AN INVESTIGATION INTO THE PRACTICE OF MIXED CROPPING IN THE NEIGHBOURHOOD ADJACENT TO ST. AUGUSTINE, WITH THE OBJECT OF FINDING OUT WHETHER THERE IS ANY VALID REASON FOR THE PRACTICE.

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INTRODUCTION

In the tropics the practice of mixed cropping is so widespread and important that any interested person will inevitably encounter it. In a tropical country the mainstay of the rural population is the native gardener, and it is his small garden rather than the large holding of the immigrant farmer that is the typical agriculture of the country. If the native gardener can be called the typical agriculturist, then mixed cropping, which plays so large a part in his system of farming, may fairly be called the favourite practice.

The native gardener has always been a source of information to immigrant farmers and planters, who have adopted his crops, and to some extent his methods. The immigrant farmer wishing to produce crops on a large scale can benefit, and has benefited by the adoption of modified methods of native agriculture. In any such utilisation of the native practice mixed cropping must inevitably come to the fore, since it is so much a part of the agriculture of the country; examples of mixed cropping adapted by the large scale farmer to his own needs can be seen on many farms, for instance on the Imperial College farm. But claims to the suitability of a method cannot be substantiated without reasons. Native methods of cropping and cultivation must be examined from the point of view of essential soundness before the large scale farmer can adopt any such methods himself. The preliminary step must be enquiry into the native practice, with especial emphasis upon the reasons underlying that practice. It is the purpose of this paper to describe the results of such an investigation, during the course of which the writer concerned himself chiefly with the reasons for the various methods followed by the native gardeners near St. Augustine.

In view of the fact that mixed cropping plays such
an important part in the agriculture of tropical countries, it is surprising to find little literature on the subject as such. Most references to the practice are found in textbooks on agriculture in various parts of the tropics, and for the most part these references are rather scanty. They serve to provide examples for comparison with the methods in Trinidad, but they give little indication of the agricultural value of the practice of mixed cropping. Articles on the subject are hard to find, but Wood (1), and Nicol (2) have suggested reasons to account for the popularity of mixed crops, though they do not give any data to support these reasons. The ecological side of the question, dealing with the effect of one crop on another and the subsequent effect on the soil, has been fairly well covered, but principally in connection with temperate countries. Data from such sources can give no more than a general idea of the theories on the subject, and are not necessarily applicable to the tropical practice. In the writer's opinion the subject has been much neglected, though its complexity and importance are certainly deserving of much greater interest.
METHODS

In the study of the question of mixed cropping the investigator must first ask himself what exactly is a mixed crop. In its broadest sense a mixed crop in the tropics can be a selectively thinned forest, or a natural, or almost natural association of crop plants sown in a haphazard fashion over an area in the manner described by Willis (3) in Ceylon. In the narrower sense a mixed crop consists of alternating rows of crop plants repeated over a field. In this investigation the narrower sense has been principally considered, since it is the more usual type of crop in Trinidad. Accidental growth of food plants has not been regarded as a mixed crop, though naturally a farmer does not object to using the odd eddo that comes up by accident in his crop of yams. A mixed crop, then, can be defined as one in which two or more species of crop plants are growing interplanted in a regular or irregular fashion in the same plot, bed, or field.

The methods of an investigator engaged on a project of this type must combine direct observation of the crops concerned, and the interrogation of the gardener who planted them, in order to obtain his reasons, if any. Interrogation brings out the reasons of which the farmer is aware; observation may indicate reasons which do not occur to the farmer himself. In gathering the material for this paper the writer has followed both methods in the neighbourhood of St. Augustine, and has supplemented his material from that region with material from most parts of Trinidad, ranging from market garden settlements such as that at Aranjuez, to remote native gardens in the wilder parts, for instance at Mal D'estomac, Turure, and Cumaco in the Northern Range. The Todd's road peasant survey area has also been the subject of some investigation, but for the most part the material
was gathered in the Freeman's road district of St. Augustine and in the district at the base of Morne Tabor, up to altitudes corresponding with that of the monastery. It is worth noting here that the practices in these two regions are markedly different, though they are only a short distance apart. In these two areas the writer has been able to carry out continual observation on a large number of fields, and to engage a large number of native cultivators in conversation extracting from them as far as possible their methods of mixed cropping, and their reasons for such methods.

The difficulties encountered were principally in connection with the interrogation of the farmers. It was not difficult to question the farmer, but in many cases it was difficult to extract coherent answers from him. In some cases the farmer did not understand the questions, and in these cases little information was obtained. A more difficult case was the farmer who partially understood, when the answer was often what he thought the writer wanted and not necessarily the truth. Implication in the question must be avoided at all costs when dealing with such men, who can be induced by the use of implications to state two completely opposite answers in as many minutes. Most of the reliable material was obtained from intelligent farmers who understood properly what they were asked, and who showed enterprise and care in the cultivation of their crops. Such men are prepared to state why they grow a particular mixed crop, and in many cases their reasons struck the writer as being quite sound.

One of the principal drawbacks in the neighbourhood of St. Augustine is the fact that there is no real necessity for a man to subsist on his own produce all the year round. Thus he is not greatly concerned with the yields he obtains from his crops so long as he can live on the produce for
a few weeks and obtain some cash by selling what is left. For this reason the writer went into the wilder parts of the island in the hope of discovering some men who subsisted entirely on the results of their own efforts in the garden. In these places the owners of the crops were generally absent, but interrogation of their wives or of anyone working on the plot produced results as lacking in the desired respect as those at St. Augustine. Though the actual cropping was different, no completely self-supporting men were discovered, and all that can be said is that men in the wilder parts appeared to grow a greater proportion of their needs than did those in Freeman's road. The lack of interest in the exact amounts produced was further complicated by harvesting methods, which usually consisted of digging up a plant or two whenever it was necessary. Data concerning yields were all too often nothing but a wild guess, and as such of no value to the investigator.

The enquiry was pursued throughout from the standpoint of reasons. Observation of crops gives data of comparative vigour and growth, but the results are purely the writer's opinion. Interrogation as to methods of cropping is important in bringing out reasons which escape the eye, and are not mentioned by the farmer. The possibility occurred to the writer that the reasons might easily be reasons of which the native farmer was not himself aware, and further, that reasons which appeared satisfactory to the farmer might not necessarily satisfy others. The combination of all possible reasons to determine the true reasons underlying the practice was the final object which the writer had in view.
THE PRACTICE OF MIXED CROPPING IN TRINIDAD.

As has been stated, it is important to know the practice of mixed cropping in order to arrive at reasons of which the native gardener may not be aware, but which are indicated by peculiarities in methods. The study of mixed crops from the point of view of food production, economy of labour, maintenance of fertility and general efficiency is of use in this connection, and the main details of the production of the crop, time of sowing, harvesting, and the yields obtained have been determined as far as possible. The results are summarised in Appendix II, but the writer believes that fuller discussion of the more important and widespread crops is of use in indicating the reasons of the native gardener for the practice. The results of the writer's investigations are below.

