RCMP Research Monograph No. 4

Opportunities for Second Cropping in Southwestern Nigeria

H. J. W. Mutsaers

Resource and Crop Management Program
International Institute of Tropical Agriculture

1991

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Trials and farmer tests with maize, soybeans and cowpeas in Alabata and Ayepe (1985-1989)

H.J.W. Mutsaers

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Preface

The RCMP Research Monograph series is designed to widely disseminate results of research on the resource and crop management problems of smallholder farmers in sub-Saharan Africa, including socioeconomic and policy-related issues, and to contribute to existing knowledge on improved agricultural principles and policies and the effect they have on the sustainability of small-scale food production systems. These monographs summarize results of studies by IITA researchers and their collaborators; they are generally more substantial in content than journal articles.

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I. Introduction

Southwestern Nigeria straddles the semi-deciduous forest and forest-savanna transition vegetational zones. The soils are predominantly Alfisols and Entisols. The area has a bimodal rainfall pattern (Table 1) with two rainy seasons. The first season starts in late March or April and ends in early August. The second starts late August or early September after a short break which is rather erratic and sometimes does not occur at all.

Second season planting of food crops is of minor importance. The main food crop operations are carried out in the first season with the maize + cassava intercrop as the dominant pattern. Maize is harvested by August and cassava usually a year or more later (Fig. 1). A maize + cassava cycle may also start between July and August (Fig. 1, second row), but fewer farmers cultivate fewer and smaller plots in the second season. Other second season crops are cowpeas + cassava or a mixture of vegetables (tomatoes, leafy vegetables). Sometimes farmers plant a second season plot with only short cycle crops (maize, maize + cowpeas, vegetables), to be followed by yams early in the next dry season (Fig. 1, third row). This is more common in the forest-savanna transition than in the forest area. Farmers mostly clear a new plot for the second season crop or sometimes use a plot where cassava has been harvested.

The performance of maize and cowpeas in the second season is generally poor. Maize suffers from streak virus, and stem borers (*Sesamia calamistis* and *Eldana saccharina*), and nutrient deficiencies, particularly + nitrogen. Yields are often negligible. Uncertain rainfall in August and sometimes early cessation of the rains in late October also make the second season risky for maize production. Cowpeas, more often than not, are wiped out by the cowpea pest complex in the absence of chemical control. Vegetables do reasonably well but their importance varies with distance to market. They may be grown as main crop in relatively small plots or on heaps prepared for yams.

Cocoa, harvested in October/November, used to be the major source of cash income. The decline of cocoa during the oil boom period left many farmers in the area with a serious cash constraint. The crop became more attractive for a short while, due to the devaluation of the naira in 1986 (Dorosh and Akanji 1988), but domestic prices declined in 1989 as result of depressed world prices. Furthermore, the cocoa groves are in a poor state and production will be slow to pick up.

With little prospect of cocoa prices improving, a second season cash crop would help to maintain current levels of labor hiring and generally improve farmers' cash availability. Three possible options for second season cropping have been considered.

1. Improvement of second season maize.
2. Improvement of cowpea growing.
3. Introduction of a new crop, viz., soybeans.

For the improvement of second season maize, research can offer streak resistant varieties while fertilizer could compensate for more severe nutrient stress. No viable remedy is, however, available at present for the stemborer problem.

Table 1

Table 1. Monthly rainfall in Alabata and Ayepe, 1986-1989 and long-term mean monthly rainfall for IITA (Ibadan) and for the Obafemi Awolowo University farm (Ile-Ife).

	1986		1987		1988		1989		1971-1988	1969-1989
Month	Alabata	Ayepe	Alabata	Ayepe	Alabata	Ayepe	Alabata	Ayepe	IITA Ibadan	OAU Ile-Ife
Jan	0.5	na	1.8	0.0	0.0	0.0	0.0	0.0	5.3	11.0
Feb	45.2	na	12.7	0.0	92.2	21.8	6.4	54.0	19.6	20.4
Mar	173.7	na	72.2	53.6	87.4	169.2	112.5	40.0	79.5	80.5
Apr	64.3	72.4	80.0	27.6	169.7	204.0	69.3	43.8	126.2	133.6
May	109.1	83.5	172.9	113.7	113.3	111.0	221.0	211.6	159.8	166.8
Jun	196.3	105.7	101.0	233.6	303.8	330.2	121.2	212.6	198.2	177.4
Jul	156.7	193.3	190.4	206.8	133.4	177.8	204.7	209.8	170.6	202.0
Aug	33.8	32.3	313.6	449.8	81.0	132.0	174.8	170.4	132.2	156.7
Sep	263.1	210.8	206.8	189.7	139.2	170.5	159.8	164.4	194.1	208,7
Oct	154.3	166.1	188.7	105.2	190.2	231.8	121.7	182.4	171.8	210.0
Nov	8.6	31.7	0.0	0.0	29.2	4.6	0.0	1.8	26.4	29.7
Dec	0.0	0.0	0.0	2.0	10.2	0.6	0.0	0.0	8.2	4.7
Total	1205.6	-	1340.1	1382.0	1349.6	1553.5	1191.4	1290.8	1291.5	1402.0

