreases.

The high nodulation observed in March, may be attributed to adequate sunlight, moisture, temperature, decomposition and release of required nutrients thereby, favoring maximum nodulation. Nutrient availability and subsequent absorption by plants produce high nodulation. This is in agreement with Obasi and Msaakpo, (2005), who proposed that date of harvest is significant in good and desirable seed production in Kerstings groundnut. While a lower nodulation may be attributed to leaching of soil nutrients as well as nutrient loss by rain splash and run-off in line with Sexane *et,al.*, (1983).

High, severity of Tikka recorded by 444,444 plants/ha may be attributed to crowded condition which encourages disease severity and spread. Also, this density encouraged high competition for nutrient absorption, space and sunlight and insufficiency of these may re4sult to disease manifestation and spread in agreement with ICRISAT, (1983). Low Tikka disease severity and high nodulation recorded by 250,000 plants/ha, may be attributed to ideal utilization of available soil nutrients, which in turn enhanced biochemical and physiological activities of the plant. Also biochemical and physiological activities of leguminous plants like groundnut enhance nitrogen, characterized by nodule formation as proposed by Graham, (1980); Buton, (1976) and Mangual-Crespo *et,al.*, (1987).

High nodulation recorded by planting depth of 3cm, may be attributed to adequate plant depth that favors nodulation best of all planting depth investigated. This is because organic matter and primary nutrients are at top 2-5cm and decreased as soil depth increased.

The direct relation of Tikka severity with plants age, may be attributed to the fact that plants respond to diseases as the age. At early plant's development, the plants respond slowly to diseases. At this stage, they possess high ability

to wage war against disease penetration to the host. They are very active physiologically and metabolically and can suppress disease symptom and manifestation. As plants ages, they become less active and photosynthetic and metabolic activities slow down drastically. This is coupled with weak nutrient absorption .All these create unhealthy situation for the plants to guard against disease manifestation thus highest tikka disease severity recorded at 12 weeks of plants age as observed by McDonald, (1985); Coffelt and Porter, (1982) as well as Ihejirika and Nwufo, (2001).

Conclusions

Groundnut planted in February had significantly lower Tikka disease severity and low percentage defoliation than those planted in March and April recorded highest in all the seasons investigated. March recorded highest nodulation followed by February while April had lowest in both seasons investigated. 250,000 plants/ha recorded lowest Tikka severity while 444,444 plants/ha recorded highest in both seasons. Plant depth was not significant on Tikka disease severity. However, 3cm recorded the highest nodulation, while 250,000 plants/ha recorded the highest nodulation in all the seasons investigated.

Table 1: Time of planting, Plant Population and Plant Depth on Nodulation in 2005 and 2006

Month	2005	2006
Feb.	11.19	11
March	11.65	11.62
April	9.48	9.73
$LSD_{0.01}$	**0.865**	**0.75**
Population		
444,444	10.44	10.22
250,000	13	13.19
160,000	10.28	10.14
111,111	9.35	9.44
$LSD_{0.01}$	**0.996**	**0.867**
Depth		
3	11.67	11.56
7	11.1	11.17
11	9.54	9.52
$LSD_{0.01}$	**0.865**	**0.75**

Table 2: Severity of Tikka at 4, 8 and 12 Weeks After Planting (WAP)

Months	Weeks After Planting					
	2005			2006		
	4	8	12	4	8	12
Feb.	0.31	0.65	1.46	0.31	0.75	1.81
March	0.6	0.85	1.96	0.63	1.27	2.25
April	0.6	1	2.67	1.27	1.29	2.98
$LSD_{0.01}$	**0.254**	**0.322**	**0.309**	**0.246**	**0.321**	**0.277**
Population						

444,444	0.78	1.26	2.78	0.81	1.69	3.14
250,000	0.22	1.47	1.06	0.28	0.53	1.03
160,000	0.63	0.83	2.14	0.56	1.11	2.56
111,111	0.5	0.78	2.25	0.6	0.97	2.67
$LSD_{0.01}$	**0.293**	**0.371**	**0.356**	**0.284**	**0.37**	**0.321**
Depth						
3	0.44	0.79	1.96	0.42	1	2.26
7	0.5	0.92	2.13	0	1.21	2.44
11	0.58	0.79	2.88	0.58	1.02	2.86
$LSD_{0.01}$	**0.264**	**0.322**	**0.309**	**0.247**	**0.321**	**0.277**

Table 3: Time of Planting, Tikka Disease Severity and Defoliation in 2005 and 2006

Month	Tikka Severity		Defoliation	
	2005	2006	2005	2006
Feb.	0.81	0.96	76.23	76.76
March	1.14	1.38	84.48	84.48
April	1.45	1.38	87.54	88.15
$LSD_{0.01}$	**0.28**	**0.305**	**0.71**	**0.789**
Population				
444,444	1.6	1.88	80.14	80.67
250,000	0.58	0.61	82.97	83.44
160,000	1.17	1.44	83.86	84.11
111,111	1.18	1.34	84.03	84.28
$LSD_{0.01}$	**0.323**	**0.353**	**0.82**	**0.911**
Depth				
3	1.06	1.22	82.68	82.98
7	1.18	1.42	83.13	83.58
11	1.16	1.32	82.64	82.81
$LSD_{0.01}$	**0.28**	**0.305**	**0.71**	**0.789**

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Estimation of the Lime Requirement of Selected soils in some Ecological Zones of Nigeria

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Abstract

Liming is necessary for sustainable crop production on acid sands. A plot experiment was conducted in year 2004 on "Acid-sands" of Akwa, Kugbo from the derived savannah and Akufo from Southern Guinea Savannah Agro- ecological Zones of Nigeria to estimate their lime requirements. The treatments consisted of three soils (Awka, Kugbo and Akufo) and two lime sources (Calcium Carbonate and Hydrated lime) applied at the rates of 0, 2, 4, and 6 ton ha^{-1} to the soils. The experiment was laid out in split plot design replicated three times. Soil pH was determined potentiometrically on the soil sub- samples at 4, 6, 8 WAL (weeks after liming) in 0.01M $CaCl_2$ at soil solution ratio of 1:2. Regardless of lime sources, at least liming up to 2 ton ha^{-1} was necessary to raise soil pH from 6.0 - 6.5 at 6-8 weeks after liming (WAL). Benefits to liming with $CaCO_3$ may never be obtained at 4 WAL unless liming rate is increased to 4 ton ha^{-1} for Awka soil and 6 ton ha^{-1} for Akufo and Kugbo soils, respectively. In the case of liming with hydrated lime, even 6 ton ha^{-1} lime will hardly give appreciable benefit with respect to soil fertility improvement, since the reference pH of 6-6.5 could not be attained. Lime of carbonate source seems to be a better choice than hydrated lime on this note. Further studies should however be carried out to investigate accrued benefits to crops due to liming of these acid sands.

Key words: Acid sands, Tropical soils, Acid sands, Fertility improvement, Liming rate, Lime requirement.

INTRODUCTION

"Acid – sands" are acid soils that occur in the parts of the tropical humid climates which have mean annual rainfall ranging between 1400 – 4000m in areas having underlying geology made up of sedimentary rocks or unconsolidated sediments (Bredenkamp *et al*., 1996). They are mostly ultisols and degraded Alfisols. The degraded Alfisols are less acidic but due to the continuous use of acid forming fertilizers such as ammonium sulphate on these soils, acidity problem is aggravated (Hoekenge *et al*., 2003). In Nigeria, most of the soils in the rainforest, derived savannah and southern guinea savannah Agro – ecological zones are affected (FAO, 2004). The management of acid soils has usually been tackled from the view point of lime application to neutralize soil acidity (Faveretto, 2006). This is because the maintenance of satisfactory soil fertility levels in humid regions depends considerably on the judicious use of lime to balance the losses of calcium and magnesium from the soil (Ojeniyi, *et al*., 2001; FAO, 2004). The attainment of an appropriate soil reaction (pH) by liming acid soil is therefore imperative towards increasing food production in the affected part of the country (Ojeniyi *et al*., 1999). Presently more than 95% of farmers in these areas do not lime their soils as a routine, due to inadequate awareness of benefits of lime as a soil conditioner (FAO, 2004). Another problem facing the farmers in the area is the unawareness of the rate of application per unit area of land. This is probably because a limited study on liming has been carried out in Nigeria unlike the case of chemical fertilizer

(Bababe *et al*., 1999; Lalijee, 2000). The need therefore arises for specific studies aimed at assessing the influence of increasing lime rates on soil pH and recommending levels at which specific lime materials could be judiciously used.

Table 1. Selected Physicochemical Properties of soil prior to Liming

Parameter	Akufo	Kugbo	Akwa
Sand	65	70	85
Silt	23	20	3
Clay	12	10	12
pH (0.1 $MCaCl_2$)	4.7	4.8	4.7
Organic Carbon (%)	0.8	0.60	0.9
Total N (%)	0.05	0.04	0.03
K^+(cmol kg^{-1})	0.10	0.33	0.12
Na^+(cmol kg^{-1})	0.04	0.31	0.10
Ca^+ (cmol kg^{-1})	0.30	2.0	0.52
Mg^+(cmol kg^{-1})	0.16	0.32	0.30
Exchange acidity	5.4	7.04	5.80
(cmol kg^{-1})	5.64	10.0	6.84
Effective C.E.C (cmol kg^{-1})	23	30.0	15
Base Saturation (%)			
Al saturated (%)	77	70	85

Materials and Methods

The soil samples were collected from three different locations of different pedogenic characteristics and from the Derived Savannah and Southern Guinea Savannah Agro – ecological Zones of Nigeria. These locations are Akwa (Typic paleustults and Haplustults). Akufo (Oxic or Orthic Luvisol) and Kugbo (Colluvium and Nupe sand stone residuum) (Ohiri *et al*., 1989; Akamigbo, 2002). The soil samples were air – dried and passed through a 2mm sieve to determine particle size of hydrometer method, soil pH in H_2O and 0.01m $CaCl_2$ by pH meter, organic carbon by Walkley - black method, total N% by Kjeldahl method and available P using the vanado – molydate wet digestion, Exchangeable cations by Ammonium Acetate (NH4OAc extraction method at pH 7.0, Exchangeable acidity and percentage Aluminium saturation by titration with 1N HCL. Powders of hydrated lime $Ca(OH)_2$ and lime stone ($CaCO_3$) were obtained from Kano and Anambra states, Agricultural development project, repectively. These treatments consisted of two lime sources at four rates (0, 2, 4 and 6 ton ha^{-1}) and three soils in a split plot design with three replicates. The lime was applied to each pot containing 2.5kg soil kept moist for eight weeks after liming. Soil pH was then determine potentiometriically on the soil sub – samples at 4, 6 and 8 weeks after liming in water and in 0.01M $CaCl_2$ at soil solution ratio of 1:2. All the relevant data collected were subjected to statistical analysis using statistical analysis software (SAS, 2002). LSD was used to separate the means.

Table 2. Soil pH values at 4WAL as affected by lime rate [$CaCO_3$]

	Lime Rate (t ha^{-1})				
Soil	**0**	**2**	**4**	**6**	**Means**
Akufo	4.7	5.4	5.5	5.6	5.3
Kugbo	4.9	5.3	5.4	5.6	5.3
Akwa	4.7	5.7	6.3	6.5	5.8
Means	**4.7**	**5.5**	**5.7**	**5.9**	

$LSD_{.05}$ (main effect of soils) = 0.07
$LSD_{.05}$ (main effect of lime) = 0.08
$LSD_{.05}$ (subplot effects for same soil) = 0.10
$LSD_{.05}$ (Subplot effect for different soil) = 0.20

WAL = weeks after liming
LSD = least significant difference

Results and Discussion

Soil pH as affected by liming

The choice of pH 6-6.5 as a reference was suggested by Kamprath (1973). Averagely, soil pH values were raised significantly as Calcium Carbonate application increased (Table 2-4). Irrespective of soil type, the reference pH of 6.0-6.5 could not be achieved at 4 weeks after liming (WAL) but at 6 or 8 WAL (Table 3-4), however only within the liming rate of 2 to 6 ton ha^{-1}. This is because at 4 WAL, substantial amount of Ca and Mg had not migrated to the subsoil where subsoil Aluminium saturation prevents deeper root development. The reverse was probably the case at 6 WAL and 8 WAL. Several workers

(Follet *et al*., 1981; Havlin *et al*., 1999) found out that under intensive management, an application of tons ha^{-1} of lime caused Ca and Mg to move from top soil into subsoil within a given time. A similar trend was also observed when Hydrated lime was used. This implied that a reference pH of 6.0-6.5 could either be achieved with little sacrifice in lime up to 2 ton ha^{-1} or much sacrifice in lime up to 6 ton ha^{-1} depending on time.

Table 3. Soil pH values at 6WAL as affected by lime rate [$CaCO_3$]

	Lime Rate (t ha^{-1})				
Soil	**0**	**2**	**4**	**6**	**Means**
Akufo	4.6	6.3	6.6	6.6	6.0
Kugbo	4.9	6.4	6.7	6.8	6.2
Akwa	4.7	6.5	6.7	6.8	6.2
Means	**4.7**	**6.4**	**6.7**	**6.7**	

$LSD_{.05}$ (main effect of soils) = NS
$LSD_{.05}$ (main effect of lime) = 0.09
$LSD_{.05}$ (subplot effects for same soil) = 0.15
$LSD_{.05}$ (Subplot effect for different soil) = 0.20
WAL = weeks after liming
LSD = least significant difference

Table 4. Soil pH values at 8WAL as affected by lime rate [$CaCO_3$]

	Lime Rate (t ha^{-1})				
Soil	**0**	**2**	**4**	**6**	**Means**
Akufo	4.7	6.4	6.6	6.6	6.1
Kugbo	4.7	6.4	6.5	6.7	6.1
Akwa	4.7	6.5	6.6	6.7	6.1
Means	**4.7**	**6.4**	**6.6**	**6.7**	

$LSD_{.05}$ (main effect of soils) = 0.02
$LSD_{.05}$ (main effect of lime) = 0.12
$LSD_{.05}$ (subplot effects for same soil) = 0.20
$LSD_{.05}$ (Subplot effect for different soil) = 0.30
WAL = weeks after liming
LSD = least significant difference

Averagely, Akufo, Kugbo and Awka soils could only achieve a pH of 6 or near 6 at 6 to 8 WAL with Calcium Carbonate (Table 3-4). The same trend was observed when Hydrated lime was used (Table 6 and 7).

Table 5. Soil pH values at 4WAL as affected by lime rate [Hydrate lime]

	Lime Rate (t ha^{-1})				
Soil	**0**	**2**	**4**	**6**	**Means**
Akufo	4.7	5.0	5.5	5.5	5.2
Kugbo	4.7	5.3	5.5	5.7	5.3
Akwa	4.6	5.5	5.7	5.8	5.4
Means	**4.7**	**5.3**	**5.5**	**5.7**	

$LSD_{.05}$ (main effect of soils) = 0.10
$LSD_{.05}$ (main effect of lime) = 0.08
$LSD_{.05}$ (subplot effects for same soil) = 0.10
$LSD_{.05}$ (Subplot effect for different soil) = 0.20
WAL = weeks after liming
LSD = least significant difference

Table 6. Soil pH values at 6WAL as affected by lime rate [Hydrate lime]

	Lime Rate (t ha^{-1})				
Soil	**0**	**2**	**4**	**6**	**Means**
Akufo	4.6	6.2	6.6	6.7	6.0
Kugbo	4.7	6.3	6.4	6.6	6.0
Akwa	4.6	6.6	6.7	6.7	6.2
Means	**4.6**	**6.4**	**6.6**	**6.7**	

$LSD_{.05}$ (main effect of soils) = 0.11
$LSD_{.05}$ (main effect of lime) = 0.10
$LSD_{.05}$ (subplot effects for same soil) = 0.09
$LSD_{.05}$ (Subplot effect for different soil) = 0.20
WAL = weeks after liming
LSD = least significant difference

Table 7. Soil pH values at 8WAL as affected by lime rate [Hydrate lime]

	Lime Rate (t ha^{-1})				
Soil	**0**	**2**	**4**	**6**	**Means**
Akufo	4.6	6.5	6.5	6.6	6.1
Kugbo	4.6	6.5	6.5	6.7	6.1
Akwa	4.7	6.6	6.6	6.7	6.2
Means	**4.7**	**6.5**	**6.7**	**6.7**	

$LSD_{.05}$ (main effect of soils) = 0.12
$LSD_{.05}$ (main effect of lime) = 0.10
$LSD_{.05}$ (subplot effects for same soil) = 0.12
$LSD_{.05}$ (Subplot effect for different soil) = 0.20
WAL = weeks after liming

Regardless of lime sources, at least liming up to 2 ton ha^{-1} was necessary to raise soil pH from 6.0-6.5 at 6-8 WAL. Benefits to liming with $CaCO_3$ may never be derived at 4 WAL unless liming rate is increased to 4 ton ha^{-1} for Awka soils and 6 ton ha^{-1} for Akufo and Kugbo soils respectively (Table 2). In the case of liming with hydrated lime, even 6 ton ha^{-1} lime will barely give appreciable benefits with respect to soil fertility improvement (Table 5), since the reference pH of 6.0-6.5 could not be attained. Lime of carbonate source seems to be a better choice than hydrated lime on this regard. Although Akwa soil prior to liming had an Al saturation of 85% (Table 1), averagely Awka soil recorded higher pH, irrespective of liming rate and source probably due to structural stability: a better ratio of sand: silt: clay content (Table 1). Brady (1993) reported differences in pH limed soils as a result of textural variability while Schuffalen and Middleburg (1954) reported the formation of smaller aggregates due to liming to neutrality.

Conclusion

Results obtained shows that liming is an important step towards the management of acid sands.

Irrespective of lime sources, at least liming up to 2 ton ha^{-1} was necessary to raise soil pH from 6.0-6.5 at 6-8 WAL. Benefits to liming with $CaCO_3$ may never be obtained at 4WAL unless liming rate is increased to 4 ton ha^{-1} for Awka soil and 6 ton ha^{-1} for Akufo and Kugbo soils, respectively. Further studies should however be carried out to investigate and evaluate the impact of lime on nutrient use efficiency of crops grown on acid sands from the Derived Savanna and Southern Guinea Savanna Zones of Nigeria.

Table 8. Physico-chemical Properties of the Soils after Liming

Soils	Limes Levels (t ha^{-1})	Ca (cmol kg^{-1})	Mg (cmol kg^{-1})	K (cmol kg^{-1})	Na (cmol kg^{-1})	Exchangeable Acidity (cmol kg^{-1})	ECEC ((cmol kg^{-1})	Al Sat (%)	BS (%)
AKUFO	0	0.3	0.16	0.10	0.04	5.40	7.0	77	23
	2	0.5	0.12	1.10	0.05	3.60	4.47	80	30
	4	2.0	1.40	1.18	0.30	3.40	8.48	42	58
	6	3.4	1.88	1.78	0.08	1.70	7.17	22	78
KUGBO	0	0.2	0.32	0.33	0.01	7.04	9.08	70	30
	2	1.0	0.29	0.35	0.05	6.19	12.18	67	33
	4	2.0	1.24	1.18	0.70	1.30	5.79	27	73
	6	2.3	1.32	2.08	0.14	0.70	6.82	21	79
AKWA	0	0.5	0.30	0.12	1.10	5.80	6.84	85	15
	2	1.0	0.08	1.14	0.60	5.20	6.48	80	20
	4	1.9	1.18	0.26	0.76	1.76	6.33	42	57
	6	2.0	1.36	0.32	0.81	6.60	7.59	34	63

ECEC = Effective Cation Exchange Capacity, BS = Base Saturation

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SCREENING OF COWPEA CULTIVARS FOR YIELD AND RESISTANCE TO COWPEA POD BORER (*Maruca testulalis)*

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ABSTRACT
Field experiment was conducted at the Research and Training Farm of the Federal University of Technology, Owerri to assess the yield and level of infestation of some cowpea cultivars by *Maruca testulalis*. Six treatments namely: IT98KD-288, IAR-48, IT89KD-391, IT86D-719, IT81D-985 and a local variety were randomly used in a Randomized Complete Block Design (RCBD) replicated three times. Results show that (IT81D-985) Cultivar had the highest number of pods per plant and the least *Maruca* infestation level and could be recommended to breeders for enhanced breeding work and to farmers for cultivation.

Keywords: Cowpea cultivars, *Maruca testulalis*, Resistance, Performance

INTRODUCTION
Cowpea (*Vigna unguiculata* L. Walp.) is a grain legume grown mainly in the savannah regions of the tropics and sub tropics. It is a very important but cheap source of dietary protein for many Countries of the tropics (Lale and Efeovbokhan, 1991; Ofuya, 2001). Food legumes occupy a prominent place in the nutrition of Nigerian people because their edible seeds form a cheap alternative source of protein diets (Ofuya, 2001). However, Cowpea production is being limited by insect pests attack both in the field and store. Prominent among these pests are *Maruca testulalis, Ootheca mutabilis, Callosobruchus maculatus,* etc.

Legume pod borer (*Maruca testulalis*) is a tropical pest of legumes particularly cowpea and pigeon pea. It is an important pest in Africa and Asia where losses of about 20 – 80 % have been reported (IITA, 1983). In the recent past, the control of the pest was basically through the use of synthetic chemicals which are hardly recommended because of their adverse effects on human health and the environment (Lale, 1995; Adedire and Akinneye, 2004). Presently, pest control options that are environmentally safe and sustainable such as the use of resistant varieties, biopesticides, cultural control and integrated pest management are recommended.

In recent times, the difficulties faced by many peasant farmers in obtaining chemicals and the need to curb environmental pollution due to the use of insecticides have been a great concern to farmers, environmentalists and researchers working on Cowpea improvement. These have prompted the need to develop a sustainable pest management strategy capable of minimizing pre-harvest loss, enhance production and consequently improve

the diets of the people. The development of host resistance is appropriate for the resource poor peasant farmers to avoid the use of insecticides (Smith, 1989, Singh, 1995, IITA 1989). Resistant varieties when combined with other control options in a compatible manner will lead to effective and sustainable pest management (Arnason *et al*., 1992). Snelling (1941) had defined host plant resistance as those characteristics that will enable a host to avoid, tolerate or recover from the attack of insects under conditions that will cause injury to other hosts. The most widely accepted mechanisms of resistance in plants are non preference, antibiosis and tolerance .

The objective of this research was to identify cowpea cultivars with high yield and less *Maruca* infestation for enhanced breeding work and integrated pest management.

MATERIALS AND METHOD

Experimental site

The experiment was conducted in 2009 at the Research and Training Farm of the Federal University of Technology, Owerri. The site is located between latitude 05^{o} 20′N and longitude 07^{o} 02′E . Randomized Complete Block Design (RCBD) replicated three times was used. Six treatments were used and these include: IT98KD-288, IAR-48, IT89KD-391, IT86D-719, IT81D-985 obtained from National Seed Services, Umudike Station, Abia State and a local variety obtained from Obinze market in Owerri West Area of Imo State.

Field preparation and planting

The experimental site was cleared of existing vegetation and stumped. The experiment comprised 18 plots with each plot measuring 2.0 m x 2.0 m using inter plot spacing of 1.0 m and intra plot spacing of 30.0 cm. Three Cowpea seeds were planted per hole and later thinned down to 2 seedlings per hole.

Data collection and analysis

Data were collected on the following:

i. Germination count at one week after planting
ii. Plant height
iii. Number of flowers / plant
iv. Number of pods / plant
v. Cowpea flower and pod borer (*Maruca testulalis*) count

Data collected were analyzed using analysis of variance (ANOVA) and separated using Least Significant Means (LSD P≤0.05).

RESULTS AND DISCUSSION

Significant differences were observed among cultivars for all parameters measured. This is probably an indication of host plant preference for feeding. Similar observation was reported by Jackai et al.,(1996) in their study of resistance to the legume pod borer in some wild Vigna under Laboratory feeding bioassays. They observed significant varietal differences in their susceptibility to *Maruca* pod borer.

Percentage germination

From Table 1 which represents the effect of different treatments on percentage germination at one week after planting, all the treatments were significantly higher than control (Local variety) (P≤0.05). This may be due to the genetic traits of the other improved cultivars which enabled them to withstand adverse environmental and soil conditions.

Table 1: Effect of different treatments on percentage germination count at 1 week after planting.

Treatments	Percentage Count
IT891D-288	91.6
IAR-48	59.0
IT891D-391	73.0
IT86D-719	63.0
IT81D-985	69.3
Local variety	30.3
$LSD_{0.05}$	22.54

Number of flowers

Effect of different treatments on number of flowers (Table 2) showed that the variety (IT89KD-288) had the highest number of flowers per plant while varieties; IAR-48, IT89KD-391 and the local variety had the least number of flowers at six weeks after planting. This could be due the phenology of different cultivars (some are early maturing while others mature late).

Table 2: Effect on different treatments on the number of flowers at 6 weeks after planting.

Treatments	Flower Number
IT891D-288	10.0
IAR-48	0.0
IT891D391	0.0
IT86D-719	5.6
IT81D-985	` 6.0
Local Variety	0.0
$LSD_{0.05}$	3.45

Number of pods

The results on the effect of different treatments on the number of pods per plant at maturity showed that the variety (IT81D-985) had the highest number of pods per plant while the local variety had the least number of pods (Table 3). It could be recalled that (IT81D-985) also had the highest number of flowers. This corroborates the findings of many researchers that flower numbers are positively and significantly correlated with fruit number unless there is a flower abortion.

Table 3: Effect of different treatments on number of pods at maturity.

Treatments	Number of Pods
IT891D-288	10.6
IAR-48	13.0
IT891D391	9.6
IT86D-719	11.6
IT81D-985	14.6
Local Variety	5.3
$LSD_{0.05}$	2.56

Plant height

Results from Table 4 on the effect of different treatments on plant height at maturity showed that local variety were taller than other variety while the variety (IT81D-985) had the least value. The observed difference in plant height may be due to genetic compositions of the varieties.

Table 4: Effect of different treatments on plant height at maturity.

Treatments	Plant height (cm)
IT891D-288	30.3
IAR-48	23.6
IT891D-391	27.0
IT86D-719	25.0
IT81D-985	20.3
Local Variety	39.3
$LSD_{0.05}$	5.36

Maruca testulalis count

Significant differences were observed among cultivars for Maruca testulalis count. Results from Table 5 show that the variety (IT81D-985) recorded the least population of *M. testulalis* (0.6) while the local variety had the highest population (3.6) per plant. However, there were no significant differences between the varieties (IAR – 48 and the local variety) but they significantly differed from other treatments ($P<0.05$) .Similar observation was reported by Jackai et al.,(1996) in their study of resistance to the legume Pod borer in some wild Vigna under laboratory feeding bioassays. Oghiakhe (1995) also observed high level of resistance to Maruca in some wild cowpea cultivars Tvu N72 and Tvu N73. The low infestation recorded by variety (IT81D-985) may be attributed to the report of Painter (1951) that the most widely accepted mechanisms of resistance in plants are non-preference, antibiosis and tolerance.

Table 5: Effect of different treatments on mean *M. testulalis* population per plant

Treatments	*M. testulalis* Count
IT891D-288	1.6
IAR-48	3.0
IT891D-391	1.3
IT86D-719	1.6
IT81D-985	0.6
Local Variety	3.6
LSD0.05	1.04

CONCLUSION

The results from this research show that the variety (IT81D-985) which had the highest number of pods per plant and recorded the least population of *M. testulalis* could be recommended for enhanced breeding work and also to farmers as a component in Integrated Pest Management (IPM).

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Influence of Herbicide rates and weeding frequency on the yield and yield components of rice *Oryza satival L.*

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ABSTRACT

Field experiments were conducted during 2008 and 2009 rainy seasons to investigate the influence of weeding frequency (0,1,2 and 3) and herbicide, propan, 360, N-3 4D rates (0,120 and 240)ml/plot on the growth, yield and yield components of rice dwarf variety (D224) an upland variety on a low land Rogosol in zuru, savanna zone of Nigeria. The experiments were conducted using Randomized Complete Block Design (R.C.B.D) in three (3) replications. The results obtained show that there was significant (P≤0.05) yield depression of (82.10, 74.08, and 47.74%) when the highest herbicide rate plus 3 weeding frequency (wf), (240 ml + 3 wf) per plot and the other treatments were compared suggesting the need to use both increased rate of herbicide application and increased weeding frequency for rice productivity in this environment. Application of two hundred and forty (240) ml/plot without hoe weeding gave a significant and more number of grains / panicle and number of grains / plant but, significant lower 1000 seed weight (seed – index.)

Key Words: **Herbicide Rate, Weeding Frequency, Rice, Yield and Yield components.**

INTRODUCTION

Rice (*Oryza sativa L)* is a cereal of enormous economic importance from the Poaceae family. It is an important staple food crop the world over. Many families in savanna ecological zone of Nigeria depend on rice as a staple food crop and for economic reasons. Kebbi state has abundant fertile Agricultural land that could sustain both upland and fadama rice production, (Aiki, 2000). However, constraints to rice production in this zone include weeds, low but torrential rainfall of short duration, use of low yielding varieties by farmers, lack of infrastructural facilities.

Weeds are the major source of yield loss in upland rice (Fischer et.al., 2001; Labrada, 2003).They often compete with crops for nutrients, light and space. The yield loss can be as high as 75% in planted rice in Nigeria arising from weed competiton (Imeokpara, 1994). The use of hoe weeding in the control of weeds by most smallholder farmers in developing countries is known to be time consuming and labour intensive. It can take more than 50% of the farmer,s input in crop production (Fadayomi, 2001).

Although herbicides usage alleviates the problem of labour for weeding, continous and incorrect usage may lead to resistance and environmental problems (Labrada, 2003). Hence, the need for integrated weed management

cannot be over emphasized. It is for this reason that field experiments were conducted during 2008 and 2009 rainy season to find out the effects of weeding frequency and herbicide rates on the growth, yield and yield components of rice variety (dwarf 224) on low land soils of zuru in the savanna zone of Nigeria using propan 360, N-3, 4D herbicide).

MATERIALS AND METHODS

The study was conducted in 2008 and 2009 at the Agricultural demonstration and research farm of the College of Agriculture, Zuru Nigeria (11^0 35'- $11^0$55'N, $4^0$55'-$5^0$35'E). The physical and chemical properties of the experimental site is shown on Table I. Upland rice variety (Dwarf 224) obtained from Kebbi State Agricultural and Rural Development Authority and a selective herbicide, propan 360, N-3,4D an emulsifiable concentrate were used for the experiments.

The study site was cleared and tilled for both years on 18/6/2008 and 8/6/2009 respectively. Ploughing was done using ox-drawn implement while puddling of the soil was done manually by the use of hoe. Each plot measured (2.5x2) m^2. Plots were separated one from another by a space of one m. A total of 36 plots were involved. The treatments consisted of three (3) rates of the herbicide (0,120, and 240) ml/plot and four (4) weeding frequency (0,1,2, and 3) or periods. The treatments were factorially arranged and assigned to the plots using Randomized complete block design (RCBD) and was replicated three (3) times. Four seeds of the upland rice variety (dwarf 224) were sown per hole on 28/6/2008 and 28/6/2009 respectively using a spacing of 25 cm between and within rows and to a depth of 2.5cm.

Weeding and herbicide application were not uniformly conducted but were done selectively and in stages. The first weeding was done on selected plots on 12/7/2008 and 12/7/2009 respectively. Exactly 2 weeks after sowing (WAS) on treatments of the plots and while herbicide application was done 3 weeks after sowing on the 19/7/2008 in 2004, respectively but, the second weeding was done on selected plots 5 weeks after sowing (WAS). The last weeding was conducted on 23/8/2008 and 2008 eight weeks after sowing (WAS) neither disease nor insect incidence was noticed on the experimental plots.

Data on 5 randomly selected plants were collected on plant height (cm) using meter rule;

The plant height was measured starting from the ground level to the flag leaf of the plant. Weed density was measured using a quadrant per $m^{2.}$ Also determined was the number of days to tillering, number of tillers/plant, number of days to booting (heading), number of panicles per plants, number of grain/plant. These were done by counting and whereas seed index, (1000 grains) weight was done by counting and weighing. In addition, yield (tones/ha) was determined

Data Analysis

Data obtained were analysed using ANOVA while the least significant different (LSD) was used to separate the means in order to find out if there were significant differences among the means (Gomez and Gomez, 1994; Salako, 2004)

Results and Discussion

Plant height:- The results showed that treatments from plots where three weeding frequencies without propan 360, N-3, 4D herbicide application

produced taller, plants of 75.88 cm high, that were significant when compared with the control and the other treatments but not significantly(P≥ 0.05)different from higher rate of herbicide (240 ml) with three, two and one weeding frequency as shown on Table 2.

Weed Density.
The control (plots without herbicide) had heavier weed density meter/square than the rest of the treatments followed by plots treated with 120ml herbicide rate without hoe weeding. Danladi and Harima, (2004) worked on a similar variety of rice and observed similarly that heavier weed density was observed on un-

wedded plots. The type of weeds that appear on the plots were mostly from the cyperacae family.

Number of days to tillering and number of tillers/plant. The number of days it took the plants to tiller was influenced by weeding frequency and herbicide rates. It took longer days for plots un-weeded with or without herbicide application to tiller than those plots weeded with or without herbicide application. It took the crop between 30-40 days to finish tillering. Plots with higher rates of herbicide application tillered between 1-2 days earlier than those un-weeded and without herbicide application. Omisore and Chukwu (2006) worked on planting density and weeding frequency on weed control and yield of maize and made a corrobrative observation in line with Akobundu, (1987). These observations are in agreement with the report herein which suggests that timely weeding particularly in early stage of the crop development is necessary to minimize yield reduction caused by uncontrolled weeds.

Soil Analysis : Soil samples were analyzed for particle size, pH in 1: 2.5 soil solution ratio, ECEC after Ammonium Acetate extraction at pH 7 solution, available P, % Organic carbon using Standard methods as outlined in IITA Manual (1979).

Table 1: Physio-chemical properties of the experimental site at college of Agriculture, Zuru demonstration and research farm during 2008 and 2009 seasons before experimentation.

Soil Properties	Unit	Range	SD
Sand	%	91.5-97.3	1.19
Silt	%	0.9-66	1.46
Clay	%	1.8-9.0	0.96
Sodium	Cmol/kg	6.0-18.0	2.00
potassium	Cmol/kg	42.0-25.0	8.00
Phosphorus	ppm	0.2-0.25	0.12
pH		5.7-5.9	0.12
EC	us/cm	32.0-52.0	3.20
Organic carbon	%	3.6-4.4	0.49

EC = Electrical Conductivity

Number of tillers per plant.

Number of tillers per plant as a component of yield decreased with lack of weeding implying that frequent weeding is needed for increased tiller/plant which subsequently lead to higher rice productivity.

Number of days to Booting.
Number of days to booting was significantly (P≤ 0.05) influenced by weeding frequency and rate of herbicide application. Higher rate of herbicide application + three weeding frequencies reduced booting period by a day when compared with un-weeded plots (without herbicide application) Table 2

Table 2. Effects of weeding frequency and rates of herbicide application on plant height (cm), weed density, number of days to tiller, number of tillers/plant and number of days to booting (heading) after sowing (WAS).

Treatments Plants Height (cm)		**weed Density m^2**	**number of days to tiller**	**number of tiller/plant**	**number of days of booting**
HO WO	41.52	24.00	34.00	5.00	40.00
HO W1	51.68	15.00	33.00	8.70	39.67
HO W2	61.57	10.00	40.00	11.00	39.50
HO W3	75.88	6.00	30.00	10.00	38.50
H1 WO	57.88	16.00	32.00	9.00	39.50
H1 W1	59.50	13.00	31.00	10.00	39.83
H1 W2	65.06	5.00	30.00	14.00	38.33
H1 W3	73.10	14.00	31.00	8.00	39.83
H2 WO	60.03	8.00	30.00	11.00	40.00
H2 W1	73.10	6.00	30.00	11.00	38.67
H2 W2	72.55	4.00	30.00	16.00	38.33
LSD Ì O.05	6.29	2.08	0.85	2.47	0.66
NS	*	*	*	*	

Ns significant/significant
* = significant at 5% probability level.

NB: HOWO = No Herbicide application, no weeding (control)
HOW1 = No Herbicide, only one weeding frequency
HOW2 = No Herbicide application, two weeding frequency
HOW3 = No herbicide, three weeding of periods or frequency.
H1WO = 120ml/plot applied Herbicide without weeding
H1W1 = 120ml/plot applied Herbicide with one weeding frequency
H1W2 = 120ml/plot applied Herbicide with periods of weeding
H1W3 = 120ml/plot applied Herbicide with periods of weeding
H2WO = applied of 240ml, herbicide without weeding
H2W1 = applied of 240ml, herbicide with one weeding frequency
H2W2 = application of 240ml, herbicide with two (2) weeding frequency
H2W3 = application of 240ml, herbicide with three (3) weeding frequency

Table 3: Effects of weeding frequency and rate of herbicide application on the number of panicle/plant, number of grains/panicle, number of grains/plant, and 1000 – seed weight (Seed index) and grain yield kg/ha

Treatments	Number of Panicle/plant	Number of Grains/panicle	Number of Grains/plant	Seed index (100 – seed wt)	Grain yield kg/ha
HOWO	-	-	-	.007	9.880
HOW1	2.00	10.08	75.17	17.83	67,000
HOW3	8.92	26.58	198.92	31.32	214,340
HOW3	10.83	50.83	447.92	32.54	333,340
H1WO	12.83	57.58	787.83	18.19	63,860
H1W1	7.83	19.50	152.93	20.28	63,000
H1W2	11.7	38.50	357.08	31.86	141,800
H1W3	11.58	50.58	524.67	34.19	332,180
H2WO	15.00	66.67	844.42	19.20	67,460
H2W1	9.25	44.00	341.25	26.67	1044,00
H2W2	11.08	57.33	641.25	31.51	171,460
H2W3	7.33	56.58	724.42	34.47	349,600
LSD (0.05)	-	15.68	182.05	3.67	295.40
	NS	*	*	*	*

Average of Two years data

HOWO = No herbicide application and No weeding
HOW1 = No herbicide application but only one weeding frequency
HOW2 = No herbicide application but only two weeding frequency
HOW3 = No herbicide application but 3 hoe weeding frequency
H1W2 = 120 in./plant application but 2 hoe weeding
H1W1 = 120ml./plot herbicide application and 2 hoe weeding frequency
H1W3 = 120ml./plot herbicide application and three (3) hoe weeding frequency
H_2WO = 240ml./plot herbicide application but no hoe weeding frequency
H_2W1 = 240ml./plot herbicide application and only one hoe weeding frequency
H_2W2 = 240l./plot herbicide application and 2 hoe weeding frequency
H_2W3 = 240ml./plot herbicide application and 3 hoe weeding frequency
LSD = least significant difference
NS = Not significant at 5% probability level.

From the table, it could be observed that no significant difference was observed among the treatments when the numbers of panicle per plant were compared. Apart from treatments where no weeding was conducted and no

herbicide applied. Higher rate of herbicide application without weeding produced greater number of grains per panicle and number of grains per plant but lower 1000- seed weight (g) and Grain yield kg/ha. Two hundred and forty
240ml. herbicide applied/plot with 3 periods of weeding (frequency) produced greater quantity of grain kg/ha than the rest treatments and also higher seed- index as indicated on table 3 and 4.

General observation made from Table 2 points to the fact that integrated weed control measure appears better option that either chemical or manual and /or hoe weeding. Tauro in De Datta, (1979) as quoted by Akobundu (1987) combined chemical weed control with rotary weed and was able to reduce the time of rotary weeding in transplanted rice. Similarly, much more rice productivity could be obtained and labour, saved, with the combination of a higher rate of herbicide application with 2 and 3 weeding frequency as observed from these experiments. The ability of the variety used (D 224) to tiller well may have helped in weed reduction and subsequent increase in yield kg/ha.

Table 4: Effect of Herbicide rate and weeding frequency on grain yield/ha weeding frequency

Herbicide Rate	WO	W1	W2	W3	MEAN
HO	9,880	67,000	214340	333,340	32773.3
H1	63,880	63,000	141,800	332180	199953.3
H2	67460	104000	171460	349600	230846.6
Mean	47073.33	78000	175866.66	338373.33	

Conclusion

Problems posed by weed interference in this environment could be reduced and increased productivity of this rice variety (D 224) achieved by applying 240ml with three (3) weeding frequency since there were significant yield increase of (82.11,74.08 and 47.7)% greater than the control and the other treatments.

1. It is recommended that the rate of the herbicide application be increased further and the period of weeding kept constant to find out if there will be further increase in the yield as a result of increased herbicide rate.
2. Cost/benefit analysis be conducted between the use of herbicide/weeding manually and or the use of both.

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EFFECT OF ORGANIC MANURE TYPES ON GROWTH AND YIELD QUALITY OF GREEN OKRA (*Abelmoschus esculentus*)

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Abstract.
A field experiment was conducted at Teaching and Research Farm of the Federal University of Technology, Owerri between *March and May 2010 and repeated between June and August the same year cropping season, to assess the effect of organic manure types on the production and quality of green okra (Abelmoscus esculentus) in Owerri Southeastern Nigeria. The experiment was laid out using the Randomized complete block design with four replications and eight treatments. The treatments includes: 10 ton /ha of poultry manure, 10 ton /ha of pig slurry, 10 ton /ha cow dung, 10 ton/ha farm yard manure, 5 ton/ha poultry manure +5 ton/ha farm yard manure, 5 ton/ha pig slurry +5 ton/ha farm yard manure, 5 ton/ha cow dung +5 ton/ha farm yard manure and 0 ton/ha as the control. Okra seeds were planted after the incorporation of the organic manure. Data on various growth and yield parameters, including the proximate analysis on nutrient content of the okra pod were measured and subjected to analysis of variance. (ANOVA). Means were separated using the Least Significant Difference tested at p=5% level of probability. Results indicated that different organic manure types influenced positively on the growth and yield of okra. The poultry manure gave the highest fresh pod number of 121,875 pod /ha and fresh pods yield of 420kg /ha when compared with a corresponding low fresh pod number of 40,625 pods /ha and fresh pod yield of 142.188kg/ha as recorded in zero manure treatment. The crude fibre content and moisture content of fruits under poultry manure treatment was also less when compared with the control. All the mineral content under different organic manure treatment were statistically different at 5% level of probability. Soil post chemical analysis indicates that substantial amount of various soil chemical properties significantly increased with different organic manure types. Therefore, farmers in this area or related agroclimatic conditions are encouraged to apply poultry manure at 10 ton/ha for better growth and yield of okra.*

Keywords: Green okra, yield quality and growth organic manure types.

Introduction

Organic manure is traditionally a key fertilizer in sustainable soil management (Anon, 1997).However, Organic amendment provide a ready source of carbon and nitrogen for microorganisms in the soil and in turn the structure of the soil and infiltration is improved thus reducing erosion, lowering the temperature at the soil surface and also aid in seed germination Bavec and Bavec (2007).

One of the main problems in conventional farming is the loss of productive soil. Soil quality deterioration in Owerri, southeastern Nigeria is mainly caused by erosion, structural deterioration and pollution (Onweremadu, 2010 personal discussion).The practice of using high inputs to increase yields eventually leads to irrational application of synthetic fertilizers, pesticides and irrigation, thus resulting in destruction of soil structure, alteration of nutrients only

for short period of time thereby causing accumulation of hazardous materials in the soil thereafter. It has been observed that increased organic matter content has a positive effect on soil quality and improved soil P^H (Ibeawuchi *et al.,* 2010) especially in the production of vegetables.

Okra is one of the crops that are heavily affected by shortage of soil organic matter content and soil fertility level and of the leading vegetables grown in Nigeria (Taylor, 1996). It belongs to the Malvaceae family. Okra known by many other names is a flowering plant and belongs to the same family with such species as cotton, cocoa, hibiscus and; it is valued for its edible green fruits. It is cultivated throughout the tropical and warm temperature regions of the world for its fibrous fruit containing round white seed when fresh and black or grey seed when dry. The fruits are harvested when immature and eaten as vegetable. Okra plant is among the drought-tolerant crops (John and Whorter, 2002).

Several varieties of okra differing in maturing time, morphology and fruit characteristics are grown in Nigeria (Katung, 2007). There are however two main types of okra under which different varieties are grouped. These are the dwarf- early fruiting type use for commercial production and the tall type which takes longer time to come into bearing but continues to fruit for months while they are being harvested. When mature fruits are left on the plant, they reduce flowering and fruit sets (Martin, 1982). The nutritional value of okra is extremely high as it is a significant source of dietary fibre, vitamins A and C, calcium, potassium and other minerals .Okra seeds may be roasted and ground to form caffeinate, free substitute for coffee (Harvery *et al*, 1998).Matured okra seeds contain about 25% of edible oil which can be used in cooking. The greenish yellow edible oil has a pleasant test, odour and is high in unsaturated fats such as oleic and linoleic acid (Martin, 1982).

Okra is easily dried for later use and this characteristic makes it exportable in dry or powdery form. A little dried okra in prepared dishes produces much the same results as does the fresh product. It has good results as a brightening agent for electroplated parts, particularly in nickel electroplating; it is a leather conditioner, a carrier and stickers for foliage insecticides and fertilizer (Agarwal *et al*, 2003)

Results have shown that in medicine okra serves as an ulcer medication; the roots are very rich in mucilage which is used as a plasma replacement (Chopra *et al.*, 1986). Therefore, the use of organic manure types to meet the nutrient requirement of okra would be an inevitable panacea in the future for sustainable production of okra plants and fruits. (Maheswarappa *et al*, 1999).

Although the organic manures contain plant nutrients in small quantities as compared to the inorganic fertilizers, the presence of growth promoting elements like enzymes and hormones, besides plant nutrients make them essential for improvement of soil fertility and productivity, improve the soil physical, chemical and biological properties along with conservation of the moisture holding capacity of the soil, thus, resulting in enhanced crop productivity along with maintaining the quality of crop produced (Bhuma, 2001).

Based on the above scenario, the broad objective of the research is effect of organic manure types on the productivity and quality of fresh okra pods in Owerri southeastern Nigeria.

Materials and methods.

A field experiment was conducted between March and May 2010 and repeated between May and August the same year. This was done at teaching and research farm of the School of Agriculture and Agricultural Technology, Federal University of Technology Owerri located in the rainforest zone of Southeastern Nigeria. The training and research farm is situated at 05^0, 27'N and 07^0, 02'E.The soils of the area are characterized by deep porous red soils derived from sandy deposits in the coastal plain and are highly weathered, low in mineral reserve and naturally infertile (Eshett,1993). The area has a minimum and maximum temperature of 20 - 32 ^{0}C, respectively with a mean annual rainfall of about 2500 mm and the relative humidity of the area is between 88 and 90% annually

An experimental area that measured 325m^2 was cleared of the existing bush and the trash packed. This was followed by manual soil pulverization and making of plots/beds measuring

(2 x 2) m. The plot was separated from one another by 1m demarcation using pegs. A total of 32 plots were made and subsequently partitioned into 4 blocks containing 8plots per block. The blocks were separated from each other by 1m space. This was for easy management practices such as weeding, disease check, insect removal and incorporation of organic manure in the soil. Since the study was on the effect of organic manure, the experiment was laid out using the randomized complete block design (RCBD) and replicated 4 times. The treatments include:

- 10 tons/ha of Poultry manure
- 10 tons/ha of Pig Slurry manure
- 10 tons/ha of Cow Dung Manure
- 10 tons/ha of Farmyard Manure
- 5 tons/ha of Poultry Manure + 5ton/ha of Farmyard Manure.
- 5 tons/ha of Pig Slurry Manure+ 5 ton/ha of Farmyard Manure.
- 5 tons/ha of Cow Dung Manure + 5 ton/ha of Farmyard Manure.
- No Manure as Control.

Various organic manure types as listed above were collected, cured, measured out and spread out uniformly on the plots according to the treatment and they were incorporated into the soil before planting. A week was allowed for any further decomposition to take place before planting was done. These 8 treatments were randomly assigned to the 8 plots in each block using piece of paper method of treatment allocation and this was repeated severally until four replication were covered.

Soil sampling:

Soil samples were randomly collected from the experimental site using the soil auger at the depth of 0 – 20cm (top-soil) and bulked for soil nutrient analysis in the laboratory before planting. The soil sample collected were air – dried under shade for 3days then passed through 2mm sieve. This same process was repeated after the experiment although it was on plot by plot bases.

The samples of the cured organic manure (poultry manure, pig slurry Manure, Cow dung Manure, and Farm yard manure) for the conduct of the experiment were air-dried and ground. Samples were dry-ashed at 500^0C for 6hrs in furnace and extracted with nitric perchloric acid mixture (AOAC, 1990). Nitrogen content was determined by MicroKjedahl method(Bremner, 1996), phosphorus by calorimeter(Olson and Sommers, 1982), potassium and sodium by flame photometery(Olson and

Sommers, 1982). And Ca and Mg were determined by EDTA method.

Planting of okra seeds:

The okra variety used in this study was the dwarf cultivar CV "Otukwuruma-omia" (47-4).

The treated seeds were soaked in water for 24 hours before sowing at 2 seeds per hole and planting distance of 0.3m × 0.6m, and plant population of 111,112 plants per hectare. The okra plants emerges 4-6 days after planting.

Data collection:

Data were collected on okra Leaf area, days to 50% flowering, plant height, number of leaves, number of pods, total fresh pod yield and proximate analysis were also determined.

Nutrient composition was determined on all immature fresh pod samples harvested 6 days after anthesis using stared and AOAC (1990) methods. Fruit sample collected for analysis were properly washed with distilled water and air-dried. Ash determination involved the incineration of each sample in a muffle furnace at 660^0C for 12hrs at Crop Science Laboratory of Federal University of Technology Owerri. Crude fat determination was achieved by exhaustively extracting the samples with diethyl ether. Crude fiber was estimated from the loss in weight of the crucible and its contents on ignitions after ashing, following the sequential extraction of the samples with 1.25% sulphuric acid and 1.25% sodium hydroxide. Protein was determined using microkjedahl nitrogen method (Bremner, 1996) which involves the digestion of 0.5g of sample with sulphuric acid and a catalyst followed by calorimetric determination of nitrogen that was multiplied by 6.25 to obtain crude protein. The carbohydrate content was by subtracting the values of ash, crude fibre, fat, and protein from the total dry mater (Antia *et al., 2006*). All samples were analyzed in duplicate. The proximate composition obtained was analyzed. The magnesium, iron, and calcium were measured using EDTA method after digestion of the sample (Olson and Sommers, 1982). Phosphorus content was obtained by converting phosphate into phosphorus molybdate blue pigment and assays at 660nm in a ultra violet spectrophotometery (Antia *et al.,* 2006). Sodium and potassium was determined by flame photometery (Olson and Sommers, 1982).The data for the experiment were subjected to analysis of variance. Differences between means were separated using least significant difference (L S D) as described by Obi and Obi (2002) at p=0.05.

