AGRICULTURAL PRODUCTION ON HILLSIDES

THE ALLSIDES PROJECT CASE STUDY

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ABSTRACT

This paper pertains to the results and implications of the Allsides/Olive River Pilot Hillside Agricultural Project, a joint effort by the Ministry of Agriculture of Jamaica and the Inter-American Institute for Co-operation on Agriculture. The project is aimed at increasing production and productivity of hillside lands through application of structured Multiple-Cropping systems and/or intensive cultivation of appropriately conserved lands.

Results obtained over a four-year period indicate that:

(i) useful biomass production could be tripled;

(ii) farm income and on-farm employment could be doubled; and

(iii) nutritional profiles could be markedly enhanced if the small hillside producer adopts a system of Multiple-Cropping cum improved crop and soil management practices.

Indications are that by comparison soil conservation measures other than bench-terracing can lead to a considerable reduction in soil loss while at the same time reducing considerably the expenditure and infrastructural preparation. These have important implications for policy decisions especially where the cost of bench-terracing is highly subsidized by Government.

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3/ Extension Officer at Allsides

INTRODUCTION

The preparation of this paper is based on empirical data obtained at Allsides and Olive River in the parish of Trelawny.

The paper was prepared by Dr. Abdul H. Wahab in association with Dr. Percy Aitken-Soux, Irving Johnson and Bo-Myeong Woo, Howard Murray and Joseph Dehaney, for presentation at this Seminar. In the absence of Dr. Wahab who is on leave, the Director General has requested that the paper be presented by Dr. Irving Johnson.

The importance of the paper relates largely to the fact that in Jamaica rural small hillside households account for slightly less than 50% of the population. On the hillsides some 80% of farmers farm steep erodable hillsides and produce over 90% of food produced for local consumption. These farmers occupy the least fertile lands available for production. This situation arises from an uneven distribution of agricultural land and also by the high density of the farm population; and a high level of rural unemployment.

The results which indicate that on hillsides such as are used in Jamaica, farm incomes can be more than doubled through the adoption of polyculture systems of intensive agriculture on appropriately soil-conserved lands.

The development inherent in the project outcome is of great significance in view of the fact that Agriculture is the largest employer in the country. It contributes to increasing production to meet domestic consumption, reduces reliance on imports, increases employment opportunities, and farm incomes which will materially assist in improving the quality of life of rural people.

This paper which is prepared for presentation at the Inter-American Congress of Food and Agricultural Production, in Sao Paulo, Brasil, September 8th - 11th, 1981, could have implications for trial and adoption in other countries of the Caribbean basin, in which similar conditions relating to man, land and economic development exist.

Dr. Percy Aitken-Soux
DIRECTOR

CUTLINE

1. BACKGROUND AND INTRODUCTION

1.1 Jamaica is the largest of the British Commonwealth island within the Caribbean. It is located 18° North of latitude and longitude 77°W. At the most distant points it is 146 miles long and 51 miles wide. The area 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° (36%) and greater and as a consequence only 30% of the total area lends itself to mechanized agriculture (Fig. 1). The flat lands are dedicated mainly to the cultivation of export crops such as sugar cane and banana, while the hilly lands supply most of the domestically consumed foodstuffs and substantial quantities of animal protein.

1.2 There is a close relationship between the topography, soil and climate of Jamaica. For the purposes of this presentation five zones may be identified.

(a) The Blue Mountains. These dominate the eastern part of the island and attain an elevation of 7,400 feet (2,220 m) plains. The metamorphic and sedimentary rocks of this high rainfall area give rise to very steep slopes being subjected to heavy erosion, particularly when not protected by permanent forest.

(b) The Central and Western Limestone Plateau. Approximately 60% of the island is derived from limestone formations which mostly occur in this plateau. It seldom exceeds 3,000 ft. (1,000m) in elevation and in part shows extreme 'karst' landforms such as are typified in the Cockpit Country. In broader valley bottoms porous Fauxitic soils may reach sufficient depth to be exploited as a mineral resource. Problems of soils, rehabilitation of mined -out land as well as soil and water conservation are important in the agricultural development of these areas.

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1.2 There is a close relationship between the topography, soil and climate of Jamaica. For the purposes of this presentation five zones may be identified.

(a) The Blue Mountains. These dominate the eastern part of the island and attain an elevation of 7,400 feet (2,256 m) plus. The metamorphic and sedimentary rocks of this high rainfall area give rise to very steep slopes [illegible] subjected to heavy erosion, particularly when not protected by permanent forest.

(b) The Central and Western Limestone Plateau. Approximately 70% of the island is derived from limestone formations which mostly occur in this plateau. It seldom exceeds 3,000 ft (1,000m) in elevation and in part shows extreme karst landforms such as are typified in the Cockpit Country. In broad valleys of this [illegible] bauxitic soils may reach sufficient depth to be exploited as a mineral resource. Problems of soils, rehabilitation on mined-out land as well as soil and water conservation are important in the agricultural development of this zone.

(c) The Central Inlier and Similar Areas. The limestone plateau has been breached in 9 areas to expose inliers or 'windows' of easily erodible sediments which are mainly of volcanic origin. Moreover, the intensively cultivated steep-sided valleys have little residual forest cover. The heavy rainfall which occurs has contributed to considerable soil erosion especially in areas in which farming has been undertaken under conditions of unsound land use.

(d) Interior Valleys. These are mainly poorly drained alluvial inland valleys, and include St. Thomas Ye Vale, Queen of Spains Valley, and the Upper Morass of the Black River, the latter now being reclaimed.

(e) The Coastal Plains, are best developed on the South Coast as most of the important rivers flow in this direction. There are many dry river beds in the limestone areas, and these during heavy rains are subject to flash floods. The Southern plains being on the leeward side of the prevailing winds often suffer from a prolonged dry season and so are dependent during those periods on irrigation water for certain crops.

1.3 Climatic. A wide range of micro-climates exists in the island. The prevailing winds are east-north easterly. The parish of Portland due to its location and topography, receives the highest rainfall, reaching a maximum of over 200" (5,000mm) annually. The central part of the Southern coastal plain, and the coastal area between Montego Bay and Discovery Bay on the north suffer from severe dry seasons lasting 4 - 5 months of the year. The Central Plateau above the 2,000 ft. (600m) contour receives 60 - 100 inches (1,500 - 2,500 mm) rain which falls over a period of 8 - 11 months. The remaining area with an annual rainfall of 20" - 60" (500 - 1,500 mm) has a marked dry period of 1 - 3 months. Average rainfall data over a period of 90 years provide a useful general guide. However, within recent years

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there have been considerable variations from these averages both on annual and on monthly bases. There are two recognizable rainy periods, one peaked on May and the other on October. Rainfall is very unevenly distributed and the ability to predict its incidence is very low. This sometimes results in crop loss through diseases, pests, drought, flood, etc.

Temperatures on the plains average 86° - 90°F (30° - 33°C) during the day with a corresponding low of 69° - 75°F (20° - 24°C) at night. Temperatures may be 10° - 20°F (1° - 6°C) cooler in the hills where the daily range is 15°F (9°C). It is evident that the varied rainfall and temperature patterns need consideration in the selection of crops and the management of soils.

1.4 Soils and Land Capability. Over 90 soils have been identified in soil surveys which were mapped in Jamaica on a parish basis, on a scale of 1:12,500 and reduced for publication to 1:50,000. The soils are conveniently classified according to their geological derivation, and each soil type is given a Map number. Each soil type is typified by texture, structure, and chemical analysis, and fertilizer recommendations are made on this basis. Recommended crops for an area are specified in the Technical Guide Sheets. These recommendations take into consideration the fact that easily erodible soils need appropriate conservation measures and that a favourable soil/crop relationship must be maintained to give a productive economic crop, regardless of slope or soil type.

1.4.1 All available data including information on climate and local agriculture has been used as the basis for placing lands into land capability classes (classes 1 - VI or A - F) based on slope (Table 1). The limitations of each class necessitate particular management. Land capability maps have been prepared from the soil survey maps by the Agricultural Chemistry Division of the Ministry of Agriculture. They have been reduced in scale to present a general Agricultural Land Capability map of the island. However when undertaking specific feasibility and development studies for certain types of project, more

detailed surveys and land capability maps may be required, depending on the degree of precision needed and the availability of the necessary financing.

1.4.2 Other (ecological and economic) factors determine the final choice of farming systems for any given location, e.g. micro-climatic, accessibility, irrigation, drainage, availability of water and marketing facilities, as well as inputs and techniques necessary to secure optimum returns.

1.5 Distribution of Land. The available land, according to Land Capability classes, on a Parish basis is set out in Table 1 & Fig. 1 and was compiled from the Soil Survey reports.

1.5.1 Table I indicates that land having slopes E and F, (classes I - IV) which are not usually recommended for cultivation, occupy more than half the available area in Jamaica. The best land (of A and B slopes) represents only a sixth of the total land and is mostly used for the production of export crops, e.g. sugar cane and bananas. The E and F slopes of the limestone areas cannot be cultivated and are best left in natural forest, but those occurring, for example, in the Central Inlier and Yallahs Valley are formed of easily erodible sedimentary rocks. Where these occur in high rainfall areas they should only be used for intensive agriculture after appropriate soil conservation practices have been provided and these should be associated with sound land use practices through the cropping systems pursued. Ideally this land would be retained in forest, but can and does serve as an important food growing area. Farming systems suitable to these ecological areas need to be studied so as to increase their productivity and become economically attractive to the farmers.

1.5.2 The distribution of land in Jamaica is presented in Table 2 in terms of number and size of farms. Agriculture (including forestry) occupies approximately 55% of the total land in Jamaica. Farms of less than 5 acres represent 78% of the number of farms and account for only 15% of the land in farms, while those over 500 acres (200 hectares) represent 0.15% of the number of farms and account for as much as 45%

of the land in farms. Data from the 1978/79 Agricultural Census is still being processed. Due to the most recent distribution policies since the previous census (1968/69) it is not possible to guestimate the levels of change in land distribution.

1.6 Population. As estimated in 1979 population was 2.1 million with approximately 66% living in rural areas. In 1979 population density based on arable land was 190 persons per km^2 and population was increasing at 1.5% per year. Mortality in 1976 was 20.4 per 1000 live births and life expectancy at birth was 70.6 years.

1.7 The Labour Force. The population (unadjusted) of Jamaica at the end of December 1979 stood at approximately 2.1 million. The rural population represents approximately 66% of the total population and also the greater part of the labour force, including many unskilled labourers. Classifying the labour force in sectors, 33.8% (233,000) of the total labour force was involved in agriculture. Statistics show little significant change in labour force figures between 1962 and 1975. It is stated in the National Physical Plan of Jamaica 1970 - 1990, that "it is foreseen that there will be a continuous decline in the portion of the labour force in agriculture with the consequent increase in demand for the jobs in services, manufacturing and other non-agricultural sectors". For many reasons these targets have not been reached.

1.7.1 The agricultural labour force represented approximately 40% of total employment in 1960. Some of the factors contributi to projected decreases in the percentage of the labour force in agriculture are:

(1) The seasonality of agricultural employment produced by the preponderance of a few crops on the larger farms;

(2) the stigma which traditionally is attached to agricultural labour;

(3) the higher price paid for unskilled agricultural labour in the bauxite industry, and better incomes which can be obtained in other sectors of the economy;

(4) low revenue productivity of labour in agriculture due to -

(a) scarcity of skills which in turn leads to bottle-necks in production;

(b) worsening terms of trade for agriculture particularly in respect to inputs imported from developed countries;

(c) inadequacy of training facilities for providing lower-level skills in agriculture;

(d) poor marketing and storage facilities and the waste that ensues; and

(e) inefficient and inadequate processing facilities.

.8 Socio-economic reality. Demographically, small farmers onstitute the most important group of producers of domestically onsumed foods. These small producers are:

(i) located on the hills;

(ii) cultivate lands that are highly erodible and inherently infertile;

(iii) practice low technology agriculture; and

(iv) depend entirely on rainfall for crop production.

.8.1 The heavy population density, the scarcity of land of good uality and the continuing high dependence of many persons on griculture render it imperative to devise ways and means for tilizing hillside lands more effectively for agricultural purposes.

1.8.2 The present socio-economic reality of Jamaica makes it imperative that inter alia, food imports be substituted by domestically produced foods, and that farm production and productivity be increased. In cognizance of this the Government of Jamaica has identified food production and rural employment as areas of high priority and as means for redressing problems such as:

i) inadequacy of supplies of domestically grown crops for home consumption;

ii) high concentration of small farmers on the hillsides (80% of all farmers occupying 15% of the total agricultural land);

iii) serious erosion of hillside lands;

iv) disparity in income distribution between the rural and urban populations (J$600 vs J$2,500 per capita per annum; [1] and

v) high unemployment (over 40% of the labour force) in the rural areas, and as a direct consequence a high rate of migration of rural youths into the cities.

1.9 Interventions by Government and IICA. One of the first actions of the Government of Jamaica towards promoting sound land use and increased food production on steep lands was to quantify the extent of soil erosion on these lands as a result of improper cultural practices. In this context a series of studies over the period 1969 - 1973 resulted in the following principal conclusions:

(a) there was an average soil loss of 136 t/ha/yr (54 t/ac/yr) from unprotected yam plots having a 17° slope, and as a consequence a reduction in soil fertility and productivity;

(b) when hillsides are bench-terraced soil loss is reduced to 18 t/ha/yr (7.3 t/ac/yr) and soils can be cropped on a sustained basis (2).

1.9.1 On the basis of these findings the Government of Jamaica embarked on an ambitious programme of soil conservation throughout the island. By 1976, however, the recognition of the fact that:

i) soil conservation measures ipso facto could not solve the problems of low food production on the hillsides;

ii) bench terracing requires very costly capital investment, (J$7,000 ha presently); and

iii) it was a sine qua non that appropriate and viable systems of production be developed and implemented to justify the high costs of bench terracing.

1.9.2 The Government of Jamaica sought and obtained the assistance of IICA in addressing these problems. Principally, IICA was expected to develop systems of agricultural production for newly terraced land which would lead to increased levels of production and productivity.

1.9.3 On hillside farms in general, farmers only use about one-third of the land under their control even on small farms. Thus there is an additional factor which contributes to the reduction of agricultural production. The reasons are that farming on these steep lands is rather irksome, returns are low and additionally it is difficult to obtain capital and labour for farming these lands. Again, by deliberately leaving land idle (fallowing) fertility level is restored. This latter reason, however, ignores the fact that judicious fertilizer usage can achieve such a goal.

2. THE ALLSIDES PROJECT

2.1 General. Information. The project encompasses 251 ha (622 ac.) 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). It is

[illegible]

located in the Allsides area of the parish of Trelawny, at an altitude of approximately 800 meters above sea level.

2.1.1 The predominant soil type of the area is an Utisol locally classified as Wirefence Clay Loam, Map No. 32. This soil is very highly acidic (pH 4.9) and contains high levels of exchangeable aluminium. It is relatively infertile as evidenced by medium, low and very low levels of N, P and K respectively (Table 3). Annual precipitation over a four year period (1977 - 1981) averaged 1878mm (74 inches) and is characterized by a bimodal distribution pattern with wettest months occurring in May and October (Fig. 2,3,4,5 & 6). Maximum temperatures range from 24C to 29°C while minimum temperatures range from 15C to 23C. Hottest months are July, August and September and coolest months are November, December and January. Yam (Dioscorea spp) a root crop and an important staple in Jamaica 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.

2.1.2 The overall objective of the project is to develop a body of knowledge for intensive hillside farming (on protected or soil-conserved land) using cropping systems conducive to changing the traditional pattern of hilly land farming (4). Specifically, it is expected that the project would develop production systems for bench terraces which could result in:

(a) increased levels of production and productivity;

(b) increased farm income;

(c) enhanced nutritional profiles of farm families; and

(d) increased opportunities for rural employment.

2.1.3 Additionally, the high costs of bench terracing implied that the cropping systems would need to include high valued crops and that early steps would have to be taken to find alternative and cheaper measures for controlling erosion.

2.2 Strategy for Achieving the Project Objectives

Following construction of bench terraces, the farmers' hillside plots are rendered almost flat and thus can be cultivated with more ease and greater intensity than before terracing. For instance, terraced land can be used to great advantages in cropping systems in which yam grown on continuous mounds is intercropped with other row crops such as potatoes, ginger, peanuts and red peas. Such a multiple cropping system has the added advantage of:

i) substantially reducing splash erosion because of the continuous crop cover resulting from the crops selected for the system; and

ii) mitigating the hazards of farming under completely rainfed agriculture (5).

2.2.1 More importantly however, a system of intercropping in the context of Jamaica hillsides ensures optimal exploitation of the dimensions of:

(a) space;
(b) available soil moisture;
(c) available soil nutrients and applied fertilizers;
(d) incoming solar radiation; and
(e) available farm labour.

2.2.2 Thus the strategy employed in achieving the project objectives was to:

i) test and identify farming systems which are suited to the edaphic and climatic conditions of Allsides, Trelawny, where farming is done entirely under rainfed conditions;

ii) determine the financial feasibility of those systems of production which have been identified as being agronomically and nutritionally sound for the area;

iii) ascertain the feasibility of maintaining a combination of small (goats) and large (cattle) livestock from the forage produced on the risers of the terraces;

iv) conduct rapid adaptive research aimed at solving problems related to soil and crop management e.g. fertility, liming, crop density and crop variety trials;

v) produce acceptable seed material for distribution to adoptors of the improved technology and

vi) provide training opportunities for national technicians in the areas of watershed management and research techniques with special emphasis on farming systems for hillsides.

2.2.3. Concomitantly, a vigorous programme of on-farm soil and water conservation works cum crop development is conducted on plots operated by the target group.

2.3 Experimental Approach and Methodology

2.3.1. Consistent with the strategy spelled out above, research and developmental work was conducted inter alia on a total of 20 systems of production during the crop years 1977/78 and 1978/79. Beginning in October 1978 and again in March 1979, 1980 and 1981 respectively, work continued on the further refinement and economic viability of eight of the more promising cropping systems.

2.3.2. Presented in Figures 7 through 11 are the cropping patterns which have undergone and continue to undergo evaluation. For each cropping system the dates of planting and harvest of the respective component crops are plotted on scale. For example, in Figure 9, the planting and harvest dates of System 2, are as follows:

Yams - March 3, 1979 and February 13, 1980;
Irish potato - April 20, 1979 and July 11, 1979;
Radish - July 17, 1979 and August 27, 1979 and
Peanut - September 20, 1979 and January 23, 1980

2.3.3. 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 (1.2 t/ac) were applied to ameliorate soil acidity and fertility respectively. Irrespective of the cropping pattern, rates of fertilizer application for the first two crop years remained constant as follows:

N - 200 kg/ha (178 lb/ac) as urea or ammonium sulphate;
P_2O_5 - 300 kg/ha (268 lb/ac) as triple super phosphate; and
K_2O - 150 kg/ha (134 lb/ac) as muriate of potash

2.3.4 These were the suggested rates arising from data on fertility assessment of the test soil conducted at the initiation of the project (6). Commencing in 1980, the fertilizer dosage was adjusted upwards to conform to a commercially available blend which the farmers are accustomed to using. Presently, 1,460 kg of 12:24:12 is administered per hectare per crop year, together with 60 kg/ha Nitrogen as Urea or ammunium sulphate. This results in the application of N, P_2O_5 and K_2O at the following rates.

	Kg/ha	lb/ac
N	235	210
P_2O_5	350	312
K_2O	175	156

2.3.4.1 The 12:24:12 mixture was applied as follows:

- for the yam monocrop 730 kg/ha was banded circularly six weeks after the 'heads' were planted. This was followed by a similar application at eight weeks thereafter (14 weeks after planting). The Nitrogen side dressing (133 kg/ha urea or 60 kg/ha N) was applied at 28 weeks from planting;

- for the yam intercrop 300 kg/ha of 12:24:12 is applied at six and 14 weeks from planting respectively, 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 pea, cow pea, peanuts and Irish potato 365 kg/ha of 12:24:12 is 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 six and 18 weeks from planting respectively. This was followed at 24 weeks from planting with an application of 133 kg/ha urea (60 kg/ha N) banded 5 - 8 cm away from the ginger rows at a depth of 5 - 8 cm.

- In situations where solid stands of legumes, Irish potato and ginger were established the same fertilizer programme was used as when they were intercropped with yam.

2.4 Crop Density. Irrespective of whether Yellow yam (Dioscorea cayenensis) the principal crop of the year is grown as a sole crop or in association with other crops. The density is kept constant at approximately 10,000 plants/ha (4,050/ac). As presented in Figure 12 yams 'heads' are planted on the ridges of continuous mounds which are spaced 1.4 m apart. One yam 'head' is planted every 0.66-0.67 m interval along the mound. This requires approx-mately 8 tonnes/ha of planting material ('heads'). As the yam seedling develops into tendrils wooden stakes are emplaced centrally between two adjacent mounds with each stake equidistant to four yam plants. Stakes vary in height from four to six meters and one stake accommodates four yam plants (2,500 stake/ha).

2.4.1 Irish potato (Solanum tuberosum) when planted with yam at the beginning of the crop cycle is sown in rows spaced 0.75 m apart and at 0.25 - 0.30 m intervals along the row (Fig. 13). This seeding rate approximates a population of 53,000 plants/ha and requires about 2+/ha of seed material. Seed material of varieties Red Pontiac, Spunta, Draga and Sebago have been tested over the four year period during which the studies were conducted.

2.4.2 Peanut (Arachis hypogaëa) when grown as an intercrop with yam at the commencement of the crop cycle (Fig. 14) is sown in rows

constructed 0.4 m apart with an intra-row 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 (Fig. 15) Seeds of the Valencia type Spanish peanut were used. This variety has a seed weight of 45 - 50g/100 seeds and gives a shelling percentage of 75%. Thus the quantity of unshelled material required at the commencement and latter half of the crop year is 156, and 78 kg/ha respectively.

2.4.3 The spatial arrangement employed for red pea (Phaseolus spp) and Cowpea (Vigna spp) at the beginning of the crop cycle is rows 0.4 m apart with seeds planted at intervals of 0.15 m within the row (Fig. 16). This results in a population of approximately 166,000 plants/ha. Cropped with yam during the latter half of the crop year seeds are planted in 0.4 m rows that are peripheral to two consecutive yam mounds as shown in Fig. 14. Crop density is thus reduced to 83,000 plants/ha. Varieties of red pea tested were Miss Kelly and Tom Red whereas the cowpea used was of the African red variety. At the beginning of the crop cycle seed requirements of red pea and cowpea are 84 kg and 15 kg/ha respectively. Planted during the latter half of the crop cycle seed requirement is reduced by one-half.

2.4.4 Radish when grown following the harvest of Irish potato is direct seeded in rows 0.40 m apart and at approximate intervals of 0.15 m along the row. This requires 0.3 kg/ha of seed material.

2.4.5 Ginger (variety yellow) when grown with yam for most of the crop year (Fig. 17) is sown in rows 0.4 m apart and at 0.25 - 0.30 m intervals along the row, this requires approximately 4.4 t/ha of seed material. Red pea of the Tom Red variety grown together with yam and ginger during the first quarter of the crop cycle is seeded in rows spaced 0.40 m apart alternated by ginver rows. Seeds were placed at intervals of 0.20 m along the row. The quantity of seed required is 44.0 kg/ha.

2.4.6 Grain corn (Zea mays) of the Pioneer x-306 hybrid grown together with yam during the first quarter of the crop year is seeded in rows spaced 0.70 m apart and at 0.25 m along the row. This gives a population of approximately 50,000 plants/ha and requires 18 ha/ha of seed material.

2.4.7 Cabbage (Brassica oleraceae) of the KK hybrid grown with with yam during the latter half of the crop cycle is grown at the rate of 33,000 plants/ha. The quantity of seed required is 0.1 kg/ha.

Field observations included:

(a) Crop adaptability;
(b) total and marketable crop yields, under both mono and intercropping situations;
(c) crop performance as affected by various planting dates;
(d) time-motion data on discrete operational variables involved in the production of each of the eight promising cropping systems inclusive of land preparations; and
(e) variable costs of materials required for production of the crops.

