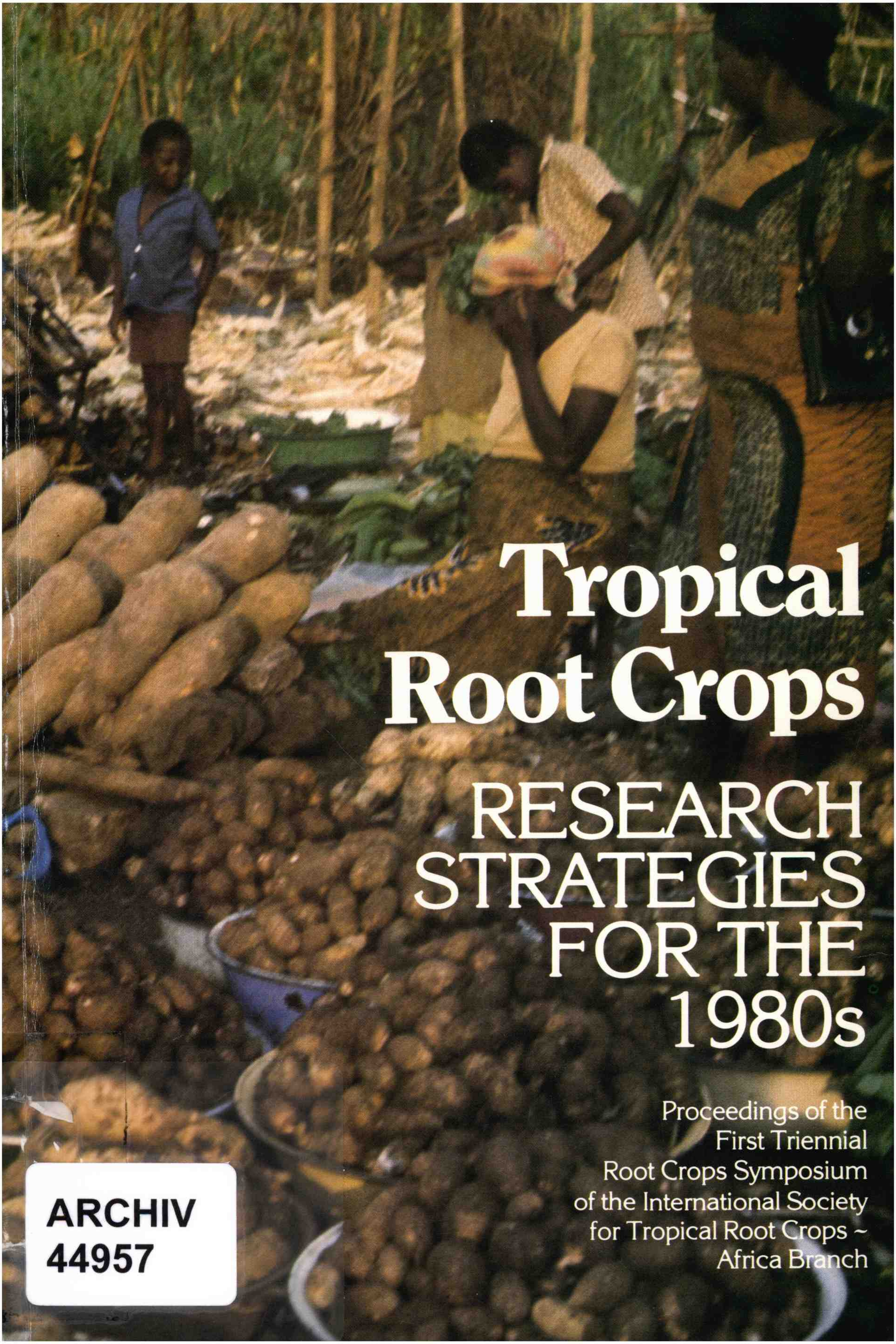

Tropical Root Crops

RESEARCH STRATEGIES FOR THE 1980s

Proceedings of the First Triennial Root Crops Symposium of the International Society for Tropical Root Crops ~ Africa Branch

