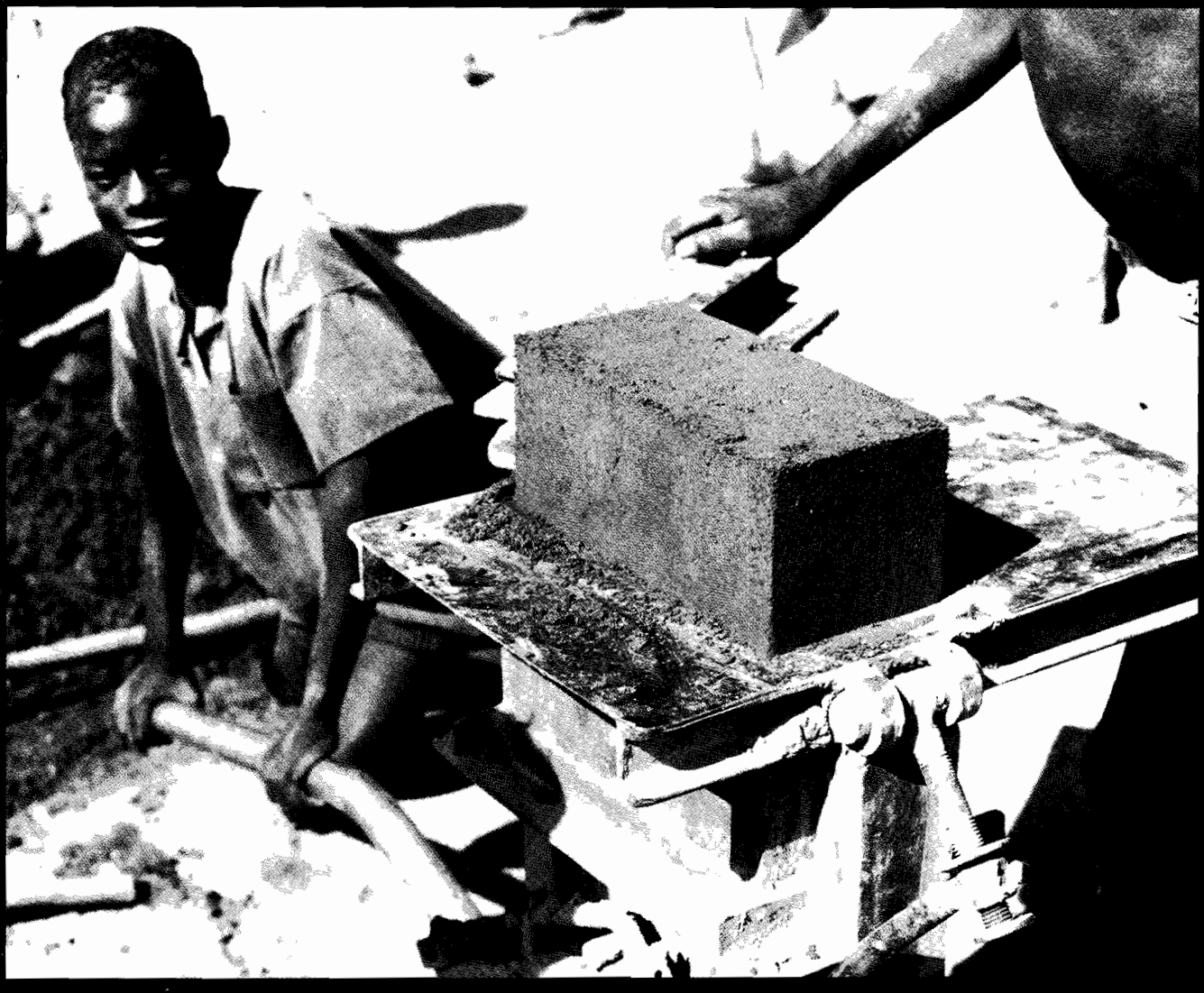

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TROPICULTURA, 2001, **19**, 4, 161-165

ARTICLES ORIGINAUX OORSPRONKELIJKE ARTIKELS

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Economic Evaluation and Prospects for Double Rice Crop Production in Humid Forest Inland Valley Ecosystems of South Eastern Nigeria

C. I. Ezedinma*

Keywords: Inland valley – Double rice crop – Income – Labour productivity – Intensification

Summary

The inland valleys of the humid forest ecology show considerable potential for double rice crop production because of a longer rainfall regime; but this is not commonly practised. The question as to wether the magnitude of farm income from a second rice crop would lead to its adoption was evaluated. Data was obtained between March and August 1999 from farmers fields and from an on-farm late trial with improved inputs between September and December 1999 in the Ozu Abam inland valley near Bende in South eastern Nigeria.

Results indicate that a second rice crop within the year will improve farmer income by 74 percent.

Labour costs will reduce by nine percent while capital operating costs will double with the use of improved inputs. However labour bottlenecks due to competition with upland crops, absence of mechanised dryers, power tillers and storage facilities may limit the adoption of double rice cropping.The availability of these farm level equipment and infrastructure may facilitate the adoption of double rice crop production technology in humid forest inland valley ecosystems.

Résumé

Evaluation économique et perspectives d'une double saison culturale de riz dans un bas-fond d'une forêt humide au sud-est du Nigeria

Les bas-fonds des forêts humides présentent des potentialités pour pratiquer deux saisons culturales de riz par an à cause d'une bonne répartition des précipitations. L'objectif de cette étude était d'évaluer les revenus générés par la riziculture ainsi que sa faisabilité.

Pour cela, des essais ont été réalisés, d'une part, chez des fermiers (entre mars et août 1999) et, d'autre part dans un champ expérimental (entre septembre et décembre 1999). Ce champ se situait dans un bas-fond de Ozu Abam près de Benda au sud-est du Nigeria et il a été exploité en utilisant des intrants. Les résultats obtenus montrent que la réalisation de deux récoltes par an a permis d'augmenter le revenu des fermiers de 74%. Les charges de structures ont été réduites de 9% tandis que les charges proportionnelles ont été doublées. Toutefois, la pratique de cette deuxième saison culturale présente plusieurs contraintes: concurrence avec le riz de montagne, manque de séchoirs mécaniques, manque de logements des récoltes. La résolution de ces problèmes est nécessaire pour envisager l'extension de cette pratique.

Introduction

One strategy by which intensification of agricultural production can be achieved with minimal environmental stress is to improve production in the inland valleys. The inland valleys comprise the toposequence of valley bottoms and minor flood plains which are often submerged for part of the year, their hydromorphic fringes and contiguous upland slopes and crest contribute run off and seepage to the valley bottom (1, 5). They differ from fadamas in that they have streams which also define the shape and character of the valley.

The inland valleys of the humid forest ecology show considerable potential for double rice crop production annually because of a longer rainfall regime; but double rice cropping is not commonly practised by farmers due perhaps to labour and capital constraints (3). The magnitude of farm income contributed by a second rice crop within the year would probably justify the dissemination of the technology to farmers in the humid forest inland valley ecosystems. The objective of this paper therefore is to evaluate the economic costs and returns and identify the perceived constraints and prospects for double rice crop production in humid forest inland valleys. This will provide baseline information for futher evaluation of the technology under intensive agricultural in humid inland valley ecosystems.

Methodology

Ozu Abam village is the site selected for the Inland Valley Consortium project in the humid forest ecology of

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Nigeria. The village has several inland valleys devoted to rice production under poor water control systems. Ozu Abam is located 15 kilometers north east of Bende (Latitude 5°34'N and longitude 7°37'E) in Arochukwu local government area of Abia state, Nigeria. Mean annual rainfall is approximately 2220 mm with three dry (< 60 mm rainfall) season months and about 240 days of rainfall on the average. Rainfall distribution is bimodal, peaking in July and September respectively. Annual ambient temperature range from 20°C to 32°C with a mean of 26°C.

In the 1999 farm production season 30 randomly selected farmers in one of the Ozu Abam inland valleys (Ubidia-Awalo) were allowed to grow rice using their own improved varieties with one weeding but without fertilizer input. A second crop rice was planted in September after the first crop was harvested by farmers in August 1999. Four varieties, namely WITA-1, WITA-4, FARO-44 and the farmers local best, SUAKOKO-8 were planted on five hectares of the same valley. Since farmers were not used to second rice cropping, the late season crop was researcher managed. Inputs such a fertilizer and a second weeding were done in the second rice crop. Labour for all farm activities were obtained from within the village at the going wage rate in 1999. The second late rice crop was harvested at the end of December 1999.

Yield samples were obtained from both the first (early) and second (late) rice crop fields. Thirty-two samples were obtained from 20 m^2 plots in farmers fields in the early season crop. Forty samples (10 samples per rice variety) were obtained at harvest from the second season rice crop. Output price as at December 1999 was obtained from the village market. Cost of production was recorded for labour, capital operating costs and land rent. Labour wage rates were obtained for nursery raising, land clearing, land preparation (packing and tilling) transplanting, weeding, bird scaring, harvesting, threshing and milling. Labour wage rates were usually based on a per "paddy" basis.
A "paddy" is about 0.089 hectares. This constitute a standard rice field size upon which all wages for labour and rent on land were based (3, 5). Milling costs was based on a service charge by millers in the village while bird scaring costs were based on a mean monthly cost. Conversion rate from paddy rice to milled rice is 0.66 following Onwueme and Sinha (7).
Capital operating costs include purchased rice seeds, interest on borrowed capital tools/equipment. Land rent is the only fixed capital item. Seed and tools were purchased by farmers from the local market. Farmers borrowed money from various sources for rice cultivation and interest paid on the loan were used to estimate cost and return in both early and late season rice cultivation. Other information collected from the village include mean landholding for rice, rice varieties cultivated by farmers, proportion of rice output that is sold, consumed at home and kept as seed stock. Data is computed using means and percentages and presented in tables and figures. Analysis of variance was used to test the statistical significance in yield of the different rice varieties planted in the second season.

Results and discussions

1. Landholding, rice varieties, productivity of labour in early and late rice output

Table 1 indicates the land area allocated to rice and other arable crop enterprises by farmers in Ozu Abam village. Mean area per household is 0.653 hectares or 7.33 fields of rice. The fallow rotation intensity (8) indicates that rice is continuously cultivated in the inland valley every year. In contrast, farmers allocate a mean of 0.409 and 0.345 hectares to the upland crop enterprises of cassava (CBCM) and yam (YBCM) based crop mixtures.

Table 1
Land Resource Allocation in Cassava (CBCM) Yam (YBCM) and Rice enterprises in Ozu Abam Inland Valley

Item	Rice	CBCM	YBCM
Mean area (ha) per household	0.653	0.409	0.345
Mean number of Fields/household	7.33	4.13	3.40
Total number of fields	220	132	105
Fallow rotation intensity	100	14.29	14.29

CBCM = Cassava based crop mixture
YBCM = Yam based crop mixture

Table 2
Rice varieties cultivated by farmers in Ozu Abam Inland Valley

Variety	Number of fields	Percentage
Suakoko-8	113.50	52
IR-5	59.75	27
Faro-15	36.25	16
Faro-29	10.5	5
Total	220	100

Table 3
Yield (tons/ha) and Productivity of Labour (kg/person day) in First and Second Rice Crop in Ozu Abam Inland Valley

Season/ Variety	Yield (Tons/ha)	n	SE	cv (%)	SD	Labour productivity (kg/person/day)
First season Improved varieties	2.54	32	0.06	13.00	0.33	13.77
Second season						
WITA-1	2.50	10	0.33	44.11	0.99	13.52
WITA-4	3.63	10	0.35	29.80	1.06	19.63
FARO-44	2.00	10	0.14	20.50	0.41	13.33
Suakoko-8	2.71	10	0.24	27.00	0.73	14.69

Table 4
Analysis of Variance on the Yield of Second Season Rice Varieties in Ozu Abam Inland Valley

Source of variation	Degrees of freedom	Sum of squares	Mean square	F-ratio
Between groups	3	15.32	5.11	6.64*
Within groups	36	27.82	0.77	
Total	39	43.14	-	

* Significant at 0.05

Table 5
Production Costs, Input use and Returns per hectare for first (early) rice crop in Ozu Abam Inland Valley, 1940.

Item	Unit price (₦)	Unit/ha	Value (₦/ha)
Rice output (milled)	34000	1.68 tons	57,120
Capital operating costs			
Seed	24	30.4 kg	729.60
Tools	1341.1	1	1341.10
Invest on Capital	3166.06	1	3166.06
Total capital operating cost			5236.76
Labour costs			
Nursery	200	1 Manday	200
Land clearing	213.76	33.26"	7109.66
Packing	225.88	17.41"	3932.57
Land preparation	382.62	18.43"	7051.69
Transplanting	182.04	20.22"	3680.85
Fertilizer application	-	-	
First weeding	216.30	28.30"	6121.29
Second weeding	-	-	
Bird scaring	39.14	32.13"	1257.57
Harvesting and thresting	134.89	36.51"	4924.83
Milling	3200	2.54 tons	8128
Total labour cost			42406.46
Total variable cost			47643.22
Gross margin			9476.78
Fixed cost			
Land rent	3616.63	1 ha	3616.63
Total cost			51,2556.85
Net farm income			5863.15
Returns par naira invested			0.11

NB : ₦100 = US$ 1.00

Rice varieties in the study area were all improved varieties (Table 2). The important varieties cultivated by farmers Suakoko-8 or "Sofinco" in the local language.

Suokoko-8 was found in 52 percent of the farmers fields; IR-5 was found in 27 percent of the fields, FARO-15, 16 percent and FARO-29, five percent. Suokoko-8 is the farmers local best and was introduced into the study area in the early 1980's during the iron toxicity trials by the International Institute of Tropical Agriculture. Iron toxicity is still a major problem in the Ozu Abam inland valley and farmers have discovered that this variety is fairly resistant to the problem. In contrast, FARO 29 or BG 90 is one of the earliest improved varieties introduced into the area, but it is beginning to loose popularity among the farmers because of poor yield.

Rice is a commercial crop in Ozu Abam village. About 78 percent of farmers rice output is sold while 13 percent is consumed at home. Nine percent is retained as seed stock. Table 3 shows the yield (tons/ha) and productivity of labour (kg/person day) in first and second season rice crops in the Ozu Abam inland valley. Mean paddy obtained from the first (early) rice crop was 2.54 tons per hectare. The highest yield was obtained from the second rice crop of WITA-4. WITA-4 gave a yield of 3.63 tons per hectare of paddy rice, followed by the farmer's local best, Suakoko-8 with 2.71 tons per hectare. FARO-44 gave the poorest yield of 2.00 tons per hectare in the second rice cropping.

The table further indicates that labour is most productive for WITA-4 and least productive for FARO-44. Hence land and labour productivity will be most productive for WITA-4 and Suokoko-8 in the rice producing inland valleys of Ozu Abam. Table 4 indicates the analysis of variance on yield of second season rice varieties in the study area. The calculated F-value of 6.64 suggests that there is a significant difference among the second season rice varieties with respect to their yield (tons/ha) in Ozu Abam inland valley.

2. Cost and returns in early and late season rice output

Table 5 shows the production costs and returns for the early rice crop in the Ozu Abam inland valley. Total value of output is ₦ 57,120 per hectare obtained from 1.68 tons of milled rice. Total operating capital amounts to ₦ 5,236.76 per hectare or 10 percent of the total cost of production. Total labour cost (₦ 42,206.46) accounts for 83 percent of total costs while land rent (fixed costs) account for seven percent of the total cost of production. The most important cost item is milling which accounts for almost 16 percent of the total cost of production. Farmers on the average are likely to net ₦ 5,895.63 per hectare from the early rice crop. This results in a return of 11 kobo for every naira invested in the early rice crop.

Table 6 presents the production costs and return for the second (late) rice crop for the best variety (WITA-4) in the Ozu Abam inland valley. Total value of output (₦ 81,600) per hectare was obtained from 2.40 tons of milled rice. Total operating capital account for 21 percent of the total cost of production. Labour costs account for 74 percent of the total cost of production while fixed costs account for five percent of the total cost of production. The total operating capital doubled from the first (early) season planting while total labour costs declined. This is because farmers weeded once in the early rice crop while two weedings were done in the second (late) rice crop. This second weeding accounted for an extra cost of 11 percent. Similarly, fertilizer purchase and use together accounted for about 16 percent of the total cost of production. Labour charges increased by 23 percent for transplanting because labourers were asked to plant according to a recommended spacing of 20 cm by 20 cm instead of the traditional staggered planting. By contrast, land clearing and 'packing' costs reduced by 50 percent because of reduced incidence of weeds and plant biomass which made both activities easy after the harvest of the first rice crop in August 1999.

Table 6
Production Costs, Input use and Returns per hectare for second rice crop (best variety WITA-4) in Ozu Abam Inland Valley, 1999.

Item	Unit price (₦)	Unit/ha	Value (₦/ha)
Rice output (milled)	34000	2.40 tons	86,600
Capital operating costs			
Seed	24	50 kg	1,200
Tools	1,341.1	1	1,341.10
Fertilizer costs	30	300 kg	9,000.00
Interest on capital	3,166.06	1	3,166.06
Total capital operating cost			14,707.16
Labour costs			
Nursery	200	1 Manday	200
Land clearing	106.88	33.26"	3,554.83
Packing	112.94	17.41"	1,996.29
Land preparation	382.62	18.43"	7,051.69
Transplanting	227.27	20.22"	4,494.30
Fertilizer application	199.93	11.24"	2,247.21
First weeding	277.92	28.30"	7,865.1
Second weeding	277.92	28.30"	7,865.1
Bird scaring	39.14	32.13"	1,257.57
Harvesting and threshing	134.89	36.51"	4,924.83
Milling	3200	3.63 tons	11,616.00
Total labour cost			53,042.92
Total variable cost			67,750.08
Gross margin			3,849.92
Fixed cost			
Land rent	3,616.63	1 ha	3,616.63
Total cost			71,366.71
Net farm income			10,233.29
Returns par naira invested			0.14

NB : ₦100 = US$ 1.00

Table 7
Production Costs, Input use and Returns per hectare for second (late) rice crop (farmers best, Suakoko-8) in Ozu Abam, 1999.

Item	Unit price (₦)	Unit/ha	Value (₦/ha)
Rice output (milled)	34,000	1,79 tons	60,860.00
Capital operating costs			
Seed	24	50 kg	1,200
Tools	1,341.1	1	1,341.10
Fertilizer costs	30	300 kg	9,000.00
Interest on capital	3,166.06	1	3,166.06
Total capital operating cost			14,707.16
Labour costs			
Nursery	200	1 Manday	200
Land clearing	106.88	33.26"	3,554.83
Packing	112.94	17.41"	1,996.29
Land preparation	382.62	18.43"	7,051.69
Transplanting	227.27	20.22"	4,494.30
Fertilizer application	199.93	11.24"	2,247.21
First weeding	277.92	28.30"	7,865.1
Second weeding	277.92	28.30"	7,865.1
Bird scaring	39.14	32.13"	1,257.57
Harvesting and threshing	134.89	36.51"	4,924.83
Milling	3200	2,71 tons	8,672.00
Total labour cost			50,099.00
Total variable cost			64,806.16
Gross margin			- 3,946.1
Fixed cost			
Land rent	3,616.63	1 ha	3,616.63
Total cost			68,422.79
Net farm income			- 7,562.79
Returns par naira invested			- 0.11

NB : ₦100 = US$ 1.00

Net farm income from second (late) rice crop production is about ₦ 10,233.12 per hectare. This implies that income from a second rice crop using improved inputs and management will actually exceed the first (early) rice crop returns by 43 percent. Together, farmers will make 74 percent more income from second (late) rice cropping in Ozu Abam inland valley. On the other hand cost of production increased by 39 percent using improved inputs in the second season cropping.

Table 7 shows that under the same improved production methods as WITA-4, Suakoko-8 (i.e. the farmers local best) would make a negative return of 11 kobo on every naira invested. This may justify the absence of fertilizer use and two weedings by farmers when they plant this variety in the study area. Farmers maintained that the inland valley is fertile and hence there was no need to apply fertilizer.

3. Constraints and prospects for adoption of double rice crop production in Ozu Abam inland valley

Farmers observed that even though rice yields from late season planting were high and required less winnowing, a primary constraint to the adoption of the technology is its competition with upland crops for labour. Best results for double rice cropping can be obtained by planting early between the months of March and July for the first (early) rice crop and between August and December for the second (late) crop. However, this crop calendar may conflict with the upland cropping system. Labour bottlenecks are likely to arise in the months of March and April which are also the land preparation months for the upland crop enterprises of yam and cassava based crop mixtures (Figure 1). Provision of power tillers may enable farmers overcome labour bottlenecks that may be associated with early rice cropping.

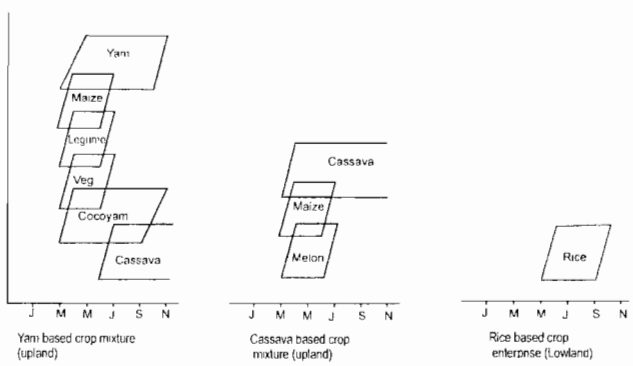

Figure 1: Major Arable cropping systems and calendar in Ozu Abam Inland Valley Ecosystem; Southeast Nigeria

Presently, farmers tend to adjust their lowland production months to the upland production months such that inland valley cultivation tend to commence after planting in the upland fields. Adjusting to double rice crop production may not be difficult for (tenant) farmers who do not own upland field but they may require wage labour for timely harvest of the early rice crop and replanting of the second crop between July and August when most labour will be allocated to weeding in upland fields. But because weeding is a female activity (2, 3) in both upland and lowland productions, while land preparation and planting of rice in the lowland are male dominated

activities, the scarcity of labour during this period is not envisaged.

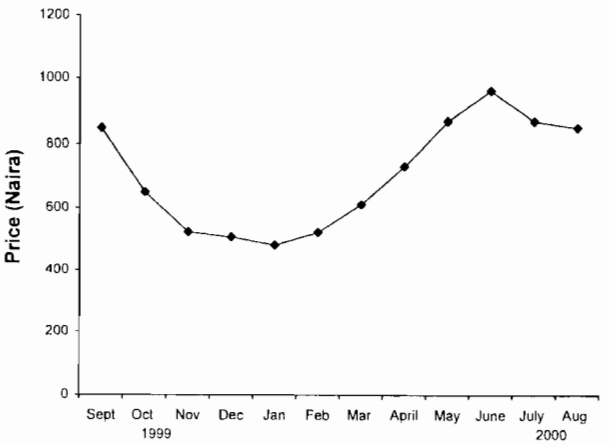

Figure 2: Mean mounthly price (Naira) of millied rice per bushel in the study area

The typical seasonal price pattern for rice which is presently harvested once a year in the study area in shown in figure 2. Rice prices begin to decline from the harvest time (because supply is large relative to demand) and rises to a peak (in June/July) prior to the next harvest. Hence as the market anticipates the increase quantity and lower prices which the new harvest will bring, prices tend to fall rapidly one to two months (August, September) before the harvest begins. Poor on-farm storage and rural infrastructure coupled with the fact that farmers need to offset debts borrowed during the production season, force them to sell most of their output at harvest when prices are relatively low. The adoption of two rice cropping per year may help even out the seasonal price peaks in (May, June and July) and troughs (December and January) within the production season. This is because the anticipated harvest of the first rice crop in the months of July and August will reduce rice prices in the hitherto peak months of June and July. The harvest of the second rice crop may stabilize prices well into the next cropping season. However, storage facilities may be necessary to enable farmers store their rice output. Otherwise, they may be forced to sell all proceeds at the time of harvest; a situation that may result in low prices for rice in the study area.

Finally another constraints to double rice cropping is that the early season crop will be harvested during the rainy season (July, August). The rains will make the traditional open-air drying difficult. This implies that a blow dryer would be required to enable farmers take advantage of the high prices of rice during this period.

Conclusion

Double rice crop production technology is feasible in humid forest inland valleys because of a favourable rainfall regime. Evidence suggests that a second rice crop within the year will improve farmers income by 74 percent under improved management.

However, there are some perceived constraints to farmer adoption of double rice crop production. These include labour bottlenecks due to competition with upland crops early in the season; the absence of mechanized dryers, power tillers and storage facilities. Partial mechanization is recommended because there is need to even out labour bottlenecks with intensification of rice production and improve drying during the rain months. The initial acquisition of power tillers and blow dryers will depend heavily on external support from government or non government organisations as the cost of investments in such technologies will be significant for small scale farmers in the study area. However, there is need for further studies to determine the cost and benefits of such an envisaged technological change on the production process (especially with respect to the demand for labour and capital outlay). There is also a need for further studies to ascertain the consequences of mechanization on the institutional, social, administrative and political systems of the study area.

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Sensibilité à *Mononychellus tanajoa* Bondar (Acari: Tetranychidae) de quelques cultivars de manioc (*Manihot esculenta* Crantz) et incidence des attaques sur le rendement, dans la région des hauts plateaux de l'Ouest Cameroun

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Keywords : Cassava – *Mononychellus tanajoa* – Cassava green spider mite – Damage - Sensibility – Mite density – Yield loss

Résumé

L'étude de la sensibilité vis-à-vis de l'acarien vert du manioc (Mononychellus tanajoa) *et de l'incidence des attaques sur le rendement a été effectuée dans la région des hauts plateaux de l'Ouest Cameroun. Quatre cultivars de manioc* (Manihot esculenta *Crantz*) *ont été utilisés: deux cultivars locaux cultivés dans la zone (Dschang et Njombé) et deux cultivars améliorés (IITA 8017 et IITA 82516). Les résultats obtenus montrent que les densités (acariens/cm²) sont faibles durant la période de forte pluviométrie et élevées pendant la saison sèche. Les pluies réduisent par lessivage les populations d'acariens ou induisent leur mortalité. La densité moyenne la plus élevée (3,40 acariens/cm²) est obtenue sur le cultivar local Njombé qui par conséquent est le plus sensible. Par contre, le cultivar local Dschang ayant la densité la plus faible (1,40 acariens/cm²) est le plus résistant suivi du cultivar IITA8017 (1,74 acariens/cm²). Le cultivar IITA 82516 a une densité moyenne de 2,65 acariens/cm². Les pertes de rendement vont de 36,90 % pour le cultivar IITA 8017 (1,74 acariens/cm² et niveau d'attaques égal à 2,75) à 58,70 % pour le cultivar local Njombé (3,40 acariens/cm² et niveau d'attaques égal à 3,84). Le cultivar local Dschang (1,40 acariens/cm² et niveau d'attaques égal à 2,96) et IITA 82516 (2,65 acariens/cm² et niveau d'attaques égal à 2,96) ont respectivement les pertes de rendement de 38,10 % et 41,80 %. Les résultats obtenus montrent que plus le niveau d'attaques et même la densité des populations sont élevés, plus les pertes de rendement sont importantes sauf si le cultivar est tolérant.*

Summary

Sensibility to *Mononychellus tanajoa* Bondar (Acari: Tetranychidae) of some Cassava *(Manihot esculenta* Crantz*)* Cultivars and Effect of Damage on Yield Loss in the Cameroonian Western Highlands

The study of the sensibility towards the green mite Mononychellus tanajoa *Bondar of some cassava* (Manihot esculenta *Crantz*) *cultivars and the assessment of the effect of damage on the yield losses was carried out in the Western highlands of Cameroon. Four cassava cultivars were used: two local (Dschang and Njombé) and two improved varieties (IITA 8017 and IITA 82516). The results obtained showed that the density (mites number/cm² of leaf area) was low during the rainy season and high during the dry season, which means that rains reduce the mite population by washing or lead the mites to death. The highest mean density (3.40 mites/cm² of leaf area) was obtained on the local Njombé cultivar which is consequently the most sensitive. On the contrary, the local Dschang cultivar, with the lowest mite density (1.40 mites/cm² of leaf area) was the most resistant followed by the IITA 8017 cultivar (1.74 mites/cm²). The IITA82516 cultivar had a mean density of 2.65 mites/cm². Yield losses ranged from 36.90 % for IITA 8017 (1.74 mites/cm² and damages level of 2.75) to 58.70 % for local Dschang (3.40 mites/cm² and damages level of 3.84). Local Dschang cultivar (1.40 mites/cm² and damage level of 2.96) and IITA 82516 (2.65 mites/cm² and damage level of 2.96) had a yield losse of 38.10 % and 41.80 %. The results showed that higher the mite density and damage level are, higher is the yield loss, unless the cultivar is tolerant.*

Introduction

Le manioc *(Manihot esculenta* Crantz) est une plante amylacée, très cultivée en Afrique subsaharienne, tant pour la consommation de ses racines tubéreuses, que ses jeunes pousses et feuilles (8). Bien que cette culture présente une grande faculté d'adaptation, les dégâts causés par plusieurs ravageurs constituent une contrainte qui limite sa production. Parmi ceux-ci, l'acarien vert du manioc *(Mononychellus tanajoa* Bondar*)* est un ennemi majeur. Découvert, pour la première fois à Makerere (Ouganda) en 1971 (2, 5, 6, 7), cet acarien s'est propagé dans toute la zone africaine, productrice de manioc. *M. tanajoa* se nourrit en rongeant les cellu-

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les palissadiques, puis lacuneuses à la face inférieure des feuilles dont il résulte des chloroses puis le dessèchement et la chute des feuilles; la défoliation peut être complète, mais elle entraîne rarement la mort du plant (4, 9). La chute des feuilles et la formation des chloroses réduisent la surface foliaire et donc la photosynthèse, ce qui affaiblit la plante. Les attaques dues à l'acarien vert du manioc peuvent aussi entraîner la pourriture des racines (3, 9) et aussi la répartition de l'acide cyanhydrique dans la plante (1). Une meilleure étude des rapports existant entre les populations de *M. tanajoa* et la baisse de rendement doit permettre de mieux connaître la sensibilité, vis-à-vis de *M. tanajoa*, des cultivars de manioc avant de les vulgariser auprès des paysans. Cette étude permet aussi de connaître si les mesures de lutte sont nécessaires et rentables en déterminant un seuil d'intervention.

Matériel et méthodes

Conditions pédoclimatiques

Les expérimentations ont été menées durant la saison culturale de 1998/1999 à la ferme expérimentale de l'Université de Dschang située dans les hauts plateaux de l'Ouest Cameroun. L'étude a été conduite sur un sol ferralitique typique (13: 35: 52, sable/limon/argile; pH de l'eau= 5,0 ; CEC= 33,7 meq/100g). Le terrain utilisé n'a pas été cultivé en manioc pendant deux ans et le précédent cultural était le maïs. Les précipitations mensuelles moyennes durant le cycle cultural (12 mois) furent de 210 millimètres et la température journalière moyenne de 20°C.