2.4.8 Additionally, Napier grass (Pennisetum purpureum) was established on the risers of bench terraces to stablize these structures thus rendering them less susceptible to erosion from heavy rains. As a spin-off, the fodder was harvested at regular intervals and fed to four goats and two heads of cattle on a year round basis, observations were taken of fodder yield and weight gains.

2.5 Alternative Approaches to Soil Conservation - Olive River. Due to the relatively high capital costs associated with bench terracing the need was felt to test the effectiveness of less costly soil conservation measures cum using proven cropping system. This exercise commenced in April 1980 at Olive River in the Lowe River area of Trelawny. Run-off

plots ($40m^2$) were constructed on a 20° slope and they were assessed for soil loss following a combination of soil conservation cum cropping system treatments.

2.5.1 The treatments were:

- control i.e. yams were grown alone on individual hills down slope as farmers grow the crop;
- individual hills interruped by a hillside ditch mid-way down the plot (7.5) with a cropping system of yam in association with Irish potato followed by radish and peanut;
- continuous contour mounds interruped by a hillside ditch mid-way down theplot (7.4 m) with a cropping system of yam plus Irish potato plus radish plus peanut; and
- continuous contour mounds interrupted by a grass buffer strip with a cropping system of yam plus Irish potato plus radish plus peanut.

2.5.2. Following a heavy storm or at the end of several rainy periods, the amount of soil loss from each plot was quantified. Crop data included total and marketable yield. For the purpose of this report data for the first crop year will be presented.

2.6 Principal Results and Accomplishments (Allsides) Presented in Table 4 are yields of each crop component and cropping 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 tubers. Yields ranged from a low of 26.570 t/ha in the cropping system where sweet potato and red pea were grown in association with yam to a high of 40 t/ha in the system where sweet potato was established in the latter half of the crop cycle following the failure of ginger to establish an acceptable crop stand.

2.6.1. Except for cropping system number 8 (yams grown in association with sweet potato followed by red pea) there was an appreciable increase in total yam output by every other treatment compared to the check treat-

ment (system No. 1). Further, Irish potato of the red pontiac variety sown together with yam and harvested 85 days thereafter produced a yield of over 9 t/ha of good quality tubers.

2.6.2 It was significant that other component crops such as onion, corn, pumpkin, cabbage, carrot, cassava, ginger and sweet potato performed poorly. This was attributed to several factors viz:

i) poor seed quality which resulted in extremely poor crop stand in the case of onion and ginger;
ii) inability of the soil to supply adequate quantities of magnesium for acceptable corn growth and yield;
iii) inability of the cassava and sweet potato crops to accumulate carbohydrates despite excellent top growth;
iv) a high population of cabbage looper which rendered a high percentage of the heads unmarketable; and
v) significant loss in carrot stand due to seed loss from yam mounds consequent to heavy rains and prior to seedling emergence.

2.6.3 The encouraging yam, Irish potato and red pea yields coupled with the direct soil conservation benefits to be gained from yam cultivation on mounds and the demonstration of an improved farm cash flow situation which could accrue to the small hillside farmer stimulated further work in identifying viable systems of production.

2.6.4. During the 1978/89 crop year, corn was again tested and new crops such as the 'dwarf determinate' variety of pigeon pea (UWI - 17), bodie bean (Vigna spp), peanut and lettuce were included in the crop mixes.

2.6.5. The yield data for each cropping system are presented in Table 5. Except for Systems 6 in which yams were grown with peanut and sweet potato an increase in saleable yam tuber yield over the yam monoculture was recorded for each of the other systems tested.

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

2.6.7. Again, as was observed in the 1977/78 crop, corn, onion, sweet potato and carrot performed poorly as intercrops. The pigeon pea crop yielded poorly whereas lettuce seeds failed to germinate. Overall, the legume mixes resulted in a fair level of performance.

2.6.8. To ascertain yield response of yams and other crop mixes when established during the September - October rainy season, four production system were tested on semi-commercial sized plots. The crop mixes consisted of:

i) yam as sole crop;
ii) yam grown together with peanut followed in sequence by Irish potato and radish;
iii) yam grown together with peanuts followed by Irish potato; and
iv) yam grown together with African red pea and followed by peanut

2.6.9. The yield data of yams and each component crop are shown in Table 6. Total yam tuber yield was highest (27 t/ha) when this crop was grown as a monocrulture and production declined by a average of 23% as other crops were intercropped with yam.

2.6.10. Notwithstanding periods of sustained drought conditions which could have led to the overall lowering of yam yields, peanut performed well on both terraces which had been planted to this crop 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.

2.6.11. The Irish potato crops were severely affected by early and late blight. This resulted in immature ripening of the crop and as a consequence, tuber size was small. The radish crop performed well and when viewed in the context of its short maturity period (4-5 weeks) appears promising.

2.6.12. Following a detailed review of the results obtained from April 1977 to February 1979, eight crop mixes were established during the period March 1979 to February 1980 on whole terraces thereby simulating in size, farmers terraced plots. These terraces varied in hectarage from 0.02 to 0.07 ha (0.05 to 0.17 ac). The mixes were selected on the basis of their:

i) demonstrated high yielding potential;
ii) nutritional values;
iii) ability to establish a good crop canopy at an early stage of the yam growth cycle;
iv) ability to enhance farm income; and
v) labour intensive requirements

2.6.13. Notwithstanding the fact that yam yields were greater than those of the project farmers (Table 7)., information indicates that several factors might have militated against higher yields. These are:

i) inter-crop competition particularly when yam is cropped with sweet potato;
ii) sustained periods of unseasonably heavy rains which resulted inter alia in leaching and thus decreased effectiveness of applied fertilizers and other available soil nutients;
iii) a build-up in the levels of yam specific nematodes in the yam tubers which resulted in a high loss of marketable tuber material; and
iv) late staking of yam vines (12-14 weeks after planting) due to unavailability of yam stakes at time of tendril development.

These are important aspects which must be taken into consideration in divising crop mixes, improving the performance of polycultures and providing a satisfactory basis for projecting revenue.

2.6.14. 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 t/ha respectively of excellent quality grains. Each cropping system was evaluated for its economic viability and its nutritional output and these aspects will be discussed in later sections of this report.

Limit [illegible]

[illegible]

[illegible] factors [illegible] of [illegible] might [illegible]

[illegible]

2.6.15 Yield data for the 1980 - 1981 period (Table 8) indicate that when yam was intercropped tuber yields were generally better than those obtained in the previous crop year (1979-1980). For example, the cropping system was evaluated for its economic viability and its nutritional output and these aspects will be discussed in later sections of this report.

2.6.16. Yield data for the 1980 - 1981 period (Table 8) indicate that when yam was intercropped, tuber 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 (9,793 lbs/ac) versus 9.8 t/ha (8,729 lb/ac) for yam in the same system last year. This improvement would probably have been more marked had it not been for the high incidence of "pine heart" 1/ and to a lesser extent "hollowing" 2/ which rendered a high portion of the yield unmarketable. In the case of yam + peanut + red pea, Yam + cow pea + 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.

2.6.17. The yields of table yam as a mono-crop changed very little from 13.0 t/ha (11,589 lb/ac) last crop year to 12.8 t/ha this year (11,401 lb/ac). It should be noted that last year's yields were greatly affected by the high incidence of 'burning'. 3/ Earlier reaping and better monitoring this year reduced that problem somewhat but there were instances this year, where the presence of the "pine heart" condition (e.g. Terrace 3 with yam + Irish potato + radish + peanut) also severely affected marketable yield. Yam quality was good and physically the yams were 'solid'. These three crops also provided excellent crop cover which reduced the necessity for weeding the yams after the May rains.

1/ Agranulated or grainy appearance of the yam tuber tissue at harvest which renders the tuber unattractive and thus unsaleable.

2/ Deterioration and eventual disintegration of the yam tissue at harvest although the outmost layers of the tissue may be intact.

3/ Dry rot of yam tubers caused by the nemotode Pratylenchus coffeae.

2.6.18. The red pea yield was not encouraging (0.49 t/ha). This has been the pattern, on the demonstration site, whenever red pea is planted in the Spring. Crop Stand and vigour on the continuous mounds were significantly lower than when the same seeds were sown at the same time within the project fence but not on mounds. The reasons for this variation are not apparent.

2.6.19. Performance of the ginger crop were disappointly poor compared to the excellent yields obtained the previous year. Climatic conditions were favourable, for the most part, and the planting material was of good quality. The Plant stand following germination was unacceptable and this 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.

2.6.20. SECOND INTERCROPS

2.6.20.1 The second intercrops (peanuts, cow pea, red pea), in general performed very poorly. In the case of peanuts intercropped on Terraces 1 & 3, germination was good but shading effects of the then seven (7) months old yam canopy considerably reduced the yield. This was evident from the tall, narrow canopy of the peanuts as well as apparent reduction in podding vigour. This problem was aggravated also by the flourishing of persistent weeds in the latter stages of the peanut crop at which time it would have been unwise to introduce any weeding operation for fear of depressing yam yields. Further, the shading effect of some of these tall growing weeds plus the yam provided a cool, protected environment for rats and/or crickets which damaged the pound pods.

2.6.20.2 Cow pea and red pea stands were non-existent. Despite replanting of the cow pea the resulting stand was still very poor. Consequently the cow pea and red pea stands were abandoned.

2.6.20.3. It should be noted that the second intercrops are planted at half the population of the first intercrop or pure stand situation because of the growing yam canopy and thus yield expectations would be reduced accordingly.

LISTA N° 33 DE DOCUMENTOS DEL CIDIA PARA ENCUADERNACION

1. Módulo semillero "Alfa" para áreas bajo riego
2. Informe anual CATIE
3. Proyecto de palnificación integral de las fincas... Colegio agrop. de Corredor
4. Tercera reunión de la comisión asesora del programa cooperativo...
5. Proyecto de planificación integral de las fincas... Colegio agrop. de San Mate
6. Agricultural production on Hillsides. The allside project case study
7. Seminario de producción animal en áreas de agricultura tradicional
8. Seminario de currículos e métodos
9. 1er Seminario - taller sobre el desarrollo de la autogestión
10. Desarrollo cafetalero en la zona sur de Manabí
11. Seminario de evaluación de programas de huertas...
12. Fitomejoramíneto genético del café con énfasis en resistencia a la roya...
13. Paln de tabulación
14. Programa de capacitación
15. Cater - Documento de trabajo
16. El caso del ICTA en Guatemala como institución dedicada a la generación...
17. Convenio IMSS-Coplamar el establecimiento de servicios...
18. Agriculture government policy papers for Jamaica
19. Reunión de programación de investigación agrícila del Itsmo Centroamericano
20. Semianrio nacional sobre criterios para programas de colonización
21. Seminario nacional normas jurídicas y operativas para el uso del agua de rieg
22. Semianrio nacional sobre administración de la política agrícola
23. Reprogramación de actividades proyecto Gobhol - IICA/PRACA
24. La educación como práctica colectiva: La experiencia de fundación...
25. Seminario sobre producción de semillas de forrajeras

LISTA Nº 23 DE DOCUMENTOS DEL CATIE PARA ...

1. [illegible] semillero "Alfa" para áreas bajo riego
2. Informe anual CATIE
3. Proyecto de planificación integral de las fincas... Colegio agrop. de
4. Tercera reunión de la comisión asesora del programa cooperativo...
5. Proyecto de planificación integral de las fincas... Colegio agrop. de
6. Agricultural production on hillsides. The allsidesproject case st
7. Seminario de producción animal en áreas de agricultura tradicional
8. Seminario de currículos e métodos
9. 1er Seminario - taller sobre el desarrollo de la autogestión
10. Desarrollo cafetalero en la zona sur de Manabí
11. Seminario de evaluación de programas de huertas...
12. Fitomejoramiento genético del café con énfasis en resistencia a la roya..
13. Red de cal[illegible]ción
14. Programa de capacitación
15. Cater - Documento de trabajo
16. El caso del ICTA en Guatemala como institución dedicada a la generación.
17. Convenio IMSS-Coplamar el establecimiento de servicios...
18. Agriculture government policy papers for Jamaica
19. Reunión de programación de investigación en [illegible] del Istmo Centroam
20. Seminario nacional sobre criterios para programas de colonización
21. Seminario nacional normas jurídicas y operativas para el uso del s...
22. Seminario nacional sobre administración de la política agrícola
23. La programación de actividades proyecto [illegible] - IICA/[illegible]
24. La educación como práctica colectiva: La experiencia de fundación...
25. Seminario sobre producción de semillas de forrajeras

2.6.21 PURE STAND

2.6.21.1 For the cropping year 1980 - 1981 the practice was adopted whereby there was simultaneous establishment of pure stands of the prevailing intercrops.

2.6.21.2 The objective was to compare the performance of these crops in pure stands vs. intercropped.

2.6.21.3 Terraces 8 and 9 (relatively farther down the original slope) have always displayed inherently lower fertility than the ones (1 to 7) above them. Thus the performance of the pure stands on these terraces did not accurately reflect their potential (Table 9). It would not therefore be valid to compare pure stand vs. intercrop yields for 1980 - 1981, as the intercrops were exposed to far superior conditions, vis a vis, moisture and inherent fertility, other things (e.g. planting material and applied fertilizer) being equal. It is planned to repeat this test this year (1981 - 1982) but on terraces which display basically the same features.

2.7 ECONOMIC ASSESSMENT

2.7.1 On the basis of preliminary economic assessment of performance of the multi-cropping systems investigated at the 'experimental' level of the project, the seven best systems and yam as the sole crop were used for further study. These studies were carried out on plots which simulated the size of plots used for pure stand cropping in the project area, varying between 0.02 and 0.07 hectare.

2.7.2 The data presented for 1977/78 (Table 4) and 1977/79 (Table 5) are regarded as being largely experimental and were obtained for small plots. The data for 1979/80 and 1980/81 are from larger sized plots, but those for 1980/81 are preliminary. For the purposes of this presentation discussions relate largely to the data for 1979/80.

2.7.3 Data presented in Table 7 show the yields of biomass and economic edible products obtained for the year 1979/80 while the data presented in Table 7 (a) provide input-output relationships

and net benefits for the selected systems mentioned in Section 2.7.1

2.7.4 The data shown in Table 10 represent the input-output relationships and net benefits for 'yellow yam as the sole crop',(YASC) used as the basis for comparison, and seven polyculture systems which had the highest margin of value of outputs over production costs. Input-output data were obtained for each system as well as for each component crop of each system. On the basis of an overall system, three (3) systems namely No. 2 (111%); No. 4 (5%); and No. 5 (90%) had a higher measure of value of outputs for all seven (7) systems exceeded that for the YASO "system". In System 7 which showed a total deficit of 43% below the monocrop yellow yam, there were also deficits for the other component crops, and for reasons as yet undetermined yam as a component crop was produced at an overall loss. The data indicate considerable variations in the performance of individual crops in the systems, the outstanding examples being Ginger in System No. 5; and Yellow Yam in Systems Nos. 7 and 2.

2.7.5 The operations on the plot used by the Project for experimentation and on which the data were collected for analysis, provide a number of differences from those which are employed on the plots owned by farmers. In the first instance, bench-terracing is provided by the Soil Conservation Division of MINAG. The multiple cropping systems are then pursued on the bench-terraced land. The farming operations on the farmers'holdings are therefore under the direct management of the farmers, who are responsible for financing, risk-bearing, etc.

2.7.5.1 On an island basis MINAG provides a subsidy equal to 75% of the cost of bench-terracing. The farmer provides the remainder whether in cash or in kind. Since bench-terracing can be done by machine, manually or by a combination of the two, where manual operations are concerned the farmer is able to earn wages by performing part of the manual operations himself. In

a situation in which there is a high degree of unemployment it may be desirable to increase the input of manual operations where feasible.

2.7.5.2 The main problem, however, relates to the high cost to government for undertaking a programme of bench-terracing, and this has implications for government policy in terms of using soil conservation measures other than bench-terracing. This led to the investigations of polyculture systems on land at Olive River, having similar slopes to those at Allsides, and alternative soil conservation measures. These measures are:

(i) Individual hills with hillside ditches.
(ii) Contour mounds with hillside ditches.
(iii) Contour mounds with a grass buffer strip.
(iv) Individual hills were used as the check.

Results and analysis of the first two years of this study are being finalized.

2.7.6. The statistics shown in Table 10 have to be modified to provide a format for farmers. This modification includes costs for interest charges, as well as for tools, soil conservation (that portion paid by farmers) contingencies and rent. The farmer is required to provide 25% of the soil conservation costs on an in kind basis.

2.7.7 Cost estimates for bench-terracing:

Slopes	Machine Built $ per hectare	Hand Built $ per hectare	Type of Conservation
0° - $< 7^{\circ}$	580	-	Hillside Ditch
7° - $<15^{\circ}$	7,385	-	Bench Terrace
15° - $<20^{\circ}$	7,295	-	" "
20° - $<25^{\circ}$	-	12,660	" "
25° - $<30^{\circ}$	-	9,130	Orchard Terrace
30°+	-	3,375	Forestry

2.7.8 Tools

The cost of tools is approximately $150 per hectare for the first year reducible on a depreciation basis to $10 during the fifth year.

It is assumed that the bench-terrace with proper care and maintenance will last for at least 10 years without requiring major modifications. Using the slopes ranging between 7^{o} and 25^{o} as those to be bench-terraced the average cost of $9,100 or $910 per annum over the 10 year period, the farmer's cost is $230 per hectare per annum.

2.7.9 The results presented in Tables 7, 7(a) and 10 indicate rather positively that for the crop year 1979 - 1980 a number of multi-cropping systems proved to be economically superior to the yellow yam monocrop system. On the basis of the results shown in Table 7 (a), systems No. 2 (yellow yam, Irish potato, radish and peanut); No. 5 (yellow yam, red pea and ginger) and No. 4 (Yam, Cowpea and Peanut) in that order, out-performed the yellow yam monocrop. System 2 gave the best performance with a gross margin of J$10,693 per hectare and a net farm income of $10,266 per hectare in comparison with yellow yam as the monocrop (Gross margin J$4,844/ ha and net farm income J$4,377/ha).

2.7.10 Yellow yam as a monocrop is not being recommended as a system since it falls short in terms of nutrition, employment and production of total biomass (Table 7). In general, however, it should be observed that although 6 of the 7 systems had a higher output value than the yam monocrop in all systems except one (No. 7 - Yellow yam, Corn and Cabbage - a marginal increase only) the value of the output of yellow yams from the monocrop exceeded that for yellow yams produced within a multicropping system.

2.7.11 Results obtained for the 1980/81 crop year also indicated that multiple cropping systems can significantly augment farm incomes. The most profitable cropping systems (No. 3) yielded a gross margin of J$18,478/ha, and a net farm income of J$18,405/ha, Irish potato being the best intercrop (Table 11). Crop production costs increased over those for the previous year due largely to increased labour rates and increased (25%) costs of materials.

2.7.11.1 Some of the increases in production costs were associated with a number of investigatory and improvement aspects. Adjustments must be made to ensure that they do not inappropriately negate the economic benefits which could have been obtained. Measures taken to restrict cost escalation include:

i) improved efficiency in field tillage, crop sowing and harvesting operations;
ii) rationalization of the disease and pest control programme; and
iii) rationalization of the soil - crop management programmes.

2.7.11.2 The results presented in Tables 10 and 11 further indicate that on the hillsides of Jamaica farm family incomes could be increased several fold, provided that the farmer adopts the practice of polyculture together with improved technology.

2.7.12 However, the high costs of production of the intercrops would require the establishment of a closely supervised farm credit scheme to ensure that inputs are acquired and used on a timely schedule. Also a strong Extension input is a sine qua non for transferring the research information to the farmer - who is an individualist and manifests a behaviour which depicts the motto "Every Man for Himself". (7)

2.7.13 Another distinct advantage of polyculture at Allsides and other hilly areas in Jamaica is that the entire holding can be cultivated continuously versus the present traditional practice in which areas are allowed to go into fallow or "ruinate" for one year following three years of continuous yam cultivation. Farmers claim that this practice "enables the land to recover its strength. (7)

2.8 Nutritional Evaluation

2.8.1 One of the major problems of the developing countries today is inadequate food production. In Jamaica, the critical shortage of foreign exchange requires a greater dependence on domestically produced foods. As in other islands of the Caribbean the small farmers will

continue to play the dominant role in food production. They will require assistance to enable them to use those crop mixes which can provide a balanced food intake. A nutritional survey was conducted using farm families of the project area as the source for ascertaining levels of consumption patterns of farm families. (8)

2.8.2. The survey results indicate that polyculture is a far more efficient producer of calories than monoculture when the same principal crop is included in both systems. Also, the multiple cropping systems performed nutritionally superior to the yam monoculture. It is gratifying to observe that within the project area of Allsides, a significant number of producers who previously grew root crops continuously are now including peanuts, cow pea, red pea and Irish potato in their cropping mixes. This will result eventually in a more balanced dietary intake, by the target group.

2.8.3. Based on the edible product yields of the 1979/1980 commercial trials, food energy, protein and carbohydrate values were computed for each of the cropping systems. These values are presented in Table 12. The changes in energy yield and food values relative to the yam monoculture are shown in Table 13. Figure 17 is a graphical representation of energy and food protein values obtained from each of the eight cropping systems. In terms of total nutritional energy, five of the seven crop mixes yielded more than the yam monoculture, the exceptions being yam intercropped with sweet potato an d yam and red pea and cow pea. The energy contents varied fro 57.25 x 10^6 kilojoules for yam alone, to 102.10 x 10^6 kilojoules when yam was intercropped with Irish potato, radish, and peanut, an increase of 78% (Tables 12 and 13). Again, protein and carbohydrate values were lowest (0.20 t/ha and 2.12 t/ha, respectively, for the yam/sweet potato system and among the highest (0.69 t/ha and 5.51 t/ha, respectively), when yam was intercropped with Irish potato, radish and peanut. Protein and carbohydrate values for the yam monoculture were 0.31 t/ha and 3.14 t/ha, respectively. As expected the legume mixes viz., yam + peanut + red pea, and yam + cow pea + peanut produced the highest protein yields. Values were 0.76 and 0.67 t/ha, respectively and when compared to the yam monoculture out yielded it by 143% and 113%, respectively.

2.9. Employment Evaluation

2.9.1. Jamaica as well as many other developing nations is experiencing rising unemployment. The rural areas are worst affected. Consequently, there is a tendency for rural youths to migrate to the large cities. This trend has led to severe pressures on existing social and health facilities in the urban centres and as one direct consequence crime rates in the cities have increased considerably. In cognizance of this, deliberate efforts are made to create projects which have a favourable employment generation potential. Indeed, one of the objectives of the project was to demonstrate the employment potential by the adoption of a rational system of crop and soil management for the Allsides area.

2.9.2. Presented in Tables 14 and 15 are the observed monthly labour inputs required for the establishment and maintenance through to crop maturity of the eight cropping systems, evaluated on whole terraces during the 1979/1980 crop year. When contrasted with the traditional practices of the farmers there is little difference in the total labour required for yam monoculture produced on continuous mounds on the terraces, although there is variation on a monthly basis.

2.9.3. Although farmers claim that they use more labour than that required by the project, for every cropping system used the labour requirements have been much greater than for the traditional farming practices.

2.9.4. Another important consideration is related to the direct soil conservation benefits which will accrue from the use of continuous mounds on terraced land in such a system, i.e. a recorded soil loss of 18 t/ha/yr compared to 136t/ha/yr sustained by farmers on plots having a 17° gradient.[2/]

2.9.5. Systems 2 and 5 which produced the highest farm gate revenues and quantities of energy and protein were also shown to have high employment potentials. These findings are even more meaningful when congnizance is taken of the labour distribution patterns over the 12-month cropping cycle.

2.10. Livestock

2.10.1. The possibility of converting grass produced on the risers of terraces into animal protein was examined. It has been successfully demonstrated over the period 1977/1980 that two heads of large livestock (cattle) and four heads of small livestock (goats) can be maintained by zero grazing from the Napier grass produced on a total riser area of 0.07 ha (.18 ac).