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TROPICAL ROOT CROPS: RESEARCH STRATEGIES FOR THE 1980S

PROCEEDINGS OF THE FIRST TRIENNIAL ROOT CROPS SYMPOSIUM OF THE INTERNATIONAL SOCIETY FOR TROPICAL ROOT CROPS — AFRICA BRANCH, 8–12 SEPTEMBER 1980, IBADAN, NIGERIA

EDITORS: E.R. TERRY, K.A. ODURO, AND F. CAVENESS

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WEED CONTROL IN MAIZE–CASSAVA INTERCROP

I. OKEZIE AKOBUNDU

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Two improved cassava cultivars consisting of a profusely branching type (TMS 30395) and an upright, moderately branching type (TMS 30001) were grown at two population densities as components of mixtures involving two maize (TZB) populations. Maize yield was depressed by TMS 30395 at the higher cassava population density of 10 000 plants/ha but not at 5000 plants/ha. Cassava cultivar TMS 30001 did not affect maize yield at either of the two population densities. Two hand weedings or the use of a preemergence herbicide (Primextra) limited yield reductions caused by weeds in the maize–cassava intercrop. Root yield was generally higher for TMS 30001 than for TMS 30395. The highest root yield for each cultivar was obtained when 10 000 cassava plants/ha were intercropped with maize at 20 000 plants/ha. This combination gives the optimum plant population (30 000 plants/ha) for the mixture. The highest total food energy and the lowest weed weight were observed at this population. Cost of weeding was lowest where the herbicide, Primextra, was used. This treatment gave the highest return on investment at the optimum crop combination.

Deux cultivars améliorés de manioc, le TMS 30395 à feuillage abondant et le TMS 30001 à feuillage modéré érigé ont été cultivés à densité différente en association avec deux peuplements de maïs (cv. TZB). TMS 30395 a réduit les rendements de maïs lorsque la population comprenait 10 000 individus par hectare mais n'eut aucun effet sur celle de 5 000 plantes par hectare. Le cultivar TMS 30001 n'a pas affecté la production de maïs quelle qu'ait été la densité de la population associée. Deux sarclages ont été nécessaires ou l'emploi d'un herbicide en pré-levée (Primextra) afin de réduire au minimum l'action des mauvaises herbes. Le rendement en tubercules a été généralement plus élevé avec TMS 30001 qu'avec TMS 30395. Et la production de tubercules pour chaque cultivar a été plus élevée lorsque la culture associée comprenait un peuplement de manioc de 10 000 plants par hectare et celle du maïs de 20 000 plants par hectare. Cette combinaison de 30 000 plants par hectare est la meilleure proportion pour une production optimale. C'est également dans cette proportion qu'on a obtenu l'énergie alimentaire totale la plus élevée et le plus faible volume de mauvaises herbes. Le sarclage a été le moins coûteux avec l'emploi de l'herbicide Primextra. Ce traitement a été le plus rentable pour cette combinaison de cultures associées comprenant le maïs et le manioc.

Mixed cropping constitutes a major component of the traditional cropping system in tropical Africa (Okigbo and Greenland 1976). In most parts of the world, cassava is grown as an intercrop by smallholder farmers. Crops commonly intercropped with cassava include food legumes, cereals, and horticultural crops. Maize–cassava appears to be the most popular intercrop among farmers in tropical Africa, Latin America, and Asia (Okigbo 1978; Mureno and Hart 1979; and Kumar and Hrishi 1979).

Farmers intercrop for a variety of reasons including insurance against crop failure, better and more efficient use of labour, prevention of erosion, and protection against crop pests (Watters 1971; Andrew 1975; Norman 1975). Although a desire to control weeds may have influenced the evolution of cropping patterns, the farmer generally uses very wide spacings adjusted more to the fertility level of the soil than to early canopy cover and weed control. Lagemann (1978), in a study of the traditional farming systems of three villages in eastern Nigeria, noted that the average plant population density of a mixture of arable crops in the fields was only 12 000 plants/ha. This figure is low compared with the 30 000 plants/ha generally recommended for arable crop mixtures.