Methods of cultivation.

It is convenient to describe the methods of cultivation employed as a whole, rather than deal with them in detail with every crop. The cultivation in the Freeman's road district is very stereotyped, and one farmer is very much like the next in his methods, though the thoroughness of his application of those methods is subject to a wide variation.

The beds on which the crops are grown are derived from sugar-cane beds, and are thus twenty two feet wide with a marked hump in the centre and deep drains along either side. These latter are more evident if, as is often the case, the farmer uses part of his holding for growing sugar-cane. The main beds are divided into smaller beds, and on these smaller beds the crops with which the writer was concerned were grown. These smaller beds may be so cultivated that they tend to disguise the presence of the larger sugar-cane bed beneath, but investigation will
show the presence of the latter. These small beds are always cultivated to some extent, and it is here that the difference between farmers makes itself evident. The usual implement of cultivation is the fork, and sometimes very thorough work is done with it. No form of plough has been observed. The beds may be forked over, and left flat, or they may be made into ridges, which vary in dimensions according to the crop to be planted. If manure is incorporated it is dug in before the ridges are made; this is the general rule but here and there there may be manuring of individual plants in the ridges, in which case cows' urine is generally used. If the beds are left flat, the crop is eventually planted in shallow holes dug with a cutlass; these holes may be rows, or spaced evenly over the whole area without regard to rows. The crops are all hand planted, and subsequent cultivation consists entirely of weeding and earthing up, with few exceptions. These general methods of cultivation vary very little, except from farmer to farmer; an enterprising man will fork the bed thoroughly before planting in holes; a less energetic individual may merely dig the holes.

The same types of cultivation are characteristic of other parts of Trinidad, and the writer has found them wherever sugar cane beds of the standard type have been made. In the more hilly districts, such as that at the base of Morne Tabor, the cultivations are not so thorough, the usual practice being to plant in holes, which may be in rows or spaced irregularly. Ridges are seldom observed, but in a few places terracing is resorted to. Rows of crops planted in holes are frequently on the contour, thus affording some protection against erosion.

In the wilder parts of the country, the cultivation is usually of the hole type on a previously broken plot where the ground is flat, but on steep slopes terraces may be found, and these terraces may be thrown into ridges or round hills. Such districts are the only places where the
writer has observed hills; a large part of the cultivation in these districts bears a resemblance to the association type described by Willis (3).

At Aranjuez the cultivation is much more intense, but is similar in type to Freeman's road; the place of the sugar cane bed is taken by one designed for irrigation, very similar in dimensions and form to the cane bed. Rice fields are sometimes cultivated both at Aranjuez and Freeman's road in the dry season, root crops being planted on ridges in December. The soundness of this last practice is open to question, since soil loose enough for root crops can hardly retain water efficiently when planted with rice at the onset of the rains.

Enough has now been said to describe the preparation of the land for the crop; discussion of the crops themselves now follows.

Crop Mixtures

The actual mixtures investigated by the writer were numerous and varied. In Freeman's road, for instance, half an hour's investigation produced fourteen different combinations of crops. With this large variety of material it may be helpful to attempt to divide the practice into well-marked systems, for as will be seen, every mixed crop is not grown in the same way nor with the same object in view.

Three such systems can be described, and they are distinct from one another in the main, though a certain amount of intergradation may be found. The first and by far the most common system is to grow a definite mixture of crops, the components of the mixture having much the same habit, and the object being to dispose of the whole crop as food. Examples of such mixtures are cassava and eddo, maize and pigeon pea, yams and beans. The second system is to grow a short-term food crop while a cash crop such as sugar cane is at a young stage. This system embraces
types of nurse crops and catch crops, and an example is maize, sweet potatoes, and sugar cane. The third method of mixed cropping is that described by Willis (3), the association method. In this case a number of crop plants of different species will be found growing in a haphazard fashion over an area, with little or no regard for spacing and the probable object of obtaining a little of each for domestic purposes.

These methods involve definitely divergent agricultural practices and will serve as a general classification of mixed crops. Each method will now be considered in greater detail, with description of the crops and mention of the reasons given by the native gardeners for their methods.

(1) Food crop mixtures. System 1.

Maize, pigeon pea and yam mixtures.

*Pigeon pea and yams.*

This crop usually grows in holes on a flat bed but may sometimes occupy ridges; such ridges are three to four feet apart and may be 18" high. Both crops are planted in May; the pigeon pea spaced three to four feet in one row, the yams one foot to 18" in the next. The writer believes that these spacings are measured with the cutlass blade or the whole cutlass, and that no farmer is greatly concerned about their accuracy. Divergence in the method of training the yams is found; they may either grow on poles in the yam rows or climb on the pigeon pea. If they are on poles, there will be one pole to every two yam plants; poles are seldom more than six feet high, and are the exception in Freeman's road, where it is common to see pigeon peas completely smothered in yam vines. This saves poles and the labour involved in their use altogether, and the majority of farmers who adopt
this practice affirm that the pigeon peas are planted mainly as a support for the yams. The latter wither and are dug in December and January and the pigeon peas are gathered in February and March. This gives some little return from the pigeon peas but it is not half the crop obtained when the yams are grown on poles. The majority of intelligent farmers will not allow the yams to climb on the peas, for in the worst case this method results in a widely spaced crop of yams with the yield over an area greatly reduced as a result, with a few pigeon peas thrown in for nothing. Yield data do not bear out the contention of some farmers that the yams bear better when climbing on peas, as in each case the amounts given for five 22 foot rows were 100 to 120 lbs. of yams. The yield of the pigeon peas appears to be reduced from 40 lbs. to 20 lbs., or even less, when the interference due to the climbing yams is severe. In the writer's opinion the loss in yield of pigeon peas is too serious to justify the saving of labour and poles. This is also the opinion of most of the intelligent farmers, who also maintain that the pigeon pea roots are liable to produce fancy yams. The arguments are thus not in favour of growing pigeon peas with yams, especially if the yams climb on the pea bushes.

Maize and pigeon pea.