Matériel végétal et mise en place

Quatre cultivars de manioc ont été utilisés: deux cultivars traditionnels (Dschang et Njombé) cultivés dans la zone, et deux cultivars améliorés (IITA 8017 et IITA 82 516) fournis par l'Institut de Recherche Agronomique (IRA) d'Ekona au Cameroun. Les cultivars Dschang et Njombé ont un port dressé, de nombreuses ramifications et leurs pétioles sont rouges. Ce cultivar Njombé a une tige élancée et une floraison précoce. Le cultivar amélioré IITA 8017 est le seul parmi les quatre à avoir un port étalé et rampant. Sa tige est vert claire alors que celle du cultivar IITA 82516 est grise. La mise en place a été effectuée manuellement en début de saison des pluies (18 mars 1998) à partir des boutures de 30 cm de long et 3 cm de diamètre ayant la même maturité, jugée selon le rayon de la moelle dans la tige coupée, en vue de réduire les variations aléatoires dans la taille des plants. Ces boutures ont été prélevées dans la région basale des tiges de plants non infestés par la mosaïque (virose) et leur orientation était uniforme (inclinaison à angle inférieur à 90°C, vers la droite). Les écartements étaient de 1 m entre les lignes et 1 m sur la ligne. Les parcelles étaient sarclées tous les deux mois durant toute la période de l'essai.

Dispositif expérimental

Dispositif expérimental en cinq blocs (répétitions)

L'essai a été conduit selon un dispositif en split-plot comprenant cinq répétitions.

Les parcelles élémentaires mesuraient 10 x 5 m et étaient toutes séparées par une allée de 3 m, afin de limiter les interférences; les blocs étaient distants, l'un de l'autre, de 4 m et chaque parcelle comprenait 50 plants dont 30 plants des trois lignes centrales étaient destinés à l'échantillonnage, les autres constituant, de part et d'autre, une ligne de bordure (Figure 1).

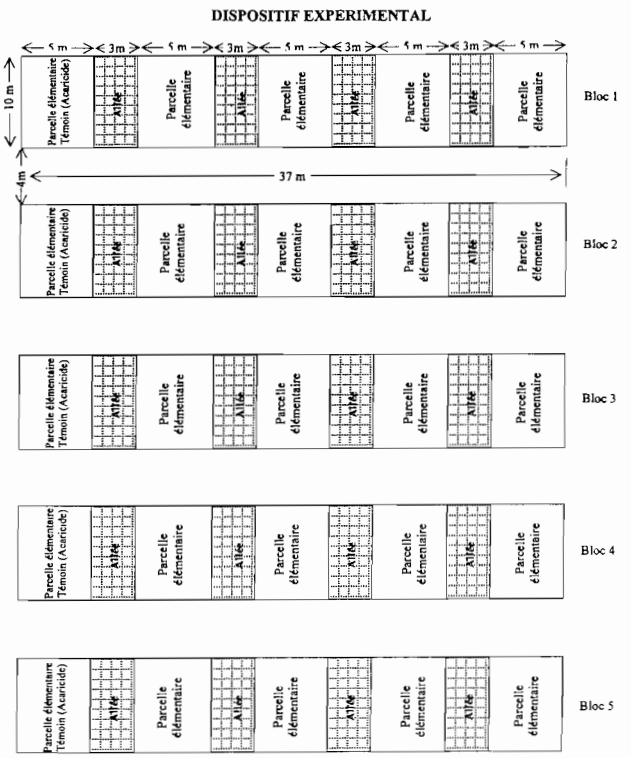

Figure1: *Dispositif expérimental*

Traitements aux pesticides

Il est difficile d'évaluer avec précision l'impact de *M. tanajoa* sur le rendement du manioc dans la zone subsaharienne, car des dégâts d'autres ravageurs notamment *Zonocerus variegatus* et *Phenacoccus manihoti* et d'une maladie foliaire (mosaïque) se superposent à ceux de l'acarien dans les essais. Pour les maîtriser, des traitements insecticides ont été effectués chaque semaine sur l'ensemble des parcelles durant toute la période de l'essai, et les boutures furent prélevées sur les plants de manioc indemnes de mosaïque. En outre, le témoin (une parcelle sur cinq dans chaque bloc) a été traité chaque semaine aux produits acaricides. Les matières actives suivantes ont été utilisées: (a) un insecticide, l'undène 75 WP à la dose de 150 g m.a. ha^{-1} , (b) un acaricide, le diméthoate EC 40 à la dose de 4000 g m.a.ha^{-1}. Le dispositif expérimental étant un split-plot, les parcelles traitées à l'acaricide étaient regroupées d'un côté, les parcelles non traitées de l'autre, les deux types étant séparés par deux lignes de protection, ce qui a facilité l'application des pesticides et a permis d'éviter les problèmes de dérive. Les traitements ont été faits à l'aide d'un pulvérisateur à dos délivrant environ 900 l/ha à une pression maximale de 7 kg/cm^2 avec une buse à jet plat. Un dispersant – mouillant, le monobutyl éther de l'éthylène – glycol (Excell ; 0,05% v/v), a été incorporé à la bouillie et le jet de la buse était

aussi orienté vers la face inférieure des feuilles. Les parcelles non traitées à l'acaricide (quatre cinquièmes de la superficie totale) ont été soumises à l'infestation naturelle de *M. tanajoa*. Dès lors, toute baisse de rendement observée dans les parcelles non soumises aux traitements acaricides était due aux seules attaques de *M. tanajoa*.

Collecte et analyse des données

Les densités des populations (acariens / feuille) ont été déterminées chaque deux mois, à partir de la date de mise en place des boutures sur dix plantes prises au hasard dans chaque parcelle. Elles ont été obtenues en examinant la première feuille pleinement développée de couleur plus foncée et ayant un pétiole attaché à la tige en un angle inférieur à 90°C (9). Les plants utilisés ont été choisis à partir de la troisième ligne à l'intérieur de chaque parcelle pour éviter l'effet de bordure. Les densités ainsi obtenues sur chaque surface foliaire ont été rapportées en nombre d'acariens/cm^2. L'étude du niveau d'attaques dues à *M. tanajoa*, a été aussi effectuée sur dix plants de chaque cultivar pris au hasard dans chaque parcelle et après examen de la première feuille pleinement développée selon l'échelle des cinq valeurs (9) ci-après:

1 (aucun dégât d'acariens);
2 (présence de taches chlorotiques blanches sur moins de 5 % de la surface foliaire);
3 (chlorose plus grave, couvrant entre 5 et 50 % de la surface totale de la feuille, celle-ci est parfois rabougrie);
4 (chlorose très grave couvrant plus de 50 % de la surface totale de la feuille, celle-ci est jaunâtre en raison de l'absence de chlorophylle);
5 (la feuille est morte ou tombée suite aux attaques d'acariens).

En ce qui concerne l'incidence des attaques sur le rendement, les racines tubéreuses ont été récoltées, dénombrées et pesées à la fin du cycle cultural (12 mois). Les données ont été soumises à l'analyse de la variance pour les niveaux d'attaques, et la séparation des moyennes a été faite selon le test de comparaison multiple de Duncan (p= 0,05).

Résultats et discussion

Densité des populations de *M. tanajoa*

Le tableau 1 présente les densités (acariens/cm^2) de *M. tanajoa* obtenues tous les deux mois sur les quatre cultivars durant le cycle cultural (12 mois).

Tableau 1
Densités (acariens/cm^2 de surface foliaire) des populations de *M. tanajoa* sur les quatre cultivars de manioc (*Manihot esculenta* Crantz) durant le cycle cultural

		Densité moyenne (acariens/cm^2)						
Cultivars		2 mois	4 mois	6 mois	8 mois	10 mois	12 mois	Moyenne
IITA 8017	Moyen.	0,59a	1,30a	1,85a	2,10a	2,18a	2,40a	1,74a
	E_T	0,42	0,83	1,44	0,27	1,07	0,82	0,67
ITA 82516	Moyen.	0,85b	1,89b	2,76b	2,85b	3,64b	3,88b	2,65b
	E_T	0,20	1,02	0,97	0,62	1,10	0,58	1,13
Local Dschang	Moyen.	0,42c	0,65c	1,08c	1,83c	2,30c	2,10c	1,40c
	E^T	0,31	0,37	0,20	0,08	0,28	0,70	0,79
Local Njombé	Moyen.	1,31d	2,70d	3,10d	3,02d	4,90d	5,40d	3,40d
	E_T	0,28	0,73	0,81	1,01	1,20	0,98	1,50
	C.V. (%)	12,89	27,57	23,01	36,28	39,85	28,64	33,86
	Signif. (F)	1,03 NS	23,85 HS	20,24 HS	24,50 HS	26,01 HS	19,54 HS	24,06 HS

Les moyennes sur la même colonne suivies par les lettres différentes sont statistiquement différentes selon le test de Duncan (p = 0,05).

Tableau 2
Niveaux d'attaques de *M. tanajoa* sur les quatre cultivars de manioc (*Manihot esculenta* Crantz) durant le cycle cultural.

		Niveau d'attaques						
Cultivars		2 mois	4 mois	6 mois	8 mois	10 mois	12 mois	Moyenne
IITA 8017	Moyen.	1,03a	2,55a	2,61a	2,70a	3,69a	3,90a	2,75a
	E_T	0,21	0,38	0,56	0,78	0,59	0,87	1,02
ITA 82516	Moyen.	1,12b	2,78b	2,80b	2,90b	3,83b	4,60b	3,00b
	E_T	0,32	0,46	0,38	0,64	0,38	0,03	1,17
Local Dschang	Moyen.	1,04c	2,71c	2,89c	3,45c	3,74	3,96c	2,96c
	E_T	0,28	0,63	0,71	0,86	0,68	1,00	1,05
Local Njombé	Moyen.	1,30d	2,96d	3,95d	4,88d	4,96d	4,89d	3,84d
	E_T	0,18	0,77	0,31	0,01	0,02	0,08	1,07
	C.V. (%)	27,01	28,57	26,84	19,86	12,44	16,67	8,84
	Signif. (F)	1,08 NS	23,85 HS	21,12 HS	14,09 HS	11,49 HS	12,80 HS	5,04 HS

Les moyennes sur la même colonne suivies par les lettres différentes sont statistiquement différentes selon le test de Duncan (p = 0,05).

Il ressort que les densités sont faibles durant la période de forte pluviométrie (début du cycle cultural) et élevées pendant la saison sèche (janvier – début mars) qui coïncide avec la fin du cycle cultural. Ceci montre que les pluies par lessivage réduisent les populations d'acariens ou induisent leur mortalité. Bien que vivant généralement à la face inférieure des feuilles, les pluies battantes souvent accompagnées de vents violents qui caractérisent la zone tropicale atteignent les acariens. Les densités moyennes obtenues chaque deux mois sur les quatre cultivars durant le cycle cultural sont statistiquement différentes.
Le développement des populations de *M. tanajoa* atteint la densité moyenne la plus élevée (3,40 acariens/cm²) sur le cultivar local Njombé qui par conséquent est le plus sensible. Par contre, le cultivar local Dschang ayant la densité moyenne la plus faible (1,40 acariens/cm²) et est le plus résistant vis-à-vis des infestations de *M. tanajoa* suivi par le cultivar IITA 8017 (1,74 acariens/cm²). Le cultivar IITA 82516 avec une densité moyenne de 2,65 acariens/cm² peut également être considéré comme sensible.

Niveau d'attaques

Le tableau 2 présente les niveaux d'attaques relevés tous les deux mois durant le cycle cultural.

Ces niveaux d'attaques sont en rapport avec la densité d'acariens sauf si le cultivar est tolérant. Le cultivar local Njombé a la densité d'acariens la plus élevée (3,40 acariens/cm²) et le niveau d'attaques moyen le plus élevé (3,84); le cultivar IITA 82516 a une densité d'acariens de 2,65 acariens/cm² et un niveau d'attaques moyen de 3,00. Par contre, bien que la densité du cultivar IITA 8017 (1,74 acariens/cm²) soit supérieure à celle du cultivar local Dschang (1,40 acariens/cm²), son niveau d'attaques (2,75) est inférieur à celui du cultivar local Dschang (2,96); ce qui indiquerait que le cultivar IITA8017 soit tolérant. Les niveaux d'attaques moyens des quatre cultivars sont statistiquement différents (p= 0,05). L'analyse de la variance donne des coefficients de variation hautement significatifs. Ce qui montre que les niveaux d'attaques des quatre cultivars sont très différents.

Incidence sur le rendement

Le tableau 3 présente les rendements et les pertes de rendement.

Dans les parcelles protégées, le cultivar local Dschang a le rendement le plus élevé 74,04 tonnes/ha suivi de IITA 8017 (38,93 tonnes/ha) et du cultivar IITA 82516 (30,32 tonnes/ha); le cultivar local Njombé a le rendement le plus faible (6,50 tonnes/ha). Il ressort (tableau 3) que les pertes de rendement sont en rapport avec la densité d'acariens, le niveau d'attaques et le cultivar sauf si celui-ci est tolérant. Les pertes de rendement vont de 36,90 % pour le cultivar IITA 8017 (1,74 acariens/cm² et niveau d'attaques égal à 2,75) à 58,70% pour le cultivar local Njombé (3,40 acariens/cm² et niveau d'attaques égal à 3,84). Le cultivar local Dschang (1,40 acariens/cm² et niveau d'attaques égal à 2,96) et IITA 82516 (2,65 acariens/cm² et niveau d'attaques égal 3,00) ont respectivement les pertes de rendement de 38,10 % et 41,80 %. Les pertes de rendement de 10 à 80 % ont été observées par d'autres auteurs (9) mais les densités d'acariens n'ont pas été données ni les niveaux d'attaques. Les résultats obtenus montrent que plus le niveau d'attaques et même la densité des populations de *M. tanajoa* sont élevés plus les pertes de rendement sont importantes (sauf si le cultivar est tolérant). La densité de 1,74 acariens/cm² et le niveau d'attaques de 2,75 constituent déjà, des seuils susceptibles de causer des pertes assez importantes (36,90 %) d'où la nécessité d'une intervention (chimique, culturale ou autres) précoce, c'est-à-dire qui a lieu bien avant que ces seuils soient atteints en vue de combattre *M. tanajoa*.

Tableau 3
Densités moyennes d'acariens et niveaux d'attaques moyens sur les quatre cultivars de manioc *(Manihot esculenta* Crantz) durant le cycle cultural, rendements et pertes de rendement

Cultivars		Densité moyenne (acariens/cm²)	Niveau d'attaques (1-5)	Rendement en tubercules des parcelles non protégées (tonnes/ha)	Rendement en tubercules des parcelles protégées (tonnes/ha)	Perte de rendement (tonnes/ha)	Perte de Rendement (%)
IITA 8017	Moyen.	1,74a	2,75a	24,56a	38,93a	14,37a	36,90
	E_T	0,67	1,02	4,37	9,05	4,68	
ITA 82516	Moyen.	2,65b	3,00b	17,65b	30,32b	12,67b	41,80
	E_T	1,13	1,17	6,25	5,47	0,78	
Local Dschang	Moyen.	1,40c	2,96	45,83c	74,04	28,21c	38,10
	E_T	0,79	1,05	9,94	10,21	0,27	
Local Njombé	Moyen.	3,40d	3,84d	2,85d	6,90d	4,05d	58,70
	E_T	1,50	1,07	1,01	2,83	1,82	
	C.V. (%)	33,86	8,84	21,67	8,79	7,90	
	Signif. (F)	24,06	5,04	12,60	16,01	4,01	
		HS	HS	HS	HS	HS	

Les moyennes sur la même colonne suivies par les lettres différentes sont statistiquement différentes selon le test de Duncan (p = 0,05).

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Contribution à la domestication des essences forestières recherchées et exploitées par la population rurale dans le Parc National de Kahuzi-Biega (PNKB): Cas d'*Arundinaria alpina*, Est de la République Démocratique du Congo

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Keywords: Kahuzi mountain forest- Bamboo- *Arundinaria alpina*- Domestication- Biodiversity conservation- Agroforestery- Eastern of Congo Democratic Republic

Résumé

Ce travail a été effectué dans la région Est du Congo - Kinshasa. Il a pour but de présenter les possibilités de domestication du bambou Arundinaria alpina *(variété Kahuzi), une des essences forestières les plus consommées par les chimpanzés du Parc National de Kahuzi-Biega, mais malheureusement fortement exploitées par les populations rurales voisines du parc. Les essais culturaux et l'évaluation après une période de 54 mois d'observation en culture, ont montré que cette espèce jusqu'à présent sauvage est domesticable et présente une croissance rapide en milieu rural. Nous avons obtenu une récolte oscillant entre 600 et 1700 tiges de bambou adultes/ha/an à partir de 50 boutures semées à l'hectare par site d'essai. La récolte est en moyenne de 2200 tiges de bambou adultes/ha/an pour le même nombre de jeunes touffes suivies au parc, leur milieu naturel, durant la même période d'essai. Les paysans riverains du parc peuvent intégrer* Arundinaria alpina *(variété-Kahuzi) dans leurs systèmes de production sylvicole ou agroforestière au lieu de dévaster le parc. En adoptant cette proposition, ils contribueront à la conservation de la diversité biologique de l'Est du Congo-Kinshasa.*

Summary

Contribution on the Domestication of Forest Plants Used by Peasants from the Kahuzi -Biega National Park: The Case of *Arundinaria alpina* in Eastern Part of Congo Democratic Republic

This work has been carried out in Eastern of Congo-Kinshasa region. It aims to show domestication possibilities of Arundinaria alpina *(Kahuzi variety) out of the forest.* Arundinaria alpina *is one of the wild plant species of* Kahuzi-Biega *National Park which are mainly consumed by chimpanzees. However, these wild plants are also exploited by peasants neighbouring the park for many purposes including house building, medicines,... The agricultural trial of* Arundinaria alpina *in South-Kivu rural areas, has shown that 50 slips of the bamboo planted per hectare yield after 54 months, 600 to 1700 stems of adult bamboos/ha/year. A survey within the park has shown that under natural conditions, 50 observed clusters could normally bear 2200 adult stems/ha/year. It means that the South-Kivu peasants could easily row the bamboo under the villages by integrating it in their agroforestery farming systems and stop ravaging natural resources of the national park. Such kind of practice will help to protect the Eastern Congo-Kinshasa biodiversity.*

Introduction

La forêt de montagne du Parc National de Kahuzi-Biega (2°5' S -28°45' E), située à l' ouest du Lac Kivu , renferme une très riche diversité biologique (faune et flore) avec un fort degré d' endémisme (7). Elle est aussi caractérisée par une diversité de biotopes et d' écosystèmes riches en espèces végétales et animales dont le patrimoine génétique serait de très grande utilité pour l' avancement des sciences biologiques appliquées (agronomie, zootechnie, médecine,...), (14). Le PNKB (600 km^2) est inscrit sur la liste du patrimoine mondial comme sanctuaire des gorilles de plaines de l'est *(Gorilla gorilla graueri)*, (10) .

Cependant, la population riveraine du parc y exerce une forte pression en se livrant à des activités dévastatrices comme la recherche des plantes médicinales, la collecte d'insectes comestibles (chenilles,...), la cueillette des fruits des plantes sauvages, la coupe des bois de chauffe et de construction, la recherche des essences utiles pour la fabrication du charbon de bonne qualité commerciale et la chasse de petits et grands animaux (primates, éléphants, rongeurs, oiseaux, grenouilles,...). D'autres paysans par manque de terres arables, dans leurs villages d'origine, vont dans le parc pour chercher à y créer anarchiquement des concessions privées sous forme de ferme d'élevage ou des champs de cultures.

Dans le but de sauvegarder la biodiversité endémique du parc menacée d'extinction par l'homme, l'Institut

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Congolais pour la Conservation de la Nature (I.C.C.N) en collaboration avec la GTZ (Office allemand pour la coopération au développement) a mis au point une stratégie de conservation et de mise en valeur des ressources naturelles renouvelables (1) dans une approche de conservation de la nature intégrée au développement rural de l'est de la R.D. Congo. Parmi une série des mesures envisagées pour y arriver, on peut citer la sensibilisation et la généralisation de l'éducation environnementale de la population, la participation de cette population dans l'élaboration des mesures de protection des ressources du parc, la fourniture d'intrants agricoles, et le renforcement de la sécurité alimentaire et foncière des villageois riverains du parc, l'écotourisme et la création d'emploi visant à dévier les activités anthropiques.

Très peu d'idées orientées vers la domestication des espèces animales et végétales sauvages ont été jusqu'alors émises dans les milieux des gestionnaires du parc. En ce qui concerne les essences forestières convoitées par les paysans, on s'est contenté jusqu' alors de promouvoir la production et la distribution des plantules sylvicoles et agroforestières (10). On croyait qu'avec le bois provenant de ces arbres, les paysans cesseraient d'aller au parc. La plupart des actions menées dans ce cadre ont échoué car les paysans préfèrent les essences forestières trouvées au PNKB que les plantules sylvicoles et agroforestières fournies par l' ICCN.

Parmi les principales espèces végétales *(Albizzia gummifera, Strombosia scheffleri, Bridelia bridelifolia, Maesa lanceolata, ...)* recherchées et exploitées au PNKB par les paysans, il y a le bambou *(Arundinaria alpina)*, composante essentielle des biotopes et du régime alimentaire des gorilles et des chimpanzés du parc. Trente-sept pourcent de la superficie totale de la forêt de montagne du parc est composée essentiellement de bambous d'altitude (7, 11). La pression de l'homme sur le parc pourrait entraîner la régression de ces bambousseraies naturelles et par conséquent perturber le régime alimentaire des chimpanzés en particulier. L'I.C.C.N estime que plus de 6% de la superficie de bambousseraies du parc sont dévastées par les villageois chaque année malgré les mesures de protection mises en place (1). On estime que plus de 15000 tiges de bambou sont coupées au parc et vendues sur les marchés locaux et urbains chaque année; alors que le taux de régénération naturelle de ces bambousseraies ne dépasse pas 7790 tiges/an/ha (1). En dehors de son usage dans les travaux de construction rurale, le bambou permet de produire une bonne pâte à papier (6,12). Les pousses de bambou *(Phyllostachus pubescens)* sont utilisées comme légumes dans l'alimentation de l'homme et des animaux de ferme (2) .

Dans le but de conserver la biodiversité du parc et de contribuer à la révolution arboricole ("tree revolution") en agroforesterie (3, 4, 13), une série d'essais de domestication des espèces sauvages exploitées par les villageois dans le parc sont entrepris depuis 1991 au département de biologie du Centre de Recherche en Sciences Naturelles de Lwiro.

Cet article présente les résultats préliminaires de l'essai de domestication d'une variété de bambou *(Arundinaria alpina)* d'altitude du PNKB. De cette façon, on espère pouvoir répondre aux préoccupations des paysans en leur montrant qu'il est possible de produire ces essences localement et de minimiser ainsi le risque de dégradation liée aux entrées illicites dans le parc.

Matériel et méthodes

1. Milieu d'essai

L'essai a été conduit dans la localité de Kabumbiro-Kasheke (1°30'58"S, 28°31'20"E) du 10 octobre 1994 au 30 mai 1999; le long de la rivière Nyabarongo prenant sa source dans le parc et se déversant dans le Lac Kivu. L'essai a été conduit dans les sites (Kamandwa et Shabaganda) localisés dans une concession (550 ha) située le long de cette rivière. Cette concession appartient à un fermier congolais intéressé par le commerce des tiges de bambou dont il souhaiterait faire la culture.

Le climat du milieu dans lequel se trouve nos sites est de type Aw3. Il est tropical tempéré par l'altitude et comparable du point de vue température, humidité relative, fréquence et distribution des pluies à celui du PNKB (7).

Ce climat connaît une saison pluvieuse de 9 mois (septembre à mai) et une saison sèche de 3 mois (juin à août). La moyenne annuelle des précipitations oscille entre 1450 et 1870 mm, celle de la température entre 16° et 19,5°C et celle de l'humidité relative entre 70% et 87%. Le relief est montagneux, vallonné par endroits. Le sol du milieu est un ferrisol (8,15).

2. Enquête préliminaire sur le rôle du bambou

Une enquête préliminaire visant à connaître le rôle socio-économique et culturel du bambou dans la vie des paysans riverains du parc a été menée en avril, mai et en juillet 1994. Il ressort de cette enquête que parmi les 5 variétés de bambou de montagne *(Arundinaria alpina)*, seule la variété dénommée Kahuzi présente des caractéristiques agro-socio-économiques et technologiques intéressantes. Par rapport à toutes les espèces de bambou sauvages et ou cultivées au Kivu *(Bambousa arundinacia, Gigatochloa maxima, Bambousa vulgaris, Oxytenanthera abyssinica,...)*, seule la variété Kahuzi d'*Arundinaria alpina* présente un caractère de résistance de longue durée aux attaques de charançons *(Dinoderus* sp.*)*. Dans les travaux de construction rurale (maisons d'habitations, clôtures,...), les tiges de ce bambou résistent naturellement pour plus de 20 ans contre les insectes xylophages d'après les affirmations des paysans interviewés. C'est la raison pour laquelle ces paysans l'exploitent dans son milieu naturel qui est par excellence le parc.

3. Déroulement de l'essai

En date du 1er octobre 1994, nous avons prélevé à la machette des boutures sur des tronçons de tiges aoûtées (variété Kahuzi) , âgées de 2-3 ans sur des touffes d'une bonne bambousseraie naturelle (située à 2000 m d'altitude, tout près de la station de Civanga) au parc. A la même occasion, des éclats de souches ont été prélevés. Etaient retenus, les éclats de souche sur lesquels on retrouvait 1ou 2 rejetons en émergence. Les jeunes touffes de bambou situées au lieu de récolte des boutures, ont été identifiées et suivies pour une comparaison ultérieure des paramètres tels que le dia-

mètre au collet, la hauteur des tiges, avec le bambou domestiqué (cultivé en milieu rural). Trois sites (Tableau 1) ont été choisis suivant un critère altitudinal le long de la rivière. Les boutures et éclats de souches ont été plantés en date du 9 octobre 1994 dans le sol bien labouré à la houe, ameubli, aéré et enrichi en matières organiques (14 t/ha de compost fabriqué avec les ordures ménagères). Les boutures étaient plantées sur buttes. La plantation des boutures a été faite en allées sur des lignes distantes de 10 m. Sur la ligne, la distance minimale entre 2 boutures plantées était de 10 m (écartement de 10 x 10 m). Dans chaque site d'essai deux types de plantation étaient aménagés. Une plantation était aménagée le long des berges de la rivière (biotope humide) et l'autre au milieu du champ du fermier (biotope moins humide). Les deux plantations étaient distantes l'une de l'autre de 120 m. Elles sont installées sur un même type de sol au point de vue granulométrique.
Pour chaque type de plantation et dans chaque site d'essai, la parcelle était de 0,5 ha, soit 100 boutures semées/ha. Toutes les boutures avaient bien repris. Aucune n'avait séché. Une année après le semis, toutes les jeunes touffes portaient plusieurs tiges primaires. Après la plantation, l'entretien (désherbage, sarclage conduite du tallage, coupe des brindilles ou tiges primaires,...) et le suivi étaient assurés par le propriétaire de la concession sous notre supervision.

Tableau 1
Caractéristiques des sites d'essai

Site d'essai	Kawandwa	Shabaganda	Lemera
Température (°C)	19,5	17,6	18,5
Hauteur des pluies (mm)***	1550	1650	1700
Humidité relative (%)	73	76	80
Pente du terrain (%)	3,5	6	10
Altitude (m)**	1650	1960	2410
Type de sols	Sol noir argileux, aéré, profond et fertile	Argilo-sablonneux, peu profond, peu fertile	Argilo-limoneux, sensible à l'érosion

(***)= Moyenne annuelle calculée sur 7 ans
(**)= L'altitude du terrain a été déterminée en utilisant un altimètre portatif de fabrication suisse
(*)= Source: Laboratoire de pédo-climatique de l'Institut National pour l'Etude et la Recherche Agronomiques (INERA), Station de Mulungu. Données compilées de 1992- 1998.

4. Observations faites

A ce niveau d'observation, toutes les composantes du rendement ne peuvent pas être relevées. La récolte à la machette était intervenue lorsque les bambous avaient atteint l'âge de 4,5 ans. La récolte était répartie sur le 2ème semestre de l'année 1998 et le 1er semestre de l'année 1999. On récoltait les tiges mâtures, c'est-à-dire celles portant une panicule avec des épillets ou celles dont la couleur des entre- nœuds virait du vert - jaune au rouge - violet ou au brun.
La tige retenue était débarrassée de ses branchioles, son bout terminal, ses poils duveteux avec les écailles spathiformes des nœuds et de ses fleurs. Une fois récoltée, la tige de bambou était séchée jusqu'à ne contenir que 25% d'eau. L'évaluation du rendement a été faite par comptage des tiges récoltées. Les composantes du rendement évalué sont: le diamètre au collet, la hauteur des tiges, l'épaisseur des parois des tiges, le poids de la tige séchée à 25% d' eau et la longueur des entre-nœuds. La hauteur des tiges considérée ici est la longueur de la tige située entre le bout terminal et le collet. Le poids de la tige était évalué par une balance de précision de 100 grammes près. Le diamètre au collet et l'épaisseur des parois des tiges avaient été mesurés par le pied à coulisse. La teneur en eau des tiges récoltées, puis séchées avant la pesée était évaluée par un humidimètre portatif. La longueur des entre-nœuds était évaluée par un mètre-ruban. Pour les touffes de bambous suivies au parc (Station de Civanga), l'évaluation du rendement était faite aussi par comptage des tiges récoltées. La coupe a été autorisée par les autorités administratives du parc.

Résultats et discussion

1. La récolte des tiges de bambou

Le tableau 2 présente la production obtenue pour les coupes réalisées d'avril à décembre 1998 et de janvier à mai 1999.

