

Growth and early yield of cashew intercropped with food crops in northern Ghana

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Abstract

A field trial aimed at investigating the agronomic performance and profitability of intercropping cashew (*Anacardium occidentale* L.) with food crops during the establishment phase was carried out at Bole in the Guinea savannah agro-ecological zone. The treatments included sole cashew, cashew + groundnut (*Arachis hypogaea* L.), cashew + maize (*Zea mays* L.), cashew + sorghum (*Sorghum bicolor* (L.) Moench), cashew + yam (*Dioscorea alata* L.), cashew + sorghum in rotation with groundnut, and cashew + groundnut in rotation with maize and were arranged in a randomised complete block design with three replicates. Growth and early yield of cashew and net returns from the food crops were assessed. Intercropping significantly improved the girth of cashew seedlings in the cashew+ maize combination. Height of cashew seedlings was significantly higher in the cashew + maize and cashew + sorghum/groundnut system. Intercropping did not substantially alter early yield of cashew nuts. Economic analysis of the packages, however, indicates that maize and yam intercropping during the establishment phase was profitable. It is therefore advisable to intercrop cashew with yams and maize in northern Ghana during the early period of establishment to generate additional returns to the growers.

Keywords: Intercropping, Cashew nut yield, Economic analysis.

Introduction

Intercropping tree crops during the establishment phase with food crops is an age-long practice in the tropics. The benefits of such a practice may include food security for the household, income generation to partially offset the cost of establishment, weed control, and better use of growth resources (Rodrigo et al., 2001; Opoku-Ameyaw et al., 2003). However, the success of cashew (*Anacardium occidentale* L.) + food crop intercropping system will depend on whether the food crops compete with the young cashew seedlings for growth resources. Ohler (1979) recommended the use of early bearing low growing food intercrops and suggested that tall intercrops like certain varieties of sorghum (*Sorghum bicolor* (L.) Moench), and millet should not be grown with cashew as they cast too much shade and affect the growth of the latter. However, in Nigeria crops that vary in height like maize, cassava (*Manihot esculenta*

Crantz), bambara groundnuts (*Vigna subterranea* (L.) Verdc.), cowpea (*Vigna unguiculata* (L.) Walp.), melon (*Citrullus lanatus* (Thunb.) Mansf.), and plantain (*Musa* spp.) have been successfully grown along with cashew. Cashew was also introduced into Ghana in the early 1960's but was neglected despite its enormous export potential. As one of its strategies to alleviate rural poverty and widen the base of agricultural exports, the Government of Ghana is presently promoting cashew cultivation in the savannah and transitional zones of the country. It also recommends intercropping cashew with food crops during the establishment phase. Although a variety of inter crops such as maize (*Zea mays* L.), millets, groundnuts (*Arachis hypogaea* L), soybeans (*Glycine max* (L.) Merr.), yams (*Dioscorea alata* L.), and cowpea are grown with cashew, virtually no scientific knowledge exists on the biological effects of these crops on cashew growth and yield under Ghanaian conditions. This paper reports the findings

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of a study aimed at developing sustainable cashew/food intercropping systems that improve cashew growth and yield and at the same time increase financial returns during the establishment phase.

Materials and Methods

The experiment was carried out at the Bole substation of the Cocoa Research Institute of Ghana in the Guinea Savanna zone between 2005 and 2010. The soils are mainly Ferric Luvisols with smaller areas of Eutric Regosols and Lithosols (FAO-UNESCO, 1977). The long-term mean annual rainfall and daily temperature of the site are 1087 mm and 26.1°C, respectively. Annual rainfall for the experimental period was 1178.7, 1084.8, and 946.9 mm for 2005, 2006, and 2007, respectively. A one-year-old cashew farm (10 x 10 m spacing) was selected for the experiment. The cropping systems investigated were: sole cashew, cashew + groundnut, cashew + maize, cashew + sorghum, cashew + yam, cashew + sorghum in rotation with groundnut, and cashew + maize in rotation with groundnut. The treatments were laid out in a randomized block design and replicated thrice. In all intercropping treatments, the distance between cashew and the food crops was ~ 1 m. Each year, yam was planted in April and the other food crops in late June to early July. Groundnut, maize, sorghum and yam were planted at 50 x 50, 80 x 40, 70 x 30, and 120 x 120 cm, respectively. The maize plots received fertilizers at the rate of 233 kg ha⁻¹ NPK 15:15:15 mixture and 233 kg ha⁻¹ of sulphate of ammonia, while 233 kg ha⁻¹ NPK 15:15:15 and 175 kg ha⁻¹ sulphate of ammonia were applied to sorghum. Yam and groundnut were not given any fertilizers following the local farmers' practice of not applying fertilizers to these crops. The plots were manually weeded. Data collected included soil nutrient content at the beginning and end of the intercropping period, costs of planting materials, fertilizers, labour for planting, plot maintenance, and harvesting, besides growth of cashew seedlings (assessed in terms of girth at 15 cm from stem base and height), canopy spread, proportion of trees flowered at two years after treatment, yield of cashew nuts, and yield and value of food crops. The net returns for each cropping system during the period of inter-

