Multiple Cropping in the Hillsides of Jamaica[1]

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ABSTRACT

Results of a project aimed at increasing production of hillside lands through application of multiple cropping systems and intensive cultivation of lands are presented. Data obtained over a 5-year cropping period indicate that useful biomass production could be tripled through adequate cropping systems. Yam yields were not adversely affected by intercropping with legumes, corn, tubers and root crops. Yam as a monocrop produced 40 to 48 t/ha in the first cropping year; then yields declined gradually to approximately 20 t/ha by the 5th. year. When intercropped, maximum yam yields were 55 t/ha in the first year and followed the same declining trend as the yam monocrop in succeeding cropping seasons. Irish potato, as an intercrop, produced 9 to 15 t/ha of good quality tubers in 4 out of 5 years. Red beans, cowpeas, ginger, peanuts and radish were good intercrops in some years. Onions, corn, pumpkin, cabbage, carrot, cassava, and sweetpotatoes performed poorly as intercrops.

INTRODUCTION

Jamaica is located in lat. 18° N and long. 77° W. The island is 4,411 square miles (11,400 km^2), 80% of which is hilly to mountainous. Over 50% of the island is characterized by slopes of 20° and greater and, as a consequence, only 30% of the total area is suitable for mechanized agriculture. The flat lands are dedicated mainly to the cultivation of export crops such as sugarcane and banana, whereas the hilly lands supply most of the domestic foodstuffs and substantial quantities of animal protein.

The Allsides Project, in southern Trelawny, encompasses 251 ha and consists of 233 farm families totalling 1,398 individuals (3). A detailed topographic survey of the project indicates that over 55% of the area is characterized by slopes 15° and greater (4).

Yam (*Dioscorea* spp.), is an important staple in Jamaica (1, 2, 3). It is grown by almost every hillside farmer in the project area who generally cultivates the crop on individual mounds with little or no regard to soil erosion control measures. The overall objective of the project herein reported was to develop appropriate technologies for intensive hillside farming terraced land using cropping systems conducive to changing the

[1] Manuscript submitted to Editorial Board June 15, 1984.

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traditional pattern of hilly land farming (4). Specifically, it was expected to develop systems for bench terraces which could result in increased levels of production (6). Thus, increased farm income, enhanced nutritional profiles of farm families, and increased opportunities for rural employment could be expected.

MATERIALS AND METHODS

Following construction of terraces in early 1977 and prior to crop establishment, limestone in the form of marl and poultry manure each at the rate of 3 t/ha were applied. The experimental site was located in the Allsides area of the Parish of Trelawny, at an altitude of approximately 800 meters above sea level.

The soil is an Ultisol locally classified as Wirefence clay loam. It is very acid (pH 4.9) and contains high levels of exchangeable Al. It is relatively infertile as evidenced by medium to low levels of N, P and K. Annual precipitation over a 4-year period (1977–1981) averaged 1878 mm and was characterized by a bimodal distribution pattern with wettest periods occurring in May and October. Maximum temperatures range from 24° C to 29° C, while minimum temperatures range from 15° C to 23° C. Hottest months are July, August and September and coolest months are November, December and January.

A total of 20 systems of production were tested during the crop years 1977–78 and 1978–79. They are described in tables 1, 2, 3, 4 and 5. Beginning in October 1978 and again in March 1979, 1980 and 1981, respectively, work continued on the further refinement of eight of the more promising cropping systems.

In the 1978–79 crop year, corn was again tested and new crops such as the dwarf determinate variety of pigeonpea (UWI-17), bodie bean (*Vigna* spp.), peanut and lettuce were included in the tests.

To ascertain yield response of yams and other crop combinations when established during the September–October rainy season, four production systems were tested on semi-commercial sized plots. The cropping systems consisted of: 1) yam as a sole crop; 2) yam grown together with peanut followed in sequence by Irish potato and radish; 3) yam grown together with peanuts followed by Irish potato; 4) yam grown together with African red beans and followed by peanut.

Following a detailed review of the results obtained from April 1977 to February 1979, eight crop systems were established during the period March 1979 to February 1980 on whole terraces, thereby simulating farmers' terraced plots in size. These terraces varied in size from 0.02 to 0.07 ha.