Tableau 2
Rendement moyen obtenu dans les différents sites: nombre moyen des tiges récoltées à l'hectare et données moyennes sur les composantes du rendement évaluées

Site d'essai		Lemera			Shabaganda		Kawandwa	
	Année	Mn	T*	Mng	Mg	Mng	Mg	Mng
Rendement : Nombre de tiges récoltées /ha	1998	850	1200	800	620	700	710	694
	1999	380	1150	350	400	307	306	350
Poids moyen de la tige (kg)		1,1	1	0,9	0,88	0,9	0,8	0,71
Epaisseur des parois de la tige (mm)		8,3	8	7	8	7	5,5	6
Longueur des entrenoeuds (cm)		40	30-45	30	45	30	35	25
Diamètre au collet (cm)		11	8,8	8	8	6,6	7	5,5
Hauteur de la tige (m)		8	12	5,5	6,7	4,6	4	3,8

T*= Les données dans cette colonne ont été receuillies sur les bambousseraies naturelles. Des jeunes touffes localisées en milieu humide ont été identifiées et suivies au PNKB, Station de Civanga durant la même période d'observation du bambou cultivé en milieu rural.
Mn= Milieu humide (Biotope humide)
Mng= Milieu moins humide (Biotope moins humide)

De ce tableau, il ressort que la production oscille en moyenne entre 300 et 850 tiges/ha/semestre. Pour les bambous suivis au parc, le rendement moyen obtenu était de 1200 tiges/ha/semestre. En plantations orientées vers la production de la pâte à papier (Ouest du Kenya), on obtient un rendement de 9000 tiges/ha/an en bambousseraies artificielles (d'*Arundinaria* sp.) âgées de 10 ans (6, 12). Comparativement au rendement obtenu au Kenya, le rendement obtenu dans notre essai est minime mais satisfaisant d'autant plus que la variété Kahuzi s'est montrée apte à la domestication (culture) en dehors de son aire de distribution, qui est le parc. La variété Kahuzi s'est très bien comportée dans le site à altitude voisine à celle de son biotope naturel (parc). Le sol humide est le meilleur milieu pour obtenir des récoltes satisfaisantes. Le site de Lemera a permis d'obtenir des tiges de 8 m de hauteur. En milieu naturel qui est le parc, la hauteur des tiges est en moyenne de 12 m. Le diamètre au collet, le poids de la tige récoltée et l'épaisseur des parois de tiges sont restés sensiblement les mêmes que ceux de la tige récoltée au parc. Les données obtenues pour le diamètre au collet, le poids de la tige récoltée et l'épaisseur des parois de la tige, oscillent respectivement entre 5,5 et 11 cm; 0,7 et 1,1 kg et entre 5,5 et 8 mm. Au parc ces mesures sont en moyenne de 8,8 cm; 1 kg, et 8 mm respectivement pour le diamètre au collet, le poids de la tige récoltée et l'épaisseur des parois des tiges. On peut donc affirmer qu' àprès une sensibilisation rationnelle, les paysans pourront donc gagner des revenus importants s'ils intègrent la culture de la variété Kahuzi dans leurs exploitations sylvicoles ou agroforestières au lieu de prendre le risque d'aller dévaster le parc chaque jour. Tenant compte du prix actuel de la tige de bambou, sur le marché local, à savoir 0,25 $, le paysan gagnerait un montant oscillant entre 50 et 225 $ U.S. (300-850 tiges X 0,25 $) en emblavant une surface d'un ha consacrée au bambou par semestre.

2. Test de résistance du bambou (variété Kahuzi) aux charançons (*Dinoderus* sp.)

La plupart des espèces de bambou cultivées jusqu'alors dans le milieu rural possèdent dans leurs tissus parenchymateux, une masse compacte d'amidon très utile pour la croissance des larves *(Dinoderus* sp.*)* d'insectes pouvant réaliser leur cycle biologique complet en 2-3 mois (6, 11). La variété Kahuzi expérimentée a moins d'amidon pouvant favoriser le développement des larves de ces charançons. Pour les tiges coupées en 1998, nous avons choisi au hasard 4 lots de 50 tiges chacun dans chaque site et pour chaque type de plantation. Ces lots de tiges de la variété Kahuzi ont été stockées en mélange avec les tiges de *Bambousa vulgaris et* d'*Oxytenanthera abyssinica*. Après neuf mois de stockage, soit du 5 juin 1998 au 10 mars 1999 , ces dernières s'étaient retrouvées sérieusement dégradées par les charançons *(Dinoderus* sp.*).* Seulement 27% (13/50) des tiges (variété Kahuzi) produites dans le site de Kamandwa (milieu humide) étaient attaquées par les *Dinoderus* sp. Ceci s'explique par le fait que le bambou produit à Kamandwa (1650 m d'altitude), était riche en amidon dans son tissu parenchymateux, condition essentielle pour la multiplication des charançons. En effet, nous avons envoyé des échantillons (150 morceaux de tiges de bambou) issus de différents sites au laboratoire d'analyses bromatologiques de l'Institut National pour l'Etude et la Recherche Agronomiques en avril 1999. Les résultats des analyses montrent que les échantillons de bambou en provenance du site de Kamandwa contiennent 20% d'amidon par rapport aux échantillons issus d'autres sites. Dans les autres sites, la teneur des bambous en amidon était de 3,9 %. On constate bien que la résistance du bambou a été partielle. Elle n'est ni durable ni stable dans le temps et dans l'espace, car au niveau du site de Kamandwa, nous trouvons que le bambou est sensible aux variations de l'environnement. Toutefois, il est admis que l'environnement d'un milieu joue un rôle dans la perte de la résistance naturelle d'un cultivar donné même en face du même type de pathogène ou de ravageur (9). Le fait que certaines tiges de cette variété soient attaquées signifie que les paysans vivant dans les zones agro-écologiques (entre 1500 et 1750 m d'altitude) ont raison de dire que ce bambou perdait sa qualité technologique une fois cultivé dans les villages. Ce constat avait été révélé bien avant par les paysans lors de nos enquêtes préliminaires sur le rôle du bambou en milieu rural. Dans les autres sites d'altitude supérieure à 1750 m, nous avons obtenu des résultats satisfaisants à ce sujet. Aucune tige n'a été attaquée.

3. Qualité commerciale du bambou cultivé

Dans chaque site, nous avons pris au hasard 3 lots de 100 tiges chacun parmi les tiges récoltées, séchées et stockées pendant 6 mois. Nous avons mélangé chaque lot en nombre égal avec les tiges coupées au parc pour la même variété. L'ensemble a été amené au marché local de Katana. Les tiges de bambou ont été achetées globalement; les consommateurs les ont appréciées autant que celles en provenance du parc. En d'autres termes, la variété Kahuzi conserve ses caractéristiques morphologiques et technologiques malgré la domestication réalisée en dehors de son milieu naturel.

Conclusion et suggestion

Cet essai visait à domestiquer une variété de bambou de la forêt de montagne du PNKB. Le but principal de l'essai était de savoir si la plante perdait, à cause de la domestication, ses caractéristiques, morphologiques, technologiques et de résistance naturelle aux attaques d'insectes xylophages (*Dinoderus* sp.,...); caractéristiques pour lesquelles les paysans l'exploitent dans le parc de façon illicite et dévastatrice.

Des résultats qui précèdent, nous pouvons conclure que:

- Contrairement à l'avis de certains exploitants, la plante ne perd pas toutes ses caractéristiques utiles, du moins, dans les différents sites où nous l'avons essayé.
- Ce bambou est domesticable. Le rendement obtenu (nombre des tiges de bambou adulte/ha) en cultivant la variété Kahuzi en milieu rural durant 5 ans oscille entre 300 et 850 tiges/ha/semestre, à partir de 100 boutures plantées/ha.

Comme pour toutes les autres espèces (végétales ou animales) menacées d'extinction, puisque surexploitées par l'homme dans le parc, nous recommandons aux chercheurs du parc de mener des études plus

poussées, orientées vers la domestication et la vulgarisation de cette variété de bambou dans différentes zones agro -écologiques du Sud- Kivu, afin de diminuer la pression anthropique sur le parc en vue de la conservation intégrale de sa biodiversité. Aux donateurs de fonds, nous les prions de financer plusieurs travaux de recherche appliquée car il n'existe pas de développement sans recherche .

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Seed Production, Herbage Residue and Crude Protein Content of Centro (*Centrosema pubescens*) in the Year of Establishment at Shika, Nigeria

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Keywords: *Centrosema pubescens* - Phosphorus - Establishment - Herbage residue - Seed - Nigeria

Summary

*A field trial was carried out on seed production pattern of centro (*Centrosema pubescens*) in the year of establishment in a sub humid environment of Nigeria as influenced by sowing date and phosphorus application levels. The herbage residue and its crude protein content were also determined after pod harvest. The variation in seeds per pod for plantings between June 21 to August 2 was from 16.5 to 14.5, while for unfertilized and fertilized plots seeds number varied between 12.6 and 16.2/pod. The weight of 1000 seeds decreased with delayed planting. Phosphorus application improved seed weight. Seed yield was highest (1000 kg/ha) for July 5 sowing with phosphorus application of 60 kg/ha P_2O_5 combination. The variation in mean seed yield for planting between June 21 and August 2 was 782.0 to 360.3 kg/ha. The application of 0 to 60 kg/ha P_2O_5 resulted in mean seed yields of 405.7 to 776.8 kg/ha. Herbage residue was favoured more by June 21 sowing and the application of 60 kg/ha P_2O_5. The crude protein content was better with August sowing and 60 kg/ha P_2O_5 .*

Résumé

Etude de la production de graines, de fanes et du contenu en matières protéiques brutes de *Centrosema pubescens* lors de sa première année de récolte à Shika, Nigeria

Un essai au champ a été réalisé dans une zone subhumide du Nigeria pour étudier l'effet de la date de semis et celui de différentes doses d'une fumure phosphatée sur la production de graines de Centrosema pubescens *lors de sa première année de récolte. La quantification de la production en fanes et de leur teneur en matières protéiques brutes a été faite après la cueillette des gousses. Le nombre de graines par gousse variait de 16,5 à 14,5 graines en fonction de la date de semis (21 juin et 2 août) et de 12,6 à 16,2 en fonction de la fumure (0 et 60 kg/ha P_2O_5). Il a été constaté que le poids de 1000 graines diminuait avec les retards de semis et que l'application du phosphore a eu un effet positif sur le poids des graines. Le plus haut rendement en graines (1000 kg/ha) a été obtenu pour le semis effectué le 5 juillet avec une application de 60 kg/ha P_2O_5. Ce rendement s'est élevé à 782,0 et 360,3 kg/ha pour les semis effectués respectivement le 21 juin et le 2 août. L'application d'une fumure phosphatée (60 kg/ha P_2O_5) a permis d'augmenter le rendement en graines de 405,7 à 776,8 kg/ha par rapport au témoin non fumé. La meilleure production de fanes a été obtenue pour la date de semis la plus précoce (21 juin) et dans les parcelles ayant reçu 60 kg/ha de P_2O_5. Quant au contenu en matières protéiques brutes, il a été le plus élevé pour les plantes semées en août et ayant également reçu une fumure phosphatée (60 kg/ha P_2O_5).*

Introduction

The National Animal Production Research Institute (NAPRI) is located at Shika, Zaria in the northern Guinea Savanna zone of Nigeria. The zone is suitable for seed production of food and forage crops because of its climate, topography and soil conditions. The mandates of NAPRI, include research, training and development of forage resources for animal production. Forage species have other uses apart from providing feed for livestock. The legumes in particular are used as green manure, cover crops and short term pastures in rotation with cereal crops. Production of forage seeds in the Institute commenced for commercial purpose over twenty years ago. The Institute remains the major seed producer of most forage/cover crop in the country. How-

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ever, one of the main constraints in use of centro (*Centrosema pubescens*) on large scale in the country is availability of foundation seeds in sufficient quantity. Despite the fact that NAPRI is situated within the zone that is suitable for seed production of food and forage crops, seed yields are comparatively low. Concomitant with this is the paucity of research data on pasture seed production. Increases in demand of centro seeds by both private and government establishments from National Animal Production Research Institute (NAPRI) for establishing legume-based pastures strongly suggest the need for intensive investigations on ways and means of increasing seed production.

A study by Akinola and Agishi (4) showed that seed production of centro was significantly improved by staking and successive pod harvests. Recently, Omokanye (11) reported the beneficial effect of early sowing with the application of 60 kg/ha P_2O_5 on forage yield and quality of centro. No report was found in the literature on the effect of time of sowing and phosphorus levels on its seed production in Nigeria within a specific time of one growing season in order to ensure wide outreach of centro seed distribution. This study was therefore designed to examine the effect of sowing date and phosphorus levels on seed yields and yield characteristics of centro in the year of establishment.

Table 1
Weather observations at Shika and Samaru during the experimental period

Month	Total rainfall (mm)	*Mean daily temp (0°C) Min	Max	*Relative humidity (%)	*Sunshine (hours/ day)
1991					
May	314.60	21.3	30.8	68.6	6.4
June	162.90	20.7	30.1	71.3	6.9
July	243.20	20.0	28.1	75.1	5.7
August	341.10	19.7	27.9	78.5	5.0
September	080.80	20.0	31.3	65.8	8.1
October	042.55	18.0	32.0	44.5	8.5
November	-	12.9	31.6	19.0	8.9
December	-	12.6	28.6	18.7	7.7
1992					
January		12.3	28.6	18.0	5.3
February	-	15.0	26.7	10.8	7.3

* Records from Institute for Agricultural Research, Samaru (Latitude 11°11' N, Longitude 7°38' E) is about 12 kilometers from Shika (Latitude 11°15' N, Longitude 7°32' E), Nigeria.

Materials and methods

Site description

The experiment was sited at the National Animal Production Research Institute (NAPRI), Shika, in the sub humid zone of Nigeria (Latitude 11°15' N, Longitude 7° 32' E, altitude 610 m above sea level). The climate of the study area is characterised by a well- defined wet and dry season. The wet season begins in April/May and ends in late September/mid October. The dry season on the other hand lasts from October to April with a low relative humidity and a dry north-east wind. The long-term annual rainfall (1980 - 1991) averaged 1118.2 mm. The highest mean maximum air temperature of 36.0°C is recorded in April while the lowest mean minimum temperature of about 11.5°C occurs in December/January. The soils of the study site have been classified as belonging to the ferruginous tropical soils derived from sandy parent material and crystalline acid rock (8). Kowal (9) described the physical properties of the soil as well-drained sandy loam soil with a clay fraction consisting mainly of kaolinite and small quantities of illite deficient in N and P. Based on World Reference Base for Soil Resources (WRB) and the FAO/UNESCO Soil Map of the World (7), Shika soil could be classified as Arenosols. This site (0-15 cm topsoil) just before the trial consisted of 10% clay; 11% silt; 79% sand; 5.6 pH; 0.030% total N; 11.9 ppm total P; 2.17 meq/100 g Ca^{2+}; 0.098 meq/100 g K^{+} and 0.118 meq/100 g Mg^{2+}. The weather observations during the trial period are reported in table 1.

Experimental design and procedures

The experimental area was disc-ploughed and twice harrowed to obtain a fine seedbed prior to sowing. Seeds harvested in November 1990 and treated with 98°c sulphuric acid for nine minutes to break hardiness, were used in the trials. Seeding was accomplished by hand drilling of the dry treated seeds into seedbeds. The experimental design was a split plot design with four sowing dates (21st June, 5th July, 19th July and 2nd August, 1991) as main plots and three phosphorus (P) levels (0, 30 and 60 kg/ha P_2O_5) as sub-plot. The treatment combinations were replicated twice. Each sub plot measured 2 m x 3 m with 1m allowance between plots. Seeding was done by drilling at the rate of 7.5 kg seeds/ha in 50 cm rows. Basal fertilizer application of 10 kg N/ha as starter dose was hand broadcast on individual plots at planting.

Establishment stands/m^2 branching/plant were determined 6 WPP. Plots were cross-staked 12 weeks after planting in order to facilitate hand picking of pods and to increase flower density and/ or pod set. Successive hand pickings as described by Akinola and Agishi (4) were used to obtain seed yields. Cypermetrin, an insecticide, was sprayed at the rate of 25 ml to 15 litres of water onto all the plots at flowering in order to control the attack of mealy bugs (*Ferrisia virgata*) and blister beatles (*Mylabris trifaciata*).

Hand picking of dessicated, ripped pods was done at four-day intervals from late November, 1991 to early February, 1992. The harvested pods were then threshed and winnowed to extract the seeds. Herbage residues after pod harvest were determined by cutting two 1 m x 1 m quadrat from each plot at a height of 7.5 cm above the ground level after oven drying at 60°C for 48 hours.

Chemical analyses of whole plant samples

The oven dried samples were ground with Christy and Norris Laboratory mill using a 1 mm mesh. These were subsequently analysed for N content on DM basis according to the standard Micro-Kjedahl method (5). Crude protein (CP) content was calculated as 6.25 x % N.

Statistical analysis

Data were statistically analysed using Proc GLM procedures of SAS (14). Only the means pooled across treatments are presented and discussed.

Results

Table 2 presents data on establishment stands, branching and days to 50 % flowering. Sowing date and P levels significantly (P< 0.05) affected plant density.

Table 2
Establishment stand count and branching (6 WPP) and days to 50 % flowering of centro (C. *pubescens)* as influenced by sowing date and phosphorus level at Shika, Nigeria

Treatment	Stand count (NO./m²)	Branching (NO/plant)	Days to 50 % flowering
Sowing date:			
June 21	27.4[a]	2.9	118 [a]
July 5	23.2[b]	3.1	111 [b]
July 19	17.7[c]	2.5	103 [c]
August 2	11.5[d]	2.5	98 [c]
Phosphorus level (kg P_2O_5/ha):			
0	18.4	2.2[b]	103[b]
30	21.2	2.8[a]	107[b]
60	20.3	3.3[a]	113[a]

Means in a column with different superscripts differ significantly (P< 0.05).

Number of stands was highest (27.4 plants/m²) and gradually decreased with delay in sowing date to 11.5 plants/m² with the last sowing date. The application did not show any significant difference on number of stands at establishment. Branching was higher with early July sowing and the dates was not significant (P> 0.05). Branching however increased from 2.2/plant when no P was applied though 2.8/plant for 30 kg/ha P_2O_5 to 3.3/plant for 60 kg/ha P_2O_5. Late sowing favoured early days to 50 % flowering than did earlier sowings. The application of P delayed days to 50 % flowering.

Table 3 presents data on seed number/pod, weight of 1000 seeds, seed yield, herbage residues and CP content of centro as influenced by sowing date and phosphorus level in establishment year. Seed number per pod decreased (P< 0.05) as the sowing date was delayed till August. The responses due to phosphorus application were not significant. Seeds per pod was best (i.e. 16 seeds/pod) for sowing between June 21 and July 19. The range in seeds per pod for plantings between June 21 to August 2 was 16.5 to 14.5. The lower seed number (i.e. 14.5 seeds/pod) was obtained with delayed planting in August. For unfertilized and fertilized plots seeds number varied between 15.6 to 16.2/pod.

The viability of seeds is normally estimated from weight of the seed. The weight of 1000 seeds is used as standard procedure. Weight of 1000 seeds decreased (P< 0.05) with delayed planting. Phosphorus application improved weight of seed but there was no significant difference in weights obtained at 30 or 60 kg/ha P_2O_5 application. Mean weights of 1000 seeds for plantings between June 21 and August 2 varied between 19.5 to 18.3 g. For unfertilized and fertilized plots the mean weights varied between 18.2 and 19.3 g/1000 seeds.

Seed production was influenced by both sowing date and phosphorus application with significant interaction (P< 0.05) between the two factors. Seed yield decreased (P< 0.05) with delayed sowing date but increased with P application. Seed yields was highest (1000 kg/ha) for July 5 sowing with phosphorus application of 60 kg/ha P_2O_5. The variation in mean seed yields for planting between June 21 and August 2 was 782.0 to 360.3 kg/ha. The application of 0 and 60 kg/ha P_2O_5 resulted in mean seed yields of 405.7 to 776.8 kg/ha, respectively.

Herbage residue was significantly (P< 0.05) affected by sowing date. This was highest (3205 kg DM/ha) for June 21 sowing and lowest (2491 kg DM/ha) for August 2 sowing. There was an impressive performance of centro when given P fertilizer. The application of 30 and 60 kg/ha P_2O_5 recorded herbage residue of about 65 and 68 % higher than the unfertilized control plot.

Surprisingly, sowing in the first week of August which performed least for other parameters examined had the highest CP content (12.25 %) after pod harvest in the dry month of February in a sub humid zone of Nigeria. A cursory look at Table 3 on CP content shows that CP content gradually increased with delay in sowing date. The application of 0; 30 and 60 kg/ha P_2O_5 respectively had 8.19; 13.13 and 13.69 % CP.

Table 3
Seed yield and yield components, herbage residues and crude protein (CP) content of centro *(C. pubescens)* as influenced by sowing date and phosphorus level at Shika, Nigeria

Treatment	Seeds/ pod (NO./m²)	1000 seeds weight (g)	Seed yield (kg/ha)	Herbage residue (kg/ha)	CP content (%)
Sowing date:					
June 21	16.4[a]	19.4[a]	718[b]	3205[a]	11.25[b]
July 5	16.5[a]	19.5[a]	782[a]	3016[a]	11.44[b]
July 19	16.0[a]	18.5[b]	572[c]	2782[b]	11.69[a]
August 2	14.5[b]	18.3[b]	360[d]	2491[c]	12.25[a]
Phosphorus level (kg P_2O_5/ha):					
0	15.6	18.2[b]	406[c]	1755[c]	8.19[b]
30	16.2	19.3[a]	642[b]	3217[b]	13.13[a]
60	15.8	19.3[a]	777[a]	3649[a]	13.69[a]

Means in a column with different superscripts differ significantly (P< 0.05).

Discussion

The data on establishment stand and branching recorded in this study are similar to an earlier findings in the same environment (12). Observations of the plots showed that the application of 60 kg/ha P_2O_5 on centro under rainfed condition prolonged the vegetative stage by about 7 days and caused profuse flowering than did at 30 kg/ha P_2O_5 or unfertilized control plots. These observations had earlier been reported for horsegram (*Macrotyloma uniflorum*) (12 & 13) and centro (*Centrosema pubescens*) (11) in the same environment.

Seed production from a given area is a function of seed number and weight of seed produced. Results in this study indicated that seed number per pod is a genotype characteristics as it was not influenced by P-fertilizer application. The low number observed from the late

planted plots which differed significantly from other planting date treatments could have resulted from incomplete development of reproductive organs - an effect further reflected in seed weight and total seed yield. Early plantings (June 21 and July 5) in combination with P-fertilizer application (30 and 60 kg/ha P_2O_5) resulted in heavier seeds. The yields for the 21 June and 5 July plantings were 718.0 and 782.0 kg/ha, respectively while yields for the 30 and 60 kg/ha treatments were 642.0 and 776.8 kg/ha. These yields, with respect to either planting date or P-fertilizer treatment, were considerably higher than the seed yields (overall average of 390 kg/ha) obtained by Akinola and Agishi (4) working in the same environment. In the latter study 12 kg/ha P_2O_5 was applied in the form of 20 N: 4 P: 8 K which could have favoured fodder over seed production. For seed production in forage legume the results in this study support numerous reports in the literature (2, 3, 4, 5, 7, 15) and these indicate that P-fertilization should take precedence over N-fertilization. The data obtained seems to suggest that during the year of establishment, centro if planted earlier with adequate amount of P fertilizer following staking as earlier recommended (4), would suffice for satisfactory amount of seed yield. Another advantage is that centro would also produce substantial amount of herbage residue that would be well above the 7 % CP contents considered for maintenance of livestock (10) and in the range recommended in the diet of ruminants (1).

Conclusion

The results of this study seem to suggest that early plantings (June 21 and July 5) in combination with phosphorus fertilizer application (30 and 60 kg/ha P_2O_5) will suffice for satisfactory heavier seeds and seed production per unit area. Seed yield in the present circumstances are considerably higher than the seed yields (overall average of 390 kg/ha) obtained by Akinola and Agishi (4) working in the same environment.

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Adoption of Rice Production Techniques among Wetland Farmers in Southeastern Nigeria

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Keywords: Wetland rice production- Production techniques- Intensity of adoption- Agricultural extension

Summary

The study was designed to determine wetland rice production techniques adopted by a sample of 80 farmers in Enugu State, Nigeria, and the factors influencing the intensity of adoption. Out of the 15 techniques prescribed in the wetland rice production leaflet of the State Agricultural Development Authority, five were not adopted by a majority of the farmers. The mean yield for paddy was 1.99 ton/ha. However, there was no significant difference in yield between high and low adopters. It was also shown that intensity of adoption was influenced by level of education, farming experience, primary occupation and tenurial status. Because some of the farmers were part-time and non-resident in the farm locations, it was recommended that rescheduling extension visits in the farms during weekends when many of them can be located in the farms will improve extension contact. Mass methods of extension especially radio should be utilized to increase awareness.

Résumé

Adoption des techniques de production du riz dans une rizière humide au sud-est du Nigeria

L'étude s'est proposée de déterminer non seulement les techniques de production du riz dans une rizière humide, adoptées par un échantillon de 80 cultivateurs dans l'Etat d'Enugu au Nigeria, mais également les facteurs influant sur l'intensité de l'adoption. Parmi les 15 techniques vulgarisées par le «State Agricultural Authority», cinq n'ont pas été adoptées par la majorité des cultivateurs. La production moyenne de riz paddy était de 1,99 tonnes/ha et aucune différence significative n'a été observée entre les fermiers pratiquant ces techniques à différents niveaux. L'étude a également révélé que l'intensité d'adoption était influencée par le niveau d'éducation, l'expérience agricole, le métier principal et le statut foncier. Comme quelques agriculteurs travaillent à temps partiel et ne résident pas sur le lieu de travail, il a été recommandé que les visites chez les fermiers se fassent les week-ends afin d'améliorer les contacts. L'utilisation de la radio représente un moyen médiatique de sensibilisation.

Introduction

In Nigeria, rice has become a staple food especially in urban centers and has assumed a cash crop status in production areas. Domestic consumption of rice rose from about 3 kg/yr person in 1970 to about 11 kg/yr per person in 1980 (7). This has led to chronic rice shortages because the increasing demand for rice has outpaced the supply from domestic production. Attempts to reduce the shortages led to massive imports which rose to 600,000 metric tons in 1982 (6) and caused a serious drain on the nation's foreign exchange reserve. To check this trend and encourage local production, the government prohibited rice imports in 1985. This action was contrary to trade liberalization which has been prescribed by the World Bank as one of the strategies for restoration of growth in the developing countries (4, 13). Since then, domestic rice shortages have re-emerged together with other food shortages. A number of steps have been taken to increase local production. One of these steps was the Structural Adjustment Programme (SAP) which was intended to reserve some of the adverse developments in the agricultural sector (5) and to induce the adoption of improved farm practices (8), especially in smallholder agriculture. The establishment of state-wide Agricultural Development Programmes (ADPs) as opposed to enclave integrated rural development projects was a bold step toward supervised extension management systems with the objective of transferring farm innovations to farmers through fortnightly visits by extension agents following the Training and Visit (T and V) extension principle. However, since its inception, SAP has drastically reduced subsidies on agricultural inputs. Devaluation of the local currency has led to inflation. This has impaired the capacity of the nation to finance technology, imports and domestic substitutes, and to adequately finance the operational and wage costs of the ADPs in ordre to ensure effective discharge of their functions. Given the inflationary trend in cost of inputs and dwindling funds for extension, it is doubtful if the continued adoption of farm technologies by rice farmers is possible, especially in the absence of adequate credit and extension services. However, in view of the growing demand for rice, the assumption

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here is that farmers' adoption of improved production practices will be on the increase. The objective of the paper, therefore, is to investigate farmers' adoption of rice production practices as disseminated by the ADPs. More specifically, the study intends to:

- determine the levels of use or adoption of the practices;
- compare farmers' yield per hectare according to intensity of adoption; and
- isolate factors which influence farmers' adoption of the practices.

Methodology

Data for the study were primary data collected by means of repeated visits and use of semi-structured questionnaire from a sample of rice growers in Enugu State in the 1995 farming season. Two agricultural zones, Enugu and Abakaliki, out of the three in the State, were selected for the study. One local government area (L.G.A.) namely, Ishielu, in Abakaliki zone and Awgu zone, was selected from each zone. From each L.G.A., one community each (Ezillo in Ishielu and Oduma in Awgu) was selected. A list of rice growers was compiled with the assistance of extension supervisors from which 120 farmers were randomly selected. However, only 80 copies of the questionnaire were correctly completed and were used for the analysis.

Data analysis

Mean adoption score was calculated for each of the 15 practices prescribed in the Enugu State Agricultural Development Programme (ENADEP) leaflet on rice production. Each practice adopted was scored one while non-adoption of the practice was scored zero. An average adoption score was calculated (0.69) and was used as adoption index. For each of the respondents the total number of practices used was summed up and a grand mean was calculated (10.7). Rice growers whose intensity of adoption scores were less than 10.7 were grouped as low adopters, while those with scores greater than 10.7 were labelled high adopters. A chi-square test was used to determine any significant difference in yield per hectare between the two groups ($P< 0.05$). In order to determine the functional relationship between intensity of adoption and a set of relevant socio-economic variables which influence adoption, the following model was adopted:

$$Y= (x_1, x_2, x_3, x_4, x_5, x_6, x_7, u)$$

Where:

Y= adoption intensity measured by number of techniques or practices prescribed by ENADEP extension agent in wetland rice production adopted by the farmers;

X_1= farmer's age in years;

X_2= farmer's level of education measured by number of years in school;

X_3= farming experience measured in years in rice growing;

X_4= primary occupation. This is a dummy variable with a value of unity if the subject is a full-time farmer and a zero if otherwise;

X_5= farm size measured in hectares of rice farm in 1994;

X_6= frequency of extension contact measured as the number of times the farmer was visited by an extension agent;

X_7= tenurial status. This is a dummy variable with a value of unity if the farmer is owner operator and zero if otherwise.

The expectation of the above model is that the seven independent variables have a positive relationship with the dependent variable (Y) up to a certain limit. Three functional forms were tested, namely: linear, semi-logarithmic and doubt logarithmic forms. The semi-logarithmic form was found to best fit the data, and was chosen as the lead equation for the interpretation.

Result and discussion

Socio-economic characteristics

The mean age of the sampled farmers was 40.8 years. Most of the farmers were young with 41.3 percent in the age bracket of 31- 40 years; 32.5 percent were between 41- 50; and 15.0 percent were in the 20- 30 years age bracket. Level of literacy was high with 72.5 percent having had 4 to 11 years of formal schooling. Slightly over half (56.3 percent) of the rice growers were full-time farmers; 12.5 percent were wage earners made up mainly of teachers and civil employees; and 21.2 percent were petty traders and artisans. It was interesting to note that over half of the growers (57.1 percent) were resident in urban areas and commuted to work their fields. About 74 percent had grown rice for between one and ten years indicating their relatively young entry into the enterprise. Mean size of the farms was 2.1 ha with about 34 percent cropping 1- 1.9 ha and 30 percent cropping 2- 2.9 ha. It was also interesting to note that 28 (80 percent) of the part-time operators had contiguous fields in single blocks while a majority of other farmers had their plots scattered in two to three locations. Most part-time operators rented government agricultural land mainly at Ezillo while the others depended on private plots. Extension contact for the growers was low. About 19 percent had no contact in 1994; 23 percent had three to four contacts; 10 percent had five to six contacts and five percent had over six contacts. Among the sample the mean yield of paddy was 1.99 ton/ha in 1994. This was found to be close to 2.19 ton/ha reported for male rice growers in the State for 1994 by the monitoring and evaluation unit of ENADEP (2). About 31 percent had yields of 1- 1.9 ton/ha; 26 percent recorded 2- 2.9 ton/ha; 25 percent had 3- 3.9 ton/ha; and about 18 percent had less than 1 ton/ha.

Adoption of rice production techniques

Out of the 15 techniques prescribed and disseminated by extension, over half of the farmers were not using five of the techniques (Table 1).