cropping (2005 to 2007) were computed by deducting the cost of production (labour, fertilizers, and seed) from the revenue generated, using the prevailing market prices. The data on cashew growth were analysed using ANCOVA with the initial measurements as covariates while cashew nut yield and soil nutrients were analysed with ANOVA and the treatment means separated by least significant differences.

Results and Discussion

Cropping systems did not significantly affect the nutrient content of the soil at the end of the intercropping period. In the 0 to 15 cm layer, soil carbon, nitrogen and available phosphorous content ranged from 2.1 to 3.8 g kg⁻¹, 0.41 to 0.54 g kg⁻¹, and 2.85 to 4.46 µg g⁻¹, respectively. The corresponding values for the 15 to 30 cm layer were 0.7 to 1.4 g kg⁻¹, 0.27 to 0.3 g kg⁻¹, and 1.56 to 2.63 µg g⁻¹ respectively. The absence of significant differences in soil nutrient content under the different treatments indicates that intercropping did not adversely impact the soil fertility status.

Intercropping, however, significantly ($p < 0.05$) affected the girth and height of the cashew seedlings two years after the treatment application (Table 1). Plant girth was significantly higher in the cashew + maize and cashew + sorghum in rotation with groundnut than sole cashew. Plant height, on the other hand, was significantly improved when cashew was intercropped with maize and sorghum. This beneficial effect of intercropping on the growth of cashew may be due to the tillage and other crop husbandry practices such as weed control and fertilizer application (Warui, 1985; Abeyasinghe, 2009). In a previous study at this site also, cashew seedlings responded positively to fertilizer application (Opoku-Ameyaw and Appiah, 2000). Neither the canopy spread of cashew trees nor percentage of trees that flowered was significantly affected by intercropping (Table 1).

The yields of food crops are presented in Table 2. In the 2005 season, sorghum crop failed due to severe bird damage. Intercrop yield during that year was generally poor and may be attributed to the comparatively low

Table 1. Effect of cropping systems on the growth and development of three year-old cashew seedlings two years after intercropping and the proportion of plants flowering at four years of age in the Guinea Savanna zone of Ghana.

Cropping system	Girth (mm)	Height (cm)	Crown spread (cm)	Proportion of plants flowered (%)
Sole cashew	37.5 ^c	125.0 ^c	195.6	78.8 (64.1)
Cashew + groundnut	38.4 ^{bc}	132.9 ^{bc}	190.5	81.6 (65.9)
Cashew + maize	41.9 ^a	159.1 ^a	236.4	77.3 (66.0)
Cashew + sorghum	38.4 ^{bc}	146.9 ^{ab}	199.1	62.1 (53.3)
Cashew + yam	40.1 ^{ab}	122.5 ^c	194.2	87.9 (71.3)
Cashew + sorghum/groundnut	41.4 ^{ab}	139.0 ^{bc}	205.7	90.9 (75.1)
Cashew + groundnut/maize	37.4 ^c	130.6 ^{bc}	205.9	83.4 (67.3)

Values followed by the same letters in a column are not significant different at $p = 0.05$; values in parenthesis are transformed data.

rainfall (116.2 mm) in August of that year. This was a general trend during that year as maize plot at another parts of the station also performed poorly. In 2006, the establishment of food crops was better than the previous year, but yields declined slightly in 2007 probably due to a decline in soil fertility, especially in the case of yam which has high demand for soil nutrients and yields decline quickly when grown repeatedly on the same soil (Jenssens, 2001; O'Sullivan, 2010). Although rainfall in August of 2006 (167.8 mm) was better than that of the previous year, yield of groundnut was lower than that obtained under unfertilized conditions in another locality within the Guinea savanna zone (Konlan, 2010). This could be due to the low phosphorus content of the soil and plant population density used in the present study. It seems reasonable to suggest that groundnut cultivation without the application of fertilizers by farmers in the locality may have to be reconsidered. Bird damage affected the performance of the sorghum throughout the

intercropping period, which is a major constraint of this study.

