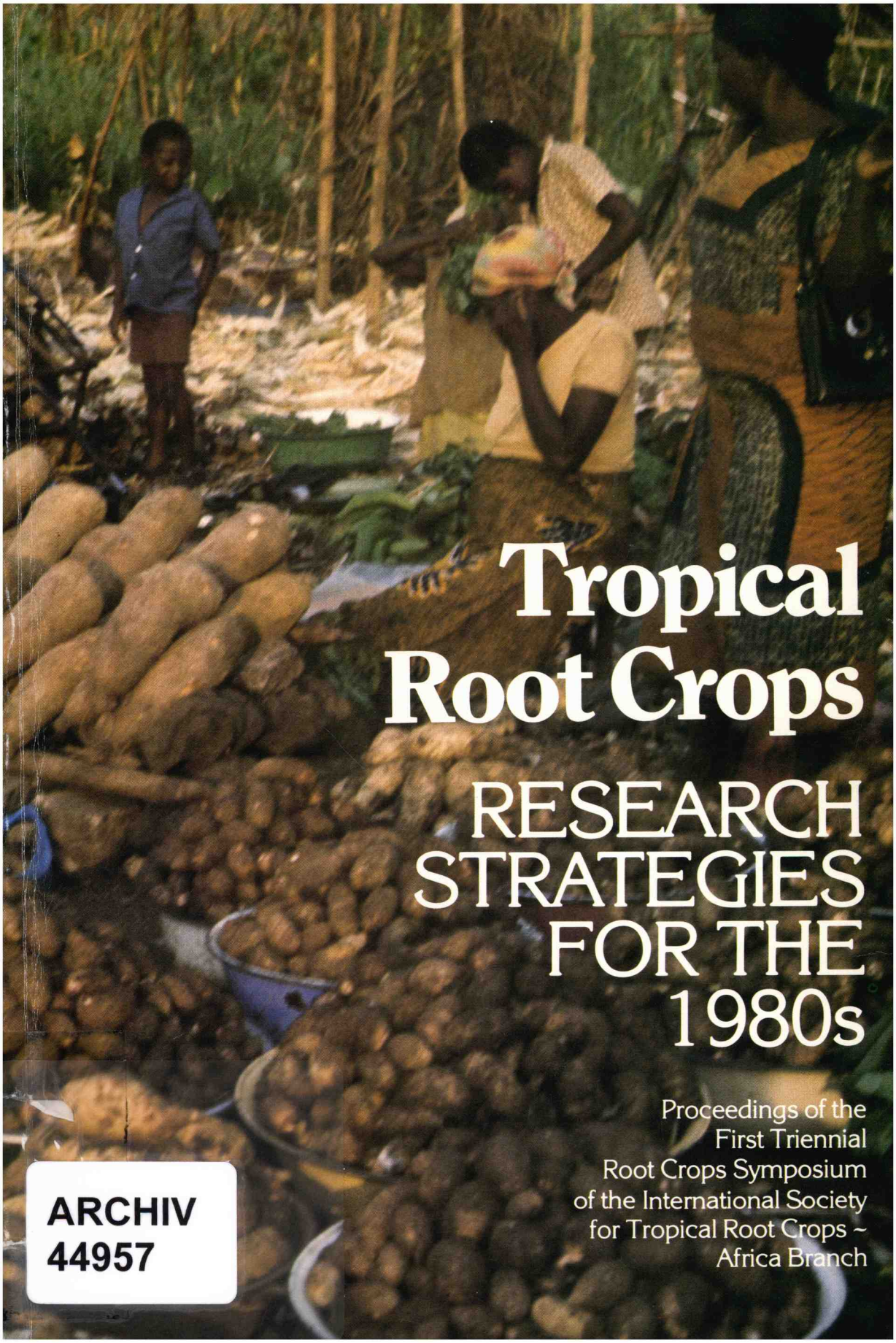

Tropical Root Crops

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

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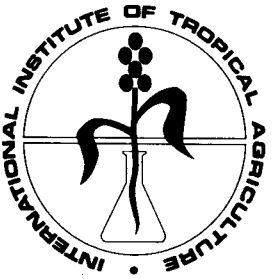

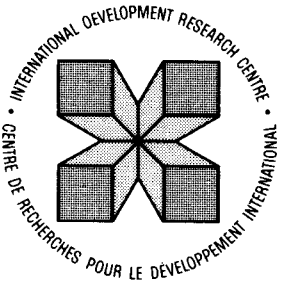

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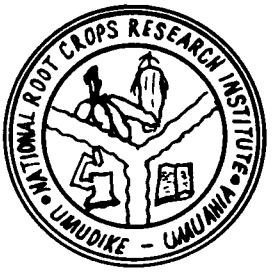