About 63.0 percent of the sample did not dress seeds with APRON PLUS or Fernasan D; all farmers used different fertilizer formulations 2- 3 weeks after planting but 68 (85.0 percent) did not carry out second application with nitrogen fertilizer at 9- 10 weeks after planting;

Table 1
Distribution of Non-adopters and major reasons for Non-adoption of recommended technical knowledge

S/No	Techniques	Mean Adoption	No. of Non-adopters	Major Reasons for Non-adoption
1	Selected hydromorphic soil	0.90	0 (0.0)*	—
2	Selected recommended HYV	0.35	29 (36.3)	Own seeds reliable
3	Dress seeds with Apron PLUS or Fernasan D	0.45	49 (61.3)	Agrochemicals are unavailable
4	Use 45- 50 kg of seed per ha	0.56	11 (13.8)	Seed rate not known
5	Plant nursery 3- 4 weeks	0.91	0 (0.0)	—
6	Transplant June- July	0.66	11 (13.8)	Time depends on rainfall
7	Transplant 3- 4 seedlings at 20 cm x 20 cm	0.69	8 (10.0)	Unawareness
8	Weed twice at 2- 3 weeks and 6- 7 weeks	0.96	13 (16.3)	High cost of labour
9	Apply 8 bags of NPK 15-15-15 per ha 2- 3 weeks after transplanting	0.95	15 (18.8)	Fertilizer is costly
10A	Apply 2 bags of CAN or 1 bag of Urea 9- 10 weeks after transplanting	0.42	68 (85.0)	Unawareness
11	Apply systemic insecticide at 25 kg per ha forthnightly to prevent gall midge	0.58	62 (77.5)	Pesticides are scare and costly
12	Scare birds from flowering until harvesting	0.86	19 (23.8)	Unnecessary
13	Harvest when 75% - 80% of panicle head turn straw colour	0.85	3 (3.7)	Seeds go bad easily
14	Dry field 2 weeks before harvesting	0.55	74 (92.5)	Unnecessary
15E	Expected yield is 1.5 ton/ha to 4.5 ton/ha	0.35	63 (78.8)	Unawareness

Adoption index = 0.69 *Numbers in parentheses are percentages

62 (78.0 percent) did not apply any insecticide; 74 (92.5 percent) did not drain their fields before harvesting; and 63 (79.0 percent) did not know the expected yield range of 1.5 to 4.5 ton/ha. Reasons commonly given by most farmers for not using these five techniques included: high cost and unavailability of insecticides (78.0 percent); most farmers did not know about topdressing (87.0 percent); draining the field before harvesting is unnecessary (80.0 percent); and that yield was dependent on the amount of rainfall in the year (87.0 percent). With an adoption index of 0.69 as the cut off point, it could be shown that seven practices were highly adopted (Table 1). These were soil selection (0.90); nursery planting (0.91); transplanting and spacing (0.69); weeding at 2- 3 weeks and 6- 7 weeks after planting (0.69); application of fertilizer at 2- 3 weeks (0.95); scaring of birds (0.86); and harvesting when 75%- 80% of panicle heads turn straw colouring (0.85). In spite of the reasons given, it could be deduced that farmers tended to internalize and practise techniques which they consider essential for production irrespective of extension messages delivered. Secondly, repeated extension visits become necessary in order for the farmers to become convinced of the importance of agronomic practices as a condition for obtaining higher yields. However, a chi-square test of significance showed that there was no significant difference between high and low adopters of the techniques (χ^2= 0.8955, table χ^2= 5.99 at 5 percent). This lack of difference could be attributed to the fact that the year under study was a "good year" according to the farmers. There was no incidence of pest and disease on an epidemic level and rainfall was adequate. In spite of the claims, it should be admitted that the farmers could still obtain higher yields without adopting some techniques such as draining field before harvesting, and which they might consider unnecessary. This could strongly influence the above result.

Regression result of adoption of rice production techniques

The functional relationship between intensity of adoption (Y) and some relevant socio-economic characteristics influencing it is as follows:

$$\text{Ln } Y = 6.72 - 0.24x_1 + 0.32x_2 + 0.28x_3 + 0.31x_4 - 0.42x_5 - 0.35x_6 + 0.26x_7$$

(SE)= (0.95) (0.042) (0.052) (0.002) (0.14) (0.043) (0.03)

Multiple R	0.97
R^2	0.95
Adjusted R^2	0.92
Standard Error	0.13
F- Statistics	34.19

The value of coefficient of determination (R^2)= 0.96. The result shows that intensity of adoption (Y) is an increasing function of such socio-economic characteristics as level of education (x_2), farm experience (x_3), occupation (x_4) and tenurial status (x_7). By the standard error test these variables have significant influence on adoption of rice production practices by growers in the study locations.

However, age (x_1), farm size (x_5) and extension contact were not found to be significant parameters of adoption within the content of the study. As for the age the finding is consistent with those reported by Okoye (9), Onu (10) and Onyenweaku and Mbuba (11). The findings on farm size and extension contact were unusual because other writers such as Agbamu (1) and Atala *et al.* (3)

have shown them to influence adoption. This finding could arise from inadequate information supplied in our own data.

The value of coefficient of determination (0.96) indicates that about 96 percent of the total variation in the dependent variable (Y) was explained by the variations in the explanatory variable (x_5). The adjusted R^2 was also high (0.93). It could be concluded that there is a strong positive relationship between adoption (Y) and level of education (X_2), farm experience (X_3), primary occupation (x_4) and tenurial status (x_7), and this agrees with the expectation.

Conclusion

The study revealed that rice growers were relatively young and had a good level of education. Although a fairly large number of them were part-time farmers and some were resident outside the farm locations, their age and education should be considered an advantage for the acceptance of innovations. However, the non-residency of some of the farmers posed a problem to extension agents as places and time of day to meet them could not be predicted. This could be seen in the lack of influence of extension contact on adoption and the low level of extension contacts reported. In a situation where extension contact is very poor, it is suggested that agents in collaboration with supervisors should develop a strategy for overcoming the difficulty in visiting farmers. This will entail shifting emphasis away from home visits to farm visits. Secondly, because part-time farmers are more likely to work on weekends, agents could schedule to visit such farmers in the field on weekends, and in agreement with their supervisors they can take days-off during the working week. Thus, through increased contact, farmers will interact often with agents and will be in a better position to adopt all the techniques as prescribed by the ADP. Personal contact can be supplemented with radio jingles especially during the production season in order to create awareness. Lastly, extension agents should emphasize those techniques that directly influence yield and leave out those considered unnecessary by farmers such as bird scaring and field draining before harvesting.

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Effect of Spatial Arrangement on Growth and Yield of Cowpea in a Cowpea-maize Intercrop

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Keywords : Crop competition – Radiation – Spacing

Summary

Cowpea growth and yield performance when intercropped with maize was studied for 3 consecutive seasons under three spatial arrangements, i.e., maize planted at 90 x 30, 100 x 27, and 120 x 22.5 cm, with 2 rows of cowpea between the maize rows. Growth and yield of cowpea was improved significantly by widening maize inter-row distances as compared to the 90 x 30 cm spacing.
Hence, intercropped cowpea needs to be sown where maize rows are wide apart, but the maize rows should not be too wide as this would lower the grain yield of maize.

Résumé

Effet des écartements sur la croissance et le rendement du niébé cultivé en association avec le maïs
La croissance et le rendement de deux variétés de niébé cultivées en association avec le maïs ont été étudiés pendant trois saisons consécutives en modifiant la densité de semis des deux composantes (deux lignes de niébé par ligne de maïs avec les densités de semis suivantes pour le maïs: 90 x 30 cm, 100 x 27 cm, 120 x 22,5 cm). La croissance et le rendement du niébé ont été significativement améliorés par l'augmentation de la distance entre les lignes de maïs comparé à l'écartement 90 x 30 cm. Les meilleurs rendements en niébé sont obtenus pour les écartements les plus élevés entre les lignes de maïs. Une trop grande augmentation de ces écartements risque cependant de se traduire par une diminution sensible de la production du maïs.

Introduction

Cowpea (*Vigna unguiculata* (L.) Walp) forms one of the major sources of proteins and revenues in many areas of the semi-arid tropics (4, 6). In Uganda, the crop is widely grown in the northern and eastern regions, but yields in the farmers fields are quite low (< 300 kg/ha). Many farmers grow cowpea in association with other crops especially maize, sorghum, greengram and cassava (1, 8). However, there is paucity of information about the appropriate spatial arrangements to achieve high yields. The objective of this study was to evaluate the effect of spatial arrangement on growth and yield of cowpea in a cowpea/maize intercrop.

Material and methods

Field experiments were carried out at Makerere University Agricultural Research Institute, Kabanyolo (32° 37'E, 0°28'N, 1200 m above sea level) and at Serere Agricultural and Animal Production Research Institute (33°27'E, 1°31'N, 1000 m above sea level) during the first (February- June) and second (September- December) seasons of 1996. It was repeated at Kabanyolo during the first rainy season of 1997.

Mean monthly rainfall during the first and second cropping seasons of 1996 averaged 159.3 and 138.2 mm for Kabanyolo and 246.7 and 144.1 mm for Serere. For the first season of 1997 at Kabanyolo monthly rainfall averaged only 96.8 mm. At both locations no fertilizer was added. Two cowpea varieties Ebelat (local) and an introduced variety IT82D-716 (from the International Institute of Tropicultural Agriculture, IITA, Ibadan) were planted as sole crops or intercropped with maize cv. Longe 1. The experimental design was a split-plot with varieties as the main-plots and spatial arrangements randomized as sub-plots.

The following spatial arrangements were investigated;

SA_1 – Maize planted at 90 x 30 cm with two rows of cowpea 40 cm apart planted between the maize rows. Thus, each cowpea row was 25 cm from the nearest maize row (8 cowpea and 5 maize plants/m^2, respectively).
SA_2 – Maize planted at 100 x 27 cm, with two rows of cowpea 40 cm apart planted between the maize rows. Each cowpea row was 30 cm from the nearest maize row (8 cowpea and 4 maize plants/m^2, respectively).
SA_3 – Maize planted at 120 x 22.5 cm, with two rows of cowpea 40 cm apart planted between the maize rows. Each cowpea row was 40 cm from the nearest maize row (8 cowpea and 5 maize plants/m^2).

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Field procedures and data collection and analysis basically followed those described by Obua *et al.* (6) for the cowpea-sorghum intercrop trial. Leaf area index (L.A.I.) and plant dry weight were determined for both sole and intercrop treatments at the vegetative, anthesis and pod/ear filling stages. Other variables measured included height of maize plants at maturity and number of branches per cowpea plant. Seed yield and yield components were also determined for both crops. For maize, the yield components measured included the number of kernels rows per cob, number of seeds per kernel row, 1000-seed weight and grain yield/6 m^2. Yield components were determined after sun drying the cobs to approximately 13% moisture content.

Land equivalent ratios were calculated to determine intercrop benefit (3). Analysis of variance (ANOVA) procedures using Mstatc computer programme (Russels O. Freed, Michigan State University, USA) and mean separation using LSD were the statistical tools (9).

Results and discussion

There was low and poorly distributed rainfall during the first season of 1997 (96.8 mm/month), causing failure of the maize crop. However, the cowpea crop still yielded relatively well. As such, discussions that follow are restricted to the two seasons of 1996 when successful growth of the two crops was achieved.

Spatial arrangements significantly (P= 0.05) affected both the growth and yield of cowpea. Highest L.A.I., branching habits and plant dry matter (DM) were obtained under SA_3, where the inter-row distance for maize were widest. SA_1 recorded the lowest L.A.I., DM/plant and fewest branches of cowpea (Tables 1 & 2). The wider inter-row distance between adjacent maize rows in SA_3 probably allowed more solar radiation to penetrate into the lower cowpea canopy as compared to SA_2 or SA_1 where the inter-row spacings for maize were narrower. There was no significant effect of the cowpea varieties on L.A.I., but variety x spatial arrangement interaction was significant at Serere during the first rains (Figure 1). For this season, there was higher L.A.I. at Serere than Kabanyolo because Serere experienced heavy rainfall which favoured more vegetative growth. Contrastingly, the relatively higher L.A.I. for cowpea at Kabanyolo than Serere during the second rains was due to the poor distribution of rainfall at Serere. As during the first season of 1996, varietal differences did not significantly influence the cowpea branching habits.

The effect of spatial arrangement was significant at both locations and during the two seasons of 1996. The spatial arrangement, in which the inter-row spacing for maize was the widest (SA_3) gave the highest number of cowpea branches. This was followed by SA_2, where the inter-row distance for maize was medium, and the least number of branches per plant was obtained with SA_1, in which the inter-row spacing for maize was the narrowest. Widening the inter-row spacings for maize seemed to provide adequate space and thus, enabled enough sunlight to reach cowpea, which in turn enhanced more branching of cowpea than under the narrower inter-row spacings. The highest numbers of branches per plant were obtained from the sole crop treatments compared to the intercrops. This probably indicated some degree of shading in the intercrop by the taller component crop, i.e., maize, which hindered the formation of many branches under the narrower spacings (SA_1 and SA_2).

Generally, as the distance between two adjacent maize rows was widened, there was a corresponding increase in the dry matter production in cowpea irrespective of the cowpea variety. The more branches of cowpea formed under wider inter-row spacings for maize must have contributed to the higher dry matter accumulation.

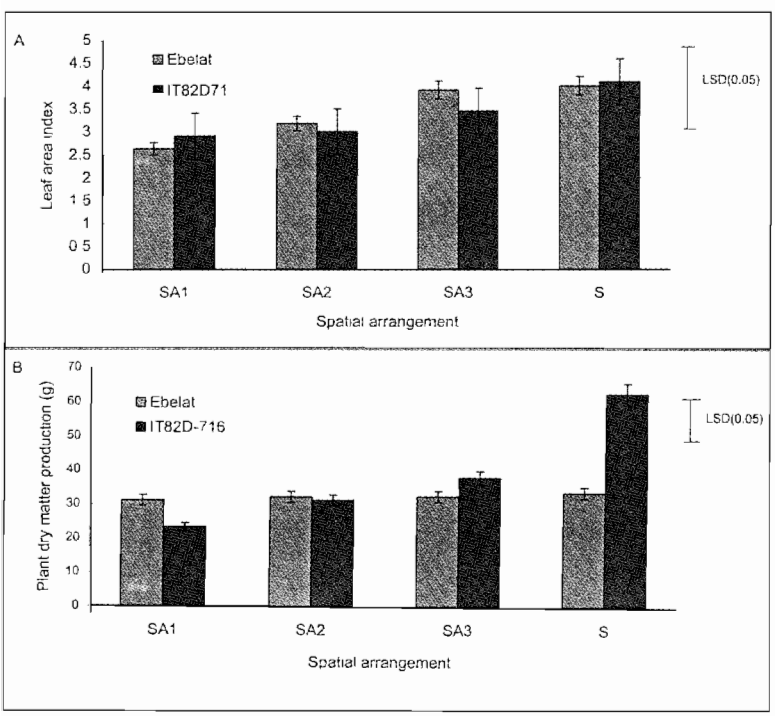

Figure 1: Effect of variety x spatial arrangement interaction on LAI (A) and dry matter production (B) of cowpea during the 1st rains.

IT82D-716 (V_2), however, showed a higher dry matter production in comparaison to the local variety, Ebelat (V_1) during the first rains both in the sole crop and when intercropped with maize but in the second rains, the reverse was true (Tables 1 & 2). There was, however, no statistical difference in dry matter production for the two cowpea varieties at Serere.

Grain yields very closely followed the growth trend. Highest number of pods/plant and grain yield (kg/ha) were obtained under the SA_3 spatial arrangement, and the lowest under the SA_1 arrangement (Table 3). The trend was similar for both Serere and Kabanyolo. Similar results were reported by Leihner (2). The higher grain yields under-wider inter-row spacing is attributed to the more branching achieved by cowpea due to less shading from the tall maize plants. Sole cowpea crops had the highest yield compared to those intercropped with maize, albeit the low cowpea population in the intercrop. However, higher grain yields were obtained from Ebelat than IT82D–716, at both locations, except at Serere during the second rains. The lower yield IT82D-716 during the second season at Serere was partly due to scab disease (data not presented) rather than

Table 1
Effect of spatial arrangements on growth of cowpea intercropped with maize

Treatments	L.A.I.	Branches/plant	DM/plant (g)
V_1 x SA_1	1.96	5.93	21.78
V_1 x SA_2	2.16	6.70	29.87
V_1 x SA_3	2.22	7.67	32.74
V_1 x S	2.73	7.00	43.52
Mean	2.26	6.83	31.98
V_2 x SA_1	2.11	6.40	25 .33
V_2 x SA_2	2.24	6.73	30.72
V_2 x SA_3	2.36	7.07	36 .97
V_2 x S	2.60	7.93	50.09
Mean	2.33	7.03	35.78
LSD (0.05)	0.23	0.78	4.62
C.V. (%)	5.55	6.35	7.68

V_1 = Ebelat; V_2 = IT82D-716
SA_1 = maize planted at 90 x 30 cm + 2 rows of cowpea between maize rows
SA_2 = maize planted at 100 x 27 cm + 2 rows of cowpea between maize rows
SA_3 = maize planted at 120 x 22,5 cm + 2 rows of cowpea between maize rows
S = sole cowpea

Table 2
Effect of spatial arrangements on growth of cowpea intercropped with maize

Treatments	L.A.I.	Branches/plant	DM/plant (g)
Kabanyolo			
V_1 x SA_1	1.95	11.93	38.26
V_1 x SA_2	1.89	11.73	40.28
V_1 x SA_3	2.01	14.73	49.97
V_1 x S	2.74	21.20	63.13
Mean	2.15	14.90	47.91
V_2 x SA_1	1.56	12.87	29.20
V_2 x SA_2	2.10	14.03	35.71
V_2 x SA_3	2.02	16.80	37.36
V_2 x S	2.87	22.40	61.21
Mean	2.14	16.53	40.87
LSD (0.05)	0.91	2.66	11.11
C.V. (%)	23.71	9.53	14.07
Serere			
V_1 x SA_1	1.29	8.50	24.38
V_1 x SA_2	1.52	8.16	32.10
V_1 x SA_3	1.58	11.17	40.63
V_1 x S	2.22	17.57	52.64
Mean	1.65	11.35	37.44
V_2 x SA_1	1.33	9.23	19.86
V_2 x SA_2	1.61	10.77	31.07
V_2 x SA_3	1.52	13.13	31.35
V_2 x S	2.53	18.27	51.52
Mean	1.75	12.85	33.45
LSD (0.05)	0.53	2.82	8.41
C.V. (%)	17.65	13.08	13.33

V_1 = Ebelat; V_2 = IT82D-716
SA_1 = maize planted at 90 x 30 cm + 2 rows of cowpea between maize rows
SA_2 = maize planted at 100 x 27 cm + 2 rows of cowpea between maize rows
SA_3 = maize planted at 120 x 22,5 cm + 2 rows of cowpea between maize rows
S = sole cowpea

solely to lower yield potential of this variety.
Cowpea yield was higher at Kabanyolo than at Serere (Table 4) during both the first and second growing seasons. The heavy rainfall at Serere during the first rains contributed to the excessive vegetative growth at the expense of reproductive growth. Secondly, the occurrence of scab disease during the first growing season at Serere lowered the grain yields. During the second

Table 3
Effect of spatial arrangement on the number of cowpea pods/plant when intercropped with maize

	Kabanyolo		Serere	
Treatments	1st rains	2nd rains	1st rains	2nd rains
V_1 x SA_1	24.60	13.50	11.77	13.50
V_1 x SA_2	27.87	30.93	12.50	14.63
V_1 x SA_3	28.27	40.73	14.20	15.93
V_1 x S	51.93	79.73	18.27	30.43
Mean	33.17	44.02	14.18	18.63
V_2 x SA_1	8.93	14.13	12.33	13.27
V_2 x SA_2	14.47	22.47	12.20	14.50
V_2 x SA_3	19.07	28.87	12.93	16.00
V_2 x S	31.67	62.73	15.80	40.70
Mean	18.53	32.05	13.32	21.12
LSD (0.05)	19.92	8.61	2.62	7.62
C.V. (%)	43.32	12.72	10.57	21.55

V_1 = Ebelat; V_2 = IT82D-716
SA_1 = maize planted at 90 x 30 cm + 2 rows of cowpea between maize rows
SA_2 = maize planted at 100 x 27 cm + 2 rows of cowpea between maize rows
SA_3 = maize planted at 120 x 22,5 cm + 2 rows of cowpea between maize rows
S = sole cowpea

Table 4
Effect of spatial arrangement on grain yields of cowpea (kg/ha) intercropped with maize

	Kabanyolo		Serere	
Treatments	1st rains	2nd rains	1st rains	2nd rains
V_1 x SA_1	888.39	525.56	187.67	975.00
V_1 x SA_2	832.78	892.78	197.56	1280.56
V_1 x SA_3	1126.28	1120.00	232.11	1500.00
V_1 x S	1619.39	2821.11	450.06	1425.14
Mean	1116.71	1339.86	266.85	1295.14
V_2 x SA_1	315.83	255.56	161.17	1308.33
V_2 x SA_2	403.50	662.78	169.56	1450.00
V_2 x SA_3	474.55	922.22	214.89	1552.78
V_2 x S	973.39	2551.11	247.00	1689.45
Mean	541.82	1097.92	189.15	1500.14
LSD (0.05)	432.67	598.00	107.63	325.83
C.V. (%)	29.33	27.57	26.02	13.11

V_1 = Ebelat; V_2 = IT82D-716
SA_1 = maize planted at 90 x 30 cm + 2 rows of cowpea between maize rows
SA_2 = maize planted at 100 x 27 cm + 2 rows of cowpea between maize rows
SA_3 = maize planted at 120 x 22,5 cm + 2 rows of cowpea between maize rows
S = sole cowpea

Table 5
Effect of spatial arrangement on the Partial and Total land equivalent ratios (LERs) of cowpea/maize intercrop

	First rains			Second rains		
	Partial LER		Total LER	Partial LER		Total LER
Treatments	Cowpea	Maize		Cowpea	Maize	
Kabanyolo						
V_1 x SA_1	0.55	0.87	1.42	0.19	0.80	0.99
V_1 x SA2	0.51	0.69	1.20	0.32	0.88	1.20
V_1 x SA3	0.70	0.83	1.53	0.40	0.80	1.20
V_2 x SA_1	0.33	0.76	1.09	0.10	1.17	1.27
V_2 x SA_2	0.42	0.93	1.35	0.26	0.95	1.21
V_2 x SA_3	0.49	0.80	1.29	0.36	0.97	1.33
Serere						
V_1 x SA_1	0.42	0.69	1.11	0.68	0.92	1.60
V_1 x SA_2	0.44	0.77	1.21	0.90	0.91	1.81
V_1 x SA_3	0.52	0.82	1.34	1.05	0.73	1.78
V_2 x SA_1	0.65	0.77	1.42	0.77	0.85	1.62
V_2 x SA_2	0.69	0.86	1.55	0.86	0.57	1.43
V_2 x SA_3	0.87	0.83	1.7	0.92	0.76	1.68

V_1 = Ebelat; V_2 = IT82D-716
SA_1 = maize planted at 90 x 30 cm + 2 rows of cowpea between maize rows
SA_2 = maize planted at 100 x 27 cm + 2 rows of cowpea between maize rows
SA_3 = maize planted at 120 x 22,5 cm + 2 rows of cowpea between maize rows
S = sole cowpea

rains, there was relatively poor distribution of rainfall at Serere which contributed to the low yield, but better yield of IT82D-716 as a result of absence of scab.
The LERs under the three spatial arrangements were greater than one (Table 5). This implied a yield advantage from intercropping cowpea and maize (5, 7), irrespective of the spatial arrangement. The highest yield advantage was achieved from SA_3, in which maize was planted at 120 x 22.5 cm, and the lowest was in SA_1 (90 x 30 cm). These results were independent of the seasons and locations.
The first rains recorded higher LER than the second rains at Kabanyolo as a result of greater contribution of cowpea (partial land equivalent ratio) to the intercrop system, while the reverse was true for Serere (Table 5). The first season at Serere was characterized by too much vegetative growth and scab epidemic which depressed cowpea yield. Cowpea recorded increased yields at Serere during the second rains and this increased its partial LERs, and hence, the total LER during the second season was higher than during the first season.
In conclusion, there was yield benefit from intercropping cowpea and maize for all the three spatial arrangements, but the yield benefit was greater under wide maize inter-row spacing, i.e., less competition for space between maize and cowpea. Similar results were reported on cassava/cowpea intercrop (2). Hence, to obtain higher yield of cowpea in a cowpea/maize intercrop, a spatial arrangement under which maize rows are wide apart would be ideal as this would allow adequate radiant energy to reach the cowpea canopy for growth and production. However, maize rows should not be spread very far apart as this would lower the yield of maize substantially. The successful growth of cowpea during the poor rainfall season of 1997, in contrast to total failure of the maize crop, explains why cowpea is a popular crop in the semi-arid tropics (4).

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An Appraisal of Line Performance in Upland Cotton (*Gossypium hirsutum* L.) Breeding Trials in Northern Nigeria Using the Performance Index Approach

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Keywords: Cotton- Performance Index- Stability

Summary

The importance of genotype x environment interactions reflects the necessity of evaluating genotypes in more than a single environment. The plant breeder selects superior genotypes for eventual release as commercial varieties based on a rating of these genotypes across varied environments for stability/adaptability. This paper describes the performance of ten advanced cotton lines in experiments replicated over two seasons and four locations in northern Nigeria. A rating of the ten lines across environments was also attempted using the performance index approach. The lines SAMCOT-10 and ACSA (79) 5B were the most outstanding in yield performance across years and locations while ASA (74) 80 and RASA (78) 11A were the lowest in performance. The use of the performance index approach in the rating of cultivars across varied environments is recommended because of ease of computation and interpretation when the number of entries and test environments are large

Résumé

Evaluation de la performance des lignées du cotonnier *(Gossypium hirsutum* L.) au moyen de l'indice des performances dans les régions du nord du Nigeria

L'importance des interactions génotype x environnement souligne la nécessité d'évaluer les génotypes dans plus d'un environnement. L'améliorateur des plantes cultivées sélectionne des génotypes aux caractéristiques supérieures pour une éventuelle diffusion en tant que variétés commerciales en fonction de la stabilité et de l'adaptabilité de leurs performances dans une large gamme de milieux. Cet article décrit les performances de 10 lignées élites de cotonniers dans des essais répétés au cours de deux saisons de culture et dans quatre sites du nord du Nigeria. Le classement de ces dix lignées a également été effectué au moyen de l'indice de performance. Les lignées SAMCOT-10 et ACSA (79) 5B ont été les meilleures pour l'ensemble des sites et les deux saisons de culture tandis que ASA (74) 80 et RASA (78) 11A étaient les lignées les moins compétitives. L'utilisation de l'indice de performance dans le classement des génotypes à travers différents environnements est recommandée à cause de la facilité de calcul et d'interprétation de ce paramètre quand le nombre d'entrées et le nombre de sites d'évaluation sont élevés.

Introduction

The ultimate aim of a crop improvement programme is the development of improved crop varieties and their release for production. Before lines are released as superior performing types, they are tested in multilocational and macroplot experiments for several years. Such zonal trials identify which line is best for what environment. The identification of superior lines is based on an assessment of differences among line means and their statistical significance. Whenever a significant test is used to discriminate between entries, the usual way of presenting data is to arrange the entry means in order of descending magnitude. Any two means not differing significantly are either underscored by the same line or signed by the same letter. Likewise any two means differing significantly are not underscored by the same line or are signed by different small letters. This presentation of data although universally established, lacks simplicity and as the number of entries increases, discrimination by the eye becomes problematic (6). This paper presents the use of an alternative approach, the performance index (6) to evaluate the performance of entries in upland cotton variety trials in northern Nigeria.

Material and methods

The materials used as entries were selections from advanced breeding lines from the germoplasm pool of the Institute for Agricultural Research, Ahmadu Bello University, Samaru (2, 3, 4). Ten of these lines were evaluated for two years, 1992 and 1993 at four locations, Samaru, Daudawa, Kadawa and Tumu, in northern Nigeria using the randomized complete block design with three replications. Plots consisted of two rows 10 m long, spaced 0.91 m apart. Four to six dressed seeds were planted per hole with 45 cm spacing between holes and the seedlings were thinned to two plants per hill at 3- 4 weeks after planting. Boronated single superphosphate (with 5% borax as source of boron) was applied to the experimental area at the rate of 125 kg per hectare during land preparation. Calcium

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ammonium nitrate (Nitrochalk) was applied at the rate of 125 kg per hectare after thinning. Weeding started early and was done regularly. Insect pests were controlled by three fortnightly sprays of Cymbush 10 EC at the rate of 2.5 liters per hectare starting at 9 weeks after planting. Data used for the analysis was taken from mean seed cotton yields per plot. An analysis of variance was done according to Steel and Torrie (10). For computation of the cultivar performance index, the mean values of seed cotton yield for the entries were arranged in descending order of magnitude per site and per year. Applying a one –tailed test, LSD obtained from the analysis of variance for each site and year was substracted from the first mean. The value obtained was compared to the entry means. The number of entry means smaller than this value depicts the number of entries that are significantly inferior, at the chosen level of significance, to the first entry mean. This number is noted "m". The process is repeated for the second and subsequent entries and a series of "m" values are obtained for each entry in each year and site. The cultivar performance index calculated as:

$$P = \frac{100\ m}{(n-1)} \qquad .....(6)$$

Where: m = number of significantly inferior lines
n = number of lines tested in the trial

Results and discussion

The performance of the ten advanced lines in two years and four locations are summarized in tables 1 and 2.

The lines, SAMCOT-10 and SAMCOT-8 with cultivar performance indices of 56 and 44 respectively were the most outstanding in yield performance in the 1992 trials at Samaru. Their performance indices denote that these lines outyielded significantly 56% (SAMCOT-10) and 44% (SAMCOT-8) of all the lines tested at Samaru. The lines SAMCOT-6, SAMCOT-9, ACSA (79) 8C and RASA (78) 11A have zero P, denoting that they failed to outyield significantly even a single line at this location. At Kawada, the lines SAMCOT-10, RSA (79) 4A, SAMCOT-6 and ACSA (79) 5B performed very well, outyielding significantly, 11% of all the other lines entered in the trial. There were however no significant differences between entries in the trial at Daudawa (P= 0). Although the entries RSA (79) 4A, ACSA (79) 5F, RASA (78) 11A and ACSA (79) 8C all had a performance index of 11 at Tumu, indicating that their yield performance were not significantly different from each other, each one of them was significantly higher yielding than 11% of all the other entries at this site. The trend in performance of the entries in the 1993 trials (Table 2) was apparently different from 1992 trials.

