ISSN 1819-1894

Asian Journal of Agricultural Research

http://knowledgiascientific.com

Knowledgia SCIENTIFIC
A Place to Publish Outstanding Research

Asian Journal of Agricultural Research 10 (1): 38-46, 2016
ISSN 1819-1894 / DOI: 10.3923/ajar.2016.38.46

Economic Performance of Maize under Incorporated Legumes and Nitrogen in Northern Guinea Savanna Zone of Nigeria

[1]A.G. Adesoji, [2]I.U. Abubakar and [2]D.A. Labe
[1]Department of Crop Production and Protection, Faculty of Agriculture and Agricultural Technology, Federal University, Dutsin-Ma, Katsina State, Nigeria
[2]Department of Agronomy, Institute for Agricultural Research, Faculty of Agriculture, Ahmadu Bello University, Zaria, Nigeria

Corresponding Author: A.G. Adesoji, Department of Crop Production and Protection, Faculty of Agriculture and Agricultural Technology, Federal University, Dutsin-Ma, Katsina State, Nigeria

ABSTRACT

An economic analysis was done using the partial budget procedure to evaluate economic performance of maize (*Zea mays* L.) under incorporated legumes and nitrogen in Northern Guinea Savanna zone of Nigeria. Results showed that plots without nitrogen fertilizer produced maize at loss throughout the three years of study and their average data except in 2006 where a very little profit was made. Maize production using 120 kg N ha^{-1} gave the highest gross margin and profit per naira (₦) invested throughout the three years of study with an exception of 2005 where there was a loss. However, in the three year average data, application of 90 kg N ha^{-1} in maize production gave the best profit per naira (₦) invested, which made incurring of extra cost of 30 kg N ha^{-1} from application 120 kg N ha^{-1} of no benefit. The most profitable green manure method for maize production was lablab green manure which gave the highest gross margin and profit per naira (₦) invested. When using nitrogen fertilizer and green manure on maize production was compared, incorporation of any of the legumes was better economically than any of the nitrogen levels. The results of this study suggest that using incorporated legumes in maize production was more profitable than using nitrogen fertilizer.

Key words: Green manure, economic analysis, maize, gross margin, nitrogen fertilizer

INTRODUCTION

Maize is the most widely and popular cereal in Nigeria that has found its usage in every home either as food for human beings or feed for animals and importantly, raw material for food industries. World total cereal production in 2012 showed that maize was the first most important cereal in Nigeria followed by sorghum and rice as stated by FAO. Africa produced 7.9% of the world's total from 34.7 million ha. Nigeria which came second after South Africa in Africa produced 8.7 million Mt from 5.7 million ha which represented 1% of the world's total in 2012. Nigeria's production is very low compared with 273.8 million t produced by USA in 2012. This study was conducted in Savanna zone of Nigeria that accounts for over 70% of the maize production in the country (Uyovbisere *et al*., 2001). The reason cannot be farfetched because the average yield per hectare in Nigeria is still very low to the tune of 1500 kg ha^{-1} in 2012 as stated by FAO. However, in sub-Saharan African countries, low crop yield has been linked to challenges such as poor planting materials, soil infertility, erosion, climate change and improper use of agro-chemicals or excessive use of high external inputs (Ibeawuchi *et al*., 2009).

Maize is one of the crops that depend substantially on nitrogen for growth and development. It has been established that among all the essential nutrients, nitrogen seems to have the most pronounced effect on plant growth and development (Lombin, 1988). As importance as nitrogen is in plant life, it is low in soils of Nigerian Guinea Savanna. The soils of this zone are characterized with low organic carbon, total nitrogen, available phosphorus, effective Cation Exchange Capacity (CEC) and exchangeable cations as well as clay and silt contents (Singh, 1987). It has been observed that nitrogen is most important constraint to increased maize production in the Guinea Savanna of Nigeria (Singh *et al*., 2001). Hence, application of nitrogenous fertilizer becomes inevitable to guarantee increased maize production for maximum yield. It should be noted that the growth and productivity of any plant rest on degree of effectiveness of such a plant to absorb and mobilize the nutrients that are available in the soil for plant growth and dry matter accumulation (Adesoji, 2015). The efficient use of mineral fertilizers without compromising the fertility and productivity of soil is the major key to boost crop production (Adesoji, 2015).