RESULTS

Table 1: Soil physical and chemical properties preplanting

CHEMICAL SOIL ANALYSIS	Top soil (0-15cm).
Ph H_2O	5.18
Organic matter content (%)	1.12
Nitrogen (%)	0.15
Sodium(Cmolkg^{-1}	0.018
Available Phosphorus (Cmolkg^{-1})	19.58
Magnesium(Cmolkg^{-1})	0.216
Aluminium(Cmolkg^{-1})	0.430
Potassium(Cmolkg^{-1})	0.032
Calcium(Cmolkg^{-1})	0.700
Total Exchangeable Acidity (Cmolkg^{-1})	0.54
Total Exchangeable Base (Cmolkg^{-1})	0.97
Cation exchange capacity (CEC) (Cmolkg^{-1})	1.506
Clay (%)	4.99
Silt (%)	10.63
Sand (%)	84.38

Soil Textural Class - Sandy loam

Table 2: Chemical composition of organic manure before planting.

ORGANIC MANURE FARMYARD COMPOSITION	POULTRY MANURE	PIG SLURRY	COW DUNG	MANURE
Nitrogen (%)	**2.37**	**1.89**	**1.83**	**1.34**
P^H in H_20	**7.78**	**8.62**	**8.55**	**10.37**
Organic matter content (%)	**36.20**	**31.60**	**17.73**	**17.48**
Available Phosphorus ($Cmolkg^{-1}$)	**0.55**	**0.46**	**0.61**	**0.88**
Potassium ($Cmolkg^{-1}$)	**0.58**	**1.15**	**0.92**	**1.04**
Sodium ($Cmolkg^{-1}$)	**0.48**	**0.43**	**0.38**	**0.88**
Magnesium ($Cmolkg^{-1}$)	**0.74**	**0.61**	**0.44**	**0.38**
Calcium ($Cmolkg^{-1}$)	**2.91**	**2.21**	**1.83**	**1.91**

Table 3: Post Harvest Soil Chemical Analysis

Manure treatments/ Plot (ton/ha)	Ph H_2O	N	OM	P	K	Mg	Ca	Na
	→	%	←	→	CmolKg^{-1}			←
10 pig slurry	7.02	2.89	10.09	10.40	0.14	1.14	0.35	0.20
10 cow dung	6.90	1.98	10.57	14.72	0.35	0.98	0.52	0.28
10 poultry manure	6.58	4.06	11.17	28.60	0.38	0.28	0.70	0.47
10 farm yard manure	5.63	1.39	2.97	8.35	0.23	0.97	0.48	0.18
5 pig slurry + 5 FYM	7.89	1.34	7.56	8.03	0.09	2.45	0.84	0.14
5 poultry manure+ 5 FYM	6.99	2.22	9.67	20.34	0.23	0.86	0.64	0.36
5 cow dung +5 FYM	7.08	1.11	7.55	12.54	0.30	0.76	0.44	0.19
Control (zero manure)	7.67	0.45	5.63	19.45	0.17	0.45	0.33	0.45

Table 4: Effect of organic manure type on plant height (cm) of okra (*Abemoschus esculentus*) at 4, 8 and 12 wap.

Manure treatments/ Plot (tons/ha)	Mean plant height (Cm)		
	4WAP	8WAP	12WAP
10 pig slurry	9.90	24.70	31.00
10 cow dung	8.95	23.78	28.84
10 poultry manure	9.95	25.31	33.99
10 farm yard manure	6.89	15.00	23.19
5 pig slurry + 5 farm yard manure	8.70	19.95	28.89
5 poultry manure+ 5 farm yard manure	8.25	21.51	28.33
5 cow dung + farm yard manure	6.95	16.78	24.78
Control (zero manure)	5.90	19.95	24.00
L.S.D(P=0.05)	NS	6.10**	5.98**

NS =Non-significant at 5%

** =Significant at 5%

WAP=weeks after plantingS

Table 5: Effect of organic manure type on number of leaves of okra (*Abemoschus esculentus*) at 4, 8 and 12 wap.

Manure treatments/ Plot (tons/ha)	**MEAN NUMBER OF LEAVES**		
	4WAP	**8WAP**	**12WAP**
10 pig slurry	**6.00**	**7.25**	**9.25**
10 cow dung	**5.00**	**8.50**	**10.00**
10 poultry manure	**6.01**	**8.25**	**10.25**
10 farm yard manure	**4.75**	**7.50**	**9.00**
5 pig slurry + 5 farm yard manure	**5.50**	**6.75**	**8.00**
5 poultry manure+ 5 farm yard manure	**5.75**	**7.50**	**9.00**
5 cow dung +5 farm yard manure	**4.25**	**7.00**	**8.25**
Control (zero manure)	**4.50**	**5.50**	**7.50**
L.S.D(P=0.05)	**1.04****	**NS**	**NS**

NS =Non-significant at 5%

**** =Significant at 5%**

WAP=weeks after planting

Table 6: Effect of organic manure types on leaf area (cm^2) of okra (*Abemoschus esculentus*) at 4 and 8 WAP.

Manure treatments/ Plot (tons/ha)	MEAN LEAF AREA(Cm^2)	
	4WAP	8WAP
10 pig slurry	51.64	61.29
10 cow dung	46.25	61.67
10 poultry manure	66.67	90.61
10 farm yard manure	20.49	45.83
5 pig slurry + 5 farm yard manure	33.87	55.10
5 poultry manure+ 5 farm yard manure	41.45	69.84
5 cow dung +5 farm yard manure	21.44	46.58
Control (zero manure)	19.09	33.37
L.S.D(P=0.05)	17.075**	18.99**

**= Significant difference

WAP=Weeks after planting

Table 7: Effect of organic manure types on Okra (Abelmoschus esculentus) at 50% flowering, Pod number, and fresh yield (kg/ha)

MANURE TREATMENT PLOT (TONS/HA)	MEAN 50%/ FLOWERING	MEAN NUMBER PODS/HEC	MEAN FRESH POD YIELD
10 pig slurry	25.00	97,500	341.25
10 cow dung	23.21	87,500	306.25
10 poultry manure	33.93	121,875	420.00
10 farm yard manure	9.82	60,000	210.00
5 pig slurry + 5 farm yard manure	16.07	76,250	265.88
5 poultry manure+ 5 farm yard manure	23.21	83,750	293.13
5 cow dung +5 farm yard manure	8.04	82,750	240.63
Control (zero manure)	6.02	6,950	142.19
L.S.D(P=0.05)	10.37**	15495.70**	53.70**

MANURE TREATMENTS/ PLOT(TONS/HA)	MEAN MINERAL CONTENT OF OKRA FRUITS (%)				
	P	Mg	Na	Fe	Ca
10 pig slurry	0.58	0.47	0.55	0.21	0.47
10 cow dung	0.44	0.35	0.43	0.18	0.37
10 poultry manure	0.61	0.49	0.70	0.24	0.52
10 farmyard manure	0.50	0.32	0.36	0.17	0.28
5 pig slurry + 5 ton/ha farm yard manure	0.39	0.40	0.49	0.18	0.40
5 poultry manure+ 5 ton/ha farm yard manure	0.47	0.43	0.52	0.20	0.34
5 cow dung +5 ton/ha farm yard manure	0.53	0.39	0.61	0.16	0.44
Control (zero manure)	0.32	0.31	0.46	0.14	0.29
L.S.D(P=0.05)	**0.1026****	**0.1050****	**1.976****	**0.064****	**0.111****

CHO=Carbohydrates

Table 8: Effect of organic manure types on mineral content of Okro. *(Abelmoschus esculentus)*

Table 9:Effects of organic manure types on nutrient content of Okro fruit *(Abelmoschus esculentus)*

Discussion

The pre- planting soil physical and chemical analysis Table 1 show that the soil pH measured in water is (5.18) indicating acidic reaction.

Table 1: Soil physical and chemical properties preplanting

CHEMICAL SOIL ANALYSIS	Top soil (0-15cm).
Ph H_2O	**5.18**
Organic matter content (%)	**1.12**
Nitrogen (%)	**0.15**
Sodium(Cmolkg^{-1}	**0.018**
Available Phosphorus (Cmolkg^{-1})	**19.58**
Magnesium(Cmolkg^{-1})	**0.216**
Aluminium(Cmolkg^{-1})	**0.430**
Potassium(Cmolkg^{-1})	**0.032**

Manure treatments/ Plot (tons/ha)	MEAN NUTRIENT CONTENT OF OKRA FRUITS (%)					
	FATS	PROTE-IN	ASH	MOISTURE	CHO	CRUDE FIBRE
10 pig slurry	2.05	2.29	1.00	87.10	5.52	2.04
10 cow dung	1.75	2.12	1.33	86.54	5.03	1.23
10 poultry manure	2.13	3.17	1.44	83.08	4.04	1.23
10 farm yard manure	1.74	0.88	1.00	86.82	8.11	1.45
5 pig slurry + 5 farm yard manure	2.09	1.82	0.61	84.65	9.21	1.60
5 poultry manure+ 5 farm yard manure	2.01	2.16	1.04	88.91	9.52	1.62
5 cow dung +5 farm yard manure	1.82	1.70	0.92	87.56	6.92	1.08
Control (zero manure)	1.45	1.52	0.48	89.16	10.65	1.74
L.S.D(p=0.05)	0.57**	0.62**	0.44**	NS	NS	0.71**

Calcium(Cmolkg^{-1})	**0.700**
Total Exchangeable Acidity (Cmolkg^{-1})	**0.54**
Total Exchangeable Base (Cmolkg^{-1})	**0.97**
Cation exchange capacity (CEC) (Cmolkg^{-1})	**1.506**
Clay (%)	**4.99**
Silt (%)	**10.63**
Sand (%)	**84.38**

Soil Textural Class - Sandy loam

The value of the organic matter is also low (1.12%) with low nitrogen content (1.12) and exchangeable cations such as Na^{+}(0.018 Cmolkg^{-1}),P(19.57 Cmolkg^{-1}),Mg^{+}(0.216 Cmolkg^{-1}),K^{+}(0.032 Cmolkg^{-1}),Ca^{+}(0.700 Cmolkg^{-1}),Al^{3+}(0.430 Cmolkg^{-1}). This means that soil nutrient status is poor thus confirming earlier work done by Ohiri (1992) who report that soil in southeastern Nigeria are characterized by low pH, low organic matter and low exchangeable cations. The P content is below the recommended critical level of 8.51mg/kg soil (Agboola *et al., 1982).* This indicates serious deficiency problems. High exchangeable Ca in the soil suppresses Boron up take by plants as reported by (Osiname, 2000) there by resulting in distortion of leaves and stunted root growth (Anonymous, 2004). The high content of Ca shown in Table 1 is an indication of low pH, a condition that is unsuitable for most plant growth (Veldkam, 1992). Exchangeable Mg is low, thus Mg is likely to constitute constraint to agricultural productivity in the soil. Based on criteria defined by (Osiname, 2000), the soil organic carbon contents and total nitrogen are low, indicates low fertility status of the soil. This could be due to high temperatures, continuous cultivation and lack of incorporation of organic materials in the soil. This low attribute status implies that for effective and good yield of arable vegetable such as okra, external sources of nutrients supply need to be added to boost crop productivity and eventual yield.

From the analysis of organic manure,

Table 2: Chemical composition of organic manure before planting.

ORGANIC MANURE COMPOSITION	POULTRY MANURE	PIG SLURRY	COW DUNG	FARMYARD MANURE
Nitrogen (%)	2.37	1.89	1.83	1.34
P^H in H_20	7.78	8.62	8.55	10.37
Organic matter content (%)	36.20	31.60	17.73	17.48
Available Phosphorus ($Cmolkg^{-1}$)	0.55	0.46	0.61	0.88
Potassium ($Cmolkg^{-1}$)	0.58	1.15	0.92	1.04
Sodium ($Cmolkg^{-1}$)	0.48	0.43	0.38	0.88
Magnesium ($Cmolkg^{-1}$)	0.74	0.61	0.44	0.38
Calcium ($Cmolkg^{-1}$)	2.91	2.21	1.83	1.91

Although all the organic manure applied contained considerable amounts of essential macro-nutrients and small amount of micro-elements, the poultry manure was observed on analysis (Table 2) to contain appreciable quantity of nitrogen and magnesium which might have helped in chlorophyll synthesis and in turn increased the rate of photosynthesis. The results are in agreement with the finding of *Sanwal et al* (2007).

Among the organic manure treatments, application of poultry manure at 10 ton/ha performed better than other treatments through improved plant characteristics such as plant height, mean pod per plant, number of leaves per plant, yield and nutrient content.

Field observation showed that there were significant differences among the treatments at 4 WAP, though the control gave the lowest plant height (6. 90 cm) and poultry manure at 10ton/ha

(9.95 cm) confirming the ascertions made by Udoh *et al (*2005*).*

Table 4: Effect of organic manure type on plant height (cm) of okra (*Abemoschus esculentus*) at 4, 8 and 12 wap.

Manure treatments/ Plot (tons/ha)	Mean plant height (Cm)		
	4WAP	8WAP	12WAP
10 pig slurry	9.90	24.70	31.00
10 cow dung	8.95	23.78	28.84
10 poultry manure	9.95	25.31	33.99
10 farm yard manure	6.89	15.00	23.19
5 pig slurry + 5 farm yard manure	8.70	19.95	28.89
5 poultry manure+ 5 farm yard manure	8.25	21.51	28.33
5 cow dung + farm yard manure	6.95	16.78	24.78
Control (zero manure)	5.90	19.95	24.00
L.S.D(P=0.05)	NS	6.10**	5.98**

Result (Table 4) indicates that Poultry manure (4WAP) gave the highest plant height (25.31cm) and it was not statistically different from other treatments except the control at 8WAP. However at 12 WAP, poultry manure and pig slurry manure treatments had no statistical difference between them but were significantly different from other treatments. This agreed with the work of Dileep (2005) who reported that application of different organic manures showed a significant increase in plant height and number of fruit per plant.

Okra number of leaves per plant (Table 5) increased significantly (P= 0.05) at 4WAP.

Table 5: Effect of organic manure type on number of leaves of okra (*Abemoschus esculentus*) at 4, 8 and 12 wap.

Manure treatments/ Plot (tons/ha)	MEAN NUMBER OF LEAVES		
	4WAP	8WAP	12WAP
10 pig slurry	6.00	7.25	9.25
10 cow dung	5.00	8.50	10.00
10 poultry manure	6.01	8.25	10.25
10 farm yard manure	4.75	7.50	9.00
5 pig slurry + 5 farm yard manure	5.50	6.75	8.00
5 poultry manure+ 5 farm yard manure	5.75	7.50	9.00
5 cow dung +5 farm yard manure	4.25	7.00	8.25
Control (zero manure)	4.50	5.50	7.50
L.S.D(P=0.05)	1.04**	NS	NS

There were no significant differences observed at 8WAP. The number of leaves in plots treated with poultry manure and pig slurry manure were statistically the same, but significantly higher than other treatments, investigated in this experiment especially that of cow dung manure and farm yard manure which gave given the lowest number of leaves (40,625.00) Table 5.

From the result (Table 6), at 4WAP, poultry manure application had a mean leaf area of 66.67cm^2 which was not significantly higher than 51. 64 cm^2 observed from pig slurry plot, but was significantly higher than other treatments including the control which had the least leaf area (19.09 cm^2).

Table 6: Effect of organic manure types on leaf area (cm^2) of okra (*Abemoschus esculentus*) at 4 and 8 WAP.

Manure treatments/ Plot (tons/ha)	MEAN LEAF AREA(Cm^2)	
	4WAP	8WAP
10 pig slurry	51.64	61.29
10 cow dung	46.25	61.67
10 poultry manure	66.67	90.61
10 farm yard manure	20.49	45.83
5 pig slurry + 5 farm yard manure	33.87	55.10
5 poultry manure+ 5 farm yard manure	41.45	69.84
5 cow dung +5 farm yard manure	21.44	46.58
Control (zero manure)	19.09	33.37
L.S.D(P=0.05)	17.075**	18.99**

Furthermore at 8WAP; the trend was maintained, with the highest leaf area obtained from poultry manure plots which were statistically different from the other treatments.

The increased leaf area, number of leaves per plant and plant height has a direct impact on the pod yield of okra. Such increased yield as observed in this study may be due to the enhanced leaf area which increased photosynthetic efficiency and thus yield potential of okra. However, the results are similar with the work of Akoroda (1993) who reported that photosynthetic efficiency in a crop is closely related to the efficiency of leaf area spread as a result of maximum light interception. Thus organic manure increased the plant height and number of leaves other than the control.

Days to 50% flowering Table 7 shows that increased soil fertility by the application of organic manure increased days to 50% flowering significantly (P>0.05) when compared to control.

Table 7: Effect of organic manure types on Okra (Abelmoschus esculentus) at 50% flowering, Pod number, and fresh yield (kg/ha)

MANURE TREATMENT PLOT (TONS/HA)	MEAN 50%/ FLOWERING	MEAN NUMBER OF PODS/HEC	MEAN FRESH POD YIELD
10 pig slurry	25.00	97,500	341.25
10 cow dung	23.21	87,500	306.25
10 poultry manure	33.93	121,875	420.00
10 farm yard manure	9.82	60,000	210.00
5 pig slurry + 5 farm yard manure	16.07	76,250	265.88
5 poultry manure+ 5 farm yard manure	23.21	83,750	293.13
5 cow dung +5 farm yard manure	8.04	82,750	240.63
Control (zero manure)	6.02	6,950	142.19
L.S.D(P=0.05)	10.37**	15495.70**	53.70**

Result in relating plant flowering to fruit set shows that increase in the number of flowering brings about an increase in the number of fruits set and hence, a total fruit yield. The longer period taken by plots with poultry manure to attain 50% flowering, could largely be due to the high fertility status of the soils and subsequent fast release of plant nutrients. This agree with (Udoh *et al*, 2005) who reported that manure application promote vegetative growth in vegetables. Since flowering is a prerequisite to pod formation and finally the maturity of crop, all the flower measurements were almost significantly higher in plots treated with poultry manure.

The number of pods per plant has great effect on the final fresh pod yield of okra. It is clear (Table 7) that organic manure application differed significantly in the number of pods per plant. The results showed that poultry manure application had more number of pods per hecter (121,875) than other organic manure applications. All the treated plots produced more number of pods than untreated plots (control). Significant differences were observed in the number of pods at harvest .The result got from this study on the number of pods per plant agreed with Smith *et al* (2002) and Olufolaji *et al* (1989) who separately reported that organic manure has significant effects on plant growth and development irrespective of rate of application, unless when applied in mixture with organic fertilizer.

Yield is the end result of the many complex, morphological and physiological processes that occurred during the growth and development of okra plant. Okra fresh pod yield differed significantly with maximum pod yield recorded from plot treated with poultry manure and the least obtained from the control, this is because poultry manure has high nitrogen content which is required by vegetables especially okro. Thus it assist farmers to improve the soil through addition of essential nutrients and also serve as a reservoir of soil chemical properties that are essential for plant growth (Fagbenro, 1998) .This significant influence in growth characteristics that resulted in increased yield obtained in the experiment might have been due to the enhanced uptake of nutrients favored by the addition of the different organic manure. Addition of

poultry manure brought about improvement in most of the soil chemical properties: soil pH, organic matter, and total nitrogen base saturation were improved. The significance of organic manure in sustainable agriculture is well established. (Guar et al, 1972; Subbarao et al, 2001) especially in soil residual effects which help in the second cropping on the same piece of land.

Results of the fruit proximate analysis from Table 8 and 9 showed that the nutrients (Magnesium, Fat, Protein, Crude ash, Crude fibre, Sodium, Iron, Calcium, and Potassium) of okra fruits were significantly influenced by treatment application but carbohydrate and moisture
content are not significantly different.

MANURE TREATMENTS/ PLOT(TONS/HA)	MEAN MINERAL CONTENT OF OKRA FRUITS (%) P	Mg	Na	Fe	Ca
10 pig slurry	0.58	0.47	0.55	0.21	0.47
10 cow dung	0.44	0.35	0.43	0.18	0.37
10 poultry manure	0.61	0.49	0.70	0.24	0.52
10 farmyard manure	0.50	0.32	0.36	0.17	0.28
5 pig slurry + 5 ton/ha farm yard manure	0.39	0.40	0.49	0.18	0.40
5 poultry manure+ 5 ton/ha farm yard manure	0.47	0.43	0.52	0.20	0.34
5 cow dung +5 ton/ha farm yard manure	0.53	0.39	0.61	0.16	0.44
Control (zero manure)	0.32	0.31	0.46	0.14	0.29
L.S.D(P=0.05)	0.1026**	0.1050**	1.976**	0.064**	0.111**

Table 8: ffect of organic manure types on mineral content of Okro. (*Abelmoschus esculentus*)

This result confirmed that okra fruits are rich in nutrient elements and stands out in ranking among all other vegetables in their initial contribution in human nutrition (Grubben and Denton, 2004). The relatively high protein content has highlighted the importance of Okra as a vegetable that contains a lot of nutrient element for human health and growth. The high nutrient contents are as a result of the impact of organic manure. Plot treated with poultry manure were observed to have the highest nutrient content compared to other treatments. Most rural communities in Southeast Nigeria and other parts of the world rely on vegetables as source of protein. Okra therefore plays a significant role in the provision of cheap and affordable protein for rural population. The mineral composition of the okra revealed the relatively high concentration of magnesium, iron and calcium. The amount of iron in okro is of particular importance considering the fact that 21% of the children in Africa suffer from anemia, a condition caused by iron deficiency Van Vururen (2006). This study shows that incorporation of organic manure to vegetable production

such as Okra will increase the nutrient composition of Okra plant. Therefore, okra can play a role in alleviating micronutrient deficiencies especially worldwide. Diets with low zinc status are correlated to decrease growth, poor pregnancy outcome and impaired immune functions (Lonnerdal, 2002).

Manure treatments/ Plot (ton/ha)	MEAN NUTRIENT CONTENT OF OKRA FRUITS (%)					
	FATS	PROTE-IN	ASH	MOISTURE	CHO	CRUDE FIBRE
10 pig slurry	2.05	2.29	1.00	87.10	5.52	2.04
10 cow dung	1.75	2.12	1.33	86.54	5.03	1.23
10 poultry manure	2.13	3.17	1.44	83.08	4.04	1.23
10 farm yard manure	1.74	0.88	1.00	86.82	8.11	1.45
5 pig slurry + 5 farm yard manure	2.09	1.82	0.61	84.65	9.21	1.60
5 poultry manure+ 5 farm yard manure	2.01	2.16	1.04	88.91	9.52	1.62
5 cow dung +5 farm yard manure	1.82	1.70	0.92	87.56	6.92	1.08
Control (zero manure)	1.45	1.52	0.48	89.16	10.65	1.74

Zinc and iron which are recognized to be a major nutritional problem

Organic manure gave better quality fruits with less fibre content.

Table 9: ffects of organic manure types on nutrient content of Okro fruit (*Abelmoschus esculentus)*

L.S.D(p=0.05)	**0.57****	**0.62****	**0.44****	**NS**	**NS**	**0.71****

Application of poultry manure at 10 ton/ha recorded fruits with 1.23 % crude fibre and less moisture content (83.08%) compared to control (89.16%). This indicates that organic matter accumulates more dry matter content in fruits. The results obtained are in agreement with those reported by findings of Chaney and Ross (1966).

Based in the post-harvest soil physical analysis Table 3

Table 3: Post Harvest Soil Chemical Analysis

Manure treatments/ Plot (tons/ha)	Ph H_2O	N	OM	P	K	Mg	Ca	Na
		→ % ←			→ CmolKg^{-1} ←			
10 pig slurry	7.02	2.89	10.09	10.40	0.14	1.14	0.35	0.20
10 cow dung	6.90	1.98	10.57	14.72	0.35	0.98	0.52	0.28
10 poultry manure	6.58	4.06	11.17	28.60	0.38	0.28	0.70	0.47
10 farm yard manure	5.63	1.39	2.97	8.35	0.23	0.97	0.48	0.18
5 pig slurry + 5 FYM	7.89	1.34	7.56	8.03	0.09	2.45	0.84	0.14
5 poultry manure+ 5 FYM	6.99	2.22	9.67	20.34	0.23	0.86	0.64	0.36
5 cow dung +5 FYM	7.08	1.11	7.55	12.54	0.30	0.76	0.44	0.19
Control (zero manure)	7.67	0.45	5.63	19.45	0.17	0.45	0.33	0.45

There were increase in the soil pH, indicating that acidity is decreased with different application of organic manure as a result of corresponding decrease in H^+ and AL^{3+} concentration of the soil. The reduction of acidity with organic manure application which agree with Ibeawuchi *et al* (2010) which states that effective applications of organic manure increases soil basic cations and reduces soil acidity.

CONCLUSION

The study revealed that organic manure applications are very essential for enhancing soil nutrient status and increasing yield especially poultry manure. Despite the environmental and other yield constraints encountered by the crop during growth, the overall assessment showed that it is essential to consider the main commercial fraction and quality of the product like the marketable fruit yield in choosing organic manure as a result of this it was investigated that poultry manure performed best than other organic manure applied through all plant characteristics. Thus there is more nutrient release and uptake when a higher dose of a particular manure types is used which lead to higher productivity in terms of fruit yield, leaf productivity and plant growth than its combination with farm yard manure. Based on these results the use of poultry manure is hereby recommended for adoption by our rural farmers for the study area or other environment with similar soil nutrient status.

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PROFITABILITY ANALYSIS OF *IRVINGIA (OGBONO)* KERNEL MARKETING IN OHAFIA AGRICULTURAL ZONE OF ABIA STATE, NIGERIA

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ABSTRACT

Irvingia kernel (Ogbono) has been found to be among the best soup ingredient for the majority of consumers especially in Eastern Nigeria. *Irvingia* kernels form an important part of the West and Central African diet and efforts are geared towards greater domestication of the tree crop. The marketing of this commodity has also assumed a wider dimension locally and internationally. The research study was conducted in Ohafia agricultural zone of Abia state, Nigeria. The sampling frame covered both the retailers and the wholesalers of *irvingia* kernel. Purposive and random sampling techniques were used in collection of the data. Three Local

Governments Areas (LGAs) were purposively selected with 4 markets from each Local Government Area making a total of 12 markets. 6 wholesalers and 6 retailers were drawn from each market making a total of 36 wholesalers and 36 retailers and a grand total of 72 respondents. Data collected were analyzed using Gini coefficient models, cost and returns as well as market performance indicators. From the value of the Gini coefficient obtained for the wholesalers and retailers, the market was strongly competitive with G = 0.16 and 0.18 for wholesalers and retailers respectively. The cost and returns analyses showed higher cost and profit on the side of the wholesalers than the retailers' .Also the market was inefficient as revealed by the level of marketing margin and marketing efficiency indicators. Based on the findings, from the study, it is recommended that socio-economic and marketing infrastructure should be improved upon to reduce the marketing costs. They should also form co-operatives for mutual help and assistance for the marketing activities.

Keywords: structure, performance, irvingia, marketing.

INTRODUCTION

Irvingia kernel (Ogbono) is one of the leading condiments in the Southern and South-Eastern Nigeria (Ndoye,1997). There is increasing demand of *Irvingia* kernel (Ogbono) from pharmaceutical, food and cosmetics industries (Joseph 1995). More so, in most of South Eastern States, it is used as a thickener in making soup used in eating most of our staples, such as garri, yam flour (Amala), pounded yam. And so on. Trading in *Irvingia* kernel serves as a source of income to a large number of stakeholders and so efficiency in marketing activities will enhance returns to these people to boost their livelihood. In the majority of states in the South-Eastern Nigeria which Abia State is part of, Irvingia kernel (Ogbono) has been found to rank among the best as a soup ingredient for majority of consumers. *Irvingia* kernels form an important part of the West and Central African diet, providing carbohydrate and protein (Onyeike 1995).Analysis of the marketing of this commodity is becoming more relevant as a result of the rising importance of the commodity in the economy especially with respect to profitability, market structure and efficiency of the system . Marketing is the performance of business activities that facilitates the flow of food products and services from the point of initial production until they are in the hands of consumers (Kohls and Uhl 1980).Market structure is a term used to refer to all the features that may affect the behaviour and performance of the firms in a market for instance, the number of firms in the market or the type of products they sell (Lipsey and Chrystal, 1995).

Odike (2001), viewed market structure basically in terms of degree of competition, number of buyers and sellers and other factors that determine whether the market is perfectly competitive, pure monopoly, monopolistic competition, oligopoly / duopoly or monopoly. It can therefore be argued that competition in the market is the primary determinant of the market structure (Obasi, 2008). But in the view of Abbott (1993) and Koch (1980) market structure is not only about the size distribution of buyers and sellers in the market but it is also concerned with the entry condition, products differentiation and market information among others. In this context, we analyze structure with respect to the degree of competition in the market. Marketing performance

measures the efficiency with which marketing activities are undertaken. Marketing efficiency is concerned with the effectiveness or competence with which the physical aspects of marketing are performed, as well as the terms of exchange; the degree of competition and responsiveness of the marketing system to the consumer decision (Olukosi and Isitor 1990) .Marketing efficiency also measures the output-input ratio.

The broad objective of this study was to examine the profitability, structure and efficiency of *irvingia* kernel marketing in the zone.

METHODOLOGY

The study was carried out in Ohafia Agricultural zone in Abia State, comprising of five (5) Local Government Areas namely, Umunneochi, Isiukwuato, Ohafia, Bende and Arochukwu Local Government Areas. A multi stage randomized sampling technique was used to select the respondents, the first stage was to select three (3) out of the five (5) local government areas in the zone and Ohafia, Arochukwu and Isiukwuato were selected. The second stage was to select four markets from each local government, giving a total of twelve (12) markets, 2 out of the 4 markets in each of the local government were major markets while the other two were rural markets.6 respondents were selected from each market making total of 72 respondents comprising 36 wholesalers and 36 retailers.

Data collected were analyzed using Gini coefficient model, costs and returns analysis, marketing margin and marketing efficiency. According to Okereke and Anthonio, (1988)

the Gini coefficient model is stated thus;

$G = d / 2y$ Where;

G = ratio

d = coefficient of mean difference of sales

y = mean cash of sales by the marketers

$d = 2\sum^{k} N^{1}(X_i) (1 – N (X_i)) (X_{i+1} - X_i)$

X_i = mean cash of sale of the ith class of marketer

K = number of classes

$N (X_i)$ = cumulative relative frequency of marketers up to the ith class

The model above was also used by Obasi (2008), the value of Gini coefficient ranged from 0 to 1. The nearer the value of G to 1 implied the greater the degree of concentration and vice versa (Okereke, 1978). The marketing margin is given as follows;

$$\frac{\text{Selling price – supply price}}{} \quad X \quad \frac{100}{}$$

Selling price 1

Marketing efficiency = value added by marketing (Net Return) X 100
Total marketing cost 1

RESULTS AND DISCUSSION

Table 1: Computation of Gini coefficient of *Irvingia* kernel

RETAILERS

Source; field survey Data, 2009
Gini coefficient = 0.1821

Table 2 : Computation of Gini coefficient of *Irvingia* kernel

WHOLESALERS

Range of sales (₦) per month	**Freq.**	**Cum freq**	**$N^1(X_i)$ proportion of cum.freq**	**$1-N^1(X_i)$**	**Total value (₦)**	**Mean cash of sales**	**$X_{i+1}-X_i$**	**$N^1(X_i)(1-N^1X_i)(X_{i+1}-X_i)$**
100,100-140,000	5	5	0.14	0.86	628,125	125,625	36,100	4,346.44
140,100-180,000	10	15	0.42	0.58	1,617,250	161,725	41,275	10,054.59
180,100-220,000	11	26	0.72	0.28	2,233,000	203,000	35,800	7,21.28

220,100-260,000	5	31	0.86	0.14	1,194,000	233,800	39,200	4,719.68
260,100-300,000	2	33	0.92	0.08	556,000	278,000	37,000	2,723.20
300,100-340,000	1	34	0.94	0.06	315,000	315,000	41,000	2,312.40
340,100-380,000	1	35	0.97	0.03	356,000	356,000	35,000	1018.5
380,100-420,000	1	36	1.00	0.00	391,000	391,000	0.00	0.00
Total					7,290,375			32,392.09
Mean					202510.42			

Source: field survey data, 2009

Gini coefficient (G) = 0.1600

From Tables 1 and 2, we have the result of the Gini coefficient as calculated which reveals the degree of concentration for wholesalers and retailers in the *irvingia* kernel market. The result shows a Gini coefficient of 0.1600 for wholesalers whereas that of retailers is 0.1821. G ranges from 0 (zero) to 1 (one) according to Okereke (1978), G is zero when there is perfect equality in size of distribution of buyers and is equals one when there is pure monopoly in the market (perfect inequality). These extremes may not be realistic in practice, but G falls between them. The result therefore indicates that irvingia kernel market in Ohafia Agricultural zone is strongly competitive for retailers and wholesalers, since the coefficient is close to zero (0). Also, they are not perfectly competitive since the coefficients are higher than zero but tend towards perfect competition (Obasi, 2008).

Range of sales(N) per month	Freq	Cum. freq	Proportion of cum freq $N1(X_i)$	1-$N^1(X_i)$	Total value of sales(N)	Mean cash of sales	X_{i+1}-X_i	$N^1(X_i)(1-N^1(X_i)(X_{i+1}-X_i)$
23,700-31,750	4	4	0.11	0.89	107,875	26,968.75	9,308.33	911.268
31,800-39,850	12	16	0.44	0.56	435,325	36,277.08	7,897.92	1,946.048
39,900-47,950	6	22	0.61	0.39	265,050	44,175	7,975	1,897.253
48,000-56,050	2	24	0.67	0.33	104,300	52,150	7,860	1,737.846
56,100-64,150	5	29	0.81	0.19	300,050	60,010	7,071.25	1,088.265
64,200-72,250	4	33	0.92	0.08	268,325	67,081.25	6,418.75	472.42
72,300-80,350	1	34	0.94	0.06	73,500	73,500	11,937.5	673.275
80,400-88,450	2	36	1.00	0.00	170,875	85,437.5	0.00	0.00
Total					1,725,300			8,726.393
Mean					47925			

COST AND RETURNS, MARKETING MARGIN AND EFFICIENCY

The average monthly costs and returns of the marketers is shown in Table 3

Table: 3 Cost and returns, marketing margin and efficiency

Item/operation	Retailers (N)/kg	Wholesalers (N)/kg
Average purchase price	7,994.74	34,583.33
Average selling price	13,469.44	42,458.33
Average returns for sales	47,925.00	202,510.42
Variable costs		
Transportation cost	1,332.64	5,328.11
Loading and offloading	31.94	254.72
Feeding cost	1,081.94	1,151.67
Cost of purchase	28,325.00	164,520.85
Total variable cost	30,771.52	171,255.33
Fixed costs		
Store rent	113.89	145.56
Depreciation	46.39	133.87
Total fixed costs	160.28	279.43
Total cost	30,934.8	171,534.76
• **net return (profit) for retailers**	**= 16,990.2**	
• **net return (profit) for wholesalers**	**= 30,975.66**	
• **marketing margin for retailers**	**= 41.05**	
• **marketing margin for wholesalers**	**= 18.55**	
• **marketing efficiency for retailers**	**= 54.92%**	
• **marketing efficiency for wholesalers**	**= 18.06%**	

Source: field survey data, 2009

From the cost and return analysis, a fixed cost of N160.28 gave 0.53% of the total cost of N30, 934.8 and the variable cost of N30, 771.52 gave 99.47% of the total cost. Whereas for the wholesalers, the fixed cost of N279.43 gave 0.16% and the variable costs 0f 171,255.33 gave 99.84%. From the foregoing, it revealed that the variable cost incurred were high compared the fixed costs. The net returns for the wholesalers and retailers gave N30, 975.66 and N16, 990.2 indicating that the business is profitable. The marketing margins were high for both wholesalers and retailers showing market price inefficiency. The acceptable marketing margin for storable commodities is 5% and 10% for perishable commodities (Scarborough and Kydd 1992). The marketing efficiency for retailers gave 54.92% while that of the wholesalers gave 18.06%. The result shows that the retailers enjoy more efficient marketing

per unit of the commodity than the wholesalers. According to Kohls and Uhl (1980), a higher value of the ratio of efficiency indicates improved marketing efficiency and lower value denotes reduced efficiency. But according to Kydd (1992), if the ratio is less than 100% there is inefficiency. Generally the marketing system was relatively inefficient.

CONCLUSION

The result of analyses showed that the market was profitable, competitive in terms of sales but with some level of inefficiency, characteristic of most agricultural markets in developing countries. From the performance of the marketers, it is obvious that the business is profitable with respect to the level of inputs-output relationship and people are encouraged to exploit the business opportunities in it. The transaction costs incurred in marketing the commodity appeared to have influenced the marketers' selling price and thus the marketing margin. There is need for provision of social and marketing facilities to reduce the attendant cots. More research enlightenment on the various uses of *irvingia* kernel should be done to increase its performance in the local, regional and international market

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Glyphosate exposure; Its toxicological effects on Giant African Snail *Archachatina marginata*

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Abstract
Studies were conducted to investigate oxidative stress following glyphosate exposure in a terrestrial snail (Archachatina marginata). In the work, 24 matured snails were exposed to different concentrations (0, 10, 15 and 20ml) of glyphosate for a period of one month where 0ml serves as control. Six snails were not exposed and they were used as control. The antioxidant reduced glutathiones (GSH), oxidative parameter, malondialdehyde (MDA), catalase (CAT) superoxide dismutase (SOD) and total protein were measured in snail exposed and unexposed to glyphosate. Data obtained were subjected to analysis of variance (ANOVA) The parameters investigated showed that glyphosate application caused a significant increase in lipid peroxidation marker (malondialdehyde MDA), catalase and superoxide dismutase. There was a decrease in glutathione and total protein content compared to the control. The study suggests that the redox potential of glutathione in snails was disturbed as a result of its exposure in all the concentrations of glyphosate. This also confirms the fact that glyphosate application in agricultural soil enhanced oxidative stress in snails, which strive freely in it. All these observations could lead to death of cells, damage to DNA and possible extinction of important species in the environment
Key; Mollusc, Agricultural soil, Toxicity, glyphosate

Introduction

Glyphosate usage has made enormous contribution in agricultural productivity. Its consumption was encouraged in many countries because of its effectiveness in eradicating unwanted weeds in both agricultural and nonagricultural landscape. Glyphosate as a broad spectrum, nonselective systematic herbicide is effective in killing mostly annual, perennials and woody plants in agricultural areas (Hart and Wax, 1999; Yaacoby, et al 1996). It has also been proven effective in controlling plants on the surface of aquatic environment (Nelson et al 2001) product of food crops like soya beans, corn hay and pasture (Owen, 2000).

Glyphosate is very polar substance, highly soluble in water and insoluble in some organic solvents (Veiga et al., 2000). It is moderately persistent in soil with reported half-lives ranging from 1 to 174 days Wauchope et al., (1992). However, glyphosate can be degraded by soil microbes to aminemethylphosphonic Acid (AMPA), Rueppel et al., 1977. The irrational use of glyphosate in agriculture due to its

efficiency in eradicating unwanted weeds have caused environmental pollution and potential biological effects. Exposure to pesticides generally have been reported to produce reactive oxygen species (ROS) leading to increase oxidative stress and free radical which damage the cell components which include proteins, lipids and DNA in animals (Martignoni et al 1999) Different antioxidant parameters like antioxidant enzymes which include superoxide dismutase, glutathione and catalase are commonly used to assess exposure to xenobiotics in animals. (Pichaude et al., 2008). A number of studies reported an increase in superoxide dismutase and catalase activity when an excess of reactive oxygen species (ROS) was observed in bivalves. (Cheung et al., 2004; DiGiulio et al.,1989). Malondialdehyde (MDA) is one of the final products of the membrane fatty acid – reactive substance (TBARS) and is considered as a good biomarker of lipid peroxidation, and consequently of oxidative stress.

Archachatina marginata, a terrestrial mollusk, nocturnal in nature and virtually feeds on vegetables, fruits, dead and decaying plants (Ebiloma et al 2009). The *A. marginata* is consumed in many countries including Nigeria because of its protein, iron, fats and amino acid content (Cobbinah, 1992) *Archachatina marginata* is known to strive in agricultural soil with their foot where these chemical substance is applied. Hence the objective of this work was to assess the oxidative stress imposed on this specie of snail due to its exposure to glyphosate.

Materials and Methods
Field Sampling

Snails (*Archachatina marginata*) were procured from Songhai Redemption farms Nekede Owerri Nigeria and were housed in a plastic cage that was screened with mosquito net (Cobbinah 1994). Upon arrival, the snails were allowed to acclimatize for 7 days while being maintained on a regular feed diet of vegetable and fruits. Distilled water was provided and sprinkled on the snail every evening.

Soil samples used for this study was collected from unpolluted arable soil at the depths of 0 – 15 cm. The samples were air-dried at room temperature, after they were sieved using a 2 - mm sieve were used for this study.
Glyphosate used in this study was procured from an Agro-chemical store at Ekeonunwa market in Owerri Nigeria.

Experiment
Different volumes of (5, 10, 15, 20 ml) of glyphosate were measured out and poured into the perforated plastic bucket, which contains 20 g of unpolluted arable soil. This was thoroughly mixed into a fine mixture.
After one week, the snails were transferred into the mixture of soil and glyphosate in a perforated plastic bucket and also fed with usual diet. After the 2 week treatment, the animal were sacrificed and the snail tissues were collected for measurement of reduced Glutathione levels Malondialdehyde, Catalase, Superoxide dismutase and protein content.

Live body weight of the exposed and unexposed snail (*Archachatina marginata*) were measured at interval of 7 days using an electronic weighing balance.

Biochemical Assay

Snail tissues were homogenized in potassium chloride (KCl), phosphate buffer (1.15%) with EDTA pH 7.4 and the homogenate was centrifuged for 12000 X g for 60 mins at 4 ^{O}C. The supernatant was then used immediately for measurement of marker enzyme Superoxide dismutase (SOD), catalase (CAT), reduced glutathione (GSH), malondialdehyde (MDA), and protein/

Statistical analysis

Data collected were analyzed for statistical difference using analysis of variance, and as outlined by Obi (1990) and the significant difference were separated among means using SAS statistical software (SAS, 2003)

Results

Weight of *Archachatina marginata* exposed and unexposed to glyphosate

The weight of *Archachatina marginata* exposed and unexposed to glyphosate for the period of 28 days are shown in Figure 1. The result obtained from the exposed samples showed decrease in weight of snails in the exposed compared to the unexposed

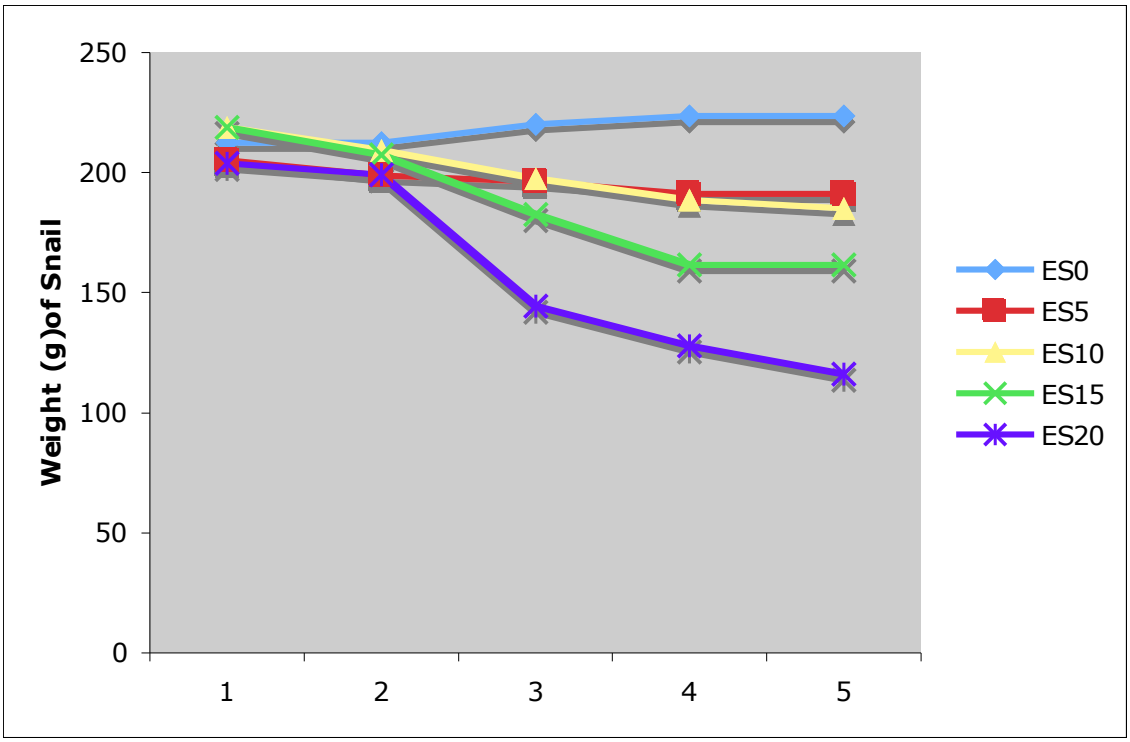

Figure I; The weight of *Archachatina marginata* exposed to Glyphosate.

Table 1; Effect of glyphosate on SOD, MDA, CAT and GSH activities of *Archachatina maginata*

n = 5

	SOD	MDA	CAT	GSH
T_0	7.606 ± 0.42	$1.25x10^{-8}$ ±$1.80x10^{-9}$	73.3 ±4 4.31	214.19 ±12.71
T_5	8.85 ± 0.92	1.35 $x10^{-8}$±1.91 $x10^{-9}$	74.75 ±3.39	182.29 ±36.77
T_{10}	10.150 ± 1.06	$1.40x10^{-8}$±0.595 $x10^{-9}$	84.29 ±6.10	168.29 ± 26.95
T_{15}	12.50 ± 0.21	1.97 $x10^{-8}$±2.53 x 10^{-9}	110.59± 5.54	111.34 ±32.3
T_{20}	11.77 ± 0.27	2.17 $x10^{-8}$±2.39 x 10^{-9}	121.31 ± 4.63	98.31 ± 29.3

Legend:

MDA Malondialdehyde

CAT Catalase

SOD Superoxide dismutase

T0 = Control

T5 = Exposed 5ml of glyphosate

T10 = Exposed 10 of glyphosate

T15 = Exposed 15 of glyphosate

T20 = Exposed 20 of glyphosate

Table 1 shows the effect of different concentration of glyphosate on antioxidant enzyme of an African snail *Archachatina marginata*. Apparently, Malondialdehyde (MDA), Catalase (CAT) and Superoxide dismutase (SOD) increased in values and the values increased with increase in concentration of glyphosate. On the other hand, glutathione and superoxide dismutase content reduced in values even as the concentration of glyphosate increased.

Protein content of *Archachatina marginata* exposed to different concentration of glyphosate is shown on Fig 2. The result obtained showed that protein content of *Archachatina marginata* decreased with increase concentration of glyphosate.

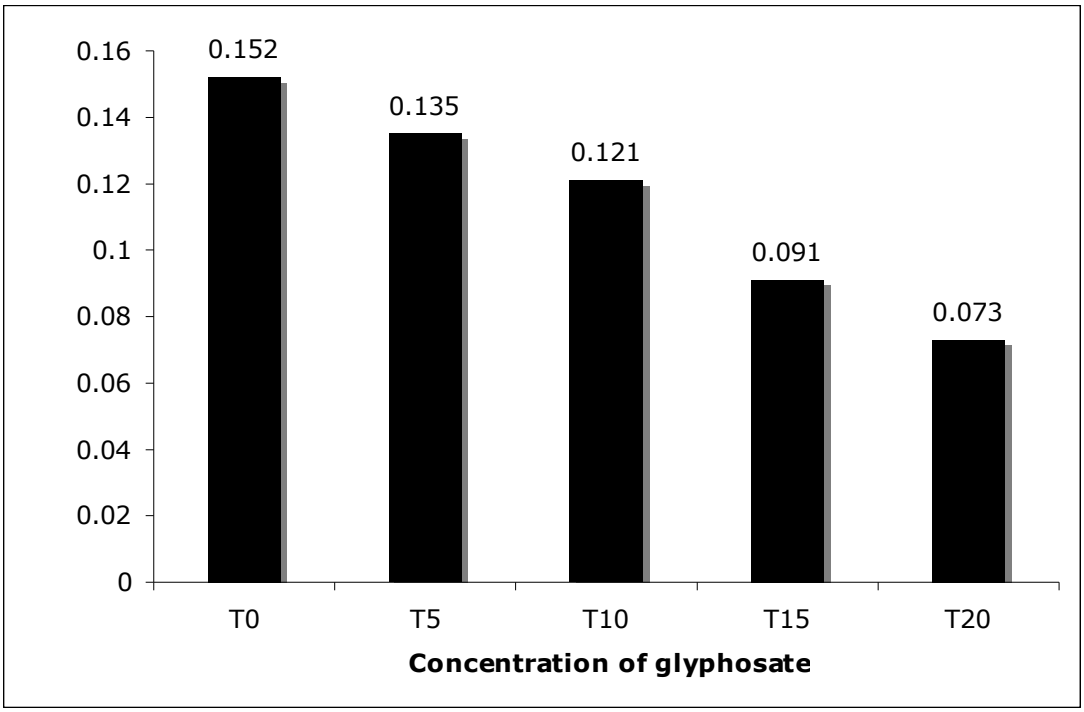

Figure 2; Protein content of *Archachatina marginata* exposed to glyphosate

Discussion

Aspects of toxicological effects of glyphosate on an important species like *Archachatina marginata* pose challenges and it is difficult to monitor because of the environment where it inhabits. *Archachatina marginata* exposure to glyphosate showed decrease in body weight compared to the one that is unexposed. It was also observed that the rate of reduction in the body weight observed in *Archachatina marginata* exposed to glyphosate could be attributable to behavioural changes which must have reduced its intake of food. Bolognesi et al., (1997) also reported similar finding when he exposed laboratory animals (Rats) to glyphosate.

This study revealed increase in Malondialdehyde (MDA) level in *Archachatina marginata* exposed to glyphosate (Table 1). Malondaldehyde (MDA) concentration increases when stress overwhelms the antioxidant system Aust et al., (1985). Oxidative stress can lead to cell and DNA damage caused by lipid peroxidation which can be assessed by the level of malondialdehyde. (George, 1979). Therefore toxic effect of glyphosate on snail can be confirmed by direct measurement of lipid peroxidation by-products Malondialdehyde (MDA) (Feng et al., 1997). This may also suggest that glyphosate induced oxidative stress through the generation of free oxygen radicles leading to lipid peroxidation and DNA damage (Abdollahi et al 2004). Increase in level of superoxide dismutase (SOD) as well as catalase (CAT) enzyme was observed in this study. Viarengo et al., (1990) made a similar observation when he exposed *mylitus galloprovincialis* to heavy metals. (Pichaud et al., 2008) reported that superoxide dismutase work in association with the catalase CAT, both of the showing the same trend. Oxidative stress result in increase level of catalase activity, an antioxidant enzyme used by the organism to detoxify cells, (Pellerin-Massicotte 1997).

