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CONTRIBUTION OF LEGUMINOUS CROPS TO NUTRIENT AVAILABILITY AND PRODUCTIVITY OF YAM BASED SYSTEMS.

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ABSTRACT

A trial was conducted at Umudike, Nigeria in 2000/2001 and 2001/2002 to determine the contribution of leguminous cover crops *Voandzea subterranea* (bambara nut), *Arachis hypogea* (groundnut) and *Cajanus cajan* (pigeon pea) to the conservation of soil resource base and productivity of yam minisett based systems. The systems studied were sole yam minisett, yam minisett/bambara nut, yam minisett/groundnut, and yam minisett/pigeon pea. Intercropping yam minisett with either ground nut or bambara nut decreased seed yam yield relative to sole yam minisett. Highest seed yam yields of 4.70 t/ha and 4.67 t/ha were obtained with yam minisett/pigeon pea and sole yam minisett respectively and these were significantly higher ($P < 0.05$) than 3.41 t/ha and 3.84 t/ha obtained with yam minisett/bambara nut and yam minisett/groundnut respectively. Highest benefit cost ratio of 5.76 was obtained with yam minisett/pigeon pea followed by yam minisett/bambara nut with 2.55, sole yam minisett with 2.11 and lastly by yam minisett/groundnut with 1.78. Intercropping yam minisett with the legumes improved soil organic matter content of the soil resource base and also ensured that large quantities of biomass was left on the soil after crop harvest in form of legume haulms. Largest amount of legume haulm of 4.57 t/ha was obtained with yam minisett/pigeon pea followed by yam minisett/groundnut with 3.94t/ha and yam minisett/bambara nut with 0.54 t/ha. Quantities of nutrients (N,P,K,Ca,Mg) in legume haulms which could be released to a subsequent crop if these haulms are incorporated into the soil were determined. For nitrogen the value was 89.52 kg N/ha in yam minisett/pigeon pea system and 8.66kg N/ha in yam minisett/groundnut system.

INTRODUCTION

National Root Crops Research Institute Umudike. Nigeria developed a new seed yam production method called the minisett technique where in small sized cut tuber pieces (varying from 25g – 50g) are used as planting material as opposed to the traditional farming system where seed tubers or cut sett of 100 – 150g are planted. The minisetts are obtained by cutting healthy mother seed yams into small (25g – 50g) pieces (Igwilo and Okoli, 1988).

Production of seed yams using the minisett requires only 6.33% of the number of mother tubers needed for the traditional farming systems on per hectare basis (Kalu, 1989).

Despite the novel nature of yam minisett technology and its economic viability, adoption rate has been low (Ogbodu, 1995. The major set back against the technology appears to be emphasis on monocropping. Farmers in the yam-growing zones of Nigeria practise intercropping. The various advantages derivable from growing crops in mixtures have been reported by many workers, (Wahua and Miller, 1976; Ikeorgu *et al*, 1989) Appropriate intercrops for yam minisett should not only be able to increase the productivity of the system but should also conserve the soil fertility. Yam production in monocropping system leads to soil nutrient mining as a greater proportion of the dry matter is harvested and taken out of the farm. Obigbesan

and Agboola (1978) reported that about 155 kg N, 18.2 kg P, 176 kg K, 3.9 kg Ca and 10.7 kg Mg per hectare are lost from the soil when tuber yield of 38.5t/ha of *yam (D. rotundata*) are harvested and taken out of the farm. Sustainable yam production will require appropriate production system, which will ensure that large quantities of crop residues are left on the soil after crop harvest. The biomass when incorporated into the soil during land preparation will replenish the nutrients removed through the harvested yam crop. Through the maintenance of large biomass on the soil, the productivity of the soil will therefore be sustained. The objective of the trial was to evaluate the contribution of some food legumes to nutrient availability and productivity of yam-based systems.

MATERIALS AND METHODS

The trial was conducted at the research farm of National Root Crops Research, Institute Umudike (05° 29'N. 07°33'E) during the 2000/2001 and 2001/2002 cropping seasons. Umudike had an annual rainfall of 1680.6 mm and 2190.0 mm respectively in 2000 and 2001. The soil (Typic Paleudult) had pH of 5.2 (1 soil: 2.5 water), 1.47% organic matter. 0.10% total nitrogen, 4.5 ppm. Bray – IP and exchangeable K, Ca and Mg of 0.06, 4.60 and 0.80 cmol/kg respectively.

