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PROFITABILITY OF PRE-SEASON GREEN MANURE PRACTICES USING MAIZE AS A TEST CROP IN A DERIVED SAVANNA OF NIGERIA

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Economic profitability of cowpea green manure was evaluated during the 2009-10 pre-cropping season using maize as a test crop. The trial involved two varieties of cowpea sown at different dates and a control (with just the native fertility) arranged in a randomized complete block design and replicated thrice. The economic profitability was evaluated using the returns on the test crop which was planted one week after incorporation of the green manure. Grain yield of the maize was significantly ($p<0.05$) enhanced by green manuring resulting in 78% returns on investment. Although manuring with both cowpea varieties gave more benefit per dollar invested across the three planting dates when compared with the control. Variety Drum was superior in terms of economic returns and was recommended to grow as early as 10-20th of March.
Keywords: Cowpea, green manure, maize, profitability, soil fertility

INTRODUCTION

In Nigeria, declining soil fertility is one of the constraints to arable crop production. Low soil nutrient is not peculiar to Nigeria as most soils in the tropical region have been reported to be highly weathered and infertile; and achieving food security for a rapidly expanding population in the tropics means intensifying food production on existing crop land through enhanced nutrient input and recycling (Hossner and Juo, 1999). Efforts directed towards ameliorating soil fertility problems include amongst others the use of fallow land. However, with increase in human population pressure on land area is increased for intensive cultivation. The fallow periods are reduced and traditional fallow management is often not sufficient to restore soil fertility, leading over time to soil and vegetation degradation and low yields (Styger and Fernandes, 2012). Inorganic fertilizer has also been used but it is often scarce and expensive (Okwu and Ukanwa, 2007).

Green manures have been used to increase the soil fertility, as it adds nutrients and organic matter to the soil. This is achieved by allowing the crop used as green manure to grow for a period of time, and then tilled into the soil (Sullivan, 2003). Green manuring has several beneficial effects in crop production. Research has shown almost universal beneficial effects of green manuring on rice yields and that green manure can substitute for up to 60-100 kg nitrogen per hectare and many studies have shown that it can enhance the availability of native or applied P and of micronutrients (Abrol and Palaniappan, 1988). Although green manuring is not too recent a soil improvement practice, it is seldom practiced by peasant farmers, who contribute up to 98% of the food consumed in Nigeria (Ozowa, 1995). Generally, the decline of food production in upland farming systems in the tropics has often been attributed to the lack of adoption of modern farming technologies and farmers have been unable to replenish nutrients lost in continuous cultivation which has replaced traditional bush fallow systems (Hossner and Juo, 1999). Growing green manure results in direct costs of seed, and increase field work necessary for preparing the seedbed, incorporating the residues and possibly for mowing. If the green manure replaces a cash crop, rather than being grown whilst the land would otherwise be fallow, then there is also a direct loss of income (Peters *et al.,* 2008*)*. Farmers are unable to appreciate the benefits of green manuring, since the benefits sometimes are not as spectacular as those observed from direct application of inorganic fertilizers (Abrol and Palaniappan, 1988). One of the main goals in farming is increased income and application of fertilizer is one of the methods employed by farmers, to increase maize grain yield and economic returns in Nigeria. Sustained growth in agricultural productivity without environmental exploitation and degradation can not be achieved unless efforts to enhance fertilizer use and organic fertilization are taken seriously (Ayoola, 2010). Research conducted in UK during 2003-2009 has showed that fertilizer prices have risen by 51%; however, in contrast, the cost of growing green manures had risen by just 7% in the same period (Philip, 2010). In order to promote the acceptability of the age old green manure technology in arable crop production in Nigeria, it is therefore imperative to go beyond the agronomic justification and further

evaluate the economic implications of the practice. Apart from some constraints of use of green manure mentioned above, is also the challenge of identifying a niche for growing the green manure without encroaching into the normal growing season which often begins when the rains have stabilized around mid May in the derived savannah ecological zone of Nigeria. Over the years, it had been observed that some amount of rain is received during January and April in this ecological zone of Nigeria. Rains during this period are too erratic, with wide intervals between successive rains to support any crop. This period is, therefore, often used for land clearing in preparation for the cropping season, rather than for growing of arable crops. Cowpea (*Vigna unguiculata* L.) is a widely grown leguminous crop in Nigeria. Cowpea has a high potential as green manure. It is adapted to a wide range of soils from sandy to heavy, moderately tolerant of drought and reported to have the potential of contributing as high as 80 kg/ha of nitrogen to a subsequent crop when used as green manure (Whitbread and Lawrence, 2006). The aim of this study was to evaluate the economic profitability of pre-season cowpea green manure in a derived savannah ecological zone of Nigeria using maize as a test crop, with the objective to determine the profitability cowpea green manuring with respect to the appropriate time of planting before the cropping seasons begins.