Low plant densities mean that large areas of soil surface are exposed and so favour weed establishment. Effective use of intercropping to suppress weeds requires adequate plant populations and spatial arrangements of crops in the mixture. The objective of this study was to assess the impact of plant type and population density on the effectiveness of selected weed control treatments.

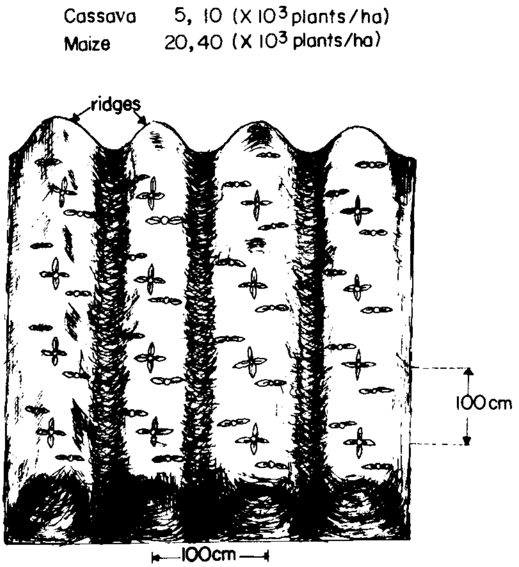

Fig. 1. *Effect of maize plant population on maize grain yield.*

MATERIALS AND METHODS

The experiment was set up in an alfisol (Apomu sandy loam soil) at the International Institute of Tropical Agriculture. Two improved cassava cultivars consisting of a profusely branching type (TMS 30395) and an upright, moderately branching type (TMS 30001) were used at two spacings (100 × 100 cm and 100 × 200 cm) as components of mixtures involving maize (cultivar TZB). The maize was intercropped at a spacing of 100 × 25 cm (Fig. 1). The two crops were planted at the same time. Cassava stakes were 25 cm long and were planted on the top of ridges in a slanting position (approximately 45°). Maize was planted on both sides of the ridges at two seeds per hill and thinned to one stand/hill 2 weeks after emergence. In addition to the intercrop treatments, weed-free control plots of sole maize and sole cassava, each at the various plant populations used in the intercrop, were included. Fertilizer was applied (N, P_2O_5, and K_2O, 30 kg/ha) during land preparation, and 60 kg N/ha was applied to the 4-week-old maize as side dressing.

Weed-control treatments were one hoe weeding; two hoe weedings; preemergence application of a formulated mixture of atrazine and metolachlor (2.5 kg a.i./ha); a weed-free plot; and an unweeded control plot. Data on crop performance, weed control, and yield of economic components of the crops were collected and statistically analyzed.

RESULTS AND DISCUSSION

The results showed that maize yield (at 40 000 plants/ha) was depressed in the profusely branching cassava cultivar (TMS 30395) at 100 × 100 cm spacing but not when the cassava spacing was 100 × 200 cm (Table 1). Reduction in maize yield

Table 1. Effect of cassava (TMS 30395 and TMS 30001) spacing (population) on yield of maize (TZB).[a]

		Maize grain yield (t/ha)			
		TMS 30395 spacing		TMS 30001 spacing	
	Weed control	1.0 × 1.0 m	2.0 × 1.0 m	1.0 × 1.0 m	2.0 × 1.0 m
40 000 maize plants/ha	Weeded at 2 WAP	1.84	1.83	1.85	2.59
	Weeded at 2+5 WAP	2.28	3.10	2.54	2.30
	Primextra 2.5 PE	2.69	2.35	3.25	2.50
	Weed free until harvest	2.81	3.25	3.13	3.11
	Weedy	0.66	1.09	1.35	0.96
Mean		2.06	2.03	2.43	2.29
LSD 0.05 (within cassava)[b]		1.46		0.92	
20 000 maize plants/ha	Weeded at 2 WAP	1.85	1.30	1.90	1.65
	Weeded at 2+5 WAP	1.12	1.26	2.09	2.07
	Primextra 2.5 PE	1.32	1.46	2.14	1.26
	Weedy	0.37	0.42	1.47	1.08
Mean		1.17	1.11	1.90	1.52
LSD 0.05 (within cassava)[b]		0.74		0.86	

[a]Yield from sole maize plots, kept weed free, was 3.24 t/ha at 40 000 plants/ha and 2.33 at 20 000 plants/ha.