2.10.2. In addition to serving principally to stablize risers, Napier grass could be used to significant advantage in enhancing . \ income and increasing the availability of animal protein to the population of Jamaica. It is most important that the grass be zero-grazed to protect the risers from destruction by the animals.

2.10.3. The agro-socio-economic data reported herein that under rainfed conditions intensive farming of hilly lands in Jamaica could result in:

i) increased food production;
ii) increased farm income;
iii) decreased rural unemployment;
iv) improved standard of living;
v) improvement in the Government's import substitution efforts;
vi) an increase in G.N.P.; and
vii) positively influencing the rate of national economic growth

2.10.4. It is extremely encouraging that the improved technology is being adopted by a significant number of producers within the area and elsewhere. However, to achieve greater success it is necessary that a strong Extension Unit be set up together with a Farmers' Credit Unit, charged specifically with serving the credit needs of the small hillside producers.

3. Results of the Olive River soil loss cum cropping systems studies

3.1. Presented in Table 16 are the sampling intervals and quantity of rainfall which occurred over the first year of the trial (April 26, 1980

through March 3, 1981). Over this 312 day period rainfall totalled 1,295mm and rainy days numbered 89. There were 11 soil loss measurements.

3.2. Table 17 shows the actual and equivalent soil losses converted on the basis of acreage and hectarage respectively. There was a dramatic decline in soil loss from 179 t/ha of oven-dry soil observed from the check plot (yam planted traditionally) to 43 t/ha when plots were treated with continuous contour mounds and a grass buffer strip and multiple cropped. This represents a 75% reduction in effective land area available for cropping. Viewed differently, under the gradient, rainfall and cropping pattern conditions which obtained during the period, the upper 15 cm soil layer of the check treatment will be lost in 12.5 years [1/] whereas 52 years will be required to sustain a similar loss if the land is prepared with continuous contour mounds interrupted at appropriate intervals with a grass buffer strip and cultivated with a multiple cropping system.

3.3. Results of crop yields for the treatments are presented in Tables 18 and 19. Gross yam tuber yields were highest for the check treatment and lowest for treatments 3 and 4, although there was no difference in yield between the latter two. It is likely that the intercrops depressed yam yields due to competition for available nutrients and moisture.

3.4. Notwithstanding this, due to the high prices which obtain for Irish potato and the non-traditional radish crop, overall farm income for treatments 2, 3, and 4, will exceed that for the check treatment. Also, by planting these short-term crops the subsistence farmer could enhance his cash-flow position and nutritional profile.

3.5. The first year's results of Olive River are very significant in terms of providing a factual basis for assisting Government in

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1/ Based on the consideration that a one hectare - 15 cm furrow-slice common in mineral soils can have an oven-dry weight of 2,242 tonnes.

modifying its policy with respect to subsidizing soil conservation work in agriculture for the island. Terraces although highly productive are very costly and the soil conservation measures being evaluated are simpler and significantly less expensive.

3.6 Further, when it is recalled that (i) the bulk of available plant food is found in the plough layer; (ii) 80% of Jamaica's farming community is located on the hillsides; (iii) productivity of hillside agriculture has declined over the years; (iv) hillside agriculture is the source of the island's domestic food supply; and (v) hillside agriculture is the principal source of rural employment, it is paramount that efforts aimed at mitigating soil erosion be continued until farmers are convinced of the virtues of adopting proper soil management practices.

4. Perspectives for future development

4.1 There already exists a number of "cropping systems" even if they are not operated on very structured lines. The main objective is to ensure that all resources are used optimally, by modifying these systems on a gradual and pragmatic basis.

4.2 High population density on available agricultural land has created the necessity for more intense use of land resources. The fact that so high a percentage of agriculture practised on hillside lands continues to provide most of the local food production implies that appropriate intensive measures must be developed. These measures require that the land must be suitably conserved.

4.3 The use of tested cropping systems is a means to this end. As is observed from the Allsides experience yields of individual crops per unit area will not necessarily increase over those for the crops when intercropped. The total output of crops will increase due to more effective and optimum use of the land and available resources.

4.4 Farmers in general have become accustomed to leaving portions of their already small plots of land fallow to allow the land to recuperate. This is especially the case on hilly lands which are low in fertility and

which suffer a further reduction in fertility due to man-made erosion associated with unsound agricultural practices.

4.5. Demonstrations have shown that increased fertility may be assured through the judicious use of fertilizers. Farmers, however, have certain age-worn concepts concerning the effects of fertilizers on the health of people. They also have resistances due to "high" price of fertilizers (and other chemicals). All these are areas which extension officers can and must explain if farmers are going to adopt practices which will lead to more intensive but sould land use.

4.6. Many farmers in surveys (old and new (12) have indicated that lack of credit is a major factor which limits production. In spite of their willingness to adopt new practices they cannot do so without the availability of adequate credit on a timely basis. One possible way is to link credit and marketing arrangements very closely.

4.7. Undoubtedly, the intensive use of land will require more labour, some of which may have to be bought. This cost can be included in the credit needs and can be recovered from the crop output.

4.8. The difficult terrain on which much of the hillside farming is practiced requires mechanisms which will take the "irk" out of work. For too long has Jamaica paid too little if any attention to the "invention" of modest types of equipment which will assist farmers in undertaking certain farming operations. The technology exists elsewhere and the time is right to endeavour to adapt some of this type of equipment for adoption by hillside farmers.

4.9. The information and the data presented in this paper refer to a particular situation with specific conditions relating to land, topography and slopes, climate, farmers and tradtional cropping patterns as found in Allsides area of Southern Trelawny. The principles involved do not change and it is necessary to develop ecosystems, appropriate cropping mixes and technological packages for other situations.

4.10. Where policy is concerned there is the time-worn argument concerning financing the cost of soil conservation (especially bench terracing). The data available indicate that with intensive cropping and sound use of appropriately soil-conserved land, at optimum performance levels the revenue obtained can pay for the soil conservation measures and still leave a residual income which is greater than that which farmers now earn. While the high cost of terracing dictates that cheaper but effective soil conservation measures be found (such trials are being undertaken at Olive River in Trelawny as a support to the Allsides Project) the question of the ability of any government to subsidize soil conservation measures at current levels must be seriously addressed.

TABLE 1 APPROXIMATE ACREAGE (hectares) OF LAND CAPABILITY CLASSES PER PARISH

Parish	A(0-2°) slope	B(2-5°)	C(5-10°)	D(10-20°)	E(20-30°)	F(over 30°)
St. Andrew	800 (320)*	450 (180)	5,750 (2,300)	11,750 (4,700)	55,550 (22,220)	12,100 (4,840)
St. Catherine	20,000 (8,000)	20,000 (8,000)	85,000 (34,000)	45,000 (18,000)	30,000 (12,000)	85,000 (34,000)
Trelawny	432 (173)	41,659 (16,664)	22,956 (9,182)	11,293 (4,517)	39,521 (15,808)	107,202 (42,881)
St. Ann	1,075 (430)	39,793 (15,917)	56,304 (22,522)	59,223 (23,689)	80,680 (32,272)	59,537 (23,814)
St. Elizabeth	5,492 (2,197)	49,816 (19,926)	68,901 (27,560)	3,333 (1,333)	29,327 (11,731)	98,152 (39,260)
Clarendon	21,000 (8,400)	27,000 (10,800)	91,000 (36,400)	38,000 (15,200)	45,000 (18,000)	52,000 (20,800)
Manchester	324 (130)	10,558 (4,223)	60,908 (24,363)	16,614 (6,645)	30,804 (12,321)	82,220 (32,888)
Hanover	870 (348)	15,340 (6,000)	16,200 (6,400)	18,900 (7,560)	18,020 (7,208)	43,625 (17,450)
St. Mary	9,000 (3,600)	10,500 (4,200)	50,500 (20,200)	40,000 (16,000)	18,500 (7,400)	6,250 xx (2,500)
Portland	5,950 (2,380)½	8,050 (3,220)	28,750 (11,500)	17,000 (6,800)	59,900 (23,960)	18,400 (7,360) xxx
Westmoreland	5,392 (2,157)	47,009 (18,803)	24,712 (9,885)	22,934 (9,173)	19,527 (7,811)	66,247 (26,499)
St. Thomas	5,430 (2,172)	19,570 (7,828)	24,465 (9,786)	11,390 (4,556)	59,800 (23,920)	15,305 (6,122) xxxx
St. James	1,700 (680)	12,650 (5,060)	13,600 (5,550)	18,650 (7,460)	15,600 (6,240)	74,350 (29,740)
Total	77,445 (30,978)	322,395 (128,966)	549,046 (219,618)	314,087 (125,635)	502,231 (200,892)	720,368 (288,147)

* hectares in parentheses

TABLE 2. - Farms, Number, Size and Acreage in Jamaica in 1968 1/

Farm size (acres)	(ha)	Number	% of total	Acreage	% of total acreage
0 - ⁄5	2	149,703	78.8	223,818 (89,527)	14.9
5 - ⁄25	2 - ⁄10	36,881	19.0	333,584 (134,219)	22.1
25 - ⁄100	10 - ⁄45	3,004	1.6	125,104 (50,042)	8.2
100 - ⁄500	45 - ⁄200	699	0.4	148,501 (59,400)	9.93
500+	200	295	0.2	676,426 (270,570)	44.9
All Farms		190,582	100.0	1,507,397 (602,959)	100.0

* hectares

1/ Source: Statistical Yearbook of Jamaica 1978.

TABLE 3 Selected physical and chemical properties of the 0-45 cm soil layer of the Allsides, Trelawny soil (an Ultisol, locally classified as soil type No. 32, Wirefence Clay Loam), immediately after the soil was bench terraced (April 1977) and following the completition of the third year cropping cycle February 1980

Physical and chemical properties		Value
Sand (%)		15.21
Silt (%)		22.01
Clay (%)		62.78
Bulk density (g/cc)		1.16
Field capacity at 1/3 bar (%)		49.32
	April 1977	February 1980
pH (1:2.5)	4.9 vha 1/	4.9 vha
Organic matter (%)	0.67 vl	3.09 ml
Nitrogen (%)	0.14 m	0.16 m
Phosphorus (ppm P_2O_5)	10 Vl	32 ml
Potassium (ppm K_2O)	109 L	111.50 L
CEC (meq/100 g)	18.50 m	21.00 m
Ca (" ")	5.28 m	6.26 m
Mg ((" ")	1.51 m	0.96 L
k (" ")	0.24 L	0.25 L
Al (" ")	8.16	
Cu (ppm)	1.35	2.80
Fe (")	77.50	93.75
Mn (")	8.05	5.50
Zn (")	3.37	2.0

1/ Vha - very highly acidic
Vl - very low
Ml - medium low
M - medium
L - low

TABLE 4 Marketable yields of Yellow yams (Dioscorea cayenensis) and other crops grown alone and in a polyculture system at Allsides, Trelawny, during the 1977/1978 crop year

Cropping Systems	Crops	Marketable Yield (t/ha)	New Yam "Head" Yield (t/ha)	Change in total yam yield over monocrop (%)
1	Yam alone	31.502	16.917	0
2	Yam	36.794	16.692	10.46
	Red pea	0.552		
	Onion	0.053		
3	Yam	38.752	17.274	15.71
	Sweet corn	7500*		
	Red pea	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 pea	0.296		
6	Yam	38.734	17.840	16.84
	Pumpkin	0.000		
	Sweet corn	3133*		
7	Yam	33.006	17.010	3.30
	Cabbage	0.695		
	Carrot	0.108		
	Red pea	0.093		
8	Yam	26.565	13,668	16.91
	Sweet potatoes	2.129		
	Red pea	0.105		
9	Yam	36.794	15.861	8.75
	Cassava	0.000		
	Red pea	0.539		
10	Yam	39.899	17.032	17.58
	Ginger	0.000		
	Sweet potatoes	1.616		

1/ Yields were extrapolated from 30m² plots
* Ears of corn

TABLE 5 Marketable yields of Yellow yams (Dioscorea cayenensis) and other crops grown alone and in a polyculture system at Allsides, Trelawny during the 1978/1979 crop year

Cropping Systems	Crops	Marketable Yield (t/ha)	New Yam "Head" Yield (t/ha)	Change in Total yam Yield over Monocrop(%)
1	Yam alone	10.90	10.40	0
2	Yam +	14.08	10.74	16.5
	Corn +	0.304		
	Pigeon Pea	0.125		
3	Yam	15.82	11.16	26.7
	Red pea (Ms. Kelly cv)+	0.455		
	Ginger	3.058		
4	Yam +	12.60	9.78	5.1
	Bodie Bean +	2.470*		
	Onion	0.131		
5	Yam +	13.37	8.83	4.2
	Irish potato +	6.15		
	Radish +	0.312		
	Cowpea (African red) +	0.298		
6	Yam +	10.32	9.18	-8.5
	Peanut +	2.13		
	Sweet potato	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	0.0(		
9	Yam +	14.16	12.08	23.19
	Red pea (Tom red cv) +	0.316		
	Peanut	0.163		
10	Yam +	15.80	11.54	28.36
	Carrot +	0.099		
	Bodie Bean	0.127*		

* Fresh pod yield

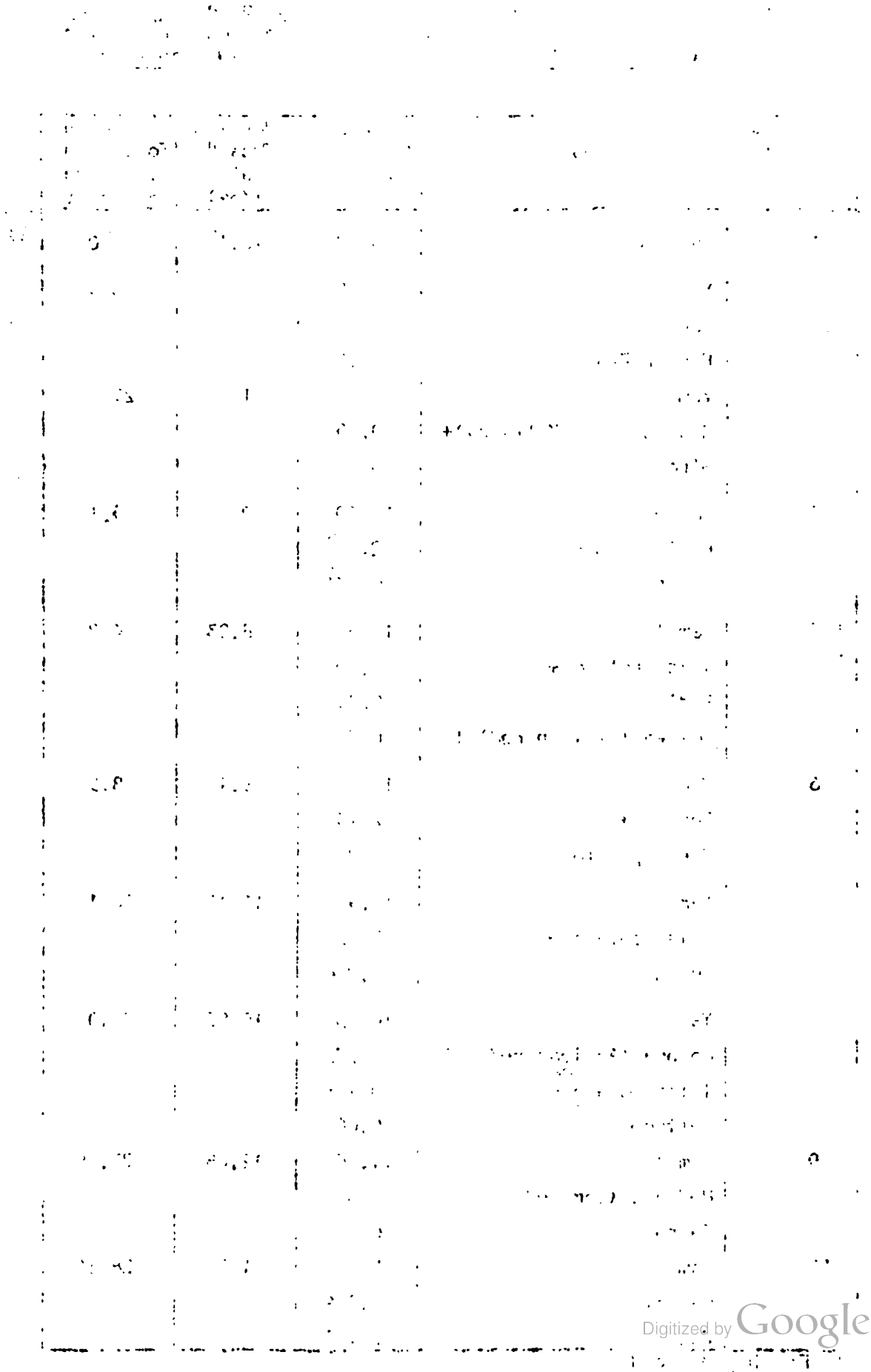


TABLE 6 Marketable yields of Yellow yams (*Dioscorea Cayennensis*) and other crops alone and in a polyculture system at Site II, Allsides, during the October 1978 - November 1979 cropping period 1/

Cropping Systems	Crops	Marketable Yield (t/ha)	New Yam "Head" Yield (t/ha)	Change in Total yam yield over Monocrop (%)
1	Yam alone	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		
	Yam	15.16	9.12	- 977
	Red pea (African red cv)	0.337		
	Peanut	0.78		

1/ Yield extrapolated from whole terraces having an acreage area of 0.05 ha.

TABLE 7: Quantity and Value of Biomass Produced From Yellow Yams (*Dioscorea cayenensis*) and Seven Selected Polyculture Systems, Allsides Trelawny, March 1979 - February 1980

(per Hectare)

No.	Systems		Biomass	
			Quantity (tons)	Value ($)
1.	Yellow Yam (Sole Crop)	Edible Tuber	13.03	8,600
		New "Head" *	9.85	8,678
			22.88	17,278
2.	Yellow Yam	Edible Tuber	9.80	6,462
		New "Head"	9.88	8,704
	Irish Potato		13.25	9,110
	Radish		1.27	2,798
	Peanut (Shelled)		0.77	1,690
			34.97	28,764
3.	Yellow Yam	Edible Tuber	7.53	4,970
		New "Head"	8.71	7,674
	Peanut (Shelled)		2.51	5,536
	Red Pea		0.40	2,195
			19.15	20,375
4.	Yellow Yam	Edible Tuber	8.22	5,425
		New "Head"	9.06	7,982
	Cow Pea		1.50	6,600
	Peanut (Shelled)		0.45	985
			19.23	20,992
5.	Yellow Yam	Edible Tuber	9.50	6,270
		New "Head"	8.02	7,066
	Red Pea		0.34	1,881
	Ginger		13.87	15,272
			31.73	30,489
6.	Yellow Yam	Edible Tuber	7.33	4,838
		New "Head"	5.12	4,511
	Sweet Potato		1.31	577
			13.76	9,926
7.	Yellow Yam	Edible Tuber	13.08	8,633
		New "Head"	9.92	8,739
	Grain Corn		0.28	124
	Cabbage		0.00	-
			23.28	17,496
8.	Yellow Yam	Edible Tuber	7.95	5,247
		New "Head"	8.25	7,268
	Red Pea		0.73	4,004
	Cow Pea		0.43	1,883
			17.36	18,402

* New "Head" - Planting Material

TABLE 7(a): Input-Output Data For Yellow Yam (Dioscorea cayenensis) and Seven Polyculture Systems, Allsides, Trelawny, March 1979 - February 1980

	CROPPING SYSTEMS							
	1	2	3	4	5	6	7	8
1. Gross Returns ($)	17,278	28,764	20,374	20,992	30,489	9,926	17,496	18,402
2. Variable Costs ($)								
(a) Labour	3,321	6,521	7,161	6,020	5,074	3,642	3,834	7,209
(b) Materials	8,409	10,527	9,898	9,125	14,898	9,470	8,965	10,242
(c) Other (Int.)	704	1,023	1,023	908	1,198	787	768	1,047
TOTAL	12,434	18,071	18,082	16,053	21,170	13,899	13,567	18,498
3. Fixed Costs ($)	467	467	467	467	467	467	467	467
4. Total Costs ($)	12,901	18,538	18,549	16,520	21,630	14,366	14,034	18,965
5. Gross Margin ($)	4,844	10,693	2,292	4,939	9,319	(3,973)	3,929	(96)
6. Net Farm Income ($)	4,377	10,226	1,825	4,472	8,852	(4,440)	3,462	(563)
7. Labour (Total - Manday/Year)	316	639	702	590	497	357	376	707

Systems 2, 5 and 4 selected as best, in order of ranking.