Note: na = not available

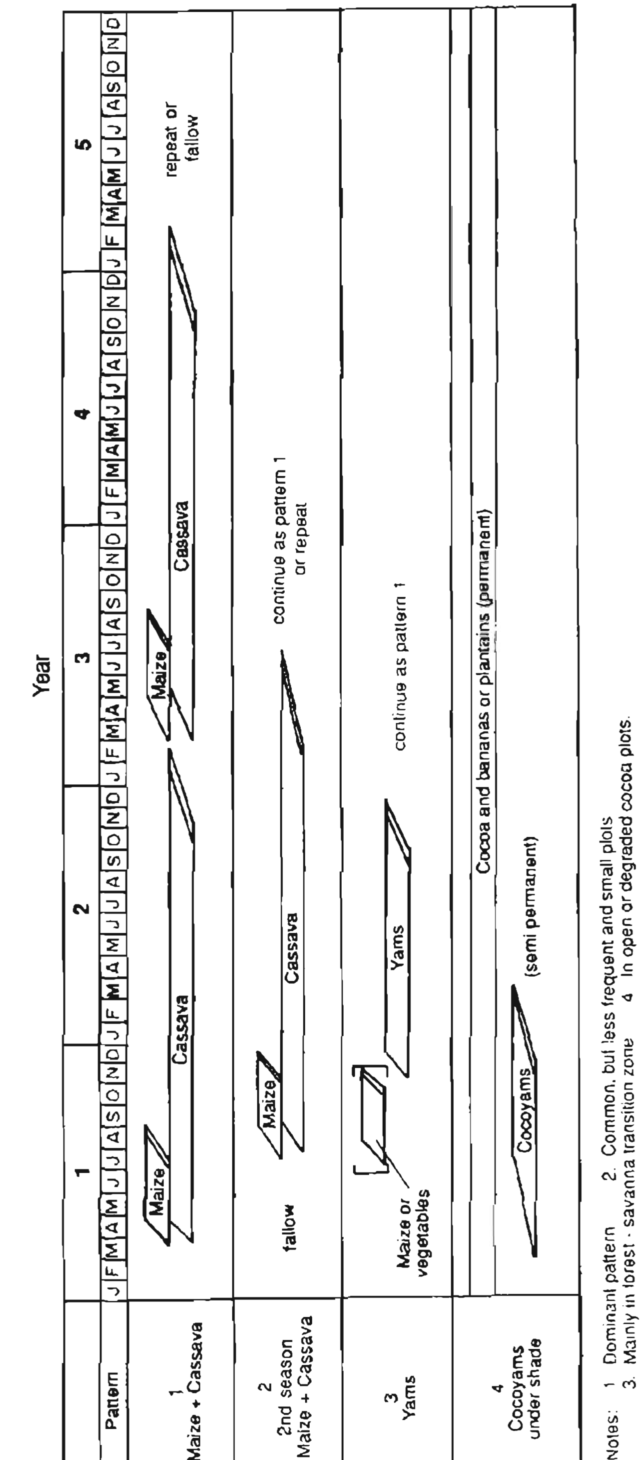


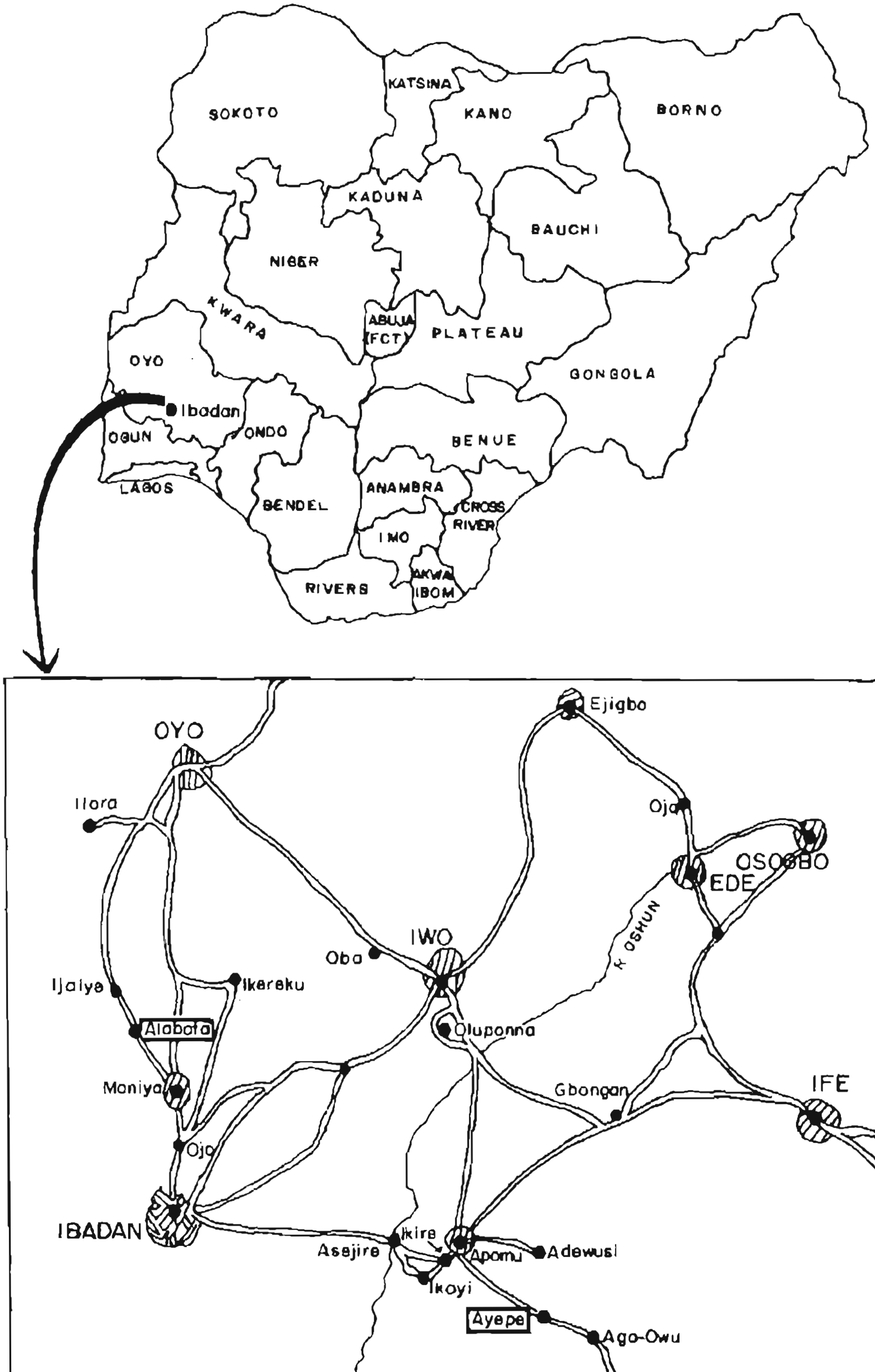
Figure 1. Common cropping patterns in southwestern Nigeria.

Profitable cowpea growing in this area requires the use of insecticides. Research proposes a package consisting of determinate, early-maturing cowpea varieties with 3-4 insecticide treatments.

Soybeans at the moment cannot really be considered as a cash crop because the market for soybeans is poorly developed. However, the devaluation of the naira and banning of imports of vegetable oils in 1986 appear to have increased the demand for domestically produced soybeans, and prices and production are increasing in the traditional soybean growing areas (Joyotee Smith, personal communication). At the same time, the incorporation of soybeans into the local diet is being promoted by the government and other agencies in rural and urban areas. Therefore, there is the prospect of soybeans improving the farmers' diet as well as providing a cash income in the future. On the technological side, IITA has developed varieties which nodulate freely with indigenous rhizobium strains, and which have improved seed longevity.

Experimental studies on second season cropping were conducted in two village clusters, one in the forest-savanna transition zone (Alabata) and one in the semi-deciduous non-acid forest area (Ayepe). Alabata is about 15km northwest of the large urban center of Ibadan, while Ayepe is 15km from the nearest medium-sized urban center (Apomu) and 50km to the southeast of Ibadan (Map 1). Table 1 shows the monthly rainfall recorded from 1986 to 1989 in the two areas, as well as the long-term averages for the IITA main station, Ibadan, and the Obafemi Awolowo University Farm, Ile-Ife. The former has rainfall similar to Alabata, the latter similar to Ayepe.

In Ayepe, only about a third of the farmers plant any foodcrops in the second season (Smith and Oyewole, in preparation). No figures are available for Alabata but the percentage is probably somewhat higher. Second season maize and soybeans were studied in both villages, but improved cowpea technology was not considered a viable option in Ayepe at present, because of the absolute necessity of chemical pest control, and the difficult input supply situation in this rural area. Cowpeas were, therefore, tested only in Alabata, since proximity to Ibadan makes access to input supply easier.



Scale 1: 700,000

Map 1. Location of the two village clusters in Oyo State, Nigeria.

II. Experimental Materials and Methods

The experimental work was preceded by diagnostic surveys conducted in Alabata in 1984 (Palada et al. 1985) and in Ayepe in 1985-86 (Mutsaers et al. 1987). The surveys provided a largely qualitative characterization of current farming practices, as well as hypotheses about major constraints and opportunities. The work on second season cropping addressed "underutilization of the second growing season" which was perceived as an opportunity for improvement by improving existing crops or introducing a new one. The surveys, which were conducted during the dry season, failed to identify stemborers as a major problem of second season maize.

In the following sections, the results are reported of several on-farm studies on second season cropping (Table 2), conducted in Alabata and Ayepe since 1985. The earlier experiments in Alabata addressed specific aspects of the individual crops such as choice of cowpea and soybean varieties, their yields under intercropping, and spray regimes for cowpeas. Results have been reported by Palada and Vogel (1986) and Palada et al. (1990) and will be summarized below. Data on farmers' soybean growing in Ayepe in 1988 and 1989 were collected by M.A. Baten and will be published in detail in his PhD thesis at the University of Ibadan. The information on the 1988 trial reported here was provided by Mr. Baten.

Table 2. Trials and farmer tests on second season cropping, Alabata and Ayepe, southwestern Nigeria, 1985-1989.

	Alabata		Ayepe	
Year	Types of trial or test[1]	No. of farmers[2]	Types of trial or test	No. of farmers[2]
1985	1. cowpea intercropping trial	10		-
	2. soybean intercropping trial	14		
1986	1. cowpea variety trial	11	maize, soybean, groundnut comparison	13 (5)
	2. cowpea intercropping trial	11		
	3. soybean variety trial	26		
1987	1. maize, cowpea, soybean comparison.	25 (5)	1. maize, soybean comparison	24 (4)
	2. farmer soybean tests	26 (5)	2. farmer soybean tests	16 (1)
1988	1. farmer cowpea tests	36 (6)	1. farmer soybean tests	36 (6)
	2. farmer soybean tests	30 (4)	2. maize stemborer trial	23 (4)
1989	1. farmer soybean tests	40 (3)	1. farmer soybean tests[3]	36 (6)
	2. farmer soybean tests	8 (0)		

1. The 1985 and 1986 trials in Alabata are reported in Palada and Vogel (1986) and Palada et al. (1990).
2. No. of female farmers in brackets. 3. Not reported here; part of PhD thesis.

At Ayepe, soybeans were first tested in 1986 in a simple comparative observation, with groundnuts as the other crop. In 1987, soybeans and two maize varieties were tested in both sites in a comparative observation. At Alabata, this test also included cowpeas.

The disastrous yields of maize in this trial at both sites led to a study on stemborer damage, conducted at Ayepe in 1988.

Because of farmers' apparent interest in soybeans and, at Alabata, in cowpeas with pest control, farmer-managed observations (called "farmer tests" in the following) were conducted on soybeans at both sites in 1987, 1988, and 1989, and on cowpeas at Alabata in 1988 and 1989.

The various trials and tests and the numbers of participating farmers are summarized in Table 2. The experimental materials and methods of the trials and farmer tests at each site will be briefly described in this section. Further details can be found in the results sections of this report.