At Samaru, the lines SAMCOT-9, with a performance index of 56 was the most superior, outyielding, significantly, 56% of all the other entries. At Kadawa, ACSA (79) 8C outperformed 44% of all the lines tested. The two lines SAMCOT-10 and SAMCOT-6 were the highest yielding entries at Daudawa where they both significantly outyielded 33% of all the other entries. All the entries in the trial at Tumu in 1993 performed very well. One entry, ACSA (79) 5B, however stands out as superior, outyielding significantly 67% of all entries at the

Table 1
Performance of ten advanced cotton lines according to mean and performance index (P), 1992

Entry	Samaru			Kadawa			Daudawa			Tumu		
	Mean	m	p	Mean	m	p	Mean	m	p	Mean	m	p
SAMCOT- 10	1058	5	56	1355	1	11	452	0	0	1154	0	0
SAMCOT- 8	1002	4	44	1172	0	0	500	0	0	1044	0	0
RSA (79) 4 A	874	2	22	1338	1	11	302	0	0	1209	1	11
ACSA (79) 5B	874	2	22	1374	1	11	494	0	0	1154	0	0
ACSA (79) 5F	842	1	11	1282	0	0	420	0	0	1191	1	11
ASA (74) 80C	793	1	11	1209	0	0	540	0	0	915	0	0
RASA (78) 11 A	700	0	0	971	0	0	538	0	0	1172	1	11
1ACSA (79) 8C	693	0	0	1209	0	0	375	0	0	1227	1	11
SAMCOT- 9	608	0	0	1300	0	0	522	0	0	1136	0	0
SAMCOT- 6	484	0	0	1429	1	11	375	0	0	1117	0	0

Table 2
Performance of ten advanced cotton lines according to mean and performance index (P), 1993

Entry	Samaru			Kadawa			Daudawa			Tumu		
	Mean	m	p	Mean	m	p	Mean	m	p	Mean	m	p
SAMCOT- 10	613	0	0	567	0	0	760	3	33	1172	1	11
SAMCOT- 8	358	0	0	591	0	0	492	0	0	1282	1	11
RSA (79) 4A	568	0	0	696	0	11	570	0	0	1209	1	11
ACSA (79) 5B	468	0	0	751	0	11	503	0	0	1483	6	67
ACSA (79) 5F	559	0	0	623	0	0	557	0	0	1154	1	11
ASA (74) 80C	681	0	0	824	0	0	532	0	0	916	0	0
RASA (78) 11A	496	0	0	586	0	0	562	0	0	1264	1	11
1ACSA (79) 8C	757	0	0	916	4	44	750	2	22	1300	1	11
SAMCOT- 9	988	5	56	824	0	0	448	0	0	1319	1	11
SAMCOT- 6	613	0	0	696	0	11	782	3	33	1191	1	11

site. The differential performance of the ten genotypes in the two years and four locations used for these trials brings out very cleary the existence of genotype x environmental interactions. The existence of genotype x environmental makes the screening of genotypes for high stability/adaptation under varying environmental conditions an essential step in all any plant breeding programme. The rating of genotypes across environments for yield stability/adaptation has been done using several methods (1, 7, 8, 9, 11, 12). An alternative method is the cultivar performance index (P). A rating of the ten lines tested across years, locations and year x locations using this method is presented in table 3.

Across the two years, SAMCOT-10, SAMCOT-9 and SAMCOT-8 having the highest values of P were the most superior lines at Samaru. ACSA (78) 8C, RSA (79) 4A and SAMCOT-10 were the best in Kadawa, SAMCOT-10 and ACSA (79) 8C were the most outstanding at Daudawa and ACSA (79) 5B was the most outstanding at Tumu. When the performance index is taken across the four locations, the best entries in 1992 were SAMCOT-10, SAMCOT-8 and RSA (79) 4A and in 1993 were ACSA (79) 8C, SAMCOT-9, and ACSA (79) 5B. Across the two years and four locations the most outstanding lines were SAMCOT-10, ACSA (79) 5B and ACSA (79) 8C. It will be noted that apart from small shifts in position, the performance index brings out the two lines SAMCOT-10 and ACSA (79) 5B as the most outstanding in these trials. The lines SAMCOT-10 incidentally has been found to be a very stable cotton cultivar and was recently released for production as a new cotton variety (5) because of this attribute. The attraction of the performance index approach in the rating of cultivars across environments is in relation to its ease of computation and interpretation especially when the number of entries and test-environments are large, a situation which makes other conventional methods more cumbersome.

Table 3
Rating of ten advanced cotton lines using to performance index

Entry	Across two years Py				Across four locations Ps			Across 2 years = & four locations	
	Samaru	Kadawa	Daudawa	Tamu	Entry	1992	1993	Entry	Pys
SAMCOT- 10	28	6	17	6	SAMCOT-10	17	11	SAMCOT-10	15
SAMCOT- 9	28	0	0	6	ACSA(79)5B	8	17	ACSA (79)5B	13
SAMCOT- 8	22	0	0	6	SAMCOT- 8	11	3	ACSA (79)8C	11
RSA (79) 4A	11	6	0	11	RSA (79) 4A	11	3	SAMCOT- 9	9
ACSA (79)5B	11	6	0	34	SAMCOT- 6	3	11	SAMCOT- 8	7
ACSA (79)5F	6	0	0	11	ACSA (79)5F	6	3	SAMCOT- 6	4
ASA (74) 80C	6	0	0	0	ACSA(79)8C	3	19	RSA (79) 4A	7
ACSA (79)8C	0	22	11	11	RASA(78)11A	3	3	ACSA (79)5F	4
SAMCOT- 6	0	0	0	6	SAMCOT- 9	0	17	RASA(78)11A	3
RASA(78)11A	0	0	0	11	ASA (74) 80C	3	0	ASA (74) 80C	1

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Evaluation of the Allelopathic Influence of Selected Multipurpose Tree Species on Maize (*Zea mays*) under a Simulated Field Condition

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Keywords: Alley cropping - Allelopathy - Germination - MPTs - Maize

Summary

Germination and growth response of maize (Zea mays) *that was periodically watered with 200 ml of leaf leachates of three selected multipurpose tree species (MPTs)* - Inga edulis, Anthonatha macrophylla and Dactyladenia barterii *were evaluated under a simulated field condition to determine their allolepathic characteristics and suitability for alley cropping. There was a significant (P≤ 0.05) difference in the germination percentage of the maize seeds among the MPTs studied. Maximum germination percentage (76.7%) of the seeds and seedling growth as indicated by radicle length, shoot length, fresh weight and plant height at taselling were obtained from seeds watered/treated with rainwater as the control treatment. Reduction in germination percentage (33%) was observed in* Anthonatha macrophylla *leachates while moderate germination percentage of 50% was observed in* Dactyladenia barterii *leachate.* Anthonatha macrophylla *leachate inhibited both radicle and shoot lenght. Similarly,* Inga edulis *leachate had inhibiting effects on radicle and shoot of germinating maize seeds. This result suggets that* Inga edulis, Anthonatha macrophylla *and* Dactyladenia barterii *produce allelochems which inhibit seed germination and growth of maize under the conditions of the experiment. Investigations on allelopathic characteristics of potential MPTs could be integrated in farm planning strategies in a tropical agroecology especially where alley cropping is contemplated.*

Résumé

Evaluation de l'influence allélopatique des essences forestières sur la culture du maïs (*Zea mays*) en conditions contrôlées

Cette étude évalue la germination et la croissance du maïs (Zea mays) *en conditions contrôlées.*

L'objectif de cet essai était d'identifier et de caractériser des allochèmes produits par des essences forestières avant d'envisager leur éventuelle utilisation comme alley cropping. Les plantes ont été arrosées régulièrement avec une solution (200 ml) de filtrats de culture produits par des feuilles d'essences forestières aux propriétés allélopathiques (Inga edulis, Anthonatha macrophylla *et* Dactyladenia barterii).

Différents paramètres (taux de germination, longueur des radicelles et des pousses, hauteur de la plante à la floraison, poids de la matière fraîche) ont été comparés à ceux des plantes témoins arrosées avec de l'eau de pluie.

Les résultats obtenus montrent des différences significatives (P≤ 0,05) entre traitements. Ces essences produiraient des allochèmes qui inhibent la germination et la croissance du maïs. Le taux de germination le plus élevé (76,7%) a été obtenu avec les plantes témoins. Les plantes arrosées avec les filtrats produits par Dactyladenia barterii *ont montré un taux de germination moyen (50%) tandis que les plantes arrosées avec les filtrats produits par* Anthonatha macrophylla *étaient caractérisées par un taux de germination le plus bas (33%). Cette étude montre également que la solution des filtrats de culture de* Inga edulis *a inhibé la croissance des radicelles et des pousses.*

D'autres études relatives à la caractérisation chimique de ces filtrats s'avèrent nécessaires avant de proposer l'intégration de ces essences dans les systèmes agroécologiques des régions tropicales.

Introduction

Maize *(Zea mays)* is a cereal crop belonging to the poaceae family and is believed to have originated from Central America, probably Mexico (10). It is a major cereal for numerous people in developing countries. It is grown under a wide range of agroecological conditions. It is also one of the major fodder crops in the humid tropics. As such it is also one an integral component of most farming systems in Rivers State, South-eastern Nigeria (15).

The traditional agrotechnic of shifting cultivation and related bush-fallow systems have for generations provided resource-poor farmers with an efficient and stable food production system in the absence of purchased inputs (12). When land becomes limiting and fallow peri-

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ods are shortened so that adequate nutrient levels are no longer restored, the system deteriorates (1). In recognition of this and knowing the importance of deep-rooted trees and shrubs in nutrient recycling; scientists at the International Institution of Tropical Agriculture (IITA) have developed alley cropping which involves growing annual food crops in alleys between hedgerows of trees/shrubs (5). Hedgerows are periodically pruned to prevent excessive shading of food crops and to supply green manure and mulch. The practice is increasingly becoming accepted as a cropping system with the potential to provide stable and sustainable food production (3, 14). If alley cropping (6) is to be considered as an alternative to shifting cultivation, then it becomes imperative to evaluate the compatibility of pruned hedgerow species with major food crops such as maize. A constraint to alley cropping is the competition of hedgerow tree or shrub roots with those of companion food crops for available water and nutrients in the top soil (11) and reduce significantly the yields (7). Again, the superficial large roots of hedgerow trees or shrubs may cause some cultivation difficulties. In addition to competing for light, water and minerals, plants can inhibit seed germination and growth of neighbouring plants by releasing a variety of toxic chemicals, called allelochems (9). The phenomenon of one plant (donor) having a direct or indirect detrimental chemical effect on another (receptor) plant through the production of allelochems is called allelopathy(9). Allelopathic compounds are known to inhibit seed germination or reduce plant seedling growth by inhibiting cell division, reducing mineral uptake, increasing or decreasing respiration and inhibiting protein and haemoglobin synthesis (9). Other effects may include decline in number and dry weight of seedlings and decline in productivity and eventual death. In the present investigation seed germination and growth response of maize, periodically watered with leaf leachates of three selected multipurpose tree species - *Inga edulis, Anthonatha macrophylla* and *Dactyladenia barterii* were conducted under a simulated field condition to determine their allelopathic characteristics and their suitability for alley cropping.

Anthonatha macrophylla belongs to the family leguminosae. It is a small tree (8-12 m high) which is common throughout the rain forest of Nigeria. It has 2-4 pairs of leaflets on a common stalk of 6-20 cm long and minutely hairy.

Dactyladeria barterii belongs to the family chrysobalanaceae. It is a genus of 27 african species, previously included in the american genus *Acioa*. In Nigeria it is the most common species. It is a glabrous shrub with cordate leaves.

Inga edulis is an exotic germplasm probably of the american origin. Not much is known about the allelopathic potentials of these MPTs on maize germination and seedling growth.

Material and methods

Dry leaves of three multipurpose tree species (MPTs) viz: *Inda edulis, Anthonatha macrophylla* and *Dactyladenia barterii* were obtained from the International Centre for Research in Agroforestry (ICRAF)/International Institute of Tropical Agriculture (IITA) High Rainfall Station, Onne South-eastern Nigeria. Leaf leachates were prepared following a modified method as describeb by Bhandwaj (4). Dry leaves of the three MPTs weighing 93 g/each were immersed in 20 liters of rainwater separately and allowed to stand for 7 days. The rainwater was collected during a rainy day from corrugated roofing sheets over an office block of the University. Rainwater was preferred over other sources of water supply to simulate natural field condition since all farming systems in this agroecology are rainfed dependent. The solutions were then filtered and filtrates obtained constituted experimental treatments with the rainwater as control. Twenty healthy seeds of a local maize variety (local white) obtained from a peasant farmer in the locality during the planting season (April, 1999) were used. Prior to sowing, germination test was carried out and found to be 98.6%. The seeds were planted in 40 x 40 x 40 cm polythene bags in a completely randomised design (CRD) and replicated 3 times and a total of 1440 seeds were planted in all. Polybags were filled with non-fumigated top soil obtained from the Research and Experimental Farm of the Rivers State University of Science and Technology, Port Harcourt, South-eastern Nigeria. Polybags were lightly mulched with dry leaves of the selected MPTs according to the treatments to supply leachates continuously during the rains. This method simulated natural field conditions. Prepared leachates of the selected MPTs were watered periodically when necessary and at an even level of 200 ml per polybag. Germination records were obtained daily for 7 days and thereafter seedlings were thinned to 2 plants per polybag for plant height and fresh weight observations. Data were analysed by the analysis of variance (ANOVA) method.

Results and discussion

Germination which is the emergence and development of embryonic radicle through the seed coat was found to be significantly different with leaf leachates of *Inga edulis, Anthonatha macrophylla* and *Dactyladenia barterii*. Maximum germination percentage (76.7%) was observed in maize seeds watered with rain water (Table 1). However, reduction in germination percentage (33%) calculated against germination test results of approximately 100% was observed in *Anthonatha macrophylla* leachates while moderate germination per-

Table 1
Effect of *Inga edulis, Dactyladenia barterii* and *Anthonatha macrophylla* leachates on germination and seedling growth of maize cv. local white*

Character attribute	*Inga* leachate	*Dactyladenia* leachate	*Anthonatha* leachate	Rain water
Germination %	44.3[c]	50.0[b]	33.0[d]	76.7[a]
Radicle length (cm)	1.7[b]	1.5[b]	0.9[b]	3.3[a]
Shoot length (cm)	7.0[b]	9.2[b]	5.1[c]	11.6[a]
Fresh weight (g)	13.2[b]	15.0[b]	8.9[c]	21.5[a]
Plant height at tasselling (m)	1.9[a]	1.8[a]	1.6[a]	2.4[a]

* Mean values with identical letters within a row are not statistically different at P< 0.05
a. Radicle length at the end of germination (7 days)
b. Shoot length at the end of germination (7 days)
c. Fresh weight at 21 days after sowing

centage (50%) was observed in *Dactyladenia barterii* leachates. The present investigation indicates that *Inga eduli*, *Anthonatha macrophylla* and *Dactyladenia barterii* leaves probably produce allelochems which inhibits germination of maize. Studies on allelopathy have been conducted on other plant species but such reports on *Inga eduli, Anthonatha macrophylla* and *Dactyladenia barterii* are scare. For instance, Anwar (2) indicated that *Eucalyptus* spp. had allelopathic effect on the growth of maize seedlings. Similarly, Malkania (8) reported the decrease in germination of certain crop plants from leachates of *Celtis australis* and *Juglans regia*.

The growth of the radicle as indicated by its length and shoot of maize seedlings indicated that *Anthonatha macrophylla* leachate is inhibitory to probably cell elongation. The control treatment (rain water) promoted the growth of the radicle as well as the maize seedling. Following Wareing and Phillips (16), plant development involves both growth and differentiation. Tian and Kang (13) reported phytotoxic effects of *Gliricidia sepium* leachates on maize and cowpea seedlings in both laboratory and field conditions. In that report, growth of maize was significantly reduced by addition of *G. sepium* prunings. Leaf leachates of *Robina pseudoacacia* were found to reduce germination percentage and growth of shoots and roots of *Zea luxurians* (4).

As evident from table 1, fresh weight and plant height values were higher in control than in the leachates obtained from the evaluated multipurpose tree species. This further suggests that these MPTs are allelopathic on maize crop, although their degree of influence may appear naturally variable.

Conclusion

The three MPTs investigated appear to inhibit germination and growth of maize. This suggests their allelopathic potential probably due to the existence of allelochems in the MPTs. However, *Anthonatha macrophylla* exhibited a stronger allelopathy than the others. Of these species, *Dactyladenia barterii* and *Inga edulis* are moderately allelopathic on maize seed germination and seedling growth.

Further studies on the allelopathic characteristics of root exudates and aqueous extracts obtained from soils under these MPTs are currently in progress to correlate the results obtained from the pot experiments.

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Snail Farming in Mature Rubber Plantation: 4. Studies on some Artificial Methods for Hatching of Snail Eggs and Protection of Young Snails during the Dry Season

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Keywords : *Archachatina marginata- Archachatina papyracae- Limicolaria flammae/aurora-* Artificial hatching methods- Dry season protection

Summary

Three species of edible land snails of the moist forest belt of Nigeria, Archachatina marginata *(Swainson),* Archachatina papyracae *(Pfeiffer) and two phenotypes of* Limicolaria *species, sometimes named* Limicolaria flammae *(Muller) and* Limicolaria aurora *(Jay), were used in the study of three methods of artificial hatching of snail eggs and their young ones for the study of two methods of reduction of mortality during the dry season. The results of egg laying performance by the three species of snails showed a significantly (p< 0.01) higher population explosion in a given breeding season for* L. flammae/aurora *than for either* A. papyracae *or* A. marginata. *The results of artificial methods for hatching of snail eggs indicated that the use of plastic containers, plus either loose topsoil or cotton wool for the incubator mediums or the use of cellophane containers (bag) plus loose topsoil for the incubator medium, were in each case suitable for adoption in successful hatching of snail eggs artificially.*

Leaking coagulation pans or wooden boxes, half filled with heat sterilized loose topsoil and placed on the ground under shade of rubber tree canopy as dry season protection methods for the snails, were again in each case effective in the reduction of field mortality of the young snails. The survival rates were 100% ; 90.6% and 71.2% for youngs of A. marginata, A. papyracae *and* L. flammae/aurora respectively. *The results further indicated that the dry season protection method deemed optimum for the youngs of A. marginata may not necessarily be optimum for the youngs of either* A. papyracae *or* L. flammae/aurora.

Résumé

Elevage d'escargots dans une vieille plantation d'arbres à caouthouc: 4. Etudes de quelques méthodes artificielles d'incubation d'œufs d'escargots et protection des jeunes escargots pendant la saison sèche

Trois espèces d'escargots terrestres comestibles de la zone forestière humide du Nigeria Archachatina marginata, Archachatina papyracae *et deux phénotypes de l'espèce* Limicoloria *parfois nommés* L. flammae *et* L. aurora *ont été utilisées.*

Les résultats de ponte ont montré une beaucoup plus grande explosion démographique pendant la saison de reproduction chez Limicoloria *sp. Les résultats d'incubation indiquent que l'emploi de récipients en plastique avec soit de la terre meuble, soit de l'ouate comme substrat convient aussi bien pour réussir l'incubation artificielle que l'usage de sacs de cellophane avec la même terre meuble.*

La réduction de mortalité sur le terrain des jeunes escargots a été aussi effective en employant, en guise de protection des escargots pendant la saison sèche, des récipients à coagulation de récupération ou des caisses en bois, à moitié remplis de terre meuble stérilisée à la vapeur et installés sur le sol sous l'ombrage des arbres à caoutchouc. Les taux de survie ont été de 100% ; 90,6% et 71,2% pour les jeunes de A. marginata, A papyracae *et* Limicolaria *sp. respectivement. De plus, les résultats obtenus montrent que la méthode de protection qui paraît la meilleure en saison sèche pour les jeunes* A. marginata *n'est pas nécessairement la meilleure pour* A. papyracae *ni* Limicolaria *sp.*

Introduction

The three main species of edible land snails of the moist forest belt of Nigeria are *Archachatina marginata* (Swainson), *Archachatina papyracae* (Pfeiffer) and phenotypes of *Limicolaria species*, sometimes named *Limicolaria flammae* (Muller) and *Limicolaria aurora* (Jay). These species of snails vary widely in their respective liveweights to very mature liveweights of about 120 g to over 500 g for *A. marginata,* 18 g to over 30 g for *A. papyracae* and 8 to over 13 g for both phenotypes of *L. flammae/aurora.* Of these species, only *A. marginata* is available in the market throughout the year. Both *A. papyracae* and *L. flammae/aurora* are usually available in the market during the wetter period of the year, especially May to September, tending to become less available toward the end of the rains, with *L. flammae/aurora* disappearing faster than *A. papyracae.*

In spite of the value of snail meat in human nutrition (1, 5), no significant effort had been made in snail farming in Nigeria, compared to the farming of cattle, goats, sheep, pigs and poultry. Apart from its potentials for huge returns on investment with extremely low level of inputs, snail farming is also a convenient agricultural

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enterprise that can be accommodated within a family back yard (2). This makes it an attractive venture for house wives, retired civil servants and those without substantial capital or those seeking for farming ventures to augment their income capacity.

Farming edible land snails will command high acceptability in Nigeria, if their farming techniques are appropriately developed and disseminated. Two important areas in the development of snail farming technology that should be given proper attention are the development of appropriate methods of artificial hatching of snail eggs and the prevention of mortality, especially young snails and in particular during the dry harmattan period of the year. There is therefore increasing need for snail farmers to acquire efficient means of hatching their eggs artificially in order to keep pace with the scale of egg production under intensive system of management. Furthermore, since young animals in terms of smaller body size, have greater surface area per unit size, young snails with relatively greater surface exposure would be more vulnerable to a given prevailing adverse weather condition, especially during the harsh harmattan dry season. Very little attention had hitherto been given to the studies on the development of appropriate methods for artificial hatching of the eggs of edible African land snails and to the protection of young snails during dry season of the year.
This study was undertaken to identify ways in which snail farmers could increasingly hatch their eggs artificially and also ensure maximum survival of the young snails during the dry season. Meteorological data are provided in table 1.

Table 1
Meteorological data from July, 1999 to March 2000

Month/Year	Mean ambient temperature (°C)	Mean rainfall (mm)	Mean air relative humidity (%)
July, 1999	25.3	412.3	91
August, 1999	25.4	232.0	90
September, 1999	25.8	396.0	90
October, 1999	25.5	472.5	92
November, 1999	27.7	97.8	83
December, 1999	27.6	9.4	78
January, 2000	27.8	4.0	79
February, 2000	27.5	73	59
March, 2000	28.9	60.8	77

Materials and methods

Two experiments were carried out. The first of these was conducted in July to September, 1999 and the second, in November, 1999 to March, 2000.

In the first part of experiment, eggs laid by common species of edible land snails of the moist forest belt of Nigeria, namely, *Archachatina marginata, Archachatina papyracae* and a mixture of two phenotypes of *Limicolaria* species, *Limicolaria flammae* and *Limicolaria aurora* were used in the study of three methods of artificial hatching of snail eggs. Their mean liveweights were 143.5 ± 4.78; 24.6 ± 0.32 and 10.6 ± 0.34 g; for *A. marginata*, *A. papyracae* and *L. flammae/aurora* respectively. The snails were managed outdoors under mature rubber plantation by staff of the Farming Systems Research and Extension Division, Rubbers Research Institute of Nigeria, Benin.

Ten breeding snails each of the species *A. marginata, A. papyracae* and *L. flammae/aurora* were housed in raised wooden breeding boxes measuring 90 x 90 x 30 cm. The lids of the boxes were covered with plastic mosquito proof nettings to improve aeration and visibility of the contents. Smaller wooden boxes with the tops removed and each measuring 45 x 30 x 15 cm were filled with loose topsoil and placed in the centre of the breeding boxes for snails to enter and lay their eggs. Eggs laid by the snails were collected and incubated according to the artificial hatching method for snail eggs (3).

All snails were fed with green pawpaw fruits (*Carica papaya*) and cocoyam leaves (*Xanthosoma mafaffa*). These foods were offered fresh at 08:00 hours every day. Fresh drinking water was provided daily in a flat plastic container. About 40 g calcium carbonate was provided for the snails; twice a month for *A. marginata* and once a month for *A. papyracae* and *L. flammae/aurora*.

Clutches of eggs laid by each of the species of snails were incubated in the months of July, August and September, using three methods of artificial hatching cells described below :

- Plastic containers, using loose topsoil medium:
Plastic containers with covers, approximately 14 cm diameter, and 8 cm deep which had been perforated, top and bottom, were half filled with loose topsoil. Clutches of eggs laid were placed (according to species) in the hatching cells. The eggs were then covered with more of the soil, sealed, labeled and placed in boxes similar to the breeding boxes and designated as the hatching unit.

- Plastic containers using cotton wool medium:
The plastic containers were the same as those described above. Instead of loose topsoil, cotton wool was used as the hatching cell medium. The cotton wool was soaked in water, then gripped firmly with the hand and pressed to squeeze out most of the water for some 3 seconds. The cotton wool thus treated was used to incubate the eggs, imitating the method described for plastic containers, using loose topsoil medium.

- Cellophane bags, using loose topsoil medium:
Cellophane bags of the type and size used in wrapping (smaller) loaves of bread were obtained and prepared in similar way to the method of plastic containers, using loose topsoil medium to incubate the eggs.

All hatching mediums were moistened occasionally to prevent them from getting dry. They were examined for signs of hatching by carefully exposing the snail eggs in the hatching cells every alternate days, starting from the 22nd to the 44th days after incubation. Young snails that hatched out were collected, weighed and their dimensions were taken and then they were transferred to intensive rearing unit for young snails. The means of the data obtained for the months of July, August and September were used in subsequent calculations.

In the second part of this experiment, two types of materials, metal and wooden structures were used in the study of their effectiveness for dry season protection of young snails.
The metal equipment consisted of 6 leaking coagulation pans for natural rubber latex each measuring 45 x 30 x 15 cm. They were half filled with heat sterilized loose topsoil, cooled and moistened with water. Eighty young snails each of the species *A. marginata, A. papyracae* and *L. flammae/aurora,* about 2 weeks to 2 months old, were sorted out into 2 sizes per species and placed in these pans (40 young snails per pan). A second coagulation pan was then inverted over the first to form as cover.
The wooden equipment consisted of 6 boxes with the tops removed and they were constructed to the same dimension as those of the coagulation pans decribed above. They were given the same treatments as the contents of the coagulation pans and contained 40 young snails per wooden box. A second wooden box was inverted over the first to form as a cover.
Fresh cocoyam leaves (*Xanthosoma mafaffa*) and sliced green pawpaw fruits (*Carica papaya*) were provided for each group of snails *ad libitum.* Each of the three species of snails were assorted into 2 sizes and were replicated in the metal and wooden box equipment. These were placed on the ground under good shade formed by rubber tree canopy on the 25th November 1999. Inspection was done every morning to remove stale foods and to provide fresh ones. The soil in these equipment were occasionally moistened slightly to prevent them from being excessively dry. To avoid further accidental crushing of young snails with top covers of both dry season protection methods, daily inspection times were handled with utmost caution. Thereafter, no further accidental deaths by crushing was recorded throughout the duration of this study.

On the 31st day of March, 2000 after rainfall had resumed, the surviving young snails were estimated and compared with the results of earlier experiments (4) to evaluate methods of reducing field mortality of snails (*A. marginata*) during the dry season.

Results

The mean liveweights of the three species of snails, including their egg laying performance plus the weights of the eggs are presented table 2. The mean liveweights of the snails used in this study indicated that the relative liveweight of one *A. marginata* was equivalent to 5.8 individual numbers of *A. papyracae* or to 13.5 individual snails in the *Limicolaria* phenotype mixture of *L. flammae/aurora.* Also, the relative liveweight of one *A. papyracae* was equivalent to 2.3 individual snails in the *L. flammae/aurora.*
The average number of clutches of eggs laid by the ten snails in each of the three species of snails in the months of July, August and September were 5; 8.3 and 13.7 clutches of eggs per month for *A. marginata, A. papyracae* and *L. flammae/aurora* respectively. The number of clutches of eggs laid per month for *A. papyracae* was slightly higher than for *A. marginata*, but the difference was not significant ($P > 0.05$). Both were however, significantly ($P < 0.05$) less than the clutches of eggs per month laid by *L. flammae/aurora.* Average number of eggs laid per month were approximately 42.3; 68.3 and 1339.7 eggs and which were equivalent to 8.5; 8.2 and 98 eggs per clutch for *A. marginata, A. papyracae* and *L. flammae/aurora* respectively. The average number of eggs per clutch for *A. marginata* and *A. papyracae* were similar ($P > 0.05$), but both were highly significantly ($P < 0.01$) less than the average number of eggs per clutch for *L. flammae/aurora.*

The relative weight of an egg of *A. marginata* was 6.9 times heavier than an egg of A. papyracae or 96.7 times heavier than an egg of *L. flammae/aurora.* Likewise, an egg of *A. papyracae* was about 14 times heavier than an egg of *L. flammae/aurora.*
The hatching response of eggs of the three species of edible land snails to three methods of artificial incubation are presented in table 3. All snail species that hatched out from the plastic containers plus cotton wool incubation medium had consistently light (opaque) shell colour while those that hatched out from containers plus loose topsoil incubation medium had dark shell pigmentation.
The mean hatchability percentage, using plastic containers plus loose topsoil medium for artificial incubator across snail eggs species was 90.2 ± 1.48%. The use of plastic containers plus cotton wool medium for artificial incubator across snail eggs species was 88.7 ± 0.72%, while the use of cellophane containers plus

Table 2
Comparative egg laying performance of three species of edible land snails from July to September, 1999

	Archachatina marginata	*Archachatina papyracae*	*Limicolaria flammae/aurora*
Number of breeding snails Mean liveweight :	10	10	10
Start of Experiment (g)	143.5 ± 4.78	24.6 ± 00.32	10.6 ± 0.34
Range of liveweight (g)	127.01-156.16	20.03 - 29.26	8.89 - 12.40
Mean shell lenght (mm)	96.0 ± 3.03	60.2 ± 5.84	50.3 ± 0.47
Mean shell breadth (mm)	54.6 ± 0.96	27.8 ± 0.49	18.7 ± 0.42
Number of clutches of eggs laid	15	25	41
Total number of eggs laid	127	205	4.019
Range of eggs/clutch	7 - 10	6 - 10	36 -115
Average number of eggs/clutch	8.5	8.2	98
Mean weight of egg (g)	2.9 ± 0.14	0.42± 0.01	0.03 ± 0.01
Mean lenght of egg (mm)	21.8 ± 0.26	10.5 ± 0.46	4.6 ± 0.22
Mean breadth of egg (mm)	16.0 ± 0.24	8.13 ± 0.29	3.5 ± 0.11
Mean liveweight at hatch (g)	2.7 ± 0.30	0.34 ± 0.01	0.02 ± 0.01
Mean lenght at hatch (mm)	9.1 ± 0.18	7.7 ± 0.21	3.9 ± 0.04
Mean breadth at hatch (mm)	8 ± 0.16	5.9 ± 1.52	2.5 ± 0.05

Table 3
Hatching response of eggs of three species of edible land snails under different incubation methods during the months of July to September, 1999

Incubation method	*Archachatina marginata*	*Archachatina papyracae*	*Limicolaria flammae/aurora*
Plastic container plus soil medium:			
Incubation period (day)	31.6 - 1.29	31.1 ± 1.12	28.9 ± 0.63
Range (day)	26 - 41	26 - 36	24 - 32
Mean hatchability (%)	89.8 ± 4.68	92.9 ± 4.07	87.8 ± 5.01
Range (%)	66 - 100	87.5 - 100	64.1 - 100
Plastic container plus cotton wool:			
Incubation period (day)	29.8 ± 3.68	28.8 ± 1.20	28.3 ± 3.33
Range (day)	27 - 38	26 - 36	24 - 30
Mean hatchability (%)	88.9 ± 11.15	89.9 ± 6.83	87.4 ± 6.43
Range (%)	70.8 - 100	74.9 - 100	80.3 - 100
Cellophane container plus soil medium:			
Incubation period (day)	32.9 ± 9.38	30.2 ± 4.83	29.1 ± 3.26
Range (day)	26 - 40	26 - 38	25 - 34
Mean hatchability (%)	86 .6 ± 10.21	89.9 ± 11.11	89.1 ± 9.76
Range (%)	71.6 - 100	80.7 - 100	78 - 100

Table 4
Mortality of three species of young snails under two outdoor methods of dry season management, from November, 25th, 1999 to March, 31st, 2000

	Coagulation pan method					Wooden box method				
Size 1: Larger snail	Number at 25.11.99	Accidental loses	Natural death	Number at 31.3.00	% Survival	Number at 25.11.99	Accidental loses	Natural death	Number 31.3.00	% Survival
A. marginata	40	-	-	40	100	40	-	-	40	100
A. papyracae	40	1	3	36	90	40	-	2	38	95
L. flammae/aurora	40	2	11	27	67.5	40	3	6	31	77.5
Size 2: Smaller snails										
A. marginata	40	2	-	38	95	40	1	-	39	97.5
A. papyracae	40	1	6	33	82.5	40	-	4	36	90
L. flammae/aaurora	40	3	16	21	52.5	40	5	13	22	55

loose topsoil medium across snail eggs species was 88.2 ± 0.8%. Furthermore, the mean hatching response of eggs of the three species of snails across the artificial incubation methods studied was 89 ± 0.61% and the variation between snail eggs species across the artificial incubation methods were 88.4 ± 0.9%; 90.6 ± 1.2% and 88.1 ± 0.51% for *A. marginata, A. papyracae* and *L. flammae/aurora* respectively.