Cashew started bearing four years after transplanting (i.e. one year after the intercropping period). The first three years of cashew yields were not significantly affected by the cropping systems (Table 3). This indicates that food crop intercropping during the establishment phase may not have any adverse effect on cashew yield as it was the case with soil nutrient contents, which is similar to the findings of Abeysinghe (2009).

Economic evaluation of the treatments showed that in the 2005 season, intercropping was profitable when yam produced a net revenue of US\$ 54.5 (Table 4). The other food crops were not profitable because of the very poor yields obtained due to early poor rains and bird damage in the case of sorghum. During the 2006 season, intercropping with yams and maize were profitable. In

Table 2. Yields of food crops intercropped with cashew at Bole in the Guinea Savanna zone of Ghana.

Cropping system	Food crop yields (kg ha ⁻¹)		
	2005	2006	2007
Sole cashew	–	–	–
Cashew + groundnut	132.4	212.2	194.7
Cashew + maize	462.4	2505.8	1280.7
Cashew + sorghum	–	643.5	202.5
Cashew + yam	6602	9663.1	5615.3
Cashew + sorghum/groundnut	–	198.6*	167.4#
Cashew + groundnut/maize	126.6*	2047**	1104.0**

* Groundnut only. ** Maize only, # Sorghum only

Table 3. Effect of cropping system on the first three years' yield of cashew nuts at Bole in the Guinea Savanna zone of Ghana.

Cropping system	Cashew yield (kg ha ⁻¹)		
	2008	2009	2010
Sole cashew	70.8	149.5 (21.5)	96.6 (29.4)
Cashew + groundnut	71.0	161.6 (10.6)	123.5 (32.4)
Cashew + maize	51.8	104.3 (20.8)	98.1 (33.7)
Cashew + sorghum	55.5	145.5 (36.2)	120.7 (16.1)
Cashew + yam	80.3	168.5 (10.5)	165.0 (68.3)
Cashew + sorghum/groundnut	74.9	161.3 (28.7)	88.7 (16.9)
Cashew + groundnut/maize	80.8	154.3 (59.7)	138.0 (51.5)
F test	ns	ns	ns

Values in parentheses are standard errors of the means; ns= not significant at $p=0.05$; values in parenthesis are transformed data.

particular, yam combination was highly profitable and it produced a net revenue of US\$ 462.68 as against maize, which gave an average net revenue of US\$ 75.95. As in the previous year, intercropping with groundnut and sorghum were not economically beneficial since losses of over US\$ 140 and US\$ 150 respectively were incurred when these crops were raised. Performance of yam and maize as intercrops were remarkable considering the fact that these crops were repetitively grown on the same land/plot. Furthermore, during the 2007 season, intercropping was profitable when maize was used, which gave average net revenue of US\$ 220.68. The low returns from the yam intercrop, was probably as a result of reduction in soil fertility, compared to those of the previous years when that combination proved profitable. Just as in the previous years, bird damage in the

case of sorghum and possibly low phosphorus and suboptimal plant population density of groundnut may explain the non-profitability of sorghum and groundnut included in the system.

On a final note, the findings of this study indicate that intercropping cashew with food crops during the establishment phase generally improved cashew seedling growth and did not adversely affect early cashew nut yield. Intercropping, however, was profitable only when maize and yams were used as inter crops. It is, therefore, suggested that cashew farms can be intercropped with yam and maize for the first two and three years respectively, in the savannah agro-ecological zone of Ghana to enhance establishment and generate income to partially offset the cost of establishment.

Table 4. Economics of intercropping food crops with cashew in the Guinea Savanna zone of Ghana.

Cropping system	Cost of production (US\$ ha ⁻¹)			Revenue (US\$ ha ⁻¹)			Net revenue (US\$ ha ⁻¹)		
	2005	2006	2007	2005	2006	2007	2005	2006	2007
Sole cashew	56.71	64.90	95.65	–	–	–	–56.71	–64.82	–95.65
Cashew + groundnut	147.32	289.66	294.91	85.72	149.03	135.45	–61.60	–140.66	–159.46
Cashew + maize	272.33	364.10	297.72	100.52	484.35	556.82	–171.81	+120.27	+259.10
Cashew + sorghum	100.30	248.87	359.24	–	92.71	38.28	–100.30	–156.16	–320.96
Cashew + yam	194.71	112.94	737.83	249.21	575.62	718.01	+54.50	+462.68	–19.76
Cashew + sorghum/ groundnut	100.30	289.66	294.91	–	139.46	116.49	–100.3	–150.66	–178.42
Cashew + groundnut/ maize	147.30	364.10	297.72	82.17	395.74	479.99	–65.13	+31.64	+182.27

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