It was also observed that glutathione content of the snail reduced with increase concentration of glyphosate in the tissue of *Archachatina marginata* exposed to glyphosate compared to the unexposed (control). Glutathione depletion could be related to its involvement in the detoxification of the deleterious effect of increase free radical produced within the cell, (Hassan, 1978). Ugochukwu and Babady (2002) reported that reduced glutathione depletion renders the animal more susceptible to free radical – mediated damages especially the damage induced by cellular lipid peroxidation. Droge, (2002) reported that glutathione in nucleus maintains the redox state of critical protein sulphydryls that are necessary for DNA repair and expression. Result obtained from this study showed a decrease in glutathione level in exposed snail. This implies that the rate of maintenance in redox state of a critical protein sulphydryls are impaired, affecting DNA repairs and expression. Decrease in protein content of *Archachatina marginata* exposed to glyphosate observed in this study could be attributed to the measure of its food intake. Protein contain in snails have been reported to be the pivot around which other snail nutrient requirement revolve (Ebiloma et al., 2009). Protein nutrient is known for its growth promoting potentials while

carbohydrates and oils are rich in calories. Snails eat to meet their protein requirements but because the did not feed very well due to exposure their protein content was reduced

Conclusion

From the results obtained, it can be concluded that *Archachatina marginata* exposed to glyphosate had triggered responses of the biomarkers in them. These antioxidant enzyme including superoxide dismutase, malonaldehyde and catlase which are used as biomarkers of oxidative stress were affected through increase in the levels of these enzymes above the normal levels in the organism. This work has highlighted the physiological and biochemical responses of terrestrial snail facing challenges of environmental toxicant like glyphosate. Because of the physiological effects arising from the exposure to glyphosate, organisms may suffer physiological health condition and the may be possible extinction of such an important organism.

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RESOURCE PRODUCTIVITY AND RETURNS ON YAM PRODUCTION IN KADUNA SOUTH LOCAL GOVERNMENT AREA OF KADUNA STATE, NIGERIA.

BY

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ABSTRACT

Production of abundant food crops is one of the ways in which hunger and poverty can be reduced in Sub-Saharan Africa to meet up with the ever increasing population. However, the problems of resource allocation and availability of these resources coupled with harsh weather conditions have continued to reduce the yield and profit margin of most small scale farmers who are the major stake holders of agricultural production. This study analysed resource productivity and returns on yam production in Kaduna South Local Government Area of Kaduna State. Data were collected with the aid of structured questionnaire from one hundred (100) yam farmers. Descriptive statistics, Net farm income, production function and marginal productivity to marginal factor cost ratio were used for the data analysis. The results showed the total cost incurred by yam farmers in the study area as ₦ 40, 592.80 per hectare, while their total income was ₦89, 657.30 indicating a net profit of about ₦ 49, 064.50 per hectare. Also, the benefit cost ratio on yam production was 2.2 while the rate of return on every one naira invested was ₦ 1.21. Double log production function was chosen as the lead equation with R^2 value of 0.213. The regression analysis shows that coefficients of farm size, yam sett and fertilizer were significant and positively contributed to the output of yam among farmers in the study area. Although the result of the net farm income showed positive returns from yam production by the farmers however, the resources (farm size, yam sett and fertilizer) used in its production were under-utilized based on the ratios of the marginal value product to marginal factor cost of these input resources that were greater than one. Insufficient fund, high cost of fertilizer, low farm gate price were among some of the numerous problems faced by yam farmers in the study area. It was recommended that farmers should form co-operative society in order to access loan easily from the banks as this will empower them to have access to and use the right quantity of production resources which would increase their productivity.

KEYWORDS: Resource, Productivity, Returns, Yam

INTRODUCTION

In spite of the dominance of crude oil in the economy, agriculture is still the mainstay of Nigerian economy as it provides majority of its population with employment, source of raw materials for industrial sector and stable food for the ever growing population (Orewa, 2004). One of the key elements to a meaningful and sustainable economic growth and development is growth in agricultural sector through abundant food production for consumption and export. Food production must be consistently well above demand to bridge short falls. Olukosi (1999) opined that access to adequate food by all members of the household and the entire nation at large at all times, for the maintenance of a healthy and active life is one of the major ways of combating food insecurity in many part of the world. The concept of "access" to food according to Olukosi (1999) implies the ability of a household to procure food not by begging but through food production, purchases and gathering from the forest or hunting. Food adequacy on the other hand implies quality as well as quantity and cultural acceptability of food for consumption so as to satisfy nutritional needs of different members of household for active and productive life for the creation of national wealth. Of recent, the challenge to increase the efficiency in food production level in Nigeria appears more urgent now than it has ever been in the history of the country probably due to the continuous population increase.

Over the years, yam has become an important tuber food crop in the diet of most Nigerian. Studies by Okwor *et al,* (2005) revealed that Nigeria is the world largest producer (25.2 million metric tonnes) and consumer of yam. A recent study by FAO (2006) as reported by Ogbonna *et al,* (2009) also showed that Nigeria ranked top with annual production of 36.76 million metric tonnes. However, in spite of Nigeria position in the world production of yam, the domestic supply is yet to meet the local demand due to low yield occasioned by the inefficiency in the utilization of production factors (Ugwu, 1990, Fasasi, 2006, Awoniyi and Omonona, 2006). The problems with yam production in terms of input requirements and policies on food in Nigeria are complex. These according to Ogbonna *et al,* 2009 have resulted into shift to cheaper food staples like cassava, sweet potato and cocoyam. Other factor that is of great importance in the production of yam is climatic factor. Climate varies considerably by localities because of differences in altitude, prevailing wind, elevation, proximity to large bodies of water and nature of ground cover (Oyemakin *et a*l, 2009).

The concept of efficiency in farm resource according to Balogun *et al* (2009), Effiong and Idiong (2008) is concerned with relative performance of processes in transforming a given input into output and this can be measured from production and profit function approach. Productivity of any resource can be defined in terms of a combination of resource or individual

resource used (Odii and Nwosu, 1996, Okoye *et al*, 2008). It therefore implies that if the desired increase in food productivity and food security in Nigeria and Africa at large is to be ensured, there must be further research into appropriate means of resource allocation among small farm holders who are the major stake holder of agricultural production in Nigeria. In view of this, the study was designed to examine the costs and returns, resource use efficiency and the problems associated with yam production in Kaduna South Local Government area of Kaduna State Nigeria.

MEHODOLOGY

The study was conducted in Kaduna South local Government area of Kaduna State. Kaduna State is located between latitude 9^o N and 12^o N and longitude 6^o E and 9^o E of the prime meridian. It has a population of about 6,066,562 people (NPC, 2006). Farming is the major occupation among its rural populace growing such crops as maize, sorghum, millet, soy bean, groundnut, coco yam, cassava, and yam. The major livestock include sheep, goat, cow and poultry. Systematic random sampling was adopted in the selection of one hundred farmers used for this study. The first stage involved identification of yam farmers through the extension agent in the study area; this was followed by grouping of the farmers into five units and random selection of twenty farmers each from each unit. The primary data used was obtained through the use of well structured questionnaire and interview schedule administered on the respondent. Data collected were analysed using descriptive statistics, production function, net farm income, ratio of marginal productivity to marginal factor cost and profitability index ratio. The net farm income technique was used to determine cost and returns hence profitability of yam production among farmers in the study area. Specifically, the model is specified as:

NFI = TR –TC ----------1

TC = TVC+TFC----------2

Where

NFI = Net Farm Income

TR= Total return (₦)

TC= Total cost

TVC = Total variable cost (₦)

TFC = Total fixed cost (Fixed cost depreciation value)

To obtain the annual value of the fixed inputs used in the production of yam, the cost was depreciated using the straight line depreciation method. The depreciation model is as follows:

Depreciation = $\frac{P-S}{L}$ ----------3

Where:

P= Cost price

S= Salvage value

L= Useful life

The financial success or profitability of yam production was determined through the values of operating ratio, benefit cost ratio and rate of return ratio. The models for these ratios are:

OP = $\frac{GI}{TVC}$, BCR = $\frac{GI}{TC}$ and RRR = $\frac{NFI}{TC}$ ----------4

Where

OP = Operating ratio,

GI = Gross income

BCR = Benefit cost ratio

RRR = Rate of return

Resource use efficiency with respect to each input used in yam production was computed. The first step to the computation involved the estimation of the coefficient of the input resources using the ordinary least square (OLS) regression method. This was followed by the determination of the marginal value product for each resource which is the product of marginal physical product (MPP) and the price of output. Three functional regression forms were tried and Cobb-Douglas production function gave the best fit hence was selected based on the magnitude and the appropriateness of signs of the estimated regression coefficients, magnitude of the coefficient of multiple determination (R^2), significance of the estimated coefficients (t-test) and the value of the overall significant (F-test).

The explicit forms of the production function and marginal productivity models as used by Gujarati (2005) are given as:

$Y = a + b_1X_1 + b_2X_2 + b_3X_3 + b_4X_4 + b_5X_5$ (Linear) ----------5

$LogY = a + b_1X_1 + b_2X_2 + b_3X_3 + b_4X_4 + b_5X_5$ (Semi-log) ----------6

$LogY = a + b1\log x_1 + b_2\log X_2 + b_3\log X_3 + b_4\log X_4 + b_5\log X_5$ (Double-Douglas) - -7

$r = \frac{MVP}{MFC}$ ----------8

MVP = MPP×py ----------9

MPPxi = bi (Linear) ----------10

MPPxi = $\frac{b_i}{\bar{x}}$ (Semi-log) ----------11

MPPxi = bi $\frac{\bar{y}}{\bar{x}}$ (Cobb-Douglas) ----------12

Where

Y = Yam output (kg)

X_1 = Farm size (ha)

X_2 = Yam sett (kg)

X_3 = Fertilizer (kg)

X_4 = Pesticide (li)

X_5 = Labour (Man-day)

a = Constant

b_1-b_5 = Estimated coefficient

e = error term

r = Efficiency ratio

MVP = Marginal value product

MFC = Marginal factor cost

MPP = Marginal physical product with respect to input $i^{th,}$

py = Unit price of output

bi = Coefficient with respect to each resource and $\bar{x}$ and $\bar{y}$

r >1, r < 1 and r =1 indicates underutilization of resources, overutilization of resources and optimum use of resources respectively.

RESULTS AND DISCUSSION

Costs and Return Analysis

The cost and return analysis of yam production is shown in Table 1.The total variable costs incurred on planting material, fertilizer, pesticide, transportation, labour and harvesting was ₦37, 392.80, while the fixed cost was N3, 200.00. Therefore, the total cost incurred per hectare was ₦40, 592.80. As also indicated in the Table, the variable costs constituted the major (92.12%) cost with the cost of fertilizer accounting for the highest (36.95%) cost of yam production in the area. Total revenue of ₦89, 657.30 per hectare was realized per farmer with a gross margin of ₦52, 264.50 and a net farm income of ₦49, 064.50. This implied that yam production is profitable among farmers in the study area. The cost and benefit as well as rate of return ratios of 2.21 and 1.2 respectively obtained by farmers' shows that every one naira invested on yam production yielded an additional ₦2.2 and ₦1.2 revenue respectively indicating further that yam production is profitable among farmers in the study area.

Table 1: Costs and Return analysis of Yam farmers in the study area

Item	Mean Cost/Revenue (N/ha)	Percentage
Variable Cost		
i. Labour	13, 500.00	33.26
ii. Fertilizer	15, 000.00	36.95
iii. Pesticide	750.00	1.85
iv. Transportation	3, 688.40	9.09
v. Yam sett	1, 500.80	3.70
vi. Harvesting	2, 953.60	7.28
Total Variable cost	37, 392.80	92.12
Fixed Cost		
i Economic rent of land	2, 000.00	4.93
ii Depreciation on farm tools	1, 200.00	2.96
Total Fixed Cost	3, 200.00	7.88
Total cost	40, 592.80	
Gross Income	89, 657.30	

Gross Margin	52, 264.50
Net Farm Income (Net profit)	49, 064.50
Benefit Cost Ratio	2.21
Rate of Return Ratio	1.21
Operating Ratio	0.42

Source: Field, Survey, 2008

Regression Analysis

The estimated coefficient of the resources used in yam production is presented in Table 2. Cobb-Douglas production function was chosen as the lead equation based on the magnitude of coefficient of multiple determinations (R^2), the value of F-statistics, the number and signs of significant variables. It has an R^2 value of 0.213 which implied that 21.3% of the variation in yam output was explained by the variables included in the model. The F-statistics was significant at 1% which implies that collectively, the independent variables significantly explained variation in the total yam output. The regression result also shows that the coefficient of farm size, yam sett and fertilizer contributed positively to the output of yam and were significant at 10%, 1% and 10% respectively. The significance of fertilizer input may be due to the fact that it is a major land augmenting input that helps to improve the productivity of land thus increasing yam yield per hectare

Table 2: Ordinary Least Square Regression Estimates of Yam Farmers

Variable	Linear	Semi-log	Cobb-Douglas
Constant	2087.34 (2.536)**	-4521.09 (-1.456)	6.59 (10.059)***
Farm size	374.76 (1.353)ns	852.00 (2.220)*	0.177 (2.188)*
Yam sett	104.48 (1.093)ns	1177.89 (3.367)***	0.221 (2.997)***
Fertilizer	3.49 (3.231)***	970.661 (2.324)*	0.184 (2.094)*
Pesticide	-106.59 (-0.775)^{ns}	-393.58 (-0.715)^{ns}	-0.061 (-0.527)^{ns}
Labour	-0.28 (-0.281)^{ns}	-43.08 (-0.154)^{ns}	-0.005 (-0.78)^{ns}
R^2	0.177	0.186	0.213
R^{-2}	0.133	0.143	0.171
F-statistic	4.046	5.089	7.31***

Source: Field Survey, 2008 *, **, *** = Significant at 10%, 5% and 1% respectively. Ns = not significant

Resource Use Efficiency

The efficiency of farmers in the area of resource use was determined through the ratio of MVP to MFC and is shown in Table 3. All the significant variables (farm size, yam sett and fertilizer) of the lead equation examined have resource use efficiency indexes that were greater than unity value. This shows that these resources were underutilized by the farmers in the study area. The result implies that yam farmers in the study area have inadequate knowledge of resource allocation with respect to the crop because they did not attain optimum use of any of the resources. Therefore, for farmers in this area to reach the optimum production level, the resources underutilized should be increased. Fasasi (2006) and Awoniyi and Omonona (2006) in their separate study on production efficiency in yam enterprise in Ondo and Ekiti State Nigeria respectively opined that inefficient resource allocation could limit the level of returns to the enterprise.

Table 3: Resource use efficiency of yam farmers in the study area

Resource	bi	MPPx	MVP	MFC	r
Farm size	0.177	488.503	29,190.18	2000	14.60
Yam sett	0.221	38.023	2,281.30	10.00	28.13
Fertilizer	0.184	2.014	120.84	100	1.21

Source: Field Survey, 2008

Problems of yam production

The problems associated with yam production in the study area are shown in Table 4. As indicated in the Table, insufficient funds was the foremost (70%) problem faced by the yam farmers followed by high cost of fertilizer (61%), high cost of labour (59%) and low farm gate price (56%). Studies by Usman *et al* (2009) on economic efficiency of yam production in Oyo state also revealed that inadequate fund, incidence of pest and diseases, low farm gate price as well as bad road were the major factors affecting yam production in Nigeria. Adequate fund availability is a necessary resource that can enhance effective utilization of production resources in terms of using the recommended quality and quantity of these resources hence increasing the level of resource productivity. Also when farmers are empowered with enough fund for agricultural production, the problem of low farm gate price for their produce will be minimised because farmers may not be prompt to sell their produce at all cost immediately after harvest.

Table 4: Problems of Yam production in Kaduna South Local Government Area

Problem	*Responses (n=100)	Percentage	Rank
Insufficient fund	70	70	1st
High cost of fertilizer	61	61	2nd
High cost of labour	59	59	3rd
Low farm gate price	56	56	4th
Inadequate storage facilities	45	45	5th
Pest and diseases	35	35	6th
Poor roads	20	20	7th
High cost of pesticides	18	18	8th

Source: Field Survey, 2008 * = Double Response Observed

CONCLUSION AND RECOMMENDATION

Despite the inefficient utilization of resources used by yam farmers occasioned by constraints such as insufficient fund, high cost of fertilizer and low farm gate price, yam production was found to be profitable in the area of study. However, if an optimum production is to be attained by the farmers, there is need to strengthen the production capacity of these farmers by encouraging them to form cooperative society as this will allow them have access to bank loan easily. This in turn will empower them have access to better resources for improved productivity.

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THE USE OF INFORMATION AND COMMUNICATION TECHNOLOGIES (ICT's) AMONG EXTENSION OFFICERS IN ABIA STATE, NIGERIA

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ABSTRACT
The study investigated the use of ICT's among Extension Officers in Abia State in 2009. Purposive and multistage random sampling techniques were used to select seventy five (75) ADP Extension Officers. Data were collected through a well structured questionnaire and analyzed using frequency, mean counts, percentages and chi-square analysis. Results showed that 58.7 percent of the respondents were between 41-50 years of age, 77.3 percent males, 99.3% had higher education and Job experience, (93.3%) between 11-30 years. The result also indicate that the Extension Officers frequently utilized Radio (X=2.54), mobile phone (X = 2.40), Television (X = 2.33) and Desk Top public ship (X = 2.14) in extension delivery. Furthermore, majority of the respondents used ICT's in communicating with donor agencies (96.0%), circulating correspondence (93.3%), Farm planning, monitoring and evaluation (88.0%) writing of reports/ scientific papers (86.4%), organizing field days (74.7%) and conducting OFAR/Trials (73.3%). Chi-square analysis revealed a significant relationship between Education and use of ICT's by Extension Officers (X^2 = 10.03 p<0.01). Adequate training of staff and subsidy on ICT equipment are advocated to enhance extension delivery.

Key words: Innovation, *Information and Communication Technologies Extension Officers,* Southern Nigeria.

INTRODUCTION

Technical information become useful when it circulates and reaches the people who need it. The advent of ICT's put researchers on a better position to perform greater roles in global science,

stay informed and be ready for exchange of views (Fagbola and Adebasi, 2007). According to Nwachukwu (2003), the rapid advancement of new technologies had done much to change the way in which scientific and technical information (STI) is produced and disseminated. Winrock (2003), defined information and Communication Technologies as the combination of hardware, software and the means of production that enable the exchange, processing and management of information knowledge. The information needs of small scale farmers are extension education, agricultural technology, agricultural credit and marketing. Most of the technology generated by the research institutes and universities may not get to the farmers without adequate information dissemination. Print media such as leaflets, newsletters, Posters, exhibits, visual aids and radio programmes are valuable tools in communicating agricultural information, (CTA, 2003). Omotayo (2005) observed that the use of ICT in extension became necessary in view of users demand for effective and appropriate extension delivery, dwindling government budget and advances in telecommunication. Agumagu *et al* (2008), opined that the categories of persons that require access to information technologies for proper direction are the extension managers and supervisors. They know enough to influence decisions in their organization. Arokoyo (2005) identified potentials of ICT communication in extension service delivery to include need assessment, exploring alternative production alternative, peer to peer sharing and exchange of information, early warming for disasters, training and demonstration techniques. Munyua (2000), reported that ICT had played a major role in diffusing information to rural communities and showed even much unexpected potentials. In thus regard it is established that wide diffusion and adoption of proven technologies/practices is a function of adequate information which has to be effectively disseminated, so the target beneficiaries received the information, understand and regard it as a basis for action (Mohamned and Wana, 1993). However, effective delivery of technologies is dependent on the appropriate use of ICTs by the extension practitioners.

It is against this background that this paper assessed the use of ICT's among Extension officers in Abia State.

The specific objectives of this paper were to:
(i) examine the socio- economic characteristics of the respondents.
(ii) Identify the types and frequency of use of ICT's by the respondents.
(iii) determine the uses of ICT in extension delivery
(iv) determine the relationship between the socio-economic characteristics of the respondents with the use of ICTs
(v) describe the constraints to using ICT's by the extension officers.

Hypotheses Tested

H_1: There is no significant difference between the socio-economic characteristics of respondents with the use of ICT's.

$H_{2:}$ There is significant difference between the socio-economic characteristics of respondents with the use of ICT's.

METHODOLOGY

The study was conducted in Abia State. Abia State Agricultural Development Programme (ADP) which has three (3) Agricultural zones namely, Umuahia, Ohafia and Aba were purposively chosen because of its responsibility in public extension delivery. Multistage random sampling technique was used in the selection of Extension Officers comprising Director of Extension, zonal managers, zonal Extension Officers, subject matter specialists, Block Extension supervisors and Extension agents. First, five (5) blocks were randomly selected from the three (3) agric. Zones which gave a total of fifteen (15) blocks. Also, five (5) Extension Officers each were randomly selected from the fifteen (15) selected blocks and this gave a grand total of seventy five (75) extension officers. Objectives I, III and V were achieved using descriptive statistics such as frequency, percentage, tables and mean counts, while objective II was using likert type of scale. This is to determine the magnitude of responses and value assigned to the respondents (Adejoh *et al*, 2006). Always = 3, occasionally = 2 and Never = 1

$$\text{Mean Score} = \frac{\text{Total number of scores}}{\text{Total number of respondents}}$$

Objective IV was also achieved using chi-square Analysis.

The formular for computing Chi-square is given as follows:

$$X^2 = \sum \frac{(Fo-Fe)^2}{Fe} \quad \text{---------- (1)}$$

Where X^2 = Chi- square

Fo = Observed frequencies in each cell

Fe = Expected frequencies in each cell

$\sum$= Summation sign

To calculate the expected frequency (Fe)

$$Fe = \frac{F \times C}{N} \quad \text{----------(2)}$$

Where R = Row total, C = Column total, N = Number of cases

Degree of freedom = (r-1) (c-1)

RESULTS AND DISCUSSION

Socio-Economic Characteristics of Respondents

Table 1 presents data on selected socio-economic characteristics of respondents. Results indicate that majority (58.7%) of the respondents fall

within 41-50 years. This indicates that active and innovative age category of respondents are involved in extension delivery in the state. Also, majority (64.0%) of the respondents are married. cumulatively, 99.3% of the respondents had higher education ranging from OND to MSc. The higher leveler educational attainment may encourage and influence the use of ICTs. Furthermore, majority (93.3%) of them had been working for over 10 years. this shows that a high proportion of the extension officers are experienced and likely to appreciate the use of ICT's in extension delivery.

Table 1: Distribution of Respondents According to Socio- Economic Characteristics. (N- 75)

Variables	Frequency	Percentage
Age,(years)		
30- 40	18	24.0
41- 50	44	58. 7
51- 60	13	17.3
Sex		
Male	58	77.3
Female	17	22.7
Marital Status		
Married	48	64.8
Single	27	36.0
Education Attainment		
WASC/ GCE/ NECO	1	1.35
OND	18	24.0
HND	28	37.3
BSC	7	26.8
MSC	1	9.3
Working Experience (years)		
1- 10	5	6.7
11- 20	38	50.6
21 -30	26	34.7

31- 40	6	8.0

Source: Field Survey, 2009

Extension Officers Frequent Use of ICT's

Table 2 presents data on respondents frequent use of different types of ICT's. The mean score of 2.54 out of a maximum of 3 indicates well utilized. It implies that respondents use radio effectively. This is in agreement with the work of Agade (2003), that radio is highly utilized by extension agents in extension delivery. Mean score of 2.4 (Mobile Phone) 2.33 (Television) and 2.14 (Desktop) indicate that they are sufficiently utilized in communicating agricultural information to farmers. The study also reveals that fax, internet /E-mail and CD-Rom with mean scores of 1.13, 1.49 and 1.32, respectively were used insufficiently. Aderinto *et al* (2003), states that many people were unable to utilize the whole range of ICT's equipment because of high cost.

Table 2: Mean Score Distribution of ICT Types and Use among Extension Officers in Abia State.

ICT Types	Never 1	Occasionally 2	Always 3	Total No of respondents	Total of scores	Mean scores
Radio	0	34	41	75	191	2.54
Television	0	56	25	75	175	2.33
Mobile Phone	8	29	38	75	180	2.40
Fax	70	0	5	75	85	1.13
Internet/Email	44	25	6	75	112	1.49
Desk Top Publishing	13	38	24	75	161	1.14
CD –Rom / Flash	56	12	3	75	99	1.32

Source: Field Survey, 2009

Uses of ICT's in Extension Delivery

Table 3 shows the various uses of ICT's in Extension delivery. It indicates that out of twelve (12) reasons identified, six (6) ranked highest. These include: Communicating with donor agencies (96.0%), circulating correspondence (93.3%), farm planning, monitoring and evaluation (88.0%), writing of scientific papers /reports (86.4%), organizing field days (74.7%) and conducting of OFAR/Trials (73.3%). The other reasons indicated were, keeping records. (69.3%) staff training (56.0%), personal uses (54.7%), extension administration (46.7%), computing filed results (42.7%), and sourcing of grants (41.3%). This result is in line with the findings of Agumagu *et al* (2008), where majority of the extension officers identified these major areas in extension delivery.

Table 3: Distribution of Respondents According to Extension Delivery

USES	Frequency	Percentage	Ranking
1. Circulating Corresponding	70	93.3	2nd
2. Conducting OFAR/Trials	55	73.3	6th
3. Writing of Scientific papers	65	86.7	4th
4. Staff training	42	56.0	8th
5. Communicating with Donor Agencies	72	96.0	1st
6. Keeping of Records	52	69.3	7th
7. Sourcing of Grants	31	41.3	12th
8. Computing Field Results	32	42.7	11th
9. Extension Administration	35	46.7	10th
10. Personal Uses	41	54.7	9th
11. Organizing Field Days	56	74.7	5th
12. Planning, Monitoring and Evaluation	66	88.6	3rd

Source: Field Survey, 2009
*Multiples response recorded

Relationship Between Respondents Socio-Economic Characteristics and their Use of ICT's

Results from table 4 shows that a significant relationship exist between education and use of ICT's by respondents at 1% level of significance (X^2 = 10.03 P< 0.01). Adekoya and Ajayi (2000), opined that education enhance individuals access to information for effective communication and extension delivering.

Table 4: Relationship Between Respondents Socio –Economic Characteristics and their Use of ICTs.

Variables	X^2	Df	Contingency Coefficient	P –Value	Remark
Age	7.79	1	0.04	0.82	NS
Sex	8.84	2	0.03	0.83	NS
Education	10.03	3	0.07	0.01***	S

Source: Field Survey 2009

*** Significant at 1% level.

Constraints to the Use of ICT's by Extension Officers

Table 4 presents data on constraints facing the Extension Officers in using ICTs. The table reveals that, high cost of equipment (100%), lack of regular power supply (93.3%, lack of technical know how (86.7%), Remoteness of service area (74.7%) and high air time charge by service providers (60%), were

the major constricts hindering effective extension delivery in their locations.

Tables 5: Distribution of Respondents Based on the constraints Associated in using ICT's.

Category of problem	Frequency	Percentage
Lack of technical know- low	65	86.70
High cost of equipment	75	100. 00
Remoteness of service area	56	74.70
High air time charge	40	60.00
Lack of regular power supply	70	93.30

Source: Field Survey, 2009

*Multiple responses recorded

Conclusion:

The study revealed low level use of ICT's especially the modern ones (Internet and CD-Rom /flash drives) by extension officers in the state. Information enhances development, in this regard extension outfits such as the ADP's should assist their extension agents/officers in the area of training and procurement of computer equipment. This is with a view to harnessing the agricultural and rural development opportunities embodies by ICT's in general and engaging more extension officers to fill the vacant positions. It is therefore recommended that:

- Promotion of the use of ICT's especially the modern types (Internet, CD/ROM and flash Drives) among extension officers for personal development and enhanced job performance are needed.
- . Periodic training of extension officers on ICT's usage should be encouraged to effectively assist in modern extension delivery mechanisms
- Availability and subsidy of ICT equipment is advocated in order to make them accessible for use in extension delivery.

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PRODUCTIVITY OF CASSAVA GENOTYPES AND SOYBEAN ROW PLANTING PATTERN IN CASSAVA/SOYBEAN INTERCROPPING SYSTEM.

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Abstract

Field experiments were conducted at Michael Okpara University of Agriculture, Research Farm, Umudike (Long. 07° 33´ E, Lat. 05° 29´ N) in 2001/2002 and 2002/2003 cropping seasons to assess the effect of three cassava genotypes (TMS 30572, TMS 91934 and NR 8182) and three soybean planting patterns (1:1, 1:2 and 1:3) cassava: soybean row series intercropping system on yield and productivity of the component crops. Sole of the cassava genotypes as well as sole of soybean were established for purposes of comparison. The trial was arranged in a randomized complete block with three replications. Intercropping reduced the yield of component

crops, compared with their respective pure stands. However, it generally gave greater combined yields than obtained from either crop grown alone. On the basis of land equivalent ratio (LER), the highest LER was obtained in TMS 91934 with LER averaged over two seasons of 1.89 compared to TMS 30572 (1.71) and NR 8212 (1.81), giving yield advantages of 89, 71 and 81%, respectively. Intercropping cassava with three rows of soybean gave the highest LER of 1.91 (2001/2002) and 1.96 (2002/2003). The results showed the degree of yield advantage achieved when either of these cassava genotypes (NR 8212, TMS 30572 and TMS 91934) was intercropped with soybean, irrespective of the soybean row planting pattern adopted. This study indicates that it is more productive to grow the two crops together than to grow them separately.
Key words: Cassava genotypes, Soybean, Row-planting pattern, Intercropping, Productivity.

Introduction

Cassava (*Manihot esculenta* Crantz) is a major root crop widely grown in many parts of the tropics and sub-tropics in Africa. It is an important staple food crop, which is consumed at least once daily by over 50 % of the 140 million Nigerian population at least once a day (Phillip *et al*., 2005). The crop is fast assuming a new role not only as an important animal feed and industrial raw material but also in the emerging bio-fuel economy. Soybean (*Glycine max* (L.) Merrill) production has been introduced in the farming systems in the savannah and rainforest agro-ecologies as a veritable source of human protein food, oil and animal feed as well as for soil conservation and fertility maintenance (Edwards, 1989).

The basic principles controlling crops in mixtures lies in the competition for growth factors such as light, nutrients and moisture. Intercropping is the growing of two or more crops simultaneously on the same field but in proximate stands. It is widely practiced by resource-poor farmers in south eastern Nigeria as a sustainable system of food production because it provides for efficient resource use and greater total land productivity (Chinaka and Obiefuna, 2000), and serves as insurance against crop failure and ensure market value of any single crop (Risch *et al*. 1983; Zuofa, *et al*. 1992). Also, intercropping brings a considerable reduction in insect pests attack on crops and has the agronomic importance of improving soil fertility as well as the maintenance of crop genetic resources (Ekanayake, 1995).

Appropriate arrangement of component crops in intercropping ensures more efficient utilization of growth resources such as light, water and soil nutrients (Olasantan and Lucas, 1992). Furthermore, Natarajan and Willey, (1985) in cereals and legumes intercrop surmised that the use of double rather than single alternating rows of cereals and grain legumes improved legume yields, without affecting the yields of cereals when compared with sole cropping. This implies that in intercropping, competitiveness and performance of component crops can be affected greatly by plant geometry, canopy architecture, degrees of rectangularity and relative growth duration of the crops. The objective of this study was to determine the effects of row proportion of soybean and cassava genotypes on

yield and productivity of the component crops in soybean/cassava intercrop.

Materials and Methods

Rain-fed trials were carried out at Michael Okpara University of Agriculture, Umudike, Nigeria, in the rainforest zone of southeastern Nigeria in 2001/2002 and 2002/2003 cropping seasons. The experimental area lies between longitude 07º 33' E, latitude 05º 29' N and 122 m above sea level. The area has a hot humid climate with two distinct seasons – the dry season (November – April) and wet season (May – October). The mean annual rainfall is about 2,200 mm and displays a bi-modal pattern that is characteristic of southern part of West Africa. The mean annual temperature range is 22 - 31º C and it is relatively constant through out the year. The parent material of the soil of the experimental site is coastal plain sand (FDALR, 1990). The vegetation is rainforest, although much has been degraded to secondary forest and fallows. The land was slashed, ploughed, harrowed, and 1 m ridges made. The experimental area divided into three blocks of 40.5 m x 7.0 m (283.5 m^2) each and the blocks were further divided into nine experimental plots of 6 m x 4 m. Soil samples at a depth of 0 – 20 cm were collected from different representative locations of the experimental site; bulked into a composite sample for soil physical and chemical analyses using standard laboratory procedures. The composite soil samples were dried in the laboratory, gently crushed with a porcelain pestle and mortar and sieved through a 2-mm sieve. The fine earth portions (< 2 mm) were used for the laboratory analyses. The particle size analysis was determined by Bouyoucos hydrometer method (Bouyoucos, 1982), later dispersing the soil with sodium hexametaphosphate and the resulting percentage values of sand, silt and clay ere read using textural classification triangle chart to determine the soil texture. Total nitrogen (N) and organic carbon (C) were determined using microkjedahl (IITA,1979) and Walkey and Black, 1934) methods, respectively. Available phosphorus (P) of the soils were extracted by Bray 1 extraction procedure (Page *et al.*, 1982) and read from spectrophotometer. Exchangeable potassium (K) was extracted with neutral ammonium acetate and pH in water determined potentiometrically in 1:2.5 soil:water suspension using a pH meter. The soils of the experimental sites were sandy loam with the following characteristics: Sand, clay, silt 75.8%, 20.3%, 3.9% and 76.2%, 20.1%, 3.7%, soil pH 5.0 and 5.2 (1:2.5; soil:water), organic carbon 1.17 and 1.23 %, organic matter 2.18 and 2.20 %, total N 0.07 and 0.04 %, available P 19.13 and 18.51 mg/kg, exchangeable K 0.11 and 0.13 cmol/kg, effective CEC 3.76 and 3.64 cmol/kg for 2001/2002 and 2002/2003 cropping seasons, respectively. The soils were classified as ultisol.

Three improved contrasting cassava genotypes, TMS 30572, TMS 91943 and NR 8212 with varying morphological characteristics such as: (i) low to medium branching with dense spreading canopy (TMS 30572); (ii) low to medium branching with sparse

canopy (TMS 91934) and (iii) erect, high branching with moderate canopy (NR 8212); were used. The cassava genotypes were obtained from International Institute of Tropical Agriculture (IITA), Ibadan and National Root Crops Research Institute (NRCRI, Umudike). Early maturing soybean variety TGX-485-1D used in the intercrop was obtained from IITA, Ibadan.

The treatments were factorial combinations of three cassava genotypes, TMS 30572, TMS 91934 and NR 8182 and three soybean row planting patterns in 1:1, 1:2 and 1:3 cassava genotype/soybean row series intercropping system. A randomized complete block design with three replications was adopted. Sole crops of the cassava genotypes and soybean were established for comparing the soles and the respective intercrops. Cassava cuttings were planted on the crest of ridges at 1 m x 1 m spacing to give 10,000 plants/ha. Supply of missing stand was done 2 weeks after planting. Between the cassava ridges, soybean seeds were sown at 1, 2 or 3 rows to achieve 1:1, 1:2 or 1:3 cassava: soybean planting patterns. N:P:K:Mg 12:12:17:2 fertilizer was applied 3 WAP at the rate of 400 kg/ha as recommended by Enwezor *et al*. (1989).

Soybean was harvested at 4 months after planting (MAP) when the leaves had turned brown while cassava was harvested at 12 MAP. The data collected from the inner rows of the plots were separately subjected to analysis of variance (ANOVA) for each year using Genstat (2002) stastical software package. Treatment means were compared using Fisher's least significant difference (LSD) at 5 % level of probability according to Obi (2002).

The productivity of the system was determined by land equivalent ratio (LER), which is the sum of the ratios of the yields of the intercrops to those of the sole crop component of each species (Mead and Willey, 1980).

Results and Discussion

Cassava yield and yield components

Table 1 shows the analyses of variances for yield and yield components of cassava in 2001/2002 and 2002/2003 cropping seasons. Except number of tubers plant^{-1}, the other yield components such as weight of tubers plant^{-1} and fresh tuber yield (t ha^{-1}) were significantly ($P < 0.01$) affected by cassava genotype in 2001/2002 cropping season. However, the trend was not the same in 2002/2003 in which the number of tubers plant^{-1} was affected by cassava genotype while weight of tubers plant^{-1} and tuber yield were not. Soybean row planting pattern significantly ($P < 0.01$) influenced number of tubers plant^{-1} in the two seasons but did not affect weight of tuber plant^{-1} and tuber yield. There were no significant ($P > 0.05$) interaction effects for all the parameters in the two cropping seasons.

Table 1: Mean squares from the analysis of variance for cassava yield and yield components in 2001/2002 and 2002/2003 cropping seasons.

Source of variation	Df	Mean squares		
		Total no. of tubers plant^{-1}	Weight of tubers (kg Plant^{-1})	Tuber yield (t ha^{-1})
2001/2002				
Replicates	2	1.8148	0.00101	0.101
Cassava genotype	2	1.4443ns	0.37613**	37.613**
Soybean row planting pattern	2	9.3126**	0.01373ns	1.373ns
Cassava genotype **x** Soybean row planting pattern	4	0.3420ns	0.00473ns	0.473ns
Error	16	0.4943	0.03549	3.549
2002/2003				
Replicates	2	0.9456	0.00863	0.863
Cassava genotype	2	2.1085*	0.10063ns	10.063ns
Soybean row planting pattern	2	7.7185**	0.02143ns	2.143ns
Cassava genotype **x** Soybean row planting pattern	4	0.1554ns	0.00088ns	0.088ns
Error	16	0.5851	0.04378	4.378

Significant at 5, 1 % probability level, respectively; ns denotes not significant.

The total number of tubers plant^{-1}, weight of fresh tubers plant^{-1} and fresh tuber yield (t ha^{-1}) were not affected ($P > 0.05$) by intercropping, irrespective of soybean row planting pattern and cassava genotype in 2001/2002 (Table 2). However, the trend was not the same in 2002/2003 in which sole NR 8212 cassava genotype gave higher number of tubers plant^{-1} than sole TMS 91934. The high fresh yuber yield in intercropping with soybean implies that cassava with its long duration in the farm benefited from the residual decomposition left by the soybean component crop after harvest. The results obtained corroborated studies by Ikeorgu *et al*. (1984) in complex mixtures involving cassava/maize/okra and *egusi*-melon and Adeniyan and Ayoola (2007) in soybean/maize/cassava intercrop. The total number of tubers plant^{-1} was significantly affected by soybean row planting pattern in the two cropping seasons. However, cassava intercropped with three rows of soybean gave the highest number of tubers plant^{-1} and in general, the highest fresh tuber yield ha^{-1} in both cropping seasons. The results agreed with the findings of Watananonia (1986) in the Philippines that high yield in cassava could be partly attributed to high number of roots plant^{-1}.

Cassava genotype irrespective of cropping system and soybean row planting pattern had no effect on total number of tubers plant^{-1} but significantly ($P < 0.05$) affected fresh tuber yield in 2001/2002. The trend was the same in 2002/2003. Overall, the highest fresh tuber yield was obtained under TMS 30572, perhaps due to its dense spreading canopy with which it intercepts solar radiation and tap other growth resources better than TMS 91934 and NR 8212. Similar studies by Eke-Okoro *et al*. (2001) showed high fresh tuber yield in profusely branching cassava genotype such as TMS 30572 with dense spreading canopy when

compared with other genotypes with intermediate or sparse canopy. Also, Egesi *et al*. (2007) reported that high yields in cassava could be as a result of the genetic make up of the cultivar.

There was no significant ($P > 0.05$) effect in the interaction between cassava genotype and soybean row planting pattern in the two cropping seasons. The results show that the magnitude of intercrop competition in this study depends more on cassava genotype than on soybean row planting pattern.

There was a strong positive relationship ($r = 0.49$, $P < 0.01$) between fresh tuber yield and the number of tubers plant^{-1} in 2002/2003, an indication that number of tubers plant^{-1} plays a significant role and may even be used as an index in determining fresh tuber yield of cassava.

Table 2: Effects of cassava genotype and soybean row planting pattern on total no. of tubers plant^{-1}, weight of tubers plant^{-1} and fresh tuber yield of cassava in cassava/soybean intercrop in 2001/2002 and 2002/2003 cropping seasons.

Treatments	Total no. of tubers plant^{-1}	Weight of tubers (kg plant^{-1})	Fresh tuber yield (t ha^{-1})
2001/2002			
Cropping system			
Sole cassava NR 8212	5.28	2.05	20.5
Sole cassava TMS 30572	4.89	2.11	21.1
Sole cassava TMS 91934	4.70	1.76	17.6
Sole cassava (Mean of the cassava genotypes)`	4.96	1.97	19.7
Cassava/Soybean intercrop	4.80	2.14	21.4
F- LSD 0.05	ns	ns	ns
Intercropped cassava genotype			
Cassava NR 8212	4.77	2.16	21.6
Cassava TMS 30572	5.17	2.33	23.3
Cassava TMS 91934	4.45	1.92	19.2
F- LSD 0.05	ns	0.19	1.88
Soybean row planting pattern			
One row soybean	4.00	2.12	21.2
Two rows soybean	4.43	2.11	21.1
Three rows soybean	5.96	2.18	21.8
F- LSD 0.05	0.70	ns	ns
2002/2003			
Cropping system			
Sole cassava NR 8212	6.16	2.03	20.3
Sole cassava TMS 30572	5.49	2.12	21.2
Sole cassava TMS 91934	5.22	1.87	18.7
Sole cassava (Mean of the cassava genotypes)	5.62	2.01	20.1
Soybean/cassava intercrop	5.56	2.09	20.9
F- LSD0.05	0.62	0.08	0.79
Intercropped cassava genotype			
Cassava NR 8212	5.51	2.11	21.2
Cassava TMS 30572	6.07	2.19	21.9
Cassava TMS 91934	5.10	1.98	19.8
F- LSD 0.05	ns	ns	ns
Soybean row planting pattern			
One row soybean	4.66	2.04	20.4
Two rows soybean	5.51	2.10	21.0
Three rows soybean	6.51	2.14	21.4
F- LSD 0.05	0.77	ns	ns

Soybean yield and yield components

The results of the analysis of variance for crop yield and yield components of soybean are presented in Table 3 for 2001/2002 and 2002/2003 cropping seasons. The results showed that the number of pods plant^{-1}, seed weight plant^{-1} and grain yield of soybean significantly ($P < 0.05$) varied while 100-seed weight did not show any significant difference ($P > 0.05$) among the cassava genotypes in 2001/2002 and 2002/2003 cropping seasons. The effects of soybean row planting pattern were significant for all yield parameters in both cropping seasons. There were no significant cassava genotype x soybean row planting pattern interaction on all the parameters in 2001/2002 and 2002/2003 cropping seasons.

Table 3: Mean squares from the analysis of variance for soybean yield and yield components in 2001/2002 and 2002/2003 cropping season.

Source of variation	Df	Mean squares			
		No. of pods plant^{-1}	Seed weight (g plant^{-1})	100 seed weight (g)	Grain yield (Kg ha^{-1})
2001/2002					
Replicates	2	10.560	4.274	2.040	5293.519
Cassava genotype	2	81.23*****	9.198*****	5.840ns	29157.301******
Soybean row planting pattern	2	87.73*****	21.552******	12.675*	46683.104******
Cassava genotype **x** Soybean row planting pattern	4	8.78ns	0.328ns	0.655ns	1505.077ns
Error	16	19.44	1.604	2.060	2769.430
2002/2003					
Replicates	2	15.78	1.091	2.775	560.281
Cassava genotype	2	160.243*****	7.508*****	2.804ns	20699.172*****
Soybean row planting pattern	2	159.650*	27.856******	15.520**	107293.465******
Cassava genotype **x** Soybean row planting pattern	4	45.440ns	2.309ns	0.587ns	1158.313ns
Error	16	32.805	2.352	1.866	6052.668

Significant at 5, 1 % probability level, respectively; ns denotes not significant.

In the two cropping seasons, sole cropped soybean gave higher number of pods plant^{-1}, seed weight plant^{-1}, 100 seed weight and grain yield than the intercrop (Table 4). The row planting pattern of soybean, irrespective of the cassava genotype influenced the number of pods plant^{-1}, seed weight plant^{-1} and grain yield in both seasons. The number of pods plant^{-1} , seed weight plant-1 and grain yield were higher in three than one row soybean in both cropping seasons. Similar studies by Preston *et al.* (1986) on *Arachis hypogea* varieties x row spacing interactions and Agele *et al*. (2007) on radiation interception by *Helianthus annuus* showed that planting pattern of crops to a large extent determined the availability of solar radiation and other growth resources to the crop species.

Table 4: Effects of cassava genotype and soybean row planting pattern on number of pods plant^{-1}, seed weight plant^{-1}, 100-seed weight and grain yield of soybean in cassava/soybean intercrop in 2001/2002 and 2002/2003 cropping seasons.

Also, Aliyu (2007) in pearl millet/cowpea and Muoneke *et al*. (2007) in maize/soybean intercrops concluded that plant competition could be minimized by row arrangement of crops. Furthermore, grain yields of soybean obtained under three rows of soybean alternating with one row of cassava out yielded those in one or two rows by 29 % and 5 % (2001/2002) and by 35 % and 7 % (2002/2003), respectively. The observations corroborated the findings by Ebwongu *et al.* (2001) in maize/*Solanum* potato intercrop and Njoku *et al*. (2007) in sweet potato/okra intercrop, stressing the importance of minimizing plant competition in intercropping.

Cassava genotype significantly ($P < 0.05$) affected soybean seed weight plant^{-1}, and number of pods plant^{-1} but not on 100 seed weight, irrespective of soybean row planting patterns in the two cropping seasons. The highest number of pods plant^{-1} was obtained with TMS 30572 while the least was with TMS 91934 in both seasons. Conversely, intercropped TMS 91934 gave the highest seed dry weight plant^{-1} and grain yield compared with the other cassava genotypes (TMS 30572 and NR 8212) in both seasons. In terms of grain yield, TMS 91934 out yielded TMS 30572 and NR 8212 by 24 % and 7 % in 2001/2002 and by 17 % and 6 % in 2002/2003 cropping seasons, respectively. The associated high yield of TMS 91934 intercropped with soybean could be attributed to less competitive interaction between component crops perhaps due to the morphology of the cassava genotype characterized by its sparse canopy that allowed solar interception into its canopy. Similarly, Mohamed *et al*. (2009) in maize/common bean mixture reported that intercrop competition occurred essentially in response of one species to the environment as modified by the presence of another species. The results obtained in this study indicated the possibility of optimizing soybean and cassava yield in an intercropping system.

Cassava genotype and soybean planting pattern interaction did not show significant effects in the two cropping seasons. The data were not, therefore, presented. Strong positive correlation was observed between grain yield and seed weight of soybean; ($r = 0.629$, $P<0.01$) in 2001/2002 and ($r = 0.681$, $p<0.01$) in 2002/2003, an indication that the seed weight plant^{-1} could serve as an effective index in assessing grain yield of soybean.

Treatments	No. of pods plant^{-1}	Seed weight (g plant^{-1})	100-seed weight (g)	Grain yield (Kg ha^{-1})
2001/2002				
Cropping system				
Sole soybean	52.76	10.69	13.18	592.31
Cassava/Soybean intercrop	45.59	6.85	11. 39	420.29
F- LSD (P < 0.05)	5.74	2.29	1.83	113.14
Intercropped cassava genotype				
Cassava NR 8212	46.00	6.66	11.45	436.61
Cassava TMS 30572	48.31	5.95	10.56	357.00
Cassava TMS 91934	42.35	7.94	12.17	467.27
F- LSD (P < 0.05)	4.41	1.27	ns	52.59
Soybean row planting pattern				
One row soybean	42.01	5.51	10.04	338.34
Two rows soybean	46.78	6.50	11.90	449.04
Three rows soybean	47.88	8.55	12.24	473.50
F- LSD (P < 0.05)	44.41	1.27	1.43	52.59
2002/2003				
Cropping system				
Sole soybean	68.54	11.60	13.76	658.76
Cassava/Soybean intercrop	57.82	6.89	11.70	506.61
F- LSD (P < 0.05)	10.19	1.94	1.498	121.71
Intercropped cassava genotype				
Cassava NR 8212	48.50	6.69	12.32	517.44
Cassava TMS 30572	52.80	6.09	11.24	454.16
Cassava TMS 91934	44.40	7.88	11.53	548.23
F- LSD (P < 0.05)	5.72	1.53	ns	77.75
Soybean row planting pattern				
One row soybean	44.00	5.41	10.29	383.14
Two rows soybean	49.30	6.42	12.89	546.27
Three rows soybean	52.30	8.83	11.90	590.42
F- LSD (P < 0.05)	5.73	1.53	1.37	77.75

*Grain yield at 13 % moisture content.
ns = not significant

Productivity of the system

Biological productivity of the system showed that total land equivalent ratio (LER) in cassava genotype/soybean intercropping system ranged from 1.70 to 1.88 and 1.72 to 1.89 in 2001/2002 and 2002/2003 cropping seasons, respectively (Table 5). TMS 91934 gave the highest LER with a yield advantage averaged over two seasons of 89 % compared to TMS 30572 with 71 % and

NR 8212 with 81 % yield advantages. The 2001/2002 and 2002/2003 cropping seasons average showed that irrespective of the cassava genotype, intercropping cassava with three rows of soybean gave the highest LER of 1.91 and 1.96 yield advantages of 91 and 94 %, respectively. The results showed the degree of yield advantage achieved when either of these cassava genotypes (NR 8212, TMS 30572 and TMS 91934) was intercropped with soybean, irrespective of the soybean row planting pattern adopted or when three rows of soybean was used, irrespective of the cassava genotype. Similar studies by Njoku *et al*. (2007) in sweet potato/okra intercrop and Mbah *et al*. (2009) in cassava/okra intercrop showed that intercropping is more advantageous, hence, resulting in higher productivity than sole cropping.

Table 5: Effects of cassava genotype and soybean row planting pattern on partial and total land equivalent ratio in sole or intercropped cassava in cassava genotype/soybean intercrop in 2001/2002 and 2002/2003 cropping seasons.

Treatments	Land equivalent ratio		
	Partial		[2.]Total
	[1.]Cassava genotype	[1.]Soybean	
2001/2002			
Intercropped cassava genotype			
Cassava NR 8212	1.05	0.74	1.79
Cassava TMS 30572	1.10	0.60	1.70
Cassava TMS 91934	1.09	0.79	1.88
Soybean row planting pattern			
One row soybean	1.08	0.57	1.65
Two rows soybean	1.07	0.76	1.83
Three rows soybean	1.11	0.80	1.91
2002/2003			
Intercropped cassava genotype			
Cassava NR 8212	1.04	0.79	1.83
Cassava TMS 30572	1.03	0.69	1.72
Cassava TMS 91934	1.06	0.83	1.89
Soybean row planting pattern			
One row soybean	1.01	0.58	1.59
Two rows soybean	1.04	0.83	1.87
Three rows soybean	1.60	0.90	1.96

[1.] Partial LER for cassava genotype effect was obtained by dividing each intercrop yield by its corresponding cassava genotype yield in sole cropping, while the partial LER for soybean row planting pattern effect was obtained by dividing each intercrop yield by the soybean sole crop yield.
[2.] Total LER = Sum of the partial LERs from the two components crops in cassava/soybean intercrop.

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DETERMINATION OF MICROORGANISMS ASSOCIATED WITH LOCAL SPICES IN IMO STATE

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Abstract

This research work was carried out at the Department of Crop Science and Technology laboratory in, Federal University of Technology, Owerri between 2006/2007. Three (3) local spices were used in this research work and they included; *Xylopia aethiopica* (Uda), *Piper guineensis* (Uziza) and *Ocimum viride* (nchanwu). The three sets of these spices were obtained from four (4) different locations. Owerri, Ishiagu, Isuocha and Umuahia. To isolate the micro-organisms that associated with the spices, the potato dextrose agar method was used. Six different micro-organisms were identified after the isolation namely; *Rhizopus spp, Aspergilus spp,Nigrospora spp, Fusarium link, Trichoderma spp,* and *Cylindrosporium spp, Rhizopus spp* was observed to be most prominent in the selected spices from the selected locations. On the percentage occurrence of some diseases on the spices from different locations, spot recorded the highest occurrence while mould recorded the lowest occurrence. It was observed that the percentage occurrence of these diseases were very low on the spices.

