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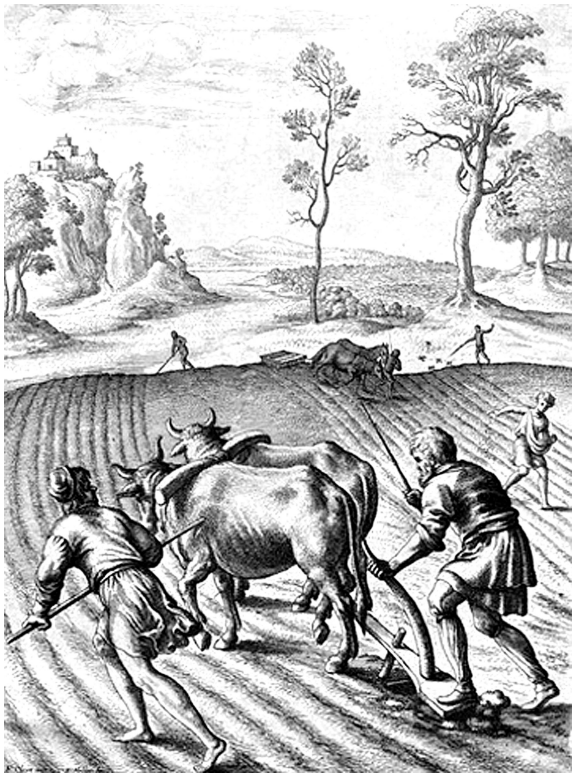

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An Exploratory Survey of Soybean Production as Influenced by Soil Nutrient Status in Northeastern Nigeria

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Abstract: A field survey on soybean (*Glycine max* L. Merr) production trials was conducted in 2004 at Mubi, Northeastern Nigeria. The survey investigated fertilizer requirement and yield variability among small scale farmers. Results revealed that soybean yield was low (993 kg ha^{-1}) while yield variability was extremely high (from less than 400 kg ha^{-1} to over 1800 kg ha^{-1}). It also showed that available phosphorus in the soil ranged from medium to below critical levels and yields increased significantly at higher P levels. Increase in K values significantly reduced yield of soybean indicating that it is not absolutely a limiting factor. Another factor affecting yield was farmers' experience followed by soil physical and chemical properties and plant population. Therefore with careful soil fertility management and increased farmers enlightment and experience, gross margin greater than Naira 40,000 ha^{-1} ($US285.71) is feasible.

Key words: Phosphorus, potassium, soybean, yield variability, gross margin

INTRODUCTION

Soybean (*Glycine max* L. Merr.) is the world most important grain legume in terms of production, consumption and trade. The world average yield of soybean is 1.7 t ha^{-1}) and African average is 1.1 t ha^{-1}) (FAO, 1989) compared to 0.35 t ha^{-1}) in Nigeria (Bello *et al*., 1996). Most reports dealing with soil fertility, in sub-Saharan Africa indicate an alarming negative nutrient balance (De Jagar *et al*., 1998, Roy *et al*., 2003). While the bleak picture is true, marked differences in soil fertility attributed to inherent soil properties and farmers induced management occur pointing to the need for a site specific management (Oorts *et al*., 2003). To improve farmers adoption of new technologies including acceptance of new high yielding varieties and for the purpose of making recommendation based on their knowledge, skills and experience, on-farm experiments are conducted (Saleh *et al*., 2004). This calls for preliminary studies before research can be sited and conducted. An exploratory survey is a simple and relatively quick method of identifying the key constraints and problems in a particular area which are responsible for preventing farmers from increasing their agricultural production to required levels (Abalu, 1985) and thus recommendations are given for improvement in future surveys (Msanya *et al*., 2003) and as basis for adoptive research. It is therefore necessary to conduct such surveys in order to learn more about the environment and structure of traditional farming system before conducting adoptive research, because too often, adoptive research is conducted to solve assumed problems before the problems are known (Schmehl, 1983). This study is a report on exploratory survey conducted to obtain information on soybean production in Mubi area in Northeastern Nigeria.

The main objectives of the survey were to assess soybean yield responses to soil fertility status, plant population and previous history on soil management system and to study variability in soybean yield under farmer's conditions and its production economic implication.