The judicious use of mineral fertilizers ensures high crop yields but their use for long time causes deleterious effects on soil health and environment (Adesoji *et al*., 2015). However, a large number of Nigerian farmers apply little or no chemical fertilizers because of their unavailability at right time, poor distribution network, high cost, fear of adulteration and risks from erratic and limited rainfall especially in Nigerian Guinea Savanna (Adesoji *et al*., 2010). Average fertilizer use rate in 2012 in Nigeria was 4.8 kg ha^{-1}, which is far lower than the average fertilizer use rate of 62 and 131.1 kg ha^{-1} for South Africa and United States of America, respectively (World Bank, 2015). The consequences of these are low crop yields, low economic returns and soil nutrients mining. With above mentioned challenges associated with the use of chemical fertilizers, it is worthwhile to explore the use of renewable alternative that optimizes the utilization of biological wastes which are environment friendly to generate plant nutrients for optimal crop production (Adesoji, 2015). Green manure is a good alternative because of its efficient capacity to generate organic matter which is a main force in the sustainability of soil fertility and productivity. Green manure has been reported to increase soil organic matter, available nitrogen, concentration of nutrients near the soil surface in available form and reduces the N loses through leaching and soil erosion (Sultani *et al*., 2007). The system of incorporating plant materials into soils after a short period of fallow is a good option for the improvement of soil physical, chemical and biological properties for safe and healthy soils.

Farming is a business and should be profit oriented. No farmer will venture into any new technology or innovation that he is not sure of its profitability. The information on economic benefits of maize production using green manure and nitrogenous fertilizer is scanty in this study area. Hence, there is a need to determine the profitability of the tested levels or types of the added inputs because a particular level or a type of an input that gave a maximum yield may not be viable economically which will make its adoption by farmers very difficult. Green manuring technology is not a well familiar technology among farmers in Guinea Savanna zone of Nigeria. The reasons for this may not be far away from some reasons like that the technology has not been well disseminated to farmers by extension workers, small farmers cannot afford to grow them at the expense of food crops in their limited land holdings (Rao and Mathuva, 2000) and some disincentive factors as stated by Fabunmi and Agbonlahor (2012) are costs of labour for establishment, maintenance and incorporation, zero output value and time and land value to cultivate the manure crops. However, profitability of any new technology or innovation is an impetus for an easy adoption by farmers. Therefore, this study was conducted to evaluate the economic benefits of maize production using incorporated legumes and nitrogen fertilizer.

MATERIALS AND METHODS

Three field trials were carried out in the rainy seasons of 2005-2007 at the Research Farm of the Institute for Agricultural Research, Samaru (11°11'N, 07°38' E, 686 m above mean sea level) in the Northern Guinea Savanna ecological zone of Nigeria. The annual rainfall for the duration of the study was 790.4, 1086.7 and 900.4 mm for 2005, 2006 and 2007, respectively. The physico-chemical analysis of the top soil (0-30 cm depth) of the experiment site before planting in 2005 as determined by standard procedures showed that the soil was loam with the following properties: pH (0.01 M $CaCl_2$), 5.0, organic carbon, 5.3 g kg^{-1}, total nitrogen, 0.53 g kg^{-1}, available phosphorus, 12.25 mg kg^{-1} and exchangeable cations (cmol kg^{-1}) of Ca^{2+}, 1.80, Mg^{2+}, 0.36, K^+, 0.14, Na^+, 0.11 and CEC, 4.8 cmol kg^{-1}. The treatments consisted of two maize varieties (SAMMAZ 12 and SAMMAZ 27), five levels of N (0, 30, 60, 90 and 120 kg N ha^{-1}) and three green manure crops (*Lablab purpureus, Mucuna pruriens* and *Glycine max* (L.) Merrill) and a weedy fallow. The experiment was laid out in a split-plot design with nitrogen and variety as main plot treatment and green manure as the sub plot treatment. The experiment was replicated three times.