Key words: Micro-organism, Diseases, Spices, Locations.

Introduction

Spices are widely used in preparing food all over the world. Some species harbor a great number of micro-organisms that may contribute to the deterioration of food products or cause food borne diseases. Spices and condiments are products of plant which are used for seasoning, flavouring and thus enhancing the taste of food, beverages and drugs (Dziezak, 1989; Iwu, 1993; Locke, 1990). The knowledge and use of plants as condiments is as old as the history of mankind (Garland, 1972). Plants used as spices and condiments are usually aromatic and pungent (Achinewu, *et al.,* 1995). Iwu, (1993) reported that these plants owe these properties to the presence of varying types of essential oils. Plants used as spices and condiments are usually aromatic and pungent (Achinewu, *et al.,* 1995). Iwu, (1993) reported that these plants owe these properties to the presence of varying types of essential oils.

Also Iwu, (1993) associated the antiseptic and preservative properties of certain spices to these essential oils. In a more elaborate treatment, Dziezak, (1989) indicated that the rich presence of essential oil and Oleoresins determine the aromatic,

raring, coloring and pungent properties of spices.

Hence the objectives of this research include to:

1) Isolate and identify some micro-organisms that attack local spices from different locations in some selected states in south eastern Nigeria.
2) Determine the percentage occurrence of some diseases on local spices obtained from different locations and identify the micro-organisms prominent in the selected spices and locations in south eastern Nigeria.

Materials and methods

This experiment was conducted at the Department of Crop Science and Technology laboratory in Federal University of Technology Owerri, Imo State from 2006 to 2007. The materials used for this research work were collected from four different locations which included; Owerri, Isuochi, Ishiagu and Umuahia in southeastern Nigeria. The materials used were;

i) *Xylopia aethiopica* - native name; (Uzizza-Ibo)
ii) *Piper guineensis* -native name; (Uda-Ibo)
iii) *Ocimum viride* -native name; (Nchanwu Ibo)

The experiment was laid out in a complete randomized design (CRD) using four treatments and three replicates. The materials were collected from these locations and were taken to the laboratory where some diseases such as rot, spot and mould were identified after proper examination on them. Then the percentage occurrences of each of these diseases were recorded. **Preparation of Potato Dextrose**

Irish potato of 200gm was peeled washed, sliced into bids and cooked for 45mns with hot plate. The cooked potato concentrate was filtered with muslin cloth after which the resultant concentrate was formed. Then, 15gm of agar-agar was put into 1000 ml volumetric flask containing 250 ml of the prepared potato broth and also 20 grm of Dextrose was added, the mixture was stirred thoroughly and then, the content was properly mixed with the help of the spatula and warmed for 10mins. on the hot plate to obtain potato-dextrose-agar (PDA).

The specimen for the work which were seeds of *Xylopia aethiopica* and *Piper guineensis* together with the leaves of *Ocimum viride* were brought from the local markets in four different locations in selected states in South-eastern Nigeria. Prior to the isolation and inoculation, the inoculating room and chamber were properly cleaned with detergent and disinfectant. The other instruments used were all properly sterilized.

The 15ml of PDA was dispensed into 3 maccanthy bottle each and the mouth of the bottles were each cooked with cotton wool, covered with aluminum foil and kept in the autoclave for I5mins at a temperature of 120°C in order to ensure proper sterilization of the medium.

After this, the contents were allowed to cool before being poured into twelve petri dishes sterilized with the aid of canister in a hot oven box at a temperature of 100°C for 1hr and this pouring was done in the inoculation chamber to prevent contamination of the dishes.

Isolation of the micro-organism

Each of the specimens was placed on separate potato dextrose agar (PDA) medium inside the petri-dishes in the inoculation chamber.

These inoculated petri-dishes were then properly covered with water proof and kept in the incubator at 30°C for 4 days so as to give room for microbial growth on the inoculated petri-dishes.

Identification of the micro-organisms

After culturing and incubating of the inoculated petri-dishes, they were sub-cultured and re-incubated for the same number of days (4 days) so as to enhance further growth and to obtaine pure culture of the micro-organisms in the plates. Then, the micro-organisms were identified with the usage of laboratory manual as described by (Bomett and Hunter, 1998).

Statistical analysis were carried out on all the data collected according to the method developed by (Cobeley and Steel, 1986), for analyzing complete randomized design. Fishers' protected least significant difference @ p=0.05 was used for detecting significant differences among treatment means.

Results and Discussion

Results of the percentage occurrence of rot, mould and spot of the spices from different locations are shown in (Table l.)The results showed that the mean values of percentage occurrence of rot, mould and spot were 15.33 %, 12.00 % and 16.33 % respectively. The results revealed that spot had the highest percentage occurrence on the spices while rot and mould showed lower percentage occurrence with mould having the lowest. Rot, mould and spot recorded 20.0 %, 10.67 % and 22.67 % as mean values of percentage occurrence respectively in Owerri.

In Ishiagu, rot, mould and spot recorded 16.67 % 12.67 % and 15.00 % respectively. Also in Isuochi, the results obtained were 15.00 % 13.33 % and 13.33 % of rot, mould and spot, respectively (Table 2). While the result showed that in Umuahia, the percentage occurrence of rot, mould and spot were 11.67%, 11.33% and 14.33%, respectively.

In Owerri, results showed that spot had the highest occurrence with 25 % while mould had the lowest with 10% occurrence on *Xylopia aethiopica*. These results were the same in Isuochi with 20 % and 15 %, respectively. Rot and spot were diseases with the highest and lowest occurrence on *Xylopia aethiopica* with 15 % and 10 %, respectively in Ishiagu, while the diseases recorded the same values of occurrences on *Xylopia aethiopica* in Umuahia (Table2).

Spot recorded highest occurrence on *Piper guinensis* in Owerri and Umuahia with 18 % and 15 % respectively. Also, mould showed the highest occurrence in Isuochi with 13 % but had the lowest occurrence on *Piper guineensis* in Owerri, Ishiagu and Umuahia with 12 %, 10 % and 10 %, respectively (Table 2). Rot recorded the highest occurrence on *Ocimum viride* in Isuochi while spot recorded the highest in Umuahia with (15% and 15%) respectively. Mould recorded the disease with lowest occurrence on *Ocimim viride* with 10 % and 15 % in Owerri and Ishiagu, respectively (Table 2).

This poor effect of these diseases on the spices may be attributed to the chemical constituents of these test plants. This is in agreement with (Obiorah, 1999) who reported that

spices contain a volatile oil- anoneceins which has an antimicrobial property. He reported that *Ocimum viride* and *Xylopia aethiopica* have repellent effect on fungal pathogens.

Table1: showing the percentage occurrence of rot, mould, and spot of the spices from different locations.

Location	Materials	% occurrence of rot	% occurrence of mould	% occurrence of spot
	X.a	20	10	25
Owerri	P.g	15	12	18
	O.v	25	10	25
	X.a	15	13	10
Ishiagu	P.g	15	10	15
	O.v	20	15	20
	X.a	20	15	20
Isuochi	P.g	10	13	10
	O.v	15	12	10
	X.a	13	13	13
Umuahia	P.g	12	10	15
	O.v	10	11	15
Mean values		15.83	12.00	16.33

Key:

X,a = *Xylopia aethiopica*

p.g = *Piper guineensis*

O.v = *Ocimum viride*

Table 2: Mean value of percentage occurrence of rot, mould and spot of the spices with respect to individual locations.

Location	Mat	% occurrence of rot	% occurrence of mould	% occurrence of spot
	X.a	20	10	25
Owerri	P.g	15	12	18
	O.v	25	10	25
Mean value		20.00	10.67	22.67
	X.a	15	13	10
Ishiagu	P.g	15	10	15
	O.v	20	15	20
Mean value		16.67	12.67	15.00
	X.a	20	15	20
Isuochi	P.g	10	13	10
	O.v	15	12	10
Mean value		15.00	13.33	13.33
	X.a	13	13	13
Umuahia	P.g	12	10	15
	O.v	10	11	15
Mean value		11.67	11.33	14.33

Key:

X,a = *Xylopia aethiopica*

p.g = *Piper guineensis*

O.v = *Ocimum virid*

Table 3; showed that these diseases were not statistically significant on locations at 5% probability level. The result showed that rot recorded the highest effect with 19.45 % while spot recorded the lowest with 3.53%. Also, out of the four different locations, rot recorded the highest with 78.33%, and spot recorded the lowest with 45.16%. This may also be attributed to the difference in geographical locations and climatic factors as well as environmental factors associated with the different locations. This is in line with the findings of (Achinewu, *et al*., 1995), who reported that climate conditions influence microbial occurrence in a given location.

Means of main effect showed that rot recorded the highest mean of 19.44 followed by spot 17.22, while mould had the least mean of 12.22. Furthermore, *Xylopia aethiopica* recorded the highest mean effect of 17.55, followed by *Ocimum viride* with 16.33 while *Piper guineensis* had the lowest with 15.00, respectively (Table 4).

Also, spot had the highest occurrence on *Xylopia aethiopica* and *Piper guineensis*. But mould recorded the lowest occurrence on *Ocimum viride* with 21.66, 20.00 and on the three spices with 12.67, 11.67 and 12.33, respectively (table 4).

Table 3: Analysis of variance of percentage occurrence of rot, mould and spot of spices from different locations investigated.

Sources	Rot%	Mould%	Spot%
Treatments	19.45	5.8	3.53
Error	19.45	3.43	111.60
Total	31.12	9.23	117.13
L1	25.00	12.33	10.33

L2	18.33	13.33	12.33
L3	20.00	15.00	10.33
L4	15.00	12.00	11.67
Total	78.33	52.66	45.16

Key:

L1 = Owerri L3 = Isuochi

L2 = Ishiagu L4 = Umuahia

Table 4: Means of main effect of rot, mould and spot on the spices.

Diseases	**Xa**	**Pg**	**Ov**	**Mean total**
Rot	18.33	13.33	20.00	17.22
Mound	12.67	11.67	12.33	12.22
Spot	21.66	20.00	16.66	19.44
Average	17.55	15.00	16.33	

Key:

X,a = *Xylopia aethiopica*

p.g = *Piper guineensis*

O.v = *Ocimum viride*

Means of main effect of rot mould and spot on different locations revealed that rot recorded highest followed by mould when spot was the lowest with 19.58, 13.17 and 11.17, respectively (Tables 5).

Spices from Owerri recorded the highest disease development followed by those from Isuochi, Ishiagu and Umuahia with 15.89, 15.11, 14.66 and 12.89, respectively. Also, rot recorded highest on spices from Owerri, with 25.00 while spot recorded highest on spices from Ishiagu with 12.33, Mould recorded highest on spices from Isuochi with 15.00. On the other hand, rot

recorded lowest on spices from Umuahia with 15.00, while mould recorded the lowest in Umuahia when spot recorded the lowest on spices from Owerri with 10.33 (Table 5). This may also be as a result in difference in environmental factors in the different locations as confirmed from the work of (Ihejirika, 2002; Nwufo, 1993; Ihejirika, *et al*., 2005), who reported that environment plays significant roles on disease development or survival in any given area or location.

Table 5: Mean of main effect of rot, mould, spot on different locations.

DISEASES	OW	ISH	ISU	UMU	MEAN TOTAL
ROT	25.00	18.33	20.00	15.00	19.58
MOULD	12.33	13.33	15.00	12.00	13.17
SPOT	10.33	12.33	10.33	11.67	11.17
AVERAGE	15.89	14.66	15.11	12.89	

Key:

OW = Owerri **ISU** = Isuochi

ISH= Ishiagu **UMU**= Umuahia

Rhizopus spp, occurred in all the locations with more than 50% occurrence in location 3 and location 4. Also, *Aspergillus spp* occurred in location 1 and location 2. While *Cylindrosporium spp, Fusarium spp, Negrospora spp* and *Trichoderma spp* in occurred in locations 1, 2, 3 and 4, respectively.

Rhizopus spp was observed to have the highest occurrence followed by *Aspergillus spp*. (Table 6). Generally, there were very low level of microbial growth on all the spices. This may be due to the antimicrobial properties of

some spices as (Shelef, 1983) reported that Allicin, isolated from garlic oil, inhibits the growth of both gram-negative and gram-positive bacteria. He also reported that Eugenol, carvacrol, and thymol are phenol compounds and, are found in cinnamon, cloves, sage, and oregano and their presence function as mold inhibitors in bakery items and in addition to adding flavor and aroma to baked products. Also, (Paster *et al.,* 1995) have shown that essential oils of oregano and thyme (which contain carvacrol and thymol) are effective as fumigants against fungi on stored grain.

The association of microorganisms on the spices may be due to contamination because of conditions in which they were grown and harvested. Spores of both *Clostridium perfringens* and *Bacillus cereus* have been found to be present in spices (Kneifel, and Berger, 1994). Also, Zaika, (1988) reported that nutrients present in spices / herbs may stimulate growth and/or biochemical activities of microorganisms.

However, the occurrence of *Rhizopus sp* in all locations may be due to its ability to adapt to environmental and weather conditions easily for its growth and survival. This is in line with the findings of (Iwu, 1993), who reported that *Rhizopus spp* is a universal microbe in this ecological zone.

Table 6: Summary of micro-organisms identified in different locations

Locations	Materials	Associated micro-organisms	
	Xylopia aethiopica	*Cylindrosporium*	*Spp*
OW	*Piper guineensis*	*Aspergillus*	*Spp*
	Ocimum viride	*Rhizopus*	*Spp*
	Xylopia aethiopica	*Fusarium*	*Spp*
ISH	*Piper guineensis*	*Aspergillus*	*Spp*
	Ocimum viride	*Rhizopus*	*Spp*
	Xylopia aethiopica	*Rhizopus*	*Spp*

ISU	*Piper guineensis*	*Rhizopus*	*Spp*
	Ocimum viride	*Nigrospora*	*Spp*
	Xylopia aethiopica	*Rhizopus*	*Spp*
UMU	*Piper guineensis*	*Trichoderma*	*Spp*
	Ocimum viride	*Rhizopus*	*Spp*

Key:

OW = Owerri **ISU** = Isuochi

ISH= Ishiagu **UMU**= Umuahia

Conclusion

This study on *Xylopia aethiopica, ocimum viride* and *Piper guineensis*, showed that out of these three disease symptoms spot, rot and mould, spot recorded the highest occurrence on the spices, while mould recorded the lowest. Generally, they symptoms showed very low occurrence rates on the spices.

Six micro-organisms were identified namely; *Rhizopus spp., Aspergillus spp., Trichoderma spp., Negrospora spp.* and *Fusarium spp.* and *Cylindeosponium spp*. Out of the six microorganisms identified, *Rhizopus spp.* was observed to be the most prominent in the selected spices and locations.

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DETERMINATION OF MICROORGANISMS ASSOCIATED WITH LOCAL SPICES IN SOME SELECTED STATES IN SOUTH-EASTERN NIGERIA.

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Abstract

This research work was carried out at the Department of Crop Science and Technology laboratory in, Federal University of Technology, Owerri between 2006/2007. Three (3) local spices were used in this research work and they included; *Xylopia aethiopica* (Uda), *Piper guineensis* (Uziza) and *Ocimum viride* (nchanwu). The three sets of these spices were obtained from four (4) different locations. Owerri, Ishiagu, Isuocha and Umuahia. To isolate the micro-organisms that associated with the spices, the potato dextrose agar method was used. Six different micro-organisms were identified after the isolation namely; *Rhizopus spp, Aspergilus spp,Nigrospora spp, Fusarium link, Trichoderma spp,* and *Cylindrosporium spp, Rhizopus spp* was observed to be most prominent in the selected spices from the selected locations. On the percentage occurrence of some diseases on the spices from different locations, spot recorded the highest occurrence while mould recorded the lowest occurrence. It was observed that the percentage occurrence of these diseases were very low on the spices

Key words: Micro-organism, Diseases, Spices, Locations.

Introduction

Spices are widely used in preparing food all over the world. Some species harbor a great number of micro-organisms that may contribute to the deterioration of food products or cause food borne diseases. Spices and condiments are products of plant which are used for seasoning, flavouring and thus enhancing the taste of food, beverages and drugs (Dziezak, 1989; Iwu, 1993; Locke, 1990). The knowledge and use of plants as condiments is as old as the history of mankind (Garland, 1972). Plants used as spices and condiments are usually aromatic and pungent (Achinewu, *et al.,* 1995). Iwu, (1993) reported that these plants owe these properties to the presence of varying types of essential oils. Plants used as spices and condiments are usually aromatic and pungent (Achinewu, *et al.,* 1995). Iwu, (1993) reported that these plants owe these properties to the presence of varying types of essential oils.

Also Iwu, (1993) associated the antiseptic and preservative properties of certain spices to these essential oils. In a more elaborate treatment, Dziezak, (1989) indicated that the rich presence of essential oil and Oleoresins determine the aromatic, raring, coloring and pungent properties of spices.

Hence the objectives of this research include to:

1) Isolate and identify some micro-organisms that attack local spices from

different locations in some selected states in south eastern Nigeria.
2) Determine the percentage occurrence of some diseases on local spices obtained from different locations and identify the micro-organisms prominent in the selected spices and locations in south eastern Nigeria.

Materials and methods

This experiment was conducted at the Department of Crop Science and Technology laboratory in Federal University of Technology Owerri, Imo State from 2006 to 2007. The materials used for this research work were collected from four different locations which included; Owerri, Isuochi, Ishiagu and Umuahia in southeastern Nigeria. The materials used were;
i) *Xylopia aethiopica* - native name; (Uzizza-Ibo)
ii) *Piper guineensis* -native name; (Uda-Ibo)
iii) *Ocimum viride* -native name; (Nchanwu Ibo)

The experiment was laid out in a complete randomized design (CRD) using four treatments and three replicates. The materials were collected from these locations and were taken to the laboratory where some diseases such as rot, spot and mould were identified after proper examination on them. Then the percentage occurrences of each of these diseases were recorded.

Preparation of Potato Dextrose

Irish potato of 200gm was peeled washed, sliced into bids and cooked for 45mns with hot plate. The cooked potato concentrate was filtered with muslin cloth after which the resultant concentrate was formed. Then, 15gm of agar-agar was put into 1000 ml volumetric flask containing 250 ml of the prepared potato broth and also 20 grm of Dextrose was added, the mixture was stirred thoroughly and then, the content was properly mixed with the help of the spatula and warmed for 10mins. on the hot plate to obtain potato-dextrose-agar (PDA).

The specimen for the work which were seeds of *Xylopia aethiopica* and *Piper guineensis* together with the leaves of *Ocimum viride* were brought from the local markets in four different locations in selected states in South-eastern Nigeria. Prior to the isolation and inoculation, the inoculating room and chamber were properly cleaned with detergent and disinfectant. The other instruments used were all properly sterilized.

The 15ml of PDA was dispensed into 3 maccanthy bottle each and the mouth of the bottles were each cooked with cotton wool, covered with aluminum foil and kept in the autoclave for I5mins at a temperature of 120°C in order to ensure proper sterilization of the medium.

After this, the contents were allowed to cool before being poured into twelve petri dishes sterilized with the aid of canister in a hot oven box at a temperature of 100°C for 1hr and this pouring was done in the inoculation chamber to prevent contamination of the dishes.

Isolation of the micro-organism

Each of the specimens was placed on separate potato dextrose agar (PDA) medium inside the petri-dishes in the inoculation chamber.

These inoculated petri-dishes were then properly covered with water proof and kept in the incubator at 30°C for 4 days so as to give room for microbial growth on the inoculated petri-dishes.

Identification of the micro-organisms

After culturing and incubating of the inoculated petri-dishes, they were sub-cultured and re-incubated for the same number of days (4 days) so as to enhance further growth and to obtaine pure culture of the micro-organisms in the plates. Then, the micro-organisms were identified with the usage of laboratory manual as described by (Bomett and Hunter, 1998).

Statistical analysis were carried out on all the data collected according to the method developed by (Cobeley and Steel, 1986), for analyzing complete randomized design. Fishers' protected least significant difference @ p=0.05 was used for detecting significant differences among treatment means.

Results and Discussion

Results of the percentage occurrence of rot, mould and spot of the spices from different locations are shown in (Table l.)The results showed that the mean values of percentage occurrence of rot, mould and spot were 15.33 %, 12.00 % and 16.33 % respectively. The results revealed that spot had the highest percentage occurrence on the spices while rot and mould showed lower percentage occurrence with mould having the lowest. Rot, mould and spot recorded 20.0 %, 10.67 % and 22.67 % as mean values of percentage occurrence respectively in Owerri.

In Ishiagu, rot, mould and spot recorded 16.67 % 12.67 % and 15.00 % respectively. Also in Isuochi, the results obtained were 15.00 % 13.33 % and 13.33 % of rot, mould and spot, respectively (Table 2). While the result showed that in Umuahia, the percentage occurrence of rot, mould and spot were 11.67%, 11.33% and 14.33%, respectively.

In Owerri, results showed that spot had the highest occurrence with 25 % while mould had the lowest with 10% occurrence on *Xylopia aethiopica*. These results were the same in Isuochi with 20 % and 15 %, respectively. Rot and spot were diseases with the highest and lowest occurrence on *Xylopia aethiopica* with 15 % and 10 %, respectively in Ishiagu, while the diseases recorded the same values of occurrences on *Xylopia aethiopica* in Umuahia (Table2).

Spot recorded highest occurrence on *Piper guinensis* in Owerri and Umuahia with 18 % and 15 % respectively. Also, mould showed the highest occurrence in Isuochi with 13 % but had the lowest occurrence on *Piper guineensis* in Owerri, Ishiagu and Umuahia with 12 %, 10 % and 10 %, respectively (Table 2). Rot recorded the highest occurrence on *Ocimum viride* in Isuochi while spot recorded the highest in Umuahia with (15% and 15%) respectively. Mould recorded the disease with lowest occurrence on *Ocimim viride* with 10 % and 15 % in Owerri and Ishiagu, respectively (Table 2).

This poor effect of these diseases on the spices may be attributed to the chemical constituents of these test plants. This is in agreement with (Obiorah, 1999) who reported that

spices contain a volatile oil- anoneceins which has an antimicrobial property. He reported that *Ocimum viride* and *Xylopia aethiopica* have repellent effect on fungal pathogens.

Table1: showing the percentage occurrence of rot, mould, and spot of the spices from different locations.

Location	Materials	% occurrence of rot	% occurrence of mould	% occurrence of spot
	X.a	20	10	25
Owerri	P.g	15	12	18
	O.v	25	10	25
	X.a	15	13	10
Ishiagu	P.g	15	10	15
	O.v	20	15	20
	X.a	20	15	20
Isuochi	P.g	10	13	10
	O.v	15	12	10
	X.a	13	13	13
Umuahia	P.g	12	10	15
	O.v	10	11	15
Mean values		15.83	12.00	16.33

Key:

X,a = *Xylopia aethiopica*

p.g = *Piper guineensis*

O.v = *Ocimum viride*

Table 2: Mean value of percentage occurrence of rot, mould and spot of the spices with respect to individual locations.

Location	Mat	% occurrence of rot	% occurrence of mould	% occurrence of spot
	X.a	20	10	25
Owerri	P.g	15	12	18
	O.v	25	10	25
Mean value		20.00	10.67	22.67
	X.a	15	13	10
Ishiagu	P.g	15	10	15
	O.v	20	15	20
Mean value		16.67	12.67	15.00
	X.a	20	15	20
Isuochi	P.g	10	13	10
	O.v	15	12	10
Mean value		15.00	13.33	13.33
	X.a	13	13	13
Umuahia	P.g	12	10	15
	O.v	10	11	15
Mean value		11.67	11.33	14.33

Key:

X,a = *Xylopia aethiopica*

p.g = *Piper guineensis*

O.v = *Ocimum virid*

Table 3; showed that these diseases were not statistically significant on locations at 5% probability level. The result showed that rot recorded the highest effect with 19.45 % while spot recorded the lowest with 3.53%. Also, out of the four different locations, rot recorded the highest with 78.33%, and spot recorded the lowest with 45.16%. This may also be attributed to the difference in geographical locations and climatic factors as well as environmental factors associated with the different locations. This is in line with the findings of (Achinewu, *et al*., 1995), who reported that climate conditions influence microbial occurrence in a given location.

Means of main effect showed that rot recorded the highest mean of 19.44 followed by spot 17.22, while mould had the least mean of 12.22. Furthermore, *Xylopia aethiopica* recorded the highest mean effect of 17.55, followed by *Ocimum viride* with 16.33 while *Piper guineensis* had the lowest with 15.00, respectively (Table 4).

Also, spot had the highest occurrence on *Xylopia aethiopica* and *Piper guineensis*. But mould recorded the lowest occurrence on *Ocimum viride* with 21.66, 20.00 and on the three spices with 12.67, 11.67 and 12.33, respectively (table 4).

Table 3: Analysis of variance of percentage occurrence of rot, mould and spot of spices from different locations investigated.

Sources	Rot%	Mould%	Spot%
Treatments	19.45	5.8	3.53
Error	19.45	3.43	111.60
Total	31.12	9.23	117.13
L1	25.00	12.33	10.33
L2	18.33	13.33	12.33
L3	20.00	15.00	10.33
L4	15.00	12.00	11.67

Total	78.33	52.66	45.16

Key:

L1 = Owerri L3 = Isuochi

L2 = Ishiagu L4 = Umuahia

Table 4: Means of main effect of rot, mould and spot on the spices.

Diseases	**Xa**	**Pg**	**Ov**	**Mean total**
Rot	18.33	13.33	20.00	17.22
Mound	12.67	11.67	12.33	12.22
Spot	21.66	20.00	16.66	19.44
Average	17.55	15.00	16.33	

Key:

X,a = *Xylopia aethiopica*

p.g = *Piper guineensis*

O.v = *Ocimum viride*

Means of main effect of rot mould and spot on different locations revealed that rot recorded highest followed by mould when spot was the lowest with 19.58, 13.17 and 11.17, respectively (Tables 5).

Spices from Owerri recorded the highest disease development followed by those from Isuochi, Ishiagu and Umuahia with 15.89, 15.11, 14.66 and 12.89, respectively. Also, rot recorded highest on spices from Owerri, with 25.00 while spot recorded highest on spices from Ishiagu with 12.33, Mould recorded highest on spices from Isuochi with 15.00. On the other hand, rot recorded lowest on spices from Umuahia with 15.00, while mould recorded the lowest in Umuahia when spot recorded the lowest on spices from Owerri with 10.33 (Table 5). This may also be as a result in difference in environmental factors in the different locations as confirmed from the work of (Ihejirika, 2002; Nwufo, 1993; Ihejirika, *et al*., 2005), who reported that

environment plays significant roles on disease development or survival in any given area or location.

Table 5: Mean of main effect of rot, mould, spot on different locations.

DISEASES	OW	ISH	ISU	UMU	MEAN TOTAL
ROT	25.00	18.33	20.00	15.00	19.58
MOULD	12.33	13.33	15.00	12.00	13.17
SPOT	10.33	12.33	10.33	11.67	11.17
AVERAGE	15.89	14.66	15.11	12.89	

Key:

OW = Owerri **ISU** = Isuochi

ISH= Ishiagu **UMU**= Umuahia

Rhizopus spp, occurred in all the locations with more than 50% occurrence in location 3 and location 4. Also, *Aspergillus spp* occurred in location 1 and location 2. While *Cylindrosporium spp, Fusarium spp, Negrospora spp* and *Trichoderma spp* in occurred in locations 1, 2, 3 and 4, respectively.

Rhizopus spp was observed to have the highest occurrence followed by *Aspergillus spp*. (Table 6). Generally, there were very low level of microbial growth on all the spices. This may be due to the antimicrobial properties of some spices as (Shelef, 1983) reported that Allicin, isolated from garlic oil, inhibits the growth of both gram-negative and gram-positive bacteria. He also reported that Eugenol, carvacrol, and thymol are phenol compounds and, are found in cinnamon, cloves, sage, and oregano and their presence function

as mold inhibitors in bakery items and in addition to adding flavor and aroma to baked products. Also, (Paster *et al.,* 1995) have shown that essential oils of oregano and thyme (which contain carvacrol and thymol) are effective as fumigants against fungi on stored grain.

The association of microorganisms on the spices may be due to contamination because of conditions in which they were grown and harvested. Spores of both *Clostridium perfringens* and *Bacillus cereus* have been found to be present in spices (Kneifel, and Berger, 1994). Also, Zaika, (1988) reported that nutrients present in spices / herbs may stimulate growth and/or biochemical activities of microorganisms.

However, the occurrence of *Rhizopus sp* in all locations may be due to its ability to adapt to environmental and weather conditions easily for its growth and survival. This is in line with the findings of (Iwu, 1993), who reported that *Rhizopus spp* is a universal microbe in this ecological zone.

Table 6: Summary of micro-organisms identified in different locations

Locations	Materials	Associated micro-organisms	
	Xylopia aethiopica	*Cylindrosporium*	*Spp*
OW	*Piper guineensis*	*Aspergillus*	*Spp*
	Ocimum viride	*Rhizopus*	*Spp*
	Xylopia aethiopica	*Fusarium*	*Spp*
ISH	*Piper guineensis*	*Aspergillus*	*Spp*
	Ocimum viride	*Rhizopus*	*Spp*
	Xylopia aethiopica	*Rhizopus*	*Spp*
ISU	*Piper guineensis*	*Rhizopus*	*Spp*
	Ocimum viride	*Nigrospora*	*Spp*

	Xylopia aethiopica	*Rhizopus*	*Spp*
UMU	*Piper guineensis*	*Trichoderma*	*Spp*
	Ocimum viride	*Rhizopus*	*Spp*

Key:

OW = Owerri **ISU** = Isuochi

ISH= Ishiagu **UMU**= Umuahia

Conclusion

This study on *Xylopia aethiopica, ocimum viride* and *Piper guineensis*, showed that out of these three disease symptoms spot, rot and mould, spot recorded the highest occurrence on the spices, while mould recorded the lowest. Generally, they symptoms showed very low occurrence rates on the spices.

Six micro-organisms were identified namely; *Rhizopus spp., Aspergillus spp., Trichoderma spp., Negrospora spp.* and *Fusarium spp.* and *Cylindeosponium spp*. Out of the six microorganisms identified, *Rhizopus spp.* was observed to be the most prominent in the selected spices and locations.

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PERFORMANCE AND ECONOMICS OF PRODUCTION OF DEEP LITTER MANAGED STARTER BROILERS FED NEEM (*Azadirachta indica*) LEAF MEAL

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ABSTRACT

A 28-day feeding trial was conducted to determine the effect of neem (*Azadirachta indica*) leaf meal on the performance and economics of deep litter managed starter broiler production. The neem leaves were harvested, air dried and milled to become neem leaf meal. The neem leaf meal was included in broiler starter diets at 0, 2.5, 5.0, 7.5, and 10% levels, respectively. One hundred and fifty (150) Anak broiler starter chicks raised on a commercial starter mash for one week were used. The birds were divided into 5 groups of 30 birds each and randomly assigned to the 5 experimental diets in a completely randomized design (CRD). Each group was sub-divided into 3 replicates of 10 birds each and each replicate housed in pens measuring 11/2 X 2m. Feed and water were provided *ad libitum* for 4 weeks. Proximate analysis of the air dried neem leaf meal contains - high crude fibre (15.56%) and moderate crude protein content (18.10%). Birds fed 7.5 and 10% diets had a significantly ($P<0.05$) lower weight gain ,feed conversion ratio and protein efficiency ratio than the other treatment groups. At 10% level feed intake was significantly reduced.Birds fed 2.5% had a slightly better weight gain,feed intake and feed conversion ratio than the control.Cost per kg

feed and broiler produced were slightly lower in birds fed 2.5% than the control and the other Neem leaf meal diet groups.

Keywords: Neem leaf meal, broiler starter performance.

INTRODUCTION:

Cereal grains and legumes constitute the major feed ingredients used in poultry production in Nigeria. However, the increasing demand for cereal grains and legumes for human food ,livestock feed and industrial raw materials had led to their scarcity and subsequent high costs. This situation has resulted to an increase in the prices of commercial feeds and invariably escalated the market prices of poultry products beyond the reach of an average Nigerian family.

. The scenario is worse in the south - eastern part of the Country where pig and poultry production has been very adversely affected (Salami and Oyewole, 1997). Soybean (*Glycine max*) and groundnut (*Arachis hypogea*) used to play key roles in the feeding of non-ruminants in Nigeria. The continued inadequate availability of these feedstuffs as a result of their multiple uses, coupled with high cost of imported ingredients, has shot up the prices of commercial feeds by about 2000% within the last 20 years (Udedibie, 2003).

There is the need therefore to determine the feeding value of graded levels of Neem leaf meal diet on starter broiler performance and economics of production. South-eastern Nigeria is highly endowed with browse plants which goats in the region feed upon. Leaf meals from some of these plants have been shown to serve as sources of protein, vitamins and minerals as well as carotenoids for non-ruminants (D'Mello *et al*, 1987). This has been demonstrated with leaf meals from *Leucaena leucocephala* (Mateo *et al,* 1970, 1980), *Cajanus cajan*, (Udedibie and Igwe, 1989), *Gliricidia sepium* (Osei *et al*, 1990), and *Alchorina cordifolia* (Udedibie and Opara, 1998). Similar observations have recently been made by Esonu *et al,* (2002) and Azubuike (2003) in their studies on *Microdesmis puberula,* another popular browse plant in the south-eastern agro-ecological zone of Nigeria.

One browse plant in the zone that has not been given serious attention as source of feed is Neem tree (*Azadirachta indica*) known in our area as 'dogonyaro' is an ever-green tree and produces a lot of leaf biomans. The leaves are used for treatment of malaria in our country. It contains 15-20% crude protein and about 20% crude fibre. Neem tree, (*Azadirachta indica*) is native to south east Asia and grows in many countires throughout the world (Schmutterer, 1990). Common names of it include: English, Neem; Indian lilac,; French, Azaradiradinde; Spanish, Margosa nim; German, Niemboaum. A. Indica propagates readily from cutting, stumps, tissue culture or seed. Neem is a large evergreen tree with a wide trunk which can grow 12-24 meters tall. It is mainly used as a shade tree in many areas because it tolerates a wide variety of field conditions (Koul et al 1990, Shmutterer 1990). Medically, all parts of the plant have been used including the fruits, seed, oil (extracted from the seed) leaves, roots and bark. Extract from the plant are also currently being investigated for use against retro viruses such as the AIDS virus, for treating cancer diabetes and allergies. Neem kernel has been reported to posses feeding value in non-ruminant diet (Uko, 2003). The presence of many toxic agents collectively called triterpenoids has limited its use as protein supplement in poultry diets Magalakshmi et al, 1996). The work of Uko; (2003) also shows that neem

kernel contains two groups toxins; heat-liable toxins, which have necrotizing effect and heat resistant ones that are anti-nutritional. However studies conducted by (Uko and Kamalu, 2006) shows that the anti-nutritional factors of neem are heat-stable and mainly concentrated in the oil inside the seed. Recent studies in our station have demonstrated that Neem leaf meal could be tolerated by weaner rabbits (Emeka, 2004) and finisher broiler (Njoku,2005) at 5% dietry level.

The objective of this study is to determine the feeding value of graded levels of neem leaf meal diet on starter broiler performance and economics of production.

MATERIALS AND METHODS

Site of study: The study was carried out during the dry season in the Poultry Unit of the Teaching and Research Farm of the School of Agriculture and Agricultural Technology and Animal Science Laboratory of the Federal University of Technology, Owerri, Imo State, Nigeria. Imo State lies between latitude 4˚4' and 6˚3' N and longitude 6˚15' and 8˚15' E. Owerri is about 100m above sea level. The climatic data of Owerri as summarized in Ministry of Lands and Survey Atlas (1994) of Imo State is as follows: mean annual rainfall, 2500mm; temperature range, 26.5 – 27.5˚C and humidity range of 70 – 80%. Dry season duration (i.e. months with less than 65mm rainfall) is 3months. The annual evapo-transpiration is 1450mm and the soil type is essentially sandy loam with average pH of 5.5.

Source and processing of Neem leaves: Fresh green neem leaves used for the experiment was harvested within the University community in batches. Each batch of collection was air dried under room temperature. They were considered adequately dried when they became crispy to touch. They were then milled, using a hammer mill with 2mm sieve, to produce neem leaf meal (NLM). Samples of the leaf meal were subjected to proximate analysis according to AOAC (1995)

Experimental Diets:

Five white maize-based experimental broiler starter diets (23% CP) were made, incorporating the leaf meal at 5 levels of 0.00, 2.50, 5.00, 7.50 and 10.00% respectively. The ingredient composition of the experimental diets is shown in Table 1. The diets were balanced for crude protein and caloric content to meet the requirements of starter broilers in the tropics (Sainsbury, 1980)

Experimental Birds and Design:

One hundred and fifty (150) Anak broiler chicks raised on a commercial starter mash for one week were used. The birds were divided into 5 groups of 30 birds each and each group was randomly assigned to one of the 5 experimental diets in a Completely Randomized Design (CRD). Each group was sub-divided into 3 replicates of 10 birds each and each replicate housed in a pen measuring 11/2 x 2m fitted with necessary brooding facilities. Feed and water were given to them *ad-libitum*. The birds were weighed at the beginning of the trial and weekly thereafter. Daily feed intake per pen was determined by weighing of the feed offered and left-over the following morning. The feeding trial lasted 4 weeks.

Data collected were subjected to analysis of variance. Where analysis of variance indicated significant treatment effects, means were separated using Duncan's New Multiple Range Test as described by Steel and Torrie (1980).

RESULTS AND DISCUSSION:

The Proximate composition of the neem leaf meal is presented in Table 2. The leaf meal contained 18.10% crude protein, 15.56% crude fibre, 2.50% ether extract, 5.26% ash and 58.22% nitrogen free extract. The leaf meal displayed same characteristics as leaf meals from other tropical browse plants – high crude fibre and moderate crude protein content as reported for *Jacaranda mimosifolia* (Okorie, 2006) and for *Microdesmis puberula* (Esonu *et al,* 2002). With relatively high crude fibre, content, (15.56%), the metabolizable energy must be low even though its gross energy content was high (4.16 Kcal/g).

The performance of the experimental birds is summarised in Table 3. The average final body weight of the broiler chicks decreased significantly ($P<0.05$) as the level of neem leaf meal increased, with the birds on 10% level recording the least body weight. The result of the work is in line with the report of Udedibie and Opara (1998) and Esonu *et al* (2002) that growth declines with high leaf meal inclusion levels. The feed intake of the starter broilers remained the same ($P>0.05$) up to 7.5% and significantly dropped at 10% level ($p<0.05$). Except for birds fed 2.5% neem leaf meal, the growth rate decreased as the level of neem leaf meal inclusion increased supporting earlier reports by Esonu *et al,* (2002) and D'Mello and Acamovic (1989). Feed conversion ratio was significantly low ($P<0.05$) in birds fed 7.5 and 10% Neem leaf meal diets relative to the control. The depressed growth rate,feedintake, feed conversion ratio and protein efficiency ratio indicates the inability of young broiler chicks to handle high fibre diets (Oluyemi and Roberts, 2000; Madubuike and Obidimma, 2009).The protein efficiency ratio (PER) of the treatment groups followed the same trend as the feed conversion ratio. One percent mortality was recorded in each of the treatment groups.The mortalites were caused by soldier ants attack and not the diets.

The cost analysis of the trial is shown in Table 4. The costs of the diets per kg were N49.45, N49.15, N48.00, N47.03 and N45.92 for T_0, $T_{2.5}$, $T_{5.0}$, $T_{7.5}$, and T_{10}, respectively. There were no significant difference ($P> 0.05$) on the cost /kg feed and cost/kg broiler produced.However,birds fed 7.5 and 10% Neem leaf meal diets had a slightly lower feed cost and higher cost/kg broiler produced than the other treatment groups.This tended to show poor utilization of high dietry inclusion levels of Neem leaf meal. However, the costs of production of 1kg broiler (feed conversion ratio x feed cost/kg) were N138.95, N129.76, N136.57, N150.97 and N161.17 for T_0, $T_{2.5}$, $T_{5.0}$, $T_{7.5}$ and $T_{10,}$ respectively. The costs of production of the birds on $T_{7.5}$ and T_{10} were much higher than those of the control, $T_{2.5}$ and $T_{5.0}$.

Conclusion:

It is therefore concluded that inclusion of neem leaf meal for young broiler chicks should not exceed 5%, since inclusion levels beyond 5% suppressed their feed intake and growth rate,and also increased cost of production

Table 1: Ingredient composition of the broiler starter experimental diets

	Dietary levels of leaf meal (%)				
Ingredients (%)	**0.00**	**2.50**	**5.00**	**7.50**	**10.00**
White Maize	50.00	49.00	47.00	46.00	45.00
Neem Leaf meal	0.00	2.50	5.00	7.50	10.00
Soybean meal	26.00	26.00	26.00	26.00	26.00
Wheat offal	10.00	8.50	8.00	6.50	5.00
Palm kernel cake	5.00	5.00	5.00	5.00	5.00
Fish meal	2.00	2.00	2.00	2.00	2.00
Blood meal	3.00	3.00	3.00	3.00	3.00
Bone meal	3.00	3.00	3.00	3.00	3.00
Common Salt	0.25	0.25	0.25	0.25	0.25
Vitamin/Trace min. premix	0.25	0.25	0.25	0.25	0.25
L-lysine	0.25	0.25	0.25	0.25	0.25
L-methionine	0.25	0.25	0.25	0.25	0.25
Total	100.00	100.00	100.00	100.00	100.00
Calculated Analysis (% of Dm)					
Crude protein	21.97	21.96	21.95	21.92	21.94
Crude fibre	4.41	4.70	5.00	5.28	5.57
Ash	4.02	4.06	4.11	4.16	4.20
Ether extract	4.34	4.32	4.33	4.31	4.30
Calcium	1.82	1.82	1.82	1.82	1.82
Phosphorus	0.98	0.98	0.97	0.96	0.95
Metabolizable Energy(kcal/kg)	2734.71	2702.91	2690.27	2683.45	2685.45

Each kg of feed contained: Vit. A, 2, 000,000 i.u; vit. $D_{3,}$ 100 iu ; vit. E, 8g ; vit. K, 0.4g ; vit. B_1, 0.3g ; vit. B_2, 1.0g ; vit .B_6, 0.6g ; vit. C, 2.40g, vit. B_{12}, 40g ; Mn, 160g ; Fe, 8.0g ; Zn, 7.2g; Cu, 0.3g ; Iodine, 0.25g ; Co, 36.0mg ; Se, 16.0mg.

Table 2: Proximate Composition of Neem Leaf Meal (100% DM basis)

Components	% of dm
Crude Protein	18.10
Crude Fibre	15.56
Ether Extract	2.50
Ash	5.62
Nitrogen free Extract	58.22
Gross Energy (Kcal/gm)	4.16

Table 3 Effect of neem leaf meal (*Azadirachta indica*) on the performance of starter broiler

	Dietary levels of neem leaf meal (%)					
Parameters	**0**	**2.5**	**5.0**	**7.5**	**10**	**SEM**
Av. initial body weight (g)	107.53	107.54	107.52	107.51	107.56	1.21
Av. final body weight (g)	880.17^{a}	911.00^{a}	860.00^{a}	765.33^{b}	676.40^{b}	28.10
Av. body weight gain (g)	772.67^{a}	803.46^{a}	752.48^{a}	657.82^{b}	568.84^{b}	28.10
Av. daily body weight gain (g)	27.59^{a}	28.70^{a}	26.88^{a}	23.49^{b}	20.30^{b}	1.00
Av. total feed intake (g)	2022.36^{a}	2119.33^{a}	2125.34^{a}	2078.35^{a}	1987.17^{b}	23.84
Av. daily feed intake (g)	72.23^{ab}	75.69^{a}	75.90^{a}	74.23^{a}	70.96^{b}	0.85
Feed conversion ratio (FCR) (g feed/g gain)	2.81^{a}	2.64^{a}	2.84^{a}	3.21^{b}	3.51^{b}	0.11
Protein efficiency ratio (PER)	1.74^{a}	1.74^{a}	1.64^{b}	1.50^{b}	1.34^{b}	0.06

Mortality	1	1	1	1	1	-

[a b] Means within the same row with different letter superscripts are significantly different (P < 0.05)

Table 4 Effects of neem leaf meal (*Azadirachta indica*) on the economics of starter broiler production

	Dietary levels of leaf meal inclusion(%)					
Parameters	**0**	**2.5**	**5.0**	**7.5**	**10**	**SEM**
Feed conversion ratio (FCR) (g feed/g gain)	2.81	2.64	2.84	3.21	3.51	0.11
Feed Cost (₦/Kg feed)	49.45	49.15	48.09	47.03	45.92	-
Feed Cost per Kg broiler (₦)	138.95	129.76	136.57	150.97	161.17	-

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HAEMATOLOGICAL AND BIOCHEMICAL INDICES OF West African Dwarf GOATS FED *Carica papaya* (Paw paw) LEAF MEAL BASED DIETS

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ABSTRACT

Twelve weaner West African dwarf (WAD) bucks, 8-10 months of age averaging 6 kg in weight were randomly divided into 4 groups of 3 goats each and housed individually in cemented floored pens. The goats were randomly assigned to four experimental diets 1, 2, 3 and 4, in a completely randomized design. The diets compounded from cassava peel meal, palm kernel meal, brewer's dried grain, molasses, common salt and bone meal contained 0, 10, 20 and 30% *Carica papaya* (paw paw) leaf meal respectively. Each animal in each group was offered an assigned diet at 5% of the body weight for 35 days. Blood samples were drawn from each animal on 21 and 35 day of the feeding trial and analysed for haematological and biochemical components. Results showed that haemaglobin (g) and packed cell volume (%) differed ($P<0.05$) significantly among treatment diets. The values were 8.43, 7.23, 7.30 and 6.30g/dl and 25.35, 21.67, 22.00 and 18.93% for diets 1, 2, 3 and 4 respectively. White blood cell (x 10^3 ml), red blood cell (x 10^6 ml), Mean corpuscular volume (μm^3), Mean corpuscular haemaglobin (pg) and Mean corpuscular haemaglobin concentration (%) were not influenced ($P>0.05$) by diets. Similarly, total protein, albumin, globulin, Aspartate amino transferase (AST) and Alanine amino transferase (ALT) did not differ significantly ($P>0.05$) among treatment groups. These results to a large extent suggests that *Carica papaya* leaf meal can be incorporated in WAD goats diet up to the level of about 10-30% without any deleterious effects on normal metabolic and physiological functions of the goats.

Key words: Haematological, biochemical indices, goats, pawpaw leaf meal

Introduction

Goats provided over 25% of the lean meat consumed (FAO, 1993) or about 147,360 metric tonnes of meat in Nigeria (FAO STAT, 2008). The West African Dwarf (WAD) goat is a trypanotolerant breed kept mainly for meat production and found within the rainforest and derived savanna ecological zone of Nigeria. The population of WAD goats in Nigeria is about 28 million (FAO STAT, 2006).

Francis (1988) reported that browse was the most commonly observed feed type given either alone or in combination with other feeds where feed was provided in households keeping goats in South Eastern Nigeria. Leaf meals obtained from neem (Anurudu and Ewuola, 2010), akee apple, *Etanda africana*, *Gliricidia* and Baobab (Belewu and Ojo-Alokomaro, 2007) and forage such as *Panicium maximum* supplemented with *Afzelia africana* and

Newbouldia laevis (Ikhimioya and Imaseun. 2007) and *Milletia thonningii* (Ajala *et al*., 2000) have successfully been fed to WAD goats with improved growth performance and haematological profile. Despite the importance of leaf meals, it is known that leaves harbour wide range of toxins like tannins, haemagglutinins, saponin, hydrocyanic acid and prosopine etc hence the potential of leaf meals is still in doubt (Belewu and Ojo-Alokomaro, 2007). Efforts to reduce competition between man and animals for conventional plant protein sources have necessitated animal nutritionist to subject to nutritional trials hitherto novel, discarded and non-conventional feed resources such as *Carica papaya* leaf meal. The aim is to provide cheap and available feed resources that will contribute to meeting the nutritional requirements of goats. Although, there is paucity of information in the use of *C. papaya* leaves as a ruminant feed, some researchers have successfully incorporated *C. papaya* leaves in diets of goats at 1.5% of body weight with improved feed intake and weight gain (Amaechi and Ibekwe, 2009). Such improved growth performance of goats might be due to protein richness of the test diets (Ajala *et al.,* 2000) as a result of the high crude protein of the paw paw leaves and anti-helminthic properties of *C. papaya* leaves (Satrija *et al.,* 1994).

Crude protein level of 30.12% has been reported for pawpaw leaves (Onyimonyi and Onu, 2009). Pawpaw leaves contain cyanogenic glucosides and tannin, which at high concentrations can cause adverse reactions in livestock (Bennett *et al*., 1997). Pawpaw leaves also contain saponin, cardiac glucoside, alkaloid (Ayoola and Adedeye, 2010), benzylisothiocyanate, glucosinolate (Kumar *et al*., 1991; MacLeod and Pieris, 1983) and alkaloids (Tang, 1979).

According to Karesh and Cook (1995) examining blood for their constituents is used to monitor and evaluate disease prognosis of animals. Much of the available information on the haematology and biochemistry of goats in the humid tropics has mostly been on animal prognosis. Thus information on blood parameters of goats offered foliages from these unconventional plants as feed have mostly been scanty. The present report presents the results of a preliminary study on the haematological and biochemical profile of West African Dwarf goats fed varying levels of *Carica papaya* leaf meal.

Materials and Methods

The experiment was conducted during the rainy season (July/August) at the Sheep and Goat Unit of the Teaching and Research Farm, Michael Okpara University of Agriculture, Umudike. Umudike is geographically located in Abia state, Nigeria on latitude 05^0 29' North, longitude 07^0 31' East at altitude of 122 meters or 400 feet above sea level. It falls within the rain forest zone of West Africa which is characterized by long duration of rainfall (April-October) and short period of dry season (November-March). Average rainfall is 2169.8 mm in 148-155 days. Average temperature is 26^0C with maximum of 36^0C and minimum of 22^0C. Relative humidity ranges from 50-95%.

Twelve (12) post weaned WAD goats were used for this experiment. The goats were randomly allocated to four treatments, with three post weaned WAD goats per treatment in a completely randomized design. Prior to the trial, the animals were dewormed and given acaricide bath. Each animal

was later housed individually in well ventilated cement floored pen equipped with feeder and waterer. *C. papaya* leaves were collected from the University environment and were identified by a botanist in the Botany Department of the University. Subsequently, they were air-dried for 2 weeks and the resultant leaf meal was ground with an electric blender into a fine powdery form. Four experimental diets 1, 2, 3 and 4 were formulated. Diet 1 containing 0% inclusion level of *C. papaya* leaf meal served as the control diet. The *C. papaya* leaf meal was added to the diets 2, 3 and 4 at 10, 20 and 30% respectively. The other ingredients were incorporated at fixed proportions (Table 1).