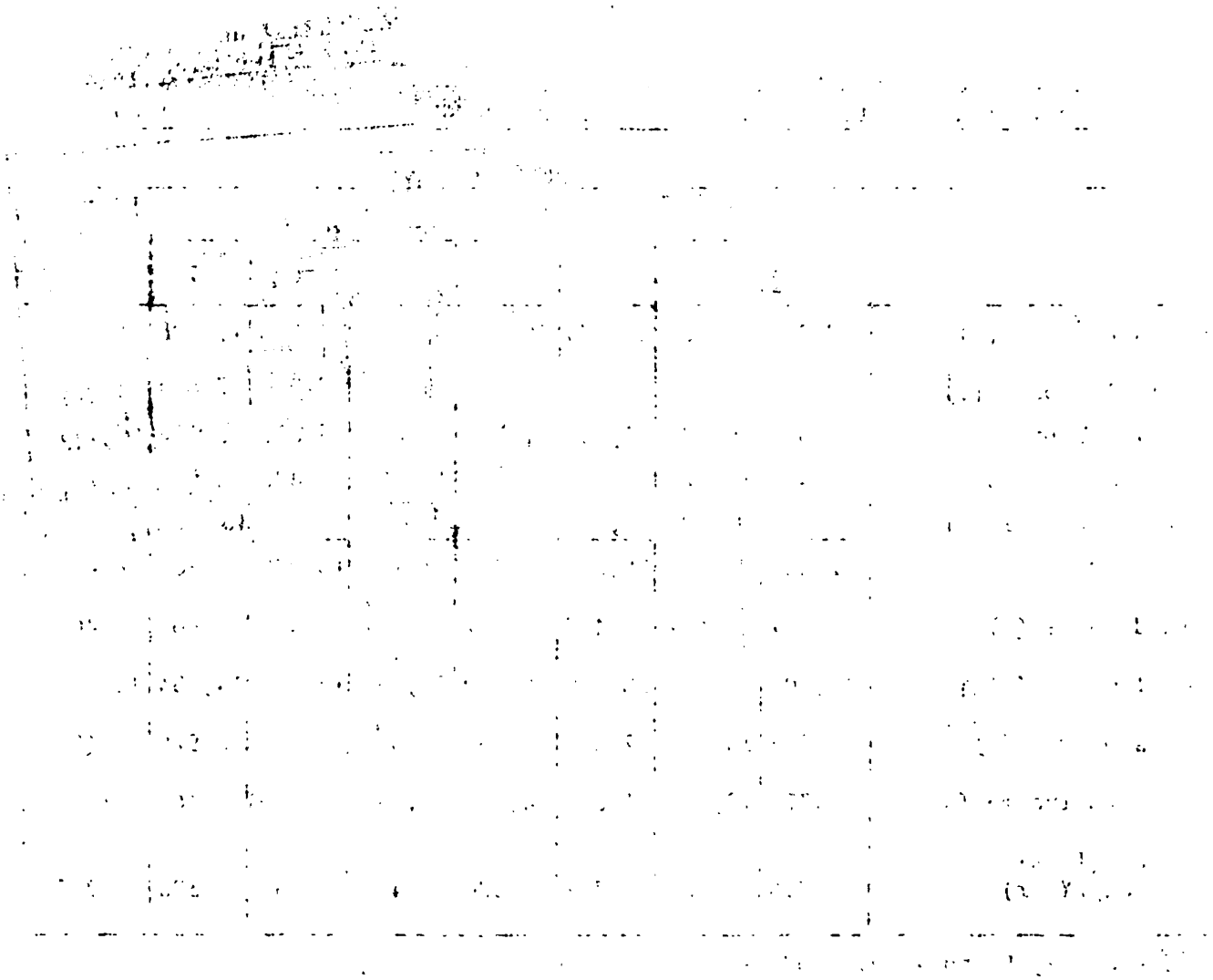


TABLE 8 Marketable yields of Yellow yams (*Dioscorea cayenensis*) and other crops alone and in a polyculture system at Allsides, Trelawny during the 1980/1981 crop year

Cropping Systems	Crops	Marketable Yield (t/ha)	New Yam "Head" Yield (t/ha) 1/	Change in total yam yield over (Monocrop (%)
1	Yam alone	12.86	5.34	-
2	Yam +	12.94	5.04	-1.2
	Cow pea +	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 pea	0.03		
6	Yam +	13.24	8.90	6.68
	Red pea +	0.49		
	Radish +	0.68		
	Cow pea	0.03		

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

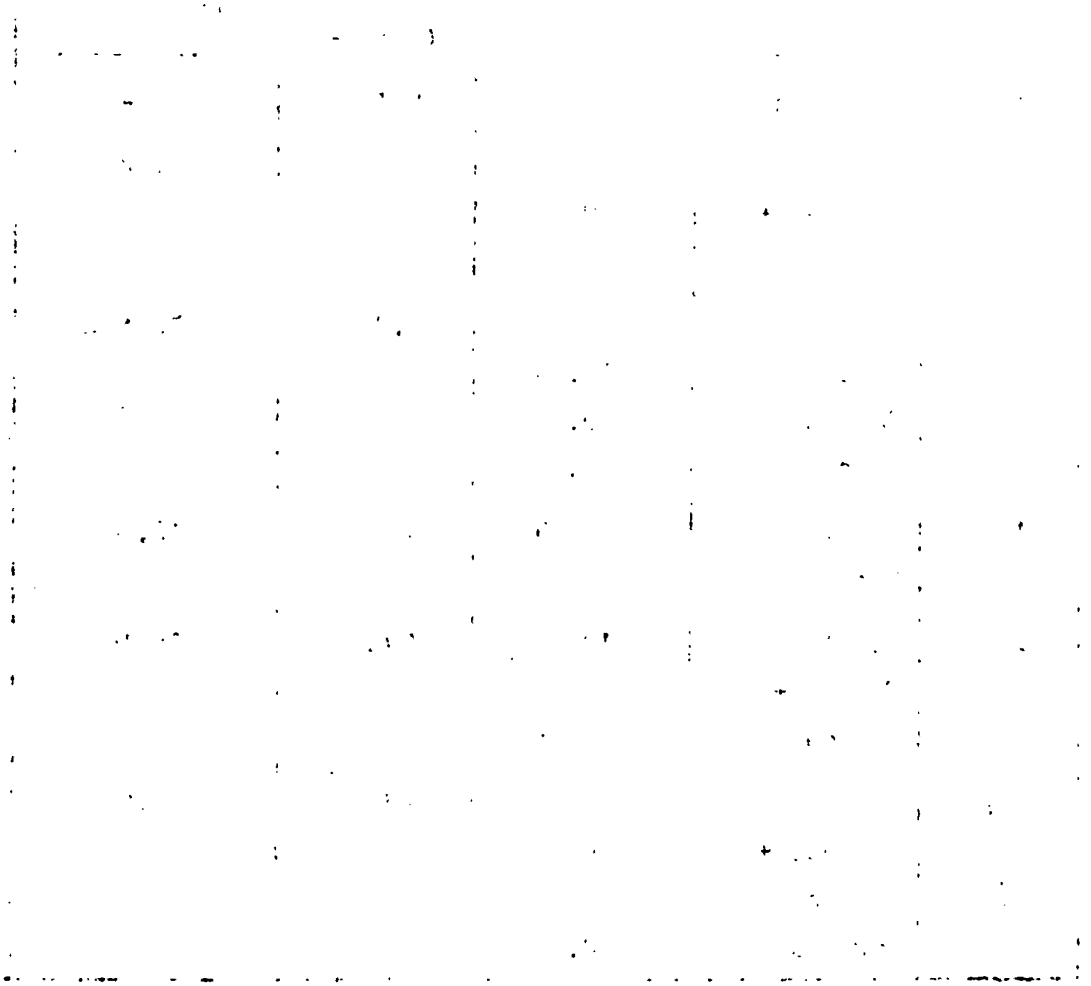


TABLE 9 Performance of selected crops when grown as a monocrop and intercrop with yams at different times of the yam crop cycle at Allsides, Trelawny during the 1980 - 81 period

Crop	Cropping period 1/	Marketable yield (kg/ha)	
		Monocrop	Intercrop
Irish potato	24/3/80 - 30/6/80	7,753	12,000
Peanut	25/4/80 - 28/8/80	847	1,400
Peanut	4/9/80 - 9/1/81	814	290
Red pea	29/4/80 - 7/7/80	414	490
Red pea	10/9/80 - 4/12/80	247	30
Cow pea	10/9/80 - 4/12/80	137	30
Ginger	15/4/80 - 20/2/81	587	1,270

1/ During the latter half of the crop year i.e. from mid-August onwards the intercrops are seeded at one-half the density used at the beginning of the cycle

BLE 10: Total inputs.outputs and net benefits of eight cropping systems validated at Allsides, Trelawny during the period March 1979 - February 1980

opping stems	Cropping Pattern	Input Costs/System/Ha.			Outputs by crop component /ha.	Return from System 2/ /ha.	% Increase (Decrease) over yam monocrop
		Labour 1/	Materials	Total			
1.	Yam as sole crop	3,230.65	8,499.03	11,729.68	17,277.65	5,547.97	-
2.	Yams +	3,230.65	8,205.49	11,436.14	15,165.68	3,729.54	
	Irish Potato +	1,610.17	1,872.97	3,483.14	9,110.00	5,626.86	
	Radish +	712.98	33.00	745.98	2,797.81	2,051.83	
	Peanut	967.16	415.74	1,382.90	1,689.70	306.80	
	Total for System	6,520.96	10,527.20	17,048.16	28,763.19	11,715.03	111
3.	Yam +	3,230.65	8,205.49	11,436.14	12,643.31	1,207.17	
	Peanut +	3,209.74	837.33	4,047.07	5,536.14	1,489.07	
	Red Pea	720.83	854.84	1,575.67	2,194.50	618.83	
	System Totals	7,161.22	9,897.66	17,058.88	20,373.95	3,315.07	- 40
4.	Yam +	3,230.65	8,205.49	11,436.14	13,407.06	1,970.92	
	Cow Pea +	1,823.86	431.48	2,255.34	6,600.00	4,344.66	
	Peanut	965.23	488.49	1,453.72	984.74	(468.98)	
	System Totals	6,019.74	9,125.46	15,145.20	20,991.80	5,846.60	5
5.	Yam +	3,230.65	8,205.49	11,436.14	13,335.62	1,899.48	
	Red Pea +	758.16	619.42	1,377.58	1,881.00	503.42	
	Ginger	1,084.79	6,073.19	7,157.96	15,271.97	8,114.01	
	System Totals	5,073.58	14,898.10	19,971.68	30,488.59	10,516.91	90
6.	Yam +	3,230.65	8,205.49	11,436.14	9,348.52	(2,087.62)	
	Sweet Potato	411.26	1,264.96	1,676.22	577.27	(1,098.95)	
	System Totals	3,641.91	9,470.45	13,112.36	9,925.79	(-3,186.57)	(- 43)
7.	Yam +	3,230.65	8,205.49	11,436.14	17,372.32	5,936.18	
	Corn +	453.59	569.79	1,023.38	123.92	(899.46)	
	Cabbage	149.53	189.66	339.19	0.00	(339.19)	
	System Totals	3,833.77	8,964.94	12,798.71	17,496.24	4,697.53	- 15
8.	Yam +	3,230.65	8,205.49	11,436.14	12,515.25	1,079.11	
	Red Pea +	2,895.88	1,717.26	4,613.14	4,004.00	(609.14)	
	Cow Pea	1,082.83	411.55	1,494.38	1,883.20	388.82	
	System Totals	7,209.36	10,334.30	17,543.66	18,402.45	859.79	- 8

1/ Computed at J$10.20/man-day
2/ Difference between outputs and inputs inclusive of labour

[illegible]

TABLE 11 Total inputs/outputs and gross returns per hectare of nine (9) cropping systems validated at Allsides Trelawny March 1980 - February 1981

Cropping Systems	INPUTS (J$)			OUTPUTS (J$)			Gross Returns	Gross profit on loss from each system (J$)
	Materials	Labour	Total	Value of mkt.yield	Value of 'now head'	Total		
Yam	8956.00	3743.64	12699.64	8306.76	3526.56	11833.32	- 866.32	(866.32)
Yam +	7524.66	4475.03	11999.69	8538.42	3324.73	11863.15	- 136.54	
Cow pea +	286.86	3313.47	3700.33	5274.50	-	5274.50	1574.17	
Peanut +	583.03	855.82	1438.85	760.32	-	760.32	- 678.53	
System totals	8394.55	8744.32	17138.87			17897.97		759.10
Yam +	4614.83	3780.57	8395.40	7258.68	4793.80	12052.48	3657.08	
Irish potato +	4064.69	974.68	5039.37	21039.04	-	21039.04	15999.67	
Radish +	20.15	171.66	191.81	220.00	-	220.00	28.19	
Peanut	567.88	768.04	1335.92	129.36	-	129.36	-1206.56	
System totals	9267.55	5694.95	14962.50			33440.88		18478.38
Yam +	7782.41	4661.68	12444099	7977.42	5490.39	13467.81	1023.72	
Ginger	1837.27	3713.39	5550.66	1114.08	-	1114.08	-4436.58	
System totals	9619.68	8375.07	17994.75			14581.89		(3412
Yam +	6955.07	2588.77	9543.84	6600.66	4482.56	11083.22	1539.38	
Peanut +	591.43	1838.69	2430.12	3756.72	-	3756.72	1326.60	
Red pea	485.84	435.24	921.08	143.00	-	143.00	- 778.08	
System totals	8032.34	4862.70	12895.04			14982.94		2087.90
Yam +	6677.44	3958.27	10635.71	8737.74	5868.75	14606.49	3970.78	
Red pea +	736.32	1890.01	2626.33	2717.00	-	2717.00	90.67	
Radish +	24.06	244.69	268.75	1188.00	-	1188.00	- 919.25	
Cow pea	187.71	506.25	693.96	110.50	-	110.50	- 583.46	
System totals	7625.53	6599.22	14224.75			18621.99		4397.24
		Solid	Stand	Cropping				
Irish potato	4506.86	2049.02	6555.88	13645.28	-	13645.28	7089.40	
Peanut	843.16	2129.11	2972.27	2368.08	-	2368.08	- 604.19	
	5350.02	4178.13	9528.15			16013.36		6485.21
Peanut	733.50	1917.94	2651.44	2148.96	-	2148.96	- 502.48	
	578.80	689.70	1268.50	2277.00	-	2277.00	1008.50	
	1312.30	2607.64	3919.94			4425.96	506.02	506.02
Red pea	880.38	1350.04	2230.42	1358.50	-	1358.50	- 871.92	
Cow pea	11123.35	1711.42	2823.77					(711.77)

1/ Computed at J$11.20/man-day

TABLE 12 Nutritional values based on Marketable yields per hectare of eight cropping systems establishing at Allsides (Site I) 1979 - 1980

		Crop Yield (tons)	kJx10^6	kcalx10^6	Protein Yield (tons)	Carbohydrate Yield (tons)
System 1	Yam	13.03	57.25	13.68	0.31	3.14
System 2	Yam	9.79	43.01	10.28	0.24	2.36
	Irish potato	13.25	45.46	10.63	0.27	2.52
	Radish	1.27	1.06	0.25	0.01	0.53
	Peanut (shelled)	0.58	13.57	3.24	0.17	0.11
	Total		102.10	24.40	0.69	5.51
System 3	Yam	7.53	33.08	7.91	0.18	1.82
	Peanut (shelled)	1.89	44.48	10.63	0.49	0.34
	Red pea	0.40	5.63	1.35	0.09	0.24
	Total		83.19	19.99	0.76	2.40
System 4	Yam	8.22	36.11	8.63	0.20	1.98
	African Red cowpea	1.50	23.79	5.69	0.38	0.88
	Peanut (shelled)	0.35	8.14	1.95	0.09	0.06
	Total		68.04	16.27	0.67	2.92
System 5	Yam	9.50	41.74	9.98	0.23	2.29
	Red pea	0.34	4.82	1.15	0.08	0.21
	Ginger (fresh)	13.87	27.28	6.52	0.22	1.25
	Total		73.84	17.65	0.53	3.75
System 6	Yam	7.33	32.20	7.697	0.18	1.767
	Sweet potato	1.31	6.41	1.53	0.02	0.359
	Total		38.61	9.22	0.20	2.12
System 7	Yam	13.08	34.93	13.73	0.31	3.15
	Sweet corn	0.47	1.89	0.45	0.02	0.10
	Cabbage	-	-	-	-	-
	Total		36.82	14.18	0.33	3.25
System 8	Yam	7.95	34.93	.35	0.19	1.92
	Red pea	0.73	10.26	2.45	0.16	0.44
	African Red cowpea	0.43	6.79	1.62	0.11	0.05

Notes: 1. Values given were computed from (i) C.F.N.I., 1974 Food Composition Tables for use in the English-Speaking Caribbean; and, for African Red Cowpea only, from (ii) Research and Development Department, Ministry of Agriculture, (Jamaica) 1980, Legume Seminar. The Nutritive value of Legumes pp 26 - 32. 2. 1 kcal (kilocalorie) = 4.184 kJ (kilojoules) 3. Values for peanut were calculated using a shelling % of 75.

TABLE 13 Comparing nutritional value of marketable crop yields per hectare of yam monocrop system with those of seven other cropping systems

Cropping Systems	% increase over yam monocrop in quantity of:		
	Energy	Protein	Carbohydrate
2. Yam+Irish potato+radish+peanut	78	118	76
3. Yam+peanut+red pea	46	143	-23
4. Yam+cow pea (African red)+peanut	19	113	-7
5. Yam+red pea+ginger	29	68	19
6. Yam+Sweet potato	-33	-38	-32
7. Yam +Sweet corn+cabbage	4	6	4
8. Yam+red pea+Cowpea (African red)	-9	45	-23

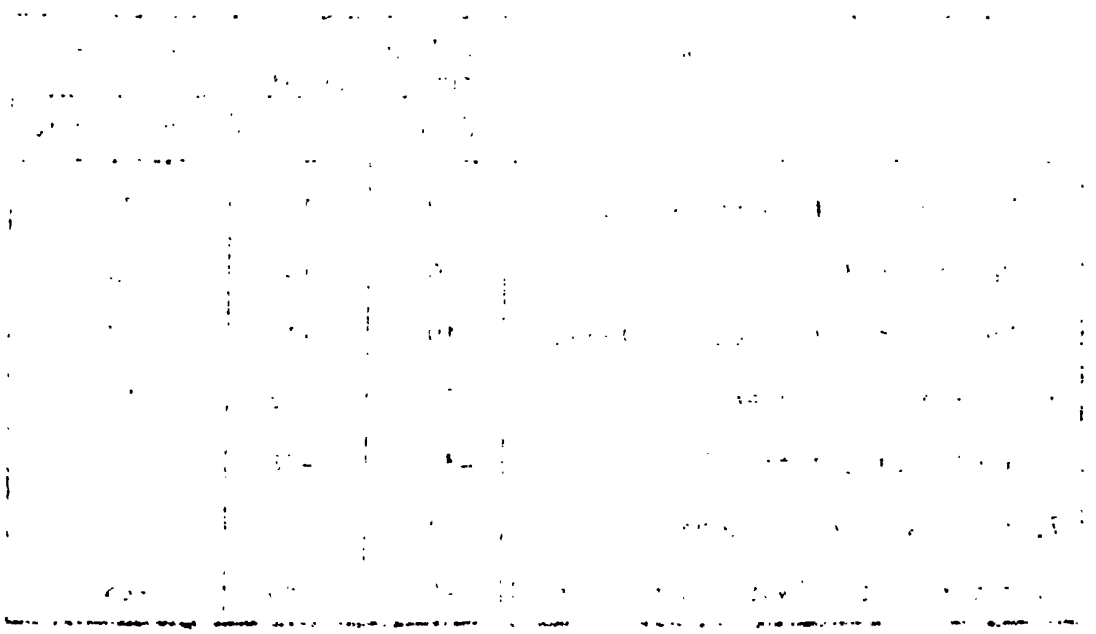


TABLE 14 Comparison of monthly labour inputs (man-days) per hectare for cropping systems established at Allsides, during the 1979/1980 crop year with farmers traditional practice

Month	Farmers*	C R O P P I N G S Y S T E M							
		1	2	3	4	5	6	7	8
March	55	147	147	147	147	147	147	147	147
April	50	54	90	203	68	120	69	89	111
May	20	18	31	18	41	18	18	24	18
June	31	0	11	6	3	4	19	3	21
July	0	12	140	16	150	67	12	18	218
August	0	0	44	157	0	22	0	4	0
September	25	17	49	54	17	17	17	31	85
October	6	6	7	8	6	6	6	6	9
November	24	9	10	41	11	9	16	9	14
December	9	0	1	0	2	0	0	0	31
January	50	1	57	52	109	1	1	1	1
February	62	52	52	0	0	86	52	52	52
Total	323	316	639	702	590	497	357	376	707

* Traditional practices of the farmers

CROPPING SYSTEMS:

1. Yam as sole crop
2. Yam and Irish potato & radish & peanut
3. Yam & peanut & red pea
4. Yam & cowpea (African red) & peanut
5. Yam & red pea & ginger
6. Yam & sweet potato
7. Yam & corn & cabbage
8. Yam & red pea & cowpea

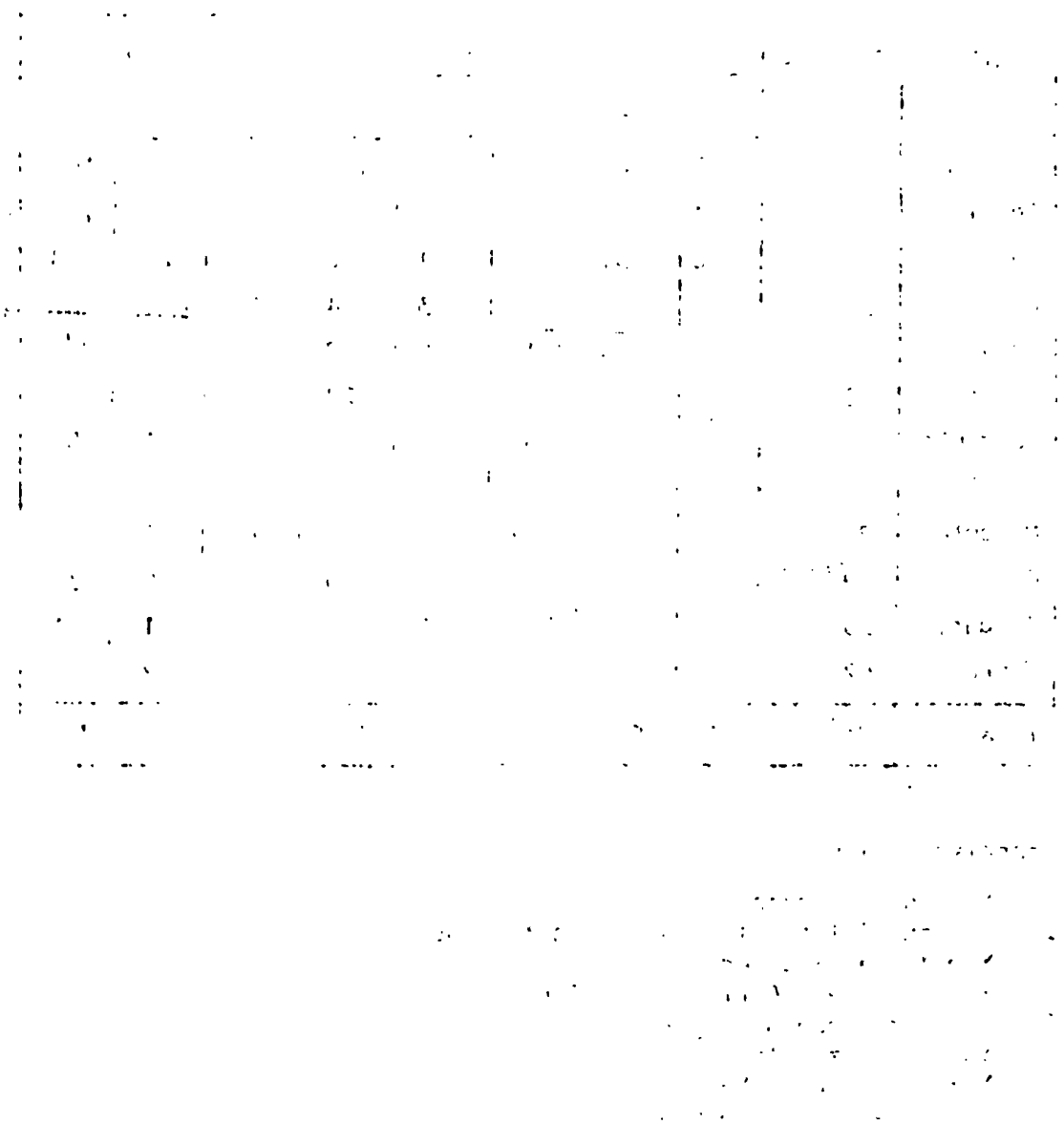


TABLE 15 Manual labour required (man-days) for the establishment, maintenance and harvest of eight cropping systems tested at Allsides, Trelawny, during the 1979/1980 crop year

Cropping systems	Man-days per hectare	Increase over yam monocrop	% Increase over yam monocrop
Yam as sole crop	316	-	-
Yam & Irish potato & radish & peanut	639	323	102
Yam & peanut & red pea	700	384	122
Yam & cowpea & peanut	590	274	87
Yam & red pea & ginger	497	181	57
Yam & sweet potato	357	41	13
Yam & grain corn & Cabbage	376	60	19
Yam & red pea & cow pea	707	391	124

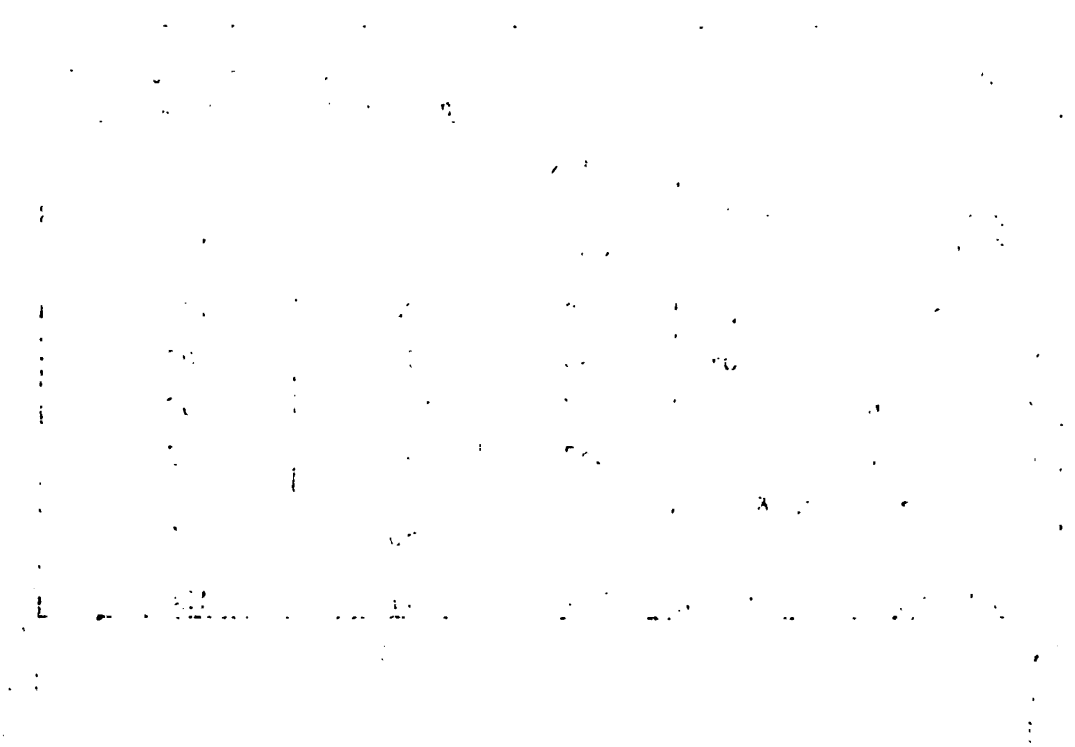


TABLE: 16 Schedule of sampling intervals and rainfall data for soil run-off studies conducted at Olive River, Trelawny during the period April 1980 - March 1981