CONTENTS

EFFECTS OF LEAF HARVESTS AND DETOPPING ON THE YIELD OF LEAVES AND ROOTS OF CASSAVA AND SWEET POTATO

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I undertook two studies, one on the effects of harvesting leaves of cassava and the other on the effects of detopping sweet potatoes at different times. My findings were that total fresh leaf yield of cassava variety Isunikakiyan was not significantly affected by harvesting frequency of the leaves unlike that of variety TMS 30211. However, compared with plants with unharvested leaves, there was a total fresh root yield decrease of 56–76%, 34–62%, and 15–32% when leaves were harvested at 1-, 2-, and 3-month intervals. Detopping sweet potato shoot tips resulted in 34–42% less shoot yield than did detopping plants at the base of each shoot. Total shoot yield was unaffected when the tips were harvested at 2-, 3-, or 4-week intervals. Tuber yield was less severely reduced when shoot tips were detopped than when they were cut at the base. As the intervals between detoppings decreased, there was a decrease in tuber numbers, individual tuber size, and total yield. The cassava and sweet potato varieties studied reacted differently to leaf harvests and detopping in terms of root and tuber yields. Harvesting cassava leaves at 2- or 3-month intervals and sweet potato shoots at 4-week intervals is recommended for reasonable overall yields.

Le document comprend deux études effectuées à des périodes différentes sur les effets de la récolte des feuilles chez le manioc et chez la patate douce. Dans le cas du manioc, Isunikakiyan n'a apparemment pas souffert de la cueillette régulière de feuilles, contrairement à TMS 30211. Cependant, si on les compare aux autres plantes non défoliées, le rendement en tubercules a diminué de 56 à 76%, de 34 à 62% et de 15 à 32% respectivement lorsque les feuilles ont été récoltées à des intervalles de 1, 2 et 3 mois. Mais la production de tubercules a été moins affectée par la cueillette de bourgeons terminaux que par celle des pousses à la base de la plante. Et plus les intervalles de cueillette de bourgeons terminaux étaient rapprochés plus le nombre de tubercules diminuait. Leur dimension était plus réduite et le rendement total plus faible. La défoliaison ou la cueillette des bourgeons affecte différemment le rendement en racines et tubercules selon les variétés de manioc et de patates douces étudiées. Il est recommandé pour obtenir des rendements raisonnables, de n'effectuer la récolte de feuilles de manioc qu'à des intervalles de 2 ou 3 mois et de 4 semaines pour les pousses de patates douces.

The roots of cassava and sweet potato provide the basic food for many people in the tropics, but the leaves of cassava and young stems, petioles, and laminae of sweet potato are also popular foods for many African and Asian peoples. In addition, livestock feed made from cassava leaves (Cresswell 1978) and the shoots of sweet potato is demanding increasing interest.

Cassava leaves are a good source of protein, vitamins, and minerals. Oyenuga (1968) reported that local Nigerian varieties average 14.7% protein, 8.4% ether extract, and 16.1% total ash. Eggum (1970) found that the amino acid content of leaves of three Nigerian varieties averages 6% lysine, 2% methionine, 11% aspartic acid, 6% valine, 5.5% arginine, and 2.2% tryptophan. Cassava leaf meal is nearly equivalent to alfalfa meal in feed value (Khajarern et al. 1977).

Sweet potato shoots are also nutritionally valuable. Kay (1973) reported that a typical analysis of the tops of 100 g of edible shoot is moisture 87.1 g; nitrogen 0.57 g; ether extract 0.67 g; fibre 1.4 g; ash 1.59 g of which 81.2 mg is calcium, 67.3 mg phosphorus, and 10.37 mg iron. The vitamin content is 3.61 mg carotene, 0.06 mg thiamine, 0.17 mg riboflavin, 0.94 mg niacin, and 25 mg ascorbic acid.

However, Ahmad (1973) and Singh and Chaudhury (1975) have reported adverse effects of leaf harvesting on yields of roots from cassava, and Gonzales et al. (1977) have noted similar effects on tuber yields of sweet potatoes from which the shoots have been regularly harvested. Methods must be developed that allow for the cassava and sweet potato foliage to be harvested and still maintain reasonable root and tuber yields. To this

end, I investigated the effects of frequency of leaf harvests on yields of fresh leaves and roots in two cassava varieties. I also conducted two other studies to investigate the effects of pattern and frequency of detopping on yields of shoots and tubers of sweet potatoes.