Table 1: Ingredient and chemical composition of experimental diets (%)

Ingredients	*Diets (%) of Carica papaya* **leaf meal**			
	Levels			
	1 (0%)	*2 (10%)*	*3 (20%)*	**4 (30%)**
Cassava peel meal	40.00	40.00	40.00	40.00
Palm kernel meal	40.00	30.00	20.00	10.00
Brewer's dried grain	17.00	17.00	17.00	17.00
Bone meal	1.00	1.00	1.00	1.00
Salt	1.00	1.00	1.00	1.00
Molasses	2.00	2.00	2.00	2.00
Carica papaya leaf meal	0.00	10.00	20.00	30.00
Total	100.00	100.00	100.00	100.00
Calculated nutrient content (%)				
Crude protein	13.50	13.55	13.60	13.65
Crude fibre	11.95	11.60	11.37	11.18
Ether extract	4.80	4.45	4.31	4.29

Haematological and biochemical studies

Two sets of blood samples were collected on weekly basis for three weeks. Blood samples (10 ml) were drawn from each goat through the jugular vein. A set of blood sample, the first 5 ml was collected from each animal in labeled sterile bijour bottles containing 1 mg ml^{-1} of ethylene diamine tetracetate (EDTA) for haematological analysis. The second 5ml was collected from each animal over anti-coagulant free sample bottles. The blood was allowed to clot at room temperature and serum separated by centrifuging within 3 hours of collection. This was used for biochemical studies.

The following indices were determined using routine laboratory methods. Packed cell volume (PCV) was determined by the microhaematocrit method as described by Dacie and Lewis (1991) and Schalm *et al*. (1975). Erythroctyes (red blood cells) were counted using the improved Neubauer haemocytometer (Dacie and Lewis (1991). Haemaglobin(Hb) concentration and Leucocytes counts (WBC) were determined by method described by Jain (1986). Mean corpuscular volume (MCV), Mean corpuscular haemaglobin (MCH) and

Mean corpuscular haemaglobin concentration (MCHC) were calculated from the PCV, Hb concentration and RBC counts as described by (Jain, 1986).Biochemical constituents of the serum samples such as total protein, albumin, globulin, aspartate amino transferase (AST) and Alanine amino transferase (ALT) were also determined as described by Toro and Ackermann (1975) and Coles (1986).

Resulting haematological and biochemical data obtained from the samples were subjected to one way analysis of variance according to the procedure of Steel and Torrie (1980). Significant differences between means were separated using the Duncan's multiple range test (Duncan, 1955).

Results and Discussion

Haematological values of WAD goats fed varying levels of *C. papaya* leaf meal are as shown in Table 2.

Table 2: Haematological values of post-weaned West African dwarf goats fed diets containing varying levels of *Carica papaya* (paw-paw) leaf meal

Parameters	*Levels of Carica papaya Leaf meal DIETS*				
	1 (0%)	2 (10%)	3(20%)	4 (30%)	SEM
White blood cell (x 10^3 ml)	5.93	7.22	5.67	6.57	0.46
Red blood cell (x 10^6 ml)	5.89	6.75	5.94	4.83	0.32
Packed cell volume (PCV) %	25.35^{a}	21.67^{ab}	22.00^{ab}	18.93^{b}	0.86
Haemaglobin (Hb) g/dl	8.43^{a}	7.23^{ab}	7.30^{ab}	6.30^{b}	0.29
MCHC (%)	33.36	33.34	33.20	33.28	0.11
MCH (pg)	14.76	10.72	12.62	13.24	0.78
MCV (μm^3)	44.20	32.11	38.40	39.76	2.29

MCHC= Mean corpuscular haemaglobin concentration; MCH = Mean corpuscular haemaglobin; MCV = Mean corpuscular volume. ^{a,b,c} Means with different superscript in a row are significantly different (P<0.05). SEM = Standard error of mean

The haemaglobin (Hb) and packed cell volume (PCV) of the goats fed the diets differed significantly (P<0.05). Packed cell volume for the goats fed the control diet (25.35%) was higher and differed significantly (P<0.05) from the corresponding values obtained for goats fed diets 2 (21.67%), 3 (22.0%) and 4 (18.93%) containing 10%, 20% and 30% *C. papaya* leaf meal respectively. However, the value obtained for goats fed diet 2 was similar P>0.05) to those fed diet 3. As a normal rule in animals, the PCV is directly related to the RBC and Hb contents (Swenson, 1977) and is reflected in this study. The PCV values were within the normal range of 21-35% reported for WAD goats (Daramola *et al*., 2005) but lower than the reported mean PCV values of 25.7%, 28.4% and 27.25% for Red Sokoto, West African Dwarf and Baladi goats respectively (Tambuwal *et al*., 2002; Opara *et al*., 2010; Azab and Abdel-Maksoud, 1999). Belewu and Ojo-Alokomaro (2007) reported PCV values of 20.5-24.8% for WAD goats fed leaf meal based diets. PCV is used as an index of toxicity and its composition varies within breeds (Azab and Abdel-

Maksoud, 1999). The pawpaw leaf meal diets generally promoted lower PCV values in goats than the control diets, implying that there were traces of some ANFs or toxic elements in the pawpaw leaf based diets relative to the control (Ahamefule *et al.*, 2005). Reduction in the concentration of PCV in the blood usually would suggest presence of a toxic factor which has adverse effect on blood formation (Oyawoye and Ogunkunle, 1998). PCV values are good indicators of the haemogramme and especially the number of circulating erythrocytes as well as the Hb (Hawkey *et al*., 1984). A decrease in its percentage shows a poor transportation of oxygen and absorbed nutrient. Such differences in PCV may also be attributable to the physiological and nutritional status of the animals (Esonu *et al*., 2001).

Pawpaw leaves is reported to contain ANFs (saponin, cardiac glucoside, alkaloid (Ayoola and Adedeye, 2010), benzylisothiocyanate, glucosinolate (Kumar *et al*., 1991; MacLeod and Pieris, 1983) and alkaloids (Tang, 1979).Anti-nutritional factors have been shown to affect blood formation in animals probably through the reduction of PCV (Ologhobo *et al*., 1992). It is likely that the increasing concentrations of some of the ANFs in test diets, as the level of paw-paw leaf meal increased from 0% to 30% in the respective diets may be responsible for the declining PCV values observed among treatment groups fed the paw-paw leaf meal based diets.

The Hb content in the blood differed significantly ($P<0.05$) among treatments but there was a decline in the values as the level of pawpaw leaf meal in the diets increased. All the values were outside the normal range of 7-15g/dl for WAD goats (Daramola *et al*., 2005) and lower than the value of 13.2g/dl reported by Taiwo and Ogunsanmi(2003) for WAD goats. However, the Hb values of the goats fed the diets were in agreement with reports of Belewu *et al*. (2006) and Belewu and Ojo-Alokomaro (2007) who obtained Hb values of 5.17 to 8.3g/dl for WAD goats fed leaf meal based diets and Trichoderma treated cassava waste diets. The reduction in RBC and Hb values observed in the goats fed the paw-paw leaf meal based diets could be due to the inherent anti-nutritional factors especially with a higher intake of tannin by goats as the level of paw-paw leaf meal increased in the diets. Eniolorunda and Fasina (2006) had made similar observations in goats fed *Cynodon nlemfuensis* and *Spondias mombin* based diets. Reduction in the values of PCV and Hb may indicate a low protein intake, or liver damage or anaemia. Haemaglobin falls gradually in anmals on a low protein intake, parasitological infestation or liver damage (Linsday, 1977).

The WBC, RBC, MCH, MCHC and MCV were not significantly affected ($P>0.05$) by dietary treatment. The similarity in the levels of WBC, RBC, MCH, MCV and MCHC in the WAD goats further substantiated the nutritional adequacy and safety of *C. papaya* leaf meal incorporated up to 30%. The RBC counts observed in this experiment did not differ significantly ($P>0.05$) between dietary treatments, but they were much lower than the 9.2-13.5($x10^6$ ml) range reported for Red Sokoto goats (Tambuwal *et al*., 2002) and 18.7 ($x10^6$ ml) (Taiwo and Ogunsanmi, 2003) for WAD goats. Red blood cell indices aid in the characterization of anaemia (Merck, 1979). Thus, the low RBC counts recorded for the goats fed the different diets present a likely high susceptibility

to anaemia-related disease conditions by these goats. This is corroborated by the fact that the goats fed the paw-paw leaf meal based diets in this study recorded MCV values that were relatively high 32.11-39.76fl compared to the normal range of 18-34fl for goats, which could have resulted from release of immature red blood cells into the blood system (Merck, 1979).The MCHC values (33.20-33.36%)were within the normal range of 30-36% for goats (Swenson, 1977; Radostits *et al*., 1997; Banerjee, 2007) or specifically 32.0-34.6% reported for WAD goats (Daramola *et al* ., 2005).

The WBC values of 5.67-7.22(x 10^3 ml) obtained in the present study are within the normal range of 4.0 to 13.0(x 10^3 ml) reported for goats in general (Radostits *et al.,* 1997). Daramola *et al*. (2005) reported a normal WBC range of 6.80-20.0((x 10^3 ml) for WAD goats which agrees with the findings of this study. The low to moderate WBC counts observed in the goats could indicate the absence or low incidence of microbial infection (foreign body or antigen) (Swenson, 1977) or parasites (Adejinmi *et al*., 2000)) in the circulating blood. High WBC counts or leucocytosis have been attributed to the presence of microbial infection, antigen (Swenson, 1977) or parasites (Adejinmi *et al*., 2000) and increased level of anti-nutritional factors (ANFs) in the diets consumed by the goats (Ahamefule *et al*., 2005).

The *C. papaya* leaf meal may have exerted its anti-helminthic effect resulting in reduction or elimination of parasites (Satrija *et al*., 1994). The rising but non-significant WBC count obtained in goats fed diets 1 to 4 in this study tended to support the existence of traces of ANFs in the diets due to pawpaw leaf meal inclusion in the diets. Nevertheless, the WBC values obtained in the present study is still higher than the values of 4.16 to 5.49 (x10^{11}) reported for WAD goats fed leaf meal based diets obtained from Akee apple, *Etanda africana* , *Gliricidia* and Baobab leaf meals (Belewu and Ojo-Alokomaro, 2007).Table 3 showed the biochemical values of post-weaned goats fed varying levels of paw paw leaf meal.

Table 3: Serum biochemical values of West African Dwarf goats fed diets containing varying levels of *Carica papaya* (paw-paw) leaf meal

Parameters	*Levels* 1 (0%)	*of* 2(10%)	*Carica papaya* 3 (20%)	*Leaf meal* 4 (30%)	SEM
Total protein (g/dl)	5.97	6.07	6.07	5.83	0.21
Albumin (g/dl)	2.97	3.23	3.13	3.23	0.17
Globulin (g/dl)	2.73	2.83	2.93	2.60	0.09
AST(iu/litre)	10.67	11.83	10.47	9.80	0.39
ALT (iu/litre)	8.50	8.50	8.23	7.57	0.38

[a,b,c] Means without superscript in a row are not significantly different (P>0.05). SEM = Standard error of mean

All the biochemical values did not differ significantly (P<0.05) among treatment means. According to Otesile *et al.* (1991) serum biochemistry is a generalized medium of assessing the health status of animals. Serum total protein, albumin and globulin values did not show any significant differences (P<0.05) in values obtained for all the treatment groups.

Serum proteins are important in osmotic regulation, immunity and

transport of several substances in the animal body (Jain, 1986). Total protein in the serum of the goats were comparable (P<0.05) among the treatment diets. Statistical non-significant (P<0.05) differences between the control and paw-paw leaf meal based diets may be related to the findings of Tewe and Maner (1980) that serum protein is not related to the amount of calories contained in the diets but to the availability of protein. The mean total protein of the goats in the present study ranged from 5.83g/dl to 6.07g/dl and is within the range of 5.28 – 6.65g/dl reported for WAD goats (Kamalu *et al*., 1988) and 5.06-6.13g/dl reported for WAD goats fed *Milletia thonningii* leaf meal based diets (Ajala *et al*., 2000).

However, the concentration of total protein in the serum of the goats in the present study is higher than the value of 5.2g/dl reported for WAD goats in Southeastern Nigeria (Opara *et al*., 2010) but lower than the values of 6.30-8.50g/dl (Daramola *et al*., 2005) and 7.53-9.55g/dl (Ikhimioya and Imaseun, 2007) and 63.33g/l (Addass *et al*., 2010) reported for WAD goats. The concentration of total serum protein in normal goats has been reported to vary from 64.0-70.0g/dl, 60.0-75.0g/dl and 64.0-79.0g/dl (Kaneko, 1989; Radostits *et* al., 1997; and Benjamin, 1989). However, the mean total protein values obtained in the present study are within the range of 5.5-10.0g/dl reported for various ruminant species (Jain, 1986; Kaneko, 1989).Generally, WAD goats have been reported to have lower concentration of serum protein (5.26 - 6.65), albumin (1.53 -2.10) and globulins (2.60 – 4.24g/dl) (Kamalu *et al*., 1988) compared to standard goats (6.90, 3.30, 3.60g/dl) (Stahr, 1977) and Nigerian goats (6.40, 2.60, 3.80g/dl) (Oduye and Adadevoh, 1976).This could be attributed to the relatively young ages of the goats used for the present study. Kamalu *et al*. (1988) and Hoversland *et al*. (1974) had reported lower serum total protein levels in kids than the adult WAD goats. Differences in the environment, nutritional regimen and genetic make up of WAD goats may account for this disparity. The diets in the present study did not significantly affect the globulin and albumin levels in the serum of the goats indicating the safety of the *Carica papaya* leaves as supplements to goats.

Ikhimioya and Imaseun (2007) had made similar observations, when they fed *Afzelia africana* and *N. laevis* leaves as supplements to WAD goats. The concentration of albumin (2.97 -3.21g/dl) in this study is similar to the values of 3.05-3.30g/dl and 2.91-2.96g/dl reported by Ikhimioya and Imaseun (2007) and Esugbohungbe and Oduyemi (2002) respectively who fed leaf meal based diets to WAD goats. It is within the range of 27-39g/l reported by several researchers (Kaneko 1989; Benjamin, 1989). Opara *et al*. (2010) had reported similar albumin values of 2.8-2.9g/dl but lower globulin values of 2.3-2.4g/dl for WAD goats compared to globulin values of 2.60-2.93g/dl reported in the present study. The similar total protein, albumin and globulin values in this study suggests that paw-paw leaves contained low levels of tannin known to diminish nutrient permeability in gut walls as well as increase excretion of endogenous protein which is subsequently passed out in the faeces and so may not alter protein metabolism(Mitjavilla *et al*., 1977).

The Aspartate amino transferase (AST) and Alanine amino transferase (ALT) serum concentrations (iu/l) ranged from 9.80-11.83 and 7.57-8.50iu/l

respectively but were similar (P<0.05) in all the goats fed the control and *Carica papaya* leaf meal based diets. The former fell outside the normal values (12-38 iu/l) for WAD goats while the later had values which were within the stipulated range (2-22 iu/l) reported by Daramola *et al*. (2005). Daramola *et al*. (2005) had observed very wide range in the concentrations of these enzymes in WAD goats. The low and comparable values in the concentration of AST and ALT are an indication of the good protein quality of the test diets. Fasina *et al*. (1999) observed that an increase in the Aspartate amino transferase (AST) also known as serum glutamate oxalo acetic transaminase (SGOT) and Alanine amino transferase (ALT) also known as serum glutamic pyruvic tranaminase (SGPT) serum concentration values would signify necrosis and myocardial infarctions which are indicators of poor protein quality in the test diets. However, Campbell and Cole (1986) cautioned against interpreting serum enzyme activity loosely because enzyme activity vary among species and tissues. For instance for a specific enzyme in a small organ, a serum increase may reflect damage to another organ with less activity programme of tissues (Ahamefule *et al*., 2005). According to Keele and Neil (1971), serum levels of AST are significantly high under disease and morbid conditions involving injuries to large numbers of metabolically active cells. However, the result of the present study, suggests a contrary situation in this regard thus indicating the potential of *C. papaya* leaves in the feeding of goats.

Conclusion

In conclusion, it is recommended that paw paw leaf meal can be incorporated in the diet of WAD goats to the level of about 10-30% without any deleterious effects on normal metabolic and physiological functions of the goats.

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EVALUATION OF SUNDRIED *MICRODESMIS PUBERULA* LEAF MEAL ON THE GROWTH PERFORMANCE OF WEANER PIGS

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Abstract

A 49-day feeding trial involving twenty four crossbred (Large White x Landrace) ten-week old weaner pigs was conducted to evaluate the growth performance of weaner pigs fed *Microdesmis puberula* (MP) leaf meal. The weaner pigs were divided into 4 groups of 6 pigs each. Each group was subdivided into 3 replicates of 2 pigs each and the pigs were randomly assigned to treatments in a completely randomized design. Four diets were formulated to contain sun dried MP leaf meal at dietary levels of 0, 5, 10 and 15%. The leaf meal at 0% was the control diet. Results of the experiment showed that there were no significant differences ($P>0.05$) in average daily gain, feed conversion ratio, total weight gain, average daily feed intake and final live weight. However, feed cost per kilogramme weight gain differed significantly ($P<0.05$) among the treatment groups. Pigs fed diet 2 (5%MP) had the least feed cost per kilogramme weight gain (N161.89) while the cost of gaining a kilogramme of meat by the pigs fed diets 3 (10%), 4 (15%) and 1(0%) were N169.97, N168.85 and N178.66 respectively. Result of this study suggests that *Microdesmis puberula* leaf meal could be incorporated up to 15% replacing 30.80% of soybean meal and 22.65% of maize in weaner pigs' diet without affecting growth performance of weaner pigs.

Key words: Growth performance, leaf meal, Microdesmis puberula, weaner pig

Introduction

The tropical zones contain a rich genetic diversity of plant species and particularly shrubs, trees, herbs, woody vines, lianas and forbs which contribute to the forage resource base of farm animals. Forage crops are potentially the most abundant protein source for livestock feeding. Conventionally, the leaves of forage plants though have been used as sources of crude protein, minerals and vitamins for rabbits, sheep, goats and cattle but they have been sparingly used as sources of crude protein in pig diets. This is inspite of their appreciable crude protein content, luxuriant growth and high biomass yield. These forage plants which are often fed to pigs fresh to fill–up and provide some vitamins compare favourably with crude protein levels of 20.53, 22.49 and 18.74% reported for palm kernel cake, brewers dried grain and wheat offal respectively (Fatufe *et al*., 2007; Amaefule *et al*., 2007; Amaefule *et al*., 2009), which are popular alternatives used by Nigerian farmers.

Feed is the largest cost in the production of pigs for slaughter as it contributes about 75-80% of the total cost (Tewe, 1997). Pig production in the humid tropics is constrained by seasonal feed deficits and high cost, erratic supply of feed ingredients and competition between humans and pigs for available feed resources (Halimani *et al*., 2007). There is a worldwide demand for additional sources of food and the exploitation of forage of low economic importance which would be a step towards better resource utilization (Lindberg and Andersson, 1998). Leaf meals which have been incorporated in poultry diets include cassava, sweet potato (Teguia *et al*., 1997), *Centrosema* (Ngodigha, 1995), *leucaena* (D'Mello and Acamovic, 1989), *Alchornea cordifolia* (Udedibie and Opara, 1998), pigeon pea, pawpaw (Udedibie, 1987), *Mimosa* (Nworgu and Fapohunda, 2002), *Microdesmis puberula (*Esonu *et al*., 2002; Esonu *et al.,* 2003), Elaeis *guineensis* (Esonu *et al*., 2008), *Mucuna* (Emenalom *et al*., 2009) among others.

The leaf meals obtained from several forage crops such as wild sun flower, *Tithonia diversifolia* (Olayeni *et al*., 2006; Fasuyi and Ibitayo, 2010), sweet potato vines, *Ipomoea batatas* (Mora *et* al., 1992; An *et al*., 2005), *Ipomoea asarifolia* (Ekenyem, 2006; Ekenyem and Madubike, 2007), cassava, *Manihot* (Bui Huy Nhu Phuc *et al*., 2001; Iyayi, 2001; Norachack *et al*., 2004), *Gmelina arborea* (Bruce, 1998; Nkwocha *et al*., 2008), *Trichanthera gigantean*, *Morus alba* (Ly *et al*., 2001), *Stylosanthes* (Norachack *et al*., 2004) and *Centrosema* (Ugwu and Chukwuka, 2001) have been incorporated in pig diets. These experiments indicated that forage (leaf meals) could partly replace cereals and protein supplements without reducing pig performance. There is still scanty information on inclusion of forage and leaf meals in pig diets. Efforts have been made to identify new plants species that can be tested and exploited in feeding pigs and other monogastrics (D'Mello, 1995; Halimani *et al*., 2005; Leterme *et al*., 2005). Observation showed that *Microdesmis puberula* leaves are relished by pigs but there is limited information on the use of the leaves in pig diet. The leaves have limited processing demand and not in competitive demand for human consumption. *M. puberula* leaf meal contains 17.32%CP, 24.84%CF, 6.52% EE, 12.25% ash, 1.61% Calcium and 0.24% Phosphorus (Esonu *et al*., 2003). Inclusion of *M. puberula* leaf meal in pig diets would therefore be an addition to the current interest in investigating the use of non-conventional feed resources in animals' diet.

The aim of this study was to evaluate the effect of incorporating *M. puberula* leaves as a protein and energy source in weaner pig diet compared with conventional protein and energy supplements on the growth performance of crossbred weaner pigs

Materials and Methods

Twenty four crossbred (Large White x Landrace) ten-week old weaner pigs of both sexes with an initial body weight of 8.92kg were used. The pigs were allocated randomly by sex into four groups, with each group (treatment) replicated three times, two pigs (one male and one female) per replicate. They were kept individually in pens at the experimental farm and given different diets twice daily.

The study was conducted at the Piggery Unit of Michael Okpara College of Agriculture, Umuagwo, Imo state, Nigeria. The college lies between

latitude 6°N and longitude 7°E within the humid Southeastern Nigeria. Fresh *Microdesmis puberula* (MP) leaves were harvested from mature shrubs. At each harvest, leaves were separated from stems and only the leafy part was chopped into small pieces about 2-3cm long, wilted and sun–dried until crisp while retaining the greenish coloration. The dried leaves were then milled, using a hammer mill with a sieve of 3.36mm to produce the leaf meal. Proximate analysis of the leaf meal was conducted using standard methods (AOAC, 1990) (Table 1).

Table 1: Proximate composition and tannin content of sundried *Microdesmis puberula* leaf meal

Constituents	*Composition (%)*
Dry matter	89.19
Crude protein	18.90
Crude fibre	20.88
Ether extract	4.88
Ash	6.00
Nitrogen free extract	49.34
Tannin	0.95

Four diets designated diets 1, 2, 3 and 4 containing 0,5,10 and 15% levels of MP were formulated. Diet 1 was the control. All the diets were isonitrogenous. Palm oil was added to adjust the metabolizable energy content of the diets (Table 2). The feed allowance was 5% of the body weight. Feed consumed was obtained as the difference between quantity offered and quantity left over. Water was offered *ad-libitum.* The pigs were weighed individually at the start of the study and subsequently on a weekly basis. The experimental design was a completely randomized design (CRD). The parameters measured were feed intake, weight gain, feed conversion ratio and cost benefit analysis. All data collected were subjected to analysis of variance (Steel and Torrie, 1980)**.**

Results and Discussion

The chemical composition of *Microdesmis puberula* leaf meal is shown in Table 1. The leaves of *M. puberula* contains on the average 18.90% crude protein on dry matter basis, which seems to be higher compared to an earlier report of 17.32% (Esonu *et al*., 2003). This suggests that it is a potential source of nutrient like other tropical forage crops and browse plants (D'Mello, 1995). The relatively high level of fibre (20.88%) in the leaf meal could be an advantage in the maintenance of a healthy gastrointestinal tract of animals thus indicating that *M. puberula* leaf can also serve as a fibre source in the diet of non-ruminant animals such as pigs. Data on the performance parameters of the pigs fed sundried *Microdesmis puberula* leaf meal are shown in Table 3. There were no significant differences in feed intake, final weight, daily gain and feed conversion ratio (FCR) among the treatments (P>0.05). Increasing the proportion of MP leaf meal to 15%, reduced (P>0.05) feed intake. Diet 1 (0%) had the highest daily feed intake value (920.0g) whereas diet 4 containing 15% leaf meal, had the least (770.0g). This may have been due to the higher fibre content of the test

ingredient (Table 1), which has been known to occur with higher level of PKM and leaf meal inclusion in diets, resulting in depressed feed intake (Jegede *et al*., 1994; Mora *et al*., 1992; Amaefule *et al*., 1999; Ugwu and Chukwuka, 2001; An *et al*., 2005; Olayeni *et al*., 2006). Decline in feed intake in pigs fed leaf meals have been reported (Ravindran, 1990; D'Mello, 1995; Laswai *et al*., 1997).

Table 2: Ingredient and chemical composition of experimental diets (%)

Ingredients	*Diets (%)*			
	0%	*5%*	*10%*	*15%*
Maize	53.71	49.75	45.64	41.54
Soya bean meal	23.44	21.00	18.61	16.22
M. puberula leaf meal	-	5.00	10.00	15.00
Palm kernel meal	8.00	8.00	8.00	8.00
Wheat offal	5.00	5.00	5.00	5.00
Local fish meal	3.00	3.00	3.00	3.00
Bone meal	2.00	2.00	2.00	2.00
Oil	4.1	5.5	7.0	8.5
Methionine	0.1	0.1	0.1	0.1
Lysine	0.1	0.1	0.1	0.1
Salt	0.3	0.3	0.3	0.3
Bone meal	2.0	2.0	2.0	2.0
Vitamin premix*	0.25	0.25	0.25	0.25
Oil	4.1	5.5	7.00	8.5
Total	100.00	100.00	100.00	100.00
Calculated nutrient content (%)				
CP	18.00	18.00	18.00	18.00
CF	4.75	5.5	6.67	7.18
EE	8.8	10.45	11.61	13.29
Lysine	1.84	1.13	1.04	0.96
Calcium	1.16	1.22	1.28	1.33
ME (MJ/Kg)	12.54	13.38	13.39	13.40

*Roche premix containing the following per kg: Vit. 9,600 i.u., Vit. D_1 1,600 i.u., Vit. K 1.6mg; Vit B_1 0.9mg; Vit. B2 3.2mg; Nicotinic acid 12.0mg; Vit. B6 1.6mg; Vit. B12 8.0mg; folic acid 0.4mg; Biotin 0.6mg; choline chloride 16.0mg; manganese 8.0mg; Iron 4.0mg; Zinc 46.88mg Copper 8.0mg; Iodine 0.48mg; Cobalt 0.28mg and selenium 0.01mg.

The daily weight gain of weaner pigs fed the control diet were comparable (P>0.05) to those fed leaf meal based diets. Average daily gain (ADG) of pigs fed diets 1(control), 2 (5%), 3(10%) and 4(15%) MP leaf meals were 210, 200, 190 and 150g respectively. The low ADG may be attributed to the low intake of these diets by the pigs. It may also be that MP leaf meals were not well digested particularly at these levels of inclusion. Such low ADG in pigs fed sweet potato leaves have been associated with low levels of essential amino acids (An *et al*., 2005) especially lysine (McDonald *et al*., 1995). Pigs fed diets containing leaf meals have been

shown to have low nitrogen retention (Cheverria *et al*., 2002). Reduced nitrogen retention is a result of a reduction in the crude protein digestibility and an increase in loss of endogenous protein (Jansman *et al*., 1995; Lindberg and Andersson, 1998; Phuc *et al*., 2000), which could explain the decline in weight gain (Phuc *et* al., 2000; Cheverria *et al*., 2002).

Table 3: Growth performance of weaner pigs fed sundried *Microdesmis puberula* leaf meal

Parameters	*DIETS*				
	1 (0%)	*2 (5%)*	*3 (10%)*	*4 (15%)*	*SEM±*
Av. Initial weight (kg)	8.92	8.92	8.92	8.92	0.02
Av. Final weight (kg)	19.41	18.70	18.30	16.83	2.97
Average daily gain (g)	214.08	199.6	191.42	161.42	11.0
Av. Daily Feed intake (g)	920.0	820.0	870.0	770.0	30.0
Feed conversion ratio	4.30	4.10	4.54	4.77	0.12
Total weight gain (kg/pig)	10.49	9.78	9.38	7.91	1.12
Feed cost per kg (N)	41.55	39.48	37.44	35.40	
Feed cost per kg weight gain (N)	178.66[a]	161.89[c]	169.97[b]	168.85[ab]	4.90

[a,b,c] Means with different superscript in a row are significantly different (P<0.05)

The daily weight gain of weaner pigs fed the control diet were comparable (P>0.05) to those fed leaf meal based diets. The comparable average daily gain is an indication that the weaner pigs could tolerate the diets containing *Microdesmis puberula* up to 15% level.

In the present study, though the feed conversion ratios of pigs fed *Microdesmis* leaf meal diets declined with inclusion level of the leaf meal up to 15%, there were no significant differences in the feed conversion ratios between the control diet and diets containing up to 15% leaf meal in the diet. The pigs fed diet 3 (10%) and 4(15%) were the poorest converters (4.54; 4.77) while those fed diet 2 containing 5% *Microdesmis puberula* leaf meal with least FCR value (4.10) were the best converters. Such similar average daily weight gain but poorer FCR in pigs fed leaf meal based diets have been reported (Halimani *et al.*, 2007).On the contrary, the studies of Malynicz (1974) show significant improvements in feed conversion ratios on inclusion of *Leucaena* at rates of up to 20% of the diet, however, Chen *et al*. (1981) indicated no differences in the feed conversion ratios between the control diet and diets containing up to 16% *Leucaena* leaf meal of the diet. Low nitrogen retention in pigs fed on diets containing leaf meals, could, possibly explain the decline in weight gain and feed conversion ratio (Phuc *et al*., 2000; Cheverria *et al*., 2002).

Lindberg and Andersson (1998) had attributed such low average daily gain and poor feed conversion to decreased digestibility of nutrient and therefore utilization by the pigs. However; they also observed that the depression in total gastro-intestinal tract digestibility of energy was less pronounced with forage fiber inclusion compared to cereals. Fibre has been identified as one of the most important factors that affect

digestibility indices in pigs (Jorgensen *et al*., 1996). The digestive utilization of dietary fibre varies with botanical origin (Chebeauti *et al*., 1991). It is possible that the high crude fibre (Samkol *et al.,* 2002) and their cell contents (Hogbergand and Lindberg, 2006) of the leaf meal may have had a negative influence on digestibility coefficient of dry matter, organic matter and other nutrients (Le Goff and Noblet, 2001) resulting in poor utilization of nutrients and manifesting in poor weight gain of the pigs. Reduction in DM and CP digestibility of pigs fed low inclusion levels of leaf meals compared to the conventional control diet have been reported (Laswai *et al*., 1997; Lindberg and Andersson, 1998; Phuc *et al*., 2000). A reduction in DM digestibility can result from an increase in the flow of digesta and total tract excretion of nutrients and energy as a result in the flow of digesta and total tract excretion of nutrients and energy as a result of the higher insoluble fibre content of leguminous leaf meals (Lindberg and Cortova, 1995). Low digestibility of protein may be due to protein being bound by polyphenols and fibre or physically entrapped by fibre in the leaf meals (Phuc *et al*., 2000). Although, the negative effect of fibre on diet digestibility and pig growth is well documented, and it is generally accepted that diets containing more than 7-10% of fibre result in decreased growth rate (Kass *et al.,* 1980).

The economics of feeding MP leaf meal to weaner pigs is shown in Table 3. In the present study, the cost of a kilogramme (kg) of feed decreased non–significantly ($P>0.05$) with increased leaf meal supplementation in the diets. However, feed cost per kilogramme weight gain differed significantly ($P<0.05$) among the treatment groups. Pigs fed diet 2 (5%MP) had the least feed cost per kilogramme weight gain (N161.89) while the cost of gaining a kilogramme of meat by the pigs fed diets 3 (10%), 4 (15%) and 1(0%) were N169.97, N168.85 and N178.66 respectively. This implies that it is cheaper to produce a kilogramme of *Microdesmis puberula* leaf meal based feed and one kilogramme of pork when *Microdesmis puberula* leaf meal was incorporated up to 15% in weaner pigs' diets. Lower feed cost and feed cost per kilogramme of meat produced on the leaf meal based diets suggest that *Microdesmis puberula* leaf meal is economically viable alternative feed material to replace maize and soyabean in pig rations. Reduced cost of a kg of feed (Ekenyem, 2006) and cost of kg weight gain when *Ipomoea asarifolia* and *Centrosema pubescens* leaf meal was incorporated up to 15% in pig diets have been reported (Ugwu and Chukwuka, 2001;Ekenyem, 2006). This could be due to the relatively cheaper *Microdesmis puberula* leaf meal which replaced proportions of costlier maize and soyabean in the diets in this study. The findings in the present study are in agreement with those of several researchers (Mora *et al*., 1992; Ugwu and Chukwuka, 2001; Iyayi, 2001; Olayeni *et al*., 2006; Ekenyem, 2006) that leaf meals obtained from various plant species could be incorporated into diets of weaner pigs at 15-20% level without affecting growth performance.

Conclusion

It can therefore be concluded that *Microdesmis puberula* leaf meal could partly replace plant protein and energy sources in weaner pigs diet if incorporated at levels up to 15% but for

optimum performance 5% inclusion level is advocated. *Microdesmis puberula* leaf meal could replace 30.80% of soybean meal and 22.65% of maize in weaner pig diet if incorporated at levels up to 15% without affecting growth performance of weaner pigs.

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ASSESSMENT OF GERMINABILITY, GROWTH AND YIELD OF SWEET PEPPER (*CAPSICUM ANNUM*) USING VARIOUS SOIL AMENDMENTS

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Abstract

An experiment was carried out at the Federal University of Technology Teaching and Research farm Owerri between May and September 2008 to investigate the germinability, growth and yield of sweet pepper using various soil amendments, such as pig manure, goat manure, poultry manure and Nursery mixture (control). A measure of 0.5 kg of manure was mixed with 1 kg of soil and placed in a 500 gauge capacity black polythene bags, while the nursery mixture (control) consists of three parts of top soil, two parts of poultry manure and one part of sharp sand properly mixed together. The treatments were laid out in Randomized Complete Block Design (RCBD) and replicated seven times. Data on various growth and yield parameters were measured and subjected to analysis of variance. Results indicated that the soil amended with goat manure significantly (P=0.05) performed better with pepper mean fresh fruit yield of 5.60 tons/ha closely followed by soils amended with pig manure which gave a pepper mean fresh fruit yield of 5 tons/ha. A post soil chemical analysis indicated that the various soil amendments reduced soil acidity from the initial soil pH of 4.50 to 6.53 (Poultry manure) 5.60 (goat manure) 6.04 (pig manure) and 5.08 (nursery mixture), respectively.

Key words: Soil amendments, pepper, germinability, fruit and soil acidity.

Introduction

Pepper (*Capsicum annum*) is the worlds second most important crop after tomato

Yoon et al, 1989). According to Adamu *et al*. (1994). Nigeria is the largest producer of pepper in Africa accounting for about 50% of annual production in Africa. There are about five different species domesticated in Nigeria namely: *Capsicum annum, Capsicum fruitscens, Capsicum baccatum, Capsicum chinese and Capsicum pubescens*. Among these specie *Capsicum annum* is the most widely spread and of high economic importance. Pepper prefers a well-drained fertile soil, tolerates day time temperature over 30^{o}C as long as night temperature fall within 21-24^{o}C (Berke,*1971*). Sweet pepper may be distinguished into different colors namely: green, red, yellow, purple, white and chocolate with shapes ranging from spherical, bell or elongated types (Berke, 1971). In Nsukka, yellow pepper is characterized by its yellow colour at fruit ripening and unique aroma with about 1-3 fruits occurring in the axil of one leaf (Amafor, 1994).

Pepper is an important soup and stew condiment in Nigerian diet and nutritionally supplies the body with various vitamins and minerals (Keshito and Ketiku, 1983). Pepper suffers delayed germination and growth especially in the nursery (Charles, 1990). In order to enhance its germinability and increased production in Nigeria, this study was specifically aimed at; determining the best soil organic amendment that will boost pepper germination, growth and yield from the nursery to the field.

Materials and Methods.

Location

This research was conducted at the Federal University of Technology Teaching and Research Farm Owerri located on latitude 5^{0} 27" 50^{0}, 23 North and longitude 7^{0} 02" 49^{0} 33" East with an elevation of 55m above mean sea level using hand/held global positioning system (GPS).It is a rainforest agroecology characterized with more than 2500 mm annual rainfall and 27-29 ^{o}C annual temperature. Soils belong to the soil mapping unit number 431 i.e Amakama Orji
Oguta Soil Association (FDALR, 1985) and derived from coastal plain sands (Lekwa and Whiteside, 1986).

Laboratory Analysis of Soil/Man 1 Samples

Particle size distribution was determined by hydrometer method (Gee and Bauder, 1986). Percent carbon was estimated by wet digestion method (Nelson and Sommers, 1982). Total nitrogen was obtained using Microjeldahl method (Bremner and Mulvancy, 1982). Exchangeable calcium, magnesium, potassium and sodium were extracted by ammonium acetate at Ph 8.0 (Chapman and Pratt,1965). Calcium and magnesium were measured using atomic absorption spectro-photometry while potassium and sodium were determined by flame emission. Exchangeable acidity was measured using the procedure of Mclean, (1982). Effective cation exchange capacity was calculated by summation of exchangeable bases and cations. Soil pH was estimated electrometrically (Hendershot *et al,* 1993). The post-harvest soil chemical analysis was also carried out in accordance with the above mentioned procedures. The chemical property of the various organic manures namely poultry, goat and pig manures were also analyzed in the laboratory using the above-mentioned procedures.

Nursery Preparation and Planting

The various organic soil amendments were measured out at the

rate of 0.5 kg of poultry manure mixed with 1 kg of topsoil, 0.5 kg of pig manure mixed with 1 kg of topsoil, 0.5 kg of goat manure mixed with 1 kg of topsoil and the control which is a standard nursery mixture of 3 parts topsoil, 2 parts poultry manure and 1 part sharp sand all mixed properly. The various soil organic amendments were placed in a perforated 500 gauge capacity black polythene bags and lined up in the green house of the University farm. Seeds of sweet pepper (*Capsicum annum*) were sown at 3 seeds/hole and later thinned down to 2 seedlings/hole. Manual watering was carried out at 3 day interval to avoid water stress. Routine cultural operations such as weeding, pest and disease control were carried out as appropriate. The experiment was laid and disease control were carried out as appropriate. The experiment was laid out in a Randomized Complete Block Design with seven replicates.

Data on various crop growth and yield parameters where measured and analyzed statistically, using analysis of various. Means were separated using least significant differences at 5% level of probability.

Result and Discussion

Soil Properties

There were variations in the pre-planting soil chemical properties (Table 1, when compared with the post-harvest soil chemical properties (Table 2). The initial pH of the soil (4.50) was reduced to pH 6.53 (poultry manure),pH 5.60 (goat manure) and pH 6.04 (pig manure) and this agreed favorably with work done by Pitram and Singh, (1993) who observed that organic manure decreased soil acidity. The mechanism for the neutralization of soil acidity by organic manure has been proposed by (Bessho and Bell, 1992; Yan *et al*, 1996; Pocknee and Sommer, 1997; Hue and Amiens, 1989). The increase in total exchangeable bases (Table 2) as a result of the various soil organic amendments confirmed earlier work by Hsich and Hsu, (1993) and Jinadasa *et al*, (1997) who reported that the residual effect of manure could last into the second, third and fourth years of cropping. The laboratory analysis of the various soil organic amendments is presented in (Table 3). The availability of the various nutrients in the manure has already been reported by (Yayock and Awoniyi, 1974).

Plant growth parameters such as height, number of leaves/plant, number of branches/plant and plant girth/plant is shown in (Table 4), with goat manure soil amendment recording highest figures on these growth parameters, which differed significantly (P = 0.05) from either poultry, pig manure and standard nursery mixture respectively. Highest mean fresh pepper fruit yield of 5.60 tons/ha was obtained from the goat manure soil amendment, followed by that amended with pig manure, which gave 5.0 tons/ha and poultry manure with 4.95 tons/ha respectively. The highest pepper fruit weight per plant was recorded in the goat manure soil amendment which gave 55.9g/plant which also differed significantly (P = 0.5) from that recorded in pig manure, poultry manure and standard nursery mixture respectively, (Table 5).

This increased fruit weight and total yield observed in the goat manure soil amendment confirms that goat manure is very rich in nutrients, an observation strongly supported by Jinadasa *et al*, (1997) who reported that animal manure such as goat manure is very rich in nutrients. Moyin Jesu (1999) reported that organic manure

significantly (P = 0.05) increased the soil and leaf chemical composition of nitrogen, phosphorus, potassium, calcium, magnesium and growth parameters of tuber crops, as can be observed in the present study with pepper, which have revealed that organic manure could preferably replace the use of inorganic fertilizer in pepper production based on its local availability, economic feasibility and environmental sustainability.

Table 1: Pre-planting Soil Physical and Chemical Properties

Soil pH (water)	4.50
Soil pH (KCL)	4.03
Exchangeable Ca (Cmol/kg)	1.70
Exchangeable Mg (Cmol/kg)	0.50
Exchangeable K (Cmol/kg)	0.10
Exchangeable Na (Cmol/kg)	0.01
Exchangeable H (Cmol/kg)	1.20
Exchangeable Al (Cmo/kg)	2.89
Effective lotion Exrch. Capacity (Cmol/kg)	5.40
Base saturation (%)	42.27
Aluminum saturation (%)	53.52
Total carton (%)	1.98
Organic mater (%)	3.41
Total nitrogen (%)	0.22
Available phosphorus (mg/kg)	9.13
Total sand (%)	92
Total silt (%)	3.8
Total clay (%)	4.2

Textural class – Sandy loam

Table 2: Post-harvest Soil Physical and Chemical Properties

	Soil	Organic	Amendments	
	Nursery	Poultry	Goat	Pig
Soil pH (water)	5.08	6.53	5.60	6.04
Soil pH (Kcl)	5.30	6.41	5.20	6.10
Exchangeable Ca (Cmol/kg)	2.50	3.02	4.50	4.20
Exchangeable Mg (Cmol/kg)	0.70	1.50	1.95	1.85
Exchangeable K (Cmol/kg)	0.30	0.85	1.08	1.02
Exchangeable Na (Cmol/kg)	0.05	0.84	0.96	0.86
Exchangeable H (Cmol/kg)	1.03	1.52	2.50	2.1
Exchangeable Al (Cmol/kg)	2.90	2.95	3.05	3.00
Effective cation Exch. Capacity (Cmol/kg)	5.6	6.95	8.95	7.0
Base saturation (%)	50.5	75.8	85.50	80.1
Aluminum saturation (%)	52.1	60.5	65.5	64.5
Total carton (%)	1.00	3.52	3.82	3.65
Organic mater (%)	4.20	5.30	6.52	5.65
Total nitrogen (%)	0.55	1.80	2.95	2.86
Available P (mg/kg)	9.15	10.66	11.58	10.92
Total sand (%)	90	92	91	94
Total silt (%)	5	3	4	3
Total clay (%)	5	5	4	3

Textural class Sandy loam

Table 3: Chemical Properties of the Various Organic Manures used in the Experiment

	Organic		Manure
	Poultry	Goat	Pig
Percent Nitrogen	3.21	4.86	2.14
pH (Kcl)	8.21	7.38	7.60
pH (water)	8.0	7.86	7.42
Percent organic carton	20.0	16.59	16.85
Percent organic matter	31.0	28.60	29.05
Available phosphorus (mg/kg)	39.20	30.20	19.26
Exchangeable K (Cmol/kg)	1.0	0.46	0.25
Exchangeable Na (Cmol/kg)	1.0	0.65	0.34
Exchangeable Mg (Cmol/kg)	3.46	5.60	4.72
Exchangeable Ca (Cmol/kg)	4.1	72	60.5
Exchangeable Al (Cmol/kg)	4.68	1.54	1.80
Exchangeable H (Cmol/kg)	4.61	3.67	4.25

Table 4: Effective of Various Organic Soil Amendment on Pepper Stand Height, Number of Leaves/plant and plant girth.

Treatments)	Pepper height (cm)					Number of leaves/plant					Number of Branches/plant					Plant girth (cm)				
Weeks	4	8	12	16	20	4	8	12	16	20	4	8	12	16	20	4	8	12	16	20
Goat manures	8.94	18.9	2.7	239	42.1	5.81	10.03	17.32	24.72	26.33	3.88	5.76	5.29	6.51	6.56	0.71	1.4	1.7	2.18	2.37
Nursery mixture	3.74	4.51	6.0	6.5	6.81	3.19	4.71	7.69	8.1	8.50	0.00	0.1	0.2	0.5	0.6	0.34	0.65	0.65	0.7	0.81
Pig waste	4.46	11.55	21.8	34.0	370	3.66	7.95	15.56	30.8	22.41	2.0	5.14	5.21	6.31	6.52	0.68	0.92	1.4	1.70	1.90
Poultry manure	2.51	10.1	22.1	32.0	38.1	2.0	5.21	14.5	21.2	23.2	1.2	3.15	4.2	5.62	6.15	0.31	0.71	1.3	1.60	1.85
LSD (0.05)	2.30	3.67	9.4	6.16	6.55	2.48	2.17	5.04	3.56	4.30	0.51	1.63	1.81	2.0	2.51	0.25	0.17	0.27	0.14	0.13

Conclusion

This experiment have revealed that animal manure possess adequate nutrients capable of improving pepper germinability, growth and aggregate yield as can be confirmed from the yield performance recorded in the current study. Soils of the study area are highly degraded, acidic and thus requires remediation using any of the organic soil amendments especially goat manure which gave the best pepper fruit yield of 5.60 tons/ha. Most farmers in the area rear goats and thus it becomes readily available, cost – effective and environmentally – friendly crop nutrient source. The post – harvest soil chemical analysis have confirmed that the residual nutrient status could perhaps carry a second and third crop of pepper without any further application and is thus highly sustainable for use by our resource – poor farmers. The ability of the various soil organic amendments to neutralize soil acidity makes it to perform dual function of enhancing soil fertility and acting as a liming agent. Based on the results of this research, goat manure is highly recommended for use by farmers to boost pepper yield and neutralize acidic soils.

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WAXING IN POSTHARVEST HANDLING OF TOMATOES USING LOCALLY SOURCED OILS AND THE PROXIMATE QUALITY DURING STORAGE

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Abstract
In a bid to encourage poverty alleviation amongst our resource poor farmers, oils from locally available crops were utilised as wax coating in the postharvest handling of tomatoes. During a two-week storage period to simulate the duration from harvest to when a consignment reaches the consumers table, the percentage moisture content, ascorbic acid (vitamin c), and Total Soluble Solids (TSS) content of freshly harvested tomato fruits were evaluated. After two weeks of storage, fruits treated with melon oils had the least decrease in percentage moisture (0.29%); the least decrease in ascorbic acid content was exhibited by fruits treated with oils from groundnut (7.48mg/100ml); while tomato fruits treated with coconut oils had the least decrease in TSS content. All of these fruits were stored in polyethene-lined boxes. The effect of the linings and the effect of the oils were highly significant for all three parameters at 5%. Although the effect of the interaction between the oils and the linings were not significant for the ascorbic acid content and the TSS; it was highly significant for the percentage moisture content. Oils from the three locally sourced crops proved to have potentials as waxing materials; however the oils from groundnut were the best. The efficacy of using polyethene as lining materials in wooden boxes was also exhibited. The adoption of modern means of packaging with adequate lining materials that can protect the produce without being the source of further microbial inoculation is advocated.

Key words: Tomatoes, Waxing, Storage quality, Indigenous technology

Introduction

Kader (1992) stated that Tomato is an important fruit vegetable that has poor storage ability due to its high moisture content. Kitinoja (2003) also reported that tomatoes being a moderately climacteric fruit with respiration rates of 10-20 mg CO_2 1kg-hr, it experiences post harvest losses, which usually result from physical losses (damage, bruising, weight loss, water loss); nutritional losses especially of vitamin C; and loss of market value and food safety problems.

In Nigeria, the fruit vegetable is produce in farms located in the northern parts of the country and conveyed to urban whole-sale markets in the southern parts of the country. Tomatoes intended for long distance transportation normally ought to be harvested at a stage of physiological maturity, which will ensure that the fruits do not all ripen at the same time. According to Sargent and Moretti

(2002), tomatoes are harvested at stages of physiological maturity ranging from mature-green through full ripe, depending on the market and production area, and also because it is difficult to accurately determine the onset of physiological maturity. Kasmire (1992) stated that after harvest, general packing house operations include pre-sorting to remove culls i.e. injured or decayed produce, cleaning and washing to remove soil or contamination, waxing to replace natural waxes lost during washing and reduce water loss; packaging and cooling/transportation, to destination markets. According to Kader (1992), washing under a running tap is also expected to help reduce the field or vital heat associated with a recently harvested crop.

In the marketing chain prevalent in Nigeria for tomatoes, tomato is harvested in the fields into plastic basins and buckets, and later transferred into grass-lined cane baskets. These baskets are transported to urban markets away from the point of production, in any available vehicle. The first attempts at washing and cleaning occur in the markets where the retailers use limited quantity of water to wash several baskets full of produce. Grading may be done to enable the retailers arrange the produce in categories for sale. No attempts are made to reduce water loss by waxing.

Artificial waxing is applied to replace the natural waxes lost during washing of fruits or vegetables. The wax amongst other functions provides a protective coating over entire surface, reduces moisture loss, permits natural respiration, extends shelf-life and enhances sales appeal (FAO, 2003). Ordinarily, food grade waxes are used to replace some of the natural waxes (Kitinoja and Kader, 1995), but as a means of alleviating poverty, any edible and lightweight wax from a local crop can be used as an alternative (Kitinoja, 2003).

Telmedpak (2000) reported that common substances which can be used as wax include carnauba wax, sugarcane wax, thermoplastic terpene, resins and shellac; while Domenico *et al.* (1972) states that anti-microbial agents may be used before, or in combination with a wax formulation after washing. However, these synthetic waxes are inaccessible; and where found, are exorbitant to procure. Also, like with all synthetic drugs, side effects might develop. This has necessitated the search for alternatives amongst local sources.

According to SARDI (2001), some specifications are desirable when selecting a wax. These include lasting shine (durability), resistance to whiting or chalking, reduce weight loss by 30 % to 50 %, rapid drying, easy clean-up, manufactured from food grade materials, no development of off-flavors, competitive price and formula must include 500 ppm of 2,4-D, amongst others. Beuchat and Golden (1989) stated that edible films can be made of many different polymers (pectin, proteins, oils, etc). These can serve as carrier for anti-microbial compounds such as organic acids, as well as improve appearance and prevent moisture losses in fresh fruits and vegetables (Hernandez-Brenes, 2002). According to Telmedpak (2000), carnauba wax, sugarcane wax, thermoplastic terpene, resins and shellac are common substances which are used commercially. However, waxes of plant origin are preferred.