Sampling-Intervals	Dates	Length of Interval (days)	Number of Rainy Days	Rainfall during Interval (mm)	(inches)	Cumulative Rainfall (mm)	(inches)
	1980						
1	April 26-May 8	13	5	87.9	3.46	87.9	3.46
2	May 9 --May 20	12	6	92.8	3.65	180.7	7.11
3	May 21-May 27	7	3	83.3	3.28	264.0	10.40
4	May 28-June 10	14	7	157.2	6.19	421.2	16.58
5	June 11-July 4	24	2	55.0	2.17	476.2	18.75
6	July 5-July 22	18	8	81.9	3.22	588.1	21.97
7	July-23-Agg. 12	21 3	3	229.1	9,02	787.2	30.99
8	Aug. 13-Sept. 9	28	8	66.4	2,61	853,6	33.61
9	Sept. 10-Oct. 7	28	10	66.3	2,61	919.9	36.22
10	Oct. 8-Dec. 10	64	18	154.5	6.08	1074.4	42.30
11	Dec. 11, 1980-March 3, 1981	83	19	220.7	8.69	1295.1	50.99
	Total days 312	89					

TABLE: 17 Soil losses recorded from four soil conservation cum cropping system treatment at the GOJ/IICA, Olive River Demonstration Site over the 1980 - 1981 period

Soil Conservation Cropping Systems Treatment	SOIL LOSS 1/					% Reduction from control
	(oven-dry)			Field soil (at 20% H20)		
	kg/plot	ton/ha	ton/ac*	ton/ha	ton/ac	
1. Yam planted as sole crop on individual hills (control)	729.59	178.97	71.25	214.76	85.50	-
2. Yam intercropped with Irish potato and Radish on individual hills with hillside ditch.	421.01	102.77	40.91	123.32	49.09	42.58
3. Yam intercropped with Irish potato and Radish on continuous contour mounds with hillside ditch	206.48	49.05	19.53	58.86	23.43	72.59
4. Yam intercropped with Irish potato and Radish on continuous contour mounds with a grass strip	172.06	42.84	17.06	51.41	20.46	76.06

1/ Values are mean of two replications

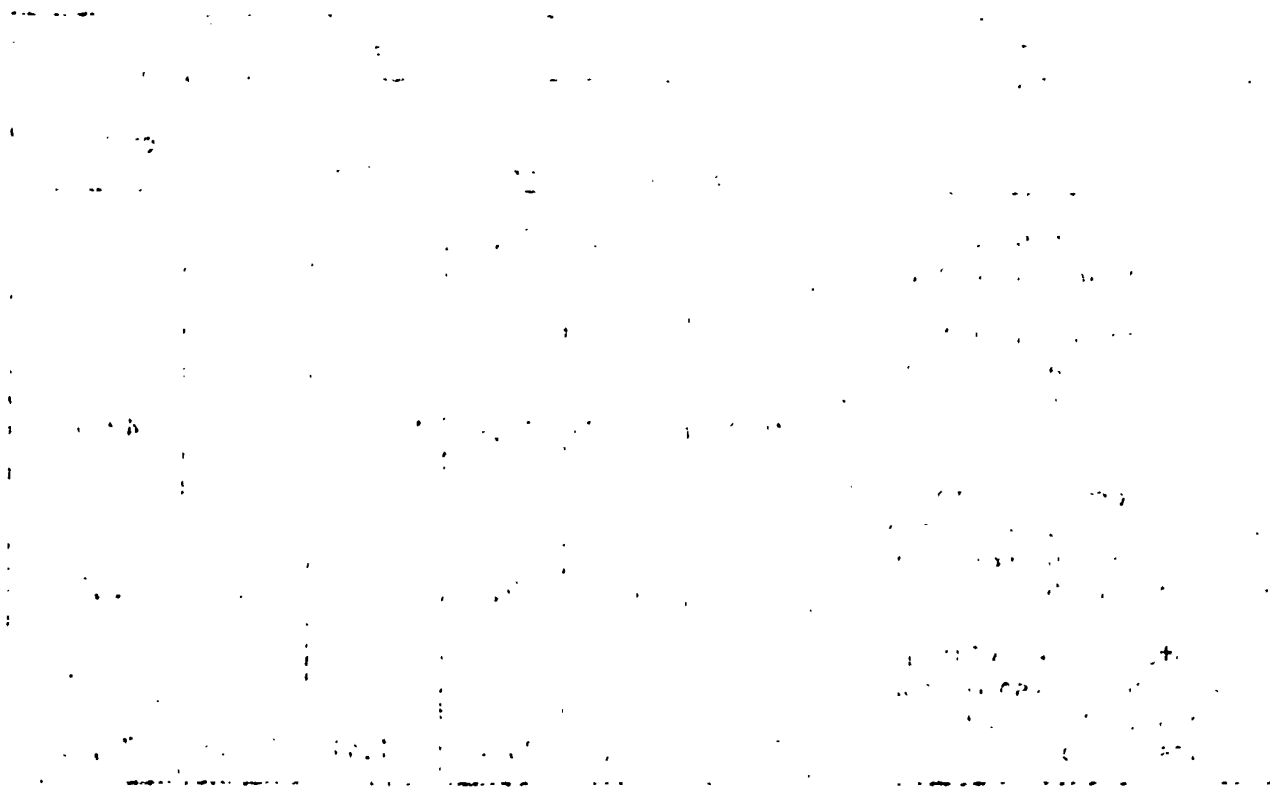


TABLE: 18 Yellow yam tuber yields of soil run-off plots treated with conservation measures cum cropping system at the GOJ/IICA Olive River Demonstration Site, Trelawny, during the 1980-'81 cropping cycle[1/]

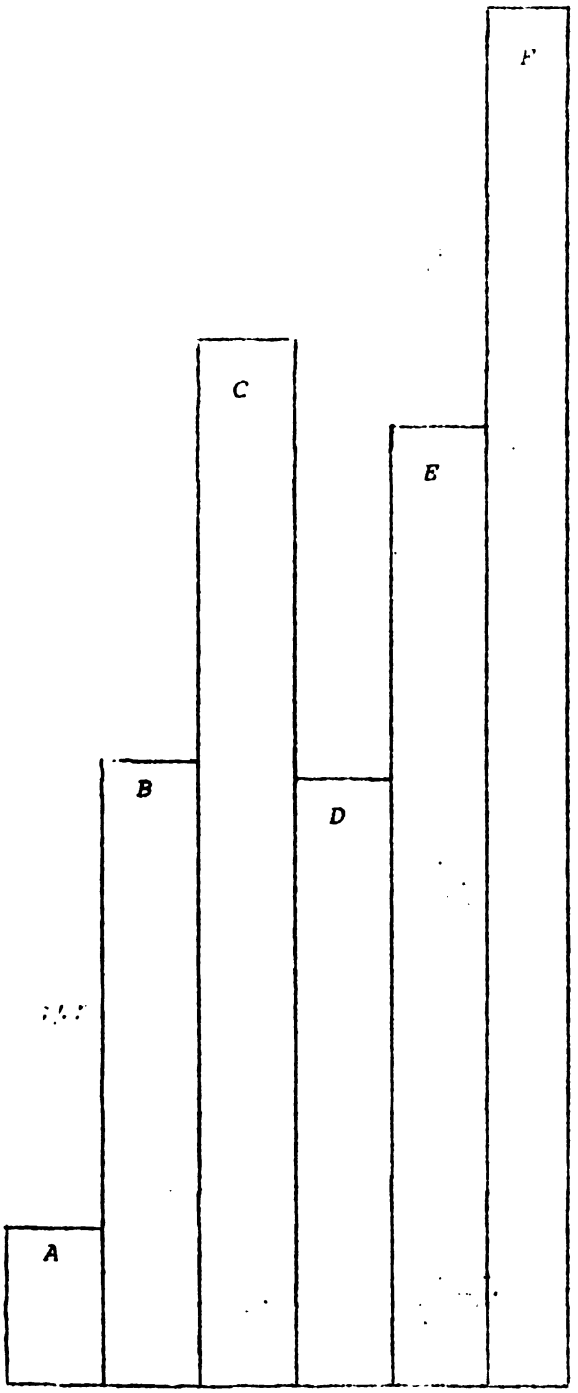
Soil Conservation Treatment	Cropping Pattern	Gross tuber Yield(t/ha)	Marketable tuber yield (t/ha)	Production of 'new heads' for planting (t/ha)
Individual hills (check)	Yam as sole crop	62.23	28.80	14.69
Individual hills with hillside ditch	Yam+Irish potato+ Radish	53.98	29.94	11.29
Continuous contour mounds with hillside ditch	Yam+Irish potato+ Radish	42.20	16.51	13.75
Continuous contour mounds with grass buffer strip	Yam+Irish potato+ Radish	42.11	17.18	13.16

1/ Values are the means of two replications

TABLE: 19 Saleable yields of yellow yam and intercrops grown on soil run-off plots at the GOJ/IICA Olive River Demonstration Site, Trelawny, during the 1980-81 cropping cycle

Soil Conservation Treatment	Cropping Pattern	SALEABLE YIELDS				
		YAM Table (t/ha)	'New Heads'	IRISH Table (t/ha)	POTATO Seed Material	RADISH (kg/ha)
Individual hills(check)	Yam as sole crop	28.80	14.69			
Individual hills with hillside ditch	Yam+Irish potato+ Radish	29.94	11.29	7.14	3.63	700
Continuous contour mounds with hillside ditch	Yam+Irish potato+ Radish	16.51	13.75	8.63	3.33	863
Continuous contour mounds with grass buffer strip	Yam+Irish potato+ Radish	17.18	13.16	7.6	3.96	588

1/Values are the means of two replications



Average by class (surveyed)

Class A (0^{o}- $\angle 2^{o}$) - 77,445 acres (30,978 ha);

Class B (2^{o}- $\angle 5^{o}$) - 322,395 acres (128,966 ha);

Class C (5^{o}- $\angle 10^{o}$) - 549,046 acres (219,618 ha);

Class D (10^{o}- $\angle 20^{o}$) - 314,087 acres (125,635 ha);

Class E (20^{o}- $\angle 30^{o}$) - 502,231 acres (200,892 ha);

Class F (30^{o} and greater) - 720,368 acres (288,147 ha)

Fig:- 1 *Histogram of total acreage of Jamaica by slope categories and land capability class*

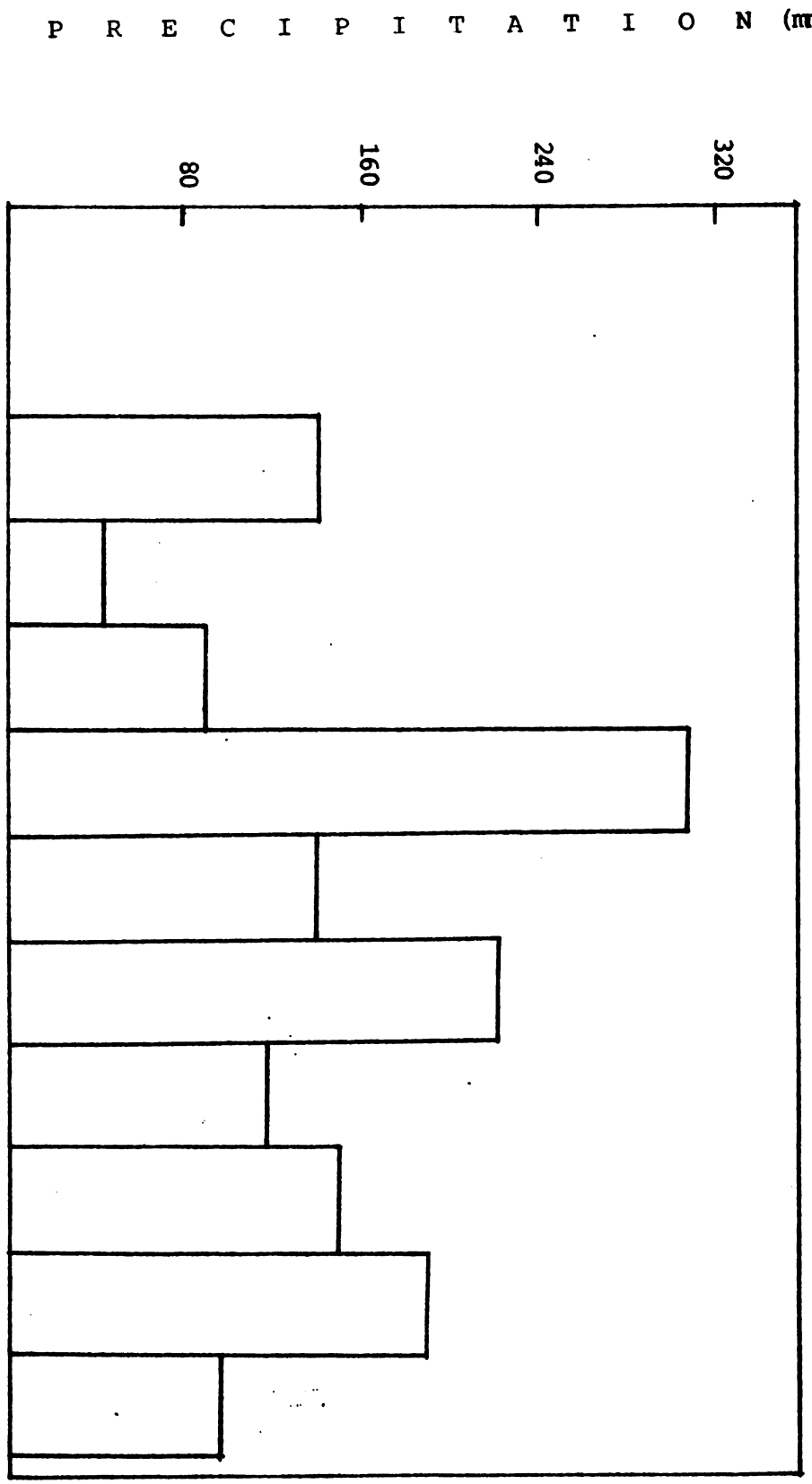
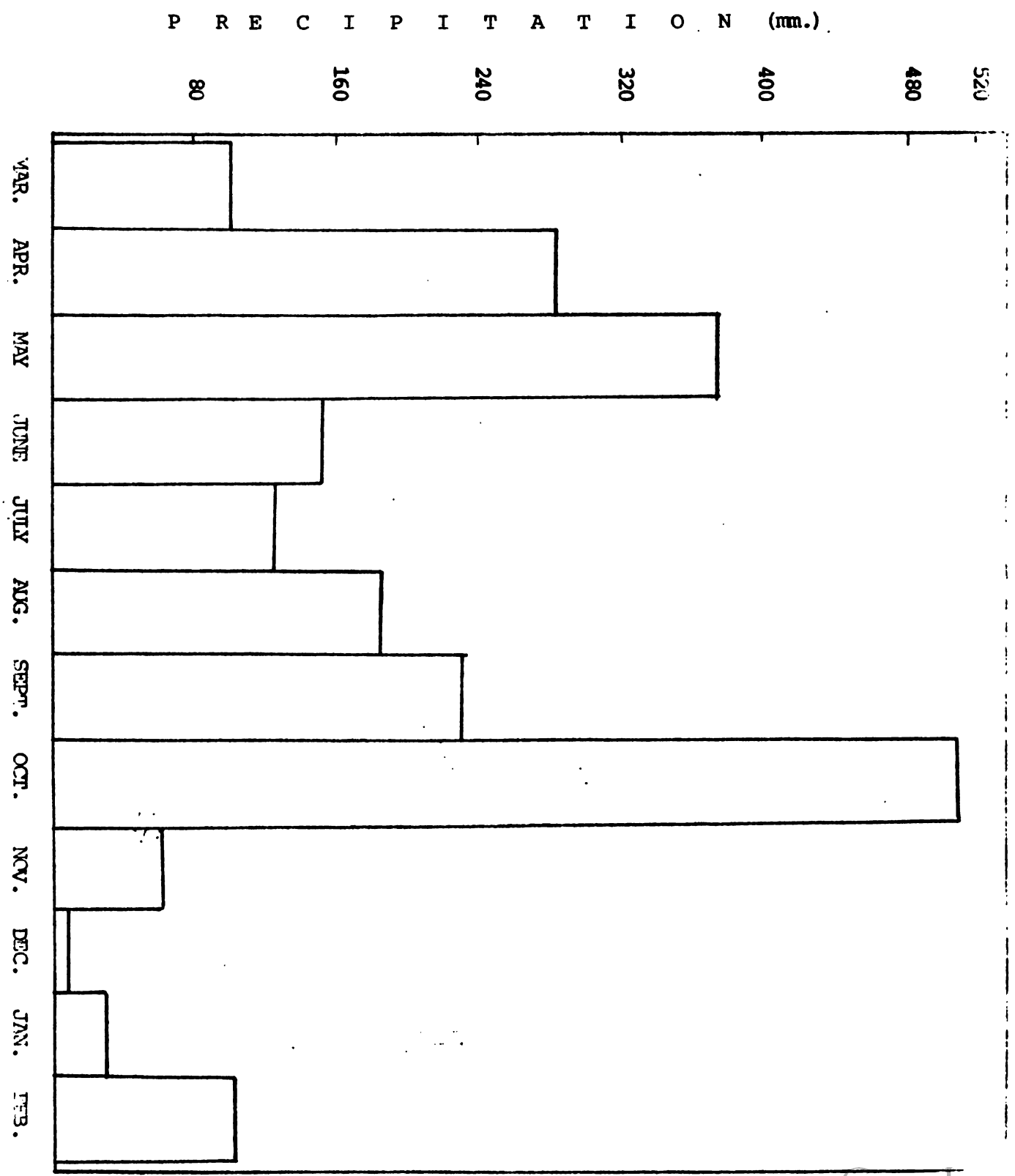


Fig. 2 - Histogram of total monthly rainfall at Allsides, Trelawny, May 1977 - February 1978



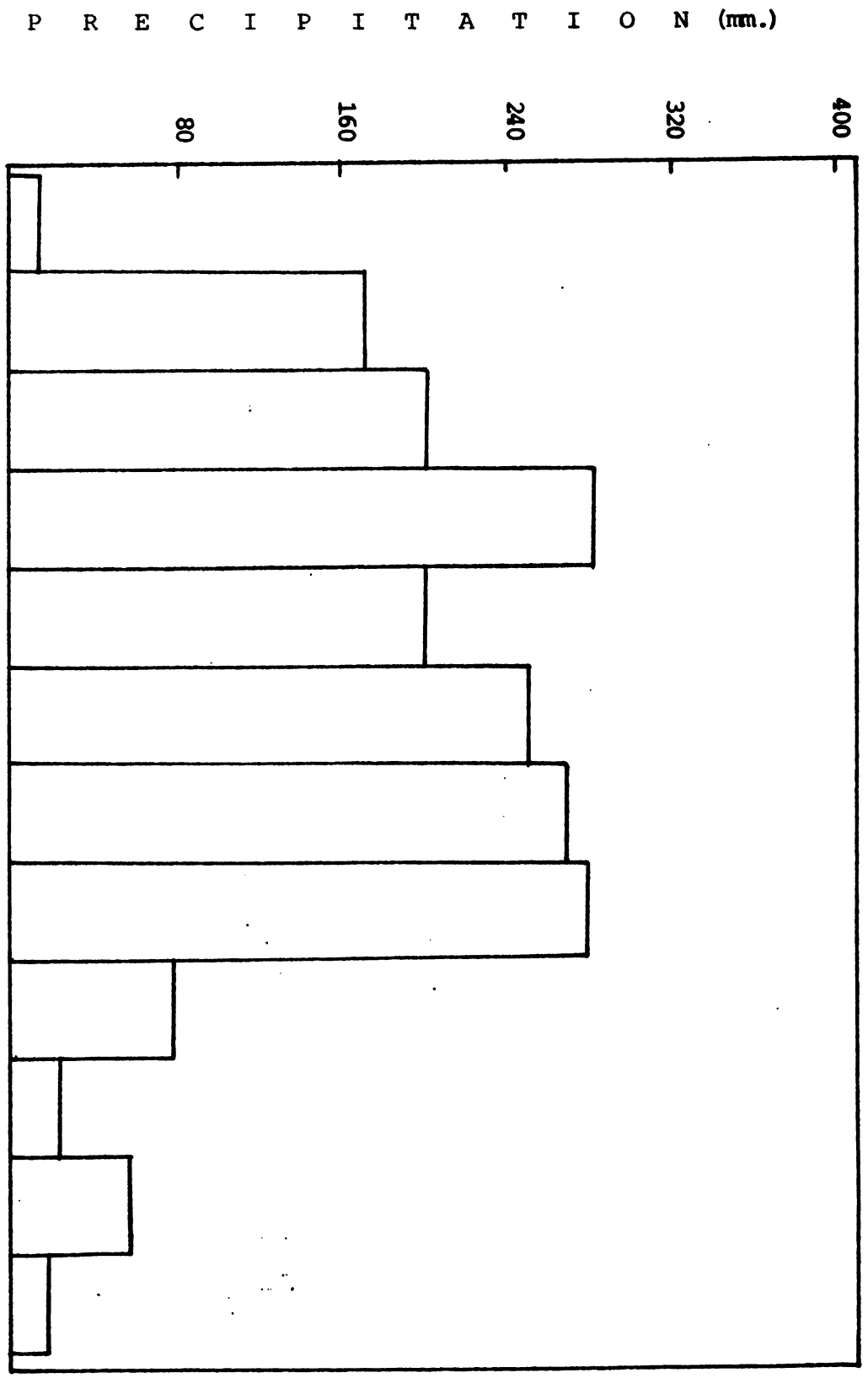


Fig. 4 - Histogram of total monthly rainfall at Allsides, Trelawny, March 1979-February 1980