Leguminous green manure crops were planted on the flat with narrower inter-row spacing of 37.5 cm. The *Lablab* was sown at 2 stands per hole at 20 cm within row and mucuna was sown at a stand per hole at 20 cm within row. The soybean was planted drilled. The leguminous green crops were incorporated at 49 days (7 weeks) after planting. After 3 days of incorporation, maize seeds were planted with two or three seeds per hole at a spacing of 25 cm on the ridges of 75 cm apart. The maize seedlings were thinned to one seedling per stand at two weeks after sowing. The experimental plot consisted of six ridges of 4.5 m apart and 4 m long (gross plot) and net plot was 3 m×3 m. The green manure crops were fertilized using 20 kg P_2O_5 ha^{-1} and 10 kg N ha^{-1} to boost their growth. Nitrogen fertilizer as urea (46% N) was applied to the maize at 2 and 6 Weeks After Sowing (WAS) according to treatment. Basal applications of 60 kg P_2O_5 ha^{-1} and 60 kg K_2O ha^{-1} were carried out at sowing. Weeds were controlled using Paraquat (Gramaxone) at 3 L ha^{-1} to kill weeds that were not properly incorporated and hoe weeding was done at 6 WAS.

Data collected from the observations were subjected to statistical analysis of variance (ANOVA) as described by Gomez and Gomez (1984) using SAS package version 9.0 of statistical analysis (SAS., 2002). The differences among treatment means were separated using Duncan‘s Multiple Range Test (Duncan, 1955). Effects were considered statistically significant at 5% level of probability. Economic analysis was done using the partial budget procedure to determine the treatment combination that would give acceptable returns at low risk to farmers (CIMMYT., 1988). Economic analysis of the data was done based on the prevailing market prices of inputs, operation and outputs. The concepts used in the partial budget analysis are defined as follows:

- Total Revenue (TR) in ₦ per hectare = Q×P
- Total Variable Cost (TVC) in ₦ per hectare = sum of the cost of labour and variable inputs, such as fertilizers, seeds and chemicals
- Gross Margin (GM) in ₦ per hectare = GR-TVC
- Gross margin per ₦ invested = GM/TVC

Where:

Q = Yield of maize for each treatment (Kg ha^{-1})
P = Average price of maize (₦)
GR = Gross revenue (₦)
TVC = Total variable cost (₦)

RESULTS

Table 1 shows the costs and returns analysis on investment of growing maize using nitrogen fertilizer and green manure in 2005. Production of maize on plots without nitrogen fertilizer brought a loss of ₦11,108 and 24 k loss per naira(₦) invested. Production of maize using 30 kg N ha^{-1} was most profitable with ₦7,329 and a profit of 15 k per naira (₦) invested. This was followed by production of maize using 60 kg N ha^{-1} which gave a gross margin of ₦7,165 and a profit of 13 k per naira invested while using 90 kg N ha^{-1} to produce maize brought a gross margin of ₦2,754 and 5 k profit per naira (₦) invested. Production of maize in 2005 using 120 kg N ha^{-1} brought a loss of ₦668 and 1 k loss per naira (₦) invested. In green manure, growing of maize on weedy fallow gave the least gross margin of ₦10,782 and a profit of 35 k per naira (₦) invested. Maize production using mucuna green manure was found most profitable with a gross margin of ₦23.980 and a profit of 64 k per naira (₦) invested while incorporation of lablab produced maize which gave a gross margin of ₦21,034 and a profit of 56 k per naira (₦) invested. Production of maize using incorporated soybean gave a gross margin of ₦16,816 and a profit of 45 k per naira (₦) invested (Table 1).

Table 2 shows the costs and returns analysis on investment of growing maize using nitrogen fertilizer and green manure in 2006. Maize production on plots without nitrogen fertilizer produced a loss of ₦11,108 and 24 k loss per naira (₦) invested. The gross margin and profit per naira (₦) invested increased with each increment of nitrogen up to the highest rate, 120 kg N ha^{-1}. Maize production using 120 kg N ha^{-1} resulted in a gross margin of ₦120,004 and a profit of ₦1.65 per naira (₦) invested. In green manure in 2006, production of maize on weedy fallow plots

Table 1: Costs and returns analysis on investment of growing maize using nitrogen and green manure in 2005

Treatments	Grain yield (kg ha^{-1})	Average price (₦ kg^{-1})	GR (₦ kg^{-1})	TVC (₦ ha^{-1})	GR-TVC (₦ ha^{-1})	Gross margin per ₦ invested
Nitrogen (kg ha^{-1})						
0	950	38	36100	47208	-11108	-0.24
30	1414	38	57732	50403	7329	0.15
60	1599	38	60762	53597	7165	0.13
90	1567	38	59546	56792	2754	0.05
120	1561	38	59318	59986	-668	-0.01
Green manure						
Weedy fallow	1086	38	41268	30486	10782	0.35
Mucuna	1613	38	61294	37314	23980	0.64
Lablab	1543	38	58634	37600	21034	0.56
Soybean	1432	38	54416	37600	16816	0.45