The mortality rate (table 4) among snail species were 1.9 ± 1.2%; 10.6 ±.2.58% and 36.9 ± 5.81% for *A. marginata, A. papyracae* and *L. flammae/aurora* respectively. When death by accidental crushing of young snails were accounted for, the adjusted mortality rates were 0.0%; 9.4 ± 2.13% and 28.8 ± 5.25% or 100%, 90.6% and 71.2% survival rates for *A. marginata, A. papyracae* and *L. flammae/aurora* respectively. The ratio of efficiency between the two methods for dry season protection, using either the coagulation pan (metal) or wooden box method was 1: 1.

The data were *A. marginata* 100 : 100%; *A. papyracae* 88.8 : 92.5% and *L. flammae/aurora* 66.3 : 72.3% for coagulation pan and wooden box methods respectively. When the efficiences of the two methods were compared across the snail species, their ratio was again 1 : 1; or 85 ± 9.91% for the coagulation pan method and 88.3 ± 8.27% for the wooden box method.

Discussion

There was highly significant ($p < 0.01$) difference between the average number of eggs laid per clutch by the three species of snails, which tended to imply higher population explosion in a given breeding season for the *Limicolaria* phenotypes, *L. flammae/aurora* than for either *A. marginata* or *A. papyracae.* Further studies would be necessary to probe the economic importance of the differences between the egg laying performance of the three species of snails in terms of ultimate edible biomass production per breeding season or per life cycle vis-à-vis the disparity in their respective liveweights.

There was no significant ($P > 0.05$) difference between the mean incubation period of the snail eggs across snail species and incubation methods. Thus, the efficiencies of the artificial incubation methods studied were similar. All snail species that hatched out from the plastic containers plus cotton wool for incubation medium had peculiar shell colour, whish were consistently very light (opaque) shell colour. Those that hatched out from containers plus loose topsoil for the incubation medium had dark shell colour or pigmentation, thus suggesting that, loose topsoil as a matter for an incubation medium was highly correlated to dark pigmentation of the shell colour of snails. Dark shell pigmentation generally adds to the aesthetic value of live snails due to mostly to its 'fresh forest colour'.

The mean hatchability percentages across the snail eggs species were 90.2 ± 1.48%; 88.7 ± 0.72% and 88.2 ± 80% for plastic containers plus topsoil medium, plastic containers plus cotton wool medium and cellophane containers (bags) plus loose topsoil medium for artificial incubators respectively. Furthermore, when the hatching response of eggs of the three species of snails were estimated across the three artificial incubation methods studied, the mean hatchability of 89 ± 0.61% was obtained. Their variations from the estimated mean were 88.4 ± 0.95%; 90.6 ± 1.2% and 88.1 ± 51% for *A. marginata, A. papyracae* and *L. flammae/aurora* respectively. The results demonstrated that each of the three methods employed in the study of artificial hatching of snail eggs could be recommended for adoption in snail farming technology aimed at keeping pace with induced scale of egg production under intensive system of management. However, the choice of which method a farmer prefers to practice in his farm is therefore an option based on convenience.

The results of the second part of this study showed that mortality rates between snail species and across the dry season protection methods were species dependent. Thus the young ones of *A. marginata* survived best, followed by *A. papyracae* and then *L. flammae/aurora*. When loses through accidental crushing of young snails with the top covers of both dry season protection methods were accounted for, the adjusted mortality rates were 0.0%; 9.4 ± 2.13% and 28.8 ± 5.25% or 100%; 90.6% and 71.2% survival rates for *A. marginata, A. papyracae* and *L. flammae/aurora* respectively. Thus, there were no other causes of death for *A. marginata* except through accidental crushing of the young ones with top covers of the dry season protection equipment, while *A. papyracae* and *L. flammae/aurora* species in addition suffered loses from other causes. This observation tends to indicate that a dry season protection method which offers optimum protection for the youngs of *A. marginata* may not necessarily be optimum for youngs of either *A. papyracae* or for *L. flammae/aurora*. In earlier work on dry season protection methods for snails out-doors (4), using three age grades of *A. marginata*: baby snails, 1-2 months old (4.6 - 9.5 g liveweight), growing snails, 4 - 6 months old (22.3 - 70.8 g liveweight) and mature snails, over 2 years old (387 - 468 g liveweight), the mature snails all survived, 100% each in all the three methods studied. The first of these dry season protection methods consisted of dry season paddock with broken corrugated asbetos roofing sheets placed on the ground as shelter for the snails, and all the three age grades of snails scored each 100% survival. The second and third methods were, dry season paddock with thick grass litter and dry season paddock with bare ground respectively. The baby snails had 100% mortality each in these two later treatments. The growing snails had 64% and 58% mortality rates for the grass litter and the bare ground treatments respectively. Hence, as in the corrugated asbestos roofing sheet experiments cited above, the results obtained for the young ones of *A. marginata* in the present study showed consistent 100% survival except loses due to accidental crushing of snails during routine management exercise. Therefore the dry season protection methods reported in this study, whether constructed with metal or with wood is recommended for adoption in outdoor integration of snail farming in tropical tree crop plantations. Obviously, wooden equipment by virtue of its being more susceptible to weathering due to exposure in the field would require frequent rehabilitation than metal equipment. However, the wooden equipment is within easy affordability of the resource poor farmers. Further studies are necessary to discover more suitable outdoor dry season protection methods to increase the survival rates of *A. papyracae* and *L. flammae/aurora* to hundred percent.

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Effets de Boscia senegalensis (Pers.) Lam. Ex Poir. (Capparaceae) sur l'évolution des populations de bruches dans les systèmes de stockage traditionnel de niébé *(Vigna unguiculata* (L.) Walp*)* en zone sahélienne

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Keywords: Bruchids- Cowpea- Insecticidal plant- Control

Résumé

Bruchidius atrolineatus *Pic. (Coleoptera- Bruchidae) et* Callosobruchus maculatus *Fab. (Coleoptera- Bruchidae) représentent, en zone sahélienne, les principaux ravageurs de graines de niébé (*Vigna unguiculata *(L.) Walp). L'infestation des gousses de niébé par ces deux espèces commence dans les cultures en début de fructification de la plante et se poursuit dans les stocks où les dégâts peuvent être considérables en l'absence de toute mesure de protection. Au cours de cette étude, nous avons examiné l'impact de la présence de* B. senegalensis *(Pers.) Lam. Ex Poir. (Capparaceae), plante à effet insecticide, sur la dynamique des populations de ces deux espèces dans les systèmes de stockage traditionnel de niébé. L'examen des résultats montre que les populations de bruches sont plus importantes dans les canaris[1] témoins que dans ceux où se trouvent* B. senegalensis.

Ainsi, les méthodes traditionnelles de lutte par utilisation de plantes à effets insecticides et/ou insectifuges semblent être un moyen efficace de lutte contre B. atrolineatus *et* C. maculatus *dans les systèmes de stockage traditionnel de niébé.*

Summary

Effects of *B. senegalensis* (Pers.) Lam. Ex Poir. (Capparaceae) on Bruchids Populations within Storage Traditional System of Cowpea beans *(Vigna unguiculata* (L.) Walp*)* in Sahelian Area

Bruchidius atrolineatus *Pic. (Coleoptera- Bruchidae) and* Callosobruchus maculatus *Fab. (Coleoptera- Bruchidae) are, in Sahelian area, the most important pests of cowpea beans, (*Vigna unguiculata *(L.) Walp). Cowpea infestation by these two species of bruchids starts in the field at the beginning of the plant fruit bearing and continues during storages where damage can be high if no control action is taken.*

In this study, the impact of several introductions of B. senegalensis *(Pers.) Lam. Ex Poir. (Capparaceae), an insecticidal plant which is usually used by farmers in Niger, on the population dynamics of the two bruchids species in traditional cowpea storage system has been investigated.*

The results obtained from this study point out that bruchid populations are more important in the standard jars than in the one, which have received regular inputs of B. senegalensis. *Thus, preservation action by regular inputs of* B. senegalensis *seems to be an efficient way to control bruchids in the cowpea traditional storage system.*

Introduction

Bruchidius atrolineatus Pic. (Coleoptera: Bruchidae) et *Callosobruchus maculatus* Fab. (Coleoptera: Bruchidae) représentent, en zone sahélienne, les deux principaux ravageurs de graines de niébé (*Vigna unguiculata* (L.) Walp). Les adultes de ces deux espèces pondent sur les gousses et les graines, tandis que les larves se développent en consommant les réserves contenues dans les cotylédons de la graine (1, 12). Les dégâts importants occasionnés par les bruches, pendant la période de stockage du niébé, ont suscité la mise au point d'un certain nombre de méthodes de lutte dans le but d'une protection durable des stocks. Parmi ces méthodes, il y a l'utilisation de plantes et/ou d'extraits de plantes (racines, feuilles, écorces, fruits) afin d'exploiter leurs activités phytosanitaires. L'utilisation de cette méthode de lutte pour protéger les récoltes contre les insectes ravageurs au cours du stockage est une pratique ancienne très répandue en Afrique et en Asie (2, 5, 6, 9, 13, 17, 19). De nombreuses recherches sont actuellement en cours en Afrique pour étudier l'action des plantes insecticides sur les insectes des stocks en particulier et notamment les coléoptères Bruchidae (11, 12).

Au Niger, les recherches sur trois plantes *(Bescia senegalensis, Anona senegalensis* et *Azadirachta indica)* ont montré que *B. senegalensis* avait un effet insecticide très puissant sur les adultes de *B. atrolineatus* et *C. maculatus* et une activité ovicide sur les œufs de ces bruches (2).

Les études menées par Seck *et al.* (17) dans des systèmes hermétiques de stockage, ont montré que l'utili-

1 Dans les pays du Sahel, on appelle "canari" des grandes jarres en terre cuite qui servent au stockage d'eau ou de denrées.

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sation des fruits de *B. senegalensis* à la dose de 1,2 g/l réduit considérablement les émergences de *C. maculatus* alors que pour une dose de 2,4- 4,8 g/l; l'émergence de la nouvelle génération de cette espèce est complètement inhibée.
Au Congo, Delobel et Malonga (5) ont montré que sur six plantes utilisées par les paysans contre la bruche de l'arachide, (*Caryedon serratus)*, seul *Chenopodium ambrosioïdes* L. possède des propriétés insecticides réelles. Au Togo, Ketoh (10) a trouvé que sur huit plantes utilisées, deux *(Cymbopogon shoenanthus* et *Lavandula* sp) sont très toxiques, et six autres le sont moins sur les adultes de *C. maculatus.*
Dans le présent travail, nous avons étudié l'action d'une plante insecticide naturelle, *Boscia senegalensis* sur le complexe bruches-parasitoïdes dans un système de stockage traditionnel de niébé. Cette approche offre l'avantage d'être simple, moins coûteuse que l'utilisation des pesticides chimiques, et offre plus de garantie de sécurité pour les paysans.

Matériel et méthodes

La souche de niébé

Notre étude a été réalisée avec un lot de gousses et de graines d'une variété locale de *V. unguiculata* (L.) Walp récoltée dans la région de Balleyara, localité située à environ 100 km au nord-est de Niamey. Ce matériel a été acheté auprès des agriculteurs au mois de novembre, deux semaines environ après la récolte. Compte tenu des études antérieures (1, 7, 8), ces gousses et graines renferment tous les stades de développement des bruches et de leurs parasitoïdes (larves, nymphes, imagos).

La plante utilisée: *Boscia senegalensis*

B. senegalensis (Capparaceae) est un petit arbuste pouvant atteindre 3 m de haut et qui pousse sur des sols très secs pierreux, argileux ou latéritiques. Cette plante très répandue au Niger est employée traditionnellement par les paysans dans la protection des stocks. Une analyse de la phénologie de cette plante en fonction du temps a permis de montrer que de novembre à mars, la plante garde des feuilles intactes; par contre entre mars et juin (date des premières pluies au Niger) les feuilles deviennent jaunes et même parfois difficiles à trouver. Les feuilles utilisées pour nos expériences sont immédiatement broyées et introduites dans les canaris après leur récolte.

Dispositif expérimental

Le dispositif expérimental utilisé est un canari d'environ 30 l de volume muni latéralement d'un piège extérieur amovible qui est constitué d'une bouteille d'eau minérale, par où pénètre la lumière, dispositif qui permet d'attirer les insectes à l'extérieur du canari (Figure 1).
Dans le canari contenant 12,5 kg de gousses de *V. unguiculata* infestées par les bruches, on introduit une cage grillagée de forme parallélépipédique (L = 21cm X l = 10,5 cm X h = 10,5 cm) à mailles lâches (0,5 cm X 0,5 cm) permettant la libre circulation des insectes dans le stock. Cette cage, enfouie au milieu du stock, renferme un échantillon de 70 gousses infestées naturellement et numérotées qui permettent d'évaluer régulièrement l'évolution de la contamination à l'intérieur du canari.

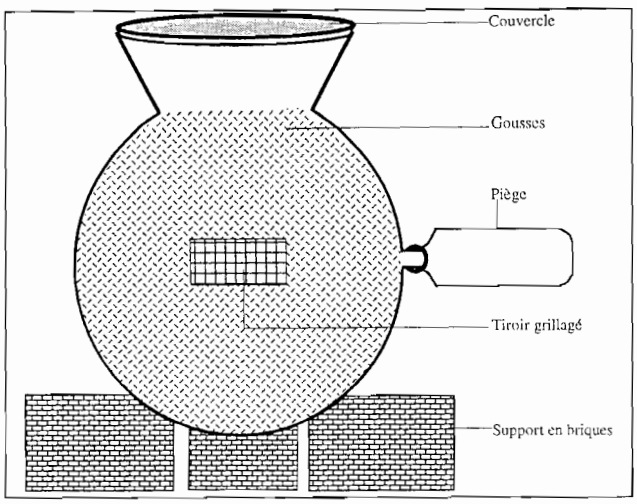

Figure 1: Dispositif expérimental de suivi des populations de bruches et de leurs parasitoïdes

Les différents lots étudiés

Les lots étudiés sont les suivants:

Un lot constitué de 2 canaris C_o et C'_o,

C'est le lot témoin dans lequel les canaris ne reçoivent pas d'introductions de feuilles de *B. senegalensis* au cours de l'étude.

Un lot constitué de 2 canaris C_1 et C'_1,

Dans ces canaris nous introduisons, tous les 15 jours, 225 g de broyat de feuilles de *B. senegalensis.*
Dans chaque lot, l'évolution de la contamination des gousses par les deux espèces de bruches et le parasitisme de ces bruches par des hyménoptères sont étudiés.
Pour cela, les cages grillagées contenant les échantillons de gousses sont ramenées au laboratoire tous les 20 jours et sur chacune des gousses, les œufs et les trous d'émergence de ces deux espèces de bruches sont dénombrés.

Test statistique utilisé

A la fin de l'expérience, les effectifs cumulés obtenus dans les deux lots sont comparés entre eux par un test du χ^2.

Résultats

Evolution de l'activité de ponte des deux espèces de bruches

***Evolution de l'activité de ponte de* B. atrolineatus**

L'évolution dans le temps des effectifs cumulés d'œufs de *B. atrolineatus* montre que l'activité de ponte est beaucoup plus importante dans le lot témoin que dans le lot ayant reçu des introductions régulières de *B. senegalensis* (Figure 2).

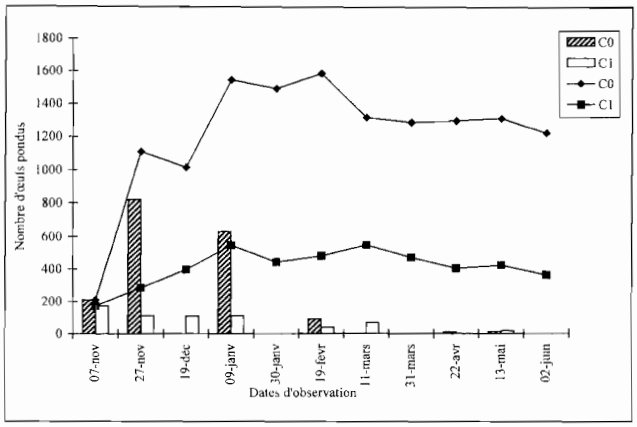

Figure 2: Evolution cumulative (courbes) et périodique (histogrammes) des pontes de *B. atrolineatus* pour un échantillon de 2 X 70 gousses pour chaque lot.
C_o= lot non traité; C_1= lot traité

Dans le lot témoin, l'examen de la courbe d'évolution des pontes cumulées montre que l'activité de ponte est relativement faible en début de stockage; puis on constate une augmentation importante des pontes émises sur les gousses jusqu'au 9 janvier avec deux pics de pontes observés respectivement le 27 novembre et le 9 janvier. A partir de cette date, l'activité de ponte reste relativement constante pendant tout le reste de la période de stockage comme le montre l'évolution périodique des pontes déposées sur les gousses.
Dans le lot expérimental (C_1) ayant reçu des introductions régulières de *B. senegalensis*, l'activité de ponte est restée relativement faible jusqu'au 9 janvier pour rester par la suite nulle.
Ces résultats montrent que des introductions régulières de *B. senegalensis* permettent de réduire de façon sensible l'activité de ponte de *B. atrolineatus* dans les stocks de *V. unguiculata.*

Evolution de l'activité de ponte de C. maculatus

Comme pour *B. atrolineatus*, l'évolution de l'activité de ponte de *C. maculatus* semble liée au traitement appliqué aux gousses. En effet, les résultats obtenus montrent que l'activité de ponte a été plus importante dans les canaris traités que dans les canaris témoins (Figure 3).

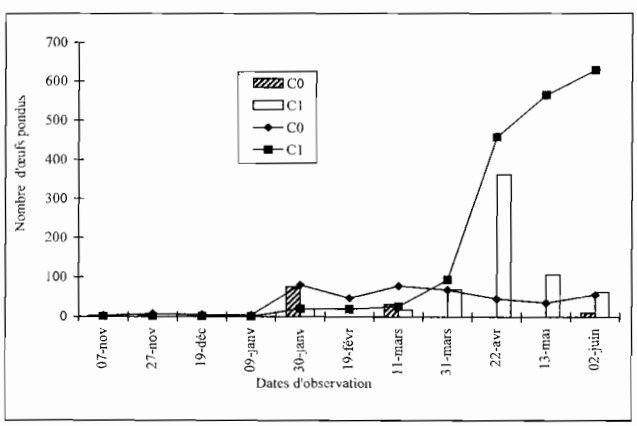

Figure 3: Evolution cumulative (courbes) et périodique (histogrammes) des pontes de *C. maculatus* pour un échantillon de 2 X 70 gousses pour chaque lot.
C_o= lot non traité; C_1= lot traité

Dans le lot témoin, on constate que jusqu'au 9 janvier, l'activité de ponte de *C. maculatus* a été presque nulle. A partir de cette date, elle croît dans ce lot où deux pics faibles sont observés respectivement le 30 janvier et le 11 mars.
Dans le lot ayant reçu des introductions régulières de *B. senegalensis*, l'activité de ponte est demeurée faible jusqu'au 11 mars, puis elle commence à croître de manière exponentielle.

Evolution des émergences de bruches

L'examen des résultats obtenus montre que l'évolution des émergences des bruches des gousses ne s'est pas faite de la même manière dans les deux lots étudiés (Figure 4).

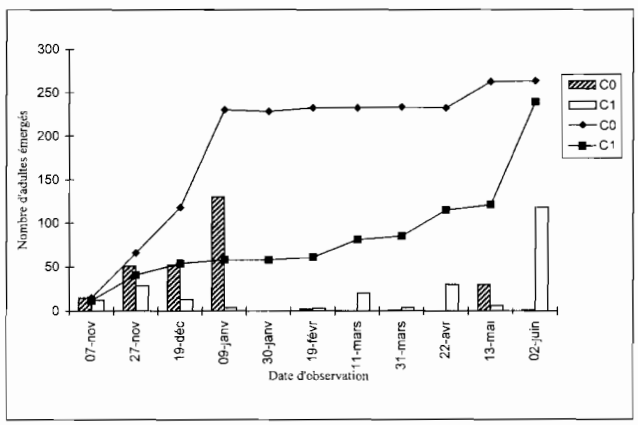

Figure 4: Evolution cumulative (courbes) et périodique (histogrammes) des émergences des adultes de bruches, pour un échantillon de 2 X 70 gousses pour chaque lot.
C_o = lot non traité; C_1= lot traité

Ainsi dans le canari témoin, deux périodes d'émergence bien marquées sont observées:
Une première période durant laquelle les effectifs de bruches augmentent progressivement dans le temps. Cette phase, qui se situe entre le 7 novembre et le 9 janvier correspond à la période où l'activité de ponte de *B. atrolineatus* est la plus importante dans le canari témoin (Figure 2).
Une seconde période pendant laquelle les émergences de bruches évoluent très peu. Cette phase qui va du 9 janvier à la fin de l'étude, correspond à la période où l'activité de ponte des deux espèces de bruches est faible dans le canari C_0. Par contre, dans les canaris C_1 ayant reçu des introductions régulières de *B. senegalensis*, les émergences de bruches, faibles pendant les quatre premiers mois de l'étude (novembre à mars), augmentent d'abord lentement pour devenir importantes à la date du 2 juin. La comparaison des figures 2, 3 et 4 permet de constater que les bruches qui émergent à la première période appartiennent surtout à l'espèce *B. atrolineatus* alors qu'au cours de la seconde période il s'agit essentiellement de l'espèce *C. maculatus.*

Discussion

L'examen des résultats obtenus montre que l'utilisation de *B. senegalensis* a réduit considérablement l'évolution des populations des bruches dans l'expérimenta-

tion sur les systèmes de stockage traditionnel du niébé en zone sahélienne. En effet, le suivi de l'évolution temporelle des pontes et des émergences des bruches révèle qu'elles sont considérablement moindres dans les canaris traités avec *B. senegalensis* que dans les canaris témoins.

Ces résultats confirment les observations de nombreux auteurs (2, 6, 17, 18) qui montrent que l'utilisation des produits bruts ou d'extraits d'origine végétale peut être un moyen efficace de lutte contre les insectes ravageurs des denrées stockées.

Selon Alzouma et Boubacar (2) et Auger *et al.* (3), l'effet des feuilles de *B. senegalensis* sur la plupart des insectes des stocks se traduit par une action létale qui entraîne la mort immédiate d'une partie de ces insectes et un état d'agonie irréversible pour les autres. Ce produit agit également sur les œufs en inhibant leur éclosion et par voie de conséquence supprime l'émergence de la future génération (2, 4, 15, 17).

Les études réalisées par Auger *et al.* (3) et Seck *et al.* (16) ont montré que l'activité insecticide de *B. senegalensis* est liée à la présence dans les feuilles et les fruits des substances actives tels que le méthylisothiocyanate et l'isopropylisothiocianate. Selon Auger *et al.* (3), ces composés peuvent avoir une rémanence d'environ huit jours.

Conclusion

Il ressort de cette étude que *B. senegalensis* est une plante insecticide très efficace dans le contrôle des populations de bruches dans les systèmes de stockage traditionnel de niébé.

Ainsi, compte tenu de cette efficacité et de son effet non nocif pour l'environnement et la santé animale, son utilisation doit être encouragée auprès des agriculteurs pour la protection de leur récolte de niébé. Toutefois, des études toxicologiques sont nécessaires pour mesurer les incidences, à court ou à long terme, de l'utilisation de *B. senegalensis* sur l'environnement et la santé du consommateur.

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Effects of Soybean Cultivars on Soymilk Quality

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Keywords: Soybean – Cultivars – Soymilk

Summary

Soymilk was prepared from twelve soybean cultivars grown under the same environmental conditions to evaluate their effects on soymilk characteristics. Significant correlations were observed between the chemical composition of the seeds and the resultant soymilk. Soymilk solids were significantly affected by seed size and seed phosphorus contents. Cultivars with dark hilum produced soymilk with less attractive colour.

Résumé

Effets des cultivars de soja sur la qualité de leur lait
Douze cultivars de soja ont été produits dans les mêmes conditions environnementales afin d'évaluer leur influence sur les caractéristiques de leur lait. Des corrélations significatives ont été observées entre la composition chimique des fèves et leur lait. La teneur en matières solides du lait a été significativement affectée par la grosseur et la teneur en phosphore des fèves. Les cultivars à hile sombre ont produit un lait de soja de couleur peu attrayante.

Introduction

Soymilk is obtained by hot-water extraction of wet-ground soybean. It is considered a high quality cholesterol-free source of protein. Having the appearance and consistency of cow's milk, it is a popular warm breakfast in Taiwan, and is gaining popularity in Japan and many western countries (4). In the United States of America, a marked increase in the consumption of traditional Asian soyfoods such as soymilk and tofu has been reported during the past decade. This increase has been attributed to a number of factors including health, ethics and the environment. Medical reports link high fat diets to cardiovascular disease and obesity (10). Kenneth (6) has reported that addition of soy protein to the diet lowers total and low-density lipoprotein cholesterol levels in individuals with hypercholesterolemia. Soybeans contain in relatively high concentrations, several compounds with demonstrated anticarcinogenic activity (10). Current soy research is focused on isoflavones, a unique class of plant hormones found primarily in soy protein with a demonstrated ability to inhibit cancer cell growth. Researchers have reported that minimally processed soy ingredients have isoflavones in concentrations similar to unprocessed soybeans (7). Soymilk is considered a minimally processed ingredient compared to tofu, a protein gel-like product widely consumed in many oriental countries. It is obtained by coagulation of hot soymilk using a calcium or magnesium salt, followed by molding and pressing to remove the whey.

Soymilk manufacturers need precise information about characteristics in the soybean seeds that contribute to the production of good quality soymilk. Soymilk is typically made from whatever bean is available. However, some manufacturers prefer high protein soybeans. Also, studies conducted to determine the relationship between soybean seed characteristics and soymilk quality attributes will provide breeders with specific guidelines for their selection.

In this study, soybean cultivars with different seed size and hilum colour were grown in the same location under the same environmental conditions to determine their effects on soymilk characteristics.

Material and methods

Twelve soyfood cultivars selected for their protein contents, seed size and hilum colour were grown in two replications of a randomized complete block design at the Agronomy Research Center of Kansas State University at Ottawa in 1997, to evaluate their effects on soymilk quality characteristics.

In this experiment, plots consisted of four 6 m long rows, spaced 76 cm apart, planted in the middle of May and harvested upon maturity. The soil is an abruptic argiaquoll, fine montmorillonitic at the test site. Seed harvested from the center rows of each plot was used for all evaluations.

Evaluation of seed characteristics

About 20 g of seeds from each replication was analyzed for protein and oil concentration using near infrared reflectance. Determination of phosphorus was based on colorimetric method in which a blue color was formed by the reaction of ortho-phosphate, molybdate ion followed by reaction with ascorbic acid at an acidic pH (11). The phosphomolybdenum complex formed was then red at

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660 nm. Determination of seed size was based on the weight in gram of 100 seed samples.

Preparation of soymilk

Soymilk was prepared using a modification of the method described by Lim *et al.* (8). To prepare soymilk, 150 g of soybeans were soaked in 500 ml of distilled water at room temperature for about 16 h in order to reach complete hydration. Hydrated beans were drained, rinsed and blended for 4 min with 400 ml of distilled water followed by addition of 600 ml boiling water (the water to bean ratio was 10 to 1 by weight). The slurry obtained was strained through 4 layers of cheesecloth to separate soymilk from insoluble residue.

Evaluation of soymilk

Samples of soymilk were evaluated for phosphorus, protein, solid contents and pH. Determination of soymilk phosphorus was based on the colorimetric method using a Technicon Auto-Analyzer II system (11). Soymilk protein was determined using LECO protein Analyzer model FP 2000 series (Leco corp. St. Joseph, MI). The sample protein was converted to nitrogen oxide which was converted over to crude protein (1). A fisher Accumet pH meter was used to measure the pH of the soymilk. Commercially prepared buffer solutions of pH 4.0 and 7.0 were used to standardize the pH meter. Duplicate soluble solids determinations were made on a few drops of soymilk using Reichert refractometer.

Determination of soymilk colour

Soymilk colour was determined on curd obtained from the soymilk and was expressed in L, a and b values using a Mini Hunter (Lab) instrument. L-value measures lightness or whiteness of the sample, a-value measures redness when positive, greenness when negative and b-value measures yellowness when positive and blueness when negative. The instrument was standardized using a standard white tile. Each sample was scanned at three different locations and averaged to determine L, a and b values (5).

Data were examined by analysis of variance and cultivars means were compared using Fisher's LSD estimates (P= 0.05). Correlation coefficients were determined to measure degree and significance of association between seed and soymilk characteristics.

Results and discussion

Cultivars means are the average of four measurements, two for each cultivar, except for colour parameters, which represent the average of six measurements, three for each replicate.

Seed characteristics

Chemical composition and seed size of the twelve cultivars are shown in table 1. Data obtained from this study using soybean cultivars planted at the same location permit an accurate comparison of cultivar differences. Significant differences among cultivars were noted for seed protein, oil and phosphorus contents, and also for seed size. The chemical composition had the following ranges: protein contents from 42 to 45.7%, oil from 18.1 to 22.2% and phosphorus from 0.55 to 0.67%. Seed size ranged from 7.9 to 27.9 g per 100 seeds. Among the cultivars studied, 'IL2', 'A93-651012' and 'PI385.942' had the highest protein contents. A significant negative correlation was noted between protein and oil contents (r = -0.67). Gurdip *et al.* (4) reported that protein and oil contents vary widely among varieties of soybean and exhibit a very strong negative correlation. 'Mercury' and 'IL2', both small-seeded cultivars showed the highest phosphorus contents. Phosphorus is found in soybeans in form of phytic acid. Lolas *et al.* (9) reported a high correlation (r = 0.98) between phosphorus and phytic acid in soybean. Phytic acid has the ability to prevent osteoporosis (10), suggesting that addition of high phosphorus soybeans to the diet has a potential health benefits.