This is a well known and recognised mixed crop and it can be seen growing on the College farm. It is one of the commonest mixtures in Freeman's road. Both crops are sown in May, generally in holes on the flat. The maize is harvested in September or October, and thereafter the treatment varies.
The pigeon peas may be left quite alone, some farmers maintaining that they need the breeze blowing through them. On the College farm they were left alone after the maize had been harvested. It is more usual, in Freeman's road, to find the pigeon peas interplanted with eddo, white stick cassava, cowpea, or bodi and salad beans. These are all quick maturing crops, or at any rate are regarded as such in Freeman's road. They are planted in November and removed in February and March when the pigeon peas come to maturity. The pea is not regarded as shade for any of these crops, and the farmers who do this interplanting maintain that the crops mentioned will grow well anywhere. They are a form of catch crop, and are only secondary in importance to the maize and pigeon peas. They are planted in holes made with a cutlass, the holes being three or four feet apart in the case of eddo or cassava and half that distance in the case of the beans or cowpea. From the maize and pigeon pea the farmer expects to obtain about 80 lbs. of mixed grain, the maize giving rather more than the pea. A large part of the peas are picked green, in which case the farmer never knows with accuracy how much he picks as he does so from day to day, according to his needs. No yield data have been obtained for the undersown crops, as these are often treated in the same way and are in any case of irregular occurrence. 40 to 50 lbs. each of maize and dry peas from five 22 foot rows is what the farmer expects. On the College farm this mixture gave 840 lbs. of maize and 1100 lbs of peas (after a certain amount had been removed green). These yields were thought
very satisfactory, and the appearance of the crop was good throughout its duration. The cultivation on the farm included the use of artificial manure and of woolly pyrol as a cover crop, but these would not be seen in Freeman's road. The spacing of the crop on the farm was markedly closer than in Freeman's road, the pigeon pea lines being 6 feet apart with the peas spaced 2 feet in the lines; in Freeman's road the lines of peas would be 6 - 7 feet apart but the peas would be spaced 3 feet at least in the row. The same applies to the maize; on the farm the spacing in the row was 15", while in Freeman's road it is seldom less than 2 feet. This may partly account for the much better ground cover given by the farm crop, but efficient cultivation on land in a comparatively high state of fertility must also have had a profound effect on the vigour of the plants. The wider spacing in Freeman's road may be due in part to unsatisfactory germination, as it is often rather irregular, with two maize plants within a foot of each other, and the next one three feet away. This is not always the case however, and the usual spacing for maize appears to be about a cutlass length, that is 18" or more. The growth of this crop on the farm, though slightly different in detail to the Freeman's road method, shows what can be done by applying efficient methods to a native crop mixture. A profit of more than fifty dollars per acre was obtained from it. *Maize, pigeon pea and yams.*

This is another frequently observed crop in Freeman's road, and it is a combination of the last two crops. It is grown on large ridges, six
feet apart and 18" high, well forked and with a little manure in the yam holes when it can be obtained. The three crops are planted in the ridge in May and June, the yams being in the middle and the corn and peas on either side. The subsequent appearance of the crop depends almost entirely upon the treatment of the yams. At first these are kept back by the growing maize, but when that is removed in September they will climb on whatever support is available; in the case of an efficient farmer this will be a pole put there for the purpose; in the case of an inefficient man it will be the maize stalks or the pigeon pea bushes. The result in the latter case is a thoroughly broken down crop, as the maize stalks nearly always collapse, and leave the pigeon pea bushes struggling up through a tangled mass of yam vines. This has all the disadvantages of an untended mixture of yams and peas alone; farmers who allow their crop to reach this condition maintain that the pigeon pea is not so severely hampered as it is only covered late in life. The result however is a very considerable loss in yield from the peas; the yield of yams is much the same in every case. Both the yams and peas are removed in February and March; farmers will not dig the yams before then for fear of disturbing the roots of the pigeon peas, though the yam vines will have withered a month or more before February. If the yams are grown on poles they are still left till the peas are mature or have been picked green. One farmer took the trouble to shift his poles to the side away from the pigeon pea, apparently with good results, as he produced a healthy
looking crop. This mixture however, is apparently one which requires considerable attention, or it will degenerate into a worse mess than any other observed by the writer. Provided poles are used and it is looked after the results are quite satisfactory, and the land is utilised very thoroughly.

**Tannier and yams**

Though not a common mixture this is quoted to show the specialised methods of cultivation some farmers apply to their mixed crops. In Freeman's road two brothers grew it, making ridges four to five feet apart to receive the crops in May. Yams occupy two ridges to one ridge of tannier, and between the two yam ridges there are bamboo poles planted in the furrow. These support the yams and train them away from the tannier which thus obtains abundant light. In one furrow the place of the bamboos had been taken by maize stalks which were the result of a crop of maize sown in the side of the yam ridge near the bottom. The stalks had mainly collapsed, and the farmer admitted that they were an inefficient support. Both of the brothers said that they grew this mixture to provide some good tanniers, which are not often cultivated properly in Freeman's road. They expected about 120 lbs. of yams from five rows, and about the same amount of tannier, with the plants spaced about four feet in the ridges. Of the total crop two thirds would be yams.

A crop of this type was also met with at Aranjuez, where one farmer grew tanniers, yams, and cassava together. All three were planted in May on very large ridges six feet broad and two feet high. The cassava and tanniers were planted
in the side of the ridge, and the yams grew on poles in the middle. The farmer said that this method gave mould for the tanniers and cassava to grow into the ridge and form big tubers, while the yam formed a good root above which would not be spoilt by interference with other roots, which he said caused misshapen yams. Like the farmers in Freeman's road he said that round yams sell better.

These two methods show the differences in cultivation that may be evolved in the growing of similar crops. In each case the farmer stated that he had invented the method himself, and as they were enterprising men who cared for their gardens their statements are quite likely to be correct.

**Eddo and dasheen mixtures.**

Eddo, in mixtures with cowpea, bodi and salad beans, cucumber, or white stick cassava is the commonest short term crop seen in Freeman's road. Two crops at least are taken in one year; planting dates for eddo are May, October or November and occasionally February. The writer has seen a field on which three successive crops of eddo were taken during the year, each crop being mixed with cowpea. It is often the case to find eddo mixed with a number of different crops, and a crop containing eddo, cowpea, cucumber, salad beans and cassava has been observed. The eddo is planted in holes about a foot deep and eight inches square, spaced about three feet apart, and often filled with a mixture of earth, rice straw and manure, this last being cows urine as a rule.

Short term cultivation of eddo is apparently
contrary to the experience of Paine (4), but it is certainly the usual practice in Freeman's road. The yield of eddo appears to be about 6 to 8 lbs. per plant which in a unit of five 22 foot rows would give about 240 lbs. The accuracy of this figure seems to the writer to be doubtful, but it has been calculated from the actual estimates of the farmers.

Dasheen is seldom grown in any of the places investigated by the writer, but it seems to be used as a long term crop in preference to cassava and yams by some gardeners.

Bean mixtures.

The variety of small leguminous crops called beans in Freeman's road is extensive. There are three short term beans grown extensively these being salad beans, bodi beans, and cowpea. Salad beans are a variety of Phaseolus vulgaris and bodi beans and cowpea are both Vigna sinensis the distinguishing mark being the very long thin pods of the bodi, which are eaten raw. Salad beans especially are planted wherever there is space, and they have been observed growing with cabbages, eddos, yams, cassava, and many other crops. Their cultivation appears to be simple, and it is noteworthy that farmers who were opposed to the use of mixed crops had generally a place where they could interplant salad beans. With the other short term beans it is generally planted in holes a few inches deep, scattered along the rows of other crops or spaced unevenly among them. Where concentrated, they are spaced about 18" apart.