1$: ₦199 (2015 autonomous exchange rate), GR: Gross revenue, TVC: Total variable cost

Table 2: Costs and returns analysis on investment of growing maize using nitrogen and green manure in 2006

Treatments	Grain yield (kg ha^{-1})	Average price (₦ kg^{-1})	GR (₦ kg^{-1})	TVC (₦ ha^{-1})	GR-TVC (₦ ha^{-1})	Gross margin per ₦ invested
Nitrogen (kg ha^{-1})						
0	1433	43	61619	56949	4670	0.08
30	2757	43	118551	60860	57691	0.95
60	3645	43	156735	64771	91964	1.42
90	4233	43	182019	68682	113337	1.65
120	4479	43	192597	72593	120004	1.65
Green manure						
Weedy fallow	2058	43	88494	35286	53208	1.51
Mucuna	3677	43	158111	43353	114758	2.65
Lablab	3921	43	168603	44068	124535	2.83
Soybean	3581	43	153983	43782	110201	2.52

1$: ₦199 (2015 autonomous exchange rate), GR: Gross revenue, TVC: Total variable cost resulted in gross margin of ₦53,208 and a profit of ₦1.51 per naira (₦) invested. Incorporation of *Mucuna* produced maize with a gross margin of ₦114,758 and a profit of ₦2.65 per naira (₦) invested while incorporation of *Lablab* produced maize with a gross margin of ₦124,535 and a profit of ₦2.83 per naira (₦) invested. Production of maize by incorporation of soybean gave a gross margin of ₦110,201 with a profit of ₦2.52 per naira (₦) invested (Table 2).

Table 3 shows the costs and returns analysis on investment of growing maize using nitrogen fertilizer and green manure in 2007. Production of maize on plots without nitrogen fertilizer produced a loss of ₦23,472 and 39 k loss per naira (₦) invested. Application of 30 kg N ha^{-1} up to the highest rate of 120 kg N ha^{-1} resulted in increase in gross margin and profit per naira (₦) invested. Application of 120 kg N ha^{-1} resulted in a gross margin of ₦33,456 and a profit of 44 k per naira (₦) invested. In green manure in 2007, production of maize on weedy fallow gave a gross margin of ₦18,357 and a profit of 51 k per naira (₦) invested. Maize production using *Mucuna* green manure gave a gross margin of ₦48,068 and a profit of ₦1.07 per naira (₦) invested while production of maize using incorporated lablab gave a gross margin of ₦48,953 and a profit of ₦1.08 per naira (₦) invested. Production of maize using incorporated soybean gave a gross margin of ₦41,589 and a profit of 92 k per naira (₦) invested (Table 3).

Table 4 shows the costs and returns analysis on investment of growing maize using nitrogen fertilizer and green manure in 2005-2007. The results showed that non application of nitrogen fertilizer in maize production brought a loss of ₦9,053 and 17 k loss per naira (₦) invested while using 30 kg N ha^{-1} to produce maize in 2005-2007 brought a gross margin of ₦24,235 and 42 k gain per naira (₦) invested. Production of maize using 60 kg N ha^{-1} resulted in a gross

Table 3: Costs and returns analysis on investment of growing maize using nitrogen and green manure in 2007

Treatments	Grain yield (kg ha^{-1})	Average price (₦ kg^{-1})	GR (₦ kg^{-1})	TVC (₦ ha^{-1})	GR-TVC (₦ ha^{-1})	Gross margin per ₦ invested
Nitrogen (kg ha^{-1})						
0	723	50	36150	59622	-23472	-0.39
30	1464	50	73200	63928	9272	0.15
60	1812	50	90600	68233	22367	0.33
90	2011	50	100550	72539	28011	0.39
120	2206	50	110300	76844	33456	0.44
Green manure						
Weedy fallow	1090	50	54500	36143	18357	0.51
Mucuna	1857	50	92850	44782	48068	1.07
Lablab	1889	50	94450	45497	48953	1.08
Soybean	1736	50	86800	45211	41589	0.92