[b]LSD 0.05 for comparison of means of different cassava spacings at 40 000 plants/ha maize is 1.61 t for TMS 30395 and 1.46 t for TMS 30001; at 20 000 plants/ha maize, it is 0.68 t for TMS 30395 and 1.10 t for TMS 30001.

Table 2. Effect of maize spacing and population on yield of cassava (TMS 30395 and TMS 30001).[a]

		TMS 30395 (TMS 30001) fresh weight yields (t/ha)	
		Maize spacing	
	Weed control	1.0 × 0.25 m	1.0 m × 0.5 m
10 000 cassava plants/ha	Weeded at 2 WAP	10.80 (13.56)	15.29 (16.78)
	Weeded at 2+5 WAP	13.07 (18.29)	15.55 (25.08)
	Primextra 2.5 (preemergent)	13.63 (16.23)	23.28 (34.78)
	Weed free until harvest	13.07 (21.18)	23.57 (30.94)
	Weedy	6.27 (7.71)	6.83 (9.32)
Mean		11.37 (15.39)	16.9 (23.38)
LSD 0.05 (within maize)[b]		14.3 (9.31)	
5 000 cassava plants/ha	Weeded at 2 WAP	10.31 (7.59)	16.50 (14.12)
	Weeded at 2+5 WAP	11.05 (15.99)	15.94 (13.56)
	Primextra 2.5 (preemergent)	11.69 (13.61)	19.40 (20.56)
	Weed free until harvest	10.68 (14.31)	19.24 (21.92)
	Weedy	4.49 (4.42)	4.02 (3.09)
Mean		9.65 (11.18)	15.02 (14.65)
LSD 0.05 (within maize)[b]		8.71 (8.21)	

[a]Yield from sole cassava plots, kept weed free, was 41.79 t/ha at 10 000 plants/ha and 29.73 t/ha at 5000 plants/ha.
[b]LSD for comparison of means of different maize spacings at 10 000 plants/ha cassava is 13.2 t for TMS 30395 and 11.4 t for TMS 30001; at 5000 plants/ha, it is 11.1 t for TMS 30395 and 20.12 t for TMS 30001.

caused by uncontrolled weed growth was greater at the narrower cassava spacing than at the wider spacing (77% and 67% respectively). This may have been caused by increased interspecific and intraspecific competition among weeds and crop mixtures. The yield reductions were greater than values generally observed in sole-cropped maize under identical growing conditions. The cassava cultivar TMS 30001 did not depress maize yield at any of the spacings used in this study (Table 1).

Cultural weed control involving two weedings by hand or the use of a preemergence herbicide was necessary to minimize yield reduction caused by weeds in the maize–cassava intercrop. The herbicide caused no visible phytotoxicity to either maize or cassava. Intercropped maize at a plant population of 20 000 plants/ha generally produced lower yields than did the same population on a pure stand.

Root yield of TMS 30395 at the two cassava spacings used in this study was depressed by maize at a population of 40 000 plants/ha but not at 20 000 plants/ha (Table 2). When good weed control was provided, root yield of TMS 30395 intercropped with maize at 20 000 plants/ha was identical to yield of the sole-cropped cassava irrespective of the cassava population. Root yield in the herbicide-treated plots was as high as that in the weed-free plots. Uncontrolled weed growth caused more yield reduction in cassava at high plant populations than at the low levels due to greater weed–crop interference at high plant densities.