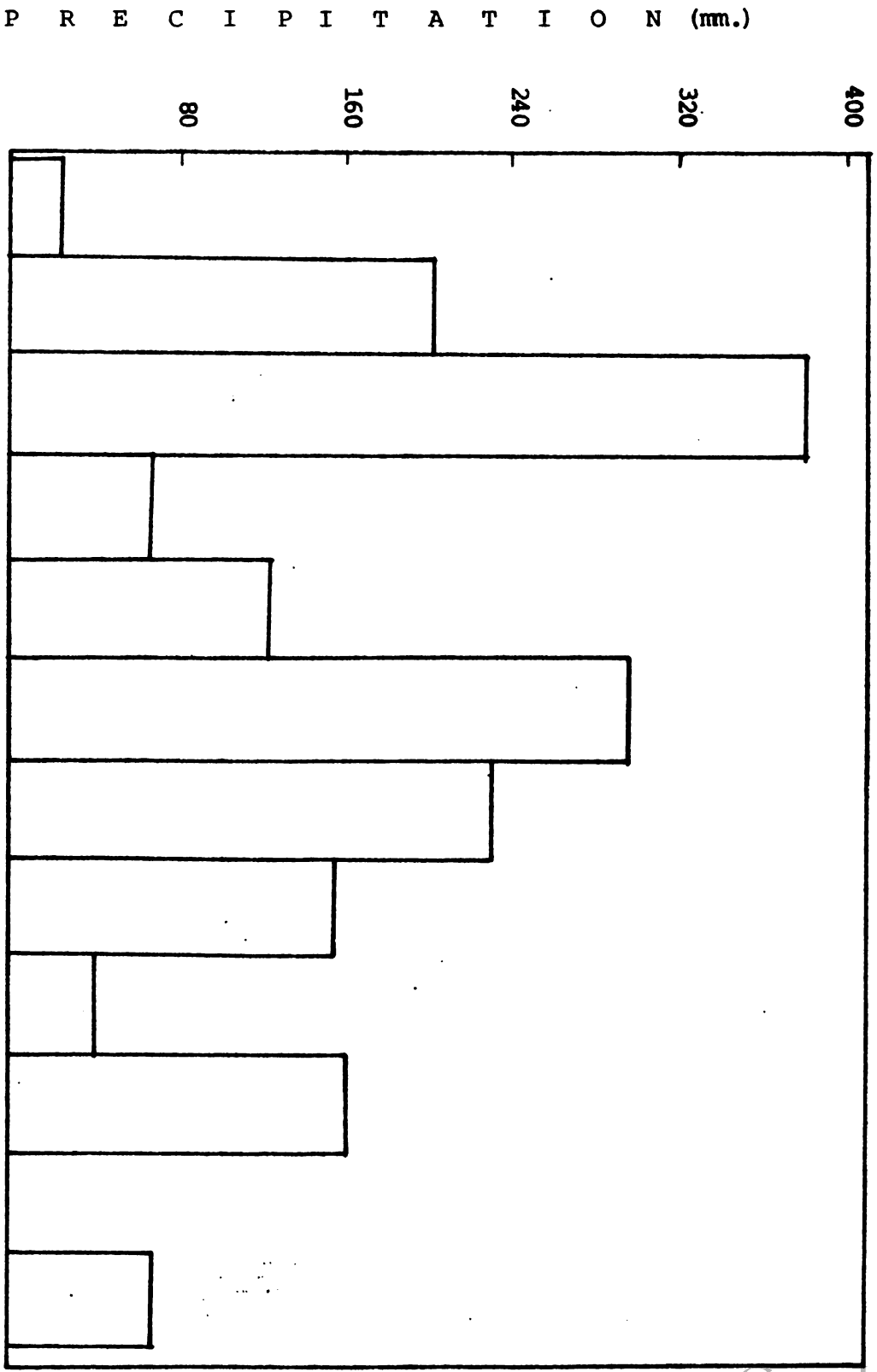


Fig. 5 - Histogram of total monthly rainfall at Allsides, Trelawny, for the period March 1980 - February 1981

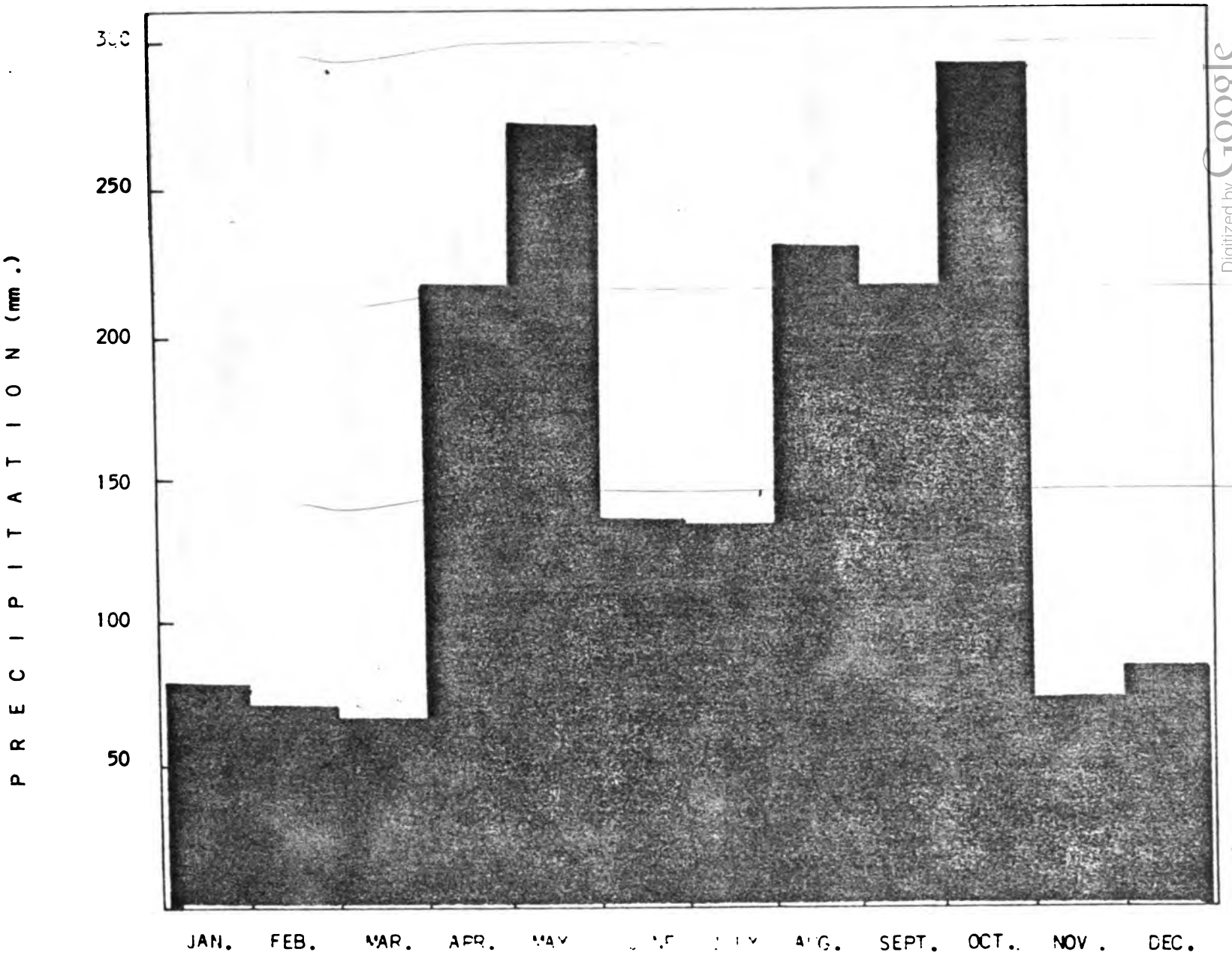


Fig. 6: Histogram of mean monthl[illegible] at Ballsbridge, Ireland, for the period January 1877 to [illegible]

Fig. 7 - Cropping Systems established at Allsides during period April 1977 to March 1978

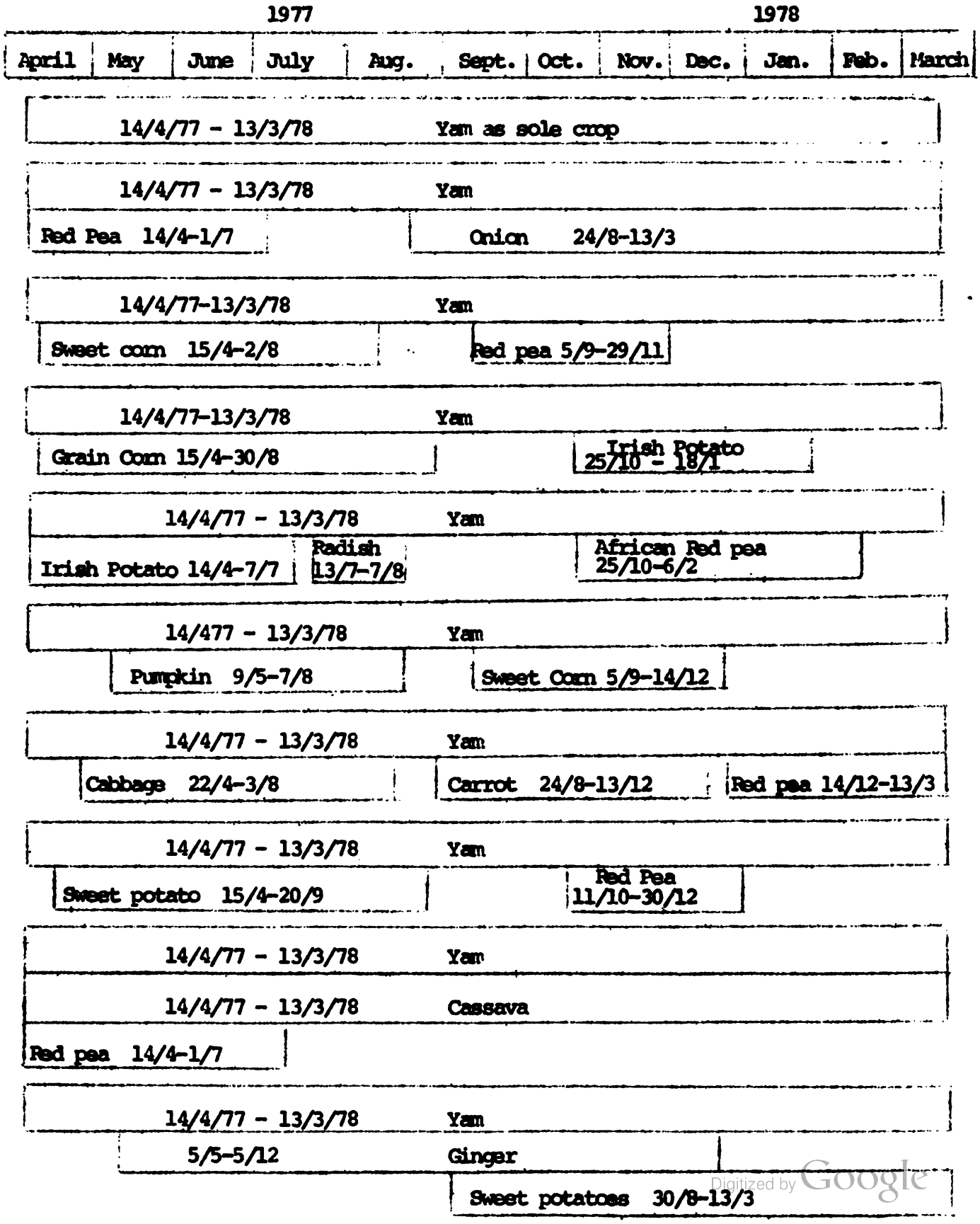


Figure: 8 Cropping Systems established at Allsides during period April 1978 to February 1979

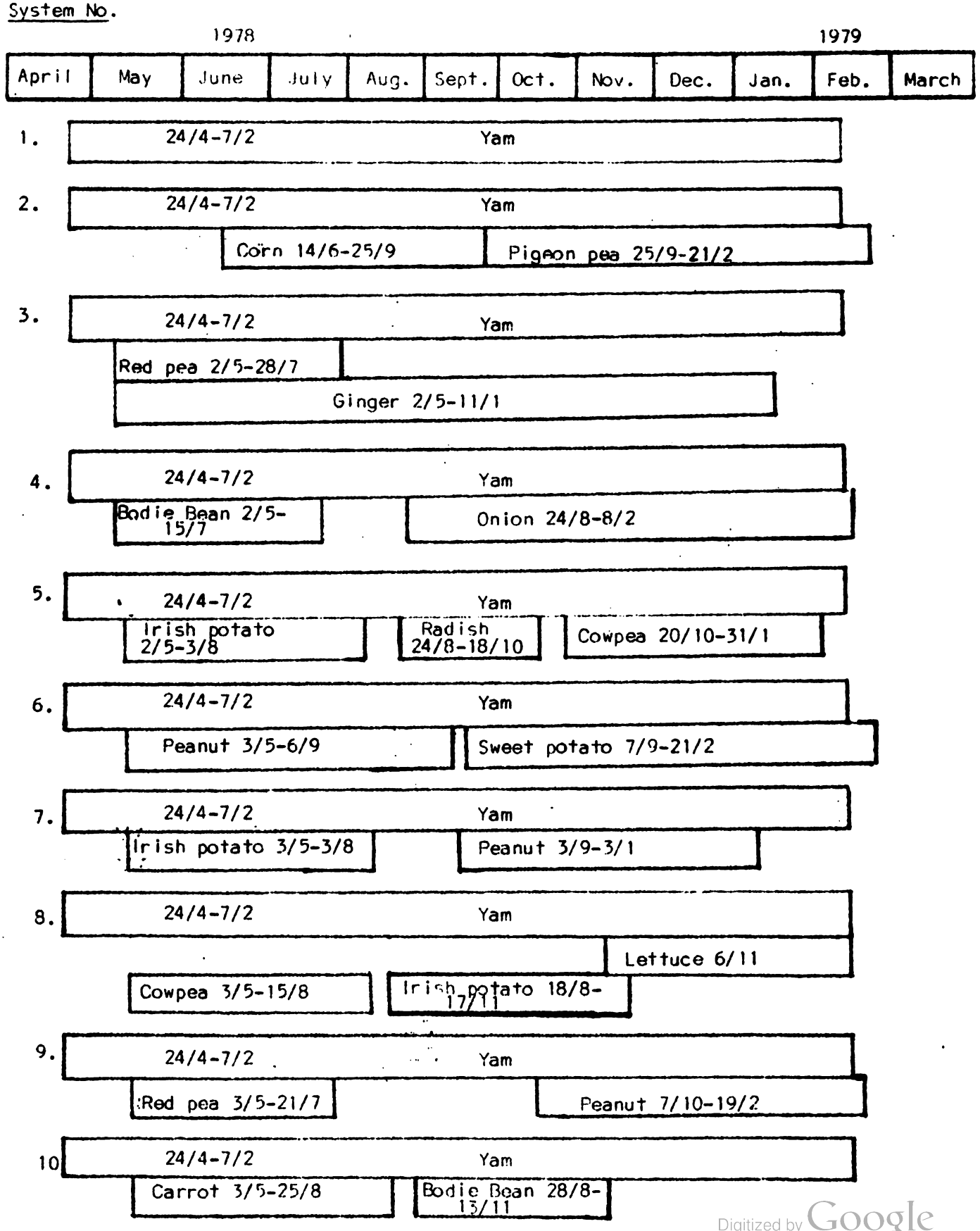


Figure 9 - Cropping Systems tested at Allsides Pilot Development Project

SITE 11 '78 - '79

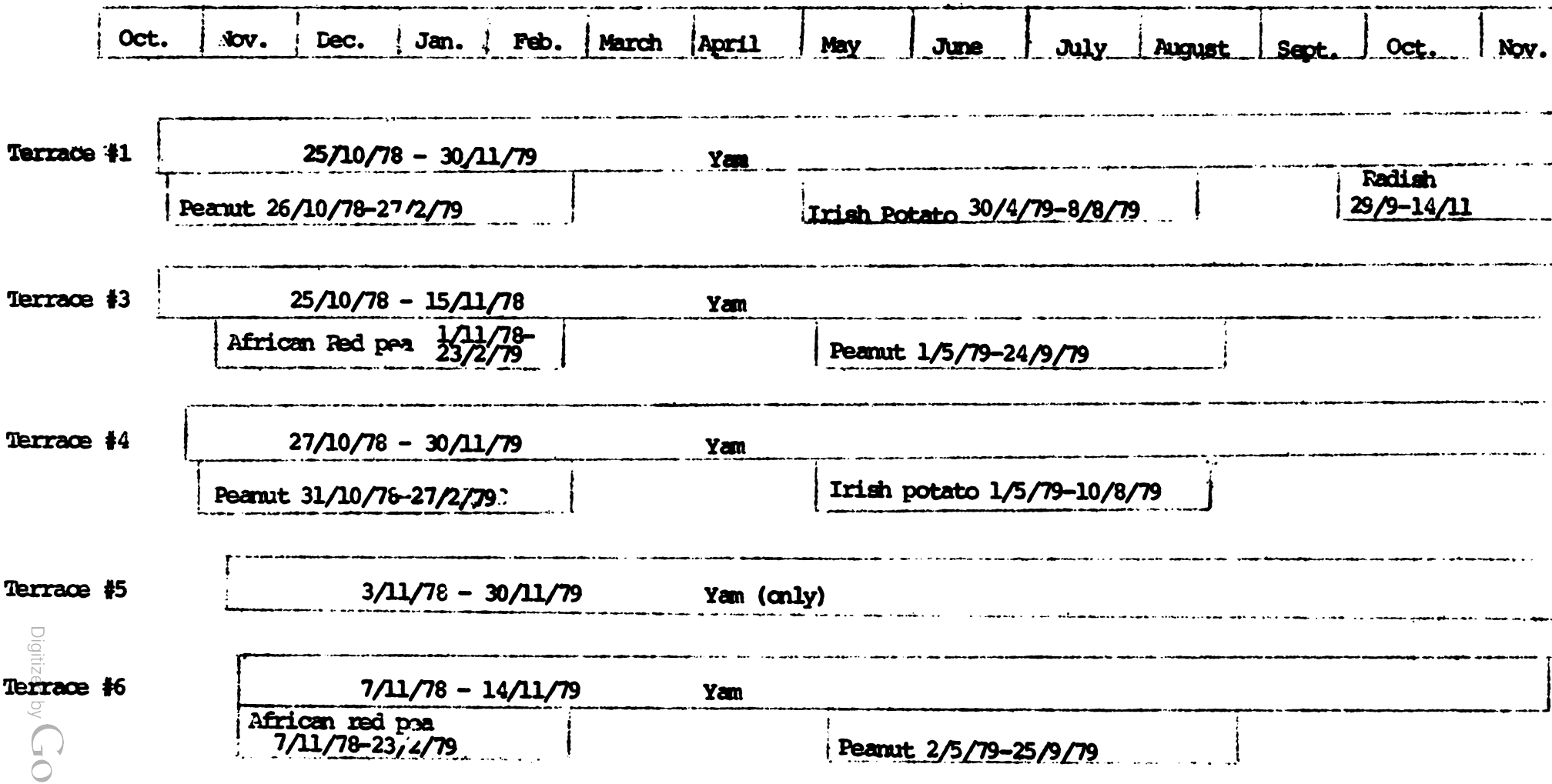


Figure 10 - Cropping Systems established at Allsides (Site 1) during period March 1979 to February 1980

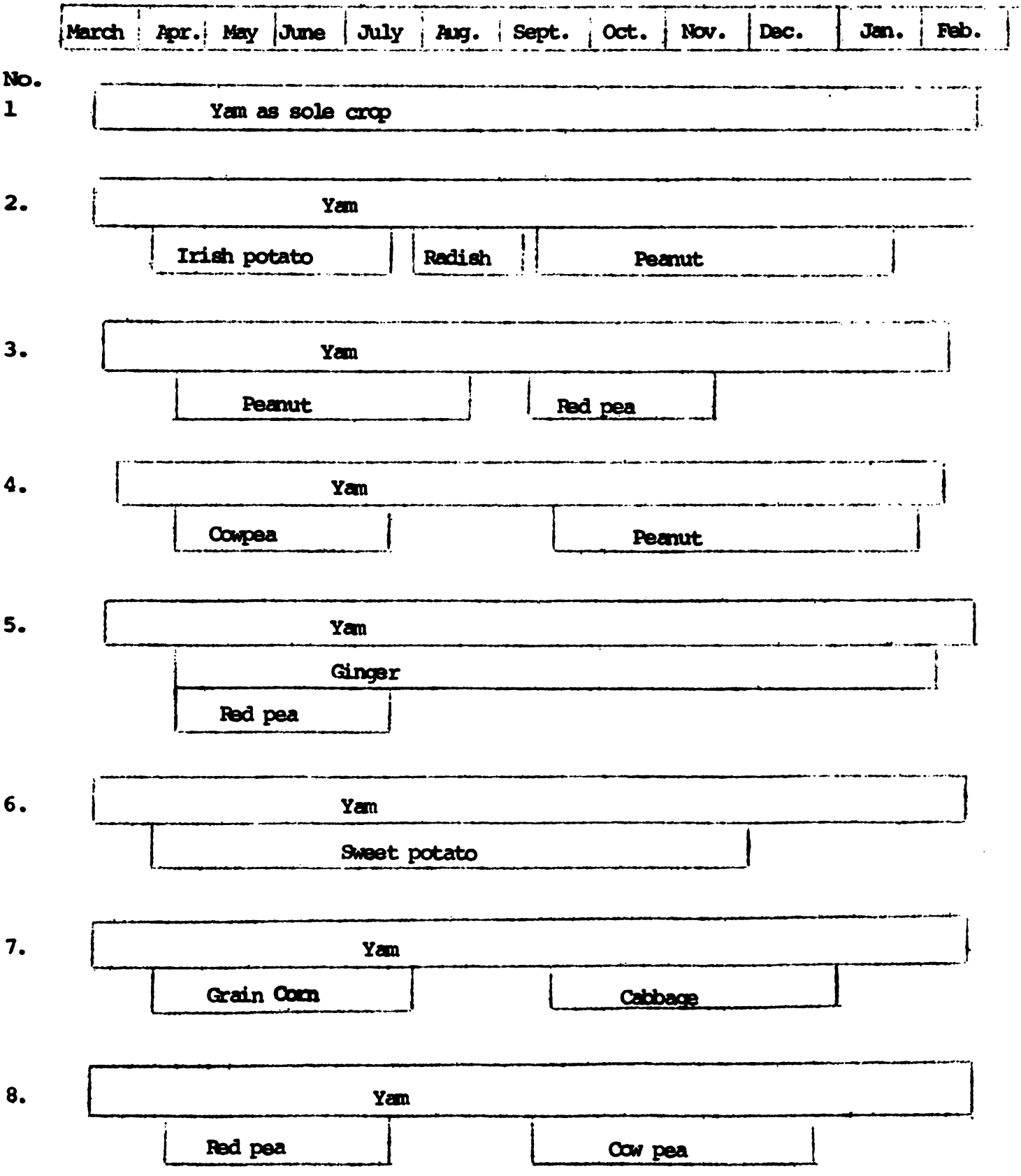


Figure 11 - Allsides Pilot Development Project Cropping Systems
Site 1 1980 - 1981