Alabata

Soybean intercropping trial, 1985 (Palada and Vogel 1986)
Soybeans (cv TGx 536-02D, 105 days) were tested in an on-farm trial as sole crop and associated with cassava. Soybean spacing was 75 x 5cm and 200 kg/ha of 15:15:15 compound fertilizer was applied.

Cowpea intercropping trial, 1985 (Palada et al. 1990)
Two varieties of cowpeas (IT 84E-124, 60 days, and IT 82D-716, 75days) were tested as sole crop and in association with maize and cassava. Cowpea spacing was 50 x 20cm with two plants per stand. The early variety was sprayed three times, the late variety four times with either Sherpa-Plus™ (knapsack) at 2.5 l/ha (from 1987 reduced to one l/ha) or Cymbush-Super ED (Electrodyn)™ at 0.8 l/ha. No fertilizer was applied.

Cowpea variety trial, 1986 (Palada et al. 1990)
Two varieties (IT 84E-124, 60 days, and IT 82D-699, 75 days) were tested as sole crop. Management practices were the same as in 1985.

Cowpea intercropping trial, 1986 (Palada et al. 1990)
Two varieties (IT 84E-124, 60 days, and a local variety) were tested in association with maize or cassava. Farmers used their own preferred density for all crops. Otherwise, management practices were the same as in 1985.

Soybean variety trial, 1986 (Palada, unpublished data)
Two soybean varieties (TGx 849-297D, 105 days, and TGx 814-26D, 115 days) were tested in an on-farm trial as sole crop, and in association with maize. Soybean spacing was 75 x 5cm and 200kg of 15:15:15 compound fertilizer was applied. Experimental plot sizes ranged from 60 to 312m^2.

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Maize, cowpea, soybean comparative test, 1987

A simple comparative test was conducted with two maize varieties (TZESR-W and TZSR-W) and one variety each of cowpeas (IT 84E-2246-4, 75 days) and soybeans (TGx 297-10F, 110 days), grown side-by-side in the same farmers' fields. The (small-seeded) soybean variety was chosen for its good seed longevity. The purpose was to compare yield levels of these crops grown under realistic management practices across a range of farmers' field conditions.

The late maize variety (TZSR-W) and soybeans were planted between 16 July and 11 August, and the early maize and cowpeas between 18 August and 3 September.

Maize was grown by farmers according to their own practices. None of them applied fertilizer. Cowpeas were planted at 50 x 20cm spacing and soybeans were dibbled in rows spaced 75cm, which produced a density much higher than intended. No fertilizer was applied.

Unsprayed cowpeas would be expected to give practically no yield. The cowpeas were therefore sprayed three times, using either Sherpa-Plus™ applied with knapsack sprayer (one l/ha in 250 liters of water), or Karate™ with Electrodyn Sprayer (at 0.75 l/ha).

The area planted to each crop varied with farmer from 55 to 426m^2. Three out of 25 farmers did not grow cowpeas, and one field was harvested before a yield record was taken.

Farmer soybean tests, 1987-1989

Twenty six farmers in 1987 and 30 farmers in 1988 planted soybeans on their own, either with seed kept from the previous year or purchased from the research team (TGx 536-02D). In 1987, planting was supervised by the field team but in 1988, advice was given only upon request. Crop establishment and yields were monitored. In 1989, only eight farmers participated in farmer soybean tests, although 25 had purchased seed from the field team.

Farmer cowpea tests, 1988-1989

In 1988, 36 farmers purchased cowpea seed from the site team (variety IT 84E-2246-4) and grew the crop on their own with advice, if requested, from the field team. Insecticide was sold to them at cost and sprayers were made available free of charge. Farmers were advised to spray at 35, 45, and 55 days after planting (DAP) with one l/ha Sherpa Plus™ or 0.75 l/ha Karate™ but they were free to decide whether to follow the advice or not. In 1989, 40 farmers participated in a similar test. The recommended spray regime was changed to four sprays, at 25, 35, 45, and 55 DAP. Farmers rented the sprayers from the field team and purchased insecticide on a cash basis.

Ayepe

Soybean /groundnut comparative test, 1986

Soybean variety TGx 814-26D and groundnut variety 69-101 (ex Benin Republic) were grown side-by-side in 13 farmers' fields. Experimental plot area varied with farmer from 45 to 330m^2 per crop. The crops were planted between 8 and 25 July at 50 x 10cm spacing. No fertilizer was applied. Most farmers cleared plots for the trial either from spacing. No fertilizer was applied. Most farmers cleared plots for the trial either from fallow or from old cassava. Only a few farmers followed the recommendation to grow a sole maize crop before the trial. Farmers were advised to interplant the soybeans and groundnuts with cassava.

Maize/soybean comparative test, 1987
This trial was similar to the maize/soybean/cowpea comparative test conducted in Alabata in 1987, as far as maize and soybean were concerned. No cowpeas were grown in Ayepe, however, because of the difficult input supply situation. Experimental plot area varied from 140 to 325m^2 per crop. The late maize variety (TZSR-W) and the soybeans (TGx 297-10F) were planted between 15 July and 6 August, and the early-maturing maize (TZESR-W) between 15 and 30 August. Farmers applied their usual management practices to the maize. Soybeans were planted at 50 x 5-10cm spacing. No fertilizer was applied to any of the crops.

Farmer soybean tests, 1987 and 1988
Soybeans were planted by 16 farmers in 1987 and by 36 in 1988 and 1989. They used their own seed or seed (TGx 297-10F) purchased from the field team. Crop establishment and yields were monitored.

Maize stemborer trial, 1988
In view of the serious stemborer problems in the area which resulted in an almost complete failure of maize in the 1987 comparative test, a trial was conducted in 1988 to estimate the losses due to these pests. Two maize varieties, TZESR-W (early-maturing) and TZSR-W (late-maturing), were grown at two levels of fertilizer (0 and 300 kg/ha of 15:15:15), with and without Furadan™ application, with one replicate per farmer. Experimental plot area varied with farmer from 104 to 240m^2.

Furadan™ was incorporated in the soil at the base of the plants at 1.5 kg/ha a.i. per application, at 2, 5 and 8 weeks after planting (WAP) for TZSR-W. Because early infestation was noted, Furadan ™ was applied at emergence, 3, and 6 WAP for TZESR-W. Stand losses were counted at 2 week intervals.

III. Experimental Results

Maize

In 1987, two varieties of maize (early-maturing TZESR-W and late-maturing TZSR-W) were grown by farmers in Alabata and Ayepe in a comparative test with other (potential) second season crops, viz., soybeans and cowpeas in Alabata and soybeans in Ayepe. At the time the severity of the stemborer problem was not recognized (Palada et al. 1985; Mutsaers et al. 1987), and it was thought that streak-resistant maize could be a viable option in view of streak incidence in second season maize. Only 4% of the farmers in Alabata planted cassava in association with maize in the trial and about 50% in Ayepe.

Many farmers were actually reluctant to plant maize because of low yield expectation, but they agreed to grow the crop as part of the trial. The majority of farmers in Ayepe and all farmers in Alabata, however, stopped maintaining the maize when they observed heavy plant losses which started right from planting. This caused the remaining plants to be overgrown by weeds and invaded by rodents. No yield was recorded in any plot in Alabata, although some farmers will have collected a few cobs. In Ayepe, yields of 380, 370, and 1470 kg/ha dry grain were recorded in only three fields out of 24, all TZSR-W.

The stand decline in Alabata during the growing season is shown in Figure 2. Stand counts were available around 15, 37, and 55 DAP (actual dates ranged between 14-16, 30-45, and 45-65 days). Planting density (estimated from number of heaps x 3) averaged 35200 plants/ha (TZSR-W) and 22700 plants/ha (TZESR-W). The curves were extrapolated assuming practically zero stand at harvest (no actual counts were made). Early losses were to some extent due to birds (particularly in TZESR) but mainly to stemborers (*Sesamia*); later losses were caused by stemborers (*Sesamia* and *Eldana*), termites, and grass-cutters. No detailed observations on the causes of stand losses were, however, conducted in 1987. The stand record for Ayepe was incomplete, being available for TZESR at around 25 days only and for TZSR at around 50 days. These counts are included in Figure 2, suggesting a stand decline similar to that for Alabata but less steep. Stand decline was more severe for TZESR, planted late August, than for TZSR, planted late July. It is likely that these failures were inflated, because many participating farmers might not have planted maize on their own account and neglected the maize in the trial.