Forty five gram yam sett (*Dioscorea rotundata* cv. *Obiaoturugo*) were planted on tractor made ridges at 0.5 m x 1.0 m to give a population of 20,000/ha. The treatments comprised:

bambara nut (*Voandzea subterranea*) planted at 80,000/ha

ground nut (*Archis hypogea*) planted at 80,000/ha

pigeon pea (*Cajanus cajan*) planted at 2,500/ha

Control (no legume)

The systems studied were therefore as follows.

Yam minisett/bambara nut

Yam minisettr/groundnut

Yam minisett/pigeon pea

Sole yam minisett

The plot size was 6m x 4m. Yam was planted on ridge crest while the legumes were planted both sides of the ridges. All the crops were planted at the same day in June. The treatments were arranged in a randomised complete block design in four replications. Weeding was done at appropriate times. Harvesting of ground nut and bambara nut were done in October. Yam and pigeon pea were harvested in January and February respectively. The harvested legumes were processed for grain, dried to 14% moisture content and thereafter

weighed. Fresh yam tubers were weighed at harvest. Haulms of the legumes were also weighed at harvest. Nitrogen, P, K, Ca and Mg, content of the legume haulms were determined using standard methods. Soil sample (0 – 20cm) were collected at the end of the trial and analysed for organic carbon according to the method of Walkley and Black (1939). Cost of input/operations were recorded. Market prices of the seed yams and legumes were also recorded. Analysis of variance for RCB design was used to assess treatment effects (Gomez and Gomez. 1976).

RESULTS AND DISCUSSION

Component Crop Yield

The effect of cropping system on the yield of component crops is shown in Table 1. Highest seed yam yields of 4.7 t/ha and 4.67 t/ha were obtained with yam minisett/pigeon pea and sole yam minisett respectively which were significantly higher ($P<0.05$) than 3.84 t/ha and 3.41 t/ha obtained with yam minisett groundnut and yam minisett bambara nut respectively. It appears that the yam minisett is not capable of competing with either groundnut or bambara nut for growth resources. On the other hand yam minisett was found to be compatible with pigeon pea. In this study only pigeon pea did not depress seed yam yield. The yields of the various legumes in the systems were 3.80 t/ha. 0.99 t/ha and 0.17 t/ha for piegon pea, bambara nut and groundnut respectively.

Table 1: Component Crop Yields in the various cropping systems (mean of 2000/2001 and 2001/2002 cropping seasons).

Cropping Systems	Yield of component crops (t/ha)			
	Yam	Groundnut	Bambaranut	Piegeon pea
Yam minisett/Bambaranut	3.41		0.99	
Yam minisett/Groundnut	3.84	0.17		
Yam minisett/Pigeon pea	4.70			3.80
Sole yam minisett	4.67			
LSD 0.59				

Economic Analysis

The economic analysis of the various cropping systems studied is shown in Tables 2 and 3. Highest benefit cost ratio of 5.76 was obtained with yam minisett/pigeon pea, followed by yam minisett/bambara nut with 2.55, sole yamminisett with 2.11 and yam minisett/ground nut with 1.78. Even though intercropping yam minisett with bambara nut led to lower seed yam yield, the higher benefit cost ratio obtained with this system (when compared with sole yam minisett) could be attributed to the enhanced revenue from bambara nut. Bambara nut costs 2.5 times more than seed yam by weight (Table 2).

Table 2: Realisable revenue from the component crops (mean of two cropping seasons2000/2001 and 2001/2002)

Cropping Systems	Yield of component crops (t/ha)		
	Yam	Legume	Revenue (N/year/ha)
Yam minisett/Bambarabnut	3.41	0.99	127.600
Yam minisett/Groundnut	3.84	0.17	89,550
Yam minisett/Pigeon pea	4.70	3.80	284,000
Sole yam minisett	4.67	93.400	

* 1 t seed yam = N20.000
1 t Bambara nut= 60,000
1 t Ground nut = 75,000
1 t Pigeon pea = 50,000

Table 3: Cost analysis of the different cropping system (mean of 2000/2001 and 2001/2002 cropping seasons)