Table 1
Means of seed characteristics for 12 soybean cultivars grown at Ottawa in 1997

Genotypes	Protein	Oil	Phosphorus	Seed size
		%		g/100 seeds
A93-651012	45.1	20.6	0.63	19.1
FG1	43.5	21.8	0.61	21.4
FG2	42.9	21.7	0.60	22.9
IA3002	42.0	22.2	0.61	23.3
IL2	45.7	19.8	0.66	10.6
KS4694	43.0	20.3	0.55	15.7
LS301	43.5	20.8	0.62	20.6
Macon	44.2	22.1	0.60	18.4
Mecury	43.2	22.1	0.67	7.9
PI385.942	45.3	18.1	0.63	22.6
Saturn	43.2	20.9	0.61	27.9
U92-3808	44.0	20.1	0.61	8.9
Mean	44.4	20.5	0.61	16.1
LSD (0.05)	1.5	0.6	0.04	0.8

Table 2
Means of soymilk characteristics of 12 soybean cultivars tested at Ottawa in 1997

Genotypes	pH	Protein	Phosphorus	Solids
		%		
A93-651012	6.59	4.94	0.67	9.5
FG1	6.71	4.73	0.67	9.9
FG2	6.56	4.68	0.66	9.9
IA3002	6.52	4.66	0.64	9.4
IL2	6.48	5.14	0.65	8.1
KS4694	6.52	4.73	0.57	9.3
LS301	6.51	4.87	0.65	9.2
Macon	6.68	5.05	0.59	9.1
Mecury	6.66	4.68	0.69	8.4
PI385.942	6.52	5.27	0.67	9.3
Saturn	6.72	4.77	0.69	9.7
U92-3808	6.62	4.92	0.68	9.6
Mean	6.60	4.91	0.60	9.09
LSD (0.05)	NS	0.19	0.10	0.58

Soymilk properties

The properties of soymilk obtained from the different cultivars are shown in table 2. There were no significant differences among cultivars for soymilk pH. The ionic strength of soymilk can affect its pH. The phosphorus content ranged from 0.57 to 0.69%. Protein contents

varied from 4.66 to 5.27%. These concentrations depend on the water to bean ratio used to prepare the soymilk. Significant differences among cultivars were observed for soymilk solid contents ranging from 8.1 to 9.9. 'FG1' and 'FG2' produced soymilk with the highest solid contents. According to Lim *et al.* (8), high protein, low fat and high soluble solids are desirable soymilk characteristics for consumers.

Relationships between seed and soymilk characteristics

Seed size was significantly correlated with soymilk solids (r = 0.65). Cultivars with large seeds tended to yield soymilk with high solid contents. Soymilk solids were negatively correlated with seed phosphorus (r = -0.62).

Significant positive correlations between the same components in soybean and soymilk were noted for protein (r = 0.89) and phosphorus (r = 0.66), indicating that cultivars with high protein and phosphorus contents are necessary to produce soymilk with high protein and phosphorus. Lim *et al.* (8) also found seed protein and phytic acid to be significantly correlated with the corresponding components in soymilk. However, this can depend on the method of soymilk preparation. Factors such as protein extractability from soybean resulting from differences in soybean hydration, grinding time and temperature, variation in extent of filtration in soymilk preparation are possible causes of variation in soymilk composition. Soymilk oil content was not determined, but it was expected that the ratio of protein to oil in the seed would affect the same ratio in the soymilk.

Soymilk colour

Soymilk differed significantly for L-value or degree of whiteness and b-value or degree of yellowness (Table 3). White or creamy white colour is a desirable soymilk characteristic (2). Soymilk produced in this study had L-values ranging from 90.4 to 93. This range was close to the standard white tile (L= 93.9). 'Macon' and 'FG1' both with dark hilum colour had the lowest L-values indicating the negative impact of dark hilum seed on soymilk colour.

Table 3
Soymilk colour parameters and seed hilum colour from 12 soybean cultivars

Genotypes	Hilum colour	L	a	b
A93-651012	Yellow	92.3	0.30	12.5
FG1	Yellow	92.8	0.21	12.4
FG2	Black	91.3	0.25	13.3
IA3002	Yellow	92.3	0.48	12.4
IL2	Yellow	92.3	0.39	13.7
KS4694	Brown	91.8	0.31	12.6
LS301	Yellow	92.5	0.27	12.7
Macon	Black	90.4	0.18	12.5
Mecury	Brown	92.3	0.29	14.2
PI385.942	Yellow	93.0	0.13	12.6
Saturn	Yellow	92.7	0.26	11.9
U92-3808	Yellow	92.3	0.47	13.9
Mean	-	92.1	0.38	12.7
LSD (0.05)	-	0.8	NS	1.4

Cultivars 'Mecury', 'U92-3808' and 'IL2' produced soymilk with the highest b-values. Evans *et al.* (3) have reported that the colour of soybean products is an important trait in the selection for export to the edible soybean industry in Japan. This is because soybean products such as soymilk and tofu become yellow as they age, and consumers will discriminate against soybean cultivars that produce yellow products. There were no significant differences among cultivars for a-values.

Conclusion

Soymilk properties such as chemical composition, solid contents and colour differed significantly among soybean cultivars. Large-seeded cultivars tended to produce soymilk with high percent solids and cultivars with dark hilum produced soymilk with less attractive colour. This study showed that soybean cultivars play an important role in soymilk production.

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Performance of Public and Non-Public Organisations in the Dissemination of Cooking Bananas in Nigeria

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Keywords: Plantains- Cooking bananas- Distribution- Institutions- Performance

Summary

The study assessed the performance of public (POs) and non-public (NPOs) organisations in the dissemination of cooking bananas in Southeast Nigeria. Cooking bananas were introduced in the area as an interim measure to reduce the incidence of black sigatoka disease on plantains. Eight POs and 4 NPOs carried out the dissemination exercise. In all, about 55,000 cooking banana suckers were distributed in about 700 villages to about 30,000 farmers. NPOs out-performed POs in the dissemination exercise; they accounted for about 90% of suckers distributed, as well as about 80% of villages and 99% of farmers reached with the crop. Without the involvement and the efforts of the NPOs, the majority of the farmers and villages would not have obtained the crop. Unfortunately, the distribution of suckers by NPOs was limited to villages within the areas where they carry out their main activities, i.e. oil exploration / exploitation. As a result, more than 80% of suckers distributed in the region were concentrated in the states of Bayelsa and Rivers. For a more even distribution of the newly developed hybrid plantains a key recommendation of the study is the involvement in the dissemination exercise of as many church and village groups as possible, especially in areas where NPOs do not operate.

Résumé

Performance des organisations gouvernementales et non gouvernementales dans la distribution des bananes à cuire au Nigeria

Cette étude a examiné la performance des organisations publiques et privées dans la distribution des bananes à cuire au Nigeria. Celles-ci avaient été introduites dans le sud-est du Nigeria comme mesure transitoire pour réduire l'incidence de la cercosporiose noire sur la banane plantain. Les résultats de l'étude montrent que 4 organisations privées et 8 publiques ont effectivement participé à la distribution des bananes à cuire dans la région. Près de 55.000 rejets de bananes à cuire ont été distribués dans environ 700 villages à environ 30.000 paysans. Les entreprises privées ont distribué près de 90% de rejets distribués dans la région, atteint près de 99% de paysans et 80% de villages. Sans l'implication des entreprises privées, la plupart des paysans et de villages n'auraient pas pu obtenir les bananes à cuire. Malheureusement, la distribution de bananes à cuire par les entreprises privées était limitée aux zones où celles-ci exercent leur principale activité, c'est-à-dire l'exploitation du pétrole. Près de 80% de rejets distribués dans la région l'ont été dans les Etats de Bayelsa et de Rivers où sont installées les principales entreprises d'exploitation de pétrole, c'est-à-dire Shell et Agip. Pour obtenir une meilleure répartition de nouveaux hybrides développés par l'IITA dans la région l'étude recommande de recourir à autant d'associations villageoises et de groupes religieux que possible, spécialement dans les régions où les entreprises privées n'opèrent pas.

Introduction

The International Institute of Tropical Agriculture (IITA) introduced cooking bananas (*Musa* spp., ABB genome) from Asia into Southeast Nigeria in the mid-1980s. They were supposed to serve as an interim measure in checking the incidence of black sigatoka disease on plantains. Black sigatoka is a leaf spot disease (caused by the fungus *Mycosphaerella fijiensis* Morelet) which has become a major threat to plantain production in sub-Saharan Africa (9, 10) reducing yield by up to 50% (9, 7), and in some instances, leading to total crop failure. The long-term strategy consisted of the establishment of a plantain- breeding programme aimed at conferring black sigatoka resistance characteristics to plantains. The major cooking banana cultivars introduced were Cardaba, Bluggoe, Fougamou, Nzizi and Pelipita (5). They all have an ABB genomic constitution and except for Bluggoe they are resistant to black sigatoka disease. Cooking bananas have other important attributes which include lodging resistance, drought tolerance, early ratooning capacity, as well as high bunch yield (4, 8). They are also less seasonal in production than plantain, have less sugar, and are rich in iron and

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potassium (3, 9). The starch content is higher than in sweet bananas and this makes cooking bananas suitable for cooking (3). Above all, due to their hardiness, cooking bananas have the potential of surviving in areas where plantains and sweet bananas do not (8). Less than 10 years after the introduction of cooking bananas into Southeastern Nigeria, the breeding programme of IITA has been able to develop very promising plantain hybrids, which are currently undergoing several tests before their release to farmers. Information obtained from this study would help improve the distribution of these hybrids in the region.

Methodology

The study was carried out in Southeastern Nigeria, where the crop was initially introduced. The first phase of this study consisted of visiting the tissue culture laboratories (TCL) at Onne (Rivers State) and Owerri (Imo State) where cooking banana seedlings were multiplied by means of *in-vitro* techniques and given to various institutions for distribution to farmers. The TCL's archives were consulted and staff members interviewed in order to identify the institutions that collected cooking banana plantlets for distribution. Other information collected at the tissue culture laboratories include the quantity of plantlets collected by various disseminating institutions and individuals, the date of collection as well as their destination. In the second phase, the institutions which collected plantlets at the tissue culture laboratories were visited and questionnaires used to collect the following information: the number and location of multiplication sites (nurseries), the year the distribution of cooking banana plantlets started, the quantity and method of transfer of suckers from nurseries to farmers, and the names of villages supplied with cooking banana plantlets. Other information was on methods of awareness creation and of distribution of suckers from multiplication site(s) to farmers. The survey was conducted between February and October 1998.

Results and discussion

Disseminating institutions

In all, 12 institutions spanning 10 states had collected cooking banana seedlings at the tissue culture laboratories and had carried out the distribution exercise (Table 1). They include 4 non-public organisations (NPOs) and 8 public organisations (POs).

The NPOs are Shell Petroleum Development Corporation (SPDC), Nigeria Agip Oil Company Limited (NAOC), the Anglican Diocese of Awka in Anambra State and the International Institute of Tropical Agriculture in Rivers State, while the POs are the State Ministries of Agriculture (MOAs) and Agricultural Development Programs (ADPs). The MOAs involved in the dissemination are from Cross River, Abia, and Rivers States, while the ADPs are from Akwa Ibon, Cross River, Enugu, and Imo States. The Imo's State Government House also participated in the distribution of cooking bananas in the region. In addition to the above institutions, a great number of individuals collected cooking banana plantlets directly at the tissue culture laboratories. However, the present study is limited to disseminating organisations.

Table 1
Distribution (%) of cocking banana suckers by state and disseminating institution

State	Institution	% of suckers distributed (Total = 55,374)	Period
Abia	Imo Govt House*	0.4	1990
	MOA	0.2	1993-96
	SPDC East	0.2	1990-98
Akwa Ibon	ADP	0.7	1995
	SPDC East	1.6	1990-98
Anambra	Anglican Diocese	0.4	1998
Bayelsa	SPDC East	67.0	1990-98
	NAOC	0.5	1988-94
Cross River	MOA	5.2	1992-95
	ADP	1.1	1994
Delta	SPDC West	NA**	1993-98
	NAOC	2.2	1988-94
Ebonyi	Imo Govt House*	0.2	1990
Rivers	SPDC East	3.0	1990-98
	NAOC	13.0	1988-94
	MOA	0.1	1992-94
	IITA-Onne	0.5	1995-97
Enugu	ADP	0.5	1994
Imo	ADP	1.5	1990-95
	Govt House*	1.2	1990
	SPDC East	0.7	1990-98
	NAOC	0.7	1988-94
Rivers	SPDC East	3.0	1990-98
	NAOC	13.0	1988-94
	MOA	0.1	1992-94
	IITA-Onne	0.5	1995-97

* Government House; ** NA = data not available.

Multiplication and distribution of suckers

The majority of the institutions that carried out the dissemination of the crop started the distribution in the early-1990s, but a few commenced the distribution earlier in the late-1980s. Plantlets were produced in two tissue culture laboratories (Onne and Owerri) by *in vitro* techniques and were taken to farmers either directly or indirectly through disseminating institutions. Between 1995 and 1997, about 6,000 plantlets were produced by the Onne tissue culture laboratory of which 96% were given to disseminating institutions, while 4% went directly to farmers (Table 2).

Table 2
Production in laboratories and distribution of cooking banana seedlings

Laboratory	Quantity produced	Quantity distributed (%) to: Institutions	Individuals
Onne*	6,038	96	4
Owerri**	2,350	65	35
Total	8,388	87	13

* for 1995 to 1998; ** for 1990 to 1995.

There was no record in Onne laboratory archives on sucker distribution for the period 1988 - 1994. However, several reports of the Plantain and Banana Improvement Program (PBIP) of IITA mentioned that during this period the Onne laboratory had yearly distributed an

average of 3,000 seedlings to various disseminating institutions (6). The Owerri tissue culture laboratory produced about 2,350 plantlets between 1990-1995 out of which 65% were given to various disseminating institutions, while 35% went directly to farmers. Direct distribution, i.e. from tissue culture laboratory to farmers is inefficient because through this channel only farmers who had easy access to the laboratories can collect plantlets; this is because cooking banana seedlings are fragile and cumbersome to transport manually over long distances. All the institutions that took part in the distribution exercise established nurseries for the multiplication of suckers. Multiplication sites enabled them to generate enough material for distribution. In the absence of an efficient transportation system, the establishment of nurseries across the operating area makes the distribution exercise much easier and increases the chances of reaching a much higher number of farmers. The wider the spread of nurseries across the operating area, the less need for long distance transportation of the material, as well as less trips by staff to the main nursery. SPDC established the highest number of nurseries (154), the NAOC had only one large nursery at its farm head office at Obrikom; while the Anglican Diocese of Awka had 7 nurseries in 6 parishes and the Bishop's court (Table 3).

Table 3
Number of nurseries, years of sucker distribution and percentage of villages and farmers reached with cooking banana suckers per institution

A	B	C	D	E
ADP, Akwa Ibon State	4	1	7	0.4
ADP, Cross River State	NA	1	NA	NA
ADP, Enugu State	4	1	1	0.1
ADP, Imo State	4	6	7	NA
Anglican Diocese, Anambra State	7	1	4	NA
Government House, Imo State	NA	1	NA	0.3
IITA, Rivers State	1	3	NA	NA
MOA, Abia State	8	4	NA	NA
MOA, Cross River State	5	4	3	0.2
MOA, Rivers State	8	3	3	NA
NAOC	1	7	5	3
SPDC	154	9	70	96
Average	19.6	3.4	12.5	16.7

Note: A = disseminating institution; B = number of nurseries; C = number of years of distribution; D = percentage of villages reached with the crop per institution (total number of villages = 687); E = percentage of farmers reached with the crop per institution (total number of farmers = 29,575); NA = data not available.

The institutions created awareness on cooking bananas through various media such as seminar / workshops, field demonstration days, contact farmers, farmer groups, extension staff visits, and announcements in church. However, extension staff visits were the most common means of informing farmers about cooking banana characteristics. Information given to farmers regarding the crop included its high yield advantage, its resistance to black sigatoka, and lodging resistance. Depending on the disseminating institution farmers were sometimes supplied with suckers at their farms or asked to collect these at the multiplication site; but most often, farmers visited the institution to obtain the suckers. This is an unsatisfactory process, because, farmers who cannot easily get access to the institutions will be scarcely reached with the crop. Most institutions supplied suckers free of charge to the farmers, while a few demanded a replacement of the same number of suckers after the first harvest in order to supply other farmers. In Burkina Faso, the "West and Central African Collaborative Maize Research Network" (WECAMAN) requires farmers supplied with improved maize varieties to pay back either with seeds or money from their sales after one year (2). The number of years of delivery of suckers to farmers varied from one institution to another; it ranged from 1 to 9 years with an average of 3.4 years (Table 1). At the time of survey, some institutions had stopped the distribution, while others were still distributing. SPDC had the highest number of years of sucker distribution, followed by NAOC.

Performance of disseminating institutions

At the time of survey, all the institutions had distributed to farmers a total amount of 55,374 suckers. SPDC, NAOC, and the MOA-Cross River State were the major distributors (Table 1). SPDC distributed about 73% of the total amount of suckers distributed in the region, NAOC 16%, and MOA-Cross River State 5%. On average, SPDC distributed 4,474 suckers per year to farmers, while NAOC distributed 1,800 suckers yearly. In all, about 700 villages were reached with cooking banana plantlets, out of which the NPOs (SPDC, NAOC, and the Anglican Diocese) accounted for about 80%. SPDC had the highest number of villages (70%) reached with the crop, followed by NAOC (5%). ADP-Akwa Ibon State and ADP-Imo State had each reached 7% of the villages supplied with cooking bananas. About 30,000 farmers were given suckers by the institutions. SPDC and NAOC alone accounted for 99% of the farmers reached with the crop. On average, SPDC reached 59 farmers per village with suckers, while NAOC reached 26 farmers per village. These were the highest figures obtained among all the institutions. Among the national agencies, the best distributor was the MOA-Cross River, which reached only 3 farmers per village. The above results clearly indicate that the NPOs out-performed the national agencies in the dissemination exercise. In essence, without their efforts and involvement, the majority of the villages and farmers would not have obtained the crop. Unfortunately, the involvement of NPOs was limited to villages within the areas where they carry out their main activities. As a result, the cultivation of cooking bananas in Southeast Nigeria is concentrated in Bayelsa and Rivers States where SPDC's and NAOC's oil exploitation activities are concentrated. A breakdown of the distribution per state shows that 84% of suckers were distributed in these two states. The high performance of the NPOs is mainly attributed to the fact that they have large financial resources, which enabled them to distribute suckers over a long period of time, to provide field incentives and better transport facilities to extension agents. SPDC had the highest number of years (9) of sucker distribution, while NAOC distributed during 6 years. Among the institutions that distributed cooking bananas, only a few provided incentives to their field staff such as on-field residential accommodation, payment of field allowance as well as

transport allowance. SPDC and NAOC showed more commitment in the provision of these incentives than national agencies. The on-field residential accommodation was provided by SPDC alone. The majority of the national agencies had poor transport facilities, which greatly impeded their efforts. In some situations, the national agents had to make use of the public transportation. The problem of inadequate transport facilities and lack of incentives is not common to Nigeria only, but to most of the less developed countries (1). In Africa, in particular, Arnon writes: "Some of the extension problems in Africa are associated with poor terms of service, living and working conditions. Pay and allowances are less than those of their peers working for parastatals or private sector organisations, ... ". In Guinea and Sierra Leone, Zinnah *et al.* (11) remarked that major problems encountered by the extension staff in the dissemination of mangrove rice varieties were, among others, inadequate mobility and lack of incentives.

Conclusion and recommendations

The study has examined the relative performance of the public (POs) and non-public (NPOs) organisations in the dissemination of cooking bananas in Southeast Nigeria. The general performance of the POs was poor compared to the NPOs. Results indicate that the NPOs supplied about 90% of suckers distributed in the region; SPDC supplied about 73% and NAOC 16%. They both reached about 75% of villages and 99% of farmers supplied with the crop. In essence, without the efforts and involvement of the NPOs most villages and farmers would not have obtained the crop. Unfortunately, the involvement of the NPOs was limited to villages located within the areas where they carry out their main activities, i.e. oil exploration / exploitation. As a result, about 84% of suckers distributed in the region were concentrated in two states, namely Bayelsa and Rivers. Heavy reliance on NPOs is likely to result in an uneven distribution of the crop in the region. In order to redress this situation and make more effective the delivery of the newly-developed plantain hybrids a rural group-based dissemination approach should be considered. As much as possible, the research institution (in occurrence IITA) is to identify and mobilise as many potential disseminating institutions (both NPOs and POs) as possible throughout the target area and have a clear idea of their respective mandate areas. The old system of utilising church and other village groups should be revived, and used to disseminate the new hybrids to the farmers. Disseminating institutions should also be made to establish as many nurseries as possible across their respective mandate areas. This will reduce transportation costs and other logistic problems and also contribute to a more even distribution of the crop within the target area. The use of cheaper and easier methods of production of the hybrids is also encouraged. For instance, multiplication sites of suckers or plantlets using the macro-propagation techniques (with corms and buds), which can be easily handled by the national agricultural extension services, should be considered.

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Correlations and Correlated Responses in Upland Cotton (*Gossypium hirsutum* L.)

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Keywords: Cotton- Correlations- Correlated responses

Summary

Plant breeders must be concerned with the total array of economic characters in their efforts to develop a crop variety acceptable to farmers. Their selection endeavours must therefore take into consideration how changes in one trait affect, simultaneously, changes in other economic attributes. The importance of correlations and correlated responses is therefore self evident in plant breeding endeavours. In this study F_3 progenies from a cross between two cotton lines SAMCOT-9 x Y422 were evaluated for two years and performance data were used to obtain correlations between nine agronomic and fibre quality traits in upland cotton. The results indicated that plant height was significantly and positively correlated with seed cotton yield, number of sympodial and monopodial branches, seed index, fibre length and micronaire index. Positive and significant correlations were also obtained between: seed cotton yield, lint percent and fibre strength and fibre length. Significant negative correlations were obtained between: plant height and lint percent; number of monopodial branches, sympodial branches and lint percent; fibre length, fibre strength and micronaire index. The correlated responses in the other eight traits when selection was practiced for seed cotton yield in the present study shows that it might be more profitable to practice direct selection for seed cotton yield compared to selecting for seed cotton yield through any of the other traits.

Résumé

Corrélations entre caractères et réponses corrélées du cotonnier (*Gossypium hirsutum* L.)

Les améliorateurs des plantes cultivées doivent prendre en compte une grande gamme de caractères dans leurs efforts de développer un nouveau cultivar qui répond aux besoins des agriculteurs. Leurs efforts de sélection doivent en conséquence prendre en considération comment un changement au niveau d'un caractère peut affecter simultanément les autres principaux caractères retenus dans leur travail de sélection. L'importance de la corrélation entre caractères et de la réponse corrélée est donc très grande dans un programme de sélection. Dans la présente étude, la descendance F_3 d'un croisement réalisé entre les lignées de cotonnier SAMCOT-9 et Y422 a été évaluée pendant deux années consécutives et des corrélations ont été calculées entre les valeurs observées pour neuf paramètres concernant la morphologie et la productivité des plantes ainsi que la technologie de la fibre. Les résultats obtenus indiquent que la hauteur de la plante est corrélée significativement et positivement avec le rendement en coton-graine, le nombre de branches sympodiales, le seed index, la longueur des fibres et l'indice micronaire. Des corrélations positives et significatives ont également été obtenues entre: le rendement en coton-graine, le rendement à l'égrenage ainsi que la résistance et la longueur des fibres. Des corrélations négatives et significatives ont également été obtenues entre: la hauteur de la plante et le rendement à l'égrenage; le nombre de branches monopodiales, le nombre de branches sympodiales et le rendement à l'égrenage; la longueur, la résistance et l'indice micronaire des fibres. Les huit caractères considérés ont montré une faible réponse corrélée aux modifications du rendement en coton-graine. Cette constatation laisse supposer que chez le cotonnier, il est plus recommandable de réaliser une sélection directe pour le rendement que de réaliser une sélection indirecte en utilisant un de ces huit caractères.

Introduction

Correlation, measured by a correlation coefficient is important in plant breeding because it measures the degree of association, genetic or non-genetic between two or more characters. If genetic association exists, selection for one trait will cause changes in other traits. This is called correlated response (4). Since plant breeders must be concerned with the total array of economic characteristics and not just one trait, the importance of knowing how changes in one character by selection may cause simultaneous changes in other

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economic traits is self-evident. In their continuous efforts to improve both yield and fibre quality attributes, cotton breeders have realized the presence of either favorable or unfavorable associations between such major attributes. The magnitude and type of these associations depend mainly on which yield components and quality attributes were taken into consideration and the kind of population under study. In the present study, phenotypic and genotypic correlations and the associated genetic changes were determined among nine quantitative characters using data obtained from a segregating generation of a cross between two cotton lines.

Material and methods

Using the hand emasculation technique, a cross was made between the cotton lines SAMCOT-9 and Y422 in the 1986 growing season. The resulting F_3 progenies from this cross was analyzed at Samaru (11°11´N, 7° 38´ E) for two years, 1991 and 1992 using randomized complete block design with three replications in each year. Plots consisted of single ridges, 5 m long and 0.91 m apart. Four to six acid delinted seeds were sown in holes spaced at 45 cm along the ridges. The seedlings were thinned to one plant per hole at 4 weeks after planting. Boronated single superphosphate (with 5% borax as source of boron) was applied to the experimental area at the rate of 125 kg per hectare during land preparation. Calcium ammonium nitrate was applied at the rate of 125 kg per hectare after thinning. Weeding started early and was done regularly. Insect pests were controlled by three fortnightly sprays of Cymbush 10EC at the rate of 2.5 litres per hectare starting at 9 weeks after planting. Data were taken from five random plants per plot on the nine traits, plant height, number of sympodial branches, seed cotton yield, lint percent, seed index, fibre length, fibre strength and micronaire index. The data were analyzed separately for each year and then the combined data for the two years were analyzed. Phenotypic and genotypic correlations were estimated following the formulae given by Miller *et al.* (16) as follows:

$$\text{Genotypic correlation } (r_g) = \frac{O^2_g\ X.Y}{(O^2_g\ X)\ (O^2_g\ Y)}$$

Where :

O^2_g X.Y is the genetic covariance between the two traits X & Y

O^2_g X is the genetic variance of trait X

O^2_g Y is the genetic variance of trait Y

$$\text{Phenotypic correlation } (r_{ph}) = \frac{O^2_{ph}\ X.Y}{(O^2_{ph}\ X)\ (O^2_{ph}\ Y)}$$

Where:

O^2_{ph} X.Y is the phenotypic covariance between the two traits X & Y

O^2_{ph} X is the phenotypic variance of trait X

O^2_{ph} Y is the phenotypic variance of trait Y

Correlated responses were computed according to Fakorede and Obilana (2) as follows:

$$CR_{Y,X} = i_x . h_x . h_y . r_x (X.Y) . O^2_y$$

Where:

$CR_{Y,X}$ is the correlated response in trait

i_x is the selection intensity of trait X

h_x is the heritability of the trait X

h_y is the heritability of the trait Y

r_x (X.Y) is the genotypic correlation between traits X & Y

O^2_y is the standard deviation of trait Y

Results

Correlations

The estimates of genotypic and phenotypic correlations among nine quantitative traits are presented in table 1. As a general observation, in practically all instances, the genotypic correlations were higher in magnitude than the phenotypic correlations. To avoid unnecessary repetition in the presentation of these results reference will mostly be made to the more important genotypic correlations.

Plant height

Positive and significant correlations were observed between plant height and seed cotton yield, number of sympodial and monopodial branches, seed index, fibre length and micronaire index. The coefficients of genotypic correlations were higher with both number of sym-

Table 1
Genotypic (upper right) and phenotypic (lower left) correlations between the nine quantitative traits in upland cotton

Trait	SCY	PH	NSB	NMB	L%	SI	FL	FS	MIC
SCY	1.00	0.28**	-0.09	0.08	0.57**	0.02	0.16*	-0.02	-0.05
PH	0.04	1.0	0.63**	8.62**	-0.28**	0.71*	0.51*	0.71**	0.17*
NSB	-0.01	0.50**	1.00	0.74**	0.36**	0.01	-0.15*	-0.00	0.08
NMB	0.17	0.60**	-0.27**	1.00	-0.30**	0.23**	0.10	0.18*	-0.16
L%	0.53**	0.27**	-0.55**	-0.29*	1.00	0.07	0.69**	0.48**	0.10
SI	-0.07	0.19*	-0.04	0.16*	-0.23*	1.00	0.54**	0.22**	0.12
FL	-0.03	-0.06	-0.15*	0.06	-0.60**	0.44**	1.00	0.38**	0.14*
FS	-0.23**	-0.05	-0.23**	0.12	-0.51**	0.19*	0.41**	1.00	0.28**
MIC	-0.07	-0.22**	-0.19*	-0.15*	0.019*	0.23**	0.16*	0.17*	1.00

* Significant at 5%, ** significant at 1%

SCY= Seed cotton yield; PH= Plant height; NSB= No. of sympodial branches; NMB= No. of monopodial branches; L%= Lint percent; SI= Seed index; FL= Fibre length; FS= Fibre Strength; MIC= Micronaire index.

podial and monopodial branches and fibre length. A significant negative correlation was observed with lint percent.

Number of sympodial branches
Correlation of number of sympodial branches with plant height has already been described above. Positive and significant correlations were obtained with number of monopodial branches and lint percent. A low but significant negative correlation was however obtained with number of monopodial branches and fibre length.

Number of monopodial branches
The relation between number of monopodial branches, number of sympodial branches and plant height has been analyzed above. Positive and significant correlations were obtained between number of monopodial branches, seed index and fibre strength. A negative and significant correlation was recorded with number of sympods, lint percent and micronaire index.

Seed cotton yield
Seed cotton yield was significantly and positively correlated with lint percent and fibre strength. Very low negative correlation was obtained with the other fibre traits. The relationship between seed cotton yield and other traits have been discussed previously.

Seed index
Correlations of seed index with plant height, number of sympodial and monopodial branches, seed cotton and lint percent have been discussed above. Seed index was also positively correlated with all fibre quality traits. Only correlations with fibre length and strength were however significant.

Fibre length
Fibre length was positively and significantly correlated with fibre strength and micronaire index. Other correlations of fibre length have been described above.

Fibre strength
Fibre strength was positively and significantly correlated with fibre strength and micronaire index. Other interrelationships with fibre strength have been described already.

Micronaire index
Correlations involving fibre fineness as measured by micronaire index were discussed in the respective sections above. To summarize these relations, selecting for increased fibre fineness could cause an increase in plant height, fibre length, fibre strength and a decrease in number of monopodial branches.

Correlated response
The overall association between seed cotton yield and the traits investigated in this study, presented as correlated response in seed cotton yield when selection is practiced for the various traits is given in table 2.