In order to quantify the effect of stemborers and fertility on second season maize, a trial was carried out in 1988 in Ayepe with maize variety, fertilizer and Furadan™ as factors. Late-maturing maize (TZSR-W) was planted between 19 July and 5 August by six farmers and two schools, and early-maturing maize (TZESR-W) by another group of 13 farmers between 15 and 30 August. One replicate each of TZSR-W and TZESR-W was managed by the field team. All 19 farmers planted cassava in association with the maize, while six of them planted both cassava and one other crop or more (cowpeas, cocoyams, tomatoes). Only the two school farms grew maize as a sole crop. Field-dry husked cobs were weighed at harvest and converted to dry grain (12% moisture) by multiplying husked cob weight by 0.55 (three year average from several trials).

Six farmers obtained no yield at all even in the plots treated with Furadan™, all of them in the early plantings of TZSR-W. This happened at least partly because the first application of Furadan™ to TZSR-W was at two WAP, whereas the first application to

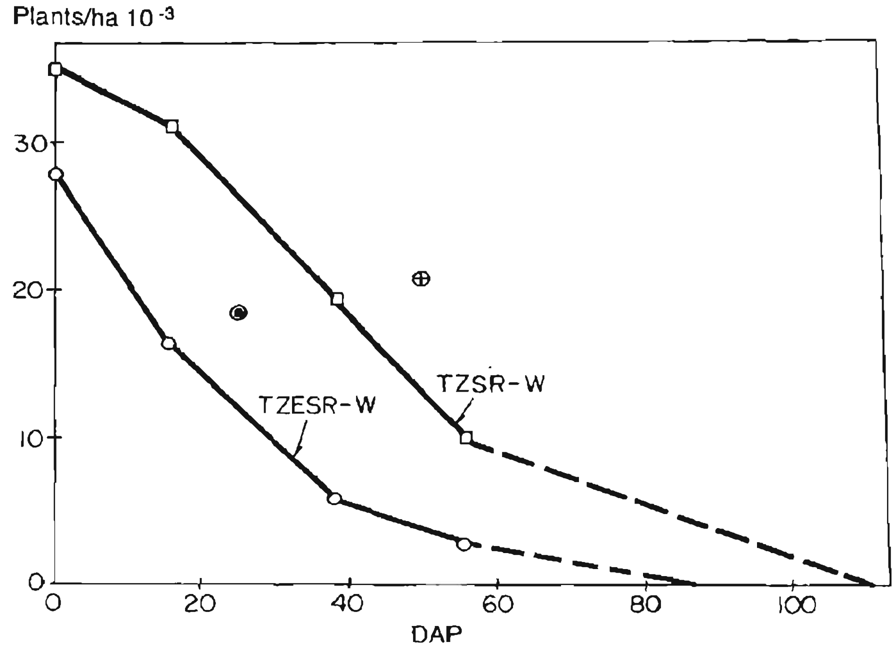


Figure 2. **Decline of maize stands in a second season on-farm trial, Alabata, 1987; averages of 25 farmers. Outlying points (◉ ⊕) are single observations in Ayepe; averages of 24 farmers.**

TZESR-W was at emergence. One field was omitted from the analysis because of probable misapplication of Furadan™. The two remaining TZSR fields fell well within the range of the TZESR fields for all measured parameters, and they were pooled with the 14 TZESR fields for the analyses.

Mean yields of the 16 fields are shown in Table 3. There was a significant effect of both Furadan ™ and fertilizer, but yield was generally low even for the Furadan™ + fertilizer combination. The very high CV (41.1%) is mainly caused by the large yield variation in the plots without Furadan™. For the treated plots alone, the CV was 26% (conclusions are not affected by the obviously different variance of treated and non-treated plots). Table 4 compares causes of stand losses in the trial with those observed in a first season trial with TZSR-W, carried out for different purposes (Mutsaers, unpublished results). Furadan™ application did not provide full protection in the second season but it reduced stemborer damage by about 60%. Fertilizer application in the absence of Furadan™ also significantly reduced stemborer damage.

Termite damage in the non-treated plots was more serious in the second season than in the first (which may have had below average termite incidence in 1988). Furadan™ reduced termite damage by 50%. Stand losses due to other causes were similar in the first and second seasons.

Table 3. Mean yields (averages from 16 fields) of second season maize (t/ha) in a farmer-executed fertilizer/ Furadan™ trial, Ayepe, 1988.

Fertilizer[1]	Furadan™ none	Furadan™ 4.5 kg/ha	Mean yield
none	0.35	0.79	0.57
300 kg/ha	0.56	1.38	0.97
SE[2]		.079	
mean	0.45	1.09	0.77
CV%	41.1		

1. 15:15:15 compound fertilizer
2. Based on ANOVA with shade as covariate and stand at harvest as "regressor" (after treatments)

Table 4. Initial and final stand and causes of stand losses (all in plants/ha x 10^{-3}) in the first and second season of 1988, Ayepe. Data are averages from 40 fields (first season) and 16 fields (second season).

	Stand at 2 WAP	Stand losses due to[1] Stem-borers	Grass cutters	Termites	Unidentified causes	Stand at harvest	% Stand reduction[2]
First season							
- fertilizer	30.9	0.2	2.9	1.8	4.0	23.6	23.6
+ fertilizer	31.7	0.1	3.0	2.2	4.3	25.7	18.9
Second season							
- fertilizer	27.0	12.0	1.3	3.3	4.1	6.3	76.7
no Furadan™							
+ fertilizer	28.6	7.6	3.2	3.7	4.2	9.9	65.4
- fertilizer	28.9	4.5	3.3	2.2	2.1	16.8	41.9
with Furadan™							
+ fertilizer	26.4	3.8	2.6	1.8	1.1	17.1	35.2
SE±		.80					

1. Scored plant losses (plants/ha x 10^{-3}) 2. % difference betweeen stand at 2 WAP and at harvest; may be less than sum of scored losses because of partial replanting of gaps by farmers.

Table 5. "Expected" maize yields (t/ha) in first and second seasons of 1988 at the same final stand of 25000 plants/ha, with and without fertilizer.

	Without fertilizer	With fertilizer
First season[1]	1.80	2.39
Second season[2]	1.25	2.05

1. TZSR-W 2. mainly TZESR-W

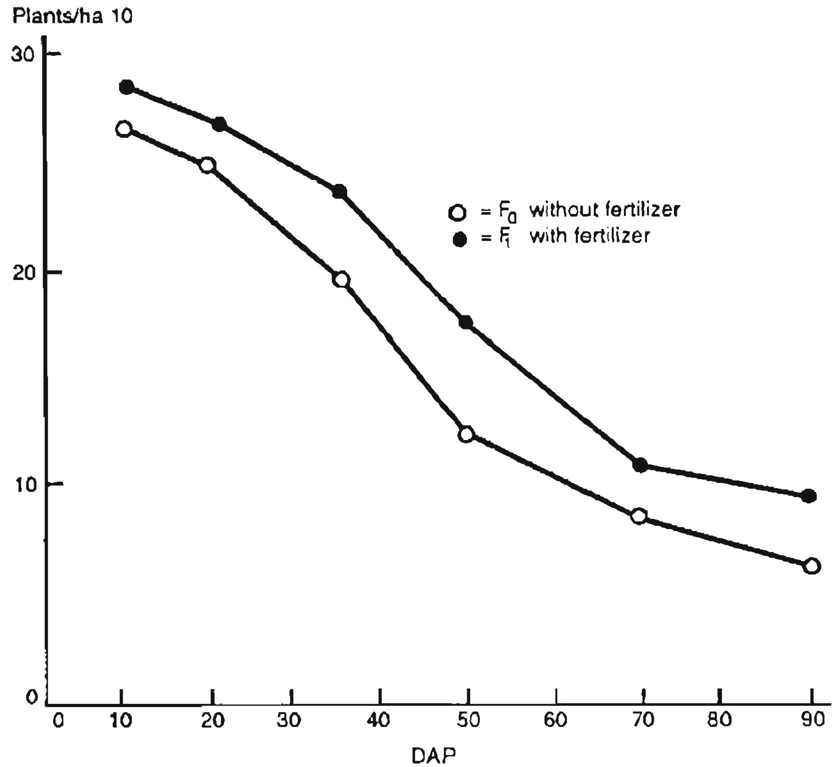


Figure 3. Decline of maize stand without Furadan™ treatment in a second season on-farm trial, Ayepe, 1988; averages of 16 fields.