Irrespective of the cropping pattern, rates of fertilizer application for the first two crop years remained constant as follows: N, 200 kg/ha as

urea or ammonium sulphate; P_2O_5, 300 kg/ha as triple superphosphate; and K_2O, 150 kg/ha as muriate of potash.

In 1980, the fertilizer dosage was adjusted upwards to conform to a commercially availale blend (12:24:12) which the farmers use. The fertilizer was applied as follows: for the yam monocrop, 730 kg/ha was banded circularly 6 weeks after the "heads" were planted. This was followed by a similar application 8 weeks later (14 weeks after planting). The N sidedressing (133 kg/ha urea or 60 kg/ha N) was applied 28 weeks from planting. For the yam intercrop, 300 kg/ha was applied 6 and 14 weeks from planting, followed by the application of 130 kg/ha (12:24:12) and 44 kg/ha urea (20 kg/ha N) at 28 weeks from planting. For the intercrops such as red beans, cowpeas, peanuts and Irish potatoes, 365 kg/ha of 12:24:12 was placed in furrows 5–8 cm below the seed. This was followed at flowering by the application of 44 kg/ha urea (20 kg/ha N). For the ginger intercrop, 12:24:12 at the rate of 365 kg/ha was banded at 6 and 18 weeks from planting. This was followed at 24 weeks from planting with an application of 133 kg/ha urea (60 kg/ha Nn) banded 5 to 8 cm away from the ginger rows at a depth of 5 to 8 cm.

Irrespective of whether yellow yam (*Dioscorea cayenensis*) was grown as a monocrop or in association with other crops, plant density was kept constant at 10,000 plants/ha. Yam "heads" were planted on the ridges of continuous mounds spaced 1.4 m apart. One yam "head" was planted at every 0.66 to 0.67 m interval along the mound. This requires approximately 8 t/ha of planting material. Wooden stakes 3 to 4 m in length were placed between adjacent mounds with each stake equidistant from four yam plants.

Irish potato (*Solanum tuberosum*) cvs. Red Pontiac, Spunta, Draga and Sebago, when intercropped with yam at the beginning of the crop cycle, was planted in rows 0.75 m apart and 0.25 to 0.30 m within the row for a population of 53,000 plants/ha.

Peanut (*Arachis hypogaea*) of the Valencia type, when grown as an intercrop with yam at the beginning of the crop cycle was planted in rows 0.4 m apart with an intrarow spacing of 0.1 m. This results in a crop density of 250,000 plants/ha. Intercropped during the latter half of the crop cycle, seeds are planted in rows peripheral to the yam at a population of 125,000 plants/ha. The quantity of unshelled material required was 78 and 40 kg/ha, respectively.

The spatial arrangement employed for red beans (*Phaseolus* spp.) and cowpeas (*Vigna* spp.) at the beginning of the crop cycle followed rows 0.4 m apart with seeds planted 0.15 m within the row for a population of approximately 166,000 plants/ha. Cropped with yam during the latter half of the crop year, seeds were planted in 0.4 m row peripheral to two consecutive yam mounds. Crop density was thus reduced to 83,000 plants/

ha. Red bean cultivars used were Miss Kelly and Tom Red, whereas the cowpea used was the African Red type. At the beginning of the crop cycle, seed requirements of red beans and cowpeas were 84 kg and 15 kg/ha, respectively. Planted during the latter half of the crop cycle seed requirement was reduced by one-half.

Radish, when grown following the harvest of Irish potato, was seeded directly in rows 0.40 m apart and 0.15 m within the row. This required 0.3 kg/ha of seed material.

Ginger (yellow), when grown with yam for most of the crop year was planted in rows 0.4 m apart and 0.35 to 0.30 m within the row; this required approximately 4.4 t/ha of seed material. Red beans of the Tom Red variety grown together with yam and ginger during the first quarter of the crop cycle were seeded in rows spaced 0.40 m apart alternated by ginger rows. Seeds were placed at 0.20 m within the row. The quantity of seed required was 44.0 kg/ha.

