INTERIM REPORT TO

UNEP

ON

STUDIES OF INTERCROPPING

ON

FARMING SYSTEMS

1975

INTERNATIONAL INSTITUTE OF TROPICAL AGRICULTURE
IBADAN-NIGERIA

REVIEW OF UNEP SUPPORTED SYSTEMS AGRONOMY CROPPING SYSTEMS EXPERIMENTS

The objective of the IITA Farming Systems Program is to replace existing food crop production systems by more efficient systems that attain good yields of improved crop varieties on a sustained basis through :-

1. developing suitable land clearing and soil management techniques that minimize erosion and soil deterioration.
2. use of appropriate crop combinations, sequences and management practices that minimize use of costly inputs e.g. fertilizers and pesticides.
3. development of appropriate technologies that increase agricultural productivity while minimizing drudgery, and
4. accurate monitoring of environmental conditions and changes in such a way as to reliably relate these to crop performance, guide timing of operations and for predictive purposes.

Emphasis in research and related activities is given to the problems and needs of smallholders in the developing countries of the tropics. As a result of continuing increases in population and labour constraints, over 70% of these mainly subsistent and partially commercial smallholders are operating small farm sizes of usually less than 2 hectares. These farms under decreasing periods of fallow are becoming increasingly subjected to serious soil deterioration and erosion under tropical rainstorms. The same degradation processes result from mechanized land, development and clearing

techniques used in large scale farms in tropical Africa.

On the basis of the above considerations, the IITA Systems Agronomy Cropping Systems investigations (see attached report) is giving top priority to the following:

1. studies of cropping patterns and sequences involving relay, strip and multiple cropping systems of various cropping sequences and rotations which will enable the smallholder to produce a range of improved food crops including vegetables and one or more crops grown for cash on a sustained basis.

2. use of crop combinations and sequences which provide effective cover and with minimum tillage and mulching effectively minimize erosion and water loss.

3. development of suitable crop residue management techniques and methods of taking advantage of biological and nitrogen fixation and mycorrhizal phosphate nutrition and various cultural and other crop and soil management practices so as to increase the efficiency of fertilizer use and reduce the amount and cost of fertilizer used by farmers in the humid tropics.

4. integrated pest and disease management including the use of improved pest and disease resistant widely adapted crop varieties and appropriate weed control techniques in addition to suitable crop combinations and sequences that minimize the use of costly and sometimes dangerous pesticides.

The following preliminary studies have as their main objective the provision of data on crop competition and compatible crop combinations for use in devising suitable relay and intercropping systems, planting patterns and rotations that give reasonably high yields while minimizing soil deterioration:

1. Maize - Melon - Cassava intercropping
2. Maize - Grain Legumes Intercropping experiment
3. Maize, groundnuts, sweet potato, and cocoyam intercropping experiment at Ikenne in 1974 and 1975.
4. Maize, cowpea, and soybean sequence of cropping and fertilizer experiment.
5. Maize, cowpea variety and pattern of planting experiment.
6. Mulching and minimum tillage experiments
7. Maize/groundnuts intercropping experiment
8. Yam, Maize, Melon, Cowpea intercropping.

These experiments have resulted in the selection of certain crop combinations such as maize/melon, maize/sweet potato and maize/cocoyam mixtures which apart from giving reasonably good yields protect the soil against erosion and control weeds. They have also resulted in the selection of possible suitable cropping sequences for all the year round cropping that should give high yields and high economic returns, protect the soil against erosion, minimize weed growth and probably disease and pest damage. In addition, they include a range of major staples and crops that can be grown for cash. Included is a range of alternative crop combinations some of which are suitable for the different ecological subregions and socio-economic requirements of the humid tropics. The spreading of labour more evenly throughout the year in the management of these cropping sequences and rotations was also taken into account. Examples of some of these combinations are as follows:-

a) Maize/melon cassava relay and intercropping experiment

b) Maize grain legume pattern of intercropping experiment

c) Maize/groundnuts/sweet potato and cocoyam intercropping experiment.

d) Maize and cowpea variety and pattern of planting experiment

e) Maize/groundnut intercropping experiment

f) Grain/maize/melon and cowpea intercropping experiment.

The maize/cowpea/soybeans sequence of cropping and fertilizer experiment and to some extent the sorghum, pigeon pea, cowpea and soybean late season intercropping experiment (the results of which are

not yet available for this report) will in addition to providing information on crop combinations and compatibility above all provide very valuable information on crop sequences that are productive in and minimize nitrogen fertilizer application by making as much use of residual nitrogen resulting from nitrogen fixation by the previous legume crop.

The crop residue management and strip cropping experiment has as its objectives (1) the evaluation of different organic waste materials including crop residues for mulching in minimum tillage, (2) the study of the multiferous effects of mulches (temperature regulation, erosion control, increased infiltration rate, addition of nutrients to the soil etc), and (3) study of effects of organic residues on pest and disease incidence as a basis of developing good organic residue management methods that minimize nematode and other pests and disease build up.

These possible cropping combinations and sequences that will be subjected to field tests economic evaluation and longterm rotation trials are listed below and diagrammed in Figure 2. In addition to other studies at IITA the UNEP funds will also be used (starting in 1976) for longterm crop combinations and sequences studies which include studies of fertilizer, requirements of crops grown in mixed culture and pest and disease incidence and management in intercropping.

Possible Cropping Combinations and Sequences

1. Melon (March-April) relay cropped with cassava or maize

2. Melon (March-April) followed by sweet potatoes (June) relay interplanted at wide spacing every 4 meters with pigeon pea (July).

3. Melon (March-April) interplanted with maize at wide spacing 4 - 6 meters - with groundnuts, soybeans, or vegetables in between followed by sweet potatoes, intercropped with groundnuts, cowpeas, or soybeans and sorghum (June - July).

4. Melon intercropped with Celosia, okra, tomatoes, groundnuts or maize at wide spacing (2 - 3 meters) fb cassava or sweet potato interplanted with pigeon peas every 4 meters.

5. Early maize relay planted with groundnuts followed by sweet potatoes intercropped with pigeon pea or sorghum intercropped with grain legumes.

6. Yams intercropped with maize alternating with rows of vegetable cowpeas followed by pigeon peas intercropped with sweet potatoes, semi-erect cowpeas or soybeans.

7. Strip cropping sequences should preferably involve alternating double rows of short or creeping plants with single rows of taller plants, e.g. sweet potatoes and tree type pigeon peas soybeans and maize, and cocoyams and maize with the taller crop at wide spacing of 4 meters apart.

8. Some of the longterm multiple (relay, double, triple and strip) cropping experiments and rotations which involve the above cropping patterns and combinations are diagrammed in Fig. 2 They will be initiated in 1976 at IITA (Ibadan), Ikenne and probably at the High Rainfall Station at Onne in 1977.

REPORT ON IITA INTERCROPPING, RELAY AND SEQUENCE OF CROPPING EXPERIMENTS FOR 1974/75

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The systems agronomy subprogram intercropping experiments involving (1) maize/melon/cassava; (2) maize/cocoyam/groundnuts/sweet potato at Ikenne, and (3) maize/grain legumes started in 1974 were completed and repeated in 1975. The studies of the effects of different mulches on maize, cowpeas, soybeans, and cassava under minimum tillage was expanded from 9 to 22 mulch treatments with several scientists cooperating and a maize/soybean/cowpea sequence of cropping and fertilizer experiment was continued in 1975. New experiments initiated to select possible components of multiple or relay cropping systems consisted of (1) yams/maize/melon/cowpeas intercropping experiment; (2) maize/groundnuts patterns of planting experiment; (3) maize vegetable cowpeas intercropping experiment; (4) cassava/maize intercropping experiment involving different lengths of cassava cuttings, and (5) late season sorghum/cowpeas/soybeans/dwarf pigeon pea intercropping experiment. Cooperative projects in which the systems agronomy subprogram was involved included the continuing root crops - oil palm systems survey with the agricultural economics subprogram and maize mulching and fertilizer continuous function design experiment with the soil fertility subprogram.

Maize - Melon - Cassava Intercropping : Results of intercropping maize and melon were presented in the 1974 annual report. No overall significant differences were observed in cassava plant population and root fresh weight means in relation to crop mixture due mainly to the high soil heterogeneity and consequently high coefficient of variability (Table 1). But there were highly significant differences among cassava

root dry weights. Plant populations, root fresh and dry weights decreased significantly with lateness of planting (Fig. 1). While plant population and root dry weight decreased with increasing number of crops in the mixture according to the trend cassava sole maize-cassava maize-melon cassava, fresh weight of roots followed the trend cassava sole maize-melon-cassava maize cassava. There were significant differences in plant population, root fresh and dry weights in relation to dates of planting (Fig. 2). As observed in maize, no significant differences in plant population and yield occurred at low and high fertilizer levels due perhaps to high fertility level in Block E following several years of cropping and fertilizer applications.

The calorie equivalents and the gross returns of the yields of the different crop combinations are shown in Table 2. There were highly significant differences in the calorie values of the different crop combinations with the highest values observed in maize-melon and maize-melon-cassava crop combinations where the cassava was planted in May, June and July. Gross values followed the same trend with the highest returns observed in maize melon-cassava mixture with the cassava relay cropped in the middle of June. Cassava bacterial blight and cercospora leaf spot damage were observed to be highest in the April planted sole cassava and cassava-maize treatments, medium in May sole cassava and maize-melon cassava treatments and lightest in the remaining treatments.

This experiment was repeated at Ikenne in 1975 and only results of the maize crops so far harvested will be presented here. There was complete failure of the melon crop due to very late planting and failure to produce

mature fruits even though there was good vegetative growth. Significant differences were observed in maize grain and stover yields and stem lodging in different crop mixtures but no significant differences occurred in plant population and root lodging (Table 3). There was a tendency for lodging to be reduced by cassava intercropping. Consequently both root and stem lodging were higher where maize was grown alone or with melon and at the very late cassava relay cropping dates where time of overlapping of cassava with maize in the intercrop was drastically reduced. In general stover and to some extent grain yields were highest in the sole cropped plots and those where cassava was planted through maize early or late. The lowest yield was observed in plots where cassava was planted on the 23rd of August 1975 followed by those planted on the 25th of October 1975. Mean grain dry weight-yield of intercropped plots amounted to about 70% of sole crop plots. No significant difference resulted from different levels of fertilizers.

From these preliminary results it can be concluded that (1) maize-melon intercropping at the usual maize population of 53,000 plants per hectare drastically reduces melon yields, (2) relay cropping of cassava through maize is feasible especially when the cassava is planted through the maize from time of planting to about two months after planting, (3) relay planting of cassava through maize beyond two months after planting may result in reduced cassava plant population, and (4) intercropping of maize and cassava reduces lodging in maize but not always significantly so.

Maize - Grain Legumes Intercropping Experiment : This experiment which was started in 1974 to study the effects of intercropping patterns on the

performance of the components of the mixtures was repeated in 1975. In this report the yields of the legume components which were not available for the 1974 report and the yields of maize for the two years are considered.