1$: ₦199 (2015 autonomous exchange rate), GR: Gross revenue, TVC: Total variable cost

Table 4: Costs and returns analysis on investment of growing maize using nitrogen and green manure in 2005-2007 (average data)

Treatments	Grain yield (kg ha^{-1})	Average price (₦ kg^{-1})	GR (₦ kg^{-1})	TVC (₦ ha^{-1})	GR-TVC (₦ ha^{-1})	Gross margin per ₦ invested
Nitrogen (kg ha^{-1})						
0	1035	44	45540	54593	-9053	-0.17
30	1878	44	82632	58397	24235	0.42
60	2352	44	103488	62200	41288	0.66
90	2604	44	114576	66004	48572	0.74
120	2748	44	120912	69808	51104	0.73
Green manure						
Weedy fallow	1411	44	62084	33972	28112	0.83
Mucuna	2382	44	104808	41816	62992	1.51
Lablab	2451	44	107844	42388	65456	1.54
Soybean	2249	44	98956	42198	56758	1.35

1$: ₦199 (2015 autonomous exchange rate), GR: Gross revenue, TVC: Total variable cost

Table 5: Grain yield with green manure types and nitrogen levels

Treatments	2005	2006	2007	Combined
Nitrogen (kg ha^{-1})				
0	950^{b}	1433^{d}	723^{c}	1035^{d}
30	1414^{a}	2757^{c}	1464^{b}	1878^{c}
60	1599^{a}	3645^{b}	1812^{ab}	2352^{b}
90	1567^{a}	4233^{ab}	2011^{a}	2604^{ab}
120	1561^{a}	4479^{a}	2206^{a}	2748^{a}
SE±	147.8	256.9	159.7	112.2
Green manure(G)				
Weedy fallow	1086^{c}	2058^{b}	1090^{b}	1411^{c}
Mucuna	1613^{a}	3677^{a}	1857^{a}	2382^{ab}
Lablab	1543^{ab}	3921^{a}	1889^{a}	2451^{a}
Soyabean	1432^{b}	3581^{a}	1736^{a}	2249^{b}
SE±	59.7	130.2	85.7	55.6

Means followed by the same letter(s) within the same column and treatment are not significantly different at 5% level of probability using DMRT

margin of ₦41,288 and a profit of 66 k per naira (₦) invested. Production of maize using 90 kg N ha^{-1} produced a gross margin of ₦48,572 and a profit of 74 k per naira (₦) invested which was higher than gross margin per naira (₦) invested of any other level of N application. Although, production of maize using 120 kg N ha^{-1} gave a highest gross margin of ₦51,104 but it had lesser profit per naira (₦) invested of 73 k than that of 90 kg N ha^{-1} which had a profit per naira (₦) invested of 74 k. In green manure in 2005-2007, production of maize on weedy fallow gave a gross margin of ₦28,112 and a profit of 83 k per naira invested. Maize production using incorporated mucuna gave a gross margin of ₦62,992 and a profit of ₦1.51 per naira (₦) invested while incorporation of lablab produced maize with a gross margin of ₦65,456 and a profit of ₦1.54 per naira (₦) invested. Production of maize by incorporating soybean produced gross margin of ₦56,758 and a profit of ₦1.35 per naira (₦) invested. The gross margin per naira (₦) invested in average data (2005-2007) for mucuna, lablab and soybean was 81.9, 85.5 and 62.7% better than gross margin per naira (₦) invested of weedy fallow, respectively (Table 4).

Maize grain yield performance was better in 2006 than 2005 and 2007 because of even distribution of rainfall in 2006 (Table 5). In 2005 and 2007, the rainfall in month of September was poor and unevenly distributed and coincided with the flowering and grain filling period of the crop. Hence, this seriously affected grain filling and consequently grain yield.

DISCUSSION

Maize performance was poor in 2005 and 2007 which could be attributed to poor rainfall and uneven distribution of rain in the month of September. Worst still, this poor rainfall pattern coincided with flowering and grain filling stages of maize. Hence, maize performance was negatively affected, which made grain yields obtained in 2005 and 2007 to be less than that of 2006. Consequently, a better maize grain yields in 2006 than that of 2005 and 2007 because the rain was better and well distributed.