The attitude of the farmers towards the salad bean was that by so growing it they obtained something
for nothing, substantiating their claims on the grounds that it used only the top inches of the soil and did not interfere with any of the other crops with which it grows. So far as yield and healthiness of the crops has a bearing on the matter the observations of the writer tend to bear out their contention. The salad bean gives three pickings per crop of 15 lbs of green beans from five 22 foot rows.

A climbing bean is sometimes grown as a long term crop with yams. It is a variety of lima bean, according to the gardeners. In the cases observed the two crops were planted in May, the beans being put in a fortnight after the yams on account of their stronger growth. The yams are harvested a month earlier than the beans, in January, always supposing that the beans are left to mature and are not picked green. Both crops grow on ridges three feet apart, spaced one foot to 18" in the ridge, and climbing together on poles in the furrows. Farmers questioned on this crop said that the beans would grow better if they were allowed to climb poles by themselves and could give no convincing reason for the mixture. Other farmers stated that they would not use this mixture because the beans interfered with the yams. There appears to be reason on both sides, however, because the yams in the cases observed were growing perfectly well and in some cases were smothering the beans. The yield of yams appears to be of normal dimensions, and no yield figures could be obtained for the beans as they were apparently picked green whenever the farmer wanted some. Certainly no positive advantage
was noted one way or the other, but the writer is of the opinion that two crops of this type would be better if planted separately, as competition between the two for space on the poles seems inevitable.

**Market garden types of mixed crops.**

As extensive gardening for a cash market alone was seldom observed in Freeman’s road the variety of mixed crops in this category is small. Mixtures spaced in holes, consisting of egg plants, peppers, tomatoes, cabbages and okra are common in local market gardens. These crops are spaced about four feet apart, occasionally less. Each plant is put in a hole, sometimes with rice straw or manure. The hole is generally about a foot square and deep; thorough cultivation of the soil is emphasised as essential. The length of life of the crop varies, but two crops a year can be taken, planted in almost any month but chiefly in May and November. Crops such as tomatoes, egg plant and pepper will be left in the land till they cease to bear any fruit and it is not uncommon to see the ragged remains of such a mixture with a few newly planted individuals growing up among it. There does not appear to be any reason for growing these crops in this way; one farmer stated that egg plants and pepper shaded the cabbages, giving better results from these. In his next bed he had a crop of cabbages by themselves which were in no way inferior, and he admitted this himself. The writer is inclined to believe that there is no marked benefit or disadvantage in either method, and that one is as good as another.
Sufficient has now been said to illustrate the first of the three systems and to show the results obtained and the kind of reason given by the farmers for their methods. The second system can therefore be discussed, and this is best done by describing the most widespread example of this type of crop.

Sugar cane, sweet potatoes, and maize.

In this crop good ridges are made three to four feet apart and a foot high. In November the cane and maize are planted, the maize on one side of the ridge, the cane on the other, each plant being near the bottom of the ridge. Spacing is three to four feet for the cane, and 18" to two feet for the maize. A month later sweet potato slips are planted in the top of the ridge, one foot to 18" apart. When these potatoes are ready for digging, in April of the next year, the ridges are split over the now growing cane. The cobs of maize are removed at the same time, and any dead potato vines or maize stalks are used for mulching the cane. The land is left flat, with a crop of cane growing on it spaced equally three to four feet apart.

The object of this method is to utilise the land while the cane is still young. Other crops may also be planted, and in Freeman's road bananas, cassava, and pigeon peas have been observed. The peas and cassava are at the ends of the original furrows, the reason for this being that when the ridges are split the roots of the cassava are exposed and dug, since they have spread into the ridges on either side.

Yields to be expected from such a crop are 150 lbs of potatoes from five ridges, 50 lbs. of maize, and an eventual crop of cane of from 15
to 25 tons of cane per acre in the first season. Ratoons are afterwards taken if the crop will stand it.

In Todd's road this method of cropping has also been observed, together with another method similar in its ultimate end but involving the use of many species of crop plants. The following crops have been observed on a field.

Maize, planted November 1939, harvested March 1940.
Tannier, planted December 1939, harvested December 1940.
Sugar cane, planted November 1939, harvested February 1941.
Cassava, white stick, planted November 1939, harvested March 1940.
Cassava, red stick, November 1939 - July 1940.
Okra, 10 foot spaced, May 1940 - October 1940.
Eddo, planted December 1939, harvested June 1940.

All these plants except the cane and the okra were planted in unevenly spaced holes; in this crop we see a gradation towards the association type of mixed crop, as tanniers and okra would be growing in the cane when it was becoming tall.

Farmers vary in their opinions of the results of this type of crop. Some are prepared to admit that the other crops will remove nutrient matter that the cane might need; others believe that the obtain all these food crops with no reduction in yield of cane. One remarkable man in Freeman's road said that he had tried this method over a period of years and rejected it because he did not obtain satisfactory yields from his cane. On the other hand the yields he did obtain were no greater than those obtained by farmers who did employ this method of cropping.

Tomatoes and pachoi. This crop was observed at Aranjuez and in
Freeman's road. The tomatoes are planted on ridges, spaced at about three feet, with the pachoi growing beneath them, slightly shaded. At Aranjuez the farmer stated that he grew it in this way because as soon as he removed the tomatoes the pachoi would grow away and give him a second crop from one cultivation. He thus regarded the tomatoes as a nurse crop. In Freeman's road the man who employed this method said that he did so because he expected the tomatoes to fail, and that if so the pachoi would come away and give him some produce to fall back upon. The views of these two men were thus practically opposite on the question of an identical crop, planted in exactly the same way in each case.

Cabbages, cauliflower, and salad beans.

This crop was produced by a most enterprising farmer in Freeman's road, who claimed to have invented the method himself. The cabbages are planted in December on the top of ridges three feet apart, and are given some dung and cows' urine. At the same time salad beans are put in half way down the ridge. A month later young cauliflowers are planted in the furrows, and are partially shaded by the cabbages and salad beans while they are young. The beans and the cabbage are removed in February and the ridges forked over to form flattish beds round the young cauliflowers, which grow away well in what is left of the cabbage manure. The farmer claimed that this crop could be so treated at almost any time of the year, but he had some facilities for watering his plants from a stream. It was the only mixed crop he grew and it seemed healthy and satisfactory.
These last methods show the use of forms of catch cropping and nurse cropping, and the thorough utilisation of the land that is practised by some farmers. Such mixtures of crops, though not so diverse in nature as in the first system, are as important to the farmer. In Freeman's road at any rate, the mixture of maize, sweet potatoes and cane probably occupies as much land as any other mixture of crops.

The association method of mixed cropping.