Grain Legumes : As expected, significant differences in fresh pod and dry grain yields were observed among legume species due to their different yielding potentialities and to some extent significantly different plant populations at which they are grown (Table 4), Climbing cowpea (Sitaopole) and pole lima produced the lowest yields when grown along the same rows with maize as compared to when it is grown in either single alternating rows or alternating four rows with maize but while pole lima in alternating four rows with maize produced more than three times the dry grain yield of those grown on the same and in single alternating rows climbing cowpea (Sitaopole) in single alternating rows produced almost five times the grain yield of those on the same rows with maize and two and a half times the yield of those in four alternating rows. The low yields of both legumes when grown on the same rows with maize is due partly to mutual shading and partly to the heavy lodging of the tall maize variety ($TZBC_3$) which is unable to support the legumes. Damage by anthracnose was higher in Sitaopole grown on the same and in four alternating rows with maize than in single alternating rows. Serious attack of golden yellow mosaic virus occurred in the lima beans because of early planting but this did not appear to reduce yields considerably. In bush lima and soybeans yields on single alternating rows with maize were lower than in four alternating rows perhaps as a result of more shading in single alternating rows but the difference was only significant in soybeans.

In erect cowpeas (Prima), dwarf pigeon pea and tree type pigeon pea, single rows alternating with maize gave higher yields than alternate four rows but only in the tree type pigeon pea was this significant. It would appear that in pigeon peas pest damage is more serious and spraying more effective in single alternating rows than in four alternating rows. In general, mean dresh pod and dry grain yields for climbing cowpeas and pole lima on single and four alternating rows were significantly higher than on the same rows with maize.

Early maize 1975 : Observations in 1975 early maize are shown in Table 5. As observed in the early maize of 1974 there were highly significant differences in lodging due to more serious lodging in maize grown on same rows with legumes as compared to those grown on different rows. Significant differences we e also observed in plant population, grain and stover yields. These differences were mainly due to higher plant populations and higher yields of maize stover and grain yields in plots where maize was grown along the same rows with legume and consequently with double the plant population and plot area than where maize single and four rows alternated with legumes.

Maize plant population, dry weight of stover and dry grain yields in 1975 amounting tó 20404 plants per hectare, 2.18 t/ha and 1.94 t/ha in plots where maize was grown on the same rows with legumes were actually lower than 22786 plants, 2.59 tons and 2.96 tons/ha respectively observed on the same plot area where single, two or four rows of maize alternated with rows of legumes. Mean plant population, stover yields and grain yields of 21827, 2.12 t and 2.16 t/ha respectively for half the plot size of sole maize plots were also lower than the comparative values on equivalent plot sizes where maize rows alternated with those of legumes.

Maize plant population and grain yields on single and double alternating rows were higher but not altogether significantly so than those in four alternating rows with legumes. Although stover weeds were lowest for maize grown in two alternating rows as compared to those on single and four alternating rows but differences were not significant. Thus individual plants on single and double alternating rows gave much higher grain yields per plant than those grown sole, on the same and in four rows with legumes. Maize grown in single alternating rows with pole lima, bush lima, dwarf pigeon pea and tree type pigeon pea gave higher grain yields than those in double and four alternating rows or on the same rows with other legumes. Similar trends were observed in stover yields. Trends in plant population stover and grain yields were similar to corresponding treatments in 1974. While alternation of single or double rows of maize with corresponding rows of legumes is somewhat detrimental to legume yields except for pigeon peas, it usually gives high maize grain yields as compared to maize grown sole or in four rows alternating with those of legumes.

Maize, groundnuts, sweet potato, and cocoyam intercropping experiment at Ikenne in 1974 and 1975

Maize : In 1974 when planting was delayed till July due to difficulties in obtaining cocoyams, there were significant differences in maize yield and significantly higher grain yields were observed on plots w th sole crop maize and those intercropped with groundnuts as compared to plots on which maize was intercropped with either sweet potato or cocoyam (Table 6) The lowest yields were obtained where maize was intercropped with sweet potato. In 1975 significant differences in grain yields occurred as a result of intercropping but while there were no significant differences among

grain yields in intercropped plots, grain yield of sole crop maize was lower than in plots where maize was intercropped with groundnuts cocoyam and sweet potato but this was significant only for cocoyam. No significant differences were observed as a result of planting the maize on the same row as the groundnut, cocoyam or sweet potato but lower yields were observed in plots with sole crop maize and where maize was planted along the same rows with the other intercrops. No significant differences were observed in maize plant population at harvest but planting of maize on the same row as the associated crop slightly decreased plant population. Plant population was lowest where maize was intercropped with sweet potato and highest where intercropped with gronndnuts.

Groundnuts : Groundnuts intercropped with maize in 1974 yielded only 7% of the sole crop dry nut yield while in 1975 the mean yield on intercropped plots was 79% that of sole cropped plots. The yield of groundnuts was almost five times higher in 1975 as compared to 1974 due to the use of improved IAR varieties (Zaria 1-4). Even though the experiment was carried out on the same plots as in the previous year, there was no serious damage by rosette or cercospora leaf spot to which the improved varieties were more tolerant than the Ikenne local used in 1974. Plant population and number of nuts produced were slightly higher where the groundnuts were planted in between maize rows than on the same row but the differences were not significant.

Sweet potato : Significantly higher fresh weight of marketable tubers and number of tubers were produced on sole crop plots as compared to maize intercropped plots. Mean yield of tubers from plots where sweet potato was planted along the same rows as maize was 96% that of plots where they

were planted in between maize rows but this was not significant. As with groundnut, sweet potato mean yield in 1974 was only 38% that of the 1975 crop grown on the same plots.

Cocoyam : Yield of corms under sole cropping was almost double the yield in plots where cocoyam (*Xanthosoma sp.*) was intercropped with maize in 1974. The cocoyam yields were very low due to serious attack by an unidentified leaf disease and late planting. The 1975 cocoyam crop has not yet been harvested. Intercropping of groundnuts, cocoyams and sweet potatoes at Ikenne in 1974 with maize resulted in higher calorie yields than sole cropping (Table 6). Similarly with the exception of sole sweet potato, gross values were higher for intercropped plots as compared to sole cropping. For one interested in growing cocoyam, groundnuts and sweet potato at Ikenne it would appear less beneficial to include maize as it is to intercrop these crops with maize where main interest is on the maize crop. As indicated in the 1974 annual report, intercropping drastically reduced weed growth in maize especially where cocoyams or sweet potato was grown with maize.

Maize, cowpea, and soybean sequence of cropping and fertilizer experiment : This experiment with the treatments indicated in Tables 7 and 8 was started to determine the effect previous cowpea and soybean crops on the succeeding maize crop in addition to estimating the extent of nitrogen fixation in soybean and cowpea crops following maize which received three levels of nitrogen. No significant differences were observed among treatment means in plant population and grain yields in the first planting of maize, cowpeas and soybeans during the late season of 1974 (Table 7).

In the second planting of the same crops in the early season of 1975, no significant differences were observed in maize plant population following cowpeas as compared to maize following soybeans and no marked differences were observed among fertilizer treatments (Table 8). Maize plants following soybeans reflected the nitrogen level treatments by their light green colour and poor vegetative growth at the lower nitrogen levels while maize after cowpeas had dark green colour at all nitrogen levels. However there were no significant differences in grain yield in maize as a result of previous cropping with cowpeas and soybeans or nitrogen fertilizer levels. Maize grain yields in the no nitrogen fertilizer treatments after cowpeas exceeded grain yields at the corresponding treatment following soybeans by up to 22 percent. Maize grain yields at the 45 kg-N and 90 kg-N following cowpeas were 7.5 percent lower and 10 percent higher respectively than maize that received corresponding treatments after soybeans. Stover yields of maize following soybeans (5.469 t/ha) was significantly higher than in maize following cowpeas (4.974 t/ha). No significant differences in grain and stover yields were observed among fertilizer levels but both yields tended to increase with fertilizer level. No significant previous cropping and fertilizer interaction occurred in plant population, grain and stover yields and no significant differences were observed among nitrogen levels in soybean plant population and grain yield following maize. Poor germination in the soybean variety (Bossier) resulted in very low plant population and yield.

As in soybeans no significant differences among nitrogen levels was observed in cowpea (Ife Brown) plant population and grain yield following maize but grain yield tended to decrease with increasing levels of nitrogen

applied to the preceeding maize crop. It is expected that all treatment effects will become more pronounced as number of years of cropping increase.

Maize, cowpea variety and pattern of planting experiment : The objective of this experiment is to study the performance of three varieties of vegetable cowpeas consisting of an unimproved local variety (Akidi) from East Central, Sitaopole supplied by GLIP and Dinna (FARV-13) recently released by FDAR, Ibadan, in intercropping with late maize planted in one two and four plants per stand.

Maize : No significant differences were observed in plant population and stem lodging (Table 9). Number of maize plants per stand id not markedly affect plant population but there was slightly higher plant population at two plants per stand. Root lodging was significantly highest in maize planted at two plants per stand with Sitaopole and lowest in sole crop maize at two plants per stand. It was also lowest at two plants per stand as compared to one and four plants per stand but not significantly so. Heavy storms during the second half of 1975 contributed to the significantly higher number and percentage stem lodging observed than root lodging. There were highly significant differences in stover and grain yields. The highest grain yields were observed in maize planted in one or two plants per stand with Dinna and Sitaopole while the lowest was observed in sole maize at one plant per stand followed by maize at four plants per stand intercropped with Dinna. Grain yield decreased slightly with increasing number of plants per stand. In sole maize plots, the lowest stover yield was observed in maize planted one plant per stand while the highest yield was in maize at two plants per stand.

Significantly higher overall stover yield was observed in maize grown at two plants per stand than at one and four plants per stand.

Fresh pod yields and grain yields in cowpeas were significantly higher under sole cropping than under intercropping (Table 9). While seed yields in cowpeas decreased slightly with increasing number of intercropped maize plants per stand, fresh weight of pods was lowest in cowpeas grown with two maize plants per stand. The local variety (Akidi) under intercropping exceeded Sitaopole and Dinna in weight of fresh pods, the actual yields amounting to 0.44, 0.42 and 0.28 t/ha respectively. Sitaopole gave higher fresh pod yields under sole cropping than Akidi which exceeded Dinna.

Cowpea plant population in sole plots significantly exceeded those in intercropped plots while plant population in intercropped plots with four maize plants per stand exceeded those with one and two maize plants per stand but not significantly so (Table 9). Pod fresh weight yields of the three cowpea varieties followed the trend sole cowpea inter-crop with one maize plant per stand with four maize plants per stand with two maize plants per stand (Table 10). Trends in grain yields were similar but yield of cowpeas intercropped with maize at two plants per stand equalled those intercropped with maize at four plants per stand. This was more pronounced in seed dry weight than in fresh weight of pods. Seed yields of Akidi and Dinna were equal but double those of Sitaopole.

Yields of cowpeas were adversely affected by the residual effect of paraquat preemergence application which killed many plants or stunted their growth in addition to flame weed control technique triad on the plots which also had adverse effects on both maize and cowpeas. It is hoped

that as the use of these techniques are perfected in future such mishaps may be avoided.