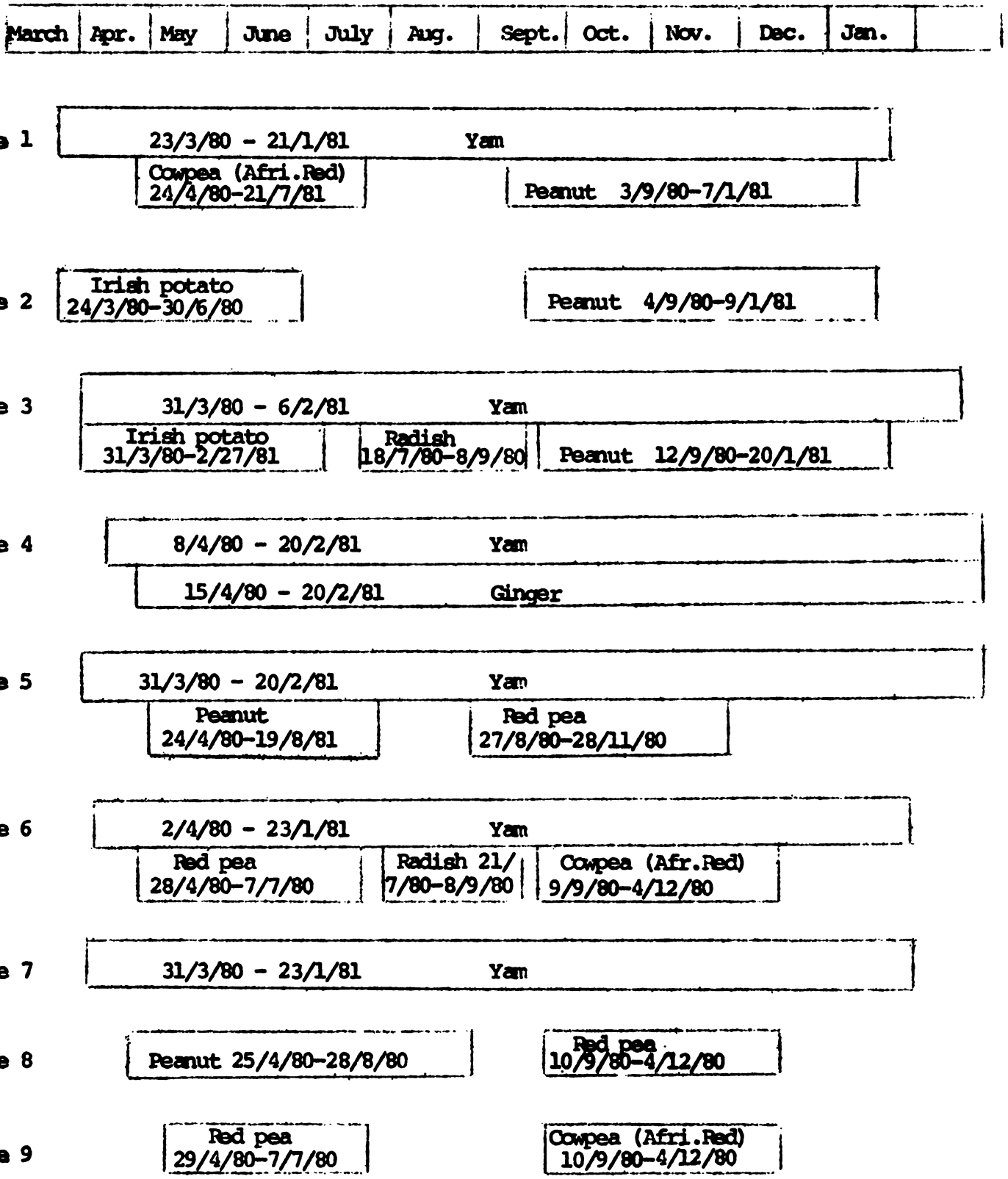
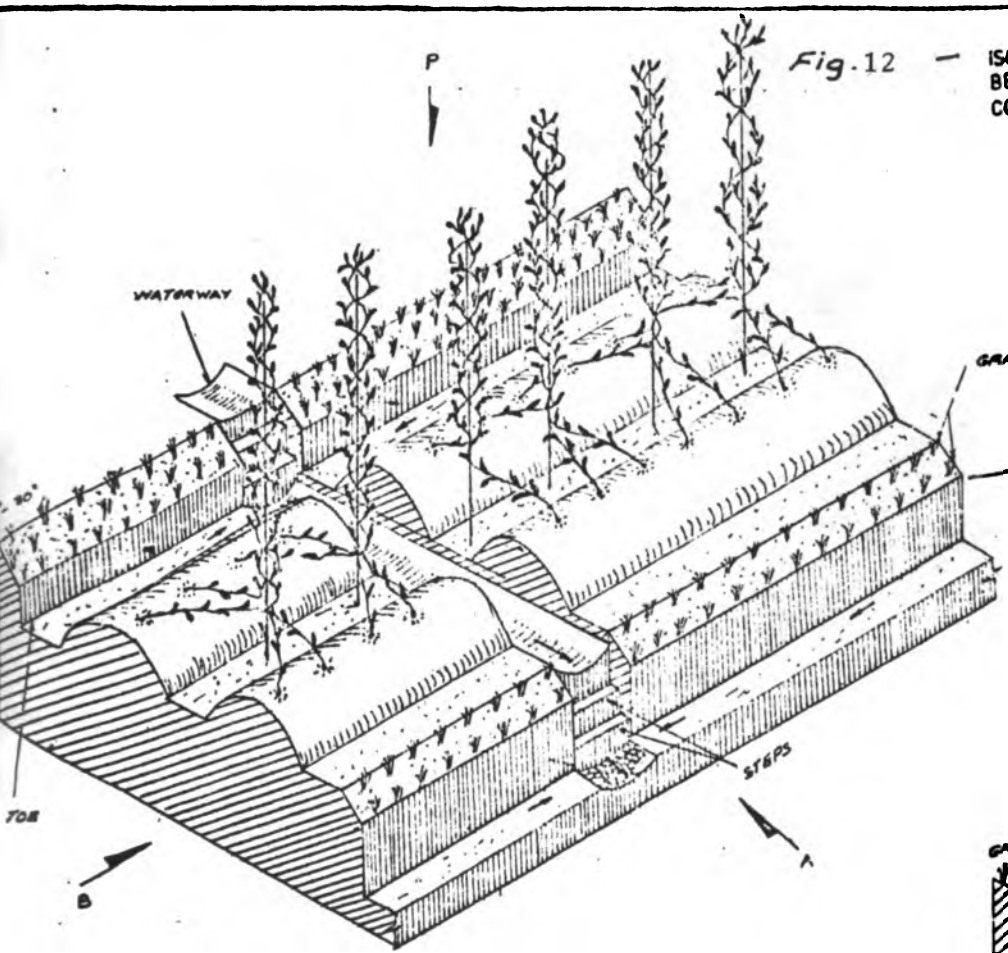
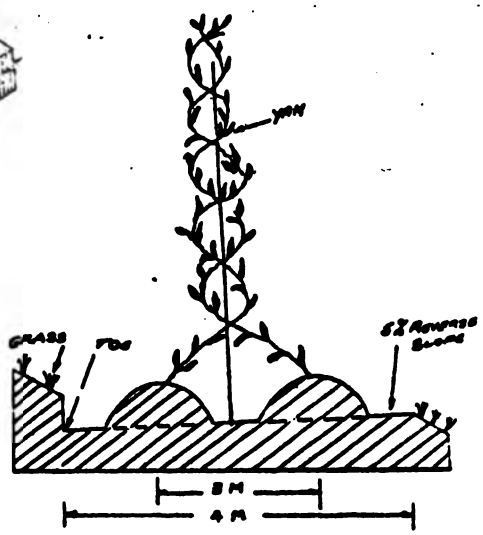


Fig.12 — ISOMETRIC & SECTIONAL VIEWS OF A BENCH TERRACE WITH YAMS GROWN ON CONTINUOUS MOUNDS. ALLSIDES/JAMAICA





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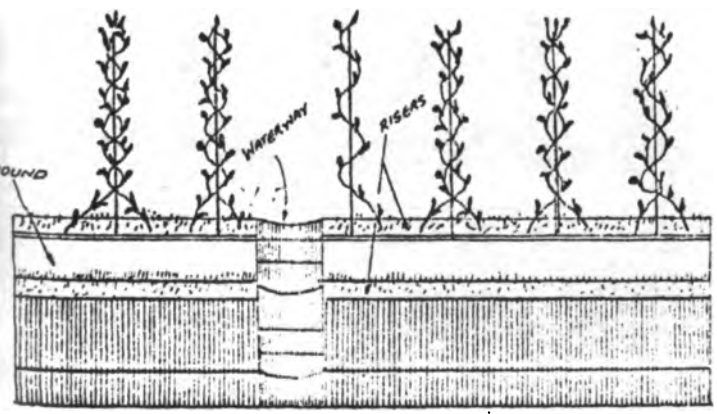

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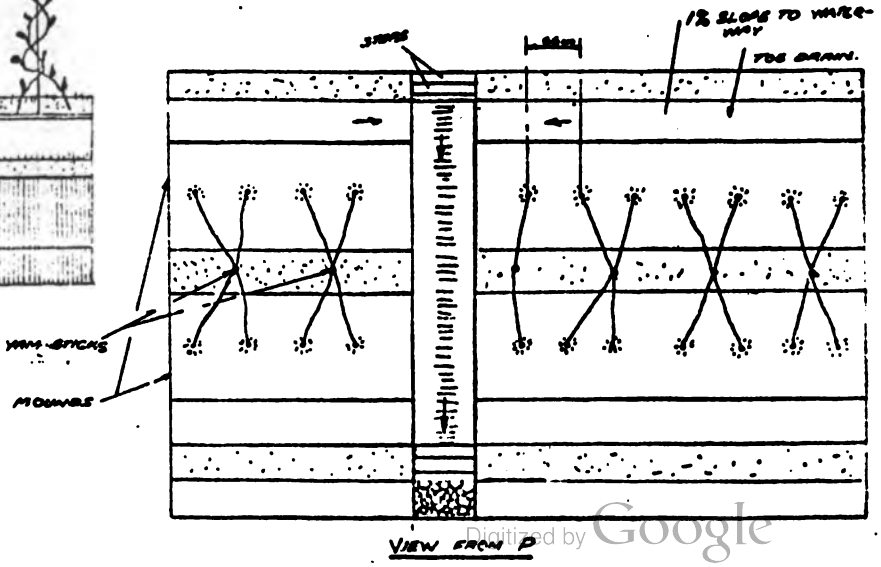

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Fig. 13 ISOMETRIC & SECTIONAL VIEWS OF A BENCH TERRACE SHOWING YAMS INTERCROPPED WITH IRISH POTATO DURING THE FIRST HALF OF THE YAM CROP CYCLE. (11 Months)

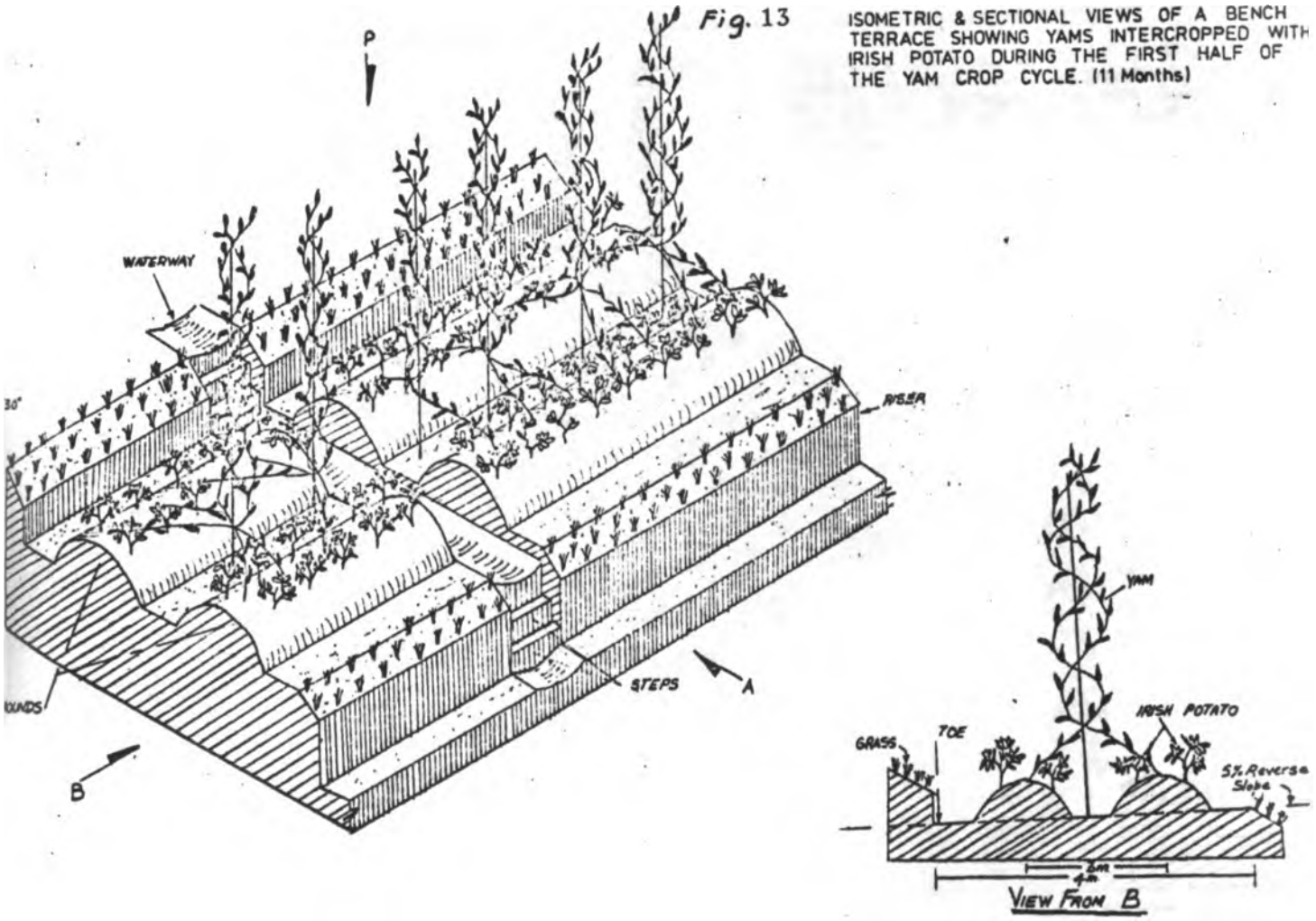
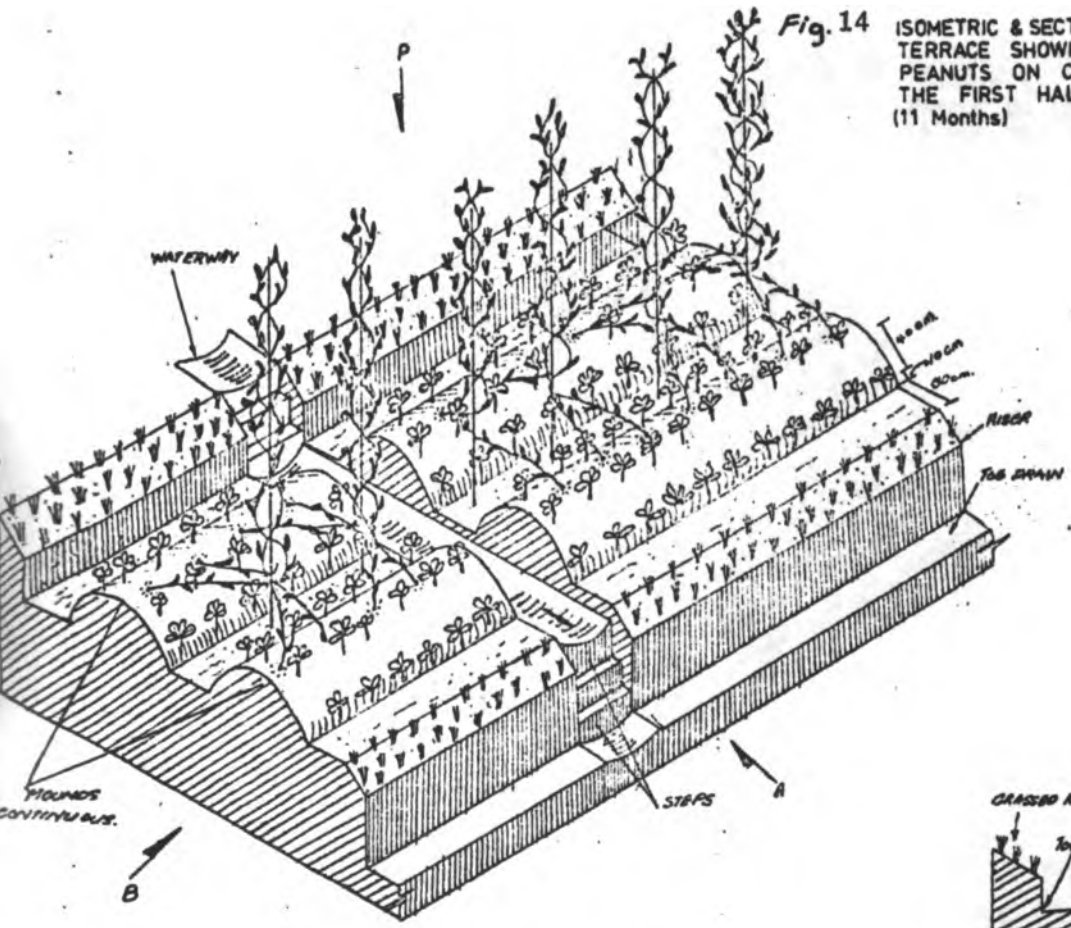
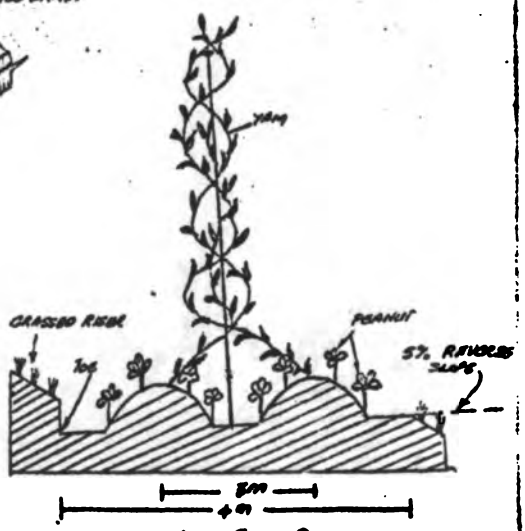
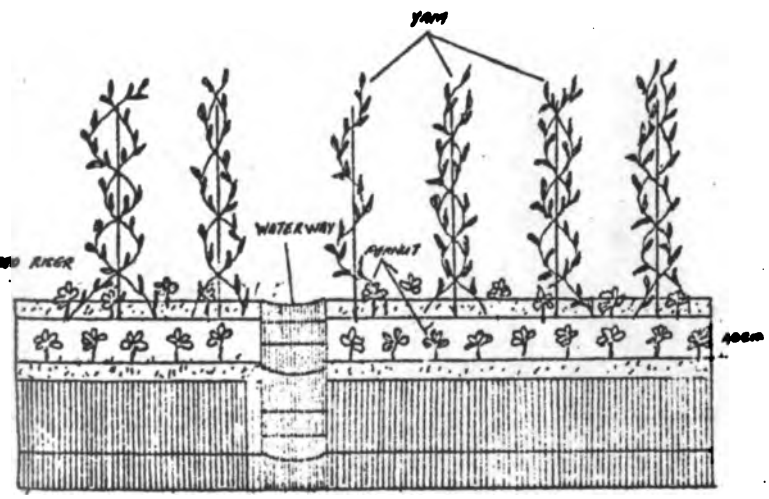
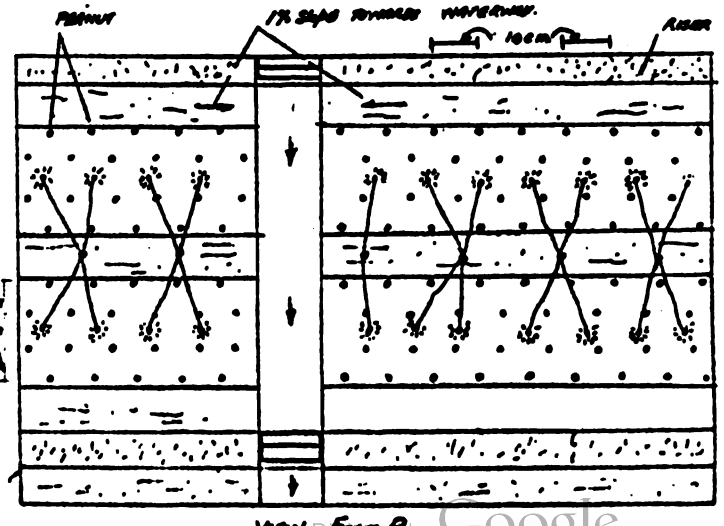


Fig. 14 ISOMETRIC & SECTIONAL VIEWS OF A BENCH TERRACE SHOWING YAMS INTERCROPPED WITH PEANUTS ON CONTINUOUS MOUNDS DURING THE FIRST HALF OF THE YAM CROP CYCLE (11 Months)









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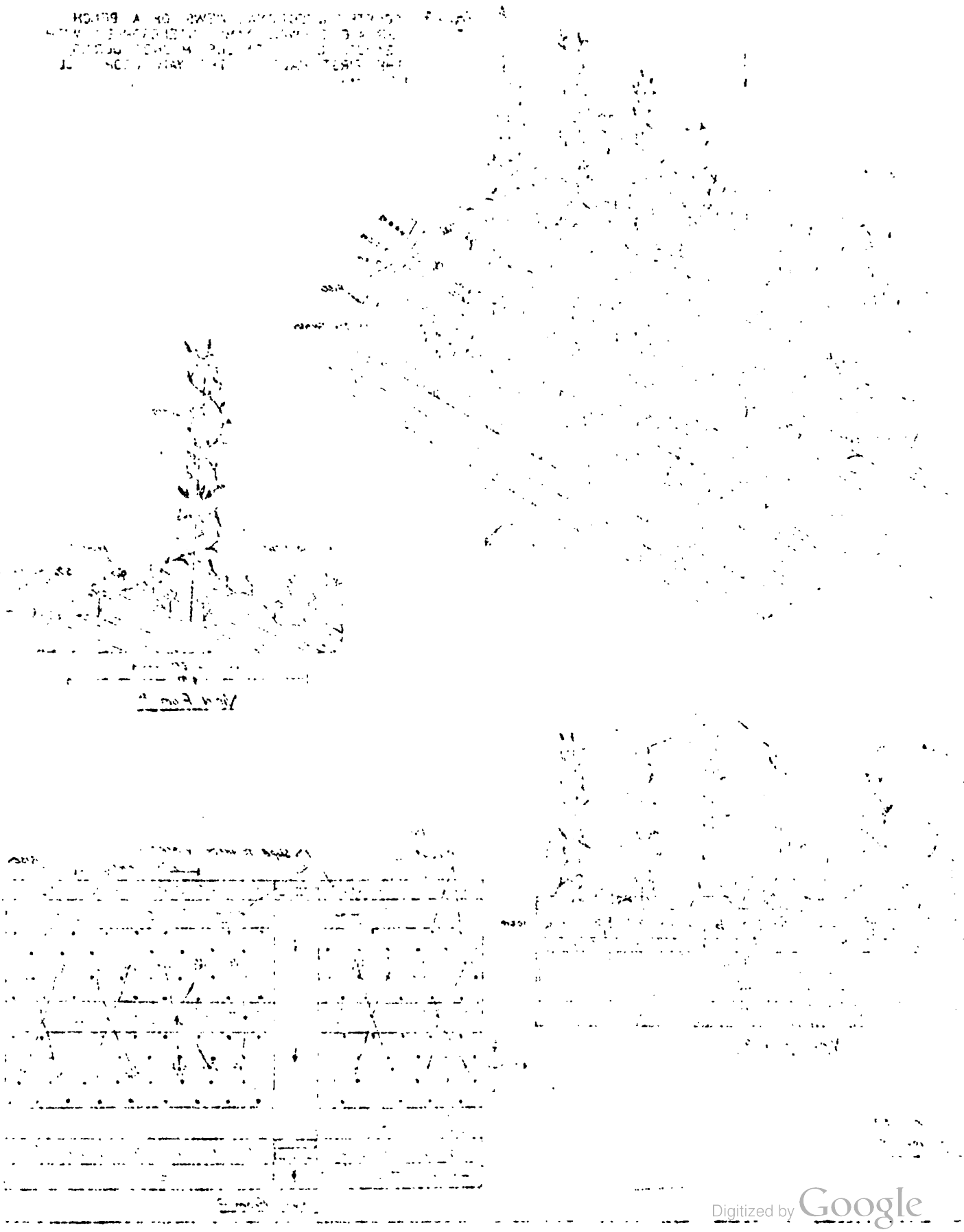
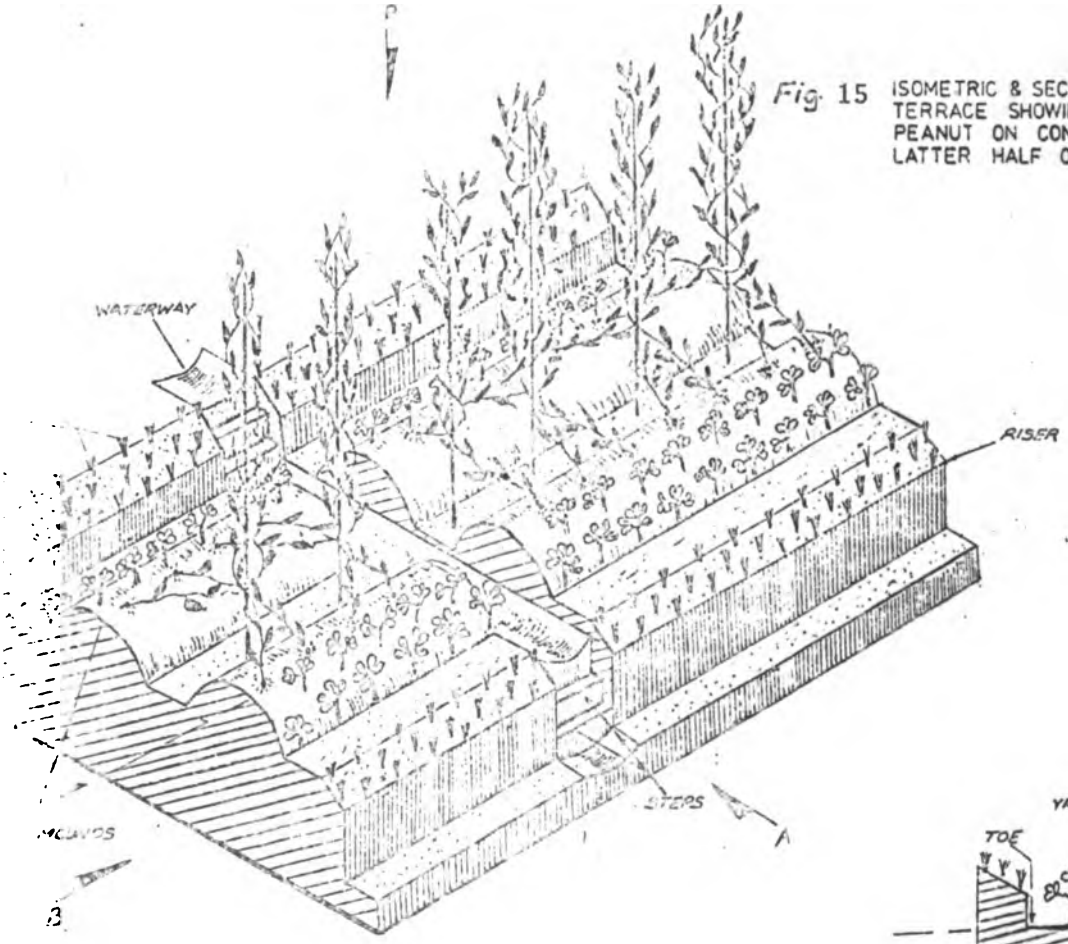
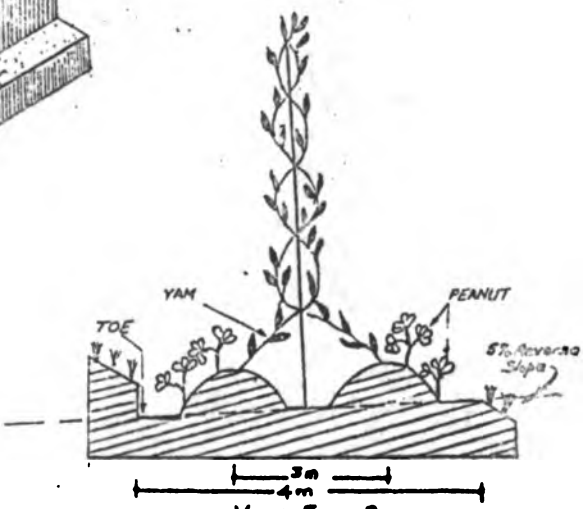