MATERIALS AND METHODS

Mubi lies 10°11 N: 13°19 E. Rainfall is the critical climatic factor in this area and the pattern is unimodal (Fig. 1). Rainfall is high in July and August. The area is in the northern guinea savanna of Nigeria. Staple crops grown are maize, sorghum, rice, groundnut and cowpea.

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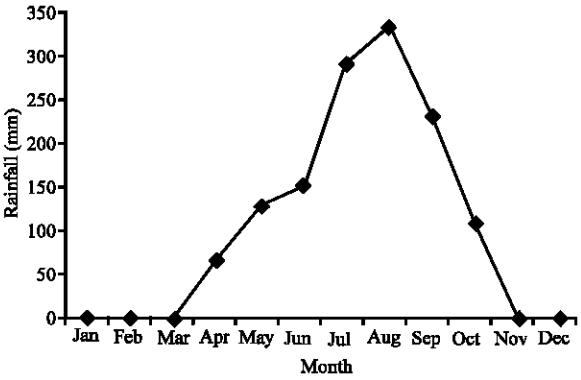

Fig. 1: Monthly rainfall in Mubi, 2004

Adamawa State University, Mubi introduced a new variety of soybean (TGX 536-02D) to farmers in 2004. The seed yield was bought by the same institution at harvest. Therefore, in boosting the production of the new variety by adopting it into its traditional farming system, seeds were sold at subsidized rate. To evaluate therefore the adoptability of this variety and it's performance as influenced by the soil nutrient status, a team consisting of a soil scientist, crop physiologist and Agricultural extensionist conducted a survey in 2004 among 54 farmers in the area who grew the improved variety of soybean.

The survey used farmer monitoring approach method described by Mutsaers *et al.* (1997). The monitored field was measured; soil samples were collected followed by routine soil analysis and an inventory made of plant densities. Data were also collected such as lodging; intercropping and planting date and preceding crop. Yield in intercrop was determined using the Land Equivalent Ratio (LER) described by Mead and Willey (1980) as follows:

$$LER = \frac{Y_{1.2}}{Y_{1.1}} + \frac{Y_{2.1}}{Y_{2.2}}$$

where Y is the crop yield in g m^{-2} and subscripts 1 and 2 denote crop 1 and 2. $Y_{1,1}$ and $Y_{2,2}$ are the mean pure stand yield for crop 1 and crop 2, respectively. Each farmer was interviewed using a questionnaire about the cropping history of the field, adoption time, agronomic practices and labour utilization. Farmers were interviewed both in their homes and on the farm. The yield data were obtained by weighing the dried grains and sold back to the university at N63.00 Nigerian naira ($US 0.43) kg^{-1}.

RESULTS AND DISCUSSION

Results of the survey showed that soybean production is carried out mainly by men (83% of the total number of growers). The age of the female farmers ranged from 29-52 years old, whereas the age of male farmers growing soybean ranged from 25-58 years old. The average size of plot cultivated by men was greater than that cultivated by women. However, the women produced higher soybean yields (average 1047 kg ha^{-1}) than the men (average 990 kg ha^{-1}) though there were no significant differences.

Table 1: Effect of farmers experience on soybean production in Mubi, 2004

Time of adoption	Percentage of farms	Yield (kg ha^{-1})
Early adopters in/before 2001	19	1340[a]
Mid adopters 2002-2003	46	1042[b]
Late adopters 2004	35	764[c]

a, b, c: Values in the same column followed by the same letter do not differ significantly at p = 0.05

Table 2: Some physical and chemical characteristics of the top soil on 54 farmers' field in Mubi, 2004

Characteristics	Mean	Standard deviation	Minimum	Maximum
Sand (%)	63.00	11.50	46.80	82.60
Silt (%)	14.00	7.20	2.50	27.40
Organic matter (%)	1.02	0.70	0.14	2.92
Total N (%)	0.16	0.06	0.10	0.36
Available P ppm (Bray 1)	9.90	5.94	1.24	20.92
Exchangeable cations (cmol kg^{-1})				
Ca	11.06	3.80	5.50	23.35
Mg	5.85	4.10	0.31	13.97
K	3.20	1.80	0.66	8.07
Na	0.96	0.10	0.77	1.13
CEC	5.46	1.70	2.96	9.85