This method is not found in Trinidad to the extent at which Willis apparently found it in Ceylon. There are, nevertheless, particularly among the mountains and in the wilder districts gardens that may be referred to as association type gardens. In these there are various crops growing perennially, including fruit trees, coconuts, and even cacao. Pigeon peas will be found, and in many cases these are left growing for two or three years so that they amount to perennials. Cassava too grows in this manner, and may be in the ground for a number of years. Fresh stocks are planted when a particular piece of land is useless. In the mountains below the Mont St. Benedict monastery the favourite crop is a mixture of neglected peas and cassava, with coconuts, okra and various other trees and food plants growing in odd places among them. One crop of this type contained a number of hedges of guatemala grass, and on inquiry it was found that the latter was planted to divide up the holding between quarrelsome members of the family.

Plants may often be found growing in the bush, and Paine (4) has described the wild yams utilised by people in the wilder parts of the northern range. Tanniers may also be found growing in this way.

In Freeman's road the association type almost always forms a part of a man's garden. He may have a mango tree, a few coconuts, and a calabash tree. There is often an arbour of bamboo poles with cucumbers swarming over it, and
eddos growing beneath it. A few peppers and egg plants, and a tanner or two will be found growing in any convenient space. The whole system is most casual, but in a modified form it is the principal method of gardening among the people in the wilder parts. It is impossible to determine whether or not there is any particular benefit in growing the crops in this way, because a man never knows how many plants he has, and on being asked will look round and count them, qualifying the resulting number by saying that without doubt he could find many more by looking carefully. Any estimate of yield is impossible under the circumstances. These association type gardens appear to be healthy enough, especially in the case of tanners' and eddos, which thrive in shady and peculiar places. In the mountains near St. Augustine however the mixtures of cassava and pigeon pea generally present a pretty wretched appearance, and the method probably does not suit everything.

In connection with this wider type of gardens the economical reason given by any farmer interrogated is that by growing crops intermixed he avoids the necessity of having to eat the same thing all the year round. In the opinion of the writer this reason is not quite valid for the peasant himself. If he requires supplies of a number of different items, he could obtain the same result by growing many small areas of pure crops. It was then in asked near a larger area because it comes to him the certain thing to do. Having a certain supply of such type of seed and being faced with his garden cultivated and ready for planting, he joins his creek in just as they come to use and, and the season starts shaping food supply is merely based on the fact that he has a number of different crop
DISCUSSION.

(1) The reasons advanced by the farmers for their mixed crops may be valid to the farmer who suggests it, it is not necessarily a valid reason for the adoption of mixed cropping as a whole. The peasants in Freeman's road grew a large number of crops that are not in general cultivation outside gardens of their type. Most of these men, when asked about a particular mixture, could give some reason that had occurred to them. In many cases, as in the case of the mixtures of tannier and yams, and of cauliflower under cabbage and salad beans, the farmer's reasons might be quite well thought out. But such reasons, for the most part, applied to particular crops, and frequently the next farmer interrogated on the subject would give quite another reason for his method. Reasons concerned with the practice of mixed cropping as a whole may be quite different to those advanced for the use of a peculiar method, and must necessarily be of a more general nature.

In connection with this wider type of problem the commonest reason given by any farmer interrogated is that by growing crops intermingled he avoids the necessity of having to eat the same thing all the year round. In the opinion of the writer this reason is not even valid for the peasant himself. If he requires supplies of a number of different crops, he could obtain the same result by growing many small areas of pure crops. He puts them in mixed over a larger area because it seems to him the obvious thing to do. Having a certain supply of each type of seed and being faced with his garden cultivated and ready for planting, he puts his crops in just as they come to his hand, and his reason about changing food supply is merely based on the fact that he has a number of different crop
species in his garden, which could serve him equally well if planted pure instead of mixed.

Such a reason is all very well in the case of a man who is growing a lot of species mixed together in an association type garden. In that case it can be understood that he might come across a small amount of planting material of each crop and grow it wherever he thinks fit. But in the case of a more systematic type of crop, planted in rows as with maize and pigeon peas, or in evenly spaced holes as with egg plant and pepper the case is different. The farmer has evidently planted with a definite design and has not merely put his hand in his pocket and pulled out one seed and then another. With such systematic mixtures the writer was more concerned, since where a particular method is in general use it may be derived from some definite benefit obtained, thus affording an example of a crop grown with a valid reason. In these cases the farmer questioned almost invariably replied "it come good that way". Without exception these men had never grown the crop components in pure stands and were not therefore in a position to state whether the mixture gave them any real benefit. Here however the farmer has a reason that is valid as far as he is concerned; the implication is that he really believes that he derives some advantage by sowing his crops in mixture, and as long as he believes that the reason is perfectly valid to him. On the other hand, without data to support it, this reason cannot be accepted as valid for the culture of mixed crops in general; the only man in Freeman's road who had tried both methods himself was against mixed cropping altogether, and claimed to have rejected the standard mixtures after giving them a fair trial. A reasoned view on the subject of pure cropping was difficult to obtain from a man who grew mixed crops, for such a man usually assumed that the writer believed in the superiority of pure cropping, in which case it was only polite to agree. In the case of most of the crops the most
likely supposition is that they are grown mixed because they have always been grown mixed in living memory, and because it is the general practice. A man who learned mixed cropping methods from his grandfather would no doubt teach his own children to follow in the same way, though he himself might never have grown a pure crop and might have no reason whatever for supposing that the one was superior to the other.

In discussing the reasons for such methods of cropping as the introduction of cane with maize and sweet potatoes, it was found that the farmers generally believed that they got better value from the land in this way. Many of the farmers were prepared to admit that the resulting crop of cane was not so good; the writer is not always inclined to agree with them on this point, because their crops of cane looked as good as any other in Freeman's road and the yields seemed to be much the same. The farmers stated however that though they might lose a certain amount of cane they were of the opinion that the maize and sweet potatoes more than replaced this loss. A few of the farmers believed that other produce growing in the young cane did not cause any loss. In either case, whether they believed that they obtained some produce for nothing or whether they felt they had better value from their land, the reason was perfectly valid to them. The only point against it from Freeman's road is the contention of the most intelligent of the farmers that the cane grown in such a way did not give as good a yield. The yield data obtained show no difference however, and over a small area that can be cultivated by hand this method might easily be worth doing, though its success must depend on the value of the subsidiary crops of maize and potatoes.

Having now discussed the reasons given in favour of mixed crops we can turn to those against the practice. These were based on the supposition that one crop "humbugged" another, and had especially been considered in the case of
pigeon pea and yam mixtures. In this case there were two schools of thought; those who employed the combination were loud in its praise, while those who did not were vehement in their condemnation of the practice. The writer has already stated that he agrees with the latter view if the yams are allowed to climb over the pigeon peas. The question of interference is most important, and many of the farmers realise this. Those addicted to mixed cropping generally took care to avoid it as far as possible, while those who confined themselves to pure crops regarded it as a final reason against mixed cropping. Some farmers, though against the practice as a whole, believed that certain crop species did not cause any interference. Salad beans and eddoes were often cited as cases in point and more than one farmer stated that they could grow well beneath pigeon peas as they were not deep rooters. Salad beans especially seem to be regarded as a crop that does no harm anywhere, and even those farmers who will grow no standard crop mixtures will often plant salad beans with their other crops.