Stand decline with time in the plots without Furadan™ is shown in Figure 3. The trend is similar to that of 1987 (Fig. 2) but shifted about 15 days to the right. Plant losses were more severe in the unfertilized plots than in the fertilized. In the unfertilized plots without Furadan™, 47.5% of the plant losses identified as due to stemborers occurred before 45 days, 49.3% between 45 and 75 days, and only 3.2% after 75 days. In the fertilized plots without Furadan™, the percentages were similar at 51.3 before 45 days, 48.1 between 45 and 75 days, and 0.6 after 75 days. The early damage, up to 45 days, was recorded as being caused by *Sesamia*. Later on, *Sesamia* and *Eldana* were both found, but the record was not sufficiently detailed as to their relative importance. Late stemborer attack, of course, does not have to lead to complete plant loss, so the low loss figures later in the season are not indicative of the magnitude of stemborer attack.

Full protection against stemborers was not obtained, so the second season trial did not provide a direct measure for the yield that may be expected in the absence of stemborer damage. Instead "expected yield" in the absence of stemborers for both seasons was estimated from the mean grain yield per plant, multiplied by an estimated average stand at harvest. For the second season, only the treatments with Furadan™ were considered. The regression lines of yield on final stand for fertilized and unfertilized maize, forced through the origin, are shown in Figures 4a and 4b.

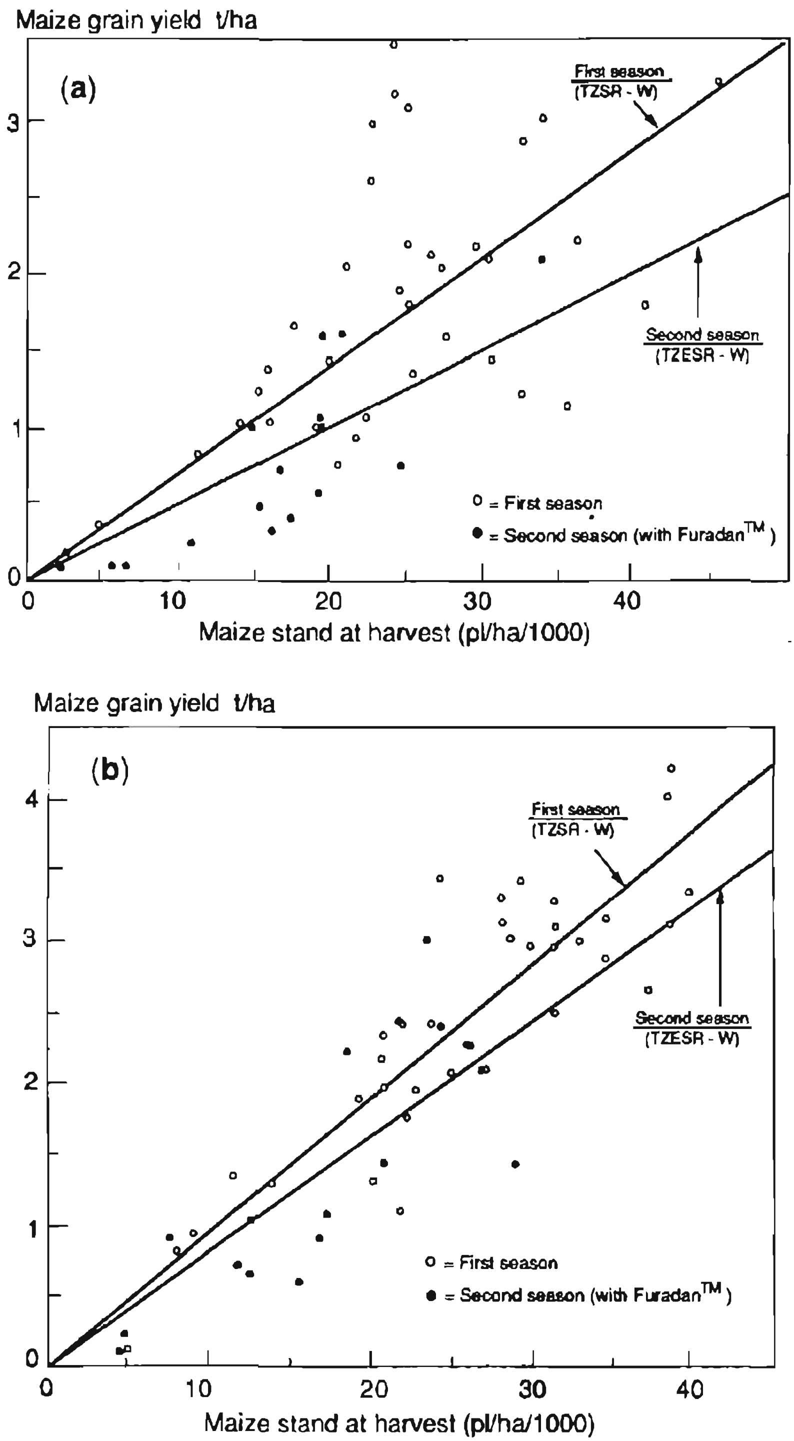


Figure 4. **Relationship between stand at harvest and maize yield, first and second season 1988, Ayepe; (a) without fertilizer, (b) with fertilizer (300 kg/ha 15:15:15).**

The slope of the regression line (i.e., grain yield per plant) was significantly smaller for second season maize than for first season maize, both in the fertilized ($P<0.5\%$) and in the unfertilized plots ($P< 5\%$). Figure 4a shows, however, that the majority of the unfertilized second season plots had less than 20,000 plants/ha. Some of the surviving plants may have been weakened by borer infestation and the data probably underestimate expected yield per plant. Assuming similar stand losses due to causes other than stemborers (Table 4), an average final stand of approximately 25000 plants/ha would be expected in both seasons in the absence of stemborers. Table 5 shows the "expected yield" for both seasons at 25000 plants/ha and mean yield per plant, as calculated from Figure 4. With fertilizer, the expected yield for second season TZESR-W was about 15% less than that for first season TZSR-W.

Soybeans

Soybeans were first introduced at Alabata in 1985 and at Ayepe in 1986. During the first few years, the crop was tested in farmer-managed variety and intercropping trials in Alabata (Palada and Vogel 1986, and Palada, unpublished data), and in comparative tests with other crops in both sites. Since 1987, the emphasis has shifted to "farmer soybean tests" where farmers grow the crop from purchased seed using their own preferred practices. In the 1985 and 1986 trials in Alabata, fertilizer (200 kg/ha 15:15:15 NPK) was applied but all other trials and farmer tests were grown without chemical inputs.

Soybean yields from all the trials and farmer tests since 1985 are summarized in Table 6. Mean yields fluctuated between 500 and 850 kg/ha (ignoring the 1986 fertilized trial in Alabata) and the yield range was fairly steady at about 150-1500 kg/ ha. The comparatively low yield in the 1988 farmer tests in Ayepe is explained by the high number of new soybean growers (15 out of 36) who purchased seed from the field team and grew the crop on their own. Mean yield of the "experienced growers" was 705 kg/ha, that of the new growers was 387 kg/ha. This is also reflected in the highly skewed yield distribution, shown in Figure 5, in comparison with that of Alabata where most growers had had previous experience with soybeans. An average yield of between 700-800 kg/ha is, therefore, attainable in this area.

The recommended planting pattern aims to produce a stand of 250,000-300,000 plants/ha. The densities actually obtained at establishment and at harvest in the farmer tests are shown in Table 7. They are largely within the range of densities where no effect on yield would be expected. (66000-666000 plants/ha; IITA 1986). No significant relationship was found between plant stand at harvest and yield in these tests.

No major plant disorders were observed in any of the trials or farmer tests. Rat damage, however, can be quite severe, especially in plots with excessive density resulting in heavy lodging. Rats remove the low-hanging green pods and dig out the seeds. Young instars of grasshoppers (*Zonocerus variegatus*) are frequently found feeding on soybean leaves, but the yield-depressing effect is probably insignificant when this happens in a maturing crop. Late plantings (August), however, may suffer serious damage when grasshoppers feed on plants in the green pod stage. Insufficiently detailed observations were made to quantify the effects of various yield-depressing factors, such as weed infestation and pest attacks.

Table 6. Mean soybean yields (kg/ha) yield range and number of farmers in soybean trials and tests, Alabata and Ayepe, 1985-1989.

		Alabata			Ayepe		
		No. of farmers	Mean yield	Range of yields	No. of farmers[3]	Mean yield	Range of yields
1985	intercropping trial[1]	14	833	77-1756	-	-	-
1986	1. intercropping/variety trial[2]	26	948	127-1954	-	-	-
	2. comparative 2nd season crop test	-	-	-	13(11)	780	190-1380
1987	1. comparative 2nd season crop test	25	720	60-1890	24(23)	733	270-1520
	2. farmer tests	26	663	224-1577	16	843	186-1630
1988	farmer tests	30	814	275-1635	36(32)	576	105-1629
1989	farmer tests	8	519	254-1053			

1. Means for sole and cassava-intercropped; 200 kg/ha 15-15-15
2. Means of 2 varieties (TGx 814-26D and TGx 849-297D) sole cropping treatment only; 200kg/ha 15:15:15
3. Between brackets, no. of farmers for whom yield was recorded.