Economic analysis of maize production using nitrogen indicated that application of 120 kg N ha^{-1} recorded in most cases highest gross margin, however, application of 90 kg N ha^{-1} gave in most cases the highest profit per ₦ invested. This is an indication that application of 90 kg N ha^{-1} fetched more profit in terms of naira invested which means the more the naira invested, the more the profit per ₦ invested. Results of the experiment revealed that the application of 120 kg N ha^{-1} added to the cost of production but did not add significantly to the output. This is obvious because increasing N rate from 90-120 kg N ha^{-1} did not lead to corresponding increase in grain yield or economic benefits to warrant the extra cost that may be incurred for additional 30 kg N ha^{-1}. Therefore, application of 90 kg N ha^{-1} was found to be economic viable rate. This result is in consonance with report of Buah *et al*. (2009), who also found that increasing N rate beyond 90 kg N ha^{-1} did not give corresponding increase in yield and net benefit to justify the extra cost that may be incurred.

The economic analysis indicated that lablab green manure is the most profitable followed by mucuna green manure which was next in terms of profitability and this was closely followed by soybean green manure. It has been reported that mucuna and lablab were preferred because of reduced labour requirements and increased net benefits compared to continuous cropping (Fischler and Wortmann, 1999). It was further reported that an efficient management of green manures increases their productivity and can reduce labour costs, which therefore leads to increase in net benefits. In the same vein, the economic analysis conducted by Hirpa (2013) indicated that cowpea green manure gave the highest net benefits compared with other green manure types. Similarly, Fabunmi and Agbonlahor (2012) reported that green manure generated from drum variety of cowpea at 80,000 plants ha^{-1} was the most economically profitable manure in the production of maize.

Results of the study clearly showed that incorporation of lablab, mucuna and soybean gave greater gross margin per ₦ invested than values recorded for any of the N rates. Therefore, investment in maize production using green manure revealed lesser cost of production of maize and higher profit than investment in maize production using N. This might be the reason due to which, Sharma and Behera (2009) reported that legume biomass N has various indirect benefits such as addition and increased availability of other nutrients, improvement in nutrient use efficiency, physical and biological properties of soil. All these presented a better soil performance beyond N-release for an enhanced yield with a lesser cost of production. Consequently, this ensures a sustainable productivity of maize. Similarly, in a study conducted in Tanzania, the partial budget analysis showed that green manure gave a net incremental benefit of Tsh 478,654 A^{-1} in comparison to chemical fertilizers used by farmers in maize production (William *et al*., 2012). These benefits were further attributed to increase in marketable yields and savings from the reduction in the costs of chemical fertilizers and labour (William *et al*., 2012).

CONCLUSION

Economic analysis of maize production revealed that application of 120 kg N ha^{-1} gave highest gross margin but application 90 kg N ha^{-1} gave the highest gross margin per naira (₦) invested. The partial budgeting study on maize production using green manure showed that lablab green manure consistently recorded the greatest gross margin and gross margin per naira (₦) invested. This was closely followed by mucuna green manure and lastly by soybean green manure in term of profitability. When incorporation of lablab, mucuna and soybean was compared with application of nitrogen in terms of profitability, incorporation of lablab, mucuna and soybean gave greater gross margin per naira (₦) invested than values recorded for any of the N rates.

REFERENCES

Adesoji, A.G., I.U. Abubakar and D.A. Ishaya, 2010. Crop Residue Management for Nutrient Recycling: Overview. In: Re-Strategizing Nigerian Agriculture in a Rapidly Changing Climatic Conditions for Sustainable Food Security: Proceedings of the 44th Annual Conference of the Agricultural Society of Nigeria (ASN), October 18th-22nd, 2010, Akinlade, J.A., A.B. Ogunwale, V.O. Asaolu, O.A. Aderinola, O.O. Ojebiyi and T.A. Rafiu (Eds.). Ladoke Akintola University of Technology, Ogbomoso, Oyo State, Nigeria, pp: 1153-1156.

Adesoji, A.G., 2015. Potentials and Challenges of Inorganic and Organic Fertilizers in Nutrient Management. In: Fertilizer Technology I: Synthesis, Sinha, S., S.S. Pant, S. Bajpai and J.N. Govil (Eds.). Studium Press LLC, Houston, TX, USA., pp: 77-100.