The most important point that arises from the views on interference stated by the farmers of Freeman's road is that the more intelligent and enterprising of the men regarded it as sufficient reason for the avoidance of mixed cropping altogether. Here the writer believes that the methods of cultivation employed are of great importance. In a garden kept by an efficient man growing pure crops the cultivation is much more thorough than in a garden containing mixed crops. Men who like to care for their crops well are continually cultivating them, and this is seldom seen among mixed croppers. Mixed cropping gives several crops for one ridging, and the care and weeding of the crops is often neglected. It is possible that men who do not employ mixed crops avoid them because they like to keep them clean, and hence sow pure stands to allow of more thorough cultivation, with cleaner and healthier crops as a result. The mixed cropper may save a
certain amount of labour in cultivation, with a resulting loss in yield. In pigeon peas and yams for instance, if the crop is thoroughly looked after, the yams climbing on suitable poles and the crop kept clean, there is no reason to suppose that any detriment would result to either component of the mixture. On the other hand in the cases where the pea is smothered by the yams because the farmer is economising on poles and the labour of their use the loss in yield is severe. Mixed crops, if they are to be grown efficiently, need just as thorough cultivation as pure crops, and the fact that this is not generally the case in Freeman's road may account for the reluctance of enterprising farmers to use mixed cropping methods.

The reasons for mixed cropping as typified in Freeman's road are thus tradition and the belief that certain cropping methods result in better value from the land. Interference between crops is the reason advanced in various forms against the practice. Of the reasons for mixed cropping that based on better value is of importance, because apart from the satisfaction of the farmers who utilise the methods concerned it implies some definite benefit, for which there is even a certain amount of evidence. On the other hand, in the case of other types of mixtures, interference is cited as an effective reason in the other direction. The question of tradition, while of importance to the farmers in Freeman's road, is of no importance to the question in general, since if any benefit resulted from a departure from tradition the latter would soon go by the board.
DISCUSSION

(2) The reasons advanced by other investigators for the practice of mixed cropping.

The majority of the work on mixed cropping refers to the practice in temperate countries, but Wood (1) and Nicol (2) have summarised the reasons that have been suggested to account for the practice in the tropics. Probably the best way of arriving at the true reasons for mixed crops is to discuss every possible reason and to estimate the worth of each. As Wood and Nicol have stated the reasons for the practice this can best be done by discussing their ideas in the light of experience gained in the neighbourhood of St. Augustine.

Both the above writers regard the system of mixed cropping as a form of rotation, or rather, as a method of cropping that takes the place of a rotational system. Their main reason for this statement is the habit of many growers of mixed crops of sowing leguminous crops in mixture with non leguminous crops. In India this is apparently the rule, but it will be seen that it is not necessarily the case in Trinidad, where as often as not the mixture consists of two or more non-leguminous crops. In the opinion of the writer the statement that mixed cropping is a form of rotation is hardly ever true in Trinidad. If mixed cropping did take the place of a rotational system this statement would be a valid reason in favour of mixed cropping. In a rotation different plants occupy the same piece of land over a sequence of years or seasons. In mixed cropping this sequence is cut down and we find different plants together on the same piece of land. Sir E.J. Russell has pointed out that different species of crop plants extract varying quantities of nutrients from the soil; every crop is not the same in its requirements. In a rotation this fact is applied, and the purpose of a rotation is to alternate exhausting and restorative crops in such a way that the
fertility of the land remains the same over a long period of years. For instance poor land in the highlands of Scotland, having provided two crops of oats and one of potatoes, is allowed to go down to grass for a period of years. Thus the fertility removed by the oats and potatoes can be replaced and the principle of the rotational system is justified. In many cases of tropical mixed cropping this cannot be said, for the land carrying mixed crops has no chance to accumulate fertility. Suppose we take the purely hypothetical case of a mixture of two crops, A and B, which demand nutrients C and D from the soil. In a rotation A removes C and leaves D for the crop of B following on; while B is on the land C can be replaced, and in the following year A is not denied its essential food supply. If these two crops were planted mixed, both C and D would be used up in one year, and the mixture could not possibly take the place of a rotation. If, on the other hand, A and B used different quantities of the nutrient C, the effect in mixture would be the same as rotation, or very nearly so, since that part of C used up by A in one ridge in one year could be partly replaced by cultivating so that the soil from the ridges of B was mixed with that of the A ridges. Or if A was a deep rooter and B a shallow rooter the C unused by A in the deeper soil could be brought to the surface by cultivation and used by B the following year. With a certain amount of C being replaced every year by natural means, manure and other methods of restoring nutrients, a balance could be reached in each of these last two cases which would have something of the same effect as a rotation. The question of the individual needs of crops is thus most important.

Arising from this theory that the rotation replaces the practice of mixed cropping and vice-versa is the fact that a mixture of pulses and cereals is known to give a greater yield in some cases than a pure crop of either. Though most of the work on this question has been done in temperate
countries, any evidence that has been gathered in the tropics is in favour of the supposition. The mixed crop of pigeon peas and maize on the College farm in 1939 gave a fair yield of maize and a heavy yield of pigeon peas. The combined effect was thus probably greater. As this was achieved at a smaller cost, due mainly to less frequent but more efficient cultivation and a smaller dressing of manure the profit was much greater than for any comparable crop of maize or pigeon peas sown pure during the last few years. This is the one example of a definite benefit obtained from mixed cropping in the tropics, and as far as it goes it affords evidence in favour of mixed cropping. It does not however solve the problem of all mixed crops in Trinidad, and should not be regarded as a reason for the adoption of mixed crops as a whole.

The next suggestion is that a mixture of shallow and deep rooters more efficiently uses the fertility of the soil. This has already been mentioned, and the possibility that it may use it too efficiently has been indicated. Maize and pigeon pea is again an example of the case in point. Howard points out that the pigeon pea will penetrate an ordinary subsoil pan, and the present writer has no doubt himself that this is a valid reason for growing some types of mixed crops. Maize and pigeon pea, and certain other types of crops already quoted show that the idea has occurred to the native farmer also, and in the cases concerned there did not appear to be any impoverishment of the land. On the other hand mixtures of yam and cassava have been described as excessively exhausting crops, and these may be a case where the soil is used up too rapidly.