Mulching and minimum tillage experiments : An experiment was started in 1974 to study the effects of nine mulches and minimum tillage on four test crops (maize, cowpea, soybean, dwarf pigeon pea and cassava) on an Egbeda soil but this was discontinued at the end of the year and in its place a more elaborate experiment to study the effects of 22 mulch treatments, on the same test crops excluding pigeon peas was started on a badly eroded Egbeda soil. Data collected in the first mulch experiment are presented in Table 11 and observations in the second mulch experiment started in 1975 are presented in Tables 12 & 13. Significant differences were observed among nine mulch treatments in maize grain yield, cowpea grain yield, soybean plant population, pigeon pea plant population and grain yield. No significant differences were observed among treatments in the early season maize crop and cassava plant population and root yields. The lowest early maize grain yield occurred in bare plots on which weeds were hand-weede and left on the surface while the highest yield was observed in the saw dust mulch. Other mulch treatments gave intermediate values. In cowpeas, the lowest yields were observed in bare clean weeded plots and translucent polythene mulch while the highest yield occurred in the rice husk mulch. In soybeans the lowest grain yields occurred on saw dust followed closely by the bare plots with weeds left in the surface while the highest yield was observed on plots mulched with rice husk as with cowpeas. Flowering and maturity in cowpeas, soybeans and pigeon peas were earlier in the translucent polythene mulch followed closely by the bare plots with and without weeds left on the surface.

In pigeon peas the lowest yield occurred on bare plots where weeds were removed followed by Guinea grass (Panicum maximum) mulch while the highest yields were obtained in hand weeded plots with weeds left on the surface followed by the maize stover mulch. Thus differential yield effects were observed with different crops but 'bare' plots gave a mean yield of 2.11 t/ha for all crops as compared to 2.35 t/ha in mulched plots for the 1974 late season and 1.59 t/ha and 1.78 t/ha for the 1975 early season crops respectively. The effects of the mulching were thus slightly more pronounced in the dry late season cropping than in the early wet season. Cassava fresh root yields were lowest on the two bare plots with weed left on surface (14.23 and 14.30 t/ha) as compared to a mean value of 21.03 t/ha on mulched plots. The highest cassava root yield occurred in the rice husks mulch followed closely by the translucent polythene mulch.

In the complex organic residue management experiment started in the 1975 only the early season crops data with the exception of the cassava are available (Tables 12 & 13). Maize, soybeans and cowpeas exhibited the best vegetative growth and dark green colour in the legume husks and pigeon pea tops mulches and the poorest growth and yellowish green colour on the bare and corn cobs treatments. Cassava had a very impressive vegetative growth on black polythene covered plots where the height of cassava plants was about double the heights of plants in other treatments at three months after planting. Cassava plants in the balck polythene covered plots were very dark green in colour before fertilizers were applied while in other treatments, the leaves were very pale or yellowish green in colour indicating that the plants may be deficient in nitrogen. In the 1975 early maize crop, significant differences were observed in time

of tasselling and silking, stem lodging and stover yields (Table 12). No significant differences were observed in plant population and grain yields. Tasselling occurred earliest in the oil palm leaves, rice husks, and legume husks mulched plots and latest on the bare, saw dust, Andropogon straw, chipped mixed twigs and translucent polythene mulches. Silking occurred earliest in the maize cobs, rice straw, elephant grass straw, Guinea grass straw, pigeon pea tops, soybean tops, and mixed twigs mulches and latest in saw dust mulch followed by bare plots. Root lodging (number and percentage) was lowest in the bare followed by elephant grass mulch and highest in the oil palm leaf mulch followed by chipped cassava stems mulch. Stover grain yield in the elephant grass mulch significantly exceeded those in other mulches while that of the maize cobs mulch was the least.

In soybeans significant differences were observed in plant population in different mulches but there were no marked yield differences (Table 13). Cowpeas exhibited significant differences among treatment means in time of flowering and grain yield. Earliest flowering and maturity occurred in the black followed by translucent polythene mulches but latest on plots covered with mixed twigs. This is probably due to the higher temperatures under the polythene mulches. Cowpea grain yield was highest in the translucent plastic mulch and lowest in Adropogon straw mulched ;plot followed by that of the bare plots. There were serious germination problems with the soybean variety Bossier and less than 15% germination occurred in the bare plots. Because of low germination, soybeans gave very low yields with the lowest yield recorded on the bare plots. In the first mulch experiment the highest weight of weeds removed were from unmulched plots

but in the second mulch experiment very high quantities of weeds were harvested from all plots. The lowest amount of weed growth occurred in the bare plots followed by black polythene mulched plots. In the rice husks and straw and legume husks mulches, a lot of seedlings removed resulting from crop seeds in the mulch contributed to the 'weed' weight.

The above results are only preliminary since at the beginning of both experiments the plots were cultivated. It is therefore very likely that the minimum tillage effects will be more pronounced as from the second year. Moreover, various observations being made on the chemical characteristics and changes in mulches and soils, nematological observations, microbiological changes etc. are still to be assembled before a true picture of what is taking place under the mulches can be presented.

Maize groundnuts intercropping experiment

Groundnuts : Significant differences in plant population at harvest, yields of dry undecorticated and decorticated nuts and cercospora leaf spot incidence were observed among varieties (Table 14). Pattern of planting of maize and groundnuts did not significantly affect plant population and cercospora incidence as it did in yield of nuts. Zaria 2 (M 25-68) and Zaria 1 (F 439-2) had significantly higher plant populations than the rest. Zaria 1 (F 439-2) gave significantly higher yield of nuts than all the other varieties while Ikenne local gave the least yield which did not differ significantly from the other three Zaria (IAR) lines. Cercospora leafspot incidence was high but Zaria 4 (M 276-70 RRI) was the least affected followed by Zaria 2 (M 25-68). The most susceptible line (Zaria 1 [F 439-2]) gave the highest yield. Yields were significantly

highest in sole groundnut plots but there was no significant difference due to either pattern of planting or planting on the flat as compared to planting on the ridge. It is very likely that as a result of the tall maize variety (TZBC3) used, pattern of planting did not affect the amount of shading of the groundnuts. No significant variety x patterns of planting interactions were observed but the plants on sole plots shed their leaves and started dying off earlier than those intercropped with maize. In all groundnut varieties germination of the nuts stated prior to harvesting and it may be necessary to plant and harvest the groundnuts slightly earlier than the maize.

Maize : No significant differences were observed in maize intercropped with different groundnut varieties or grown in different intercropping patterns (Table 14). The percentage of plants that lodged were least in maize intercropped with Ikenne local but only differences due to stem lodging were significant. At the early period of growth when maize plants were about a meter high lodging after heavy storms was least in maize grown in furrows. Pattern of planting significantly affected germination of maize, tasselling, plant population and weight of unshelled cobs at harvest. Germination was significantly lowest in maize grown in furrows which also significantly had the lowest plant population, lowest cob yields and tasselled last (i.e. attained 50% tasselling not less than two days after other pattern of planting treatments). The varieties of groundnuts in the intercropping somehow significantly affected tasselling and stem lodging. Tasselling occurred earliest in maize intercropped with Zaria 1 (IAR FM 439-2) while stem lodging was least in maize intercropped with the local variety (Ikenne local). Very poor grain yields were observed

perhaps as a result of late planting in May. On the other hand, stover yields very high. Although there were no significant differences in stover yields, the highest stover yield was observed in plots in which maize was intercropped with the local variety. Intercropping of groundnuts with maize (a practice which appears to be gaining more ground in the southern areas of Nigeria) resulted not only in higher production of calories per hectare but also higher gross values especially with an improved higher yielding variety such as Zaria 1 than as a result of different intercropping patterns.

The excessive shading of groundnuts by maize necessitates use of a shorter maize variety in addition to reducing shading by differential planting dates, lower plant populations and by planting patterns which permit more light through the maize canopy.

Yam, Maize, Melon, Cowpea Intercropping

The objective of this experiment is to study the performance of yams, melon, cowpeas, (semi-erect Tvu 1190 and vegetable type cowpea Sitaopole) and maize in different intercropping combinations using the recommended plant populations and different planting patterns. The planting patterns invovled included planting of maize in single row along the ridge with one, two or four plants per stand, staggered planting of maize in two plants per stand and alternation of yam-maize cowpea intercrop rows with those of yam-maize melon every two rows.

Yams : There were highly significant differences in plant population, number of tubers and tuber yield (Table 16). Plant population was highest in plots where yams were planted sole and which according to the planting

pattern used involved 25% more plants than in intercropped plots. Yam population and number of tubers decreased with increasing number of crops intercropped with yams. The same trend was observed in tuber yield but yam tuber yield in plots where yam was intercropped with three crops was slightly higher than where it was intercropped with one crop. The lowest tuber yield and number of tubers occurred in plots where yam was intercropped with cowpea (Tvu 1190) while the highest was in sole cropped plots. The highest tuber yield of 23.09 t/ha was observed in sole cropped yams while the lowest was in yams intercropped with maize at two plants/ stand staggered followed by plots with yams intercropped with Tvu 1190.

Maize : Significant differences in plant population, stem lodging, stover and grain yields were observed in relation to crop mixtures and patterns of planting (Table 17). Plant population was lowest where maize was intercropped with cowpea (Tvu 1190) and highest where maize at two plants per stand was intercropped with yams. Stem lodging was least in plots where maize at two and four plants per stand was intercropped with melon and highest where maize at two plants per stand was intercropped with Tvu 1190. Grain yield was lowest where maize at four plants per stand was intercropped with Tvu 1190 with or without yams and melon and highest in sole crop maize at one and two plants per stand. Stover yield was highest where maize at two plants per stand was intercropped with yams and lowest where yam was intercropped with Tvu 1190 next to which was maize intercropped with yams, melon and cowpeas. Plant population and stem lodging tended to increase with increasing number of maize plants per stand while stover and grain yields tended to decrease with the number of plants per stand. With the exception of root lodging, the stem lodging and plant population, stover and grain yields decreased with the number

and species of crops in the mixture.

Cowpeas : Significant differences were observed in plant population, fresh weight of pods and grain yield of the two cultivars of cowpeas in relation to crop combinations and associated planting patterns (Table 18). Plant population was significantly higher in some mixtures than where the cowpeas were grown as sole crop. Tvu 1190 had reduced plant population under sole cropping as compared to where it was intercropped. Sitaopole gave significantly higher pod fresh weight yield under sole cropping than in intercropping with the lowest yield observed where Sitaopole was intercropped with maize at two plants per stand and with maize, yams, and melon. Grain yield was very high in Tvu 1190 intercropped with melon. Lowest cowpea yields occurred in Sitaopole grown with maize at four plants per stand. Each cowpea variety gave decreasing plant population and grain yield with increasing number of crops in the mixture.

Melon : Plant population fruit fresh weight and seed yield differed significantly in relation to crop combinations and planting patterns (Table 19). Plant population, fresh fruit and seed yields were highest in sole crop melon but while plant population was lowest in plots where melon was intercropped with yams, maize and cowpeas, fruit fresh weight and seed yields were lowest where melon was intercropped with Tvu 1190 in staggered planting. Melon plant population, fruit fresh weight and seed yields decreased with increasing number of crops in the mixture.

The overall calorie equivalents of the various crop yields and their gross values in Naira are presented in Table 20. Highest calorie equivalent values were obtained where yams, maize, melon and cowpeas (Tvu 1190) were intercropped followed by maize-yam intercrops. The lowest calorie

equivalent was observed in sole Sitaopole. The gross values of the crops was highest in yams grown as sole crop followed by intercrops involving yams and especially yams intercropped with maize, melon and cowpea (Tvu 1190).