MATERIALS AND METHODS

CASSAVA EXPERIMENT

I harvested leaves from the top 30 cm of each branch of two cassava varieties, Isunikakiyan and TMS 30211, by plucking them from the stems at various intervals of time.

A 2 × 4 factorial design was used with treatments arranged in four randomized complete blocks, one factor being the two varieties and the other being the timing of leaf harvests — namely harvests at 1-, 2-, and 3-month intervals or no harvests (i.e., 8, 4, 3, and 0 cuts). Each plot consisted of four ridges 10 m long, with 10 stakes, each 23 cm long, planted at 1-m spacings along the ridge on 17 April 1978. At each leaf harvest, starting from 4 months after planting, the fresh leaf weights of 16 plants in the centre of each plot were recorded.

The plants were harvested for roots 1 year after being planted; the central 16 plants/plot were separated into laminae, petioles, stems, tuberous roots, and the original stake. Each part was weighed, and total and marketable roots were counted; roots with a minimum diameter of 5 cm were regarded as marketable.

Samples from roots, stems, and originally planted stakes were shredded separately and 10 (500-g) subsamples per variety of each plant part were dried in an air-ventilated oven at 65°C for 72 h for dry-matter contents. For laminae and petioles, 100-g samples of each plant part per variety were dried at 65°C for 48 h.

The crop was not irrigated; plots were regularly hand weeded. No fertilizers were applied because cassava is a low-income crop and people who grow it for leaves and roots do not normally apply fertilizers.

SWEET POTATO EXPERIMENTS

Two separate detopping experiments were conducted in 1977 and 1978 at the International Institute of Tropical Agriculture.

In 1977, two sweet potato varieties TIS 2328 and TIS 2154 were subjected to three patterns of detopping. A 2 × 3 factorial design was used with the treatments arranged in four randomized complete blocks, one factor being the two varieties and the other being the pattern of detopping, namely no detopping, detopping the tips (only 25 cm of each shoot tip), and detopping shoots at the base, i.e., 10 cm from ground level.

Each plot consisted of four ridges, each 3.6 m long, with 12 sweet potato slips (cuttings), each 30 cm long, planted at 30-cm spacings along the ridge on 4 May 1977. The crop was rainfed except for 4 h of overhead irrigation applied early for good plant establishment.

The shoots were detopped 48 and 86 days after being planted, and fresh shoot weights of 16 plants in the centre of each plot were recorded. The plants were harvested for tubers 152 days after being planted; and the number and fresh weights of total and marketable tubers were recorded, roots with a minimum diameter of 2.5 cm being regarded as marketable.

In 1978, a field experiment was conducted on the effects of frequency of detopping 25 cm of each shoot tip of two varieties, TIS 2154 and TIS 3030.

A 2 × 4 factorial design with four randomized complete blocks was used, one factor being the two varieties and the other being the timing of detopping, namely no detopping and detopping at 2-, 3-, and 4-week intervals. Slips (cuttings) were planted on 19 April 1978 at the same plot size and plant population as in 1977. The plants were irrigated for 4 h, 13 days after being planted for good establishment. First detopping was at 55 days, and plants were harvested for tubers at 154 days. The same measurements as in 1977 were taken in 1978.

The field plots were hand weeded regularly and an insecticidal spray of 5-ml Rogor 50 and 50-ml Gammalin in 10 litres of water was applied twice to control weevils and other leaf-eating insects. No fertilizers were applied.

RESULTS

CASSAVA

Total fresh-leaf yield of variety Isunikakiyan was not significantly affected by harvesting of the top leaves at 1-, 2-, or 3-month intervals. However, TMS 30211 produced a total of 13.6 and 11.9 t/ha of fresh leaves when harvested at 1- and 2-month intervals, respectively — amounts that were significantly higher than the 7.6 t/ha resulting from leaf harvests at 3-month intervals (Table 1).