MATERIALS AND METHODS

The experiment was carried out in the teaching research farm of the University of Agriculture, Abeokuta, Ogun Sate, Nigeria (Latitude $7^0$09□N and longitude $3^0$21□E) during March to September 2009 and March to August 2010.

Local cowpea varieties in the zone (Oloyin and Drum) were grown on three different dates (20^{th} and 27^{th} of March and 3^{rd} of April 2009; 10^{th}, 17^{th} and 24^{th} March, 2010) in a 2 x 3 factorial combinations arranged in a randomized complete block design and replicated three times. Variety Oloyin grows erect, while drum creeps, the two cowpea varieties were spaced at 25cm x 50 cm (80,000 plants/ha). Seven weeks after the first planting date, the cowpea was uprooted and manually incorporated in situ in all treatments.

One week after incorporation of the cowpea green manure, open pollinated maize Suwan-1-Y was planted in each of the six green manure plots per block and a control (no green manure) plot as the 7^{th} treatment.

Data of maize grain yield were collected from all treatments. Current market prices in dollar ($) were used to estimate the cost of the seeds of the cowpea used as green manure, the cost of maize seeds as well as the selling price of maize grains. Similarly, the current wages per man/day was used to estimate the labor required for various operations. Costs of planting and application of green manure also varied based on whether green manure was absent (as in control plots) or incorporated manually. The net benefit and benefit cost ratio were then calculated to determine the profitability of each practice.

- The break even yield was calculated as Total variable cost ($) divided by price per kg of maize ($).
- Total variable cost (TVC) = Sum of cost of all inputs used in production {land preparation, cowpea seed, planting and incorporation of cowpea (where applicable), procurement of, and planting of maize seeds, weeding and harvesting of maize}.
- Gross returns (GR) = Total output (maize grain yield kg ha^{-1}) multiply by price per unit output (price per kg).
- Net benefits (NB) = Gross returns minus Total variable cost (GR – TVC)
- Benefit costs ratio = NB: TVC

RESULTS AND DISCUSSIONS

Additional cost/ha of $195.87 with variety drum, and $208.87 with variety Oloyin relative to the control plot was incurred in maize production using cowpea green manure in this study. This finding is logical and consistent with previous findings. Growing green manure results in direct costs of seed, and increase field work necessary for preparing the seedbed, incorporating the residues and possibly for mowing (Peters *et al.,* 2008*)*.

There is additional cost incurred in the purchase of seed, inoculation, planting and terminating of green manure crop (Green Manuring with legumes-FAQ, 2012).

The net benefits per hectare were positive in all green manure plots in both 2009 and 2010 (Tables 1 and 2). The net benefit per hectare of maize ranged from $13.33 (Oloyin March 17) – $170.84 (Drum March 10) in 2009 (Table 1); and $89.55 (Drum April 3) – $527.62 (Drum March 20) in 2010 (Table 2). The control plots on the other had minus $105.16 and $55.10 in 2009 and 2010, respectively. The results of this study, therefore, indicated that the minimum yield that must be harvested per hectare for the farmer to break even without soil improvement is 1,071.82 kg ha^{-1}. Generally, the 1,190 Kg ha^{-1} yield of maize in 2010 is very close to the 1,300 Kg ha^{-1} average yield of maize in developed counties (IITA, 2009). This suggests that farmers operating without making effort to improve their fields would either be running at a loss as in 2009, or at a profit of less than $60 per hectare, as in 2010. The average Nigerian small scale farmer is poor and non-literate (Umunna, 2010). Most of these resource poor farmers operate with house hold/family labor and scarcely keep adequate record of cost and returns because of their low level of literacy; thus would continue to produce as long as they have what they consider as average yields.

The benefit cost ratio was the highest, 0.25:1 (Drum March 10) and the least, 0.02:1 (Oloyin March 17) in 2009. On the