Farmer experience: The length of farmers experience with soybean production significantly affected yield as indicated in Table 1. The farmers were grouped into three categories; early adopters (those who started growing soybean in/before 2001); mid adopters (those who started in 2002 and 2003) and late adopters (those who started in 2004). Nineteen percent of the farmers had started growing soybean before 2001 and their yield was significantly higher than those who started growing soybean only in 2002-2003 and 2004. Their corresponding average yields were 1340, 1042 and 764 kg ha^{-1}, respectively which agrees with the findings of Ajibefun (2003). Even though the fertility status of the soil is of concern, Scharpenseel (1977) stated that to achieve transformation of an agrobiotop, the professional caliber of the farmer matters more than the value and natural fertility of the soil. However, from this survey, it shows that the fertility status of the soil is as important as the professional caliber of the farmer. Adoption of the crop has been very limited; hence, low yields have been recorded despite some notable success in specific areas like diversification and utilization (Smith *et al.*, 1995).

Soil nutrients status: Soil analyses were carried out for the major nutrients on all the farmers' field and are categorized according to the range of nutrients (Table 2).

Table 3: Soil nitrogen, phosphorus and potassium status and soybean yield in Mubi, 2004

Nutrient	Nutrient range	Percentage of farms	Yield (kg ha^{-1})
Total N (%)	0.1-0.150	50	1034^{a}
	0.15-0.20	33	995^{a}
	0.21-0.25	11	920^{a}
	0.26->0.26	6	771^{a}
Available P ppm (Bray 1)	1.1-5.0	39	680^{d}
	6.0-10.0	15	906^{c}
	10.1-15.0	28	1247^{b}
	16.0->16.0	19	1370^{a}
Exchangeable K (cmol kg^{-1})	0.5-1.15	24	1155^{a}
	1.16-2.50	20	1099^{ab}
	2.51-3.50	24	1052^{b}
	3.51-4.50	17	912^{c}
	4.51->4.51	15	782^{d}

a, b, c and d: values in the same column followed by the same letter do not differ significantly at p = 0.05

Table 4: Effect of plant population on farmers' soybean yield in Mubi, 2004

Range (plants ha^{-1})	Percentage of farms	Yield (kg ha^{-1})
150,000 and below	48	796^{c}
150,001-250,000	32	1263^{a}
250,001-350,000	13	1142^{b}
350,000 and above	7	870^{c}

a, b, c; values in the same column followed by the same letter do not differ significantly at p = 0.05

The most important factor affecting soybean yield is the level of phosphorus available in the soil. The soil on the surveyed field tend to be low in P status (Table 3), with 39% of them in the range of 1.0-5.0 ppm of available P. The highest yield of 1370 kg ha^{-1} was obtained from farms with available P greater than 16.0 ppm. From the yields obtained, it also showed positive responses to higher soil available P status contrary to the yields recorded in most fields by Cox *et al.* (2003).

In terms of N content, 50% of the farms fell into the range of 0.1-0.15% N, while 6% of the farms were those with more than 0.26% N. Soybean yield from the groups did not show significant difference. The lack of significant response to N by soybean is in agreement with the work reported by Freeborn *et al.* (2001) and Haq and Mallarino (2000). The highest yield (1034 kg ha^{-1}) was obtained from the group in the range of 0.1-0.15% N and the lowest yield (771 kg ha^{-1}) was obtained from the group with more than 0.26% (Table 3). This agrees with the findings of Futuless *et al.* (2005) that higher levels of N decreases soybean yields even in intercrop.

In terms of K contents, yields were significantly higher from those farms which were in the range between 0.5-1.15 cmol K kg^{-1} soil than those in the higher ranges. It also showed that higher contents of K gave lower yields of soybean (Table 3). These differences in yields despite low K fertility values suggest that some factors other than K were influencing soybean yield in these fields.