Together with this suggestion,wood believes that a mixture of crops makes better use of the weather, and that the risk of crop failure is thus lessened, for where one crop does not do well another in the mixture may come on more strongly. This, the writer believes, has nothing to do with mixture; in a mixture of drought resisting and
drought susceptible plants the susceptible species will suffer in time of drought just as they would if planted pure. A certain amount of shading effect may be useful, as in the case already mentioned of cauliflowers under cabbage and salad beans. For the most part however, the effect of weather conditions will be just as it would if the crop is sown pure. The beneficial effect of the weather is also in no way changed, for if a plant will grow well in mixture under certain weather conditions, there is every reason to suppose that it will do so if sown pure. As to the question of crop failure, or the lack of it in mixed crops, the writer is of the same opinion here. Mixture of crops will not necessarily reduce the possibility of crop failure. No doubt sugar cane growing with sweet potatoes and maize is as likely to be smitten with disease as any other form of sugar cane. At any rate there is no evidence to the contrary, and if a man is planting with a view towards crop failure, he should allow for it whether his crops are mixed or pure. Irvine, in West Africa claimed that mixture of crops reduced the incidence of insect pests, and this is also believed on the College farm, where woolly pyrol is put down with pigeon peas in order to attract the mole crickets from the pigeon pea. If this can be proved it is another piece of evidence in favour of mixed cropping under certain circumstances. The writer has not observed any parallel cases in the regions he has investigated.

The use of long and short term crops in mixture has its proved benefits, as in the case of clovers sown with spring corn in temperate climates. The crops of sugar cane with maize and sweet potatoes, and of maize and pigeon pea are cases frequently observed in Freeman’s road which illustrate the same idea. Where one crop is slow growing and the other quick growing such mixtures will be satisfactory as long as the rapid grower does not kill the slow growing plants by excessive shading. This is always
a risk in cases of this sort. Another disadvantage of the method is that after one crop has been reaped the space it occupied is often left bare and may be covered with weeds by the time the long term crop is large enough to shade it. This is generally avoided in Freeman's road by growing a second short term crop, and it can also be avoided by spreading trash on the ground. In general mixtures of long and short term crops are liable to be successful and their success is a point in favour of mixed cropping.

It has been said by Wood and others that mixtures, involve a more even distribution of work than do pure crops, and as a rider to this the writer has been told that mixed crops involve less work. The fact is that there is evidence to suggest that in mixed cropping we have a system of cultivation that utilises effort more efficiently than pure cropping. The distribution of work is no better, and is in fact worse in some cases, since two crops may have to be harvested together for fear that harvesting one might disturb the other. Crops have to be planted and harvested at known times of the year, whether pure or in mixture, and there will always be a rush of work at planting and harvesting times. The cultivation of the field may however be more efficient in the case of mixed crops. On the College farm the crop of maize and pigeon pea already mentioned was produced with one ploughing, and the cultivation as a whole was less costly and more efficient. The same effect may be seen to some extent in Freeman's road; a man may cultivate the land into three large ridges instead of nine small ones for crops of maize yams and pigeon pea.

A very thick cover is obtained which enables him to dispense with a certain amount of weeding. On the other hand there is no less labour in making three large ridges, and the harvesting of crops intermingled with one another is a matter for considerable care. But provided care is taken the labour expended is likely to be more efficient in mixed
crops than in pure. The cultivation must be efficient however, and an untended mixed crop looks far worse than a neglected pure crop, no doubt because there are more species to fall over or become entangled with each other. If the cultivation is done with care the mixed crop may easily repay the farmer for his trouble.

As opposed to all these arguments for mixed cropping we have the powerful argument of interference between crops. As has been pointed out this is such a powerful argument that it has even struck the farmers. Interference between crops is a delicate matter, and there are several examples in the literature where one plant has an adverse effect on another. One such is a mixture of *Sorghum vulgare* and *Sesamum indicum*, quoted by Fletcher, who found that the *Sesamum* died if planted within two feet of the millet.

Another example is the smothering of pigeon peas by yams in Freeman's road. In both these cases the effect was severe. If mixed cropping is to be the subject of any further investigation the question of interference should be studied carefully, for as a reason against mixed cropping it is in many cases sufficiently strong to discount every reason advanced in favour of the practice.

In conclusion of this discussion of reasons advanced in favour of mixed cropping it may be said that the final decision must always be on an economic basis. If it is much less costly to produce even a smaller yield of a mixed crop than it is to produce a pure, then it is evident that mixed cropping will pay, and deserve more general adoption. If on the other hand a larger yield of mixed produce can be harvested, though at a greater cost, then mixed cropping will not pay and would be better left alone.

The types of mixed crops grown by the native might be uneconomic for the large scale farmer, since the cost of cultivation over a large area might well be prohibitive. Mixed cropping has been stated to be a paying method by several writers, but as these writers give no facts to
support their claims, and apparently base them entirely upon the prevalence of the practice itself, they cannot be said to bring forward any concrete evidence on this point. The present writer believes, however, that in some cases mixed cropping is as profitable, if not more profitable than pure cropping to the individuals who employ the method. It has been already stressed that this is not necessarily the case with every mixed crop, and that it may apply to the peasant but not to the large scale farmer. To assume from the extent of cultivation of mixed crops that the practice is always profitable seems to the writer mistaken, but with careful selection of the components of a mixture and efficient cultivation profits may result from mixed cropping which will justify the practice.
CONCLUSIONS AND RECOMMENDATIONS.

The foregoing discussions of the reasons of the native farmers and of other writers on the subject of mixed cropping indicate that in certain cases there is some evidence in favour of the practice. An efficient mixed crop, well cultivated and properly tended throughout its growth may be superior to a pure crop from the point of view of economy. This superiority of the mixed over the pure crop depends, however, upon the efficiency of the cultivation. The growth of two or more crops close together must surely result in a certain amount of competition for soil nutrients, light, and water. It is only when each crop species has an equal chance for these essential factors that mixture can be beneficial. The problem of interference between crop plants must always be kept in view, and the reactions between the components of a mixture should be studied before any such mixture is planted on a large scale. At present the only evidence that is indubitably in favour of mixture is that from temperate experimental stations in connection with mixtures of pulses and cereals; a parallel to this is found in the example quoted from the college farm. In discussing this example efficiency of cultivation was noted, and this is the keynote of the writer's views on the subject. If the cultivation and care of a mixed crop is thorough and efficient the result may be favourable; if the crop is neglected in the hope that it will grow somehow the result will in all probability be the reverse.

It is most evident in the study of mixed cropping that there has been no experimental work in the tropics on this question. The writer feels that the position would be greatly clarified if some such experiment were carried out, and he would suggest the use of a mixture of maize and pigeon pea in the experiment. This is a crop for which there is some evidence of beneficial action.
The after effects of the crop should therefore be studied as well as the yield figures, and a crop of yams, or of eddo and cassava could be taken to estimate the effect of the pea and maize mixture on the soil. This is of necessity complicated, for mixed cropping is a complex and delicately adjusted practice whose efficiency can only be determined by such methods.

In addition to the above experiment the writer would suggest that observations on the soil effects of such plants as salad and bodi beans be made, and as further examples of mixed crops that would repay investigation yams, pigeon pea, and maize, yams and beans, and the mixture of cane, sweet potatoes, and maize may be quoted. This last example might well be of great value and if the method were more generally applied huge quantities of foodstuff could be produced from cane lands. At any rate, if all the above suggestions were carried out we should have a clearer view of the value of tropical mixed crops than we have at the present time. Until more evidence of this type can be collected the general adoption of mixed cropping systems should not be recommended, though a farmer may give some a trial without any ill effects. At all times mixtures of crops that result in active interference should be condemned.
APPENDIX I.