This experiment shows that in areas where yam is a major staple and or cash crop, it would be most meaningful to intercrop it with reduced plant populations of maize and melon or grow it as a sole crop. Intercropping maize and cowpeas gave higher total returns than sole cropping only in plots involving Tvu 1190. Melon intercropped with cowpeas except when grown on the same rows with Sitaopole gave higher total yields and gross returns than sole crop melon.

More studies involving planting patterns and different dates of planting of melons and plant populations are necessary before a good picture of the performance of different crops in the mixtures can be developed and optimal yields of the various crops in mixture realized.

Table 1 : Observations on cassava (Isunikankiyan relay cropped through different maize-melon intercrops at different planting dates in 1974 at Ibadan

Treat No.	Dates of Planting	Treatments	Plant Population per ha	Fresh wt. of roots t/ha	Dry wt. of roots t/ha
3	18/4/74	Cassava	9843.75 a	26.13 a	14.95 bcd
5	18/4/74	Maize Cassava	9609.38 a	18.87 a	10.57 abc
6	18/4/74	Maize Melon Cassava	9259.38 a	21.34 a	11.95 abc
7	26/5/74	Cassava	9921.88 a	28.20 a	15.79 cd
8	26/5/74	Maize Cassava	9962.50 a	19.27 a	10.79 abc
9	26/5/74	Maize Melon Cassava	9571.88 a	20.86 a	11.68 abc
10	16/6/74	Cassava	10000.0 a	21.15 a	11.84 abc
11	16/6/74	Maize Cassava	9650.0 a	21.16 a	11.85 abc
12	16/6/74	Maize Melon Cassava	9687.50 a	34.16 a	19.13 d
13	17/7/74	Cassava	9884.38 a	18.69 a	10.47 abc
14	17/7/74	Maize Cassava	9415.63 a	17.07 a	9.56 abc
15	17/7/74	Maize Melon Cassava	9296.88 a	14.17 a	7.94 ab
16	16/8/74	Cassava	9806.25 a	13.32 a	7.46 ab
17	16/8/74	Maize Cassava	9375.0 a	12.91 a	7.23 ab
18	16/8/74	Maize Melon Cassava	9571.88 a	10.42 a	5.84 a

Table 2 : Total dry weight yields calorie values and gross returns of maize and melon relay cropped with cassava at different crop combinations and dates of cassava planting in 1974/75

Treatments Cassava planting: 16th day of each month indicated	Total Yield t/Ha	CALORIE 10^7 MAIZE	MELON	CASSAVA	TOTAL	GROSS VALUE (₦) MAIZE	MELON	CASSAVA	TOTAL
1 Maize alone (April)	4.49	16.03	..	..	16.03	991.8	..	..	992
2 Melon alone "	1.02	..	0.53	..	0.53	..	71.7	..	72
3 Cassava alone "	14.95	..	..	39.77	39.77	..	..	2000.3	2000
4 Maize/Melon "	4.66	16.60	0.03	..	16.63	1027.2	3.9	..	1031
5 Maize/Cassava "	15.17	16.42	..	28.12	44.54	1016.1	..	1416.4	2433
6 Maize/Melon/Cassava (April)	16.15	14.96	0.04	31.79	46.79	925.6	5.64	1601.3	2533
7 Cassava alone (May)	15.79	..	..	42.00	42.00	..	..	2115.9	2116
8 Maize/Cassava "	15.63	17.28	..	28.70	45.98	1069.2	..	1445.9	2515
9 Maize/Melon/Cassava (May)	15.96	15.21	0.10	31.07	46.38	941.0	13.7	1565.1	2520
10 Cassava alone (June)	11.84	..	..	31.49	31.49	..	..	1586.6	1587
11 Maize/Cassava "	16.59	16.92	..	31.52	48.44	1047.1	..	1587.9	2635
12 Maize/Melon/Cassava (June)	23.73	16.39	0.07	50.89	67.35	1013.9	9.1	2563.4	3586
13 Cassava alone (July)	10.47	..	..	27.85	27.85	..	..	1403.0	1403
14 Maize/Cassava "	14.15	16.39	..	25.43	41.82	1013.9	..	1281.0	2295
15 Maize/Melon/Cassava (July	12.99	17.74	0.04	21.12	38.90	1097.9	5.5	1063.9	2167
16 Cassava alone (Aug)	7.46	..	..	19.84	19.84	..	..	999.6	1000
17 Maize/Cassava "	11.73	16.07	..	19.23	35.30	994.1	..	968.8	1963
18 Maize/Melon/Cassava (Aug)	10.30	15.82	0.16	15.53	31.51	978.6	21.2	782.6	1782

Table 3 : Observations on maize intercropped with melon and relay cropped with cassava at Ikenne in 1975

Treat No.	Treatments	Plant Population per ha	Root Lodging %	Stem Lodging %	Dry wt. of Stover t/ha	Dry wt. of Grain t/ha
1	Maize alone 21/6/75	37500 a	42	36 a	2.69 bc	1.26 b
4	Maize melon 9/6/75	38828 a	47	33 a	2.48 abc	0.78 ab
5	Maize cassava 21/6/75	39062 a	45	30 a	2.39 abc	0.78 ab
6	Maize melon cassava 21/6/75	36758 a	45	35 a	2.59 bc	0.96 b
8	Maize cassava 24/7/75	37617 a	40	34 a	2.68 bc	0.90 b
9	Maize melon cassava 24/7/75	37930 a	35	32 a	1.51 a	0.85 ab
11	Maize cassava 23/8/75	38125 a	33	33 a	1.80 ab	0.76 ab
12	Maize melon cassava 23/8/75	38632 a	33	39 a	2.41 abc	0.54 a
14	Maize cassava 26/9/75	38945 a	39	33 a	2.71 bc	0.99 b
15	Maize melon cassava 26/9/75	40781 a	38	32 a	3.31 c	1.01 b
17	Maize cassava 25/10/75	37226 a	42	38 a	2.24 ab	0.78 ab
18	Maize melon cassava 25/10/75	40351 a	41	37 a	2.22 ab	0.69 a
	Treatments					
1	Maize alone	37500	42.00 a	36.00 a	2.69 a	1.26 b
2	Maize/melon	39063	40.20 a	34.10 a	2.39 a	0.78 a
3	Maize/cassava	38150	45.5 a	29.5 a	2.39 a	0.84 a
4	Maize/melon/cassava	38891	38.50 a	34.8 a	2.42 a	1.04 b
	Sub Treatments					
a	Normal fertilizer	39023.44a	40.58 a	33.42 a	2.49 a	0.91 a
b	Low fertilizer	37935.94a	39.58 a	34.92 a	2.36 a	0.80 a

Means in the same column opposite the same letter are not significantly different.

Table 4 : Plant population and yield data on legumes in the maize pattern of planting experiment in 1974.

	Grain Legumes		
	Plant Population per ha	Fresh Weight of Pods, t/ha	Dry Grain yield t/ha
1. Maize alone	..	..	..
2. Climbing cowpeas (Sitaopole)/maize same row	11,884 efg	1.42 g	0.08 f
3. Climbing cowpeas (Sitaopole)/maize alt. rows	9,452 efg	2.22 g	0.43 def
4. Climbing cowpeas (Sitaopole)/maize alt. 4 rows	12,301 ef	2.46 efg	0.22 def
5. Pole lima/maize same row	7,714 hi	1.41 g	0.23 f
6. Pole lima/maize alt. rows	11,815 fgh	2.96 ef	0.25 de
7. Pole lima/maize alt. 4 rows	10,495 efgh	5.46 bc	0.84 c
8. Erect cowpea (Prima)/maize alt. rows	42,603 a	1.20 fg	0.15 ef
9. Erect cowpea (Prima)/maize alt. 4 rows	43,299 a	1.01 g	0.13 ef
10. Bush lima/maize alt. rows	13,554 de	0.67 g	0.11 f
Bush lima/maize alt. 4 rows	15,707 d	1.05 g	0.15 ef
12. Soybeans/maize alt. rows	30,302 c	3.24 de	0.33 def
13. Soybeans/maize alt. 4 rows	34,472 b	4.96 cd	0.50 b
14. Dwarf pigeon pea/maize alt. rows	11,678 efg	6.69 bc	1.04 bc
15. Dwarf pigeon pea/maize alt. 4 rows	12,024 efg	5.96 bc	0.93 c
16. Tree type pigeon pea/maize alt. rows	6,047 i	11.15 a	1.78 d
17. Tree type pigeon pea/maize alt. 4 rows	8,440 ghi	8.34 b	1.29 b
Legume same row as maize	9,799 efg*	1.42 g*	0.16 ef*
Legume alt. rows with maize	17,924 d	4.02 cd	0.58 b
Legume 4 rows alt. with maize 4 rows	19,534 d	4.18 cd	0.58 b

* These figures refer to means based on climbing cowpeas (Sitaopole) and pole lima only.

Table 5 · Observations in early maize grain legumes, pattern of intercropping experiment in 1974 and 1975

Treat No.	Treatments	1975 Plant Population per Ha	1975 Dry weight Stover yield t/Ha	1975 Dry Grain yield t/Ha	1974 Dry Grain yield t/Ha
1.	Maize alone	43653 d*	4.24 de*	4.31 e*	5.01 f*
2.	Maize/climbing cowpeas (sitaopole same rows	40079 c*	5.10 f*	3.48 cd*	3.28 abcd*
3.	Maize/climbing cowpeas (sitaopole alt. rows	23770 a	2.95 abc	2.88 abc	2.94 abc
4.	Maize/climbing cowpeas (sitaopole 2 rows alt.	23388 a	2.86 abc	2.94 abc	..
5.	Maize/climbing cowpeas (sitaopole 4 rows alt.	23006 a	2.52 ab	2.50 a	2.28 a
6.	Maize/pole lima same rows	40183 c*	3.57 bde*	3.97 de*	4.72 ef*
7.	Maize/pole lima alt. rows	22139 a	3.31 abcd	3.37 bcd	3.25 bcd
8.	Maize/pole lima 2 rows alt.	21549 a	2.95 abc	3.30 bcd	..
9.	Maize/pole lima 4 rows alt.	20994 a	2.84 abc	2.58 a	2.95 abc
10.	Maize/yam bean same rows	42161 d*	4.38 ef*	4.18 de*	5.12 f*
11.	Maize/yam bean alt. rows	23527 a	3.47 bcd	2.54 a	3.40 bcd
12.	Maize/yam bean 2 rows alt.	23076 a	3.14 abc	3.01 abc	..
13.	Maize/yam bean 4 rows alt.	22659 a	2.30 abc	2.31 a	3.03 abc
14.	Maize/erect cowpeas (prima alt. rows	21514 a	2.55 ab	2.48 a	3.43 cd
15.	Maize/erect cowpeas 2 rows alt.	22035 a	2.70 abc	2.59 a	..
16.	Maize/erect cowpeas 4 rows alt.	22555 a	2.84 abc	2.70 a	2.94 abc
17.	Maize/bush lima alt. rows	23423 a	2.42 a	3.47 a	3.80 de
18.	Maize/bush lima 2 rows alt.	22694 a	2.47 ab	3.13 bc	..
19.	Maize/bush lima 4 rows alt.	21965 a	2.52 ab	2.78 abc	2.65 a
20.	Maize/soybeans alt. rows	24568 a	2.86 abc	2.80 abc	2.87 abc
21.	Maize/soybeans 2 rows alt.	22763 a	2.67 abc	2.74 a	..
22.	Maize/soybeans 4 rows alt.	20994 a	2.49 ab	2.68 a	2.77 abc
23.	Maize/dwarf pigeon peas alt. rows	24741 a	3.04 abc	3.52 cd	3.24 abcd
24.	Maize/dwarf pigeon peas 2 rows alt.	2359 a	2.80 abc	3.13 bc	..
25.	Maize/dwarf pigeon peas 4 rows alt.	22486 a	2.56 ab	2.72 ab	3.95 de
26.	Maize/tree type pigeon peas alt. rows	24117 a	2.85 abc	3.25 bcd	2.53 a
27.	Maize/tree type pigeon peas 2 rows alt.	22867 a	2.66 abc	2.95 abc	..
28.	Maize/tree type pigeon peas 4 rows alt.	21618 a	2.47 ab	2.65 a	3.00 abc
	Maize same rows as legume	40946 c	4.35 ef*	3.88 cde*	4.37 ef*
	Maize every 1 row alt. with legume	23596 a	2.96 abc	3.04 abc	3.18 abc
	Maize every 2 rows alt. with legume	22902 a	2.14 ab	3.21 bcd	..
	Maize every 4 rows alt. with legume	21861 a	2.63 abc	2.62 a	2.95 abc