Table 2
Selection for 8 quantitative traits and expected correlated response in seed cotton yield in a segregating generation of an upland cotton cross

Trait	Correlated response in seed cotton yield
Plant height	3.41
No. of sympodial branches	-0.13
No. of monopodial branches	0.13
Lint percent	2.24
Seed index	0.02
Fibre lenght	0.18
Fibre strength	-0.01
Micronaire index	-0.04

Very low correlated responses were obtained in seed cotton yield when selection was practiced for the other eight traits.

Discussion

The results of the present study demonstrated different patterns of association among the nine traits studied. In cotton, the trait of most interest to applied plant breeders is yield (5). Yield is a very complex quantitative trait, highly influenced by environmental fluctuations, hence a direct selection for yield could be misleading. It would have been desirable to have one or more traits in which indirect selection for yield could be practiced. The results of the present study have however shown very low correlated responses in seed cotton yield when selection is practiced for the remaining eight traits. Under this situation it will be profitable to practice direct selection for seed cotton yield, more so, since it has been established to have moderate to high heritability (1, 6, 7, 8). Grafius (3) has also indicated that it is not always desirable to select for components of complex traits because under conditions of low correlated response it may be more profitable to deal directly with the complex trait.

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NOTES TECHNIQUES

TECHNICAL NOTES

TECHNISCHE NOTA'S

NOTAS TECHNICAS

Caractéristiques socio-démographiques dans la filière pâte rouie de manioc au Congo-Brazzaville

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Keywords: Steeped paste - Producers - Retaileers - Die - Supplying - Congo

Résumé

*Le manioc (*Manihot esculenta *Crantz) est un aliment énergétique de base en Afrique Centrale, notamment au Congo. Sa consommation sous forme de foufou* (farine gélifiée de manioc rouie obtenue après ébullition) *ou de chikwangue* (pain de manioc obtenu après cuisson de la pâte rouie) *nécessite la transformation des racines en pâte rouie. La dynamique sociale liée à l'activité de production et de commercialisation de la pâte rouie, après enquête sur 119 personnes pratiquant cette activité a montré deux marchés à Brazzaville drainant plus de 40 % de producteurs et revendeurs, un seul grand marché à Pointe – Noire avec 60 % de producteurs et revendeurs, et l'importance du chemin de fer pour les approvisionnements de ces marchés. En effet, les grands bassins de production sont localisés en zone rurale à Mindouli et dans la Bouenza. Jadis délaissée aux femmes, la filière de la pâte rouie est de plus en plus occupée par les hommes surtout à Pointe – Noire, notamment dans la partie commercialisation, jugée moins pénible et plus rentable. L'activité de production et de commercialisation est exercée par les jeunes en majorité de 20 – 40 ans et par des personnes scolarisées. La proportion d'analphabètes est faible à Brazzaville, mais plus forte à Pointe – Noire. L'étude n'établit aucun lien associant le sexe, l'âge, l'instruction et le statut matrimonial dans cette activité.*

Summary

Socio-Demographic Characteristics in Die Cassava Paste steeped in Congo-Brazzaville

Cassava roots constitute a basic food in Congo. Its consumption in the form of foufou or chikwangue requires the transformation of the roots to steeped paste. Social dynamics related to the activity of production and marketing of the steeped paste, after investigation into 119 producers showed two markets in Brazzaville draining more than 40 % of the producers and retailers, one market in Pointe – Noire with 60 % of the producers and retailers, and the railroad importance for supplying these markets. Important activities are localised in rural zone more particularly in Mindouli and in Bouenza localities.

Formerly forsaken with the women, the die of the steeped paste is more and more occupied by the men especially in Pointe - Noire, particularly in the marketing part considered to be less painful and more profitable. Production and marketing activities are carried out by the young people.

Illiterates producers proportion is weak in Brazzaville, but stronger in Pointe - Noire. This study does not establish any bond associating the sex, the age, the instruction and the matrimonial statute in this activity.

Introduction

Aliment de base de nombreuses communautés en Afrique Centrale (6), le manioc (*Manihot esculenta* Crantz) a été introduit au Congo par les Portugais lors de la traite des esclaves (5).

L'adaptation de la plante de manioc aux caractéristiques écologiques et agronomiques de la région a permis de supplanter le petit mil, jadis aliment de base des populations (5). En effet, l'étalement de sa production culturale durant l'année et sa facilité de conservation (cossette de foufou) ont permis de juguler les disettes d'antan très courant dans la sous région (2), permettant ainsi d'assurer la sécurité alimentaire de nombreuses populations.

Aujourd'hui, malgré une forte concurrence des produits importés (pain, riz, etc.), la consommation du manioc reste très forte tant en milieux urbain que rural. Les estimations de la FAO montrent une évolution de la consommation *per capita*, s'élevant à 265 kg/an en moyenne pendant la période 1992-1994. Selon les mêmes sources, la consommation de manioc garantit un apport journalier de 762 kcal par individu soit 33,2% de la ration énergétique quotidienne.

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L'enjeu est si important que quelques tentatives de production semi - industrielle ou industrielle ont été tentées au Congo (complexe agro - industriel de Mantsoumba, unité semi - industrielle de production de chikwangue de Agricongo). Mais toutes ces innovations n'ont pas connu de perspectives durables par manque d'études socio-culturelles approfondies (4). Aujourd'hui, les Congolais continuent à produire cet aliment de base de façon traditionnelle dans les unités de type familial, dont la dynamique découle de l'organisation résiliaire (1).

L'approvisionnement étant devenu également un enjeu important du fait de la demande accrue, consécutive à la forte urbanisation, un nombre significatif d'hommes s'est investi dans l'activité de commercialisation de la pâte rouie du manioc. Un véritable réseau des micro – unités de production et de transformation à caractères individuel et collectif s'est développé au tour de ce produit. Il implique les associations religieuses "maboundou" et autres organisations villageoises "minkomboto" où le paiement se fait à la tâche.
L'importance de ces activités a conduit finalement à l'existence de deux filières distinctes: la première concerne la transformation des racines en pâte rouie, réalisée essentiellement en zone rurale et la seconde s'occupe de la transformation de cette pâte en produit fini "foufou ou chikwangue" destiné aux consommateurs.

Le but de l'étude est de connaître la dynamique sociale liée à cette activité de production et de commercialisation de la pâte rouie de manioc.
Il s'agit de:

- caractériser les aspects socio - économiques et démographiques des populations concernées;
- saisir le changement de comportements sociaux s'opérant dans le domaine de la production et de l'approvisionnement.

Méthodologie

L'enquête a été réalisée au moyen d'un questionnaire pré – codé et d'interviews auprès des personnes exerçant l'activité de production et de commercialisation de la pâte rouie de manioc. Ces personnes ont été préalablement recensées dans les deux grandes villes (Brazzaville et Pointe- Noire), strates choisies du fait de leur importance démographique.
Compte tenu du nombre de personnes impliquées dans cette activité de production et de commercialisation, nous avons privilégié de mener une enquête exhaustive des marchés où se déroulent les principales transactions de ce produit.
Les informations recueillies ont été saisies et exploitées du point de vue statistique avec le logiciel EPI - INFO version 6.0.

Résultats

Importance des marchés

L'enquête a porté sur 119 personnes recensées sur les lieux d'approvisionnement de la pâte rouie, constituant un échantillon représentatif de catégories exerçant l'activité de production et/ou de commercialisation à Brazzaville et à Pointe - Noire (Tableau 1). Les deux marchés PV et PK – Mfilou sont les plus importants pour Brazzaville et le marché de Tié-Tié pour Pointe – Noire. Il apparaît trois grandes voies d'approvisionnement pour Brazzaville, il s'agit de la voie routière pour les marchés de Bacongo et Commission (37,7%), la voie fluviale pour le marché de Yoro (21,7%) et la voie ferrée pour les marchés PV et PK – Mfilou (40,6%). Une partie des produits du marché Yoro de Brazzaville provient de la République Démocratique du Congo. Ce marché est important compte tenu de l'influence qu'il exerce dans la partie nord de la ville de Brazzaville; il est identifié comme le troisième marché par son importance (Tableau 1).

Tableau 1
Répartition des personnes enquêtées par marché d'approvisionnement

	n	%	I.C à 95%
Brazzaville			
Bacongo	16	23,2	13,9-34,9
Commission	10	14,7	7,2-25,0
Yoro	15	21,7	12,7-33,3
PV-PK-Mfilou	28	40,6	28,9-53,1
Statistique	χ^2 = 19,241; p = < 0,0001		
Total	69	100,0	
Pointe-Noire			
Frontière	16	32,0	19,5-46,7
Loandjili	4	8,0	2,2-19,2
Tié-Tié	30	60,0	45,2-73,6
Statistique	χ^2 = 17,397; p = 0,001		
Total	50	100,0	

En ce qui concerne Pointe – Noire, l'approvisionnement se fait essentiellement par la voie routière pour les marchés Frontière et Loandjili ainsi que par la voie ferrée pour le marché Tié – Tié (Tableau 2).

Tableau 2
Provenance de la pâte rouie

	n	%	I.C à 95%
Brazzaville			
Boko	1	1,9	0,0-101,1
Mindouli	43	81,1	68,0-90,6
Bouenza	6	11,3	4,3-23,0
Autres	3	5,7	1,2-15,7
Statistique	χ^2 = 23,872; p = < 0,001		
Total	53	100,0	
Pointe – Noire			
Mayombe	7	14,3	5,9-27,2
Niari	9	18,4	8,8-32,0
Bouenza	18	36,7	23,4-51,7
Frontière	9	18,4	8,8-32,0
Diosso	2	4,1	0,5-14,0
Madingo-Kayes	4	8,2	2,3-19,6
Statistique	χ^2 = 15,552; p = 0,001		
Total	49	100,0	

Bassins ruraux

Les résultats révèlent que la plupart des bassins de production sont situés en zone rurale le long du chemin de fer, essentiellement dans la localité de Mindouli pour Brazzaville (χ^2 = 23,872; p = < 0,001) et la région de la Bouenza pour Pointe - Noire (χ^2 = 15,552; p = 0,001). Ces localités sont identifiées comme des grands bassins de production de la pâte rouie. Toutefois, il est important de signaler qu'à Pointe - Noire 18,4 % des personnes enquêtées déclarent que la pâte rouie vendue au marché Frontière pourrait être produit au Cabinda limitrophe.

Opérateurs économiques de la pâte rouie

Au Congo, la filière de transformation de racines de manioc en pâte rouie "bikédi" et de production de la chikwangue est essentiellement dominée par les femmes. Cette activité économique est perçue négativement pour l'homme dans les mentalités congolaises, en raison de la pénibilité liée à la transformation des racines. Ce qui entraîne une division du travail où les hommes s'adonnent à la commercialisation, jugée plus valorisante. De nos jours, cette attitude persiste, quoique nos observations montrent que de plus en plus d'hommes s'impliquent dans les activités de production.

Le manque de débouchés économiques pourrait favoriser la poussée des hommes vers cette filière. En effet, sur 119 personnes enquêtées, plus de 45 % d'hommes dans l'ensemble (χ^2 = 31,591; p = < 0,001) exercent de façon significative l'activité de production et de commercialisation de la pâte rouie. Cette tendance est plus forte à Pointe - Noire avec 52 % d'hommes, mais seulement 39,1 % à Brazzaville (Tableaux 3 et 4).

Tableau 3
Producteurs et vendeurs en fonction du sexe

Ensemble	n	%
Sexe		
Masculin	53	44,5
Féminin	66	55,5
Statistique	χ^2 = 31,591; p £ 0,001	
Total	119	100,0
Brazzaville	n	%
Sexe		
Masculin	27	39,1
Féminin	42	60,9
Statistique	χ^2 = 23,508; p £ 0,001	
Total	69	100,0
Pointe – Noire	n	%
Sexe		
Masculin	26	52,0
Féminin	24	48,0
Statistique	χ^2 = 21,297; p = 0,001	
Total	50	100,0

En revanche, les femmes dominent nettement cette filière à Brazzaville, la différence est très significative entre les deux strates et il ressort que la variable résidence a un effet de distinction (χ^2 = 31,591).

Tableau 4
Distribution des producteurs au sein de l'échantillon

Ensemble	n	%	I.C à 95%
Producteurs			
Oui	62	52,1	42,8-61,3
Non	57	47,9	38,7-57,2
Statistique	χ^2 = 32,60; p = 0,001		
Total	119	100,0	
Brazzaville	n	%	I.C à 95%
Producteurs			
Oui	33	47,8	35,6-60,2
Non	36	52,2	39,8-64,4
Statistique	χ^2 = 25,121; p = 0,001		
Total	69	100,0	
Pointe – Noire	n	%	I.C à 95%
Producteurs			
Oui	29	58,0	43,3-71,8
Non	21	42,0	28,2-56,8
Statistique	χ^2 = 20,139; p = 0,001		
Total	50	100,0	

Caractéristiques démographiques

Les personnes qui exercent l'activité de production et de commercialisation sont en majorité très jeunes. Leurs tranches d'âge oscillent entre 20 et 40 ans (Tableau 5).

Tableau 5
Distribution de l'âge des producteurs et des vendeurs

Ensemble	n	%	I.C à 95%
Intervalle des âges			
15 – 20 ans	7	6,0	2,4-11,9
20 – 25 ans	26	22,2	15,1-30,0
25 – 30 ans	15	12,8	7,4-20,3
30 – 35 ans	26	22,2	15,1-30,8
35 – 40 ans	17	14,5	8,7-22,2
40 – 45 ans	12	10,3	5,4-17,2
45 – 50 ans	7	6,0	2,4-11,9
50 – 55 ans et plus	7	6,0	2,4-11,9
Statistique	χ^2 = 22,782; p = 0,001		
Total	117	100,0	
Brazzaville	n	%	I.C à 95%
Intervalle des âges			
15 – 20 ans	–	–	–
20 – 25 ans	16	23,9	14,3-35,9
25 – 30 ans	3	4,5	0,9-12,5
30 – 35 ans	18	26,9	16,8-39,1
35 – 40 ans	12	17,9	9,6-29,2
40 – 45 ans	7	10,4	4,3-20,3
45 – 50 ans	6	9,0	3,4-18,5
50 – 55 ans et plus	5	7,5	2,5-16,6
Statistique	χ^2 = 19,503; p = 0,001		
Total	67	100,0	
Pointe – Noire	n	%	I.C à 95%
Intervalle des âges			
15 – 20 ans	7	14,0	5,8-26,7
20 – 25 ans	10	20,0	10,0-33,7
25 – 30 ans	12	24,0	13,1-30,2
30 – 35 ans	8	16,0	7,2-29,1
35 – 40 ans	5	10,0	3,3-21,8
40 – 45 ans	5	10,0	3,3-21,8
45 – 50 ans	1	2,0	0,1-10,6
50 – 55 ans et plus	2	4,0	0,5-13,7
Statistique	χ^2 = 13,276; p = 0,001		
Total	50	100,0	

La différence dans les proportions observées entre les deux strates (Brazzaville et Pointe-Noire) est très significative (χ^2= 23,796; p= < 0,001). Il est important de souligner la présence à Pointe-Noire d'une frange de la population très jeune de 15-20 ans, exerçant précocement cette activité. Elle pourrait s'investir dans cette filière pour des raisons de manque de débouchés. Cette filière pourrait aussi servir de transition vers des activités plus lucratives.

Dans la plupart des cas, les personnes qui exercent cette activité sont scolarisées. Cependant, si on compte à Brazzaville une forte proportion de personnes ayant le niveau secondaire du premier cycle et une faible proportion d'analphabètes (10,1 %), à Pointe-Noire, la tendance en est autre. En effet, une grande proportion d'analphabètes (32 %) et de personnes ayant le niveau primaire (34,8 %) occupent la filière (Tableau 6).

Tableau 6
Distribution des producteurs et des vendeurs en fonction du niveau d'instruction

Ensemble	n	%	I.C à 95%
Niveau			
Analphabète	23	19,3	12,7-27,6
Primaire	41	34,5	26,0-43,7
Secondaire	49	41,2	32,2-50,6
Supérieur	6	5,0	1,9-10,7
Statistique		χ^2 = 30,011; p £ 0,001	
Total	119	100,0	
Brazzaville	n	%	I.C à 95%
Niveau d'instruction			
Analphabète	7	10,1	4,2-19,8
Primaire	24	34,8	23,7-47,2
Secondaire	37	53,6	41,2-65,7
Supérieur	1	1,4	0,0-7.8
Statistique		χ^2 = 29,307; p = 0,001	
Total	69	100,0	
Pointe – Noire	n	%	I.C à 95%
Niveau d'instruction			
Analphabète	16	32,0	19,5-46,7
Primaire	17	34,0	21,2-48,8
Secondaire	12	24,0	13,1-38,2
Supérieur	5	10,0	3,3-21,8
Statistique		χ^2 = 15,261; p = 0,001	
Total	50	100,0	

Les deux strates se distinguent statistiquement dans la distribution de la variable niveau de scolarité (χ^2= 30,011; p= < 0,001).
Dans les deux strates également, le statut marital se distingue aussi, c'est ainsi que 39,1 % de producteurs et revendeurs à Brazzaville sont veufs ou veuves tandis qu'à Pointe-Noire, les personnes mariées et célibataires représentent 48 % pour chaque catégorie (Tableau 7).

Tableau 7
Distribution des vendeurs et des producteurs en fonction du statut matrimonial

Ensemble	n	%	I.C à 95%
Statut matrimonial			
Mariée	40	33,6	25,2-42,8
Célibataire	35	29,4	21,4-38,5
Divorcée	16	13,4	7,9-20,9
Veuve	28	23,5	16,2-32,2
Statistique		χ^2 = 21,296; p = 0,001	
Total	119	100,0	
Brazzaville	n	%	I.C à 95%
Statut matrimonial			
Mariée	16	23,2	13,9-34,9
Célibataire	11	15,9	8,2-26,7
Divorcée	15	21,7	12,7-33,3
Veuve	27	39,1	27-51,6
Statistique		χ^2 = 18,211; p = 0,001	
Total	119	100,0	
Pointe – Noire	n	%	I.C à 95%
Statut matrimonial			
Mariée	24	48,0	33,7-62,6
Célibataire	24	48,0	33,7-62,6
Divorcée	1	2	0,1-10,6
Veuve	1	2	0,1-10,6
Statistique		χ^2 = 17,409; p = 0,001	
Total	50	100,0	

Conclusion

La dégradation de la situation économique et sociale, marquée par la paupérisation (3), conduit de plus en plus d'hommes à s'impliquer dans l'activité de production et de commercialisation de la pâte rouie de manioc. Naguère, la filière de transformation des racines de tubercules en pâte rouie (bikédi) et la production du «pain» de manioc (chikwangue) étaient exclusivement réservées aux femmes; car ces taches étaient jugées moins lucratives et considérées plus pénibles que la commercialisation. Bien qu'il y ait une participation de plus en plus d'hommes dans la filière, on compte nettement plus de femmes (plus de 60%) parmi les producteurs et revendeurs à Pointe-Noire.

Cependant, l'organisation de la filière n'échappe pas à l'évolution de la division du travail très visible dans le secteur moderne. La nécessité s'impose à cause de la consommation croissante et de l'urbanisation. Dans ce contexte, la division ancienne du travail, celle qui est répandue dans toute la société africaine tend à s'estomper. Il est en outre de plus en plus fréquent que les hommes et les femmes exercent les mêmes activités économiques. Le phénomène observé est largement répandu en milieu urbain, mais s'installe timidement dans le secteur artisanal. Il constitue un facteur positif au niveau de l'organisation du travail, car il apporte des perspectives nouvelles dans la filière manioc.

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AVIS

Nous rappelons à tous nos lecteurs, particulièrement ceux résidant dans les pays en voie de développement, que TROPICULTURA est destiné à tous ceux qui oeuvrent dans le domaine rural pris au sens large.

Pour cette raison, il serait utile que vous nous fassiez connaître des Institutions, Ecoles, Facultés, Centres ou Stations de recherche en agriculture du pays ou de la région où vous vous trouvez. Nous pourrions les abonner si ce n'est déjà fait.

Nous pensons ainsi, grâce à votre aide, pouvoir rendre un grand service à la communauté pour laquelle vous travaillez.

Merci.

BERICHT

Wij herrineren al onze lezers eraan, vooral diegenen in de ontwikkelingslanden, dat TROPICULTURA bestemd is voor ieder die werk verricht op het gebied van het platteland en dit in de meest ruime zin van het woord.

Daarom zou het nuttig zijn dat u ons de adressen zou geven van de Instellingen, Scholen, Faculteiten, Centra of Stations voor landbouwonderzoekvan het land of de streek waar U zich bevindt. Wij zouden ze kunnen abonneren, zo dit niet reeds gebeurd is.

Met uw hulp denken we dus een grote dienst te kunnen bewijzen aan de gemeenschap waarvoor u werkt.

Dank U.

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ARMAND FERON PRIZE – 2002

The Armand Féron prize is a family donation in memory of Dr. A. Féron, who devoted his short professional carrier to Development Cooperation in the third world in the field of Animal Health and Production.
The A. Féron prize (1,000 U.S.$.) is attributed every two years to one or more students, ex-student(s) or collaborator(s) of the Veterinary Department, Prince Leopold Institute of Tropical Medicine, Antwerp, Belgium.
The beneficiary of the prize should be a person from a developing country or Europe, who has made a significant contribution, through his/her work, to the rural development of the third world.
The A. Féron prize has been attributed in the past to the following persons: in 1994 to Dr. D. Zongo (Ivory Coast), in 1996 to Dr. O. Diall (Mali), in 1998 to Dr. W. Benitez-Ortiz (Ecuador) and in 2000 to Dr. M. Mulumba (Zambia).

WHO WAS DR. ARMAND FERON?

Armand Féron, a Belgian citizen, was born on 18 May 1955 at Bosondjo in Belgian Congo (Dem. Rep. of Congo), where he lived up to the age of five years.
After brilliant secondary school studies of Latin-Greek/Latin-Mathematics at Robert Catteau, Royal Athenaeum, A. Féron studied veterinary medicine successively at the Free University of Brussels and the Faculty of Veterinary Medicine of the University of Liège and obtained the degree of doctor of Veterinary Medicine in 1980. A year later, in 1981, he obtained the Diploma of Specialisation in Tropical Animal Health and Production from the Prince Leopold Institute of Tropical Medicine, Antwerp, Belgium.
As his desire was to put his knowledge at the service of developing countries, he took up an assignment, from 1982-1988, as FAO (Food and Agricultural Organisation) Associated Expert and worked under the auspices of ILCA (International Livestock Centre for Africa) as Director of a research programme on trypanotolerance in Zaïre. His assiduity and scientific contribution in this field are illustrated by a dozen publications.
In light of his competence and organisational capacity, the Belgian Cooperation assigned him to the Veterinary Laboratory, Kinshasa, Zaïre in 1988 for organising and supervising a unit of epidemiology. He passed away on 21 September 1991 at a time when his unit was in full expansion.

SUBMISSION OF CANDIDATURES

The candidatures for the A. Féron prize should contain the following information:
1. Curriculum vitae;
2. A text summarising the main activities, their impact on rural development, related reports and the references of publications;
3. Names and addresses of at least 3 (three) references.

Candidatures can be submitted throughout the year. The selection of candidates takes place in September. All the candidatures submitted before 1 September 2002 will be taken into consideration.

The candidatures should be addressed to :

Prof. S. Geerts
Department of Animal Health
Institute of Tropical Medicine
Nationalestraat 155
B – 2000 Antwerp 1 - Belgium
Fax: +32-03-24.76.268
e-mail: sgeerts@itg.be

PRIX ARMAND FERON – 2002

Le prix A. Féron est une donation familiale, en mémoire du Dr. A. Féron, qui a consacré avec dévouvement en conviction sa briève carrière professionnelle à la Coopération au Développement dans le domaine de "Production et Santé Animales" au Tiers Monde.
Le prix A. Féron (d'un montant de 1,000 U.S.$) est attribué tous les deux ans à un ou plusieurs étudiants, anciens étudiants ou collaborateur(s) du Département Vétérinaire de l'Institut de Médecine Tropicale Prince Léopold, Anvers, Belgique. Le lauréat sera ressortissant de pays en développement ou d'Europe et aura apporté par son travail une contribution significative au développement rural dans les pays du Tiers Monde.
Le prix A. Féron a été décerné aux personnes suivantes: en 1994, au Dr. D. Zongo (Côte-d'Ivoire), en 1996, au Dr. O. Diall (Mali), en 1998, au Dr. W. Benitez-Ortiz (Equateur) et en 2000 au Dr. M. Mulumba (Zambie).

QUI ETAIT ARMAND FERON?

Armand Féron, belge, est né le 18 mai 1955 à Bosondjo, au Congo Belge (Rép. Dém. du Congo) où il a passé les cinq premières années de sa vie.
Après de brillantes études d'humanités latin grec/latin mathématiques à l'Athenée Royal Robert Catteau à Bruxelles, A. Féron a entrepris les études en médecine vétérinaire successivement à l'Université Libre de Bruxelles et à la Faculté de Médecine Vétérinaire de l'Université de Liège, où il a obtenu son diplôme en 1980. Une année après, en 1981, il obtenait le diplôme de spécialisation en Médecine Vétérinaire et Zootechnie Tropicales à l'Institut de Médecine Tropicale, Prince Léopold, à Anvers. Son souhait et sa volonté étant de mettre ses connaissances au service des pays en développement, de 1982-1988, il est engagé par la FAO (Food and Agricultural Organization), comme expert associé, mis à la disposition de l'ILCA (International Livestock Centre for Africa) pour assurer la direction du programme de recherche sur la trypanotolérance au Zaïre. Son assiduité et sa contribution scientifique dans ce domaine sont illustrées à travers plus d'une dizaine de publications.

Remarqué pour ses compétences et son esprit d'organisation, A. Féron était depuis 1988 membre de la Coopération belge au Zaïre, attaché au Laboratoire Vétérinaire de Kinshasa, chargé d'organiser un Service d'Epizootiologie et d'en assurer la direction. Il est décédé le 21 septembre 1991 lorsque son service prenait la vitesse de croisière.

SOUMISSION DE CANDIDATURE

Les candidats au Prix A. Féron doivent constituer un dossier comprenant:

1. un curriculum vitae;
2. un texte substantiel résumant les principaux travaux effectués, leur impact sur le développement rural, les rapports y relatifs et les références des publications;
3. les noms et adresses d'au moins 3 personnalités scientifiques et/ou morales de référence.

La soumission des candidatures est ouverte toute l'année. Le dossier doit être composé de textes originaux. La sélection des candidats a lieu au mois de septembre. Elle porte sur les candidatures soumises jusqu'à la fin du mois d'août 2002.
Les candidatures doivent être envoyées à l'adresse suivante:

Prof.S.Geerts
Département Vétérinaire
Institut de Médecine Tropicale
Nationalestraat 155
B – 2000 Antwerpen 1 - Belgique
Fax: +32-03-24.76.268
e-mail: sgeerts@itg.be

PRIJS ARMAND FERON – 2002

De prijs Armand Féron is een familiale schenking ter nagedachtenis van Dr. A. Féron, die zijn hele loopbaan gewijd heeft aan de ontwikkelingssamenwerking op het terrein van de dierlijke gezondheid en produktie in de Derde Wereld.
De prijs A. Féron heeft een waarde van ongeveer 1,000 U.S.$ en wordt in principe om de twee jaar toegekend aan één of meerdere studenten, oud-studenten of medewerkers van het Diergeneeskundig Departement van het Prins Leopold Instituut voor Tropische Geneeskunde te Antwerpen. De laureaat of laureaten, afkomstig uit een ontwikkelingsland of Europa, moeten een belangrijke bijdrage hebben geleverd tot de plattelandsontwikkeling (in ruime zin) in een land van de Derde Wereld.
De A. Féron prijs werd in het verleden reeds toegekend aan de volgende personen : in 1994 aan Dr. D. Zongo (Ivoorkust), in 1996 aan Dr. O. Diall (Mali), in 1998 aan Dr. W. Benitez-Ortiz (Ecuador) en in 2000 aan Dr. M. Mulumba (Zambia).

WIE WAS ARMAND FERON?

Armand Féron, Belg, werd geboren op 18 mei 1955 te Bosondjo in Belgisch Congo (Rep. Dém. du Congo), waar hij de vijf eerste jaren van zijn leven doorbracht.
Na schitterende humaniora studies (Latijns-Wiskunde) aan het Koninklijk Atheneum Robert Catteau te Brussel, begon A. Féron zijn opleiding in de diergeneeskunde aan de "Université Libre de Bruxelles", opleiding die voltooid werd aan de Veterinaire Faculteit van Luik in 1980. Eén jaar later behaalde hij het diploma in de Tropische Diergeneeskunde en Zoötechniek aan het Instituut voor Tropische Geneeskunde te Antwerpen.
Aangezien hij zijn kennis ter beschikking wilde stellen van de ontwikkelingslanden, vertrok A. Féron naar Zaïre, waar hij als geassocieerd expert van de FAO (Food and Agriculture Organization) ter beschikking werd gesteld van het ILCA (International Livestock Centre for Afrika) voor de coördinatie van het onderzoeksprogramma betreffende trypanotolerantie. Tijdens deze periode (1982-1988) was hij wetenschappelijk sterk actief, wat resulteerde in een tiental publicaties.
Opgemerkt omwille van zijn competentie en zijn organisatietalent, werd A. Féron door het ABOS (Algemeen Bestuur voor Ontwikkelingssamenwerking) gevraagd om een eenheid epidemiologie op te starten binnen het kader van het Diergeneeskundig Laboratorium te Kinshasa. Hij heeft deze eenheid op een doeltreffende manier geleid tot aan zijn overlijden op 21 december 1991.

KANDIDATUURSTELLING

Personen die zich willen kandidaat stellen voor de prijs A. Féron, dienen eigenhandig een dossier samen te stellen, dat volgende stukken bevat:

1. een curriculum vitae;
2. een tekst, die een samenvatting geeft van het uitgevoerde werk, alsook van zijn impakt op de ontwikkeling van het platteland. Eventuele rapporten en wetenschappelijke publikaties kunnen daaraan toegevoegd worden;
3. de namen en adressen van minstens 3 referentiepersonen.

Kandidaturen kunnen het hele jaar door ingediend worden. De selectie heeft plaats in de maand september en heeft betrekking op de kandidaturen, die ingediend werden voor eind augustus 2002.
De kandidaturen dienen te worden opgestuurd naar volgend adres:

Prof.S.Geerts
Departement Diergeneeskunde
Instituut voor Tropische Geneeskunde
Nationalestraat 155
B-2000 Antwerpen 1 - België
Fax: int 32-03-24.76.268
e-mail: sgeerts@itg.be

AGRI-OVERSEAS, associación din ánimo de lucro (ASBL) creada con el fin de establecer relaciones profesionales de intereses comunes entre quienes laboran por el desarrollo rural en ultra-mar.
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  Ejemplo: Korbach M.M. & Ziger R.S., 1972, Heterozygotes detection in Tay- Sachs disease. A prototype community screening program for the prevention of recessive genetic disorders. pp 613 - 632 in: B.W. Volks en S.M. Aronson (Editors), Sphingolipids and allied disorders Plenum, New-York

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