Total and marketable fresh root yields of Isunikakiyan showed increases as the intervals between leaf harvests lengthened. Compared with control plants, leaf-harvested plants had decreases of 76, 62, and 15% in total fresh root yield when leaves were harvested at 1-, 2-, and 3-month

intervals, respectively. At each interval, fresh marketable root yields were reduced by about 10% more than was total root yield. Increasing intervals between leaf harvests had a significant effect on the percentage of marketable roots, falling from 78 to 69, 58, and 40 with 0, 3, 4, and 8 harvests. Significantly higher total and marketable root yields were also obtained from TMS 30211 with no leaf harvest than with harvests at 1, 2, or 3 months (Table 1). Compared with control plants, the leaf-harvested plants had decreases of 56, 34, and 32% in total fresh root yields when leaves were harvested at 1-, 2-, and 3-month intervals, respectively. Fresh marketable root yields were reduced by 71, 40, and 42%, respectively, at the same intervals of leaf harvests. Whereas 83% of total fresh root yield was marketable in control plants, 71, 75, and 54%, respectively, was marketable from plants whose leaves were harvested at 3-, 2- and 1-month intervals.

Number of roots per plant and weight per individual root were regarded as components of root yield. Intervals of leaf harvests did not significantly affect the total number of roots produced by either variety. The total number of marketable roots produced by Isunikakiyan was also unaffected by intervals of leaf harvests, but the plants of TMS 30211 with intact leaves produced significantly more marketable roots than plants with leaves harvested at 1- or 3-month intervals. As the intervals of leaf harvests shortened, there was a reduction in the weights of individual roots of both varieties (Table 1).

At final harvest, total dry matter produced by plants of variety TMS 30211 decreased as the time between leaf harvests decreased, and plants with intact leaves produced significantly more dry matter than did those with harvested leaves. The plants of variety Isunikakiyan with leaves harvested monthly produced significantly lower total dry matter than did control plants and plants with leaves harvested at 3-month intervals (Table 1).

The distribution of dry matter in the roots and other plant parts was calculated. The distribution of dry matter to the roots (harvest index) of variety Isunikakiyan decreased as the intervals between leaf harvests decreased. Plants of variety Isunikakiyan with unharvested leaves deposited 29% of total dry matter in the roots, whereas those with leaves harvested at 3-, 2-, and 1-month intervals, respectively, accumulated 24, 16, and 13% of total dry matter in the roots. There was a corresponding increase in dry-matter distribution to the stems and originally planted stakes as the intervals between leaf harvests decreased. Plants of variety Isunikakiyan with unharvested leaves deposited 53% of total dry matter in the stems and 9% in the stakes. Those with leaves harvested at 3-month intervals accumulated 57% in the stems and 9% in the planted stakes; plants with leaves harvested at 2-month intervals had 61% in the stems and 10% in the stakes, whereas those with leaves harvested monthly deposited 66% in the stems and 12% in the stakes.

The percentages of total dry matter deposited in the laminae and petioles were more or less unchanged in plants of both varieties subjected to the various intervals between leaf harvests. At each interval, TMS 30211 plants deposited a greater percentage of total dry matter in the roots and a lower percentage in the stems and original stakes than did Isunikakiyan. The pattern of dry-matter distribution of TMS 30211 subjected to the various leaf harvests was similar to that of Isunikakiyan but was less marked.

SWEET POTATO

When shoots of both TIS 2328 and TIS 2154 were detopped 10 cm from the ground, total yields of fresh shoots were significantly higher than when shoot tips were cut. When shoot tips of TIS 2328 and TIS 2154 were harvested, the shoot yields were 42 and 34% lower than those for detopped plants.

Harvesting the crop for shoots, however, led to a reduction in tuber yield, the extent of which differed between the two varieties (Table 2). Compared with control TIS 2328, there was a decrease of 48% in total fresh tuber yield when shoot tips were cut, and harvesting the shoots at the base resulted in a decrease of 62%. In variety TIS 2154, total fresh tuber yield was decreased by 31% when shoot tips were cut and 50% when shoots were harvested at the base.

Detopping plants of variety TIS 2328 affected the percentage of marketable tubers. When the plant was left intact, 69% of the total tuber yield was marketable, whereas when shoot tips or entire shoots were harvested, the marketable percentages were 55 and 48, respectively. The percentages of marketable tubers from TIS 2154 were 98 for intact plants, 95 for plants with detopped shoot tips, and 94% in plants cut at the shoot base.

The yields of fresh shoots of varieties TIS 2154 and TIS 3030 were not significantly affected when shoot tips were cut at 2-, 3-, and 4-week intervals (Table 3).

Frequency of detopping had a marked effect on total tuber yield. Intact TIS 2154 plants outyielded those detopped at 4-week intervals, whereas those cut at 4-week intervals outyielded plants detopped at 2-week intervals. There was no significant difference in tuber yields of TIS 2154 plants detopped

Table 1. Effects of frequency of leaf harvests on yields of cassava.