Table 7. Soybean population densities (plants/ha x 10^{-3}) in farmer tests, Alabata and Ayepe, 1987-1988.

	Alabata		Ayepe	
	1987	1988	1987	1988
Stand at 2 WAP				
mean	303	n.a.	207	na
range	90-668	44-662		
Stand at harvest				
mean	253	254	209	294
range	56-485	83-614	43-658	37-1043

na = not available.

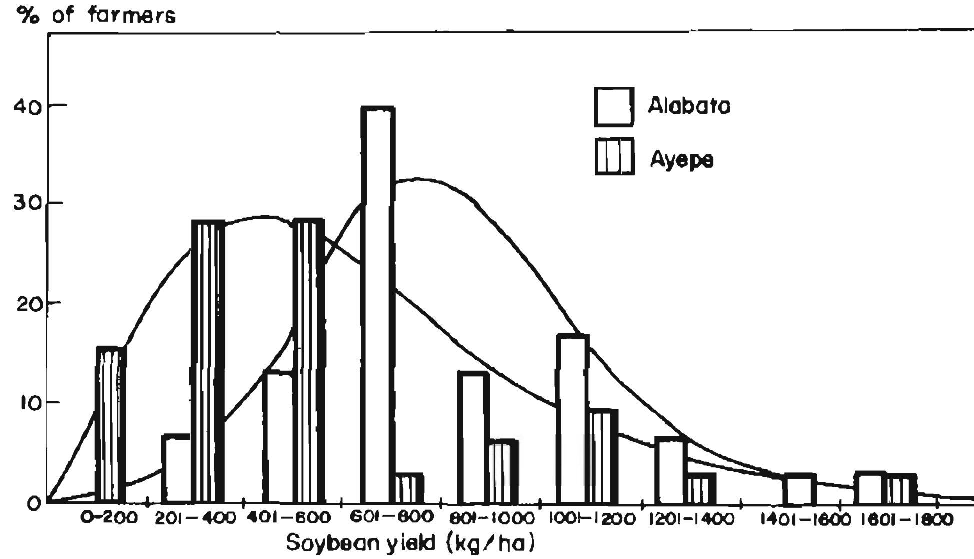


Figure 5. Distribution of soybean yields in farmer-managed plots, Alabata and Ayepe, 1988.

In the trials, soybeans were planted not later than the first week of August, and no effect of planting date on yield was found. In the farmer tests (all data from both sites for 1987 and 1988 pooled) a weak but significant negative correlation was found between yield and planting date ($r = -.23^{*}$). Mean yield (596 kg/ha) of fields planted after 5 August was significantly lower than the mean yield (812 kg/ha) of fields planted before 5 August, $P < 0.01$.

It is of interest to analyze the evolution of farmers' soybean-growing practices over the years. It should be noted that supervision and advice were gradually reduced and in 1988 farmers practically grew the crop on their own. Table 8 shows for each year (i) which crop preceded the soybeans and (ii) which crop was interplanted by farmers in the soybean plots. In Alabata, farmers most often cleared a fallow plot for the soybeans and grew the crop sole. In Ayepe, the most common practice (50%) was to grow soybeans after cassava, planted two years earlier and harvested late in the previous year or early in the same year. Although soybeans were more often associated with cassava in Ayepe than in Alabata, growing soybeans sole is also the dominant practice. Although 63% were recorded in 1987 to be growing soybeans with cassava, this is probably an overestimate. No distinction was made in that year between odd stands of cassava occurring or remaining in soybean fields and an intentionally planted soybean + cassava association. One of the reasons given for growing soybeans as a sole crop is the high (recommended) population density which does not allow enough space for cassava.

In any case, the position of soybeans in the farmers' cropping systems does not seem to have stabilized yet, and farmers continue experimenting. The available options (all observed) are the following :

- clear a new plot from short *Chromolaena* fallow,
- clear a plot in an old cassava field where the (maize +) cassava was planted two years earlier and the cassava has been harvested,
- plant soybean in a plot which was planted to maize + cassava in the first season of the same year but cassava failed partly.

In theory, soybeans could also follow cassava planted in the previous year but cassava typically remains in the field for 18-22 months and the plot would normally not be available in time. This practice was, however, observed in a few cases.

Table 8. Preceding and associated crops in farmers' soybean trials and farmer tests; Alabata and Ayepe, 1985-1988.

	1986	1987		1988
	Comparative second season crop test	Comparative second season crop test	Farmer tests	Farmer tests
Alabata				
Preceding crop (%)				
fallow[1]		36	65	50
cassava[2]		40(16)	31(4)	30(3)
other[3]		24	4	20(13)
Associated crop (%)				
cassava		4	4	3
vegetables		-	-	-
other		-	-	3
Ayepe				
Preceding crop (%)				
fallow[1]	61	42	25	25
cassava[2]	31(-)	54 (-)	50(13)	47(11)
other[3]	8	4	25	28(6)
Associated crop (%)				
cassava	n a	29	63	19
vegetables	n a	-	-	3
other	n a	4	6	-

1. Fields where maize + cassava was planted 3 years earlier are considered as fallow.
2. Between brackets fields where maize + cassava was planted the previous year.
3. Sole maize, maize + cassava but cassava failed, cowpeas, soybeans, pepper, tomatoes, yams; between brackets, grain legume (soybeans, cowpeas) as preceding crop.

In Ayepe, farmers' interest in soybeans has grown slowly but steadily. The introduction of the crop was accompanied by educational programs in which farmers and their spouses were informed about the nutritional value of soybeans, and shown ways of incorporating them into the local diet.

In 1989 (not reported here), some 40 growers were monitored but the actual number of growers probably exceeds this figure. Although soybean cultivation seems to be spreading slowly in Ayepe, plot sizes are extremely small (0.03ha) compared with an average plot size of 0.3ha (Table 9).

In Alabata, the number of known soybean growers fell from 30 in 1988 to 8 in 1989 with an average yield of 519 kg/ha. Two causes are considered likely to be responsible for this decline.

1. In an early stage, an artificial market was created by the introduction of a few individual buyers. When these buyers did not return in subsequent years, farmers were probably discouraged from further soybean growing because the crop had become regarded as a cash crop. In Ayepe, on the other hand, the crop was explicitly introduced as a "household crop". Whatever sales there were, these were made at the farmers' own initiative.

2. Farmers in Alabata had the alternative of growing sprayed cowpeas instead of soybeans. In 1989 some 40 farmers grew cowpeas with minimal assistance from the field team. It remains to be seen whether cowpeas will be viable after complete withdrawal of assistance and whether soybeans will again pick up.

More detailed information on the influence of management practices, including fertilizer use, is needed to identify the potential for increased soybean yield. A study on these issues in farmer-managed soybean plots was conducted by a PhD student with 36 farmers in 1989. Results of this study will be reported elsewhere.

There are indications that root-knot nematodes may become a problem when soybean growing increases. This suggests the need to avoid growing soybeans in the same plot in successive years and for rotation of soybeans with non-sensitive crops.

Table 9. Areas planted to soybeans in farmer-managed tests, Alabata and Ayepe, 1987-1988.

	Alabata		Ayepe	
	1987	1988	1987	1988
Average area (m^2)	381	283	309	302
Range (m^2)	35-994	81-900	80-1140	63-703

Cowpeas

Cowpeas, although an essential food item in the diet of southwestern Nigeria, are only grown to a limited extent in the area. In Ayepe, the crop is practically non-existent while in Alabata, cowpeas grown in the traditional way are a minor crop with generally very low yields due to the cowpea pest complex.

"Modern" cowpea growing has been tested in Alabata since 1985 with a package consisting of erect, determinate, early-maturing varieties, recommended plant arrangement, and chemical pest control. In 1985 and 1986, trials were conducted on varieties, pesticides, and crop associations (Table 2). In 1987, a comparative test was carried out with cowpeas, soybeans, and maize grown side-by-side in the same farmers' fields. Finally, in 1988 and 1989, farmer-managed tests were conducted as a conclusion to the work on cowpeas. In the 1988 tests, farmers used their own preferred management practices, but the field staff supervised insecticide treatment according to a recommended spray schedule at 35, 45, and 55 DAP. The first spray was afterwards advanced to 30 days because of significant early thrips damage. Insecticide was provided at cost and against cash payment. In 1989, a final set of observations was conducted without any supervision. Farmers purchased seed and insecticides, rented sprayers from the field team against cash payment, and grew the crop entirely on their own. A spray schedule of four sprays (at 25, 35, 45, and 55 DAP) was recommended. The field team only recorded final plant stand and yields, as well as the quantity of insecticide purchased and time of application.