Root yield was depressed at all intercrop combinations involving TMS 30001 (Table 2) but more so at a maize population of 40 000 plants/ha than at 20 000 plants/ha. However, crop sensitivity to weed interference was greater at the lower population. Although, generally, cassava yield was lower in plots weeded only once than in plots with other

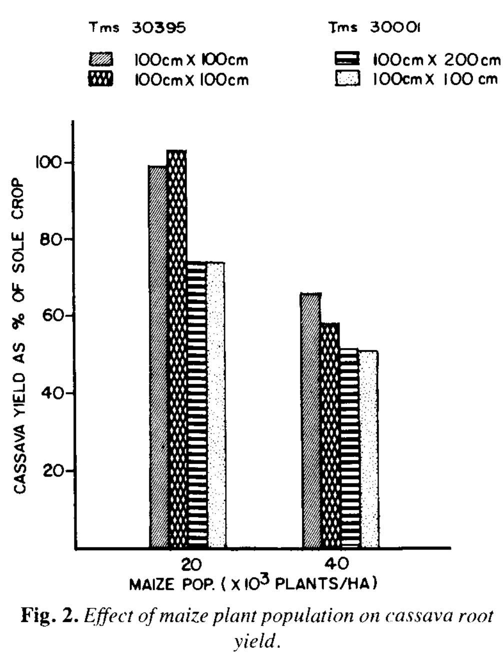

Fig. 2. *Effect of maize plant population on cassava root yield.*

Table 3. Effect of plant population on land equivalent ratio in maize–cassava intercrop.

Crop spacing		Population (plants/ha)	Land equivalent ratio		
Cassava	Maize		TMS 30395	TMS 30001	Mean[a]
2 × 1 m	1 × 0.5 m	25 000	1.86	1.30	1.58
1 × 1 m	1 × 0.5 m	30 000	1.68	1.90	1.79
2 × 1 m	1 × 0.25 m	45 000	1.59	1.47	1.53

[a]LSD (0.05) for comparison of means within one cultivar is 0.34: between the two cultivars is 0.71: the coefficient of variation is 12%.

weed-control treatments, this difference was very pronounced at the lower plant population.

How the various maize populations affect cassava root yield under weed-free conditions is shown in Fig. 2. The cassava cultivar TMS 30001 was more affected by the maize intercrop than was TMS 30395. Up to 50% yield reduction occurred in TMS 30001 when it was intercropped with maize at 40 000 plants/ha.

Lodging in the maize–cassava intercrop was affected by plant population as well as cassava cultivar (Fig. 3). When the two cassava cultivars were grown separately, lodging was kept at about 10% of the total stands. The greatest amount of lodging was observed in the maize–cassava intercrop where the maize population of 40 000 plants/ha was maintained. The upright cassava cultivar (TMS 30001) was more susceptible to lodging than the low, profusely branching TMS 30395. At 100 × 100 cm spacings, TMS 30395 practically suffered no lodging.

All the maize–cassava intercrop populations had land-equivalent ratios (LERs) greater than one, an indication that this intercrop has an overall yield advantage over growing each crop alone on the available land. The highest mean LER for the intercrop was obtained at a total maize–cassava population of 30 000 plants/ha, and the highest

Table 4. Effect of plant population and weed control on food energy values (calories) and weed growth in maize/cassava intercrop.

	Weed Control	Energy values (× 10^6 cal) cassava cultivars		Dry weight of weeds (t/ha) in	
		TMS 30395	(TMS 30001)	TMS 30395	(TMS 30001)
25 000 plants/ha	Weeded at 2 WAP	29.23	(27.08)	3.61	(3.05)
	Weeded at 2+5 WAP	28.24	(27.60)	1.20	(0.71)
	Primextra 2.5 PE	32.58	(35.12)	1.61	(2.11)
	Weed free	34.53	(37.33)		
	Weedy	7.47	(6.24)	4.97	(4.97)
30 000 plants/ha	Weeded at 2 WAP	29.38	(31.79)	2.74	(2.53)
	Weeded at 2+5 WAP	27.17	(44.84)	1.13	(1.14)
	Primextra 2.5 PE	39.39	(59.08)	1.17	(1.49)
	Weed free	40.63	(51.72)		
	Weedy	11.49	(19.09)	4.63	(3.86)
45 000 plants/ha	Weeded at 2 WAP	21.89	(20.58)	2.31	(2.64)
	Weeded at 2+5 WAP	23.50	(32.03)	0.47	(1.27)
	Primextra 2.5 PE	27.73	(29.21)	1.54	(0.87)
	Weed free	27.52	(32.44)		
	Weedy	10.57	(10.00)	4.62	(4.65)
50 000 plants/ha	Weeded at 2 WAP	23.38	(26.81)	2.51	(2.19)
	Weeded at 2+5 WAP	27.64	(36.34)	1.83	(0.77)
	Primextra 2.5 PE	29.88	(35.81)	1.49	(1.53)
	Weed free	29.52	(42.71)		
	Weedy	11.69	(16.30)	4.96	(4.65)
LSD (0.05) for comparison of means within each population		16.84	(13.00)	1.56	(1.34)
LSD (0.05) for comparison of means of different populations		16.52	(15.85)	1.46	(1.27)

Table 5. Effect of weed control methods on economic return in maize–cassava intercrop.