* Means based on whole plot area which is double the half the plot size where maize alternated in single, two and four rows with legume.

Table 6: Observations on Yield of Intercropped Maize, Groundnut, Sweet potato and Cocoyam at Ikenne in 1974 & 1975

Treatments	1974 (July Planting)						1975 (April Planting)		
	Maize Dry Grain Ton/ha	G'Nut Dry Nuts Ton/ha	Sweet Potato Tubers Fresh wt. Ton/ha	Cocoyam Corms Fresh wt. (Ton/ha)	Energy Value Calorie (10^7)	Gross Value (₦)	Maize Dry Grain Tons/ha	G.Nut Dry Nuts Ton/ha	Sweet Potato Tubers Fresh wt. Tons/ha
1 Maize sole	3.21 a	..	..	..	11.46	709	4.92 a	..	..
2 Maize/G'Nut	3.23 a	0.02 a	..	..	11.64	728	5.48ab	0.64 a	..
3 Maize/Cocoyam	2.38 b	..	..	1.67 a	10.79	744	5.87 b	..	..
4 Maize/Sweet Potato	1.87 b	..	1.92 a	..	9.00	914	5.65ab	..	5.73 a
5 Sweet Potato Sole	..	..	6.22 b	..	7.53	1623	..	..	15.85 b
6 Groundnut Sole	..	0.29 b	..	..	1.59	203	..	0.81 a	..
7 Cocoyam Sole	..	..	..	3.11 b	4.26	407	..	..	..
Pattern of Planting									
a Same rows	..	..	..	..	..	..	5.24 a	0.68 a	5.40 a
b Inbetween rows	..	..	..	..	..	..	5.71 a	0.75 a	5.36 a

Means in the same column with the same letter opposite were not significantly different

Table 7: Observations on Maize, Cowpea and Soybean sequence of cropping and nitrogen fertilizer experiment in 1974 late season.

Treatments				MAIZE			COWPEA		SOYBEAN	
				Plant Population per hect.	Stover yield Tons/hect.	Grain Yield T/Ha.	Plant Population per hect.	Grain yield Tons/hec.	Plant Population per hect.	Grain Yield Tons/hect.
A										
	N	P	K							
a	0	60	30	30000.24	2.11a	1.44a	33444	1.43a	67555a	1.07a
b	45	60	30	31222.47	2.53a	1.72a	33444	1.54a	63666a	1.18a
c	90	60	30	30111.35	2.72a	1.68a	33222	1.45a	62444a	1.27a
B										
a	0	60	30	31778.03	2.32a	1.75a				
b	45	60	30	32889.15	3.19a	1.83a				
	90	60	30	31111.36	3.31a	1.98a				
Sub-Treatment										
	N	P	K							
a	0	60	30	30889.14	2.21	1.60a				
b	45	60	30	32055.81	2.86	1.78a				
c	90	60	30	30611.36	3.02	1.83a.				

Main Treatments: Cropping sequence

A. Cowpea followed by Maize
B. Soybean followed by Maize.

Sub-Treatments: Nitrogen levels applied to maize

	P	K
a. 0 kg N per Ha +	90	60
b. 45 kg N per Ha+	90	60
c. 90 kg N per Ha+	90	60

Table 8 : Observations on maize, cowpea and soybean sequence of cropping and nitrogen fertilizer experiment (second planting early season 1975

Treatment		N	P	K	MAIZE: Plant Population per ha	MAIZE: Dry wt. of Stover t/Ha	MAIZE: Dry wt. of grain t/Ha	COWPEA: Plant Population per Ha.	COWPEA: Grain yield t/Ha	SOYBEAN: Plant Population per Ha	SOYBEAN: Grain yield t/Ha
C											
Cowpea fb	a	0	60	30	37252 a	5.091 a	3.319(22%*	33000	1.07 a	60222 a	0.237 a
Maize fb	b	45	60	30	38142 a	4.747 a	3.377(-7.5% a	32778	0.92 a	57333 a	0.210 a
	c	90	60	30	36918 a	5.083 a	4.136(10%	33889	0.85 a	57222 a	0.237 a
Mean						4.974(10%					
D											
Soybean fb	a	0	60	30	34917 a	4.615 a	2.711 a				
Maize	b	45	60	30	37141 a	5.725 a	3.652 a				
	c	90	60	30	37030 a	6.066 a	3.761 a				
Sub-Treatments		N	P	K							
	a	0	60	30	36085 a	4.854 a	3.014 a				
	b	45	60	30	37642 a	5.238 a	3.514 a				
	c	90	60	30	36975 a	5.577 a	3.948 a				

Main Treatments: Cropping sequence
A. Cowpea followed by Maize
B. Soybean followed by Maize

Sub-Treatments: Nitrogen levels applied to maize P K
a. 0 Kg^N per Ha + 90 60
b. 45 Kg^N per Ha + 90 60
c. 90 Kg^N per Ha + 90 60

* Percentage of yield increase over no nitrogen plot following soybeans

Means opposite the same letter written each column are not significantly different

Table 9 : Observations in maize grown at one, two and four plants per stand grown alone or with cowpeas in late season of 1975.

Treatments	MAIZE					COWPEA		
	Plant Population per ha	Stem Lodging %	Root Lodging %	Stover yield t/ha	Grain yield t/ha	Plant Population per ha	Green weight of pods t/ha	Grain yield t/ha
1 Akidi alone	..	..	..	..	..	29,800 de	0.97 a	0.18 a
2 Sitaopole alone	..	..	..	..	..	32,863 e	1.11 a	0.21 a
3 Dinner alone	..	..	..	..	..	25,901 cd	0.81 a	0.16 a
4 Maize 1/stand	37,361 a	47.21 a	25.28 ab	4.91 b	1.51 a	..	..	..
5 Maize 2/stand	39,028 a	48.04 a	36.65 b	5.82 c	1.69 ab	..	..	..
6 Maize 4/stand	38,611 a	42.81 a	29.86 ab	5.53 c	1.76 ab	..	..	..
7 Maize 1/stand + Akidi	85,973 a	50.97 a	21.62 b	5.39 c	1.73 ab	17,128 ab	0.62 a	0.10 a
8 Maize 2/stand + Akidi	36,250 a	48.28 a	36.78 b	5.10 b	1.65 ab	14,064 a	0.35 a	0.06 a
9 Maize 4/stand + Akidi	38,473 a	28.27 a	23.83 ab	4.36 a	1.74 ab	14,482 a	0.35 a	0.06 a
10 Maize 1/stand + Dinna	38,195 a	39.27 a	29.09 ab	4.54 a	1.98 b	23,394 c	0.26 a	0.04 a
11 Maize 2/stand + Dinna	37,361 a	49.81 a	23.05 ab	5.39 c	1.63 a	21,027 bc	0.20 a	0.03 a
12 Maize 4/stand + Dinna	35,000 a	50.79 a	36.51 ab	5.33 c	1.55 a	25,204 cd	0.39 a	0.02 a
13 Maize 1/std + Sitaopole	34,167 a	52.03 a	39.02 ab	4.55 ab	1.98 b	24,647 d	0.44 a	0.07 a
14 Maize 2/std + Sitaopole	38,195 a	49.45 a	18.91 a	5.57 c	1.99 b	25,065 cd	0.36 a	0.07 a
15 Maize 4/std + Sitaopole	33,195 a	49.79 a	30.96 ab	4.67 b	1.59 a	28,407 de	0.48 a	0.08 a
	NS	NS	*	*	*	*	NS	NS
1 Maize sole crop	38,333	46.02	30.60	5.42	1.65	29,521 de	0.96	0.18
2 Maize 1 plant/stand	36,424 a	47.37 a	28.75 a	4.85 a	1.80 a	21,721 bc	0.44 a	0.07 a
3 Maize 2 plants/stand	37,709 a	48.90 a	31.60 a	5.47 b	1.74 a	20,050 bc	0.30 a	0.05 a
4 Maize 4 plants/stand	36,320 a	42.92 a	30.29 a	4.97 a	1.66 a	22,698 c	0.41 a	0.05 a

Table 10 : Maize and cowpea grain yields (t/ha) in relation to the associated number of maize plants per plants per stand

Treatments	MAIZE				COWPEAS									
	Grain Yield t/ha				Fresh Weight of Pods t/ha					Grain Yield t/ha				
	1 Plant per stand	2 Plants per stand	4 Plants per stand	Mean	Sole Crop (Cowpeas)	1 Plant per stand	2 Plants per stand	4 Plants per stand	Mean	Sole Crop (Cowpeas)	1 Plant per stand	2 Plants per stand	4 Plants per stand	Mean
1 Sole Maize	1.51 a	1.69 ab	1.65 ab	1.62	..	..	..	..	..	..	..	..	..	..
2 Maize+Akidi	1.73 ab	1.65 ab	1.74 ab	1.71 ab	0.97	0.62	0.35	0.35	0.54	0.18	0.10	0.06	0.06	0.10
3 Maize + Sitaopole	1.98 b	1.63 a	1.55 a	1.72 ab	1.11	0.44	0.36	0.48	0.60	0.21	0.07	0.07	0.08	0.11
4 Maize+Dinna	1.98 b	1.99 b	1.59 a	1.85 b	0.81	0.26	0.20	0.39	0.42	0.16	0.04	0.03	0.02	0.06
Mean	1.80 ab	1.74 ab	1.66 ab	1.73 ab	0.96	0.44	0.30	0.41	0.53	0.18	0.07	0.05	0.05	0.09