No fertilizer was applied to any of the trials or farmer tests.

Cowpea yields from the trials and farmer tests from 1985 until 1989 are presented in Table 10. Inadequate insecticide treatment, which was corrected in 1986 (Palada et al. 1989), accounts for the very low yields in the 1985 trial. From 1987 until 1989, supervision was gradually reduced and the 1989 tests can be considered as fully farmer-managed. In the 1987 comparative test, with substantial supervision, the highest yield of all years was recorded (905 kg/ha). In the 1988 farmer tests, five farmers abandoned their cowpea plots and obtained no yield while one farmer harvested without sampling. Average yield declined to about 600 kg/ha. In 1989, all 40 farmers maintained their field up to harvest, and yields were similar to those of 1988.

It appears from these results that, under full farmer management and with current practices, an average yield of around 600 kg/ha can be expected with a range of 200-1400 kg/ha.

The planting density recommended for sole crop cowpeas was 200,000 plants/ha, but in 1988 and 1989, farmers were free to decide on cowpea planting pattern and on association with other crops. Table 11 records their actual practices. In 1988, those farmers who planted sole cowpeas (about 50%) used close to recommended densities. In 1989, however, when there was practically no intervention by the field staff, more farmers associated cowpeas with other crops, while the average cowpea density in both sole and mixed stands was similar and less than half the recommended sole crop density. Since cowpeas are a well-known crop, it appears that farmers reverted to the planting arrangement commonly used in the area for the traditional spreading varieties. This density would be expected to be too low for the erect IITA types (and perhaps wasteful in insecticide use).

Table 10. Mean cowpea yields (kg/ha), yield range and number of farmers in cowpea trials and tests, Alabata, 1985-1989.

		No. of farmers[2]	Mean yield	Range of yields
1985	Intercropping trial[1] sole	10	307	0-786
	intercropped	10	233	0-655
1986	Variety trial[1,2]	11	711	382-1546
1987	Comparative second season crop tests	21	905	267-1456
1988	Farmer tests	36 (30)[3]	588	134-1406
1989	Farmer tests	40	605	222-1269

1. Data from Palada et al. (1990).
2. Intercropped cowpeas failed due to late planting.
3. Between brackets, no. of farmers whose yield was recorded.

Regression analysis of the yield data, pooled for both years, indeed showed a significant effect of plant stand at harvest on yield (Table 12). Figure 6 shows the scatter diagram and a quadratic curve fitted to the data. The fitted curve has an optimum at about 200,000 plants/ha and 800 kg/ha, but the scatter is too large for conclusions to be drawn.

There was also a significant effect of planting date (Table 12) with yield tending to decrease with later planting. The earliest possible planting date is constrained by the main requirement that the crop must ripen after the rains have stopped. A 75-day variety should, therefore, be planted at the first opportunity after 15 August.

Table 11. Cowpea stand densities at harvest (plants/ha x 10) for sole crop cowpeas or cowpeas associated with other crops in farmer-managed observations, Alabata, 1988-1989.

					Associated with			
			Sole cowpea		Cassava		Other crops[1]	
	Mean density	Range	%	Mean density	%	Mean density	%	Mean density
1988	112.6	20-313	50	145.8	39	66.4	11	110.3
1989	88.3	30-186	33	83.2	53	97.1	14	68.8

1. maize, tomatoes, or maize + tomatoes

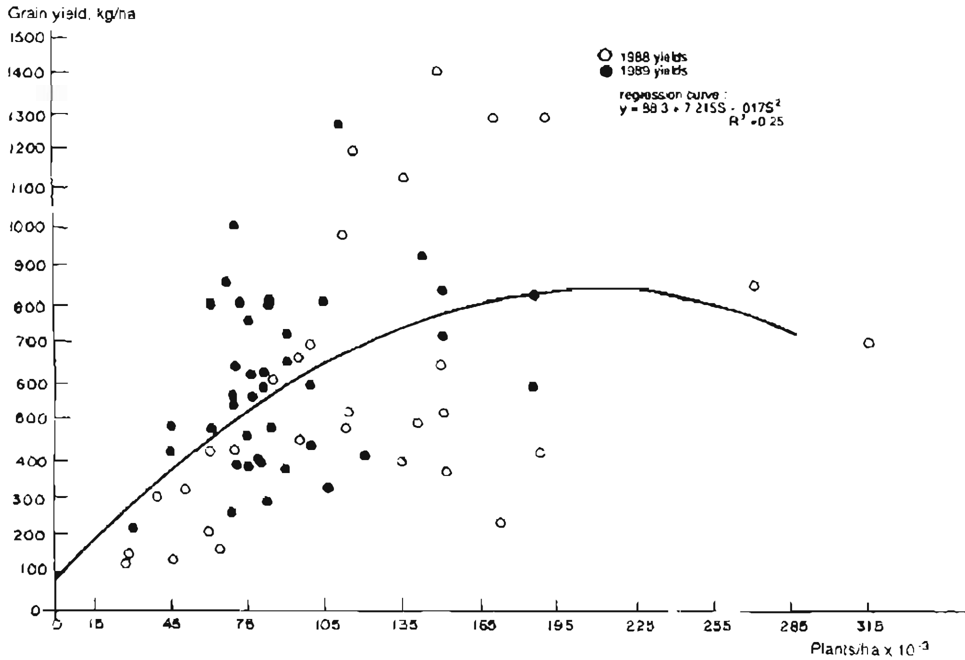


Figure 6. Cowpea stand at harvest and grain yield in farmer-managed tests, Alabata, 1988 and 1989.

With a CV of more than 40%, other major factors may be suspected of causing differences among farmers, such as differences in effectiveness of insecticide protection. Regression of yield on a number of variables related to the farmers' spraying practices (number of sprays, spray volume, date of first spray, period of insecticide protection) showed no significant effect of any of these variables. No detailed observations were carried out on insect incidence. It is well known that "calendar spraying" is not the most effective way of controlling insects, because it is not related to actual pest incidence but rather based on some average insect dynamics. Increased cowpea yields will only be attainable with more effective insect control based on field scoring. With current farmers' skills and practically non-existent extension services, however, calendar spraying is probably the only feasible approach. Under these conditions and at an adequate stand density, average yields of 600-800 kg/ha can be expected, if insecticides and sprayers are readily available.

As from 1990, the research team will completely withdraw its intervention, and farmers will be advised to obtain sprayers and insecticides from the Ibadan market. The fate of cowpea growing under these conditions will be further monitored.

Table 12. ANOVA of cowpea yield and regression on stand at harvest; farmer-managed cowpea tests, Alabata, 1988 and 1989 (data pooled).

Source of variation	DF	MS	F	P
Planting date				
linear	1	252092	4.018	.049
quadratic	1	247474	3.945	.051
Stand at harvest				
linear	1	992060	15.814	<.001
quadratic	1	418254	6.667	.012
Residual	65	62733		
R^2 = .319		CV = 41.9%		

Regression of yield (Y) on stand at harvest (S): $Y = 88.3 + 7.215\ S^2 - .017\ S$; $R^2 = .25$

IV. Conclusions

Agronomic potential of second season crops

The decline of cocoa as a major cash earning commodity in southwestern Nigeria has left farmers with a serious cash constraint. Earnings from cocoa are used for agricultural expenses as well as to finance part of the first season food-crop operations (Smith and Oyewole, in preparation). It was hypothesized that intensification of second season cropping could play a role in (i) increasing farmers' cash income, and (ii) exploiting the slack labor period in the second season which has resulted from the decline of cocoa.

The results presented here show that, at present, maize is not a viable second season crop. It suffers from very serious stemborer problems, in particular *Sesamia*. The pattern of second season rainfall may also be a factor. Historical rainfall probabilities calculated for data from the Obafemi Awolowo University (Ile-Ife) farm (Fig. 7) show that there is a 25% probability that the rainfall in the first and second 10-day period of August will be less than one third of potential evapotranspiration. The current medium-maturity maize (approx. 110 days) when planted late July/ early August would be subject to partial or complete failure due to drought after planting once every four or five years. When maize is planted in late August or early September, there is a high risk of drought during grain filling because of early termination of the rains. The planting "window" for successful planting is also quite narrow which leaves farmers little scope to spread their planting time. Early-maturing maize such as TZESR planted late August would eliminate the drought risk to a large extent, but not the *Sesamia* risk.