Table 1. Profitability of cowpea green manure planted on different dates in 2009

	Planting dates of cowpea green manure in 2009						
	D Ma 10	**D Ma 17**	**D Ma 24**	**Ol Ma 10**	**Ol Ma 17**	**Ol Ma 24**	**Control**
Maize grain yield (kg/ha)	1,880	1,630	1,770	1,630	1,560	1,680	813
Gross returns at $0.45/kg of grain	849.03	736.13	799.35	736.13	704.52	758.71	367.16
Variable cost							
Land preparation 20 MD/ha	116.13	116.13	116.13	116.13	116.13	116.13	116.13
Cowpea seed 20 kg at $0.65 or $1.03 /kg	21.68	21.68	21.68	34.68	34.68	34.68	-
Planting of cowpea 10 MD	58.06	58.06	58.06	58.06	58.06	58.06	-
Incorporation of green manure 20 MD	116.13	116.13	116.13	116.13	116.13	116.13	-
Maize seed 23 kg at $0.77/kg	17.81	17.81	17.81	17.81	17.81	17.81	17.81
Planting of maize 10 MD	58.06	58.06	58.06	58.06	58.06	58.06	58.06
Weeding 1st and 2nd 40 MD	232.26	232.26	232.26	232.26	232.26	232.26	232.26
Harvesting of maize 10 MD	58.06	58.06	58.06	58.06	58.06	58.06	58.06
Total variable cost	678.19	678.19	678.19	691.19	691.19	691.19	482.32
Net benefit	170.84	57.94	121.16	44.94	13.33	67.52	-115.16
Benefit/Cost	0.25:1	0.09:1	0.18:1	0.07:1	0.02:1	0.10:1	-0.24:1

1MD = one man day ($5.81); D- Variety Drum; Ol- Variety Oloyin; Ma– March; Apr– April $1

Table 2. Profitability of cowpea green manure planted on different dates in 2010

	Planting dates of cowpea green manure in 2010						
	D Ma20	**D Ma 27**	**D Apr3**	**Ol Ma 20**	**Ol Ma 27**	**Ol Apr 3**	**Control**
Maize grain yield(kg/ha)	2,670	1,870	1,700	2,290	2,480	2,180	1,190
Gross returns at $0.45/kg of grain	1205.81	844.52	767.74	1034.19	1120	984.52	537.42
Variable cost							
Land preparation 20 MD/ha	116.13	116.13	116.13	116.13	116.13	116.13	116.13
Cowpea seed 20 kg at $0.65 or $1.03/kg	21.68	21.68	21.68	34.68	34.68	34.68	-
Planting of cowpea 10 MD	58.06	58.06	58.06	58.06	58.06	58.06	-
Incorporation of green manure 20 MD	116.13	116.13	116.13	116.13	116.13	116.13	-
Maize seed 23 kg at $0.77/kg	17.81	17.81	17.81	17.81	17.81	17.81	17.81
Planting of maize 10 MD	58.06	58.06	58.06	58.06	58.06	58.06	58.06
Weeding 1st and 2nd 40 MD	232.26	232.26	232.26	232.26	232.26	232.26	232.26
Harvesting of maize 10 MD	58.06	58.06	58.06	58.06	58.06	58.06	58.06
Total variable cost	678.19	678.19	678.19	691.19	691.19	691.19	482.32
Net benefit	527.62	166.33	89.55	343.00	428.81	293.33	55.10
Benefit/Cost	0.78:1	0.25:1	0.13:1	0.50:1	0.62:1	0.42:1	0.11:1

1MD = one man day = $5.81; D-Variety Drum; Ol- Variety Oloyin; Ma –March; Apr– April $1

other hand, in 2010 the highest benefit cost ratio (0.78:1) was from green manure plots of Drum planted on March 20 and the least: 0.13:1 was from Drum planted on April 3. Benefit cost ratio from the control plots were -0.24:1 in 2009 and 0.11:1 in 2010 (Tables 1 and 2). The result of this study is similar to earlier report of the effect of green manure on a cereal - rice. Research has shown almost universal beneficial effects of green manuring on rice yields and green manure is reported to be able to substitute for up to 60-100 kg nitrogen per hectare (Abrol and Palaniappan, 1988); incorporation of cowpea green manure has also led to a 30% higher grain yield of maize compared to plots that received 80 Kg/ha inorganic nitrogen (Ozowa, 1995).

The results of this study revealed that growing of cowpea green manure much early enhanced the yield of the subsequent crop, as growing of cowpea variety Drum on the first planting date gave the highest economic returns from the test crop in both years. This could be attributed partly to the fact that procuring seeds of Drum is cheaper that than of Oloyin.

***Conclusions*:** Green manure can be grown without encroaching into the main cropping season. Maize grain yield was enhanced significantly by using cowpea green manure. Additional cost/ha of $195.87 with variety drum, and $208.87 with variety Oloyin was incurred in maize production using cowpea green manure in this experiment. Without the use of green manure grain yields of maize would scarcely be up to the break even value of 1,071.82 kg ha^{-1} obtained in this study. Extra effort and cost incurred in pre season growing of green manure will be profitable on the

long run. Growing cowpea green manure resulted in as much as 78% returns on investment. Cowpea variety Drum showed superiority in terms of the yield and economic returns of the succeeding maize when established either very early before the rains stabilizes or a little further into the rains. It can be concluded that growing and incorporating cowpea variety drum at 80,000 plants ha^{-1} as early as 10^{th} – 20^{th} of March, is feasible and profitable if a pre-season soil improvement activity is desired for sustainable arable crop production in south western Nigeria and related ecological zone.

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