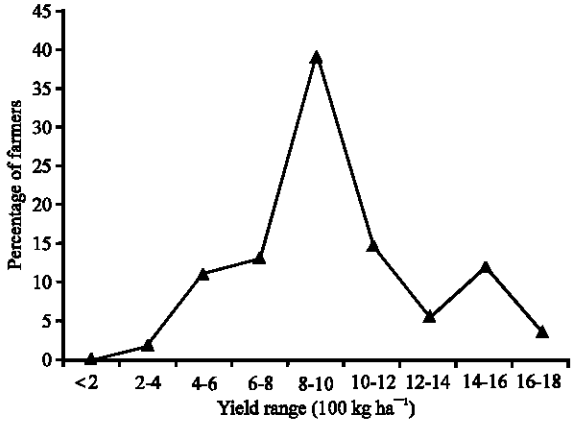

Fig. 2: Soybean yield of surveyed farmers in Mubi, 2004

Plant population: To determine the plant population, the plants were counted at harvest time and the yield grouped according to the range of plant population (Table 4). Plant population with range between 150,000 -250,000 plants ha^{-1} gave the highest yield (1263 kg ha^{-1}) slightly higher than the one reported by Ennin and Cleg (2001). The lowest yield was obtained where the range of plant population is less than 150,000 plants ha^{-1} (796 kg ha^{-1}).

Effects of intercropping: Results showed that 81% of the farmers planted soybean as a sole crop and 19% as an intercrop, mainly with maize. The sole crop soybean yield (1072 kg ha^{-1}) was significantly higher than the intercropped soybean yield (648 kg ha^{-1}). It was found that 78% of the farmers growing soybean as an intercrop were those that adopted its production in 2004 who were not ready to take the risk of growing it as a sole crop. Two reasons were advanced for this action; first, is to guide against crop failure and secondly market price as at the time of sale. Although, the total yield of the mixture is often greater than that of the crops comprising the mixture when grown as sole crop, the yield of an individual crop in a mixture is usually lower than the yield under sole cropping (Nangju, 1975; Futuless *et al.*, 2005).

Soybean yield and economic returns: An enormous variability in farmers soybean yield was recorded, from less than 400 kg ha^{-1} to over 1800 kg ha^{-1}. In Fig. 2, it has shown that most of the farmers obtained yields under 1000 kg ha^{-1}, about 59% and 91% of world and African average, respectively, whereas at the other end of the scale less than 5% of the farmers obtained yields of 1600-1800 kg ha^{-1}.

Variable costs are usually affected by innovations; therefore, in this study gross margins are calculated not based on fixed costs. The gross margin is thus the

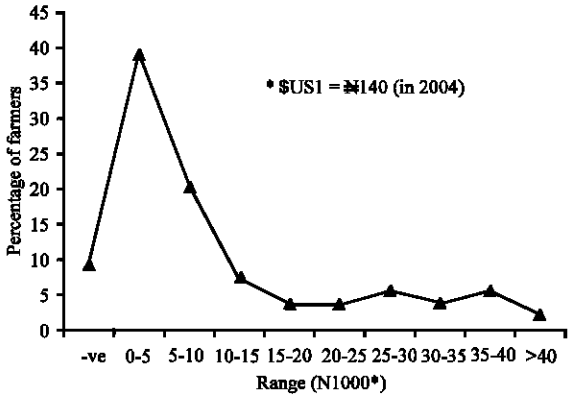

Fig. 3: Gross margin on soybean yield of surveyed farmers in Mubi, Nigeria, 2004

difference between gross return and variable costs (Gross margin = gross return-variable costs). The product of the physical yield and product price is used as the output or gross return. Variable costs are the value of the inputs such as fertilizer, seeds and labour hired for the farm operations.

The variability in the fertility status of the soil associated with farmers' experience gave rise to greater number of farmers (38.9%) with gross margin below N5,000 (Fig. 3). However, only 1.9% of the farmers were able to obtain a gross margin of N40,000 ha^{-1} and above.

CONCLUSIONS

The farmers' fields chosen for this study possessed different soil management history, soil characteristics and yields. Though some studies by Cox *et al.* (2003) reported lower yields at medium to high P in most fields, higher yields were recorded at higher p-values while farms with low values of K had higher yields. This indicates that K may not be a limiting factor at these values. These relationships suggest that factors other than fertility were yield affecting as indicated by farmers experience, cropping systems and plant populations. Economic wise, gross margins greater than Naira 40,000 ha^{-1} ($US285.71) is feasible. Therefore, this study provides a basis for further fertilizer investigation needs of soybean as it is a promising crop for Mubi.

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