Variety	Leaf harvests	Total plant dry weight (g/plant)	Total tuberous root dry weight (g/plant)	Harvest index (%)	Fresh leaf yield (t/ha)	Total roots			Marketable roots		
						Roots/ plant	Fresh yield (t/ha)	Fresh weight/ root (g)	Roots/ plant	Fresh yield (t/ha)	Fresh weight/ root (g)
Isunikakiyan	0	1352	390	28.9	0.0	4.4	14.4	328	1.9	11.2	590
Isunikakiyan	3	1377	330	24.0	4.5	5.1	12.2	240	1.9	8.4	440
Isunikakiyan	4	917	149	16.3	4.1	3.4	5.5	162	0.8	3.2	396
Isunikakiyan	8	715	93	13.0	7.7	3.6	3.5	96	0.6	1.4	239
TMS 30211	0	2298	892	38.8	0.0	9.2	37.3	406	4.7	30.9	657
TMS 30211	3	1590	603	38.0	7.6	8.4	25.2	300	3.3	17.8	392
TMS 30211	4	1526	585	38.3	11.9	9.2	24.6	270	3.8	18.5	488
TMS 30211	8	1179	397	33.7	13.6	9.6	16.6	173	2.3	9.0	540

Table 2. Effect of pattern of detopping on the yields of sweet potato.

Variety	Pattern of detopping	Fresh shoot yield (t/ha)	Total tubers			Marketable tubers		
			Tubers/ plant	Fresh yield (t/ha)	Fresh weight/ root (g)	Tubers/ plant	Fresh yield (t/ha)	Fresh weight/ root (g)
TIS 2328	Whole shoot	44.2	2.8	4.0	49	0.5	1.9	114
TIS 2328	Shoot tips	25.7	3.4	5.5	48	0.5	3.0	181
TIS 2328	None	0.0	4.4	10.6	73	1.2	7.3	184
TIS 2154	Whole shoot	35.6	2.1	12.5	182	1.4	11.8	253
TIS 2154	Shoot tips	23.6	2.2	17.1	235	1.4	16.2	348
TIS 2154	None	0.0	2.2	24.8	339	1.7	24.4	428

at 2- and 3-week intervals. Compared with intact plants, there was a tuber yield decrease of 72, 66, and 51%, when TIS 2154 was detopped at 2-, 3-, and 4-week intervals, respectively.

Intact plants of variety TIS 3030 outyielded those detopped at 4-week intervals, and plants detopped at 4-week intervals outyielded those detopped at 2- or 3-week intervals. There was a fresh tuber yield decrease of 73, 69, and 45% when shoot tips were cut at 2-, 3-, and 4-week intervals, respectively, when compared with the control plants.

At each frequency of detopping, marketable tuber yield of both varieties was reduced slightly more than was the case with total tuber yield. There was a decrease of 76, 68, and 53%, respectively, in marketable tuber yield of TIS 2154 at 2-, 3-, and 4-week detopping intervals when compared with intact plants. The corresponding percentages for TIS 3030 were 76, 72, and 42.

The percentage of marketable tubers decreased with more frequent detopping. Intact plants of variety TIS 2154 had 98% marketable tubers; plants detopped at 4-week intervals had 95%, and those detopped at 3-, and 2-week intervals had 90 and 84%, respectively. In the case of TIS 3030, 96, 93, 87, and 84% marketable tubers were produced from intact plants and from those detopped at 4-, 3- and 2-week intervals, respectively.

Pattern of detopping affected both the total and the marketable yields of tubers produced by variety TIS 2328 but not by TIS 2154 (Table 3). Intact TIS 2328 plants produced significantly more tubers than did plants subjected to the other two patterns of detopping. For each pattern of detopping, variety TIS 2328 produced more tubers per plant than did TIS 2154, but TIS 2154 produced more marketable roots.

Weight per individual root for both total and marketable tubers of variety TIS 2328 was not significantly affected by pattern of detopping, but intact TIS 2154 plants had heavier individual tubers than did plants subjected to detopping (Table 2).

As the frequency of detopping increased, the weight of individual tubers from TIS 2154 was significantly reduced, but there was no change in the number of tubers per plant. In variety TIS 3030, both individual root weights and numbers of tubers per plant decreased as frequency of detopping increased (Table 3).