Corn (*Zea mays*) of the Pioneer X-306 Hybrid, grown together with yam during the first quarter of the crop year, was seeded in rows spaced 0.70 m apart and 0.25 m within the row. This gave a population of approximately 50,000 plants/ha and required 18 kg/ha of seed material.

Cabbage (*Brassica oleraceae*) of the KK Hybrid, grown with yam during the latter half of the crop cycle, was sown at the rate of 33,000 plants/ha. The quantity of seed required was 0.1 kg/ha. Field observations included crop adaptability; total and marketable crop yields, under both monocropping and intercropping situations; and crop performance as affected by various planting dates.

RESULTS AND DISCUSSION

Table 1 gives data on yields of each crop component tested during the 1977–1978 crop year. Yam yields were excellent when compared with those obtained by farmers in the project area (10–15 t/ha of marketable roots). Yields ranged from a low of 26.57 t/ha in the cropping system where sweetpotato and red beans were grown in association with yam to a high of 40 t/ha in the system where sweetpotato was established in the latter half of the crop cycle after the failure to obtain an acceptable crop stand of ginger.

Except for cropping system number 8 (yams grown in association with sweetpotato followed by red beans) there was an appreciable increase in total yam output by every other treatment compared with the check treatment (yam monocrop, system No. 1). Further, Irish potato cv. Red Pontiac planted together with yam and harvested 85 days later, produced a yield of more than 9 t/ha of good quality tubers.

It was significant that other component crops such as onion, corn, pumpkin, cabbage, carrot, cassava, and sweet potato performed poorly.

TABLE 1.—*Marketable yields of monocrop yam (***Dioscorea cayenensis***) and yam and other crops grown in a polyculture system at Allsides, Trelawny, 1977–78 crop year*

Cropping systems	Crops	Marketable yield	"Head" yield	Change in total yam yield over monocrop
			t/ha	%
1	Yam monocrop	31.502	16.917	0
2	Yam	36.794	16.692	10.46
	Red beans	0.552		
	Onion	0.053		
3	Yam	38.752	17.274	15.71
	Sweet corn	7500[1]		
	Red beans	0.124		
4	Yam	35.441	16.713	7.71
	Grain corn	0.761		
	Irish potatoes	0.489		
5	Yam	34.480	17.289	6.92
	Irish potatoes	9.286		
	Radish	1.587		
	African red beans	0.296		
6	Yam	38.734	17.840	16.84
	Pumpkin	0.000		
	Sweet corn	3133[1]		
7	Yam	33.006	17.010	3.30
	Cabbage	0.695		
	Carrot	0.108		
	Red beans	0.093		
8	Yam	26.565	13.668	−16.91
	Sweetpotatoes	2.129		
	Red beans	0.105		
9	Yam	36.794	15.861	8.75
	Cassava	0.000		
	Red beans	0.539		
10	Yam	39.899	17.032	17.58
	Ginger	0.000		
	Sweetpotatoes	1.616		

[1]Ears of corn.

Table 2 shows yield data for each cropping system for 1978–79 crops. Except for System 6, in which yams were grown with peanut and sweetpotato, an increase in marketable yam yield over the yam monoculture was recorded for each of the other systems tested.

Further systems in which yam was intercropped with Irish potato, ginger and peanut produced marketable yields of 7.15, 3.06 and 2.13 t/ha, respectively, of these intercrops during the first half of the cropping cycle.

Again, as observed in the 1977–78 crop, corn, onion, sweetpotato and carrot performed poorly as intercrops. Pigeonpeas yielded poorly; lettuce

TABLE 2.—*Marketable yields of monocrop yam (***Dioscorea cayenensis***) and yam and other crops grown in a polycultyure system at Allsides, Trelawny during the 1978–79 crop year*