Operation/Input N/ha	Cropping System			
	Yam +B.nut	Yam+Groundnut	Yam+ Pigeon pea	Sole Yam
Land preparation	2,000	2,000	2,000	2,000
Seed yams	30,000	30,000	30,000	30,000
Legumes	1,250	1,500	1,125	
Labour for yam planting	1,000	1,000	1,000	1,000
Labour for legume planting	2,000	2,000	1,000	
Stakes and staking	5,000	5,000	5,000	5,000
Weeding	2,500	2,500	3,000	3,500
Labour for harvesting/legume	2,000	2,000	1,700	
Labour for harvesting yam	1,000	1,000	1,000	1,000
Legume processing	1,500	1,500	1,500	
Transportation	1,800	1,800	2,000	1,600
Total variable cost	50,000	50,300	49,325	44,100
Total revenue	127,600	89,550	284.00	93,400
Benefit Cost ratio	2.55	1.78	5.76	2.12

Soil Organic matter

The effect of the cropping systems studied on soil organic matter is shown in Table 4. Intercropping yam minisett with legume improved soil organic matter except with bambara nut. The highest effect was observed with pigeon pea with a value of 3.55%. This was about 20% higher than the value obtained in sole yam plots. Enrichment of soil organic matter by pigeon pea and groundnut is attributable to mineralization of senscing groundnut and fallen older leaves of pigeon pea. Bambara nut senesced later than groundnut and at the end of the trial not much of the bambara nut biomass had decomposed. The importance of maintaining high level of organic matter in the soil can not be over emphasised. Soil organic matter improves soil structure, cation exchange capacity, nitrogen, K, and P of the soil (Lal. 1995).

Table 4: Effects of cropping system on soil organic matter (Mean of 2000/2001 and 2001/2002 cropping seasons).

Cropping Systems	Soil organic matter(%)
Yam minisett/Bambaranut	2.96
Yam minisett/Groundnut	3.05
Yam minisett/Pigeon pea	3.55
Sole yam minisett	2.90
LSD 0.05	0.08

Legume residues (legume haulms)

The amount of legume haulm left after crop harvest ranged from 4.57 t/ha to 0.54 t/ha (Table 5). Pigeon pea gave the highest legume haulm followed by groundnut and bambara nut respectively. Intercropping yam minisett with the legumes used in this study will ensure that a lot of crop residue is left on the farm, which could be incorporated, into the soil during the next planting season.

Table 5: Weight of legume haulm at legume harvest (mean of 2000/2001 and 2001/2002 cropping seasons)

Cropping Systems	Weight of haulm (t/ha)
Yam minisett/Bambaranut	0.54
Yam minisett/Groundnut	3.94
Yam minisett/Pigeon pea	4.57
LSD 0.05	1.22

Lal, (1995) emphasised that crop residues returned to the soil would increase nutrient cycling decrease both nutrient losses and the need for addition of chemical fertilizer. This will however depend on the quality of these haulms. The amount of plant nutrients that could be released into the soil by these haulms is shown in Table 6. Haulm obtained from intercropping yam minisett with pigeon pea is capable of returning about 89.52 kg/ha nitrogen to the soil while groundnut and bambara nut could return 63.47 kg/ha and 8.66 kg/ha of nitrogen respectively to the soil. Levels of other nutrients such as P, K, Ca and Mg will also be enhanced in the soil by these legume haulms (Table 6).

Table 6: Nutrients contained in the legume haulms (mean of 2000/2001 and 2001/2002 cropping seasons)

Cropping Systems	*Nutrient contained in legume haulms (kg/ha)*				
	N	P	K	Ca	Mg
Yam minisett/Bambaranut	8.66	1.77	4.57	8.06	4.83
Yam minisett/Groundnut	63.47	11.94	76.09	39.43	16.56
Yam minisett/Pigeon pea	89.52	15.07	38.83	91.81	38.83
LSD 0.05	3.49	3.99	10.95	24.38	10.47

CONCLUSION

Intercropping yam minisett with pigeon pea, groundnut or bambara nut will ensure that large quantities of crop residue are left on the soil after crop harvest. The biomass of these legumes contains a lot of plant nutrients, which would be released into the soil. Intercropping yam minisett with either pigeon pea or Bambara nut results to higher benefit cost ratio relative to sole yam minisett system.

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