In this paper, the choice of oils from local crops as waxes is borne out of the desire to use cost effective, accessible and safe-to-use means of waxing as a postharvest handling method, in other to encourage poverty alleviation amongst our resource poor

farmers. Therefore, the need to study the effect of waxing on some shelf-life and storage attributes of tomato fruits stored in wooden boxes with different lining materials formed the basis for this research.

MATERIALS AND METHODS

Collection and Preparation of Plant Materials: The plant oils were collected from seeds of Groundnut (*Arachis hypogea*), Melon (*Cucumeropsis mannii*); and fruits of Coconut (*Cocos nucifera*). These were obtained from the local market. The Coconut was shelled and grated into tiny bits and oven dried at 60 ^{o}C for 24hr. The de-husked melon seeds were dried in an empty frying pan and the groundnut toasted on hot dry sand. All dried samples were blended using an Electric blender. Oils in 200 g of each plant material were extracted with 96 % ethanol in a soxhlet apparatus. The oils were then collected for use.

Collection and utilization of Tomato fruits: The tomatoes were harvested at Wannune, in Benue State (North Central Nigeria) and initial evaluation tests (moisture content, total soluble solids and vitamin C content) carried out. The fruits were transported in wooden boxes lined with the different test liners namely foil, polythene and grass in an open van to Owerri, Imo State (Southeastern Nigeria), to simulate the conventional manner of transportation. The laboratory experiments commenced exactly four days after harvest. The fruits were thoroughly washed with running water and then distilled water. They were then surface sterilized with 70 % ethanol. The plant oils extracted were then applied individually to the surface of all the fruits used in the experiments with a sterile absorbent cotton wool. This was to ensure an even spread of the oils on the surface of the fruits. The fruits were then allowed to dry before storing in the wooden boxes in a three by four factorial Design with three replications. The treatments were coconut, groundnut, melon oil and No oil; and three lining materials namely foil, Polyethene and grass.

The fruits were analyzed for their moisture content according to methods described in A.O.A.C. (1990). Total soluble solids content were analyzed according to methods in Woods and Aurand (1979). The ascorbic acid content was analyzed according to methods in Egan *et al* (1981). The fruits were analyzed before storage, four Days After Harvest (4DAH), seven Days After Harvest (7DAH) and fourteen Days After Harvest (14 DAH). The dates of destructive analysis were informed as follows: 4DAH - average period of arrival of the tomatoes at destination markets after harvest, bearing in mind delays due to bad roads and faulty vehicles; 7DAH – average time of arrival on the retailers table after harvest and 14 DAH – average period it takes for the last consumers to buy up a consignment. On each occasion, three tomato fruits were evaluated in a destructive analysis for each treatment. All results were analyzed in a two-way analysis of variance at 5 % using Genstat (2005).

Results

The results shown in Table 1 highlight the effect of plant oils on the moisture content of tomato fruits stored in wooden boxes lined with various lining materials. There was a general decrease in percentage moisture content in the fruits, with respect to their initial values (range between 87.81 - 92.45 % moisture). However, the least decrease in percentage moisture content in the tomato fruits treated with oils, relative to the moisture content at the onset of storage, was exhibited by fruits treated with Melon oil

in polythene-lined boxes (0.29 %); followed by fruits also treated with Melon oil but in foil-lined boxes (0.31 %) on the 14th DAH. High percentage moisture changes were observed in the controls for lining (fruits stored in grass-lined boxes) and controls for plant oils (fruits stored without any oil). The effect of the linings; the oils, and the interaction between the linings and the oils were highly significant 5 % level of probability.

Table 1: Effect of plant oils and package lining on Percentage Moisture content of Tomato Fruits Stored in Wooden Boxes

	Linings								
	(% Moisture 4 DAH)			(% Moisture 7DAH)			(% Moisture 14DAH)		
Oils	**Foil**	**Polyethene**	**Grass**	**Foil**	**Polyethene**	**Grass**	**Foil**	**Polyethene**	**Grass**
Coconut	0.18	0.13	12.72	0.29	0.29	27.7	0.38	0.36	17.23
Melon	0.13	0.04	13.20	0.19	0.13	25.45	0.31	0.29	18.31
Groundnut	0.13	0.06	12.06	0.18	0.26	12.59	0.33	0.59	13.34
No Oil	23.76	22.24	31.74	31.76	31.35	34.86	34.51	34.2	36.77

LSD (5%) Lining: 3.211 Oil: 3.708 Lining*Oil: 6.423

The results presented in Table 2 show the effect of plant oils on the ascorbic acid content of tomato fruits. There was a general decrease in ascorbic acid content of the fruits during the storage period. The initial ranges of ascorbic acid for the fruits were between 31.51 – 33.95 mg/100ml. The least decrease in ascorbic acid content was exhibited by tomato fruits treated with Groundnut oils in Polyethene – lined boxes (7.48 mg/100ml), after two weeks of storage. The effect of the linings and those of the oils were highly significant. On the contrary, the interaction between the linings and the oils was not significant.

Table 2: Effect of plant oils and package lining on Ascorbic acid Content of Tomato fruits Stored in Wooden boxes

	Linings								
	(mg/100ml Vit. C 4 DAH)			(mg/100ml Vit. C 7DAH)			(mg/100ml Vit. C 14DAH)		
Oils	**Foil**	**Polyethene**	**Grass**	**Foil**	**Polyethene**	**Grass**	**Foil**	**Polyethene**	**Grass**
Coconut	6.09	4.45	8.1	7.04	6.65	11.79	9.73	8.65	12.7
Melon	9.5	5.2	10.24	11.88	10.8	10.72	11.3	13.08	13.34
Groundnut	6.37	3.84	7.09	6.76	5.54	11.18	7.88	7.48	11.71
No Oil	16.18	14.85	17.44	16.44	15.7	19.28	21.17	18.74	22.81

LSD (5%) Lining: 1.954 Oil: 2.256 Lining*Oil: 3.908

The results shown in Table 3 presents the effect of plant oils on tomato fruits stored with different lining materials. After two weeks in storage, fruits treated with Coconut oils in Polyethene-lined boxes exhibited the least decrease in TSS content - 6.82 g/l (The initial values were between 37.45 – 42.15 g/l. The effect of the linings and those of the oils were both highly significant; but the effect of the interaction between the linings and the oils was not significant at 5 % level of probability.

Discussion

The percentage moisture content of the tomato fruits used during the study was observed to reduce with increasing days of storage in wooden boxes with various linings; with those in wooden boxes with polyethene-lining performing

better than those in foil and lastly grass. FAO (1989) reported that paper or plastic films are often used to line packing boxes in order to reduce water loss of the contents or to prevent friction damage. They further demonstrated the use of polyethylene as liners for bananas, whereby after undergoing washing to remove latex, and perhaps spraying with fungicides, it is typically packed into cardboard containers lined with polyethylene.

According to Ball (1997), post-harvest weight change in vegetables is usually due to loss of water through transpiration. This loss of water can lead to wilting and shriveling which both reduces market value and consumer acceptability. According to Mitchell (1992), fresh commodities constantly lose water to the surrounding environment, with many products showing visual shrivelling or wilting after losing 3 – 5 % of their initial weight. He explained that this loss of water is as a result of a water vapour gradient between their essentially saturated internal atmosphere (within the intercellular space), and the less saturated external atmosphere. Thus, the product will lose water 36 times faster at 25 ^{0}C and 30 % relative humidity, than it would at 0 ^{0}C and 90 % relative humidity; which requires that the maintenance of low temperature is essential in reducing water loss and subsequent product shrivelling and wilting.

According to Parpia (1976), lack of refrigeration capabilities is largely responsible for the large postharvest losses suffered in countries (mostly developing countries), where the cold chain does not exist. Babarinsa *et al*. (2002) and Babarinsa and Williams (2002) adopted the use of protective coating materials to reduce weight loss and desiccation in horticultural crops using synthetic materials. The use of low cost, cheap and locally available sources of plant oil such as groundnut oil coating and lime juice to prevent weight loss in tomatoes, yam and oranges has been demonstrated by Bako and Adams (2005). According to these workers, protective coatings are known to influence the gas permeability properties for all stored products. In the absence of gases such as oxygen, metabolic rates will drop because the activities of oxidative and cell wall enzymes, which break down storage and structural carbohydrates will be minimized; which therefore implies that the application of the plant oils will influence the uptake rate of oxygen which will subsequently control metabolic activities.

This has advantages with respect to environmental protection and food safety. In this research, the possibilities of controlling evapo-transpiration in tomato fruits using oils from groundnut and coconut have been demonstrated. The choice of the plant oils used in this study was informed by the need to source for viable alternatives by resource-poor farmers. Kitinoja (2003) suggested the use of oils which are edible and lightweight.

Table 3: Effect of plant oils, extracts and package lining on Total Soluble Solids (TSS) content of Tomato fruits stored in Wooden Boxes

	Linings								
	(g/l TSS 4 DAH)			(g/l TSS 7DAH)			(g/l TSS 14DAH)		
Oils	**Foil**	**Polyethene**	**Grass**	**Foil**	**Polyethene**	**Grass**	**Foil**	**Polyethene**	**Grass**
Coconut	3.88	3.49	10.45	5.75	4.77	15.46	7.82	6.82	11.33
Melon	7.35	8.93	10.77	7.98	10.28	12.54	12.95	10.52	17.78
Groundnut	3.24	3.15	9.66	4.77	3.57	19.64	11.87	7.85	10.62
No Oil	22.04	19.80	30.40	27.46	21.14	36.13	28.93	29.00	31.76

LSD $_{(5\%)}$ Lining: 2.498 Oil: 2.885 Lining*Oil: 4.997

Note: All values are means from the replicates on the three days of destructive analysis i.e. 4 Days After Harvest (4DAH), 7 DAH and 14 DAH.

During the storage period, the ascorbic acid content of the tomato fruits was observed to decrease with increase in the storage days. Srivastava and Tandon (1968) reported the complete loss of ascorbic acid content in oranges, 12 days after inoculation with *Botryodiplodia theobromae* as compared with a 39 % reduction in healthy stored fruits. Also, Aworh *et al*. (1983) observed reduced ascorbic acid content in damaged but marketable tomato fruits in comparison with damaged fruits. This agrees with the report of Oladiran and Iwu (1992) who observed a decline in ascorbic acid content of tomato fruits inoculated with *Fusarium equiseti*, *Fusarium chlamydosporium*, *Geotrichum candidum*, *Acremomium recifei*, *Aspergillus flavus* and *Aspergillus niger*. Similar decrease in ascorbic acid content was also exhibited by tomato fruits inoculated with *Rhizopus stolonifer* and *Nematospora coryli*, with increasing days of incubation (Ofor, 1999).

The least decreases in ascorbic acid content were recorded by fruits treated with groundnut oils both in polyethene – lined boxes and grass-lined baskets. Watada (1987) found that the ascorbic acid content of stored produce decreased more rapidly at higher temperatures. This happens because loss of ascorbic acid accompanies senescence and deterioration; and losses are hastened when a commodity is subjected to stresses that cause deterioration. According to Kader (1992), postharvest losses in nutritional quality, notably vitamin C (ascorbic acid), can be substantial and increase with physical damage, extended storage (incubation), high temperatures, low relative humidity and chilling injury. All of these adverse conditions except perhaps, chilling injury, are prevalent in tomatoes intended for destination markets in South-eastern Nigeria.

There were observed increases in the total soluble solids of the tomato fruits used in this study. Contrary reports were observed by Singh and Tandon (1970) who reported a considerable reduction in the glucose, malic and citric acids in oranges infected by *Curvularia lunata*. Similarly, Mehta *et al*. (1976) reported metabolic changes during pathogenesis of fruit rot diseases of tomatoes produced by *Alternaria solani* and *A. tenuis*. In both cases, glucose and maltose disappeared and free amino acids reduced quantitatively. Oladiran and Iwu (1992) reported that the total soluble sugars of inoculated tomato fruits showed a reduction trend as the storage period was prolonged, however a slight increase was observed after the

sixth day of inoculation. According to Phan (1987), fresh fruits and vegetables exhibited an increased respiratory rate when in storage. This increase brings about a sharp decrease in the soluble sugar content, both reducing and non-reducing, usually the non-reducing, as they serve as the immediate reserve for the reducing sugars which are preferred metabolites for respiration.

Znidarcic and Pozrl (2006) observed that the total soluble solids content of tomato fruits was relatively constant during postharvest storage up to 21 days, and only slight increases occurred at 5 ^{0}C and 10 ^{0}C, with the greater increase being exhibited at 10 ^{0}C. According to Salunkha *et al*. (1974), the increase in soluble solids is caused by the biosynthesis processes or degradation of polysaccharides, during maturity. Bhattarai and Gautam (2006) reported that as the storage period increases, the total soluble solids (TSS) of tomato fruits increase. The weight loss during this period which is due to water loss leads to higher concentrations of sugars in the fruits. Similar findings have also been reported by Agar and Kaska (1995); Subedi and Bhattarai (1995).

According to Kader (2001), exposure of a commodity to temperatures, relative humidity, and/or concentrations of oxygen, carbon dioxide and ethylene outside its optimum ranges will generally accelerate loss of all quality attributes. The loss of flavour (sugars) and nutritional quality of fresh intact or cut fruits and vegetables however occurs at a faster rate than the loss of textural and appearance quality. Coursey (1981) therefore suggests that with a high moisture content of between 70-95 %, the use of sophisticated techniques like refrigeration or controlled atmosphere are necessary for preserving a delicate crop like tomato. Where these are not available, simple technologies like waxing, especially with locally sourced and available alternatives, becomes appropriate and imperative.

Conclusion

During the postharvest handling of tomato fruits, it is suggested that correct handling procedures should be followed which includes washing with clean water and afterwards, waxing with oils from locally sourced oils to replace lost natural waxes. This will improve the postharvest quality prior to consumption. This study shows that oils from groundnut proved the best; followed by oils from coconut and lastly from melon. It is also advocated that the present day use of baskets as a packaging material should be discouraged as it lacks sufficient mechanical strength to protect the content during handling, transport and stacking; mechanical strength that should be largely unaffected by moisture content (when wet) or high humidity conditions. This should be replaced with wooden boxes. The use of polythene and/or sterilized grass as liners is suggested. This will curtail the issue of proliferation of inocula.

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COMPARATIVE ECONOMIC ANALYSES OF ENTERPRISE TYPE AND SIZE IN BROILER PRODUCTION IN IMO STATE, NIGERIA

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Abstract

The study focused on economic analyses of broiler brooding and rearing businesses and in the sizes of operation of the firms*. It therefore compared net returns in brooding and rearing enterprises as well as* small-*scale and large-scale businesses of the brooding and rearing enterprises. To achieve this, a sample of 180 broiler producers comprising 90 brooding farmers and 90 rearing farmers was taken. Using a set of structured questionnaire, required information was obtained from them. Data collected were analyzed using enterprise analysis method. Results showed that broiler rearing was more profitable than brooding as a business. Small-scale and large-scale brooding showed no remarked difference in net returns while small-scale rearing businesses were more profitable than large-scale outfits. It is therefore recommended that broiler producers should brood and rear their stocks to maturity for more net returns instead of concentrating on brooding alone. Size of operation should not be a thing to worry so much about in rearing since small-scale outfit in the enterprises offered more unit return than large-scale outfit.*

Introduction

Nigerians at the present 50 years of post-independence have not been able to feed themselves. Food production figure is lagging behind population growth figure. More disturbing is the fact that animal protein consumption is grossly inadequate especially in the rural areas. This is against the backdrop that animal protein is highly essential in human nutrition because of its biological significance. It is recommended that more than one third of minimum protein intake for an adult per day should be of animal origin. This is because animal protein contains all the essential amino-acids which are more balanced and readily available to meet nutritional needs than plant protein (Onyenuga, 1971; Ojo, 2003). Regrettably, animal products contributed only about 20-25% of protein intake of the nation (FRN, 1997). This becomes serious when it is weighed against the backdrop that Nigeria is endowed with abundant livestock production facilities but remained a net importer of livestock products (Abubakar, 1998). Improvement in broiler production is regarded as the fastest means of bridging animal protein demand-supply

gap in Nigeria (Ikpi, 1979; Akinwumi, 1997). This is because broiler is a good converter of feed into usable protein in meat; has low production cost per unit relative to other livestock; has palatable and acceptable meat product and short production cycle.

Broiler is offered for sale in the livestock market in three grades: the four weeks brooded popularly called brood and sale; 8 to 12 weeks reared and above 12weeks reared popularly called over grown. Producers engage in one or two or all of these depending on one's interest and production objectives. The producers equally operate at either small- scale or large-scale. This study is intended to run economic analysis involving costs and returns and profitability analyses of broiler enterprises in form of brood and sale and rearing brooded to maturity. These two distinct areas are regarded purely as enterprises in broiler production. Some producers specialize in brooding day old chicks to 4 weeks and selling them to producers who then rear them to maturity. Some buy brooded birds and rear them to maturity. There are yet another group that start from day old and grow them to maturity.

The interest of the study also extended to analyzing the enterprise types in form of scale of operation i.e. large-scale and small-scale production outfits. What is small- scale or large-scale enterprise is contextual and relative and depends on the industry in focus. In broiler production for example Anthony (2001) considered those farmers producing not more than 500 birds as small-scale farmers; those producing between 501 and 1000 birds as medium- scale farmers; and those producing from 1001 and above as large- scale farmers. The most useful economic definition of small-scale according to Adebusuyi (1977) was the one that emphasized those characteristics which might be expected to make their performance and their problem different from large-scale business. According to Okafor (2000), the definition is contextual as each country or public agency tends to adopt a definition criterion which accommodates the peculiar needs of public policy or which most appropriate the intended policy objective of agency concerned. In Nigeria enterprise size classification is based on a composite criterion of sales volume, capital or asset base and employment level. Large scale enterprise is one beyond the scope of small-scale business. For the purpose of this study, and the prevailing economic environment in the study area and the nature of livestock business, a small-scale outfit in the enterprise is taken to be one with less than 300 birds, managed by the owner and sometimes engaging one or two regular labour. The practice is that family labour is used for production. Therefore large-scale outfit is one that has300 birds and above. Use of paid labour rather than family labour is rampant. The management structure is formalized.

Although several works have been done on economic analyses of broiler production in Nigeria, they lacked specifications in brooding and rearing enterprises. The application of enterprise analysis method to these specific areas of broiler production is necessary for policy that will benefit the numerous small-scale producers who

pervade the livestock sub-sector and need proper guidance in their production decisions. This study therefore is aimed at examining and comparing performance in form of cost and returns analysis of the brood and sale business and rearing the brooded to maturity business on one hand and small and large-scale outfits of the two businesses on the other hand.

Methodology

The study area was divided into three clusters based on the existing three agricultural zones of the Imo State, namely Orlu, Owerri and Okigwe zones following the zoning arrangement of Imo Agricultural Development Project (IADP). Each zone is made up of several local government areas. Nine local government areas, three from each zone were randomly selected. Then broiler production was broadly classified into brooding and rearing enterprises. Each group was further grouped into small and large scale outfits.

In each of the enterprises, random samples of five small-scale and five large-scale farms were selected in a local government area. This gave a total of 20 farms of 10 from each enterprise in each local government area. In all therefore, a sample size of 180 farms were selected. Data collected were analyzed using enterprise analysis method thus:

II=TR-TVC-TFC

=TR-TC = TR-AVC-AFC . Where:

II=net profit; TR=total revenue, TC=total cost, TVC=total variable cost, TFC=total fixed cost, AVC=average variable cost, AFC=average fixed cost and GR=gross revenue.

Results and Discussion

Costs and Returns of Broiler Brooding and Rearing Enterprises

The costs and returns of broiler brooding and rearing enterprises are shown in the table 1. The figures in the table indicate average expenditure revenue of a broiler producer of the enterprises.A of 27280 birds were brooded by the brooding farmers while 28480 birds were reared. The gross revenue from broiler brooding enterprise was #112015.63 while in the rearing enterprise; the gross revenue was #385428.36. Average total cost of production in brooding enterprise was #91173.94 while in rearing it was #250833.34. These gave net revenue of #20841.69 and #134595.02 for brooding and rearing enterprises respectively. In other words an average broiler brooder earned 18.61% net revenue while the rearing farmer earned 34.94% net return. Return on Investment (RI) of the producers showed that an average brooding farmer earned 22k for every #1.00 invested while their counterpart rearing farmer earned 54k for the same investment. This showed that broiler rearing was more economically viable and profitable than brooding business in the area. This implied that one stood

the chance of making more profit if he concentrated more on rearing brooded broiler birds to maturity. However, the broiler brooding farmers may have made more aggregate revenue equivalent for a period one year from quick turn over nature of brooding business.

Table 1: Average Costs and Returns of Broiler brooding and rearing operations

Item	**Brooding Enterprise**	**Rearing Enterprise**
Revenue (N)	112015.63	385428.36s
Production Cost (N)		
Variable costs		
Labour	4196.55	8845
Feed usage	17003.51	118235.56
Cost of birds	62619.93	107070.63
Medication	2822.47	6510.70
Other inputs	2405.08	4922.45
Total Variable Cost (TVC)	**89047.54**	**245584.34**
Fixed Cost (N)		
Rent	1200	2300
Interest on loan	71.55	1250
Sanitation	300	300
Depreciation	554.85	1399
Total Fixed Cost (TFC)	**2126.40**	**5249**
Average Total Cost (ATC)	**91173.94**	**250833.34**
Net Revenue	**20841.69**	**134595.02**
% Net Revenue	**18.61**	**34.92**
Return on Investment (RI)	**22.8k or 22.8%**	**54k or 54%**

Source: Field Survey, 2009

Cost and Returns Analyses in Small-scale and Large-scale Broiler Enterprises.

Table 2 contains cost and returns details in small-scale and large-scale broiler enterprises. In broiler brooding enterprises, average revenue of large-scale outfit was #172819.76 while small-scale outfit was #55265.11. The production costs were #140765.98 and #44985.25 for large and small-scale respectively. This gave net revenue of #32050.70 or 18.55% for large-scale and #10279.86 or 18.78% for small-scale. Therefore for every #1.00 invested by large-scale brooder, he earned 24k while small-scale brooder earned 23k for the same investment. This shows that there was no

remarkable difference in profit margins of small-scale and large-scale outfits in broiler brooding enterprise.

In broiler rearing enterprise, average revenue were #724285.69 and #121872.66 for large and small-scale respectively. Average total cost of production were #484403.39 and #69167.80 for larges-scale and small-scale respectively giving net revenue of #239882.30 for large-scale and #52704.30 for small-scale. From this, the large-scale operator made 50k or 50% from every #1.00 invested while small-scale counterpart made 76k or 76% from the same investment. This implied that broiler rearing at small-scale gave more net returns than rearing it at large-scale. This might not be unconnected to the fact that in small-holder outfit, kitchen refuse may be used to supplement feed concentrates and labour is often imputed.

Across enterprises, small-scale producer in broiler rearing made more profit than her counterpart in brooding enterprise. Also the large-scale rearing farmer made more returns than her counterpart in brooding enterprise. This means that rearing birds to maturity offers more net returns than brooding birds and selling at about 4 weeks of age. This shows that broiler rearing was more economically viable and profitable than brooding business in study area. It then means that one stood the chance of making more profit if he concentrate more on rearing brooded to maturity .Based on this, it recommended that broiler producers should brood as well as rear their stock to maturity for more profit.

Table 2: Average Costs and Returns of Small-scale and Large-scale Broiler Enterprises.

Enterprise	**Brooding**		**Rearing**	
Variables	**Small-scale**	**Large-scale**	**Small-scale**	**Large-scale**
Revenue(#)	**55265.11**	**172819.76**	**121872.67**	**724285.69**
Production Costs				
Variable Costs				
Labour	3055.56	5419.05	2393.33	17140
Feed Usage	6944.33	27781.19	29474.20	232357.42
Cost of birds	30372.22	97171.05	32264.44	203250
Medication	1466.56	4275.24	1676.13	12726.57
Other inputs	1483.56	3392.4	1782.06	8960.09
Total Variable Cost (TVC)	**43322.23**	**138038.93**	**67590.16**	**474434.08**
Fixed Costs(#)				
Interest on loan	30.0	116.07	56.5	820.05
Rent	620	1320	500	2500
Sanitation levy	300	300	300	850
Depreciation	713.02	993.9	721.14	6299.26
Total Fixed Cost (TFC)	**1663.02**	**2729.97**	**1577.64**	**10469.31**
Average total Cost (ATC)	**44985.25**	**14068.9**	**69167.80**	**484403.31**
Net Revenue	**10279.86**	**32050.78**	**52704.87**	**239882.30**
%Net Revenue		**18.55**	**43.25**	**33.12**
Return on Investment (RI)	**24kor24%**	**23k or23%**	**76k or 76%**	**50k or 50%**

Source: Field Survey, 2010.

Conclusion

The study which disaggregated broiler production into component parts for detail study has shown that it is going to benefit the producer more if he rears his birds to maturity. It has also came to conclusion that small-scale producers made more net returns than large-scale ones in broiler rearing business while in brooding , there was no remarkable difference between the net returns of the small-scale and large-scale operators. This means that benefits of economies of size may not have been realized in this case. It is therefore recommended that broiler farmers should brood and rear their

stock to maturity fore more net returns. Size of operation should not be a thing of worry since small-scale outfits showed increased per unit returns more than large-scale outfits.

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Table 3: Growth performance of weaner pigs fed sundried *Microdesmis puberula* leaf meal

Parameters	*DIETS*				
	1 (0%)	*2 (5%)*	*3 (10%)*	*4 (15%)*	*SEM±*
Av. Initial weight (kg)	8.92	8.92	8.92	8.92	0.02
Av. Final weight (kg)	19.41	18.70	18.30	16.83	2.97
Average daily gain (g)	214.08	199.6	191.42	161.42	11.0
Av. Daily Feed intake (g)	920.0	820.0	870.0	770.0	30.0
Feed conversion ratio	4.30	4.10	4.54	4.77	0.12
Total weight gain (kg/pig)	10.49	9.78	9.38	7.91	1.12
Feed cost per kg (N)	41.55	39.48	37.44	35.40	
Feed cost per kg weight gain (N)	178.66[a]	161.89[c]	169.97[b]	168.85[ab]	4.90

[a,b,c] Means with different superscript in a row are significantly different (P<0.05)

DETERMINANTS OF ADOPTION OF COOKING BANANAS AMONG SELECTED HOUSEHOLDS IN OWERRI AREAS OF SOUTHEASTERN NIGERIA

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Abstract

The main focus of the study was to examine factors which determine the level of adoption of cooking bananas in Owerri and Mbaitoli areas of Imo State. Forty respondents who bought cooking bananas from the Agricultural Development Project (ADP), Owerri were purposively selected and interviewed. The responses received from the respondents were subjected to statistical analysis. The findings show 60 percent adoption level of cooking bananas in the area. The result also revealed that factors such as personal and socio-economic, institutional and agronomic affect adoption of cooking bananas. Problems associated with adoption include the taste of ripe cooking bananas, which most of the respondent complained about and showed disapproval. It was also found that cooking banana shelf-life was shorter than that of plantain, this quality obviously led to the wastage of the crop and discontinuance of the innovation. Appropriate training on packages of recommendation should be taken as a priority when introducing an innovation, judging from the fact that training on production and utilization boosted adoption of cooking bananas.

Keywords: Adoption, Cooking Banana, Household.

Introduction

Bananas and plantains (Musa species) are important food crops in the humid forest and mid-attitude zones of Sub-Saharan Africa, providing more than 25 percent of the carbohydrates and 10 percent of the calorie intake for approximately 70 million people in the region (IITA, 19(5). In addition to being a staple food for rural and urban consumers, plantains and bananas are important sources of income, particularly for small holder farmers who produce them in compounds or home gardens. In comparison with other crops, they are relatively high value crops whose annual production value in Sub-Saharan Africa exceeds that of several other food crops such as maize, rice, cassava and sweet potato (IITA, 1995).

Bananas and plantains are generally produced as compound crops with rapid yield decline after some production cycles. They are produced in intensively-managed gardens in which application of manure and house refuse ensure continuous high

productivity for many years. This production system has worked in the past, but now are unable to produce sufficient fruits to meet demand associated with rising population pressure.

Valuable as these crops are, lots of problems militate against their production. These include black sigatoka disease, weevil (a complex of plant parasitic nematods) and the yield decline syndrome (Vuyslteke, *et al.,* 1997). Among these constraints, black sigatoka disease seems to be the single most important threat to production. This accounts for yield reduction of about 30 50 percent (Stover, 1983; Mobambo *et al.,* 1983)

In realization of the economic and dietary value of plantain and banana in Sub-Saharan Africa, research has been geared towards tackling the black sigatoka disease through breeding resistance. This is however a long term approach. To have a short-term strategy, black sigatoka resistant cooking bananas which were collected from Asia were multiplied and distributed to farmers. They include Cardaba, Bluggoe, Pelipita, Fougamou and Nzizi. In vitro plantlets of cooking bananas were introduced and distributed to farmers in Southern Nigeria by various government agencies and institutions. The International Institute for Tropical Agriculture (IITA) in collaboration with the Agricultural Development Project (ADP) In Imo State disseminated the innovation and distributed cooking bananas in the area.

A major problem of agricultural development programmes in Nigeria is lack of appraisal and evaluation as to monitor success or failure in achieving the stated objectives at the micro level (Williams, 1978). Cooking bananas were introduced into Southern Nigeria in the 1980s as a short term remedy for black sigatoka disease of plantain and banana. To date, effort has not been made to know whether cooking banana is acceptable to farmers and if so what factors determine their adoption. To address this, the present study was conceptualized focusing at Owerri and Mbaitoli areas of Imo State Nigeria, which are a major plantain and banana producing block of south eastern Nigeria. The study sought to evaluate the level of adoption, identify and examine the problems associated with adoption of the crop, determine factors affecting adoption of cooking bananas; and assess Implications for technology generation and transfer.

Materials Methods.

The study areas, Owerri and Mbaitoli were purposively selected due to nearness to cooking banana multiplication center. Some farmers in these areas bought cooking banana propagules and suckers about fifteen years ago from lmo State Agricultural Development Project Multiplication Centre located at Egbeada. The choice of these areas would afford the opportunity of knowing how well it was accepted, being planted and whether it has diffused to other farmers and areas where it was not originally introduced.

Sample selection of respondents was purposive, concentrating on farmers growing cooking bananas. The list of farmers who bought cooking banana from ADP was a guide in selecting respondents. Forty farmers were selected for interview. Both secondary and primary data were collected for the study Primary data collected were through

the use of questionnaire and secondary data were collected through literature; ADP and Ministry of Agriculture. Oral interview was conducted with the zonal manager of ADP and some other farmers. This was done to determine their reactions towards dissemination and distribution of cooking bananas in these areas. Some of the information sought include: source of planting materials, number of years they have been planting the crop, number of plantain and cooking banana mats and fields, agricultural training they have attended in recent times, and experience with agricultural innovations, personal and socioeconomic characteristics of the farmers such as gender, age, marital status, number of years of formal education, social status, household position, occupation, and cooperative membership.

Opinion of the farmers about the characteristics inherent in cooking banana such as yield, taste, were also sought. Data generated were analysed using the statistical computer software package. Regression analysis, assessing the determinants of cooking banana adoption was carried out. Cooking banana adoption was measured by increase in the number of mats compared to the number of suckers a farmer started with. The generalised linear equation for the regression model was

$Y = f(xi)$; where,

$Xi = x_1, x_2, x_3 \ldots . x_{18}$:

Therefore:

- Y = CBMAT (cooking banana mats)
- X_1 = GEND (gender of ownership)
- X_2 = SATUS (social status of the farmer)
- X_3 = AGE (age of the farmer)
- X_4 = MARRIED (marital status)
- X_5 = HHSIZE (household size of the farmer)
- X_6 = OCCU (occupation)
- X_7 = SCHOOL (number of years of formal education of the farmer)
- X_8 = COOP (membership of cooperation)
- X_9 = EXP (past experience of farmers on agricultural innovations)
- X_{10} = TRAINING (farmers attending agricultural training)
- X_{11} = NUMSCK (number of suckers farmers received initially)
- X_{12} = FARMUNM (number of farmers that received cooking banana mat from ADP)
- X_{13} = FLELDS (total number of fields a farmer has)
- X_{14} = CBFIELD (number of cooking banana fields a farmer has)

X_{I5} = CBYLD (yield of cooking banana per time compared to plantain)
X_{I6} = CBTASTRP (taste of ripe cooking banana)
X_{17} = CBLIFE (shelf-life of cooking banana)
X_{18} = CBTASTUN (taste of unripe cooking banana)

RESULTS AND DISCUSSION

Cooking Banana Cultivation

The farmers growing cooking bananas did not start planting in the same year with the same number of suckers. The number of suckers ranged from 1 to 10 (table 1). On the average each farmer started with planting cooking banana with 2 suckers. More than half of the respondents started with 1 sucker. Three farmers started with more than 5 suckers.

Table 1: Frequency Distribution of Number of Suckers Planted.

NUMSUCK	Frequency	Percent	Cumulative frequency	Cumulative percent
1	25	62.5	25	62.5
2	6	15.0	31	77.5
3	2	5.0	33	82.5
4	2	5.0	35	87.5
5	2	5.2	37	92.5
6	1	2.5	38	95.0
10	2	5.0	40	100.0

Level of Adoption

The number of mats farmers had over the years was studied. All things being equal, it is expected that as the year progresses, the number of cooking banana mats a farmer has increases. On the average a farmer who has been planting cooking bananas up to 4 years has 9 mats, 5- 9 years has 15 mats and then for 10 years and above has 20 mats. For instance, if a farmer started with planting 1 sucker which eventually gives him 1 mat, after about 3 or 4 years, it is expected that the farmer would have transplanted some suckers from the original plant to get more mats if he is satisfied with the crop.

Sixty percent of the farmers adopted cooking bananas. This was judged by the fact that if the number of

mats a farmer presently has exceeds the number of mats/suckers he received initially, invariably he has adopted the crop, else it will he destroyed Out of 25 farmers who received I sucker initially, 12 adopted. Of the 6 who received 2 suckers, only 4 adopted. All the respondents that started with more than 2 suckers adopted. In the study, the adopters were not categorized to indicate their adoption index. This is attributed to the fact that farmers did not receive information on cooking bananas at the same time. Hence it is not justifiable to categorize adopters based on the year they started planting cooking bananas. For instance, a farmer who started in 1988 should not be classified as an Early Adopter, while another who started in 1995 be classified as a Late Adopter. It has to do with the time span when the farmer heard about an innovation to the time he starts to use it. Since the farmers were not exposed to information on cooking bananas at the same time, it was not necessary to classify adopters of cooking bananas into categories.

FACTORS AFFECTING COOKING BANANA ADOPTION.

In addition to physical factors such as climate, vegetation, topography and pedology which could influence the adoption of cooking bananas, there are personal and socioeconomic, institutional and other factors which could influence farmers' decision to adopt or not adopt, the effects of which were determined. The effect of physical factors mentioned above was not examined.

Personal and socio-economic factors

The variables included in the regression equation explain 93 percent of the variation in the number of cooking banana mats (R^2 = 0.93, table 2), though not all the variables in the model were positive and significant.

Gender of Ownership

Out of the 24 respondents who adopted cooking banana 41.7 percent were males while 58.3 percent were females. The regression analysis showed a positive and significant relationship between cooking banana mats and gender of the farmer (t = 2.78, table 2). This indicates that the probability of women to increase their mats is high more than that of men. The result indicates that females tend to have more. cooking banana mats than males.

Table 2: Parameter Estimates for Regression Analysis

Variable	DF	Parameter Estimate	Standard error	T for HO:	Prob > T
Intercept	1	-79.5311	19.5509	-4.057	0.0006
GEND	1	9.5925	4.3063	2.228	0.0376**
STATUS	1	-11.3270	8.6290	-1.313	0.2042
AGE	1	0.0632	0.1551	0.407	0.6880
MARRIED	1	0.8828	5.0984	0.173	0.8643
HHSIZE	1	1.77.46	0.6596	2.690	0.0141**
OCCU	1	2.9941	4.1807	0.716	0.4822
SCHOOL	1	-0.5506	0.4131	-1.333	0.1976
COOP	1	11.6956	3.4577	2.319	0.0311**
FIELDS	1	0.0229	0.2351	0.098	0.9232
NUMSUCK	1	6.8917	0.7252	9.502	0.0001***
FARMNUM	1	1.2230	0.2651	4.614	0.0002***
CBFIELD	1	6.690	0.8579	7.798	0.0001***
CBYLD	1	10.8653	7.7950	1.394	0.1786
CBTASTRP	1	-2.2377	3.0642	-0.730	0.4737
CBTASTUN	1	15.1319	3.2125	1.597	0.1258
CBLIFE	1	-13.5938	5.2063	-2.611	0.0167***

Note: **, *** indicates 5% and 1% level of significance respectively. Number of observations = 40, R square = 0.9304, dependent variable = CBMAT.

Age of the farmer

The analysis showed that age has a positive and no significant relationship with the number of mats a farmer has (t = 0.407, table 2). This indicates that the farmer is likely to have more cooking banana mats as he advances in age. The age distribution of the adopters were classified into three categories which include the old (over 55 years), middle age (35 - 55) and young age (less than 35 years) More than half of the adopters were middle aged. (35 - 55), that is 58.3%, while 29.2% were old people over 55 years of age. The young people below 35 years constituted only 12.5% of the total number of farmers that had cooking bananas.

Years of formal education

The analysis showed negative and no significant relationship between number of years of formal education of the farmer and the number of mat he has (t = -1.333). This result could be because most of the farmers with more formal education did not adopt cooking banana because the suckers they received initially did not survive. 41.5 percent of the adopters attended primary school, 34.1 percent attended secondary school while 24.4 percent attended tertiary institution.

Occupation

Occupation has positive but no significant relationship with the number of mat a farmer has (t = 0.716). This indicates that farmers tend to have more cooking banana mats than others in other occupations.

SOCIAL STATUS

The analysis showed that social status has negative and no significant effect on the number of cooking banana mats a farmer has (t := -1.313). This indicates that farmers who have social title are likely to have less number of mats. Only 2 respondents interviewed had social title and I adopted cooking banana.

HOUSEHOLD SIZE

Household size has positive and significant relationship with the number of cooking banana mats a farmer has (t = 2.690, table 2.) it is obvious that farmers with more members in their household tend to increase their cooking banana mats so as to increase the quantity of food they get from it to augment household consumption. 54.2 percent of the adopters have medium size families (6-9), 25 percent have large families (10 members and above) and 20.8 percent have families less than 6. Nuclear family structure indicated by small size family is least in the number in all categories. Medium size families make up over 50 percent of adopters.

MEMBERSHIP OF COOPERATIVE ORGANIZATION

The analysis showed that there is a positive and significant relationship between a farmer being a member of cooperative organisation and the number of cooking banana mats he has, (t = 3.382, table 2) This indicates that farmers who are members of cooperative society tend to be more innovative than non-members. They tend lo adopt innovations easier and earlier than those who are not members. This IS expected because farmers who are cooperative members are more enlightened about agricultural innovations and this makes them accept innovation with ease Out of the 24 farmers that adopted cooking banana only 10 were members of cooperative organisation

INSTITUTIONAL FACTORS

Variables examined under institutional factors include training and past experience of farmers on agricultural innovations. These were also added to the regression model.

The effect of training on cooking banana adoption

The result showed a positive and significant relationship between agricultural training and number of cooking banana mats. This indicates that farmers that have agricultural training increase their number of mats more than those who did not attend such training. This is basically because the farmers acquired knowledge on the production and utilization of cooking banana. Thus

the adoption level increased.

Farmers' past Experience on Agricultural innovation

The analysis showed that farmers' experience has negative and significant relationship on the number of cooking banana mats a farmer has (table 2). This indicates that farmers who had experience with agricultural innovation tend to be more skeptical about adopting new practices. Hence there is high probability of such farmers rejecting cooking banana entirely or to plant just one mat.

AGRONOMIC FACTORS

Agronomic factors are those inherent in the crop which could influence its adoption. Some agronomic factors included in the model are cooking banana yield, taste when ripe, taste of unripe cooking banana and shelf-life. The analysis showed that cooking banana yield has positive and no significant relationship with the number of mats of cooking banana a farmer has (t = 1.394). This indicates that once the farmer is satisfied with the yield of cooking banana, there is probability that he will increase his mats. Although it is not significant, it is obvious that if a farmer is impressed with the yield of the crop he is cultivating, there is the tendency that he would like to increase the field for the crop.

Taste of Ripe Cooking Banana

Taste of ripe cooking banana has a negative and no significant relationship with the number of mats of cooking banana a farmer has (t = 0.730). This indicates that farmers who did not like the taste of cooking banana when ripe tend to reduce the number of mats they plant. In spite of the fact that this variable is not significant, it does not rule out the fact that a farmer who does not like the taste of a crop he is planting would reduce the field.

Cooking Banana Shelf-life

The analysis showed a negative and significant relationship between cooking banana shelf-life and the number of mats a farmer has (t = -2.611). This indicates that because cooking banana spoils easily ones it gets ripe, farmers tend to reduce the number of mats they have. For the fact that cooking banana does not stay as long as plantain and banana before spoiling, farmers tend to have a misconception and hence reduced the number of mats they have.

Taste of Unripe Cooking Banana

The result equally showed that taste of unripe banana has positive and no significant relationship with the number of cooking banana mats. This indicates that farmers who like the taste of unripe cooking banana tend to increase the number of mat they have. It is obvious that since farmers like eating unripe cooking banana, there is probability of increasing their mats In order to have enough food for home consumption.

Others factors influencing adoption

Other factors included in the model which influenced the number of cooking banana mats a farmer has were, farmer's total number of field, number of sucker received initially, number of other farmers given suckers and cooking banana field of the farmer. These were identified as problems associated with cooking banana adoption

The analysis showed that there is a positive and no significant relationship between cooking banana mats and the number of fields a farmer has (t = 0.9232) It indicates that. Farmers who have more field are more likely to transplant cooking banana suckers to get more mats. This has to do with availability of land. All things being equal, a farmer who has enough land is more disposed to increase his mats than one who is limited by land. However, its non significant relationship may remove the guarantee that a farmer with more field would have more mats. It has to deal with what is uppermost in the scale of preference of the farmer and also his objectives.

The number of suckers farmers received initially has a positive and significant relationship with number of cooking banana mats (t = 0.9232). It indicates that farmers who received more suckers initially tend to have more cooking banana suckers. All things being equal, It is expected that farmers who started planting with more suckers should have suckers. For instance a farmer who started planting cooking banana with one sucker would have only one mat after one year, whereas one who started with five suckers would have five mats after one year.

Number of other farmers given suckers has a positive and significant relationship with number of cooking banana mats a farmer has (t = 4.614, table 2). This indicat.es that farmers tend to increase the number of mats they have in order to meet the demand of suckers of cooking banana by other farmers. For instance, a famer who has few mats would like to increase the number of mats he has so as to meet up with the increasing demand for It by other farmers. This will also result to diffusion of cooking banana.

The analysis showed *a* positive and significant relationship between cooking banana field and number of mats (t = 7.798). This indicates that farmers with more number of fields have more mats. It is expected that farmers with more cooking banana mats should have more field; given more land availability. For instance, a farmer with four fields is expected to have more mats than one with only one field.

SUMMARY AND IMPLICATIONS FOR FIELD PRACTICE

The result revealed 60 percent adoption level. Several factors either singly or collectively affected cooking banana adoption. Thus gender of ownership, household size and co-operative membership, agricultural training, had positive and significant relationship with the number of cooking banana mats farmers had. While age, marital status, occupation, cooking banana yield, taste of unripe banana and number of field a farmer has, had positive and no significant relationship with cooking banana mats. Conversely social status, number of years of formal education, and taste of ripe cooking banana, which was particularly identified as a problem associated with adoption of the crop had negative and no significant relationship with number of cooking banana mats a farmer has.

The analysis also showed that past experience of farmers on agricultural innovation and cooking banana shelf-life, the main agronomic characteristic that influenced adoption, had negative and significant impact on the number of cooking banana mats a farmer has, and invariably affected

adoption

It was concluded that there was adoption of cooking banana Perhaps the unpleasant characteristics associated with the taste of ripe cooking banana and shelf-life among other factors accounted for 40 percent non- adoption.

Some of the findings have implications for practice For Instance training on packages of recommendation should be taken as a priority when introducing an innovation, judging from the fat that training on production and utilization boosted adoption. The rate of distribution of cooking banana to other farmers both within and outside the study areas was so overwhelming. It became obvious that when innovations easy to try, compatible, simple and of relative advantage are proposed, adoption will definitely be easy. Thus these conditions and several factors found significant in the analysis must be considered for introducing innovations, especially in communities in food security gap.

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IMPACT OF HIV/AIDS EPIDEMIC ON THE EFFICACY OF AGRICULTURAL EXTENSION SERVICES

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Abstract

Human Immune Virus /Acquired Immune Deficiency Syndrome (HIV/AIDS) has a disproportionate impact on the agricultural sector in comparison to other sectors, and is closely associated with rural poverty, poor nutrition and household food and livelihood insecurity. Agriculture being the backbone of the economy of African countries contributes over 70% of the Gross Domestic Product (GDP) and 95% of the export earnings. The agricultural sector provides employment for over 80% of the rural population, the majority of whom are women, who are more vulnerable to HIV/AIDS because of biological vulnerability and prevailing socio-cultural practices. The devastating impact of HIV/AIDS has the potential to undermine government efforts geared toward increasing economic empowerment and farm productivity among the rural poor. One of these efforts is the provision of extension services to farmers. The paper thus highlights HIV/AIDS impact on extension organizations in sub-Saharan Africa. Agricultural extension organization work with farmers to develop and promote new agricultural technologies in Sub-Saharan Africa. Staff from these organizations have been badly affected by the HIV/AIDS epidemic. As farming households have to cope with losses of family and community members, so extension workers have to deal with sickness and the loss of friends and colleagues, making provision of technical support to improve agricultural productivity and food security more difficult than before. This paper argues that providing extension services can be high – risk activity if staff spend long periods in areas that are badly affected by HIV/AIDS and they are practicing unsafe sex. This lead to death of staff and reduction in the number of staff. To stem the tide, national policies on HIV/AIDS for extension services be developed, extension staff be trained and re-trained, and awareness by extension workers be carried out.

Key words: HIV/AIDS, agriculture, extension service, organization, staff.

Introduction

Agricultural extension is one of the agricultural science disciplines dealing with human resource development and technology transfer to farmers and rural households in most countries in the world. As agricultural development in a country moves forward, the knowledge and technology needs of farmers and farm households continue to increase. In countries where farm households have low levels of literacy and are attached to traditional farming practices, extension programmes will generally be more educationally focused, aiming primarily

at human resource development. These extension systems, often functioning as integrated agricultural and rural development programmes, help farmers form organizations/associations, such as commodity groups and co-operations, and promote the use of government services and improved technology (Baier, 1997). Some extension systems may expand their human resources development focus to include rural youth, child development, nutrition and household management programmes.

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Broad-based extension system that includes agriculture, population education, environment, home economics, rural youth, gender and community development components are essentially designed to improve the welfare of rural households and communities rather than achieve more limited agricultural production and technology transfer objectives.

At the FAO's 1989 global consultation on agricultural extension, it was recognized that economic pressure is forcing extension in many countries to justify itself on more immediate economic criteria that are closely related to technology transfers and increasing agricultural productivity, thus ignoring extension's traditional role in human resources development. They pointed out that pursuing an extension system that is narrowly focused on technology transfer risks promoting growth without equity. Unless the educational and technological needs of all major groups of farmers are affectively addressed, the long-term consequences will likely lead to a small proportion of very productive commercial farmers and the vast majority of rural people being left behind at the subsistence level in conditions of pervasive rural poverty thus jeopardizing the success of population programme. The socio-economic impact of HIV/AIDS on rural households requires a broad-based agricultural and rural development concept that is based on a more balanced approach to extension that takes the specific HIV/AIDS related needs of different rural groups into consideration (Baier, 1997).

Agricultural extension is in transition worldwide. Governments and international agencies are advancing structural, financial and managerial strategies to improve extension programmes. Decentralization, cost – sharing, cost – recovery, participation of stakeholder in development initiatives and the decisions and resources that affect them – these are some of the elements in extension's current transition. Given the problems and challenges mentioned earlier, priority should be given to improving and strengthening extension services, especially through farmer education and training, to meet the challenges of ensuring sustainable agricultural and rural development in HIV/AIDS – affected rural areas. Fundamental policy change and new strategic directions of approaches are urgently required to increase the efficiency of providing relevant agricultural extension and training programmes to farm families, focusing on small-scale and resource – poor farm household, and especially targeting rural women and youth . The suggestions for

improving extension activities only provide general directions for action. Each farmer education /training activity has specific goals, problems or needs. (Baier, 1997).

The Current Situation

The HIV epidemic has risen from the status of a health crisis to that of a development concern that affects all sectors (inclusive of agriculture and rural development) and segments of society (urban and rural, rich and poor, men, women and children of all ages). The magnitude and severity of the impact of the epidemic, according to the former Secretary-General of the United Nations, Kofi Annan, has made HIV/AIDS not just a social and economic problem but a security issue as well. In January 2000, the UN Security Council went as far as to convene an open debate on the impact of AIDS on peace and security in Africa--the first time that the Security Council has addressed a health crisis as a threat to peace and security (Topouzis, 2003).

Given that agriculture is the largest sector in most sub-Saharan African economies, accounting for a significant portion of production and employing a majority of workers, the impact of HIV/AIDS on this sector is of paramount importance to policy-makers. According to data from FAO (1994) and Topouzis, (2003). AIDS has claimed the lives of about 7 million agricultural workers to date and could kill an additional 16 million (up to 26% of the agricultural labour force) in sub-Saharan Africa by 2020. In macro-economic terms, the majority of countries most affected by HIV' are also those most heavily reliant on agriculture, and particularly on agricultural exports for foreign exchange needed to pay for raw materials and essential imports for development. For instance, in Malawi, where 87% of the population earns a living from agriculture and about 80% of the country's food comes from subsistence farming, with most smallholder farmers cultivating less than one hectare, adult HIV prevalence is 16%. (Bota *et al.,* 1998). In Kenya, where between 70-80% of the population earns a living from agriculture and 60% of the food comes from subsistence farming, adult HIV prevalence is more than 11% (GTZ, 1999).

Human Immune Virus is becoming an issue of increasing relevance to Ministries of Agriculture (MoA), government and non-governmental agencies which are confronted with formidable challenges in coping with epidemic impact. This is because HIV/AIDS is changing the environment in which MoA operate by exacerbating existing constraints to agricultural and rural development and by triggering or intensifying structural changes in the sector. This means that the human cost of HIV/AIDS is high.

In 2003 it was estimated that in Southern Africa, where the highest rates of HIV prevalence can be found, as many as 1.2 million people died out of more that 14 million persons infected with the virus (UNAIDS, 2004). In addition, the epidemic undermines household economics, often pushing those directly affected into poverty, and reducing the incomes of all so that not only those living with HIV/AIDS, but also many of the individuals and households not directly affected, may see their incomes fall. In regions such as Southern African, where more than

half the population already live in poverty the consequences of economic setbacks can be severe. It already seems likely that in the most affected countries, the epidemic means that many of the Millennium Development Goals will not be achieved (Slatter, and Wiggins, 2005).