Cropping systems	Crops	Marketable yield	"Head" yield	Change in total yam yield over monocrop
			t/ha	%
1	Yam monocrop	10.90	10.40	0
2	Yam	14.08	10.74	16.5
	Corn	0.304		
	Pigeonpea	0.125		
3	Yam	15.82	11.16	26.7
	Red beans (Ms. Kelly cv.)	0.455		
	Ginger	3.058		
4	Yam	12.60	9.78	5.1
	Bodie bean (Vigna sp.)	2.470[1]		
	Onion	0.131		
5	Yam	13.37	8.83	4.2
	Irish potato	6.15		
	Radish	0.312		
	Cowpea (African red cv.)	0.298		
6	Yam	10.32	9.18	−8.5
	Peanut	2.13		
	Sweetpotato	0.00		
7	Yam	13.97	11.18	18.1
	Irish potato	8.15		
	Peanut	0.274		
8	Yam	14.93	10.85	21.0
	Cowpea (African red cv.)	0.373		
	Irish potato	0.718		
	Lettuce	0.00		
9	Yam	14.16	12.08	23.19
	Red beans (Tom red cv.)	0.316		
	Peanut	0.163		
10	Yam	15.80	11.54	28.36
	Carrot	0.099		
	Bodie bean	0.127[1]		

[1] Fresh pod yield.

seeds failed to germinate. Overall, the legume mixes resulted in a fair level of performance.

Table 3 shows the yield of yams and each component crop area. Total yam yield was highest (27 t/ha) when this crop was grown as a monoculture, and production declined by an average of 23% as other crops were intercropped with yam.

Notwithstanding periods of sustained drought conditions which could have led to the overall lowering of yam yields, peanut performed well on the terraces planted together with yam in the first half of the cropping

year. Yields of whole sound kernels, expressed at a moisture content of 10%, averaged 1.46 t/ha and 0.78 t/ha during the first and latter halves respectively of the yam crop cycle.

Yields of the intercrops were very good for the most part. For instance, the Irish potato intercrop produced 13.25 t/ha of marketable tubers, whereas the peanut and cowpea intercrops produced 2.51 and 1.50 6/ha, respectively of excellent quality grains. The radish crop performed well, and when viewed in the context of its short maturity period (4–5 weeks), appears promising.

Table 4 shows yields of marketable yam as a monocrop in 1979–80. It should be noted that these yields were greatly affected by the high incidence of "burning".[3] Earlier reaping and better monitoring that year

TABLE 3.—*Marketable yields of monocrop yam (***Dioscorea cayenensis***) and yam and other crops in a polyculture system at Site 11, Allsides, during the Oct. 1978–Nov. 1979 cropping period*

Cropping systems	Crops	Marketable yield	"Head" yield	Change in total yam yield over monocrop
		t/ha		%
1	Yam monocrop	14.79	12.11	0
2	Yam	9.79	9.42	−28.6
	Peanut	1.46		
	Irish potato	2.47		
	Radish	1.59		
3	Yam	10.56	8.02	−30.9
	Peanut	1.43		
	Irish potato	2.13		
4	Yam	15.16	9.12	−9.7
	Red bean (African red cv.)	0.337		
	Peanut	0.78		

reduced that problem somewhat, but there were instances where the presence of the "pine heart"[4] condition also severely affected marketable yield. Yam quality was good and physically the yams were "solid". The three intercrops provided excellent canopy cover which reduced the necessity for weeding the yams after the May rains.

The red bean yield was not encouraging (0.49 t/ha). This has been the pattern, on the demonstration site, whenever red beans are planted in the spring. Crop stand and vigor on the continuous mounds were significantly lower than when the same seeds were sown at the same time

[3] Dry rot of yam tubers caused by the nematode *Pratylenchus coffeae.*

[4] A condition characterized by a grainy texture which renders the tuber rubbery upon cooking and thus unmarketable.

within the project area but not on mounds. The reasons for this variation are not apparent.

Performance of the ginger crop were disappointingly poor compared to the excellent yields obtained the previous year. Climatic conditions were favorable, for the most part, and the planting material was of good quality. The plant stand following termination was unacceptable and this

TABLE 4.—*Marketable yields of monocrop yam (***Dioscorea cayenensis***) and yam and other crops grown in a polyculture system at Allsides, Trelawny during the period March 1979–Feb. 1980*