Table 12 : Observations on early maize grown in different mulches in 1975

	Plant Population per ha	Days to 50% Tasselling	Days to 50% Silking	Stem Lodging %	Stem Lodging No/ Plot	Root Lodging %	Root Lodging No/ plot	Stover Yield t/ha	Grain Yield t/ha
1 Bare - No mulch	36834 a	55 ab	65 bcd	3.4 a	3.0 a	1.5 d	1.3 d	6.87 de	4.03 a
2 Maize Stover	36417 a	54 abcd	62 bcd	5.0 a	4.3 a	3.4 bcd	3.0 bcd	7.33 cde	4.04 a
3 Maize Cobs (chipped)	37392 a	52 abcd	61 bcd	4.8 a	4.3 a	7.1 bcd	6.3 bcd	6.16 e	3.71 a
4 Oil Palm leaves	37251 a	51 d	62 bcd	11.6 a	10.3 a	16.4 a	14.7 a	8.84 abcd	4.29 a
5 Rice Straw	36000 a	51 d	61 bcd	1.9 a	1.7 a	6.6 bcd	5.7 bcd	8.09 bcde	4.82 a
6 Rice Husks	36696 a	53 abcd	62 bcd	6.1 a	5.3 a	5.3 bcd	4.7 bcd	9.38 abc	5.02 a
7 Pennisetum Straw	36975 a	53 abcd	62 cd	2.6 a	2.3 a	9.8 abc	8.7 abc	7.41 cde	4.17 a
8 Elephant grass Straw	37530 a	52 cd	61 bcd	3.3 a	3.0 a	2.6 cd	2.3 cd	10.19 a	4.89 a
9 Panicum Maximum Straw	36558 a	52 bcd	60 abcd	3.8 a	3.3 a	6.8 bcd	6.0 bcd	9.04 abc	4.29 a
10 Andropogan Straw	37530 a	55 abc	62 abcd	5.6 a	5.0 a	5.6 bcd	5.0 bcd	7.62 bcde	4.64 a
11 Typha Straw	36975 a	53 abcd	63 abcd	6.0 a	5.3 a	6.4 bcd	5.7 bcd	9.38 abc	4.49 a
12 Cassava Stem Chips	36417 a	53 abcd	64 bcd	5.4 a	4.7 a	11.8 ab	10.3 ab	7.73 bcde	3.92 a
13 Pigeon Pea tops	36975 a	52 cd	61 bcd	5.3 a	4.7 a	3.8 bcd	3.3 bcd	9.73 ab	4.83 a
14 Pigeon Pea Stems (chipped)	34558 a	52 abcd	61 bcd	5.7 a	5.0 a	3.4 bcd	3.0bcd	6.91 bcde	4.06 a
15 Legume husks	37392 a	51 d	62 bcd	8.2 a	7.3 a	5.2 bcd	4.7 bcd	9.62 ab	4.52 a
16 Soybean tops (chipped)	35862 a	53 abcd	61 bcd	4.7 a	4.0 a	5.0 bcd	4.3 bcd	7.98 bcde	4.98 a
17 Eupatorium Tops	36000 a	53 abcd	61 bcd	4.3 a	3.7 a	3.1 cd	2.7 cd	8.17 abcde	4.45 a
18 Mixed Twigs (chipped)	35445 a	55 abc	64 abc	7.1 a	6.0 a	7.5 bcd	6.3 bcd	7.62 bcde	3.85 a
19 Saw dust	37250 a	55 abc	66 a	7.8 a	7.0 a	6.0 bcd	5.3 bcd	8.27 abcd	3.84 a
20 Black Plastic	37250 a	53 abcd	64 abc	3.7 a	3.3 a	6.0 bcd	5.3 bcd	9.22 abc	4.76 a
21 Translucent Plastic	37113 a	55 abc	64 abc	3.7 a	3.3 a	3.4 bcd	3.0 bcd	6.99 de	4.57 a
22 Fine Gravel	35307 a	54 abcd	64 abc	5.5 a	4.7 a	3.5 bcd	3.0 bcd	7.74 bcde	4.71 a

Means opposite the same letters in each column are not significantly different at the 5% level

Table 13 : Observations on early cowpeas and early soybeans grown in different mulches in 1975

		Cowpeas			Soybeans		
		Plant Population Per ha	Days to 50% Flowering	Grain yield t/ha	Plant Population Per ha	Grain yield t/ha	Total weight of weeds removed
1	Bare - no mulch	30162 a	48.67 ab	0.84 ef	8061 e	0.18 a	1.96
2	Maize stover	31413 a	46.67 abcd	0.95 def	30579 cd	0.26 a	2.79
3	Maize cobs (chipped)	29190 a	44.33 abcd	0.99 def	61854 a	0.60 a	2.70
4	Oil Palm leaves	31830 a	44.33 abcd	0.99 def	52690 abc	0.39 a	2.55
5	Rice straw	32664 a	44.00 abcd	1.05 bcdef	61854 a	0.61 a	2.79
6	Rice husks	26688 a	42.67 bcde	1.15 bcd	35724 bcd	0.50 a	3.19
7	Pennisetum straw	30720 a	40.33 def	0.99 def	46903 abcd	0.34 a	3.44
8	Elephant grass straw	32805 a	42.00 bcde	1.09 bcde	50457 abc	0.42 a	2.90
9	Panicum maximum straw	30858 a	42.00 bcde	0.89 def	24741 de	0.22 a	3.05
10	Andropogon straw	31813 a	40.33 def	0.81 f	42672 abcd	0.30 a	2.98
11	Typha straw	28494 a	46.33 abcd	0.87 ef	58797 ab	0.32 a	2.66
12	Cassava stem chips	29469 a	46.33 abcd	0.96 def	45732 abcd	0.39 a	3.01
13	Pigeon Pea tops	31413 a	41.33 cdef	1.03 def	37947 bcd	0.42 a	3.40
14	Pigeon pea stems (chipped)	29607 a	44.67 abcd	0.90 def	42951 abcd	0.35 a	2.47
15	Legume husks	30024 a	43.33 bcd	1.00 def	46287 abcd	0.45 a	2.86
16	Soybean tops (chipped)	29469 a	41.67 cdef	0.91 def	44481 abcd	0.39 a	2.56
17	Eupatorium tops	32247 a	47.33 abc	0.79 f	43506 abcd	0.34 a	2.69
18	Mixed twigs (chipped)	29886 a	50.33 a	1.00 def	51846 abc	0.40 a	2.03
19	Saw dust	32664 a	40.33 def	1.13 bcd	44064 abcd	0.31 a	2.54
20	Black plastic	13761 a	35.33 f	1.28 ab	45036 abcd	0.60 a	2.15
21	Translucent plastic	33498 a	36.67 ef	1.46 a	42117 abcd	0.37 a	2.56
22	Fine gravel	32109 a	44.33 abcd	1.26 abc	40866 abcd	0.59 a	2.47
			LSDOS=2.09				

Table 14: Observations on Maize and Groundnuts grown in different patterns of planting in 1975

MAIN TREATMENTS G'NUT CULTIVARS	GROUNDNUTS				MAIZE				
	Plant Pop per hectare	Dry wt of unshelled Nuts(t/ha)	Dry wt. shelled Nuts(t/ha)	Cercospora Leaf Spot Scores 1-7	Plant Pop per hectare	Stem Lodging %	Root Lodging %	Stover Yield (t/ha)	Grain Yield (t/ha)
a. Local (Ex Ikenne)	131355 b	0.63 b	0.509 b	6.53 a	46363 a	4.43 b	0.96 a	14.58 a	1.35 a
b. Zaria 1 (F439-2)	136609 a	1.37 a	1.038 a	6.73 a	44863 a	5.78 a	1.68 a	11.62 a	1.35 a
c. Zaria 2 (M25-68)	140696 a	0.89 b	0.705 b	5.67 a	47113 a	5.72 a	1.15 a	12.68 a	1.48 a
d. Zaria 3 (EM9 69- R74)	128853 b	0.92 b	0.671 b	5.87 a	43721 a	5.27ab	1.97 a	11.63 a	1.30 a
e. Zaria 4 (M276-70RRI)	132022 b	0.74 b	0.538 b	4.47 b	43280 a	6.27 a	1.42 a	11.13 a	1.30 a
SUB-TREATMENTS Planting Patterns									
1/2 Sole Crop Maize/G.nut on ridge	137193 a	3.28 a	2.515 a	5.93 a	45863 a	5.39 a	1.64 a	11.58 a	1.40 a
3 Maize &G'nut on same ridge	134441 a	0.25 a	0.208 b	5.80 a	45500ab	5.13 a	1.47 a	12.51 a	1.45 a
4 Maize on one side of ridge G'nut on other	131355 a	0.29 b	0.230 b	5.53 a	45084ab	6.04 a	1.41 a	13.26 a	1.39 a
5 Maize in furrow G'nut on ridge	134608 a	0.46 b	0.188 b	6.07 a	42363 b	5.64 a	1.38 a	11.06 a	1.18 a
6 Maize & G'nut on alt.rows on flat	129854 a	0.26 b	0.198 b	5.93 a	46363 a	5.21 a	1.62 a	13.25 a	1.36 a

Variety means or pattern of planting means opposite the same letters in each column are not significantly different

Table 15 : Calorie values and gross returns for intercropped Maize and five varieties of groundnuts

MAIN TREATMENTS	CALORIE x 10^7			GROSS RETURNS IN ₦		
	MAIZE	G'NUT	TOTAL	MAIZE	G'NUT	TOTAL
1 Maize (sole)	4.82	-	4.82	298.22	-	298.22
a G'Nut Local Ikenne	4.82	2.79	2.79	298.22	421.76	719.99
b Maize Zaria 1 (F439-2)	4.82	5.70	10.52	298.22	860.09	1159.02
c Maize Zaria 2 (M25-68)	5.28	3.87	9.15	326.93	584.16	911.09
d Maize Zaria 3 (EM9 69 R74)	4.64	3.68	8.32	287.17	555.99	843.16
e Maize Zaria 4 (M276-70RRI)	4.64	2.95	7.59	287.17	445.79	732.96
2 G'Nut Sole	-	13.81	13.81	-	2083.93	2083.93
3 Maize & G'Nut on same ridge	5.18	1:14	6.32	320.31	172.35	492.66
4 Maize on one side of ridge G'Nut on the other	4.96	1.26	6.22	307.05	190.58	497.63
5 Maize in furrow G'Nut on ridge	4.21	1.03	5.24	260.66	155.78	416.44
6 Maize & G'Nut on alt. rows on Flat	4.86	1.09	5.95	300.42	164.06	464.48

Table 16 : Plant population, number of tubers and fresh weight of tubers in yams in relation to crop combinations observed in Ibadan in 1975.

	Treatments	Plant Population per Ha	Number of tubers per Ha	Fresh weight of tubers t/Ha.
1	Yames alone	9250 b	18250 b	23.09 b
7	Yam + maize 2/stand staggered	7000 a	13500 ab	10.01 a
8	Yam + maize 2/stand same row	7000 a	14750 b	13.38 b
11	Yam + TVU 1190	6500 a	11750 a	10.93 ab
12	Yam + Sitaopole	6750 a	12000 a	12.30 ab
21	Yam + maize 2/stand + Sitaopole + melon	7000 a	12250 a	11.38 ab
22	Yam + maize 4/stand + TVU 1190 every 2 rows alt. with melon	6250 a	13000 ab	14.25 b
1	Yams alone	9250 b	18250 b	23.09 b
2	Yams + 1 crop	6813 a	13000 ab	11.66 ab
3	Yams + 3 crops	6625 a	12625 a	12.82 ab

Means opposite the same letter in each column are not significantly different.