Early outbreaks of the disease occurred predominantly in urban areas, but subsequently increasing prevalence rates in rural areas, and a tendency for those showing symptoms of AIDS to return to their villages, mean that the majority of people living with HIV/AIDS are now in rural areas. The focus of policy is therefore shifting, both spatially, from urban to rural: and sectorally-while initial early responses focused heavily on health and education, it is now clear that the economic effects will be large, including on agriculture and related activities. Thus, supporting rural households, affected by HIV/AIDS, and making efforts to ensure that gains made in agricultural growth and poverty reduction over recent decades are not lost, are high on the rural development policy agenda (Slatter and Wiggins, 2005).

Until, recently, HIV/AIDS was considered mainly as a health issue, and all programmes for combating the epidemic were based on health and medical sciences. Because of this very reason, there were mainly medical organizations, which were front-line fighters against the epidemic. However, views are changing fast. The adverse effects of HIV/AIDS on development institutions and their programmes in Africa have forced the health and non-health development agencies alike to approach the problem from an entirely different angle. The HIV epidemic is now being considered as an important cross sectoral development issue bearing far reaching implications for policies and programming, both for the government and international development agencies (Qamar, 2001; Qamar, 2003).

The loss of breadwinners due to the epidemic is leading to increased poverty and food insecurity among affected families in sub-Saharan Africa. Also professionals and other categories of skilled labour have not been spared by the epidemic. The main consequence of this calamity in many affected countries is the reversal of the social and economic progress made during the last few decades, coupled with the serious negative impact both on households and relevant organizations and institutions. This is especially true for smallholder agriculture that is considered as a vital sector for rural livelihoods and national economics in the sub-region. An enormous cost burden has been imposed on households and organizations due to diversion of resources to health care, loss of both skilled and unskilled labour, funeral costs, costs of recruiting and replacing staff and reduction in productivity due to losses of human resources.

Both subsistence and commercial agriculture have been affected by AIDS significantly in the way of decline in crop yields, increase in pests and diseases and decline in the variety of crops grown in case of subsistence farming (FAO, 1994). Major financial and social crises have been increased in the agro-industry due to protracted morbidity and mortality and loss of skilled and experienced labour (FAO/UNDP, 1999). The epidemic bears serious

implications for policy intervention, service delivery, and programme implementation by the organizations that are responsible for providing various services to the rural population. The situation necessitates the urgency for organization and institutions to respond to the challenges posed by the epidemic, through modifying their approaches and methodologies in order to make them more relevant to the needs of rural dwellers.

The Challenge to Agricultural Extension Services

There is already ample evidence that the epidemic had changed the very fabric of the farming population, bearing implication for agricultural extension services. Apart from the routine difficulties faced in daily work in rural areas by agricultural extension staff in developing countries, the challenges that most agricultural extension services face are mostly of a technical and logistic nature. Some examples are insect pest invasion, outbreak of serious diseases, locust attacks, severe climatic effect, natural disasters, and intensive campaigns for increase in agricultural production. The challenge currently posed by the HIV/AIDS epidemic to agricultural extension organizations in sub-Saharan Africa, however, is quite unusual as it affects both staff and clientele and involves human emotions to a depressing degree, that is, in addition to technical aspects. This challenge has at least three major dimensions. First, the nature of the extension work, second, the impact of the epidemic on the extension organization itself and its staff, and third, the impact of HIV/AIDS on the clientele of extension services. A brief analysis of these three dimensions is imperative.

Nature of the Extension Work

Since most of the population of the countries, worst hit by AIDS, live in rural areas, a large number of people affected by HIV/AIDS in sub-Saharan Africa are, directly or indirectly, engaged in farming. The workers, who have the most frequent contact with the small-scale farmers, are the field extension agents. The extension services, by their very mandate and character, deal with traditional and most often illiterate rural households, in order to provide them with technical advice not only on agricultural technologies but also on relevant subjects like farm input supply, credit, marketing and farm management. Most of the extension staff themselves have their genetic roots in rural families. They travel frequently in rural areas, many times spending nights away from home, and being offered “hospitality” in villages due to their status. The extension staff that are particularly vulnerable to HIV infection include mobile professional and support staff who need travel ion order to carry out their duties: agricultural extension workers, high level professionals who frequently attend seminars, conferences and in-service training as well as drivers. These groups often have to spend extended period away from their homes and families (Topouzis, 2003). Also, they are in touch with so many widows forced into farming because of their husbands’ death, who need extension advice. Thus, the extension workers have ample opportunities of getting involved with multiple sex partners. All these factors expose the extension staff to

the maximum risk of HIV epidemic (Qamar, 2003; NAADS/FAO, 2004). An impact assessment conducted by the Ministry of Agriculture and Irrigation of Malawi MAWRD (2000) found that among Ministry of Agriculture (MoA) male staff, drivers, supervisors, middle and top managers were most vulnerable to HIV infection. Among female staff, messengers and secretaries were perceived to be most vulnerable. Reasons given for this increased vulnerability included:

i) The fact that these jobs required frequent travel to the field, which separated employees from their spouses for prolonged periods of time;
ii) Better-off male staff were more likely to have more than one sexual partners;
iii) Worse-off female staff were more likely to offer sex for money (Topouzis, 2003).

Impact on Extension and Partner Institutions

Effects on extension workers as individuals

Extension staff apart from being more exposed to the risk of contracting the HIV infection due to their frequent visits to HIV/AIDS infected rural areas, suffer from the epidemic in many other ways. Many of them are sick, some chronically. A number of their colleagues have already become victim to the disease, and more bad news is feared almost everyday. The talk of colleagues' demise is common in office meetings more than ever before. Then, they have the unbearable burden, in terms of time, money and energy, to taking care of their close sick relatives and visiting sick neighbours. Some of them have lost their spouses, thus leaving them not only grieved but also with the responsibility of taking care of minor children. The situation has forced some workers to pull their children out of school. Unlike in the past, the attendance of funerals is now a frequent thing, and it involves heavy cost due to ceremonies such as slaughtering of precious animals and serving meals to large number of persons. Low morale, depression, economic worries, and less productivity are now common in extension organizations due to HIV/AIDS. Extension workers who by training are required to motivate farmers to try and adopt new agricultural technologies are themselves depressed and frustrated, and this affects their output. (Baier, 1997; FAO, 2000; Qamar, 2001).

Reductions and Disruption in Staff

Report from government extension service officials in certain African countries reveal that their capacity for delivering satisfactory services is being affected by HIV/AIDS. This is due to disruptions in their programmes caused by deaths, protracted sickness and frequent absence of staff. For example, in Uganda, between 20 and 50 percent of all working time of extension staff is lost due to the attendance of funerals of AIDS victims and for the caring of sick relative. Considerable number of skilled and experienced persons have died of AIDS. In the central province of Zambia, during the period 1991 to 1998, as many as 66 staff died due to HIV/AIDS – related causes, representing almost 20 percent of the loss of staff due to different illnesses. The same is true for many other

provinces. In Malawi, where there has been a freeze on staff recruitment since 1995, a considerable number of vacancies have resulted from the death of front – line staff, worsening the already unsatisfactory extension agent to farmer ratio, for example, in one district, a field assistant is required to cover an area of about 400 square kilometers where 4000 farm families live. The organizations, including public and non-public, are faced with time-demanding tasks of identifying, recruiting and training of new staff. The result of delays in replacing the deceased and very sick staff is that the reduced number of staff are not only psychologically depressed due to the loss of colleagues but they also have to handle a far heavier workload both within the office and outside in the field. This situation is bound to adversely affect the performance of agricultural extension organizations (Qamar, 2003).

Increased Organization Costs

Both public and private extension organizations and some relevant institutions have reported increased costs due to HIV/AIDS. The additional expenditure is related to payment for treatment of sick staff and their relatives, funerals of dead staff, compensation, salary advances, early retirements, recruitment and training of new staff and for buying insurance coverage. According to the estimate provided by different private organizations engaged in extension work in Malawi, the cost of a funeral per death, depending on the status of the deceased staff members, could range between mk 1000 and mk 50000 (one US $ = approximately 70 mk). The increased costs are bound to affect the performance of public extension departments as most of them already suffer from very low operational budgets. The frequency of visits to the field will dwindle further and the few in-service training opportunities the staff have will also disappear (FAO, 2003b).

Established Technical Practices Going Obsolete

The years old administrative, strategic, policy and operational practices of almost all relevant organizations, including public, private and NGOs, seem to be outdated due to drastic changes in the social structure including, income levels, pattern of life, and types of clientele, all caused by HIV/AIDS. Extension services, whether government, semi government, private, or NGOs, are linked to many other institutions and organizations such as those responsible for providing credit, technology, packages, marketing facilities, land tenure, and plant protection. These organizations will also be affected in their operations and practices due to the effect of HIV/AIDS on the farming populations. For example, there are now applications for agricultural credit from orphan-and widow headed households, which are often not eligible according to the existing criteria for the approval of credit applications. The extension staff who, in general, are supposed to support the applications for rural credit, fell lost in the absence of the new criteria needed for this new clientele. The staff of rural credit institutions may be faced with a dilemma of their own since the applications for credit cannot be approved unless a revised policy is in place and a new set of criteria is available for the applicants to qualify. Summarily, the organization and firms responsible for recommending farming

systems and manufacturing farm equipment would soon find themselves wondering whether their recommendations and products are still as useful and in demand as they were before the epidemic hit. (FAO, 2000; FAO, 2001b).

Emergence of Unexpected Clientele and Extension-Demand Environments

Drastic change in the composition of clientele

The epidemic is changing the traditional composition of the clientele for extension services. In the areas of high HIV prevalence, the category of healthy and able-bodied men, women and youth, in the late adolescent to middle age range, is the one that has been most affected by high levels of morbidity and mortality. One finds more women, children and elderly persons now engaged in farming due to prolonged illness and or death of their spouses, parents, guardians and other members of the family. Paradoxically, the struggle for feeding a large number of children left behind by their parents who have died young, has forced many very old persons back into farming after retiring from active farming long ago. The emerging target population for extension services increasingly includes more physically weak, sick and elderly persons, widows and young orphans. For example, according to UNAIDS estimates, in 2001, the number of AIDS orphans in Mozambique was 420,000 and by 2010, was expected to jump to one million. Zimbabwe currently has 700,000 AIDS orphans. These newcomers, who even though they are exposed to farming due to living in rural areas, have relatively less experience in agronomic practices, as compared to their elders, and have limited physical and technical capacities for the use of heavy tools, farm machinery and animal – drawn farm equipment (Pathfinder International, 2000; Qamar, 2003; FAO, 2004a). Change of this magnitude in the type and character of the clientele is bound to render the existing extension strategies and methods outdated unless they are adjusted in line with the new extension clientele and their needs. The public extension organizations, however, are not yet prepared to cope with the situation.

Distraction from Farming Activities

While traveling by road in the rural areas of the sub-Saharan African countries hardest hit by HIV/AIDS, the scenes of funerals are quite common. Both men and women, who should normally be busy in farming activities, are now forced by traditional customs, to frequently spend considerable time on attending the funerals and relevant ceremonies. These funerals are not only attended in their own villages but also in the surrounding villages for which they have to cover large walking distances. The situation does not only cause serious distraction from their normal farming operations, but also results in reduced contacts with the extension agents, and less participation in technology demonstration ad training activities. The farms are being ignored and so are the contacts with extension staff (Granich and Mermin 1999, 2003).

Farmers Increasing Queries on HIV/AIDS

The notoriously persistent denial and “conspiracy of silence” about

HIV/AIDS, common among rural communities, is gradually giving way to relative openness. The stigmatization, denial and secrecy are still prevalent, but so many and so frequent deaths occurring in the area among relative and friends can no longer be simply ignored. The escape from HIV/AIDS has understandably become so important a priority for farmers as the once eagerly sough technical advice on increasing agricultural production. The farmers questions are no longer limited to farming. There are so many queries related to HIV/AIDS. However, the extension staff who know little about the epidemic and have not received any special training in this subject, feel helpless and embarrassed in front of the farmers. They are not in a position of offer any useful information or meaningful advice (FAO, 2004b).

Worsening Supply of Farm Labour, Food Insecurity and Policy

According to UNAIDS, HIV/AIDS infections are highest amongst adult aged between 20 and 40, who account for about three-quarters of all AIDS cases (Qamar, 2003). The emerging households, where the men and women of most productive age have either died or are disabled by prolonged sickness, are now headed by orphans, adolescents, the elderly, and quite often weakened and sick adults, and have fallen deeper into poverty and food insecurity. This is because fewer family members can now spare the energy and time for earning wages in rural and non-rural employment. According to a study done in Ethiopia, AIDS – affected households spent 50 to 60 percent less time on agriculture than those not afflicted (ICRW, 2003).

In the United Republic of Tanzania, researchers have found that women spent 60 percent less time on agricultural activities because their husbands were ill. In addition, infection rates are rising among Africa women, who account for 8 out of 10 of African's small farmers, and who traditionally provided the vital coping skills needed in times of food crisis. The latest statistics shows that women now make up 58 percent of Africans already infected. At present, 14.4million people risk starvation in six Southern African countries where about 15 million are HIV positive and 1.1million were lost to the disease in 2001. AIDS has been identified as one of the causes of this famine and the single most important cause of vulnerability in the region (Kurschner, 2000; Qamar, 2003).

By one estimate, approximately two person-years of labour are lost by the time one person dies of AIDS, due to his/her weakening and the time others spend giving care. According to FAO, AIDS has killed about 7 million agricultural workers since 1985 in the 25 hardest-hit countries in Africa, and it could kill 16 million more before 2020. The loss in the agricultural labour force through AIDS in the nine hardest-hit African countries, for the period 1985-2020, may be projected as follows: Namibia 26 percent, Botswana 23 percent; Zimbabwe 23 percent; Mozambique 20 percent; South Africa 20 percent; Kenya 17 percent; Malawi 14 percent; Uganda 14 percent; United Republic of Tanzania 13 percent (FAO, 2001).

Strategies to Face the Challenge

The HIV/AIDS epidemic is spreading so fast that taking any remedial measures has become almost

a race against time. The agricultural extension organizations are not expected to be medically involved in the fight against AIDS, but they can play an extremely important role in preventing or at least minimizing the further spread of infection by educating the farming communities. Priority actions needed for preparing extension services to prevent the spread of HIV/AIDS include.

Developing a National Policy on AIDS and Extension.

The political will of national governments to recognize the seriousness of the HIV/AIDS issue and deal with it is the starting point. However, most countries of Africa are still without a national policy on agricultural extension let alone a policy on AIDS and extension. The governments should formulate a policy on the handling of the situation by extension staff in HIV/AIDS infected areas.

Revision of Pre-Service and In-Service Training Curricula.

The existing curriculum of agricultural extension certainly needs thorough revision and updating in most of the developing countries in view of significant global changes that are shaping up the future role of extension in the new millennium, presenting meaningful options for institutional reforms in the national agricultural extension systems. Intensive orientation sessions of short duration should be organized for extension staff, by the health specialist, rural sociologists for agricultural extension should run special courses on the role of extension in mitigating the spread of HIV/AIDS among farming communities. Developing extension strategies that consider the specific needs of social groups taking on new working roles.

Agricultural extension strategies, methods, and technical content, should all be revised and adjusted in light of the fact that large numbers of inexperienced widows, orphans, and elderly persons are being forced into farming due to the death of their traditional able bodied young men and women relatives. Incorporation of HIV/AIDS education messages into ongoing extension programmes, with emphasis on the interrelationship between food security, farm labour, income levels, and HIV/AIDS. Introduction and for strengthening of extension methodologies using a group approach that can be applied with relatively small number of extension staff in view of dwindling number of extension workers. Development of HIV/AIDS – oriented participating, client-focused extension approaches and technical messages in order to address specific extension and training needs of old and new clientele in terms of age, gender and experience to enable them to benefit from the extension services.

Launching HIV/AIDS prevention and awareness campaigns through extension services. Extension workers can play an important role in educating farming communities about HID/AIDS. Extension organization should prepare and produce a variety of audio-visual aids and non-formal educational materials that could be used for education and the increasing of awareness about HID/AIDS – related topics. These materials include posters, charts, flip-charts, pamphlets, leaflets, audio-cassettes, video – cassettes,

newsletters, radio messages, songs, scripts for rural theater plays and puppet shows. The central theme of these materials should be the relationship between rural poverty, agricultural production, food security, farm labour and HIV/AIDS. The materials should be prepared keeping in mind the target groups, gender, age, culture, religion, local language literacy level of the rural population, and the availability of electricity or battery cells in the area.

Conclusions

Agricultural extension organizational in Africa have already been badly affected by staff and budget cuts, loss of staff to death, and sickness of staff, leading to fewer staff available to perform the duties. These difficulties have been made worse by the rapidly spreading HIV/AIDS scourage. These challenges and difficulties associated with being an extension worker have dramatically increased, thus impacting negatively on extension organizations. This is the time when both public and private extension institutions ought to broaden their scope of work beyond transfer of agricultural technologies and consider integrating environment, population, and HIV/AIDS education into ongoing agricultural extension programmes, with a view to the sustainable livelihoods of rural people.

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PRODUCTIVITY OF COCOYAM/VEGETABLE COWPEA INTERCROP AS INFLUENCED BY SPATIAL ARRANGEMENT AND COWPEA GROWTH HABITS

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Abstract
Two years field experiments laid out in randomized complete block design were conducted during the 2006 and 2007 wet seasons in the lowland humid forest zone of south-eastern Nigeria to investigate the productivity of cocoyam / vegetable cowpea intercropping as influenced by spatial arrangement and cowpea growth habit. Cocoyam and vegetable cowpea were each planted in monoculture and intercropped within and between rows. The results showed that corm yields obtained from cocoyam intercropped within the row of climbing *Akidienu* were significantly higher than the yields when combined within erect IT86F-204-1. The erect IT86F-204-1 gave higher fresh pod yield under sole cropping while the climbing *Akidienu* gave higher fresh pod yield when intercropped within cocoyam plants. Intercropping did not depress cowpea pod yield except where cocoyam was combined between erect IT86F-204-1 in 2006. Assessment of the productivity of the mixtures using LER, ATER and monetary returns showed yield advantages. The highest LER (2.9), ATER (2.5) and net monetary returns (N491,550) (using mean of two years) were obtained when cocoyam was intercropped within the climbing *Akidienu* vegetable cowpea rows.

Introduction

Cocoyam (Taro – *Colocasia esculenta* (L) Schott or Tannia – *Xanthosoma sagittifolium* Schott) is grown in the tropical and subtropical regions of the world (Lyonga and Nzietchueng, 1986). It is an important group of tropical tuber crops, which is produced and consumed as a staple food and constitutes one of the major subsistence crops in these regions (Maduewesi and Onyike, 1980). An important characteristic of cocoyam is its high requirement for moisture and shade. Onwueme (1987) reported that cocoyams require rainfall above 2000 mm per annum for optimum yields. Ibe and Iwueke (1984) recommended

mulching as standard practice if optimum yield of cocoyams is to be obtained. Onwueme (1978) also recommended mulching especially for upland farms. Chinaka and Arene (1987) reported that mulching increased yield of *Xanthosoma sagittifolium* by 115.6% and *Colocasia esculenta* by 105.5%. It has been shown that growing crops as live mulch effectively conserved the soil moisture (Udealor, 1993). Cocoyam like yam and cassava is generally grown in mixture with other crops like maize, sugarcane, groundnut, melon and banana. (Okigbo, 1985).

Intercropping cocoyam with other crops as an efficient production system was recommended for regions where pressures on land are high (Devos and Wilson, 1973). As a companion crop in such system, cowpea is useful in nitrogen fixation (Mohammed and Clegg, 1993). Green and Blackner (1995) attributed the nitrogen value in intercropping system to the residue decomposition of cowpea rather than mineralization of nitrogen from biological nitrogen fixation by cowpea. Besides, the amount of light intercepted by crops in mixture will depend on the geometry and plant architecture of the component crops (Heiltholt *et al*., 2005). Spatial arrangement in traditional farming is haphazard, without any attempt to arrange the crops in a way that the components intercept adequate solar energy. The arrangement of the components in a crop mixture will influence the amount of solar energy available to the components, particularly when both crops are of different heights and architectures (Wahua and Millers, 1978). Information on the effect of planting pattern on cocoyam intercropping is meagre. The objective of the present study was to determine the effect of spatial arrangement and cowpea growth habit on cocoyam/cowpea intercropping.

Materials and Methods

Field experiments were conducted during the rainy seasons of 2006 and 2007 at the research farm of Michael Okpara University of Agriculture, Umudike. Umudike is located on latitude 05^{o} 29^{1} N, longitude 07^{o} 33^{1} E and at elevation of 122 m above sea level. The soil was a sandy loam soil characterized as a *typic paleudult* (Udealor, 1993). The soil physical and chemical properties of the sites are shown in Table 1.

The experiment was conducted on land that was under fallow for one year in 2006 and 2007. The field was slashed and ploughed on 9 April, 2006 and 7 April, 2007, harrowed and ridged at 1m spacing on 18 April, 2006 and 16 April, 2007. Before planting of cocoyam and cowpea, soil samples from 0-20cm depths were collected on 19 April, 2006 and 16, April 2007 from three different locations per plot with a soil auger. The soil samples obtained at the beginning of the experiment were thoroughly mixed and bulked to one composite sample, air-dried, sieved through 2mm sieve and analyzed for pH, organic matter, nitrogen, phosphorus and potassium. The second sampling was done at 28 weeks after planting (WAP) after harvest of cocoyam. The soil sample obtained after harvest of cocoyam was bulked plot-by-plot, air dried, sieved through 2 mm sieve and each analyzed for pH, percentage organic matter using wet oxidation

method of Walkley and Black, total nitrogen by Kjeldahl method of wet oxidation, available phosphorus by colorimetric method and exchangeable potassium by Flame photometer (Udo and Ogunwale, 1978).

Table 1: Soil Properties of the sites in 2006 and 2007

	2006	**2007**
Mechanical Properties of Soil	83.5	77.5
Sand (%)	11.5	14.8
Clay (%)	5.0	7.7
Silt (%)	Sandy Loam	
Textural Class		
Chemical Properties of Soil		
P^H (H_20)	4.02	5.47
OM (%)	2.10	1.14
N (%)	0.15	0.11
P (Cmol/kg)	18.20	17.03
K (Cmol/kg)	0.16	0.14

Table 2: Effect of intercropped cocoyam with vegetable cowpea and planting pattern on the soil chemical properties at harvest in 2006 and 2007 cropping seasons combined

		pH(H_20)			OM (%)			N(%)		
Treatment	Planting scheme	2006	2007	Mean	2006	2007	Mean	2006	2007	Mean
Cocoyam	Sole	3.64	5.10	4.37	1.85	0.75	1.30	0.10	0.09	0.095
Akidiani	Sole	4.21	4.21	4.21	3.18	1.64	2.41	0.21	0.17	0.190
Akidienu	Sole	4.07	5.05	4.56	3.25	1.82	2.54	0.18	0.15	0.165
IT81D-1228-14	Sole	4.34	5.03	4.69	2.25	1.82	2.64	0.15	0.18	0.165
IT86F-204-1	Sole	3.86	5.05	4.46	3.75	2.18	2.97	0.21	0.18	0.195
C + Akidiani	Within	3.87	5.10	4.49	2.65	1.54	2.10	0.17	0.13	0.150
C + Akidienu	Within	4.34	5.43	4.89	3.55	1.47	2.51	0.18	0.14	0.160
C + IT81D-1228-14	Within	4.16	5.08	4.62	2.25	2.00	2.13	0.15	0.17	0.160
C + IT86F-204-1	Within	3.90	4.13	4.02	2.80	1.77	2.89	0.16	0.18	0.170
C + Akidiani	Between	4.09	5.50	4.80	2.37	1.48	1.83	0.13	0.18	0.155
C + Akidienu	Between	4.16	4.59	4.34	3.00	1.34	2.17	0.18	0.13	0.155
C + IT81D-1228 14	Between	4.22	4.50	4.36	3.25	1.40	2.33	0.17	0.11	0.140
C + IT86F-204-1	Between	4.26	4.66	4.46	3.75	1.55	2.55	0.17	0.15	0.160
$LSD_{0.05}$		0.56	0.18	0.408	1.48	0.11	0.174	0.04	0.06	0.029
Initial value		4.02	5.47	4.75	2.10	1.14	1.62	0.15	0.11	0.130

C = Cocoyam

The experimental design was a randomized complete block design (RCBD) with 3 replicates. The block was divided into experimental units (plots) measuring 3 m X 4 m ($12m^2$). Each block consisted of thirteen treatment combinations. These include:

1. Sole cocoyam (10,000 plants per ha)
2. Sole *Akidiani* (spreading cowpea) (40,000 plants per ha)

3. Sole *Akidienu* (climbing cowpea) (40,000 plants per ha)
4. Sole IT81D-1228-14 (semi-erect cowpea) (40,000 plants per ha)
5. Sole IT86F-204-1 (erect cowpea) (40,000 plants per ha)
6. Cocoyam + *Akidiani* within row (10,000 + 40,000 plants per ha)
7. Cocoyam + *Akidienu* within row (10,000 + 40,000 plants per ha)
8. Cocoyam + IT81D-1228-14 within row (10,000 + 40,000 plants per ha)
9. Cocoyam + IT86F-204-1 within row (10,000 + 40,000 plants per ha)
10. Cocoyam + *Akidiani* between row (5,000 + 20,000 plants per ha)
11. Cocoyam + *Akidienu* between row (5,000 + 20,000 plants per ha)
12. Cocoyam + IT81D-1228-14 between row (5,000 + 20,000 plants per ha)
13. Cocoyam + IT86F-204-1 between row (5,000 + 20,000 plants per ha)

The treatments were assigned randomly to the plots. The sole crops were included in the treatments for the assessment of the productivity of the intercrop systems.

Cocoyam (cocoindia) corms/cormels and vegetable cowpea seeds were planted on the same day on 20 April, 2006 and 17 April, 2007 in all the plots. Cocoyam corms weighing 35-50 g were planted on the crest of ridges while two seeds each were sown for vegetable cowpea. The treatments comprised three planting density component ratios of 100:0, 100:100 and 50:50 percent of cocoyam and cowpea, respectively in the mixture. Records were taken on number of corms per plant, corm weight per plant (g/plant), corm yield (t/ha), number of nodules per plant, number of pods per plant, fresh pod weight per plant (g/plant) and fresh pod yield (t/ha).

Land equivalent ratio (LER – sum of the ratios of yields of intercrops to those of sole crops), area time equivalent ratio (ATER) and net monetary equivalent returns (NMER – assessed in Naira per hectare by multiplying the yield of the crop with prevailing market price of the commodity minus the total cost of production within the location) were computed with the formulae of Fisher (1977), Hiebsch and McCollum (1987) and Eke-Okoro *et al*. (2005), respectively.

For each year, separate statistical analyses were performed on cocoyam and vegetable cowpea data. The data were subjected to analysis of variance using Genstat Statistical Package (2003) discovery edition.

Table 3: Effect of intercropped cocoyam with vegetable cowpea on corm yield and yield components in 2006 and 2007 cropping seasons

		Number of corms /plant		Corm weight (g/plant)		Corm yield (t/ha)		
Treatment	Planting scheme	2006	2007	2006	2007	2006	2007	Mean
Cocoyam	Sole	16.4	19.8	41.2	42.9	10.2	8.64	9.42
C + Akidiani	Within	21.2	21.6	49.6	45.8	10.6	9.95	10.28
C + Akidienu	Within	27.6	32.2	62.5	55.0	17.3	16.06	16.68
C + IT81D-1228-14	Within	19.8	30.2	54.4	54.9	10.4	16.01	13.21
C + IT86F-204-1	Within	29.9	28.8	54.6	53.11	13.9	16.02	15.00
C + Akidiani	Between	35.2	22.9	54.5	43.1	9.6	9.29	9.45
C + Akidienu	Between	27.2	22.6	53.4	45.3	8.4	8.95	8.68
C + IT81D-1228-14	Between	25.3	20.6	52.7	45.0	7.9	9.93	8.92
C + IT86F-204-1	Between	26.7	17.8	40.9	44.2	6.9	9.00	7.95
$LSD_{0.05}$		ns	ns	ns	ns	ns	ns	7.62

C = Cocoyam

Results

The soil chemical properties at harvest of cocoyam are shown in Table 2. Under sole cropping, soil pH was significantly higher with semi erect IT81D-1228-14 than with spreading *Akidiani*. However, under intercropping pH was higher when cocoyam was mixed within climbing Akidienu than within erect IT86F-204-1 or between other vegetable cowpea types except spreading Akidiani. On the average, under sole cropping, soil organic matter and nitrogen content were significantly higher with erect IT86F-204-1 vegetable cowpea than with sole cocoyam by 128% and 105%, respectively. Soil nitrogen was also higher in sole cropped spreading Akidiani cowpea than in cocoyam monocrop. OM was higher in erect IT86F-204-1 than in the other vegetable cowpea monocrops. Under intercropping, soil OM content was higher when cocoyam was mixed within erect IT86F-204-1 plants than other planting patterns or cowpea types. Soil nitrogen did not differ significantly under intercropping among cowpea types and spatial arrangement, although the tendency was for higher values to occur in cocoyam intercropped within erect IT86F-204-1 vegetable cowpea plants.

Table 4: Effect of intercropped vegetable cowpea on number of nodules/plant in 2006 and 2007 cropping seasons

		Week after planting					
		4WAP		8WAP		12WAP	
Treatment	Planting scheme	2006	2007	2006	2007	2006	2007
Akidiani	Sole	2.00	1.67	5.70	9.83	4.03	5.00
Akidienu	Sole	1.67	2.00	8.70	6.83	3.33	3.73
IT81D-1228-14	Sole	6.33	5.07	15.70	23.37	6.33	6.89
IT86F- 204-1	Sole	9.83	7.67	11.70	22.00	4.53	10. 67
C + Akidiani	Within	1.00	1.12	13.70	25.90	8.33	3.83
C + Akidienu	Within	4.67	4.67	2.70	33.00	8.50	5.13
C + IT81D-1228-14	Within	3.33	3.00	8.30	18.03	4.83	5.27
C + IT86F-204-1	Within	6.50	5.83	11.70	3.00	9.77	9.43
C + Akidiani	Between	2.00	2.33	3.70	5.43	7.90	3.67
C + Akidienu	Between	6.00	4.17	7.00	14.40	7.40	6.93
C + IT81D-1228-14	Between	8.67	2.50	8.30	13.77	9.60	7.06
C + IT86F-204-1	Between	22.00	20.17	22.30	9.47	10.83	6.79
$LSD_{0.05}$		7.40	4.63	ns	ns	3.42	4.19

C = Cocoyam

The number of corms harvested per plant, corm weight per plant and corm yield in tons per hectare were not significantly affected by intercropping, planting pattern or cowpea growth habit (genotype) in both years (Table 3). However, as average of the two years, corm yield was significantly higher when cocoyam was planted within climbing Akidienu than between spreading Akidiani, semi erect IT81D-1228-14 and erect IT86F-204-1 by 92 %, 87 % and 110 %, respectively. Compared to sole cropping, intercropping within climbing Akidienu increased corm yield by 77 %.

Under sole cropping, the number of nodules per plant was similar in erect IT86F-204-1 and semi erect IT81D-1228-14 but significantly higher than the values in spreading Akidiani and climbing Akidienu at 4 and 12 WAP (Table 4). Similarly, under intercropping, the number of nodules produced per plant was higher when cocoyam was mixed between erect IT86D-204-1 than other cowpea types and planting patterns. In both cropping systems (sole and intercrop), the number of pods produced per plant was significantly higher in erect IT86F-204-1 vegetable cowpea than others (Table 5). Intercropping cocoyam between cowpea plants significantly increased the number of pods per plant compared to when cocoyam was within cowpea plants especially in 2006. Fresh pod weight was generally higher in semi erect IT81D-1228-14 in sole crop than in others. Under sole

cropping, fresh pod yield was significantly higher in erect IT86F-204-1 than spreading Akidienu in 2006 and other types in 2007. However, in the intercrop, fresh pod yield was higher when cocoyam was combined within the climbing Akidienu than the other cowpea types and spatial arrangement, especially in 2007. On average, intercropping did not reduce cowpea fresh pod yield except when cocoyam was combined between erect IT86F-204-1.

Table 5: Effect of intercropped cocoyam with vegetable cowpea on fresh pod yield and yield components of vegetable cowpea in 2006 and 2007 cropping seasons

		Number of pods/plant			Pod weight (g)/plant			Fresh pod yield (t/h)		
Treatment	Planting scheme	2006	2007	Mean	2006	2007	Mean	2006	2007	Mean
Akidiani	Sole	40.8	19.1	29.9	3.5	3.0	3.3	5.7	2.7	4.2
Akidienu	Sole	36.7	23.8	30.3	4.8	4.5	4.6	7.4	3.1	5.2
IT81D-1228-14	Sole	28.4	6.8	17.6	6.8	5.8	6.3	7.6	1.3	4.5
IT86F-204-1	Sole	53.0	39.6	46.3	3.1	2.8	2.9	6.6	4.4	5.5
C + Akidiani	Within	38.7	20.2	29.4	3.5	3.2	3.3	5.4	2.7	4.0
C + Akidienu	Within	42.3	24.4	33.4	7.5	5.3	6.4	8.4	5.3	6.8
C + IT81D-1228-14	Within	28.0	5.2	16.6	4.9	5.2	5.0	8.0	1.1	4.6
C + IT86F-204-1	Within	63.6	38.1	50.9	3.4	2.7	3.1	6.2	4.2	5.2
C + Akidiani	Between	57.8	36.8	47.3	4.0	3.3	3.7	4.6	2.5	3.7
C + Akidienu	Between	59.3	34.9	47.1	4.6	4.6	4.6	7.7	4.3	6.0
C + IT81D-1228-14	Between	47.4	10.2	28.8	7.8	6.5	7.2	7.4	1.4	4.4
C + IT86F-204-1	Between	79.7	50.9	65.3	3.1	3.5	3.3	3.6	3.8	3.7
$LSD_{0.05}$		15.3	10.5		1.0	0.7		1.9	0.7	

C = Cocoyam

There were yield advantages of growing cocoyam and vegetable cowpea in mixture as depicted by LER of 1.23 – 2.79 (2006) and 1.75 – 3.08 (2007), especially when cocoyam was intercropped within climbing Akidienu (Table 6). The partial LER of the component crops showed that cocoyam always contributed more to the total yield than cowpea especially when cocoyam was intercropped within cowpea plants. In 2006 and 2007 cropping seasons, the highest ATER was also obtained when cocoyam was intercropped within climbing Akidienu vegetable cowpea. Generally, intercropping within cowpea crops tended to improve the productivity of the system. In 2006 and 2007 cropping seasons, the economic performance of the cropping systems showed that more money was realized in intercropping than sole cropping (Table 7). The highest net income was

achieved when cocoyam was intercropped within climbing Akidienu in both seasons. Cocoyam intercropped within climbing Akidienu had the highest combined net return of N555100 and N428000 in 2006 and 2007, respectively.

Discussion

The results of this study have shown that soil OM and N were generally higher in the intercrops and sole vegetable cowpea than the initial values. There was a depression in the nutrient values in the sole cocoyam compared to the initial soil values. The higher values for soil OM and N in the intercrop and sole cowpea are attributable to litter falls from the vegetable cowpea plant and their subsequent decomposition. In a study involving cassava / vegetable cowpea intercropping, Udealor (2002) showed that vegetable cowpea produced up to 860 Kg/ha dry leaf litters while sole cassava produced less than 70 Kg/ha over the same period. This result also conforms to the findings of Udealor and Asiegbu (2004) in which higher soil nutrient values were obtained with cassava / vegetable cowpea and sole vegetable cowpea than with initial soil values in sole cassava. Among the cowpeas, the higher OM and N contents obtained with IT86F-204-1 (erect cowpea) reflected in the number of nodules produced by this genotype.

Corm yields were usually not depressed but increased when cocoyam was combined within climbing *Akidienu* cowpea rows, indicating complementarities between the component crops in intimate mixtures. Corm yields obtained from cocoyam intercropped within the climbing *Akidienu* was higher due mainly to the greater shading provided by the latter. According to Knipscheer and Wilson (1987), cocoyam is shade tolerant and associated crop has a moderation effect, with cocoyam producing a reasonable yield when grown under shade. The wide maturity gap between cowpea (about 3months) and cocoyam (about 7months) enhanced the compatibility of cocoyam and cowpea as intercrops especially in climbing *Akidienu*. Similar results had been reported by Udealor and Asiegbu (2005) and Njoku and Muoneke (2008) in cassava and cowpea intercrop. On the other hand, corm yield reductions occurred when cocoyam was combined with erect IT86F-204-1 owing to absence of shading and the similar height or growth habit of the intercrops, which encouraged stiffer competition. The importance of height difference among cultivars in determining the competition between species in intercropping was demonstrated by Elmore and Jackobs (1984) for Sorghum / Soybean intercropping and Okpara *et al*. (2009) for cocoyam and cowpea intercropping

The yield response of vegetable cowpea to the cropping system varied. Generally, the climbing *Akidienu* gave higher fresh pod yield than spreading *Akidiana* and erect IT86F-204-1 especially when intercropped within cocoyam plants. Both the sole crop and intercropped semi erect IT81D-1228-14 cowpea gave poor yields in 2007 due to serious rodent damage. On the whole, intercropping did not reduce cowpea fresh pod yields except when cocoyam was combined between erect IT86F-204-1, probably because of greater shading of the latter in between row planting pattern.

Assessing the productivity of the intercropping system using LER, ATER and monetary returns showed yield advantages. The highest yield advantage (mean of 2 years for LER = 2.9, ATER = 2.5 and net returns = N491, 550) was accrued when cocoyam was intercropped within climbing *Akidienu* vegetable cowpea rows. The base crop, cocoyam, was not only more productive in climbing *Akidienu*, pod yield of the latter was satisfactory with a high yield advantage of 190 % on the basis of LER. Ogbuehi and Orzolek (1987) had reported that intercropping where land is scarce would always generate higher monetary returns per unit area of land compared to sole cropping. Based on LER, ATER and monetary returns of the system, intercropping cocoyam within climbing *Akidienu* appeared to be the most productive with the highest income to the farmer, and is recommended over sole cropping system. The cocoyam crop benefits from the share of nitrogen fixed by the climbing cowpea. Further more, the two crops are compatible, as their growth stages for competition for growth resources do not overlap.

Table 6: Land equivalent ratio and area x time equivalent ratio in cocoyam/vegetable cowpea intercropping system in 2006 and 2007 cropping seasons

		Land equivalent ratio							
		Partial						Area x Time equivalent ratio (ATER)	
		2006			2007				
Treatment Combination	Planting scheme	Cocoyam	Cowpea	Total	Cocoyam	Cowpea	Total	2006	2007
Cocoyam	Sole	1.00		1.00	1.00		1.00		
Akidiani	Sole		1.00	1.00		1.00	1.00		
Akidienu	Sole		1.00	1.00		1.00	1.00		
IT81D-1228-14	Sole		1.00	1.00		1.00	1.00		
IT86F-204-1	Sole		1.00	1.00		1.00	1.00		
C + Akidiani	Within	1.04	0.95	1.99	1.15	0.91	2.06	1.60	1.71
C + Akidienu	Within	1.70	1.09	2.79	1.86	0.22	3.08	2.37	2.61
C + IT81D-1228-14	Within	1.02	0.92	1.94	1.85	0.84	2.69	1.58	2.36
C + IT86F-204-1	Within	1.36	0.93	2.29	1.85	0.95	2.80	1.93	2.43
C + Akidiani	Between	0.94	0.81	1.75	1.07	0.95	2.02	1.44	1.65
C + Akidienu	Between	0.82	0.96	1.78	1.04	0.71	1.75	1.41	1.47
C + IT81D-1228-14	Between	0.77	0.98	1.75	1.15	1.02	2.17	1.37	1.77
C + IT86F-204-1	Between	0.68	0.35	1.23	1.04	0.87	1.91	1.02	1.57

C = Cocoyam

Table 7: Effect of spatial arrangement on economic returns of cocoyam and vegetable cowpea mixture in 2006 and 2007 cropping season

	Gross Returns (Naira/ha)								
	2006			2007			Mean		
Treatment/ Cropping system	Gross income	investment cost	Net income	Gross income	Investment cost	Net income	Gross income	Investment cost	Net income
Sole									
Cocoyam	255000	94500	160500	216000	97000	119000	235500	95750	139750
Akidiani	169800	34000	135800	79500	34000	45500	124650	34000	90650
Akidienu	230100	34000	196100	129000	34000	95000	179550	34000	145550
IT81D-1228-14	227100	34000	193100	39900	34000	5900	133500	34000	99500
IT86F-204-1	198000	34000	164000	132000	34000	98300	165150	34000	131150
Spatial Arrangement									
Within Row									
C + Akidiani	426100	128500	298100	328250	131000	197250	377175	129750	247675
C + Akidienu	683600	128500	555100	559000	131000	428000	621300	129750	491550
C + IT81D-1228-14	500000	128500	371500	433850	131000	302850	466985	129750	337175
C + IT86F-204-1	532600	128500	275600	525850	131000	394800	529225	129750	335200
Between Row									
C + Akidiani	378000	128500	249500	308150	131000	177150	343075	129750	213325
C + Akidienu	431100	128500	302600	315250	131000	184250	373175	129750	243425
C + IT81D-1228-14	419500	128500	291000	288750	131000	157750	354125	129750	224375
C + IT86F-204-1	281400	128500	152900	340200	131000	209200	310800	129750	181050

C = Cocoyam

Conclusions

Based on the conditions of this investigation, it is concluded that manipulation of crop combinations, genotypes and agronomic management such as spatial arrangement may have the ultimate advantage of improving the utilization of growth resources, compatibility and performance of intercrops. Furthermore, the results showed that cocoyam / vegetable cowpea mixture is more productive than sole crop of each component because of complementary effect of the component species in this system. Hence, for higher productivity, climbing vegetable cowpea, *Akidienu*, is recommended, with cocoyam alternated within rows of climbing vegetable cowpea.

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BIOCHEMICAL EVALUATION OF SOME TROPICAL NON-CONVENTIONAL FEEDSTUFFS

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ABSTRACT
Biochemical analysis (proximate composition, minerals and anti-nutritional factors) of some tropical non-conventional feedstuffs; African oil bean – AOB (*Pentaclethra macrophylla*), African breadfruit – ABF (*Treculia africana*), wild variegated cocoyam – WCY (*Caladium bicolor*) and wild aerial yam – WAY (*Dioscorea bulbifera*) was carried out to determine their suitability as feedstuffs for animal diets. All the feedstuffs were collected fresh except rubber seed (RS) and AOB which were collected from a stored stock. African oil bean and rubber seed showed high level of protein (26.25%, 19.69%), fat (30%, 25%) ash (11%, 5%) and energy (4183, 4123 KcalGE/Kg) and with low level of carbohydrate (10.84%, 27.14%) and fibre (5.56%, 6.25%), respectively. The ABF, WAY and WCY recorded high level of carbohydrate (60.91%, 54.22, 42.69%) and energy (3412, 2829, 3010KcalGE/Kg), respectively and with low level of protein, fat, crude fibre and ash. The result of the anti - nutritional factors (mg/100g) indicated that AOB had the highest tannins (55.05) followed by RS (26.11), WAY (21.38), ABF (16.23) and WCY (7.96), while RS had the highest soluble oxalate (82), AOB (70.4), WAY (61.6) WCY (52.8) and AOB (48). All the feedstuffs analyzed showed low level of phytate and hydrogen cyanide (< 2.0 mg/100g). Results (mg/100g) of mineral composition indicated that iron (0.79), manganese (24.0) and sodium (998.68) occurred highest in rubber seed, zinc and potassium in WAY. AOB, WCY. The ABF recorded the highest magnesium (21.02), calcium (37.01) and phosphorus (11.18). However, sodium content (>990 mg/100g) was the highest in all feedstuffs, while zinc, iron and potassium (<2.5 mg/100g) were the lowest.

Keywords: Biochemical analysis, proximate composition, minerals, anti-nutritional factors, non-conventional feedstuffs.

INTRODUCTION

The world livestock sector is currently amidst a gradual transformation fueled by high increasing demand for meat, egg, wool, milk and hides and skins. Oyenuga (1957) opined that the driving force behind this soaring demand for livestock products is a combination of population growth, urbanization, and foreseen growth especially for developing countries. The challenge is to enhance animal productivity at a minimal cost. Except for the ruminant, whose bulk of feed is based on pasture, otherwise directly not competed for by man, the greatest proportion of cost of monogastric production is expended on feedstuffs. Oluyemi and Roberts (2000) estimated this to be over 70% of total cost for intensively managed animals.

Conventional feedstuffs such as maize and sorghum have become costly due to pressure from demand for human and industrial uses especially the issue of biofuel. Within the last 20

years in Nigeria, prices of concentrates rose by nearly 400 % and commercial feeds by about 2000% (Udedibie, 2003). The need arises for animal nutritionists to look for alternatives and turn their attention to exploitation of other potential feed resources, particularly those that are indigenous to our tropical environment. The competitiveness and high cost of the conventional feedstuffs according to Devendra (1985) include all those categories of feedstuffs that have not been traditionally used in animal feeding and or not normally used in commercially produced rations for livestock. He added that these materials are not in great demand by human, but are abundant and available all year round in high rainfall areas. Nevertheless, some are consumed by man but are not popular in livestock feeds such as African breadfruit, while some are not demanded by man for food such as the rubber seeds, wild aerial yam and wild cocoyam. Good number of non-conventional feedstuffs is used as traditional medicines for different kinds of ailments.

Non - conventional feedstuffs are sometimes grown as ornamental plants, planted near houses, while some can be seen growing wild. Some people refer to some of them as flowers but by biochemical knowledge of them, one could know for certain their nutrients composition and with subsequent feeding trials, a better conclusion can be drown on their nutritional quality. They can therefore be used for whole or partial replacement for the conventional feedstuffs in finishing livestock rations (Ikani and Adesehinw*a,* 2000). Hence the first step is to evaluate the biochemical content of these feedstuffs and the knowledge will aid in their utilization to enhance nutrients needs of animals. This may reduce the high cost of producing animals through nutrients optimization (*Umoh et al.,* 2004). There must be an understanding of not just how such feedstuffs are consumed, but also to ascertain their nutritive value especially now that attention is being focused for the use of non-conventional feedstuffs as possible means of cost reduction. Accurate feed formulation using available feed resources should be built around the nutrient composition of the feed ingredients. The objective of the study therefore was to identify and evaluate the biochemical composition of some non-conventional feedstuffs and ascertain their possible usefulness in livestock feeds.

MATERIALS AND METHODS

Experimental Site.

The research was conducted in the laboratories of department of Animal Science and Biochemistry of the University of Uyo, Akwa Ibom State, Nigeria. The mineral content of the feedstuffs was determined at the laboratory of Aluminun Smelting Company of Nigeria (ASCON), Ikot Abasi, Akwa Ibom State , Nigeria.

Procurement, Preparation and Biochemical Analysis of the Feedstuffs.

Samples used for this study were rubber seeds (*Hevea brasiliensis*), African breadfruit (*Treculia africana*), African oil bean seeds (*Pentaclethra) microphylla*), wild variegated cocoyam (Caladi*um bicolor*) and wild aerial yam bulb (*Dioscorea bulbifera*). Samples were obtained from various locations in Uyo, Akwa Ibom State, Nigeria. Rubber seeds were obtained from stored products from private plantation in Uyo, Akwa Ibom State Ngeria. Wild variegated cocoyam and wild aerial yam were harvested wild, while African oil bean seed and African breadfruit

seeds were obtained from the market. Wild cocoyam and wild aerial yam were peeled, chopped into smaller sizes with a steel blade knife and dried. African oil bean and rubber seeds were cracked while African breadfruit was parboiled for 20 minutes after which the seeds were spread on a wooden table and by rolling, the seed coat was removed, exposing the cotyledon and thereafter dried. The parboiling was to soften the seed coat. Dry sample were milled into flour in a Wiley mill to pass a 0.5mm mesh sieve and stored in a refrigerator throughout the period of analysis.

Proximate composition determined were crude protein, crude fibre, ether extract, ash and gross energy according to AOAC (1990). Anti-nutritional factors include, phytate, hydrogen cyanide, oxalate and tannin and minerals investigated were calcium, phosphorus, magnesium, potassium, sodium, iron, manganese and zinc.

Moisture content was determined by drying in an electric oven (Jp Slecta 2001243, Spain) at 80 ^{0}C for at least 18 - 24 hours till weight became constant. Nitrogen was determined by the standard micro Kjeldahl method (AOAC, 1990) using a digestion apparatus and titration system. The quantity of nitrogen present was multiplied by a constant 6.25 to determine the crude protein level according to McDonald (2000).

Ether extract was assayed by extraction with petroleum ether (boiling point 40 – 60 ^{0}C) in a Soxlet extraction apparatus. Ash content was determined by complete ignition at 550^{0C} in a furnace (LE/6/11/B150, Nabertherm GmbH, Germany). The gross energy was determined by using an adiabatic bomb calorimeter (IKAC4000, Janke and Kunkel, Germany). The total carbohydrate (nitrogen free extract) content was determined by difference.

The determination of mineral composition was according to AOAC (1990). Flame photometer (Corning 405) was used to determine sodium and potassium. Calcium, iron, magnesium, zinc and manganese were assayed using Alpha 4 Atomic Absorption spectrophotometer. Phosphorus content was determined by Vanado Mobybate method and read on a colorimeter (CEGLCE 3041). Hydrogen cyanide was determined using alkaline pirate method. Follin-Dennis spectrophotometric method described by Pearson (1996) was used to assay tannins, oxalate and phytic acid.

RESULTS AND DISCUSSION

Proximate Constituents

The proximate composition of the feedstuffs is indicated in Table 1. The proximate composition revealed that there is wide variation in the composition. Sminorva (1967) had reported that such variation was expected in plants. Crude protein contents ranged from 26.25% in African oil seed to 5.25 %in wild aerial yam. The protein content of African oil seed agrees with Oyenuga (1968), Okafor (1979) and later with Okigbo (1997) who reported a range of 23 – 28 %. The level of protein in African oil bean is therefore comparably higher than that found in common pulses in Nigeria such as Jackbean (23.8 %) pigeon pea (12.5 %), lima bean (22%) and sunfflower (15.3 %) as published by Kay (1979) and Obioha (1992). Furthermore, its protein content is higher than that of full fat groundnut (25 %) reported by Olomu (1995). Therefore, the African oil seed may be seen to be a likely candidate for protein source in animal diets especially monogastric animals.

Extraction of its oil may increase the level of protein. Oil extraction is said to increase protein content of oil seed feedstuffs (Olomu, 1995).

Next to African oil seed for protein is rubber seed (19.69%) followed by African breadfruit (13.13 %) than others. This is expected as seed contain more protein than roots and tubers and hence high level of protein of these crops (African oil seed, Rubber seed and African breadfruit) makes them to have great promise as concentrated sources of plant protein for animal nutrition. However, the 19.69 % protein of rubber seed is in variance with 11.4 % reported by Giok *et al*. (1967) but somehow similar to 21.70 % reported by Perez (1997). The wide variation between that reported by Giok *et al.* (1967) and this report may be due to processing method applied. Undecorticated rubber seeds when used would lower the protein content and increase the fibre content.