Fig. 15 ISOMETRIC & SECTIONAL VIEWS OF A BENCH TERRACE SHOWING YAMS INTERCROPPED WITH PEANUT ON CONTINUOUS MOUNDS DURING THE LATTER HALF OF THE YAM CROP. (11 Months)





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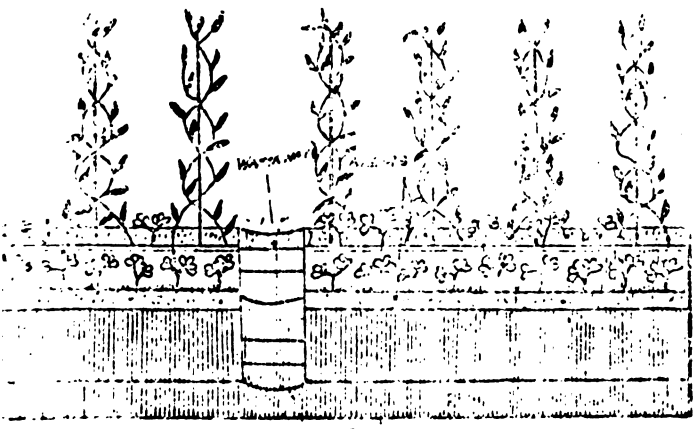

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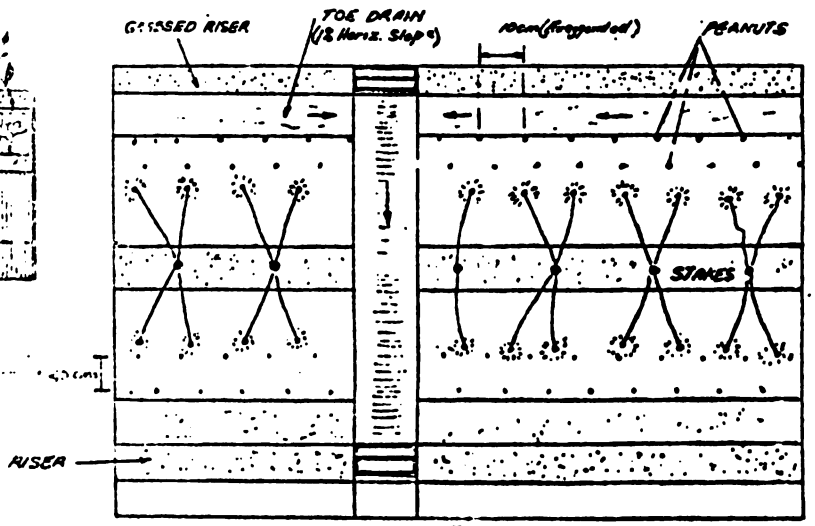

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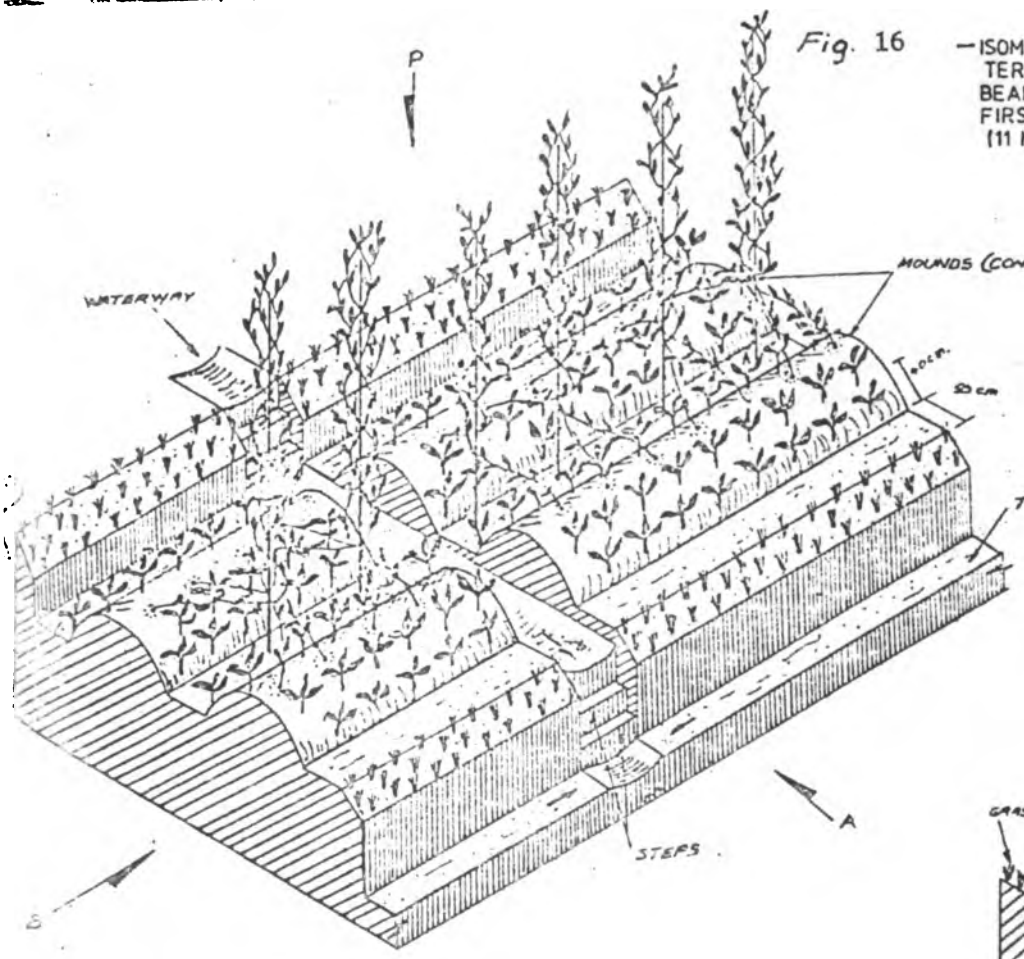
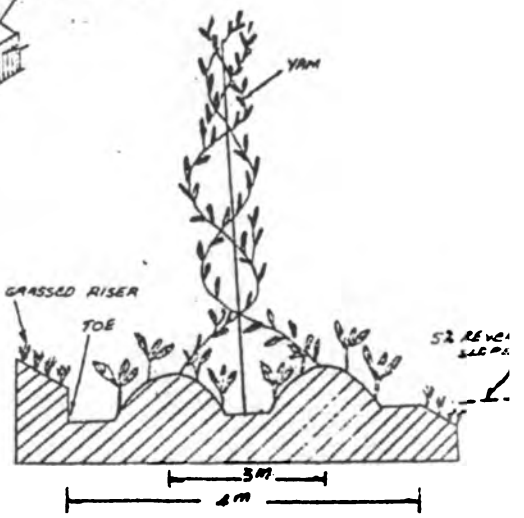
Fig. 16 —ISOMETRIC & SECTIONAL VIEWS OF A BENCH TERRACE, SHOWING YAMS INTERCROPPED WITH BEAN ON CONTINUOUS MOUNDS, DURING THE FIRST HALF OF THE YAM CROP CYCLE (11 MONTHS)





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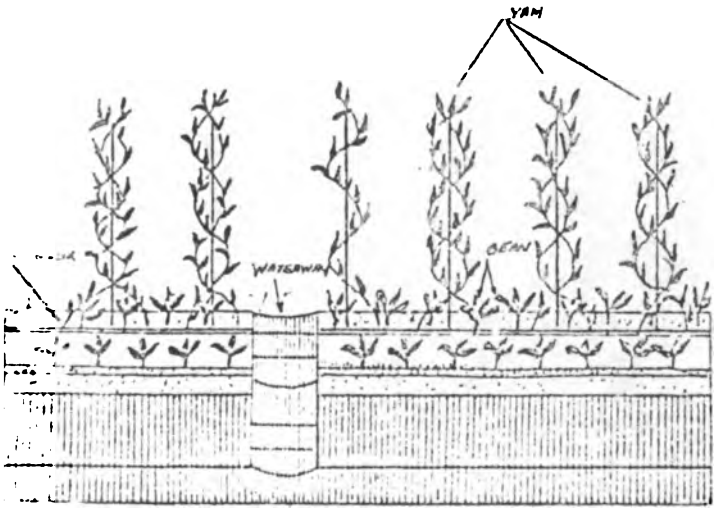

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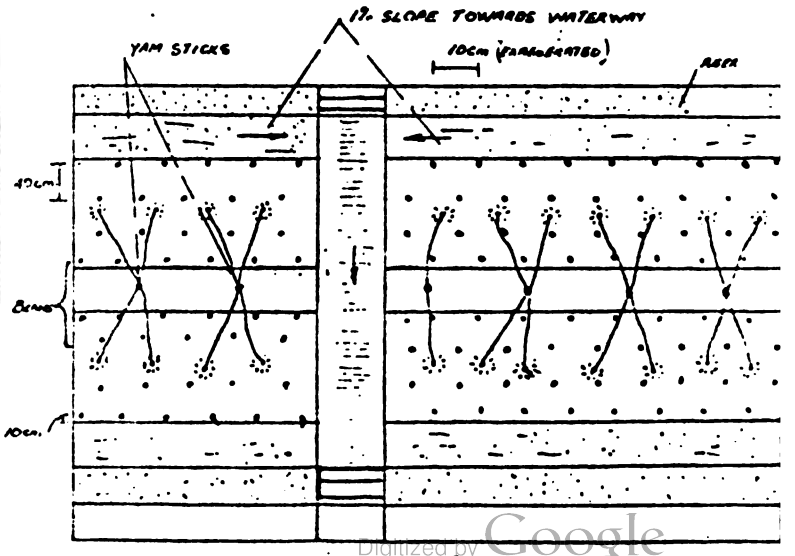

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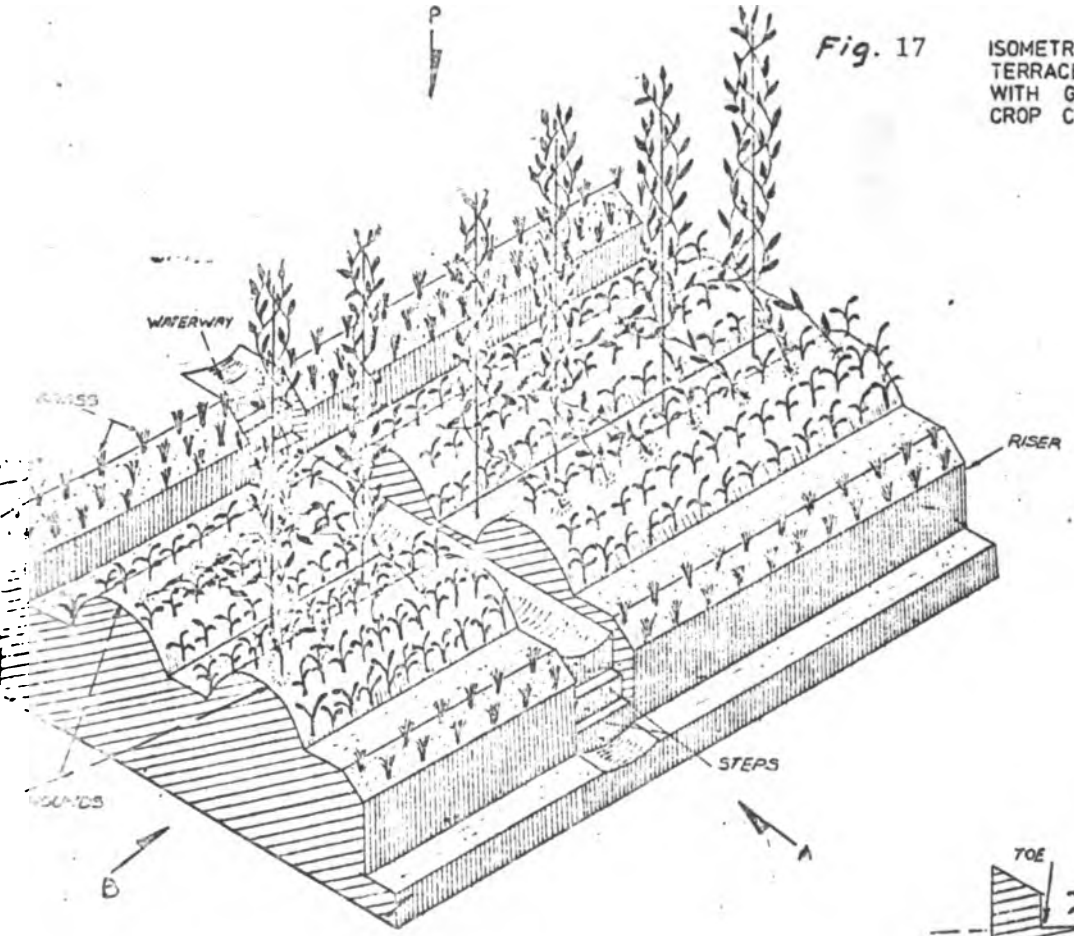
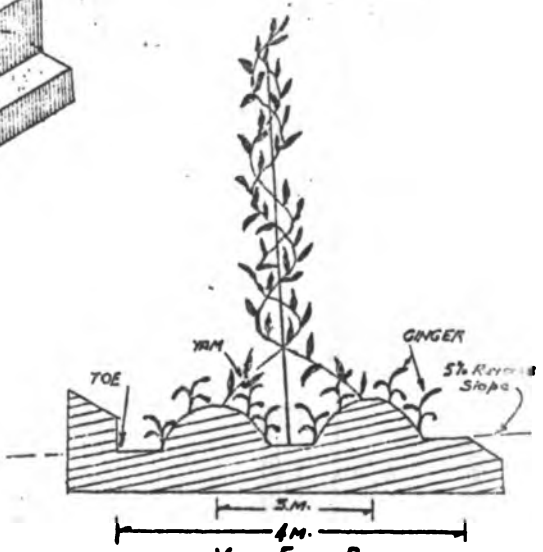
Fig. 17 ISOMETRIC & SECTIONAL VIEWS OF A BENCH TERRACE SHOWING YAMS INTERCROPPED WITH GINGER FOR MOST OF THE YAM CROP CYCLE (11 Months)





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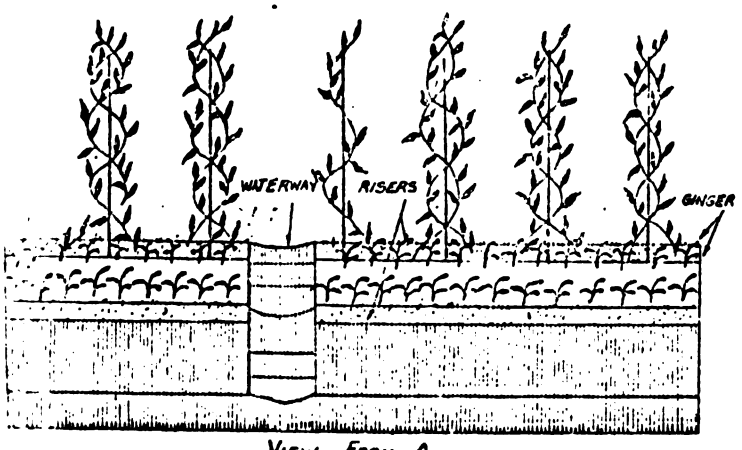

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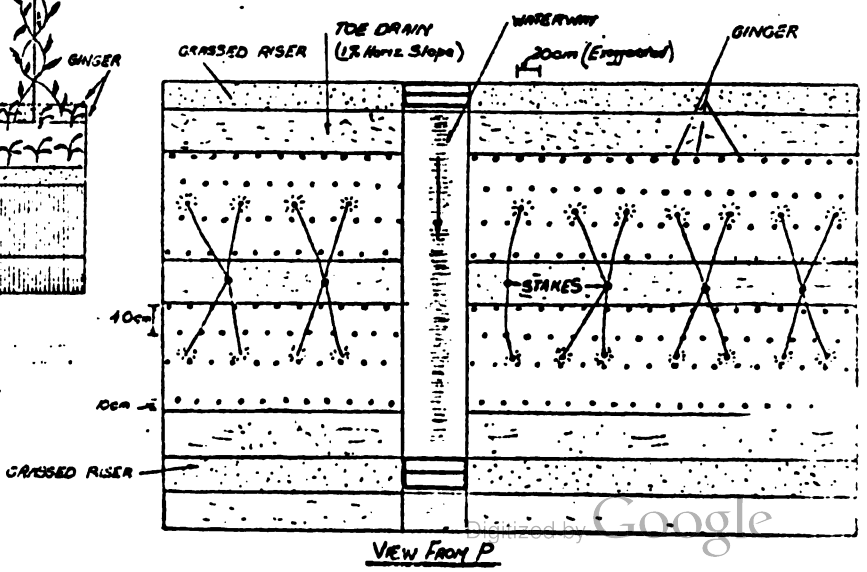

VIEW FROM P

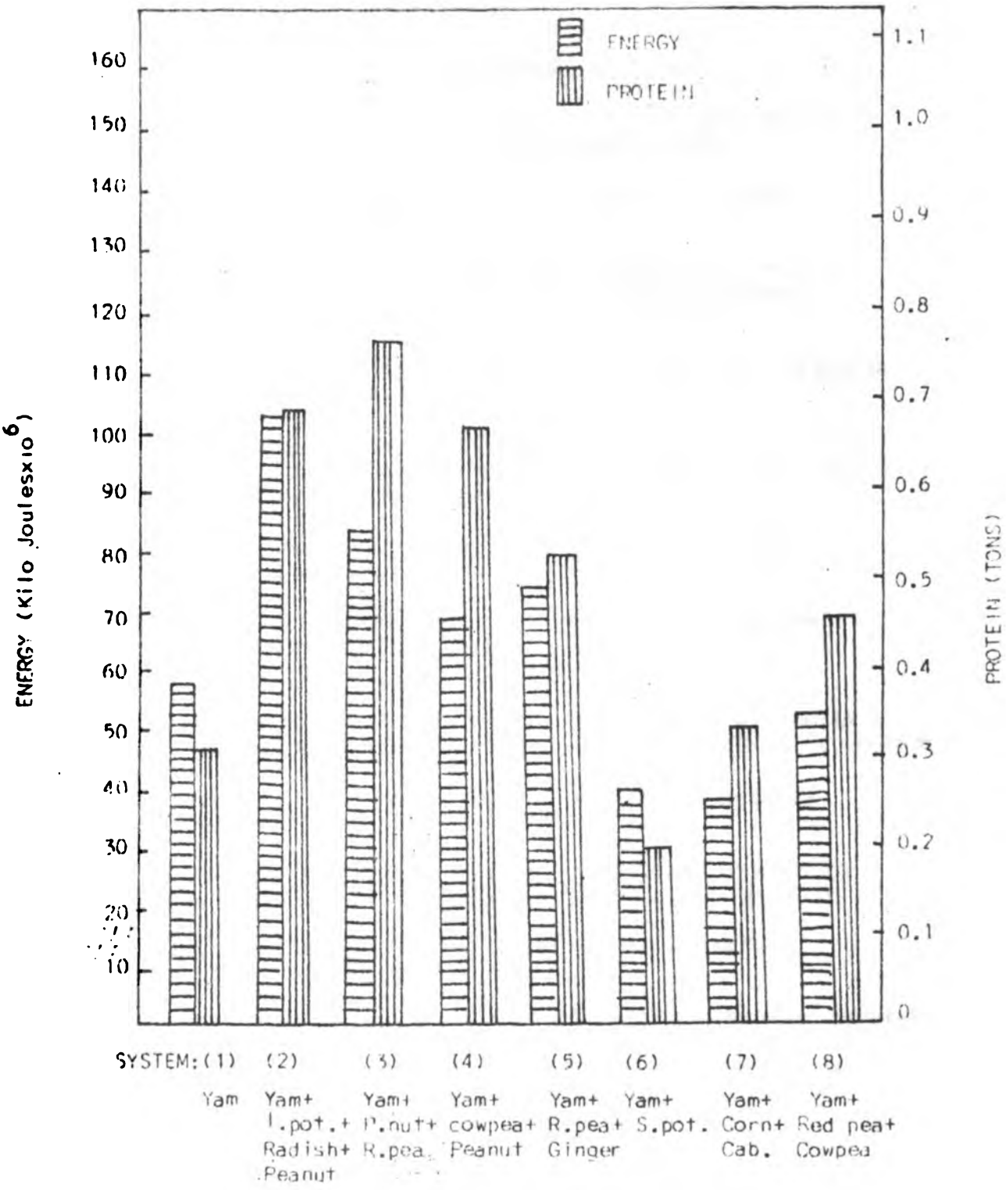

Fig. 18: ENERGY AND PROTEIN VALUES BASED ON MARKETABLE YIELDS PER HECTARE IN 1979-1980 OF YAM AS MONOCROP SYSTEM (1) AND SEVEN INTERCROP SYSTEMS (2-8)

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