Table 17 : Maize plant population, lodging and yields in relation to number of plant per stand and crop combinations.

Treat No.	Maize Treatments	Plant Population per ha	Stem Lodging Percentage	Root Lodging Percentage	Stover yield t/ha	Grain yield t/ha
2	Maize 1 per stand	37062 ab	14.33 abc	4.38 a	4.37 ef	2.928 b
6	Maize 2 per stand	44750 bc	10.89 ab	2.93 a	4.71 ef	2.955 b
7	Maize 2 + Yams	44000 c	8.45 abc	2.29 a	5.17 f	2.870 b
8	Maize 2 same row + Yam	45562 c	14.84 bd	3.57 a	3.79 cde	2.070 ab
9	Maize 2/stand + Melon	40875 abc	6.89 a	3.98 a	4.07 de	2.153 ab
10	Maize 4/stand + Melon	43125 abc	6.96 a	2.32 a	3.22 bcd	2.550 b
13	Maize 2/stand + climbing C'pea	41438 abc	13.12 abc	4.37 a	3.64 cde	2.068 ab
14	Maize 2/stand + semi erect C'pea	36500 a	27.24 d	6.85 a	3.08 bc	1.670 ab
15	Maize 4/stand semi erect C'pea	39875 abc	21.47 cd	4.39 a	2.33 ab	1.503 a
16	Maize 4/stand + climb. Cowpea	40438 abc	23.18 cd	4.64 a	3.35 de	1.988 ab
21	Maize 2/stand + climb. C'pea+Melon	43688 abc	14.74 bc	4.58 a	3.05 bc	1.905 ab
22	Maize 4/stand + yam/C'pea + 2 rows alt. with Melon	36938 ab	17.43 bc	4.40 a	1.96 a	1.553 a
	Summary					
A.	Number of Plants per stand					
	Maize 1/stand	37062 ab	14.33 abc	4.38 a	4.37 ef	2.928 b
	Maize 2 stand	46688 c	13.74 abc	4.08 a	3.93 cde	2.24 ab
	Maize 4/stand	40094 abc	17.26 bc	3.94 a	2.72 ab	1.90 ab
B.	Crop combinations					
	Maize alone	40906 abc	12.61 abc	3.66 a	4.54 ef	2.95 b
	Maize + yam	59781 c	11.64 ab	2.90 a	4.79 ef	2.47 b
	Maize + melon	42000 abc	6.93 a	3.15 a	3.65 cde	2.35 b
	Maize + climbing cowpeas	40938 abc	18.15 bc	4.51 a	3.50 cde	2.04 ab
	Maize + semi erect cowpeas	38188 ab	24.36 cd	5.62 a	2.71 ab	1.59 a
	Maize + melon + yam + Cl. C'pea	43688 abc	14.74 abc	4.58 a	3.05 bc	1.91 ab
	Maize + melon + yam + Er. C'pea	36938 ab	17.43 bc	4.40 a	1.96 a	1.55 a
	Maize alone	40906 abc	12.61 abc	3.66 a	4.54 ef	2.95 b
	Maize + 1 crop	45227 c	15.27 bd	4.05 a	3.66 cde	2.11 ab
	Maize + 3 crops	40313 abc	16.09 bc	4.49 a	2.51 ab	1.73 ab

Semi-erect cowpea = Tvu 1190; Climbing cowpea = Sitaopole

Means opposite the same letter(s) in each column are not significantly different.

Table 18 · Mean plant population, fresh weight of vegetable cowpea (Sitaopole) and cowpea dry grain yield in relation to crop combinations in 1975

	Treatments	Plant Population per Ha	Fresh wt. of climbing Cowpea (Sitaopole) Green Pods/ha	Grain yield t/ha
4	Cowpeas alone TVU 1190	39250 de	..	2.19 d
5	Climbing Cowpeas (Sitaopole) alone	38500 de	4.75 d	0.74 abc
11	TVU 1190 + Yams	42125 e	..	1.82 cd
12	Climbing Cowpeas (Sitaopole) + Yams	25625 b	2.62 bc	0.41 a
13	Climbing Cowpeas (Sitaopole)+Maize 2/stand	27875 b	0.97 a	0.15 a
14	TVU 1190 + Maize 2/stand	40063 de	..	0.86 abc
15	TVU 1190 + Maize 4/stand	39813 de	..	1.32 bc
16	Climbing Cowpea(Sitaopole)+Maize 4/stand	37563 d	1.54 b	0.24 a
17	TVU 1190 + Melon same row staggered	39000 de	..	2.64 d
18	TVU 1190 + Melon alternate rows	14188 a	..	4.60 d
19	Climbing Cowpeas(Sitaopole)+Melon same row	37375 d	3.26 bc	0.51 ab
20	Climbing Cowpeas(Sitaopole)+Melon alt. row	13000 a	2.62 bc	0.82 a
21	Climbing Cowpeas(Sitaopole)+Yams+Melon + Maize 2/stand	40063 de	1.02 a	0.16 a
22	TVU 1190 every 2 rows alternating with Melon + Maize 4/stand	38438 de	..	1.10 a
	Crop Combination Means			
	TVU 1190 alone	39250 de	..	2.19 d
	Climbing Cowpea (Sitaopole)alone	38500 de	4.75 d	0.74 abc
	TVU 1190 + 1 Crop	35038 d	..	2.25 d
	Climbing Cowpea (Sitaopole)+ 1 Crop	28288 a	2.20 bc	0.42 a
	TVU 1190 + 3 Crops	38438 de	..	1.10 a
	Climbing Cowpea (Sitaopole)+ 3 Crops	40063 de	1.02 a	0.16 a

Table 19 : Melon plant population, fruit fresh weight and seed yield in relation to crop combinations.

Treatment No.		Plant Population per hectare	Fresh wt. of fruits Ton/Hectare	Seed Yield Ton/Ha.
3	Melon alone	9562.50 b	12.03 c	.635 b
9	Maize 2/stand + Melon	8750.00 b	3.69 ab	.098 a
10	Maize 4/stand + Melon	9000.00 b	1.43 a	.035 a
17	Melon + Semi erect c'peas same row staggered	8438.00 b	0.67 a	.023 a
18	Melon + Semi erect c'peas alt. rows	9000.00 a	1.71 a	.040 a
19	Melon + Climb.c'peas same rows	9562.50 b	8.12 c	.215 a
20	Melon + Climb.c'peas alt. rows	9125.00 a	6.41 bc	.483 b
21	Yams + Maize 2/stand + c'peas + melon	8750.00 b	2.01 a	.040 a
22	Yams + Maize 4/stand + c'peas semi erect every 2 rows alt. with Melon	8000.00 a	1.94 a	.050 a
	Crop Combination Means			
	Melon alone	9563	12.03	0.64
	Melon + 1 crop	8979	3.67	0.17
	Melon + 3 crops	8375	1.98	0.05

Means opposite the same letter(s) are not significantly different.

Table 20 : Calorie equivalents and gross returns of different intercropping mixtures in 1975

	CALORIE 10^7					COST ₦				
	Maize	Melon	Cowpea	Yam	Total	Maize	Melon	Cowpea	Yam	Total
1 Yams alone	..	..	..	16.39	16.39	..	..	..	3022	3022
2 Maize alone	10.46	..	..	..	10.46	647.2	..	..	..	647
3 Melon alone	..	3.29	..	..	3.29	..	444.5	..	..	445
4 TVU 1190 alone	..	..	7.40	..	7.40	..	..	639.9	..	640
5 Sitaopole alone	..	..	2.50	..	2.50	..	..	216.2	..	216
6 Maize 2/stand alone	10.57	..	..	..	10.57	653.9	..	..	..	654
7 Yams & Maize 2/stand staged	10.25	..	..	7.11	17.36	634.0	..	..	1310	1944
8 Yams & Maize 2/stand same row	7.39	..	..	9.50	16.89	457.3	..	..	1751	2208
9 Maize 2/stand + melon	7.68	0.51	..	..	8.19	474.9	66.6	..	..	544
10 Maize 4/stand + melon	9.10	0.18	..	..	9.28	563.3	24.5	..	..	588
11 Yams + TVU 1190	..	..	6.15	7.76	13.91	..	..	531.8	1431	1963
12 Yams + sitaopole	..	..	1.39	8.73	10.12	..	..	119.8	1610	1730
13 Maize 2/stand + sitaopole	7.39	..	0.51	..	7.90	457.3	..	43.8	..	501
14 Maize 2/stand + TVU 1190	5.96	..	2.91	..	8.87	368.9	..	251.3	..	620
15 Maize 4/stand & TVU 1190	5.36	..	4.46	..	9.82	331.4	..	385.7	..	717
16 Maize 4/stand + sitaopole	7.10	..	0.81	..	7.91	439.6	..	70.13	..	510
17 Melon & TVU 1190 staggered	..	0.12	8.92	..	9.04	..	16.1	771.4	..	788
18 Melon & TVU 1190 alt. rows	..	0.21	7.77	..	7.98	..	28.0	672.1	..	700
19 Melon & sitaopole same row	..	1.11	1.72	..	2.83	..	150.5	149.0	..	300
20 Melon & sitaopole alt. rows	..	2.50	1.39	..	3.89	..	338.1	119.8	..	458
21 Yams & maize 2/stand+sitaopole	6.82	0.21	0.54	8.08	15.75	421.9	28.0	46.8	1490	1987
22 Yams & maize 4/stand+TVU 1190 every 2 rows alt. with melon	5.53	0.26	3.72	10.12	19.63	342.4	35.0	321.4	1865	2564

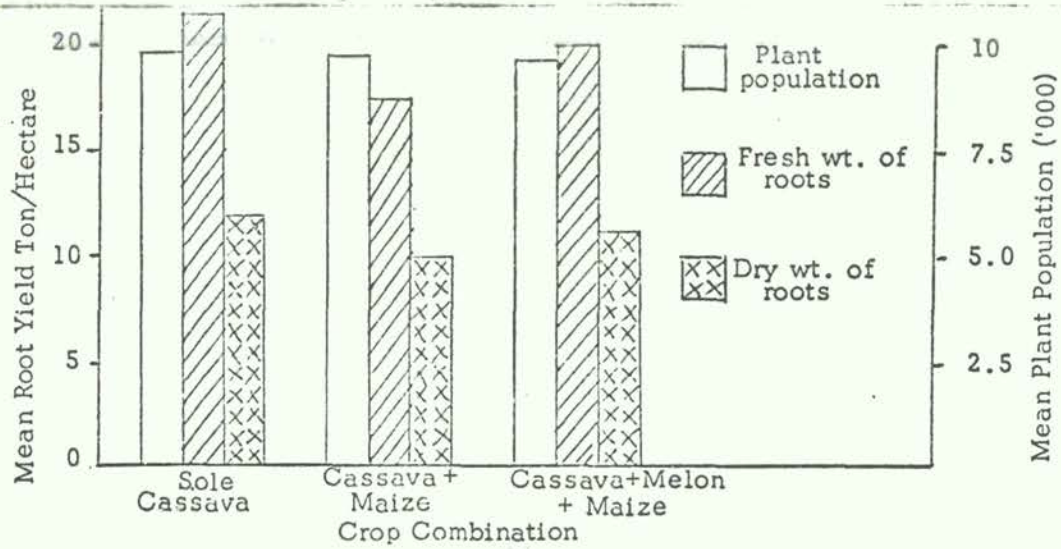


Fig. 2a. Plant population and root yields of cassava grown in different crop combinations.