Adesoji, A.G., I.U. Abubakar and D.A. Labe, 2015. Influence of incorporated legumes and nitrogen fertilization on maize (*Zea mays* L.) nutrient uptake in a semi-arid environment. IOSR J. Agric. Vet. Sci., Vol. 8: (3 ver. II): 01-08.

Buah, S.S.J., L.N. Abatania and G.K.S. Aflakpui, 2009. Quality protein maize response to nitrogen rate and plant density in the Guinea Savanna Zone of Ghana. West Afr. J. Applied Ecol., 16: 9-21.

CIMMYT., 1988. From Agronomic Data to Farmer Recommendations: An Economics Training Manual. CIMMYT Economics Program, Mexico, DF., ISBN: 9686127194, Pages: 59.

Duncan, D.B., 1955. Multiple range and multiple F tests. Biometrics, 11: 1-42.

Fabunmi, T.O. and M.U. Agbonlahor, 2012. Economics of maize production under different cowpea-based green manure practices in derived Savanna zone of Nigeria. J. Organ. Syst., 7: 5-13.

Fischler, M. and C.S. Wortmann, 1999. Green manures for maize-bean systems in eastern Uganda: Agronomic performance and farmers' perceptions. Agrofor. Syst., 47: 123-138.

Gomez, K.A. and A.A. Gomez, 1984. Statistical Procedures for Agricultural Research. 2nd Edn., John Wiley and Sons, New York, USA., ISBN-13: 9780471870920, Pages: 680.

Hirpa, T., 2013. Effect of stage at termination of legume green manures on soil organic carbon, yield and economic performance of subsequent maize crop. Int. J. Curr. Res. Acad. Rev., 1: 84-101.

Ibeawuchi, I.I., J.C. Obiefuna, M.O. Ofor, E.E. Ihem, F.O. Nwosu, V.I. Nkwocha and I.O. Ezeibekwe, 2009. Constraints of resource poor farmers and causes of low crop productivity in a changing environment. Researcher, 1: 48-53.

Lombin, G., 1988. Soil Science. In: Introduction to Tropical Agriculture, Youdeowei, A., F.O.C. Ezedinma and O.C. Onazi (Eds.). Longman Group, London, UK., pp: 34-87.

Rao, M.R. and M.N. Mathuva, 2000. Legumes for improving maize yields and income in semi-arid Kenya. Agric. Ecosyst. Environ., 78: 123-137.

SAS., 2002. Statistical Analysis System (SAS) User's Guide (Version 9.0). SAS Institute, Inc., Carry, NC., USA.

Sharma, A.R. and U.K. Behera, 2009. Nitrogen contribution through *Sesbania* green manure and dual-purpose legumes in maize-wheat cropping system: Agronomic and economic considerations. Plant Soil, 325: 289-304.

Singh, A., R.J. Carsky, E.O. Lucas and K. Danshiell, 2001. Grain yield response of maize to previous crop and residue management in the guinea savanna of Nigeria. Proceedings of the Regional Maize Workshop, May 14-18, 2001, IITA-Cotonou, Republic of Benin, pp: 214-224.

Singh, L., 1987. Soil fertility and crop yield in Savanna. Proceedings of the an International Drought Symposium held at the Kenyatta Conference Centre, May 19-23, 1986, Nairobi, Kenya, pp: 417-427.

Sultani, M.I., M.A. Gill, M.M. Anwar and M. Athar, 2007. Evaluation of soil physical properties as influenced by various green manuring legumes and phosphorus fertilization under rain fed conditions. Int. J. Environ. Sci. Technol., 4: 109-118.

Uyovbisere, E.O., K.A. Elemo and B.D. Tarfa, 2001. Effect of locust bean (*Parkia biglobosa*) and neem (*Azadirachta indica*) on soil fertility and productivity of early maize in savanna alfisol. Proceedings of the Regional Maize Workshop, May 14-18, 2001, IITA-Cotonou, Republic of Benin, pp: 185-194.

William, J.G., J.P. Hella and M.W. Mwatawala, 2012. Ex-ante economic impact assessment of green manure technology in maize production systems in Tanzania. Res. Humanit. Soc. Sci., 2: 47-58.

World Bank, 2015. Fertilizer consumption (kilograms per hectare of arable land). http://data.worldbank.org/indicator/AG.CON.FERT.ZS.