Cropping systems	Crop	Marketable yield	New Yam "Head" yield	Change in total yam yield over monocrop
		t/ha		%
1	Yam monocrop	13.03	9.85	0
2	Yam	9.80	9.88	−14.0
	Irish potato	13.25		
	Radish	1.27		
	Peanut	0.77		
3	Yam	7.53	8.71	−29.0
	Peanut	2.51		
	Red pea (Miss Kelly cv.)	0.40		
4	Yam	8.22	9.06	−24.5
	Cowpea (African red cv.)	1.50		
	Peanut	0.45		
5	Yam	9.50	8.02	−23.4
	Red beans (Tom red cv.)	0.34		
	Ginger	13.87		
6	Yam	7.33	5.12	−45.6
	Sweetpotato	1.31		
7	Yam	13.08	9.92	0.52
	Grain corn	0.28		
	Cabbage	0.00		
8	Yam	7.95	8.25	29.2
	Red beans (IICA/Duva cv.)	0.73		
	Cowpea (African red)	0.43		

clearly affected the yield. It is apparent that rhizomes undergo a period of dormancy which could exceed six months at times. The yield was merely a recovery of the planting material.

Yield data for the 1980–81 period (table 5) indicate that when yam was intercropped, yields were generally better than those obtained in the previous crop year (1979–1980). For example, the cropping system yam + Irish potato + radish + peanut yielded 11 t/ha vs. 9.8 t/ha for yam in the same system the previous year. This improvement would probably

have been more marked had it not been for the high incidence of "pine heart" and to a lesser extent "hollowing"[5] which rendered a high portion of the yield unmarketable. In the case of yam + peanut + red pea; yam + cowpea + peanut and yam + red pea + ginger, the yam yields increased from 7.5 to 10 t/ha; 8.2 to 12.9 t/ha and 9.5 to 12.1 t/ha, respectively.

TABLE 5.—*Marketable yields of monocrop yam (**Dioscorea cayenensis**) and yam and other crops in a polyculture system at Allsides, Trelawny, during the 1980–81 crop year*

Cropping systems	Crops	Marketable yield	"Head" yield[1]	Change in total yam yield over monocrop
		t/ha		%
1	Yam monocrop	12.86	5.34	—
2	Yam	12.94	5.04	−1.2
	Cowpea	0.96		
	Peanut	0.29		
3	Yam	11.00	7.26	0.33
	Irish potato	12.00		
	Radish	0.13		
	Peanut	0.29		
4	Yam	12.09	8.32	12.14
	Ginger	1.27		
5	Yam	10.00	3.62	25.16
	Peanut	1.40		
	Red beans	0.03		
6	Yam	13.24	8.90	6.68
	Red beans	0.49		
	Radish	0.68		
	Cowpea	0.03		

[1] "Head" weights were recorded at time of planting, 4 to 6 weeks following harvest. Consequently yields were lower due to moisture loss and dry weight loss from tissue respiration.

RESUMEN

Se informan los resultados de un proyecto para desarrollar sistems de producción en las laderas de las montañas de Jamaica. El objetivo era aumentar la producción mediante sistemas de cosechas múltiples intercaladas cultivadas intensivamente que, a la vez, fueran eficaces en la conservación del suelo. Los datos obtenidos durante un período de cinco años indican que la producción de biomasa utilizable puede triplicarse mediante el uso de sistemas apropiados de cultivo. En el período experimental, los rendimientos de ñame no se afectaron adversamente cuando se intercalaron las siembras de ñame con leguminosas, maíz y cosechas farináceas. El ñame, como monocultivo, produjo de 40 a 48 Tm/ha durante

[5] A condition characterized by the presence of a cavity within the tuber, such cavity resulted from a sudden burst of growth after a sustained period of drought.

el primer año; luego los rendimientos se redujeron gradualmente hasta aproximadamente 20 Tm/ha en el quinto año. Cuando se intercalaron otras cosechas, se obtuvieron rendimientos máximos de ñame de hasta 55 Tm/ha en el primer año y éstos siguieron la misma tendencia que los de ñame en monocultivo en años subsiguientes. Los rendimientos de papa, como cosecha intercalada, fluctuaron entre 9 y 15 Tm/ha de tubérculos de buena calidad en cuatro de los cinco años del estudio. Las habichuelas, los frijoles, el maní, el jenjibre y los rábanos se comportaron bien en algunos años. Otras cosechas como cebolla, maíz, calabaza, zanahoria, yuca y batata no fueron compatibles como cosechas intercaladas con el ñame.

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