DISCUSSION

Detopping sweet potato plants at the base of each shoot twice during crop growth resulted in higher shoot yield than did harvesting shoot tips but lower total and marketable tuber yields and size per individual root. If sweet potato is to be grown for both shoots and roots as human food, then it would be better to harvest only shoot tips because the effects on root yields appear to be minimized, and, furthermore, the shoot tips are tender and palatable vegetables.

As the intervals between cassava leaf harvests and sweet potato detoppings decreased, there was a significant decrease in the total and marketable root yields, suggesting that the number of leaf harvests and detoppings should be limited if the crops are to be grown for both leaves and roots.

Total fresh-leaf yield of cassava variety Isunikakiyan was not significantly affected by harvest intervals, and there was no significant difference in root yields between plants with unharvested leaves and those with leaves harvested only every 3 months. Variety TMS 30211 gave almost the same root yields when leaves were harvested every 3 or 2 months but significantly more fresh leaves when harvested at 2- than at 1-month intervals. It is,

Table 3. Effect of frequency of detopping on the yields of sweet potato.

Variety	Frequency of detopping	Fresh shoot yield (t/ha)	Total tubers			Marketable tubers		
			Tubers/ plant	Fresh yield (t/ha)	Fresh wt/ root (g)	Tubers/ plant	Fresh yield (t/ha)	Fresh wt/ root (g)
TIS 2154	None	0.0	2.7	36.9	410	2.2	36.1	493
TIS 2154	Every 4 weeks	20.8	2.3	18.0	235	1.7	17.1	303
TIS 2154	Every 3 weeks	22.2	2.2	12.7	173	1.5	11.4	228
TIS 2154	Every 2 weeks	20.5	2.6	10.4	119	1.4	8.7	185
TIS 3030	None	0.0	4.9	46.5	286	3.5	44.4	381
TIS 3030	Every 4 weeks	21.3	4.6	25.7	168	3.3	23.8	218
TIS 3030	Every 3 weeks	24.0	4.0	14.3	108	2.4	12.5	158
TIS 3030	Every 2 weeks	21.9	3.5	12.7	107	2.0	10.6	158

therefore, recommended that cassava leaves should be harvested at 2- or 3-month intervals to ensure reasonable yields of both leaves and roots.

Harvesting sweet potato shoot tips at 4-week intervals produced as much fresh shoots as detopping at 2- or 3-week intervals, but tuber yield was less affected. Harvesting shoot tips at 4-week intervals is, thus, recommended for reasonable yields of both shoots and tubers.

The two cassava varieties reacted differently to leaf harvests in terms of root yields, which were reduced more in Isunikakiyan than in TMS 30211 perhaps because the latter produces many more leaves. Pattern of detopping sweet potato affected the total number of roots produced by variety TIS 2328 and TIS 3030, but the number of roots produced by TIS 2154 was not significantly affected by frequency of detopping.

Efforts to select cassava and sweet potato for both foliage and root production should focus on high-yielding varieties whose roots and tubers are likely to be less affected by leaf harvests or detoppings.

Intervals of leaf harvests significantly affected the size of individual cassava roots but not the total number produced, i.e., the size of roots contributed more to yield than their numbers, as Williams (1974) has also reported. Because the first leaf harvest was not taken until 4 months after planting, it seems that root numbers were determined early in growth. Hunt et al. (1977) noted that the number of cassava storage roots was generally determined early in growth, and Wholey and Cock (1974) noted that the number of thickened roots per plant remained fairly constant after 3 months of growth in all but 2 of 13 cassava varieties.

Dry-matter distribution to the roots (harvest index) of cassava variety Isunikakiyan decreased with more frequent leaf harvests, and there was a corresponding increase in dry-matter in the stems and original stakes. More frequent leaf harvests led to keener competition between the roots and shoots for assimilates, and, as Waring (1970) observed, shoot systems appear to have the advantage when there is such competition.

The decrease in cassava and sweet potato root and tuber yields with more frequent leaf harvests and detoppings may be ascribed to the reduced effective photosynthetic area. Hunt et al. (1977) noted that the deposition of starch and, perhaps, the proliferation of parenchyma cells of roots are reduced if the supply of carbohydrates is curtailed, as it is when much leaf and stem material is removed.

In countries where cassava and sweet potato foliage is used as food and feed, there is a distinct possibility that the foliage and roots could be treated as two distinct crops, the roots rich in carbohydrate and the foliage rich in protein, vitamins, and minerals. These results show that reasonable tuberous root yields can be achieved if optimum leaf harvest or detopping interval is determined and adopted.