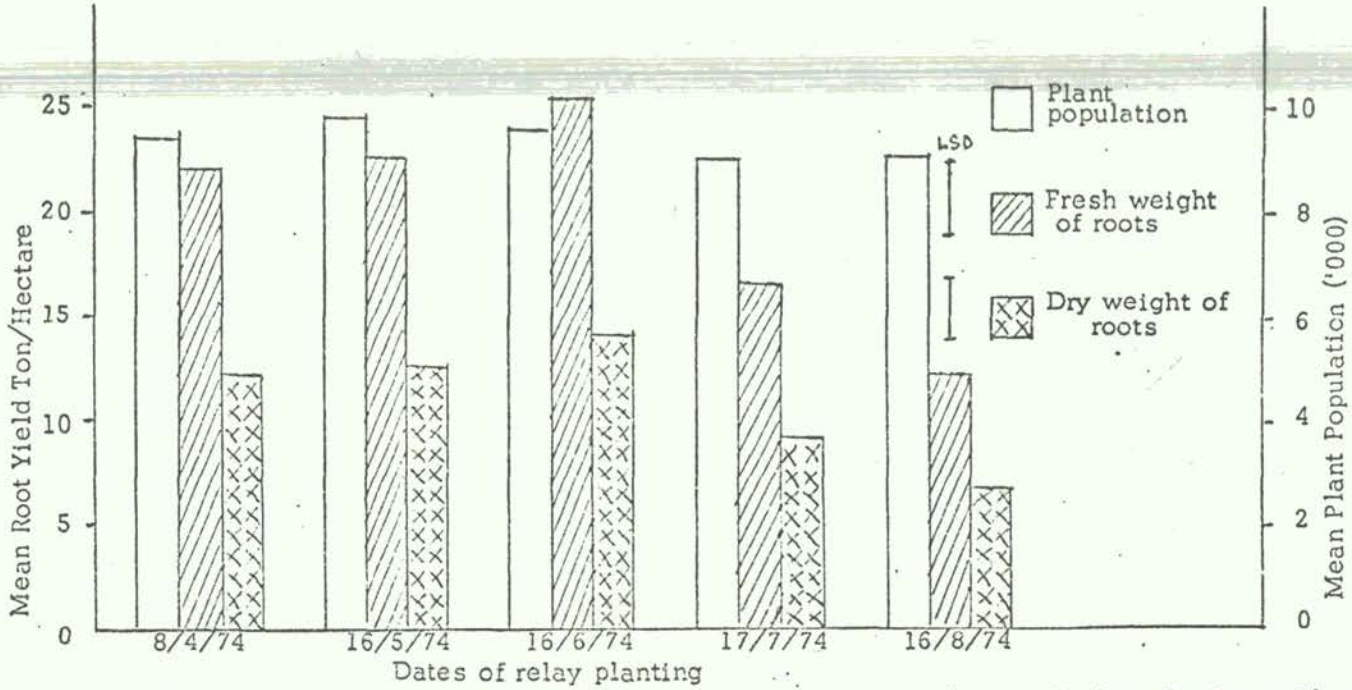
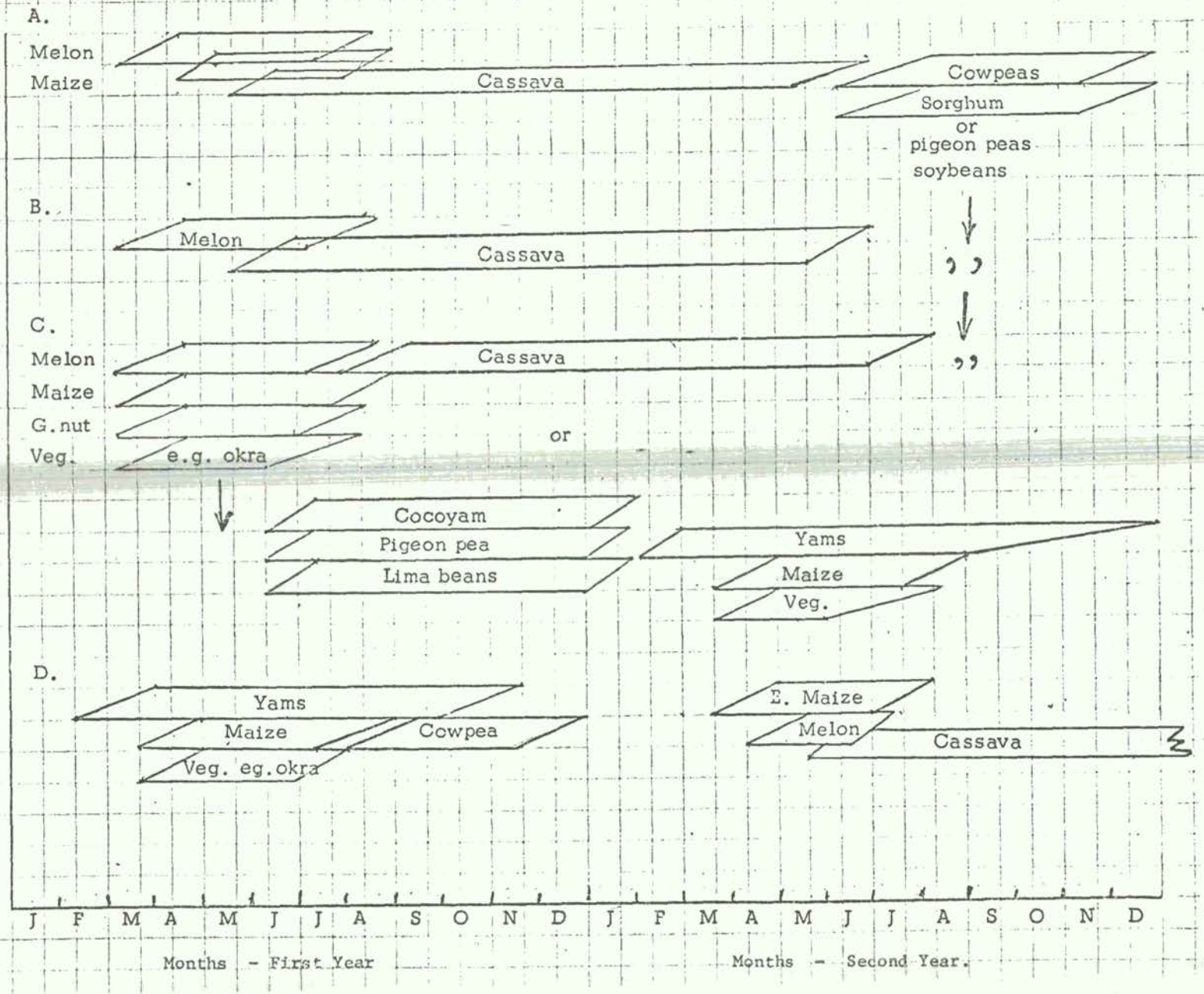


Fig. 2b: Plant population and root yields of cassava in relation to dates of relay planting with maize.

Fig. 2 POSSIBLE LONGTERM CROPPING SEQUENCES AND COMBINATIONS



Statement of Expenditure on Farming Systems Program
for the year ended 31st December 1975

	Budget $	Expenditure $
GENERAL		
Professional Salaries	256,000	253,186.56
Benefits and Allowances	202,800	208,248.19
Regular Salaries	260,850	259,272.20
Official Travel	37,960	34,632.83
Supplies and Expenses	10,310	7,569.86
Offsite Research	24,710	20,853.26
Equipment	106,730	127,899.82
	899,360	911,662.72
AGRICULTURAL ECONOMICS		
Supplies and Expenses	4,750	4,123.69
AGRIC. ENGINEERING AND LAND DEVELOPMENT		
Daily Rated Labor	13,750	13,939.96
Supplies and Expenses	24,150	25,207.50
	37,900	39,147.46
CROPPING SYSTEMS		
Daily Rated Labor	55,900	55,651.90
Supplies and Expenses	16,660	16,996.33
	72,560	72,648.23
CROP PROTECTION		
Daily Rated Labor	1,400	1,066.00
Supplies and Expenses	2,900	3,992.51
	4,300	5,058.51

	Budget	Expenditure
REGIONAL ANALYSIS	$	$
Daily Rated Labor	7,140	7,593.00
Supplies and Expenses	1,720	1,735.41
	8,860	9,328.41
SOIL CHEMISTRY & FERTILITY		
Daily Rated Labor	13,810	14,115.77
Supplies and Expenses	21,950	23,340.65
	35,760	37,456.42
SOIL PHYSICS & CONSERVATION		
Daily Rated Labor	12,460	13,534.38
Supplies and Expenses	15,050	17,137.18
	27,510	30,671.56
TOTAL FARMING SYSTEMS	$1,091,000	$1,110,097.00

The above figures are subject to audit.

D.L.C. Pritchard,
Treasurer.

27th February 1976

Statement of Capital Items Included in Expenditure on Farming Systems Program for the Year Ended 31st December 1975

(of which items marked * are specifically for work on inter-cropping systems)

Description			Amount
Hydraulic Bench - Gravimetric	.		$7,559.94
Fleco Model - Tree Pusher	.		4,019.58
3 Miniature Temperature Recorder Scales	.		4,127.21
3 Landmaster Cultivators	.	*	4,733.68
120 50mm Soil Thermometers	.	*	1,562.79
Grain Dryer RD-1200	.		1,834.81
Construction of Traversing Mechanism for Gamma Scanning Equipment			2,572.40
6 Peugeot Autocycles	.		2,099.52
1 Thermocirculator Radiant-heat Oven	.		1,638.00
1 Hot Pack Model 214300 Mech. Conversion Tru-temp Oven			7,621.60
1 Plant Growth Photometer + Accessories 4 Maximum Wind Indicator 1 Recording Rain Gauge	)))		2,043.47
2 Mech. Pyranograph, 1 Meteograph 1 Hygrothermograph 1 Mercurial Barometer	))))		3,120.42
1 Portable Area Meter + Accessories	.		6,186.32
1 Model N4000 Tecator Digestion System	.		3,950.59
Mulch Plot Run-off Collection Construction	.	*	4,000.00
1 Pneumatic Stripper Harvester	.		1,514.80
1 Harrison 13" Lathe M300 40" Centre-gapped + Accessory			5,607.98
2 Pedestrial Tractors 1 Sickle Mower + Accessories	))		2,506.38
1 Range Rover	.		11,000.00
1 KWH Unit Blower 1 Power Sprayer 1 Crop Moisture Meter 1 Soil Moisture Tester	))))		2,238.67
Biology Laboratory Furniture	.		14,980.00
			$94,918.16

18th March 1976

D.L.C. Pritchard,
Treasurer.