Population (plant/ha)	Weed control	Cost of weeding (Naira)[a]	Gross return (Naira)		Net return (Naira)[b]	
			TMS 30395	TMS 30001	TMS 30395	TMS 30001
30 000	Hoe weeding at 2+5 WAP	138.00	1271.83	2121.53	1133.83	1983.53
	Primextra 2.5 PE	42.50[c]	1813.88	2737.19	1771.38	2694.69
50 000	Hoe weeding at 2+5 WAP	138.00	1406.53	1802.43	1268.53	1664.43
	Primextra	42.50	1539.53	1848.71	1497.03	1806.21

[a]Two weedings in maize/cassava require 278 h/ha; cost is based on 6 h/day @ 3.00 Naira/day; 1.00 = U.S. $1.80.
[b]Net return does not include other production costs and these are identical for both weeding methods.
[c]Cost of herbicide plus labour; a day for each sprayer operator and assistant @ 3.00 Naira/day.

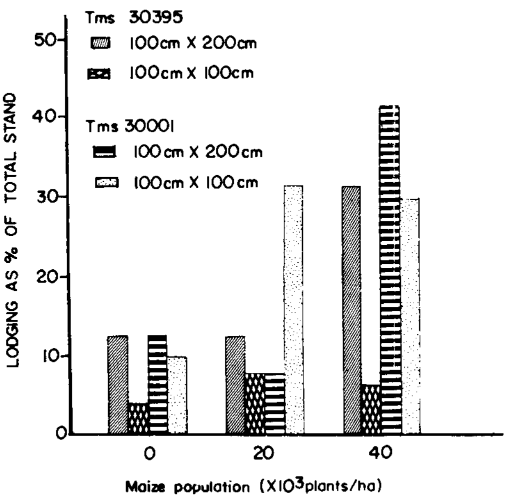

Fig. 3. *Effect of maize plant population on maize cob yield.*

LER for TMS 30001 was also obtained at this total plant population (Table 3). The concept of LER has been used by several authors to assess the advantages of sole and intercropping systems (Francis et al. 1976; Trenbath 1976).

At each plant population, the highest food energy values (kilocalories) were obtained in plots that were kept weed-free throughout the growing season either by repeated weeding by hand or by application of herbicide (Table 4). The highest energy values were obtained when each cassava cultivar was intercropped at 10 000 plants/ha with maize at 20 000 plants/ha. Also, the mean weed weight was lowest at this population mix (Table 4).

The best weed-control treatments in this study were two timely weedings by hand or the use of the herbicide Primextra. The lowest unit cost for weed control was obtained when the herbicide was used (Table 5). This treatment accounted for the highest return on investment, especially at the optimum crop combination (30 000 plants/ha).

It is generally assumed that herbicides are too expensive for the average farmer to use. Results reported in this paper show that at least in Nigeria labour for weeding is in fact manyfold more expensive than is herbicide. Besides, labour for routine farm operations has become very scarce as a result of accelerated migration of rural dwellers to urban centres. Even in countries where the daily wage is low, labour has in recent times become unreliable and often unavailable at the critical time of weed interference. Herbicide use not only provides the needed weed control at the time it is most needed by the crop but also reduces the farmer's input costs in weed control. To make chemical weed control attractive, there is need to improve on herbicide availability to small farmers in consumer-usable small packages. This type of packaging will require the cooperation of chemical industries and governments in the developing countries.

I wish to acknowledge the help given by G. Heys in providing the improved cassava stakes used in this study and the technical assistance provided by R.A. Raji in the course of the field experiments.