The fact that farmers still grow second season maize is explained by the secondary status of maize compared with cassava with which it is almost always associated. Its failure does not affect the major crop, while it is a bonus when successful. The fact that farmers may plant cassava even in late September, but then without maize, lends support to this assumption.

Soybeans at present have potential as a "garden crop" planted in small plots for home consumption. The mean yield potential under current practices is between 700 and 800 kg/ha. Soybeans would improve the nutritional status of the villagers diet. If a stable market develops, the crop area may expand.

Most farmers cleared a new plot from fallow for their soybeans. Another possible niche for soybeans (and cowpeas) in the cropping system is the second season following the harvest of the cassava planted two years earlier. Cassava, planted in the first season, is usually harvested in the dry season of the second year after planting (Fig. 8) and farmers would have to leave some land fallow during the first season preceding soybeans. If the preceding maize + cassava crop were planted in the second season two years earlier, soybeans could follow immediately after the cassava harvest (Fig. 8). The soybeans may improve the nitrogen status of the soil slightly, which would benefit a maize + cassava crop planted in the following year.

Another interesting possibility is a pattern with soybeans preceding yams. Yams, particularly in the forest savanna transition zone, are often planted early in the dry season (November-December) on heaps prepared by the end of the rainy season. They sprout with the first rains in the following year. Yam heaps may be prepared as early as

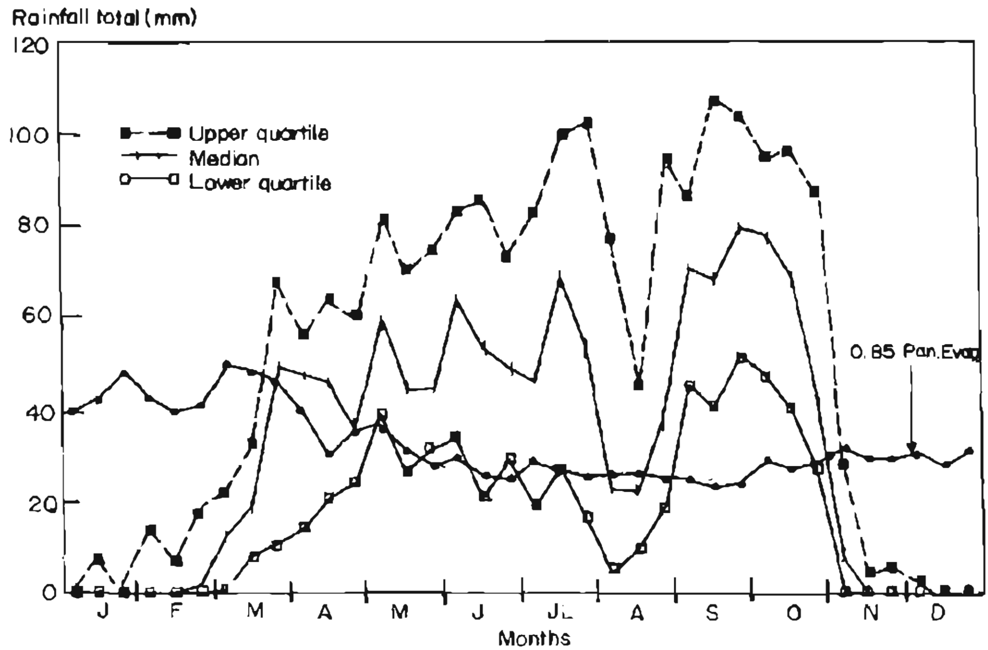


Figure 7. **Rainfall frequency diagram for 10-day periods; Ile-Ife, Nigeria, 1969-1989. (Upper and lower quartiles are rainfall amount exceeded in respectively 3 and 1 years out of 4.)**

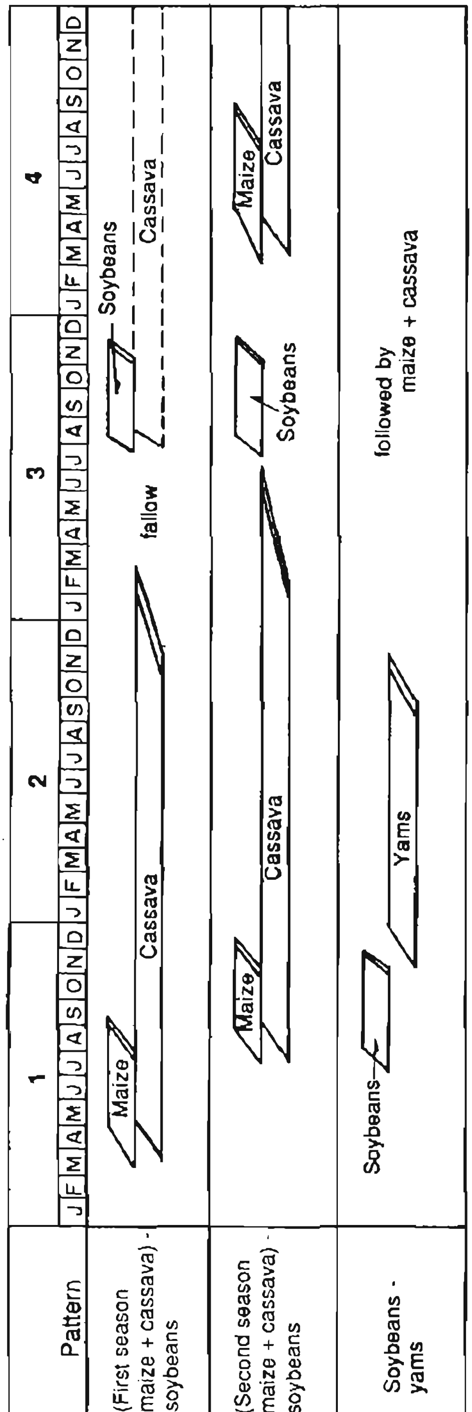
July-August and planted with vegetables before the yam setts go in. Soybeans would also be a suitable crop for planting on land prepared for yams (Fig. 8) and the yams would benefit from the nitrogen contributed by the soybeans.

A problem with soybeans is seed conservation. Some of IITA's varieties have good seed longevity, if properly dried and stored in air-tight plastic bags or containers. Varieties with good seed longevity, however, are small-seeded, while farmers clearly prefer large-seeded types.

Mean yield potential of cowpeas with 3-4 sprays is estimated at 600-800 kg/ha. The niche for cowpeas in the farmers' cropping patterns is the same as for soybeans. Sprayed cowpeas are well within farmers' management capabilities, but insecticides and sprayers probably have to be available at the village level. We will further monitor the fate of sprayed cowpeas after withdrawal of our intervention in the supply of insecticides and sprayers.

Some methodological remarks

All the trials and tests since 1986 in Ayepe and since 1987 in Alabata were largely farmer-managed. Through meetings and individual discussions, farmers were also consulted on the choice of crops for testing. In the light of the results of the trials, it is interesting to note some of the pre-trial remarks farmers made.



Notes: Same patterns apply to cowpeas, which are planted 1 month later than soybeans
In the first pattern, soybeans are associated with cassava or followed by maize + cassava in year 4.

Figure 8. Potential niches for soybeans and cowpeas in the cropping patterns of southwestern Nigeria.

1. Some farmers who had had previous experience with groundnuts (tested in Ayepe in 1986) commented that the crop should be grown in the first season rather than in the second. The results, complete failure in spite of good vegetative growth, justified their reservations. Groundnut testing was, therefore, discontinued but it would be useful to examine the causes of failure in view of successful second season groundnut growing elsewhere.

2. Farmers had reservations about second season maize. Unreliable rainfall was the reason they adduced (Mutsaers et al. 1987; Palada et al. 1985). A rainfall analysis suggested that it was sufficiently reliable at least for an early-maturing variety. We hypothesized that the problem really was streak virus for which resistance was available. Farmers turned out to be right, but mainly because of stemborer damage.

3. During a visit to IITA, farmers from Ayepe expressed surprise that we did not introduce cowpeas to them, since they were seen to grow beautifully at the IITA station. It was explained that cowpea would require sustantial investment in insecticides which were not readily available to them. They seemed to have accepted the argument because the issue was not raised afterwards.

These are examples where we ignored farmers' opinion in our choice of technology. Farmers turned out to be right in two cases, but in one of them for a reason different from the one they advanced. Nevertheless, many of them were willing to go along with the tests, but eventually discontinued maintaining the controversial crops (in particular, maize).

The trials enabled us to better understand the problems with second season maize and to identify a problem with groundnuts, but at the cost to farmers of some unproductive work. Because of the small size of the test plots, and probably because of farmers' perception of advantages from other trials in which they had participated, this has not led to problems or requests for compensation.

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