High level of fat was recorded in African oil seed (30 %) and rubber seed (23 %) resulting to high gross energy 4183 and 412 kacl/kg respectively. Wild (variegated) cocoyam, African breadfruit and wild aerial yam were found to contain total carbohydrate 42.69%, 54.22 % and 60.91 % respectively resulting also to a high energy level. High oil content of African oil seed and rubber seed may not be only good source of energy in diet for animals but they may be good edible and industrial oils. The carbohydrate content of wild aerial yam seems to flash attention as good replacement for maize, sorghum and cassava in animal feeds especially the monogastrics in the face of the high cost of them due to high demand by man and recently for biofuel production and other industrial uses.

Crude fibre content (2.0 - 6.5 %) of the feedstuffs was found to be low indicating that they may not pose any serious digestion problems associated with high fibre when fed to such animals. African oil seed recorded the highest ash content (11 %) while aerial yam contained the lowest (2 %).

Minerals

The mineral constituents in (mg/100g) of the non-conventional feedstuffs as shown in Table 2 shows that calcium (37.01) occurred highest in wild cocoyam, magnesium (21.02) in African oil bean, iron (0.79), manganese (24.0) and sodium (998.68) in rubber seed, zinc (2.14) and potassium (0.20) in wild aerial yam and phosphorus (11.18) in African breadfruit. The results agree with that reported by Achinewhu (1982) for African oil bean. However, they were in variance with that reported by Ejidike and Ajikeye (2000) for African breadfruit. Thus the mineral composition shows that the feedstuffs may be potential source of some of the essential minerals needed by animals.

From the results of this study, African oil bean and rubber seed have a great promise as concentrated source of plant protein owing to their high protein levels. The high oil content of African oil bean and rubber seed as well as the carbohydrate content of African breadfruit, wild cocoyam and wild aerial yam present them as good replacement for the conventional feedstuffs as sources of energy in animal diets. In addition to this, the low level of some anti-nutritional factors observed in this study suggests that the nutritive value of the tested feedstuffs will be comparatively less impaired when fed to animals in processed form. Thus, the result point to the fact that the analyzed feedstuffs could be profitably used in feeding livestock at a relatively low price compared to the conventional feedstuffs, considering their non-

competitive nature with human demand except for African breadfruit and African oil bean. Based on the fact that the objectives of this research work may be said to have been achieved, it may be recommended that these non-conventional feedstuffs be used as valuable feed ingredients. However, processing is further recommended to reduce the anti-nutritional factors.

Antinutritional Factors.

The anti-nutritional composition of each non-conventional feedstuff as shown in table 3 indicated that hydrogen cyanide content ranged from 0.03-1.65 mg/100g, which is below the lethal dose reported for sheep and cattle (2.0 – 40 mg/kg of body weight) by Conn (1997). African oil bean seed recorded the highest cyanide level (1.65 mg/100g) followed by wild aerial yam (0.22 mg) and rubber seed (0.12 mg/100g).

According to George *et al*. (2000) fresh rubber seed and its kernel contain about 63.8 and 74.9 mg/100g of hydrogen cyanide. This wide variation between their report and this may be due to long storage of the analyzed rubber seeds which were not collected fresh but were obtained from stored products of the month of April harvest .The experiment was conducted in July which is off season for fresh rubber seeds. Devendra (1981) had reported that the rate of reduction in hydrogen cyanide level in rubber seed is rapid for the first two months of storage, thus storage of rubber seed at room temperature for a minimum period of two months appears to be an effective method of reducing the hydrogen cyanide content of rubber seeds and its product to safe levels. African breadfruit recorded the lowest cyanide level (0.03 mg/100g) which is lower than 26. mg/100g reported by Ugwu and Oranye (2006) in fresh African breadfruit seeds. This wide variation can also be explained on the basis of storage and effect on heat on hydrogen cyanide, during the 20 minutes parboiling.

Soluble oxalate ranged from 44 - 88.0mg/100g with the highest level recorded in rubber seeds (88 mg/100g) and African oil bean seed (70 mg/100g. African breadfruit had the lowest (44.0 mg/100g). However, when total oxalate was considered, content sequence. seemed to be altered. Wild aerial yam recorded the highest level (158.4mg/100g) followed by rubber seed (140.80 mg/100g) with African breadfruit recording the lowest. Oxalates can form complexes with most essential trace elements thereby making them unavailable for enzymatic activities and other metabolic processes. Consumption of large doses of oxalic acid cause corrosive gastroenteritis, shock, convulsive symptoms, low plasma calcium and renal damage (Eneobong, 2001). The toxic range or lethal dose of oxalate has been reported to be between 3.6g for man (Warnick, 1993).

African oil bean recorded the highest level of tannins (55.05/100g) followed by rubber seed (26.11 mg/100g) while the lowest was recorded in wild (variegated) cocoyam (7.96 mg/100g). The tannins content in African breadfruit is similar to that reported in leguminous plants such as *Brachystegia eurycoma* seed (52.15mg/100g) Amah *et al*., (2001) and 51.3 mg/100g for *Prosopis chilensis* (Vaiyakumari *et al.,* 1996). Tannins are polyhydric phenols and their role in the inhibition of Trypsin, chemotrypsin, amylase and lipase activities have been confirmed (Griffiths, 1991). D'Mello (2000) reported that at moderate levels (30.40 mg/kg body weight) tannins may result in nutritional advantage. Going by D'Mello (2000) report, it seems that

animals consuming these feedstuffs except African oil bean seed may not have tannin related problems. However, at higher levels (100 - 120mg/kg body weight) tannin causes reduced gastro-intestinal parasitism.

The result also indicates that African oil seed, rubber seed, African breadfruit, wild aerial yam and wild (variegated) cocoyam contained respectively on mg/100g, 1.07, 1.53, 1.24, 0.9 and 1.49 phytate showing that rubber seed has the highest phytate content (1.53 mg/100g) which is higher than that reported by Ononogbo (1988). However, phytate level of breadfruit (0.99 mg/100g) is lower than (1.25 mg/100g) reported by Ugwu and Oranye (2006). Phytic acid inhibits the absorption and utilization of some mineral elements (Warnick, 1993).

Table 1: Proximate Composition of the Feedstuffs

	Feedstuffs				
Composition (%)	**AOB**	**RS**	**ABF**	**WAY**	**WCY**
Moisture	16.00	16.67	14.39	30.40	29.40
Dry matter	84.00	83.33	85.61	69.10	70.60
Crude protein	26.25	16.29	13.13	5.25	10.06
Crude fat	30.00	25.00	5.00	5.00	10.06
Crude fibre	5.56	6.25	3.57	2.63	3.85
Ash	11.00	5.00	3.00	2.00	4.00
Nitrogen free extract	10.84	27.14	60.91	54.22	42.69
Energy (Kcal/GE/Kg)	4183	4123	3412	2839	3010

AOB = African oil bean; RS = Rubber seed; ABF = African bread fruit; WAY = Wild aerial yam; WCY = Wild cocoyam.

Table 2: **Mineral Composition of the Feedstuffs.**

	Feedstuffs				
Composition(mg/100g)	**AOB**	**RS**	**ABF**	**WAY**	**WCY**
Calcium	29.87	11.51	25.00	18.86	37.01
Magnesium	21.02	2.87	17.20	1.91	1.57
Iron	0.26	0.79	0.23	0.70	0.44
Zinc	0.62	0.84	0.84	2.14	1.95
Potassium	0.16	0.12	0.12	0.20	0.16
Manganese	16.12	24.00	21.16	15.06	18.72
Sodium	764.86	999.68	986.74	756.58	992.94
Phosphorus	5.26	2.63	11.18	9.87	5.56

AOB = African oil bean; RS = Rubber seed; ABF = African bread fruit; WAY = Wild aerial yam; WCY = Wild cocoyam

Table 3: Antinutritional Composition of the Feedstuffs

	Feedstuffs				
Composition (mg/100g)	**AOB**	**RS**	**ABF**	**WAY**	**WCY**
Hydrogen cyanide	1.65	0.12	0.03	0.22	0.11
Total Oxalate	114.40	140.80	88.00	158.40	96.80
Soluble oxalate	70.49	88.00	44.00	61.60	52.80
Tannins	55.05	26.11	16.23	21.38	7.96
Phytate	1.07	1.53	1.24	0.99	1.49

AOB = African oil bean; RS = Rubber seed; ABF = African bread fruit; WAY = Wild aerial yam; WCY = Wild cocoyam.

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EFFECT OF BLOOD MEAL FED AS A REPLACEMENT FOR SYNTHETIC LYSINE ON GROWTH RESPONSE OF STARTER BROILER CHICKS

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ABSTRACT

A twenty eight (28) days feeding trial was carried out to determine the effect of blood meal (BM) on growth performance of broiler starter chicks as a replacement for synthetic lysine (SL). One hundred and fifty (150) unsexed Anak broiler chicks were used. There were five diets (T_1) containing 0.10 % SL and without (BM) as control. Diets 2, 3, 4 and 5 contained 1.0, 2.0, 3.0 and 4.0 % BM without SL, respectively, representing T_2, T_3, T_4 and T_5 in the same other. The experiment was arranged in completely randomized design (CRD) with three replicates per treatment of 30 birds each and 10 birds per replicate. Diets were isoproteineous (23 %) and isocaloric (11.90 MJME/Kg). At the end of the trial period, diet did not significantly ($P>0.05$) influence body weight. However, birds that fed 4.0 % BM significantly ($P<0.05$) consumed lesser feed and had better protein utilization efficiency than SL fed birds. There was no mortality.

Keywords: Blood meal, Synthetic Lysine, Broiler Starter, Growth Performance.

INTRODUCTION

The demand for broiler chickens in Nigeria is progressively rising as meat consumers' interest is gradually being shifted from red to white meat Ndelekwute (2009). But this is presently, being undermined by high cost of production necessitated by escalating cost of major and essential ingredients required for feed production Ndelekwute (2010). However, Uzegbu *et al*. (2007) maintained that as the cost of these major feed ingredients continues to increase, there is still the need to maximize productivity. Measures to achieve this maximum production, should start at early stage of life because according to Okorie (1982) and later Obioha (1992) what happens during the starter period determines the final performance of broiler chickens.

One of the measures employed by nutritionists is addition of synthetic lysine in diets for broiler chicks (Gorman and Balnave, 1995). This is because, the maize and soya bean

meal which constitute the major feedstuffs used to produce poultry diets are low in lysine and also not readily available to the birds (D'Mello, 1993). But according to Njoku (1985) in Nigeria, it is imported, expensive and may be out of reach of local farmers who may want to mix their own feeds. It has been advocated that non conventional feedstuffs and animal waste products could be included in monogastric animals diets for economic benefits (Nwokoro, 1993; Ukachukwu and Anugwa, 1995; Akpodiete and Inoni, 2000). Hence the need to look for natural, less expensive source of protein, rich in lysine, that abounds in our environment, to replace synthetic lysine. Blood meal is a good source of protein and lysine (Offiong *et al*., 1982; Odukwe and Njoku, 1987), with 80% protein (Olomu, 1995) and 7% lysine (Donkoh *et al*., 1999). Blood which is used to prepare blood meal abounds in abattoirs in Nigeria and can be collected free (Awonorin *et al*, 1991).

The objective of the study is to compare the effect of 0.10% synthetic lysine adjudged to be economical (Han and Baker, 1981) with blood meal in broiler starter diets as regards growth parameters.

MATERIALS AND METHODS

This trial was carried out at the Teaching and Research Farm of College of Animal Science and Animal Production, Michael Okpara University of Agriculture. Umudike is located on latitude $5^{0}29^{1}$N and longitude $7^{0}32^{1}$E in the rainforest zone of Nigeria with average annual rainfall of 2000 mm and relative humidity of 70 % on the average. This information was supplied bf the Meteorological unit of the National Root Crops Research Institute, Umudike, Abia State, Nigeria.

Processing of Blood Meal

Cattle blood used to produce the test blood meal was collected from a nearby abattoir and cooked immediately over firewood in a 30 liters capacity aluminum pot. It was allowed to boil at temperature of 103 degrees Celsius for 20 minutes. The cooked blood was then transferred into a Hessian sack and pressed to reduce the water content. The cooked blood in lumps was spread on a concrete floor under the sun to dry. The ambient temperature average was 34 degrees Celsius. It took three days for the blood to dry. Dry blood lumps were ground into meal and proximate component and amino acid profile analysis carried out according to AOAC (1990) is shown in table 1.

Experimental Diets and Chicks

Five diets were produced. Diets, which contained 0.10% synthetic lysine without blood meal, served as control. Diets 2, 3, 4 and 5 contained, respectively, 1.0, 2.0, 3.0 and 4.0 % blood meal without synthetic lysine. All diets were isoproteineous and isocaloric (Table 2). A total of 150 Anak broiler chicks were used. Each treatment was randomly assigned 30 birds replicated three times with 10 birds each in completely randomized design (CRD). Birds were conventionally managed and feed and water were given *ad libitum* for 28 days in a deep litter house.

Data Collection and Analysis

Daily feed intake was measured by subtracting every morning the left over from the amount fed the previous day. Data on feed intake and body weight were used to calculate the feed; gain

ratio. Protein efficiency ratio was calculated by dividing the average, daily weight gain by the average daily protein intake. All data collected were subjected to Analysis of Variance (ANOVA) according to Steel and Torrie (1981) and least significant difference was used to separate significant means.

RESULTS AND DISCUSSION

Table 2 shows the ingredient and nutrient composition of the experimental diets. The nutrients levels conform to that recommended for tropical environment (NRC, 1994). The results of dietary effect on the starter chicks are shown in Table 3. There were no significant ($P>0.05$) effects of diet on finial body weight, daily body weight and feed: gain ratio. Diet had influence ($P<0.05$) on feed intake and protein efficiency ratio. Group that fed 3.0 and 4.0 % blood meal significantly ($P<0.05$) consumed lesser feed than the group that fed 0.10% synthetic lysine, while only 4.0 % blood meal group effectively ($P<0.05$) utilized protein better than synthetic lysine group. Though, there were no significant differences between synthetic lysine group of birds and those of blood meal in body weight and feed : gain ratio, blood meal groups progressively but numerically performed better than the synthetic lysine group as the level of blood meal was increased.

Among blood meal groups, significant difference existed ($P<0.05$) only in feed intake. 3.0 and 4.0% blood meal groups consumed lesser feed than 1.0 and 2.0% groups. However, in all the parameters measured, there were progressive influences of blood meal though marginal within the blood meal groups.

Non significant effect of diet on body weight and feed; gain ratio was in accordance with Donkoh *et al.* (1999). However, better performance though numerical of 4.0% blood meal group over synthetic lysine on body weight despite lower feed intake may be attributable to better protein utilization by 4.0% blood meal group. Lesser feed intake recorded by 3.0 and 4.0% blood meal groups than that of synthetic lysine group shows that blood meal can induce negative feed intake response. Morrison (1981) had reported poor palatability of blood meal to negatively affect feed intake. Progressive but marginal reduction in feed intake as the level of blood meal was increased indicates that feed intake was affected by level of blood meal. This agrees with Odukwe and Njoku (1987). The upward performance movement trend within blood meal groups as the level of blood meal was increased is indicative to the fact that a level could be reached where significant dietary effect may be observed. The use of blood meal was reported to be beneficial in broiler production in terms of growth and economic importance (Ewing, 1947; Squibb and Braham, 1955; Galal *et al*., 1977; Khawaja *et al*., 2007).

The results indicate that 4.0 % blood meal could replace 0.10 % synthetic lysine in broiler starter diets. Also lower feed intake and at the same time marginal better body weight exhibited by 4.0 % blood meal group over synthetic lysine signifies that there could be better gross margin through feed savings and body weight increase when 4.0% blood meal is used, than 0.10 % synthetic lysine in broiler starter diets.

Table 1: **Proximate Composition and Amino Acid Profile of Processed Blood Meal**

Composition	**(%)**
Moisture	8.67
Dry matter	91.33
Crude protein	80.35
Crude fibre	1.80
Ether extract	2.00
Ash	5.00
Nitrogen free extract	2.17
Amino Acids	
Lysine	7.05
Arginine	4.01
Methionine	1.30
Histidine	5.45
Phenylalanine	6.45
Leucine	10.8
Isoleucine	0 .78
Tryptophan	1.35
Treonine	4.35
Alanine	7.0
Gross energy (MJ/Kg)	18.30

Table 2: **Composition of Experimental Diets**

Ingredients (%)	1	2	3	4	5
Maize	50.00	50.00	50.00	50.00	50.00
Soyabean Meal	31.55	30.00	28.00	26.00	24.00
Palm kernel cake	10.00	10.75	11.75	12.85	13.85
Fish meal	4.00	4.00	4.00	4.00	4.00
Blood meal	-	1.00	2.00	3.00	4.00
Palm oil	0.60	0.50	0.50	0.40	0.40
Bone meal	3.00	3.00	3.00	3.00	3.00
Salt (Nacl)	0.25	0.25	0.25	0.25	0.25
Lysine	0.10	-	-	-	-
Mathionine	0.25	0.25	0.25	0.25	0.25
Premix*	0.25	0.25	0.25	0.25	0.25
Total	100	100	100	100	100
Calculated Composition (%)					
Crude Protein	23.00	23.24	23.32	23.41	23.44
ME (MJ/Kg)	11.92	11.93	11.94	11.94	11.93
Crude fibre	3.60	3.67	3.68	3.76	3.93
Ether Extract	5.51	5.40	5.37	5.26	5.23
Nitrogen free extract	48.80	48.72	48.65	48.14	48.04
Calcium	1.25	1.23	1.22	1.21	1.20
Phosphorus	1.05	1.03	1.03	1.02	1.02
Lysine	1.35	1.25	1.25	1.26	1.26
Methionine	0.95	0.93	0.93	0.93	0.93

*Premix supplied (per kg diet): Vitamin A (15,000 I.U), Vitamin D3 (3,000 I.U), Vitamin E (20 I.U), Vitamin K (25mg), Thiamin (2mg), Riboflavin (6mg), Pyridoxine (4mg), Niacin (40mg), Cobalamin (0.02mg), Pantothemic acid (910mg), Folic acid (1.0mg), Biotin (0.08mg),

Chlorine chloride (0.05g), Manganese (0.096g),Zinc (0.06g), Iron (0.024g), Copper (0.006g), Iodine (0.0014g), Selenium (0.24mg), Cobalt (0.024mg), Antioxidant (0.125g).

Table 3: **Effect of Dietary Treatments on Performance of Broiler Starter Chicks**

Parameter	1	2	3	4	5	Sem
AV. Initial Weight (g)	40	40	40	40	40	
AV. final body weight (g)	904	910	912	921	930	30.14^{ns}
AV. final body weight gain (g)	864	870	872	881	890	28.46^{ns}
AV. final daily weight gain (g)	30.86	31.07	31.14	31.46	31.79	2.55^{ns}
AV. total feed intake (g)	1340^{a}	1320^{ab}	1312^{ab}	1196^{b}	1162^{b}	40.0*
AV. daily feed intake (g)	47.86^{a}	47.14^{ab}	46.86^{ab}	42.71^{b}	41.56^{b}	2.28*
AV. daily protein intake (g)	11.01	10.96	10.93	10.00	9.74	1.95^{ns}
Feed: gain ratio (FGR)	1.55	1.52	1.50	1.36	1.31	0.01^{ns}
Protein efficiency ration (PER)	2.80^{b}	2.83^{ab}	2.85^{ab}	3.15^{ab}	3.26^{a}	0.14*

* means along the same row with different superscripts are significantly different ($P < 0.05$).
ns = Not significant ($P>0.05$)
Sem = Standard error of the means.

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ASSESSMENT OF SOCIO-ECONOMIC FACTORS AFFECTING ADOPTION LEVEL OF SNAILERY TECHNOLOGIES IN OWERRI AGRICULTURAL ZONE OF IMO STATE

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Abstract

The study was designed to examine farmer's awareness, adoption frequency and extent of adopting snailery technologies and socio-economic factors affecting adoption levels of snailery technologies in Owerri Agricultural zone of Imo State. A total of 50 snail farmers were randomly selected and interviewed through structured questionnaire. Multiple regression model was employed to determine socio-economic factors affecting adoption level of snailery technologies implicitly stated as $Y = f(X_1, X_2, X_3, X_4, X_5, X_6, X_7, X_8, e)$. Descriptive statistics were used to ascertain awareness, adoption frequency and extent of adoption of snailery technologies. Result showed the model estimate indicating that household size was statistically significant at 10% level of probability. Access to credit was significant at 5% Level. And farmers experience in snailery was highly significant at 1% level of probability. It was recommended that farmers be provided with loans preferably at market interest rates hence access to credit is pertinent for adoption of innovations.

Keywords: Socio-economy, Adoption, Technologies, Snail farming.

Introduction

Snail farming is a profitable business among a few snail farmers in Owerri Agricultural zone of Imo State. Agrolod (1991) stated that snailery is the manipulation of snails by man based on the understanding of the science of tapping the economic benefits of the snails. In the view of Chamber (2007), snails can be reared as it is adaptable to many climatic and laboratory conditions.

Snail production is one of the packages in the agroforestry component of the Imo Agricultural Development Programme (ADP) (Egeonu and Okoro, 2005). The snailery technologies disseminated by the Imo ADP agro-forestry component include Hutch boxes, Trench pens, Mini-paddock pens, Appropriate stocking feeds, etc (Imo ADP, 2010). Technology is the systematic application of scientific or other organized body of knowledge to practical purposes (Akubuilo *et al*; 2007). This includes new ideas, inventions, innovations, techniques, methods and materials. They further stated that agricultural technologies include all the materials, techniques, practices and innovations used to maximize agricultural production.

Technology or innovation is useless and lifeless at the creation point without adoption by the end users. Adoption is regarded by Rogers (1995) as a decision to make

full use of an innovation as the best course of action available. Several empirical studies have been carried out to gain insights into the adoption of snailery in sub-Saharan Africa. The specific studies investigated the type of farmers who adopts or do not adopt agroforestry (kuntashula *et al*., 2002; Ajayi; 2006). Other studies examine the factors that drive the adoption of snailery; why do some farmers continue to adopt more than others? (Ajay and Kwesiga; 2003; Place *et al.,* 2002; Franzel *et al.,* 2002; Keil *et al*., 2005; Ajayi, 2006., Jera *et al*., 2006; Thangata and Alavalaparti, 2003). The above studies shows that: access to information on Sanilery, good quality stocks, property rights on land, size of available land, flexibility and compatibility of Snailery to existing farming among others are important factors affecting adoption of Snailery (Place and Dewees, 1999). Also, according to Agwu *et al.,* (2008); Mkpado and Onuoha (2008); Cobbinah (2008); Oladele and Folawe (2007); and Nnamani, (2004); previous studies on snail rearing in Nigeria focused on its biological and Medicinal consequences.

However, no similar study has been carried out on the socio-economic factors affecting adoption of snailery technologies Egeonu and Okoro (2005) assert that the adoption of snailery technologies in Owerri Agricultural zone over the years has not been encouraging. This study therefore assessed famers awareness of snailery technologies transferred; ascertained adoption frequency on snailery technologies, determined extent of snailery technologies adopted, and finally, examined the socio-economic factors affecting adoption level of snailery technologies

Materials and Methods

The study was conducted in Owerri Agricultural Zone of Imo State which lies between latitudes $5^0 28^1$N and $5^0 36^1$N of the equator and between longitudes $6^0 39^1$E and $7^0 14^1$E of the Greenwich (Prime) Meridian (Microsoft, 2010). It has a population of 1,806,369 persons (NBS, 2007) and an average annual temperature of 28^0C, average annual relative humidity of 80%, average annual rainfall of 1800-2500mm and attitude of about 100mm above sea level (Imo ADP, 2010). It belongs to the tropical rainforest zone of Nigeria which makes her vegetation habitable for many forest and livestock species.

Random sampling was employed to select fifty (50) snail farmers from five local government areas purposively sampled. Primary and secondary data were collected. The primary data were obtained from structured questionnaire administered to respondents. The instrument was designed to seek information on farmers socio-economic characteristics, farmers awareness level of the technology; adoption frequency on snailery technologies and extent of snailery technologies adopted. Descriptive statistics and multiple regression models were used for the analysis. The implicit model of the regression is stated as follows: $Y = F (X_1, X_2, X_3, X_4, X_5, X_6, X_7, X_8, e)$

Where Y = adoption level

X_1 = farmers age (years)

X_2 = farmers educational level (years)

X_3 = household size of farmers

X_4 = farmers experience (years)

X_5 = farm size of famers

X_6 = farmers income (N)

X_7 = farmers access to credit (Dummy) variable, Yes = 1, No = 0)

X_8 = farmers contact with extension agents

e = error term

Results and Discussion

Result in Table 1 showed that various snailery technologies have been transferred to end-users. About 28% of the respondents are aware of the use of hutch boxes. Others include the use of concrete pens (36%), use of paddock pens (12%) and use of free range pens (8%). This implies that the awareness of the various snailery technologies were created among farmers and there is likely to be high rate of adoption of these technologies since awareness should be made on a given technology before adoption (Rogers, 1995).

Table1: Percentage distribution of respondents on awareness of Snailery technologies.

Technologies transferred	Frequency	Percentage	Rank
Use of hutch boxes	35	28	1
Use of trench pens	20	16	2
Use of concrete pens	45	36	3
Use of paddock pens	15	12	4
Uses of free-range pens	10	8	5
Total	125	100	

* Multiple Responses

Source: Field survey, 2011.

As shown in Table 2, about 39.1% indicating majority of the respondents have adopted the use of hutch boxes. This is closely followed by 30.9% adopted use of concrete pens. Others include: use of trench pens (15.4%), use of paddock pens (9.2%) and use of free range pens (5.1%). Majority adopting use of hutch boxes could be because it is easy and cheaper to construct as compared to use of concrete pens that recorded highest level of awareness. Also, cheaper technologies tend to achieve high adoption rate than the expensive ones in view of the fact that most farmers are resource poor and would prefer less expensive technologies.

Table 2: Percentage distribution of respondents on adoption frequency of snailery technologies

Technologies	Frequency	Percentage	Rank
Use of hutch boxes	38	39.1	1
Use of trench pens	15	15.4	2
Use of concrete pens	30	30.9	3
Use of paddock pens	9	9.2	4
Uses of free-range pens	5	5.1	5
Total	97	99.7	

* Multiple Responses
Source: Field Survey, 2011

Result in Table 3 reveal that about 4%, 6% and 26% of the farmers adopted 5, 4 and 1 snailery technologies respectively, while only 2% of the farmers adopted non of the technologies. Result further showed that about 30% adopted 3 technologies while another 30% adopted 2 of the technologies. The average number of technologies adopted by the farmers is 2 while the average rate of adoption is 20% implying that adoption of the technologies is not satisfactory. This could be ascribed to poor transfer or delivery system of extension agents and high cost of adopting the technologies. This result confirmed the assertion of Egeonu and Okoro (2005) that adoption of snailery technologies in Owerri Agricultural zone over the years has not been encouraging.

Table 3: Percentage distribution of respondents on the extent of snailery technologies adopted

No of technologies adopted	Frequency	Percentage
0	2	4
1	13	26
2	15	30
3	15	30
4	3	6
5	2	4
Total	50	100

Average number of technologies adopted = 2
Average level of Adoption = 20%
Source: Field Survey, 2011

Table 4 shows the multiple regression analysis of the factors affecting the adoption of snailery technologies. The regression model was subjected to four functional forms (linear, semi-log, double log, and exponential forms). The linear form was chosen as the lead function for the analysis. It provided the best fit because it has the highest value of coefficient of multiple determination (R^2). It also has the highest number of significant variables. The coefficient of the multiple determination of 0.648 shows that the explanatory or exogenous variables of the model was able to explain up to 65% variations in the dependable variable. The rest of 35% was taken care of by variables not captured in the model, the age, use of credits and extension contact were negatively related to adoption. This implies that increasing them decreased adoption. Education, Household size, farmers experience, farm size, and income were positively related to adoption. It is believed that increased in them increased adoption of snailery technologies. The model estimate indicated that household size was statistically significant at 10%, use of credit was also significant at 5% and farmers experience in snailery was highly significant a 1% level of probability. Being significant shows that the variable influenced the adoption so much. The F-ratio was highly significant showing over all significance of the model. Explicit form of the model is thus $Y = 17.789 - 0.001 X_1 \times 0.129 X_2 + 0.676X_3 + 2.362X_4 + 0.182 X_5 + 0.0000045X_6 - 3.806X_7 - 0.015X_8$

Table 4. Multiple Regression Analysis of the factors affecting the adoption of Snailery technologies.

Variable	Linear form		Exponential		Semi-Log		Double –Log	
	Coefficient	T-ratio	Coefficient	T-ratio	Coefficient	T-ratio	Coefficient	T-ratio
Constant	17.789	3.627 ***	3.108	26.545***	2.267	0.143	2.693	7.398***
X_1	-0.001	0.004	0.002	0.177	-1.057	-9.844	-0.019	-0.666
X_2	0.129	0.702	0.005	1.253	1.053	0.512	0.051	1.077
X_3	0.676	1.933*	0.21	2.544**	1.945	1.057	0.072	1.701*
X_4	2.362	6.612***	0.053	6.179***	5.180***	5.800	5.119***	0.134
X_5	0.182	2.121**	0.004	2.030**	5.800	2.363 **	0.134	2.379**
X_6	0.0045	0.201	6.30E -0.08	0.118	-0.695	-0.542	-0.016	-0.530
X_7	-3.806	-1.944*	- 0.060	- 1.279	-0.059	-0.027	0.001	0.027
X_8	-0.535	-0.671	- 0.015	- 0.789	-1.910	- 0.912	-0.049	-1.017
R^2	0.648		0.639		0.551		0.572	
R^2	0.575		0.563		0.463		0.489	
F- ratio	8.955***		8.577***		6.283***		0.860***	

Source: Field survey, 2011

Note: Values in parenthesis are the t- values

* = Significant at 10%

** = Significant at 5%

*** = Significant at 1%

CONCLUSIONS

Increase in the adoption of a given technology depends on the level of awareness created among the target population. This study testified that the awareness of snailery technologies of the Imo ADP was adequately made, and their adoption require mainly young, educated, resource rich farmers with credit access and improved contact with extension agents. This therefore called for youth empowerment to embrace farming. This could be realized by good education, free access to credit and increase and regular contact with extension agents.

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DETERMINATION OF RELATIONSHIPS BETWEEN ADOPTION OF SNAILERY TECHNOLOGIES AND FARMERS OUTPUT PERFORMANCE IN OWERRI AGRICULTURAL ZONE OF IMO STATE

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Abstract

The study was designed to ascertain the effectiveness of extension agents in transferring snailery technologies, and determined the relationship between adoption of snailery technologies and farmer output performance in Owerri agricultural zone of Imo State. Fifty snail farmers were randomly selected and interviewed through structured interview schedule. Descriptive statistics, simple regression model and analysis of variance (ANOVA) were used for data analysis. The coefficient of multiple determination of 0.500 indicates that 50% variations in output of the farmers were explained by the adoption level. The variable x is significant at 1% level and the F-ratio is significant at 1% level of probability. The x variable being significant at 1% level of probability showed positive relationship between adoption and output. The hypothesis which states that there is no significant difference in the rating of various extension agent qualities in transferring snailery packages was rejected. This is because the F-calculated value of 5.10 is greater that the F-tabulated value of 2.99 at 5% level of probability. The study recommends in service training for all extension field workers in the area of technology transfer to get them equipped in the transfer of technologies, hence poor technological transfer affects its level of adoption and output performance.

Keywords: Adoption, Farmer, output-performance, snailery, technologies.

Introduction

Snails are invertebrates with soft bodies that are covered with hard calcareous shells. Snail production involves the manipulation of snails by man based on the understanding of the science of tapping the economic benefits of the snails (Agrolod, 1991). In the view of Chamber (2007), snails can be reared as it is adaptable to many climatic and laboratory conditions. Snail production is one of the packages in the agroforestry components of the Imo State Agricultural Development Programme (ADP) (Egeonu and Okoro, 2005) and the snailery technologies disseminated include hutch boxes, trench pens, concrete pens, paddock pens etc (Imo ADP, 2010).

The importance of farmers' adoption of new agricultural technology has long been of interest to agricultural extensionists and economists. Adoption of innovations refers to the decision to apply an innovation and to continue to use it (Rogers and Shoemaker, 1971). Agbamu (1993) found only knowledge of a practice to be significantly related to its adoption. According to Chukwu (2007) awareness of a new technology and benefits expected from it is significantly related to its adoption.

Technology have been defined as all the methods of production which has been developed on the basis of existing state of scientific knowledge (Roy, 1990). Technologies are viable only when they are used by farmers and its adoption is related to its expected output. No matter how well new technologies work on research stations, if farmers will not adopt them, their development would have been in vain (Sandra *et al.,* 1989).

Alimba and Mgbada (2003) stated that inappropriateness of innovation is responsible for non adoption of innovations. Farmers were reported to reject innovations not because they are conservative or ignorant but because they rationally weigh the changes in output, income and risks associated with the given technologies under their natural and economic circumstances before they take any decision. Obviously farmers of all socio-economic backgrounds are more likely to use agricultural information if they perceive the information to be useful to them.

The process of transfer of a given technology is also related to its adoption. Agricultural technology transfer involves complex processes comprising diverse structures and relationship of interdependent factors and variables aimed at facilitating adoption of necessary innovations (Farinde, 1996). Egeonu and Okoro (2005) assert that adoption of snailery technologies in Owerri Agricultural zone over the years has not been encouraging. This could be as a result of ineffectiveness of extension agents in transferring the technologies. And because of unsatisfactory adoption of these technologies, farmers output performance is yet to be fully determined. It is against this background that this study:

- ascertained the effectiveness of extension agents in transferring snailery technologies;
- determined the relationship between adoption of snailery technologies and farmers output performance;
- identified constraints militating against adoption of snailery technologies.

Materials and methods

The study was conducted in Owerri Agricultural zone of Imo State which lies between latitudes $5^{0}28^{l}$N and $5^{0}36^{l}$N of the equator and

between longitudes $6^0 39^l$E and $7^0 14^l$N of the Greenwich meridian (Microsoft, 2010). According to NBS (2007), the zone has a population of 1,806,369 persons. It has average annual temperature of 28^0C, average annual relative humidity of 80%, annual rainfall of 1800 – 2500mm with an altitude of about 100m above sea level (Imo ADP, 2010). The zone belongs to the tropical rainforest zone of Nigeria which makes her vegetation habitable for many forest and livestock species.

Field studies: A total of fifty snail farmers were sampled randomly from five local government areas purposively sampled. Primary and secondary data were collected. The primary data were obtained from structured interview schedule administered to respondents. The instrument was designed to seek information on effectiveness of extension agents in transferring snailery technologies; relationship between adoption of snailery technologies and farmers output performance; and constraints militating against the adoption of snailery technologies. Simple percentages, simple regression model and analysis of variance (ANOVA) were used to analyse the data.

Simple percentage was used to identify constraints militating against the adoption of snailery technologies. ANOVA was employed to ascertain the effectiveness of extension agents in transferring snailery technologies, while simple regression model was adopted to determine the relationship between adoption of snailery technologies and farmers output performance. The implicit model is stated as

$$Y = f(x) + e$$

Where Y = adoption level / rate

X = income from snail per annum

e = error term

Hypothesis

There is no significant difference in the rating of various extension agents qualities in transferring snailery technologies to farmers.

Results and Discussion

Table I shows the simple regression relating level of adoption of snailery technology and farmers output performance. The linear model provided the best fit because it has the highest value of coefficient of multiple determination (R^2), the coefficient of multiple determination of 0.500 indicates that up to 50% variations in output of the farmers was explained by the adoption level. The variable x is also significant at 1% level indicating that it has influenced output of the farmers tremendously. It is also positively related to output. This shows that increases in adoption of snailery technologies increased output of snail farmers. The F-ratio is significant at 1% level indicating the suitability of the model for analysis. The model also showed the correlation coefficient of 66% showing that there was a high degree of association between the variable. Explicitly, the model is thus:

$$Y = 24.682 + 2.458x$$

A unit change in x will bring about 2.453 + 24.682 = 27.135

Table I Simple regression relating the level of adoption of snailery technologies and farmers output performance.

Variable	Linear form		Exponential form		Semi log form		Double log form	
	Coefficient	T-ratio	Coefficient	T-ratio	Coefficient	T-ratio	Coefficient	T-ratio
Constant	24.682	10.498	3.321	58.113	14.023	3.279	3.061	30.292
X	2.453	6.932***	0.056	6.493***	14.723	6.191***	0.345	6.144***
R^2	0.500		0.468		0.444		0.440	
$\bar{R}^2$	0.490		0.456		0.432		0.429	
F-ratio	48.051***		42.155***		38.324***		37.747***	

Source: Field Survey, 2011

*** = significant at 1%

Result in Table 2 is on the effectiveness of extension agents in transferring snailery technologies. The quality attributes used in measuring the effectiveness is based on the Basic Principles of Extension Teaching (BPET) (Akubuilo *et al.,* 2007). The effectiveness of extension agents as regards to their quality attributes was measured from farmers perception on the performance of extension agents relative to the quality attributes. As shown in table 2, majority (70%) of the extension agents are effective in communication. Also effective are in demonstration (64%), construction of snailery (70%), monitoring and supervision (60%). But, in the application of inputs, evaluation of farmers efforts and interpretation of recommended practices, the extension agents were rated not effective. The ratings are 60%, 64% and 60% respectively.

The hypothesis which states that there is no significant difference in the rating of various extension agent qualities in transferring snailery packages is rejected. This is because the F-calculated value of 5.10 is greater than the F-tabulated value of 2.99 at 5% level of probability (Table 3). This implies that the extension agents are not good in all the quality attributes of delivering packages available.

Table 2: Effectiveness rating of Extension Agents Qualities

Items	Very effective Frequency (%)	Effective Frequency (%)	Not Effective Frequency (%)	Undecided Frequency (%)
Communication	10 (20)	35 (70)	3 (6)	2 (4)
Demonstration	8 (16)	32 (64)	7 (14)	3 (6)
Motivation	5 (10)	29 (58)	10 (20)	6 (12)
Monitoring and supervision	5 (10)	30 (60)	6 (12)	9 (18)
Application of inputs	10 (20)	8 (16)	30 (60)	2 (4)
Evaluation of farmers efforts	12 (24)	2 (4)	32 (64)	4 (8)
Interpretation of Recommended practices	15 (30)	5 (10)	30 (60)	0 (0)
Construction of Snailery	10 (20)	35 (70)	3 (6)	2 (4)

Note: Multiple Responses

Source: Field Survey, 2011

Table 3: Summary of ANOVA Table

Source of variation	Sum of squares	Degree of freedom	Mean of squares	F-ratio
Between Group	1503.2	3	501.0	5.10
Within Group	2768.8	28	98.8	
Total	4272	21		

Source: Field Survey 2011

As shown in Table 4, various problems were found to be militating against adoption of snailery technologies by farmers. Majority (14.2%) of the respondents were constrained with inadequate finance. Other problems identified include; poor knowledge of recommended practices on the technologies (10.7%), difficulty in adopting the technologies (7.14%), unfavourable environment to adopt the technologies (10.7%), unavailability of required inputs for the adoption of the technologies (7.14%), incompetency of extension agents to handle snailery technologies (10.7%), poor profits from the sale of the output (5.35%), perceived risk and uncertainty (12.5%) and lack of access to ready markets (8.92%). These problems are likely to setback the adoption of snailery technologies. This therefore calls for adequate check of these problems to motivate farmers adopts the technologies.

Table 4: Distribution of Respondents on the problems militating against adoption of snailery technologies.

Constraints	Frequency	Percentage
Poor knowledge of recommended practices on the technologies	30	10.7
The technologies are difficult to adopt	20	7.14
Unfavourable environment to adopt the technologies	30	10.7
Unavailability of inputs for the adoption of the technologies	20	7.14
Incompetency of extension agents to handle snailery technologies	30	10.7
Poor income from the sale of the output	15	5.35
High financial involvement	40	14.2
Poor information about the technology	35	12.5
Perceived risk and uncertainty	35	12.5
Lack of access to ready markets	25	8.92
Total	280	99.85

Note: Multiple Responses

Source: Field survey, 2011

Conclusion

Significant differences were found in the rating of various qualities of extension agents in transferring snailery technologies. This entails that the extension agents are not effective in all the quality attributes of delivering the technologies. It was further found that output performance of farmers depends on the level of adoption of the given technology. This therefore calls for quality in service training of the field workers especially in area of technology transfer. This is because poor transfer of technology reduces the level of adoption and hence poor output performance.

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GROWTH AND YIELD OF OKRA (*Abelmoschus esculentus L. moench*) AS AFFECTED BY ROOT-GALL NEMATODE DISEASE *(Meloidogyne javanica)*

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ABSTRACT

Study on the growth and yield of Okra (Abelmoschus esculentus L. moench) as affected by root-gall nematode disease (Meloidogyne javanica) was conducted using a 2 x 4 factorial in randomized complete block design with 4 replications. Okra varieties: spineless (VG-10R); Agharagu (101D); Nwidu (LD88) and Otukwuomia (47-4) susceptible to the nematode were planted at 222.222 plants/ha in an ultisol naturally infested by the nematode and a synthetic nematicide Furadan 3G was applied at 0 and 50kg/ha. Results showed that root-gall nematode disease caused by Meloidogyne javanica significantly (P=0.05) reduced the plant height, numbers of leaves and fruits per plant, leaf areas, and total fresh fruit weight of the four test okra varieties. Number of days to flower initiation and 50% flowering were significantly (P=0.05) increased by the root-gall nematode infection.

Key Words: Okra variety, root-gall nematode infection, *Meloidogyne javanica, performance*.

INTRODUCTION

Okra (Abelmoschus esculentus. L moench) is a popular and important food crop worldwide(National Research Council, 2006). It is cultivated throughout the tropical and warm temperate regions of the world for its fibrous fruit or pods containing round, white seeds. Worldwide production of okra as fruit vegetable is estimated at 6 million tons per year. In West Africa, it is estimated at 500,000 to 600,000 tons per year (Burkill, 1997).Okra is a powerhouse of valuable nutrient. The nutritional constituents of okra include calcium, (75 mg), protein (2.0 g), oil (0.1 g) and carbohydrate (7.6 g); others include, iron, magnesium and phosphorus (Omotoso *et al*., 2008).The essential and non essential amino acids of okra are comparable to that of soy bean (Omotoso *et al*., 2008).For consumption, the young immature fruits can be eaten cooked, boiled or fired.

In Nigeria where okra is one of the leading vegetables (Taylor, 1996) it is usually boiled in water resulting in slimy soups and sauces, which are relished. In Northern part of Nigeria, the fairly matured fruits are sliced, dried and ground into power for use as thickening agent during lean seasons. Okra production could be profitable if its pests and diseases are properly managed.

Root-gall nematode of the genus *Meloidogyne* is among the main pathogens of okra plants all over the world. Infected plants show stunting, yellowing, aberrant root system characterized by formation of galls, a general unthrifty appearance and limited fruit production. Use of synthetic nematicide has however proved most efficient in the control of root-gall nematode. Akinlade (1982)

observed that yields of carbofuran treated okra plants were superior to the untreated ones infected with *M. incognita*. The prohibitive and indiscriminate use of these chemicals by the farmers are limitations in the use of synthetic nematicide. Organic amendments also help to stimulate complex predatory microbes that keep potential pest and pathogens under control. Weathered poultry manure was reported to be effective in the management of root-gall nematodes in crops like okra and African yam bean (Adekunle , 2006 ; Agu, 2008).But little emphasis has been led on the pathogencity of *M.javanica* on okra and the consequent yield losses, this study undertook to investigate the effect of the nematode on the growth and yield of okra.

METHODOLOGY

The study was carried out at the Teaching and Research Farm of Federal University of Technology, Owerri, located between latitude 5º 20′N and longitude 7º 00′E. The soil was a loamy sand (91.40% sand, 5.14% clay, 3.46% silt) and naturally infested with a root-gall nematode, *Meloidogyne javanica.* The experimental site had a mean annual rainfall of 2334.40 mm, mean temperature of 31ºC and relative humidity of 89%.The layout was a 2 x 4 factorial in randomized complete block design with four replications. The treatments included : (a) Okra Varieties (Spineless (VG-10R), Agharagu (101D), Nwidu (LD88) and Otukwuomia (47-4)) obtained from National Institute for Horticultural Research and Training (NIHORT), Okigwe and (b) Furadan 3G (Nematicide) applied at 0 and 50kg/ha. The experimental site (488.37 m²) was divided into four blocks separated by 0.5 m furrow. Each block was divided into 8 plots, each measuring 1.2 x 8 m, and separated by 30 cm path. Each plot was randomly allocated one of the 8 treatment combinations. Control plots were two weeks before planting treated Furadan 3G at 50 kg/ha and covered immediately with black polythene films. At planting, the okra seeds were first surface sterilized in 10% commercial sodium hypochlorite solution for 2 minutes and rinsed three times with tap water. The treated seeds were soaked in water for 24 hours before sowing at 2 seeds per hole at a planting distance of 0.3 m x 0.3 m, a plant population of 222, 222 plants/ha. Emergence took place 3 to 4 days after sowing and by 5 days after sowing, missing stands were supplied. The plots were manually weeded at 3 and 7 weeks after sowing. At 6 and 8 weeks after planting, data were collected on plant height, leaf numbers and areas. Days to first and 50% flowering were also noted. Number and total fresh fruit weight per plant were recorded.

All data collected were subjected to analysis of variance as described by Steel and Torrie (1981). Difference between means were separated using Fishers Least Significant difference (F-LSD) at P=0.05.

RESULTS AND DISCUSSION

Root-knot nematode, *Meloidogyne javanica* caused severe root-gall on all the okra varieties used in plots without furadan treatment. This contrasted the free-gall roots obtained on the treated plots (control) (Table 1). This agreed with the earlier reports of Adesiyan *et al.,* (2000) which stated that furadan is one of the most effective nematicide against root-knot nematodes.

Table 1. Root-gall responses of okra varieties to *Meloidogyne javanica* as affected by furadan 3G application.

Okra Variety	Mean root-knot indices in Furadan 3G Treated Soil	Mean root-knot indices in Untreated Soil
Otukwuomia (474)	0.0	4.0
Agharagu (101D)	0.0	4.0
Spineless (VG-10R)	0.0	4.0
Nwidu (LD88)	0.0	4.0

Results obtained on the growth and yield parameter of the okra varieties showed significant (P=0.05) differences between *M. javanica* infected okra plants and the healthy okra plants (Tables 2 and 3). Uninfected Otukwuomia (47-4), Agharagu (101D), Spineless (VG-10R), and Nwidu (LD88) test okra varieties had significantly (P=0.05) higher plant height than those infected with *Meloidogyne javanica*. Duke (2004) reported a reduction in height of okra infected by *Meloidogyne incognita.*

Number of leaves per plant at 6 and 8 weeks after planting (WAP) and leaf areas were found to differ significantly(p=0.05) between the uninfected (control) and the infected plants. The uninfected plants produced significantly (p=0.05) higher number of leaves at both 6 and 8 WAP than the infected plants. The same was true for the leaf areas. These results agreed with that of Agu (2004) which reported that *Meloidogyne incognita* infection on sweet potato significantly reduced number of leaves per plant as well as tuber yields. According to Minton and Baujard (1990), this reduction may be as a consequence of the nematode development and the giant cell formation in the stele which leads to the malformation of the xylem elements and the inhibition of the secondary growth of the xylem and phloem tissues.

All the four test okra varieties had significantly (P=0.05) lower number of days to flowering than the infected. The same was true for number of days to 50% flowering of the plants. These were probably due to galling effects on the roots of infected okra plants. Otiefa and Elgindi (1962) reported that galled roots do not translocate adequate water and nutrients to the vegetative organ.

Significant okra varietals effects on the number of days to flowering and 50% flowering of the okra plants were also observed. Otukwuomia (47-4) variety took the longest number of days (64.75 days) to flower and this differed significantly (p=0.05) from those of the other varieties. Spineless variety had significantly (p=0.05) lower number of days (64.00 days) to attain 50% flowering than others.

Irrespective of the variety, it was observed that all the uninfected plants produced more number of fruit per plant than the infected (Table 3). This may be attributed to the galled roots of the infected plants which significantly

reduced the amount of nutrient uptake and translocation to the shoot (Carneiro *et al*., 1999). Shukla and Naik (1993) reported that amount of nutrient taken up by crops determine the number of fruits and the amount of dry matter produced. Agu (2004) also reported that sweet potato infected by *M. incognita* produced lower number of tubers than the uninfected. It was observed that spineless (VG-10R) variety had the highest number of fruits which differed significantly (P=0.05) from those of the others (Table 3). Otukwuomia (47-4) produced the least number of fruits per plant.

Result on the total fresh fruit weight showed no significant varietal difference between Agharagu (101D), Nwidu (LD88) and Otukwuomia (47-4) (Table 3).However, these three varieties produced total fresh weights that were significantly (P=0.05) higher than that of the spineless (VG-10R). For all the varieties, the uninfected plant had higher total fruit weight than the infected (Table 3). This higher total fresh fruit weight of the uninfected showed that they absorbed and translocated more water and nutrient than the infected plants with damaged roots. This observation agreed with Agu (2004, 2008) who reported a consistent increase in yields of sweet potato and African yam bean at decreased root-gall severity.

Table 2. Growth attributes of the four test okra varieties as affected by *Meloidogyne javanica.*

Nematode Treatment	Okra Variety				
	Otukwuomia (47-4)	Nwidu (LD_{88})	Spinelss (VG-10R)	Agharagu (101D)	Mean Growth attributes
Infected	18.03	13.96	19.00	19.93	Plant height
Control	25.17	22.46	26.29	27.29	(cm)
$LSD_{0.05=6.89}$	*	*	*	*	
Infected	7.17	7.00	6.00	6.75	no of leaves
Control	8.75	8.70	7.55	8.24	@ 6 WAP
$LSD_{0.05=1.09}$	*	*	*	*	
Infected	6.90	7.05	6.60	6.25	no of leaves
Control	9.05	8.50	8.30	8.25	@ 8 WAP
$LSD_{0.05=1.29}$	*	*	*	*	
Infected	0.214	0.200	0.167	0.236	Leaf
Control	0.395	0.389	0.231	0.416	area
$LSD_{0.05=0.098}$	*	*	*	*	
Infected	67.75	66.00	64.00	66.25	no of days
Control	63.50	64.00	58.00	63.25	to flowering
$LSD_{0.05=2.00}$	*	*	*	*	
Infected	70.70	67.70	67.20	69.50	Days to
Control	66.00	66.50	52.70	65.20	50% flowering
$LSD_{0.05=4.44}$	*	*	*	*	

* = Mean difference statistically significant (P=0.05)

N.S = Non significant difference.

No = Number

Table 3: Yield attributes of the four test Okra varieties as affected by *Meloidogyne javanica*.

Nematode Treatment	Okra Variety				
	Otukwuomia (47-4)	Nwidu (LD_{88})	Spinelss (VG-10R)	Agharagu (101D)	Mean Growth attributes
Infected	9.80	13.3	15.3	14.10	number of
Control	29.0	26.8	42.0	34.30	fruits/plant
$LSD_{0.05=11.67}$	*	*	*	*	
Infected	852	489	882	278	Total fresh
Control	1486	1123	1476	730	fruit weight
$LSD_{0.05=421.2}$	*	*	*	*	(g)

* = Mean difference statistically significant (P=0.05)
N.S = Non significant difference.

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