List of references.


(2) Nicol, H.


(3) Willis, J.C. "Agriculture in the tropics".


(5) Russell, E.J. "Soil conditions and plant growth".

(6) Irvine, F.R. "Textbook of West African agriculture".

(7) Fletcher.

Journal of Agricultural Science. 1911. pp. 245 - 248

(8) Thatcher, R.W.


(9) Howard. "Crop production in India". 1924.
<table>
<thead>
<tr>
<th>CROP COMPONENTS</th>
<th>METHOD OF CULTIVATION</th>
<th>SPACING OF ROWS OR RIDGES</th>
<th>SPACING OF PLANTS IN ROW</th>
<th>PLANTING DATE</th>
<th>HARVESTING DATE</th>
<th>YIELD FROM 5 22-FOOT ROWS</th>
<th>YIELD PER ACRE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/ Pigeon Pea Yams</td>
<td>In ridges or rows of holes dug with cutlass.</td>
<td>3-4 ft.</td>
<td>3-4 ft.</td>
<td>May 1940</td>
<td>Feb.-Mar.1941</td>
<td>10-40 lbs</td>
<td>600-2400 lbs</td>
</tr>
<tr>
<td>2/ Maize</td>
<td>As above but more usually holes.</td>
<td>3-4 ft.</td>
<td>1½-2 ft.</td>
<td>May 1940</td>
<td>Oct.1940</td>
<td>40 lbs</td>
<td>2400 lbs</td>
</tr>
<tr>
<td>Crops sown in pea after Maize include</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>40 lbs.</td>
<td>2400 lbs.</td>
</tr>
<tr>
<td>3/ Cassava (white stick)</td>
<td>In holes dug somewhat irregularly over the vacant spaces.</td>
<td>3 ft.</td>
<td>Nov.1940</td>
<td>Mar.1941</td>
<td>Mar.1941</td>
<td>15 lbs.</td>
<td>2700 lbs.</td>
</tr>
<tr>
<td>Eddo</td>
<td></td>
<td>3 ft.</td>
<td>Feb.1941 onwards.</td>
<td></td>
<td></td>
<td>45 lbs. green.</td>
<td>2700 lbs green.</td>
</tr>
<tr>
<td>Cowpea (Vigna)</td>
<td></td>
<td>1½ ft.</td>
<td>-ly, Jan.</td>
<td></td>
<td></td>
<td>150 lbs</td>
<td>9000 lbs</td>
</tr>
<tr>
<td>Bodi beans (Vigna)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>100-200 lbs</td>
<td>6000-12000 lbs</td>
</tr>
<tr>
<td>Salad beans (Phaseolus)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>100-200 lbs</td>
<td>6000-12000 lbs</td>
</tr>
<tr>
<td>Maize Yams</td>
<td>In large ridges, 6 ft. apart &amp; 1½ ft. high.</td>
<td>6 ft.</td>
<td>2 ft.</td>
<td>May 1940</td>
<td>Oct. 1940</td>
<td>30-40 lbs.</td>
<td>1800-2400 lbs</td>
</tr>
<tr>
<td>Tannier Yam</td>
<td>In ridges. 2 rows of yams to one of tannier. Poles in furrows.</td>
<td>4-5 ft.</td>
<td>4 ft.</td>
<td>May 1940</td>
<td>Jan. 1941</td>
<td>120 lbs</td>
<td>4000 lbs</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1½ ft.</td>
<td></td>
<td></td>
<td></td>
<td>120 lbs</td>
<td>4000 lbs</td>
</tr>
<tr>
<td>Tannier</td>
<td>In very large ridges 6 ft. broad &amp; 2 ft. high.</td>
<td>6 ft.</td>
<td>4 ft.</td>
<td>May 1940</td>
<td>Jan.-Feb. 1941</td>
<td>120 lbs</td>
<td>7000 lbs</td>
</tr>
<tr>
<td>Yam (Cassava (red stick))</td>
<td></td>
<td>1½ ft.</td>
<td></td>
<td></td>
<td></td>
<td>120 lbs</td>
<td>7000 lbs</td>
</tr>
<tr>
<td>Eddo</td>
<td>In holes dug with a cutlass. Irregular spacing.</td>
<td>3 ft.</td>
<td>May and Nov.1940</td>
<td>Oct.1940 and Mar.1941</td>
<td></td>
<td>240 lbs</td>
<td>14,400 lbs</td>
</tr>
<tr>
<td>Cassava (white stick)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>150 lbs</td>
<td>10,800 lbs</td>
</tr>
<tr>
<td>Eddo may be planted with Cowpea</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>45 lbs.</td>
<td>2700 lbs. green.</td>
</tr>
<tr>
<td>Bodi &amp; salad beans Cucumber</td>
<td>In holes, spaced among the eddoses.</td>
<td>1½ ft.</td>
<td>May and Nov.1940</td>
<td>Picked continuously possibly starting 6 weeks after sowing.</td>
<td></td>
<td>45 lbs green.</td>
<td>2700 lbs green.</td>
</tr>
<tr>
<td>10/ Yam Beans</td>
<td>On poles planted on ridges.</td>
<td>3 ft.</td>
<td>1½ ft.</td>
<td>May 15, 1940 June 1, 1940</td>
<td>Dec.1940.</td>
<td>100-120 lbs</td>
<td>6000-7000 lbs</td>
</tr>
<tr>
<td>11/ Egg plant Peppers</td>
<td>In holes spaced on the flat. No rows.</td>
<td>3-4 ft.</td>
<td>3-4 ft.</td>
<td>May and Nov.1940</td>
<td>Picked continuously.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12/ Other crops of this type may include</td>
<td>As above.</td>
<td>1½ ft.</td>
<td>As above.</td>
<td>As above.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cabbages</td>
<td></td>
<td>3-4 ft.</td>
<td>above.</td>
<td>above.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tomatoes</td>
<td></td>
<td>1½ ft.</td>
<td>10 ft.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Okra</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13/ Sugar cane</td>
<td>On ridges, which are later forked flat.</td>
<td>3-4 ft.</td>
<td>3-4 ft.</td>
<td>Nov.1940</td>
<td>April 1942</td>
<td>15-25 tons</td>
<td>6000 lbs</td>
</tr>
<tr>
<td>Maize</td>
<td></td>
<td>1½-2 ft.</td>
<td></td>
<td></td>
<td></td>
<td>50 lbs</td>
<td>150 lbs</td>
</tr>
<tr>
<td>Sweet potatoes</td>
<td></td>
<td>1½ ft.</td>
<td></td>
<td></td>
<td></td>
<td>150 lbs</td>
<td>18,000 lbs</td>
</tr>
<tr>
<td>14/ Cabbages</td>
<td>On ridges which are later split onto the young cauliflowers.</td>
<td>3 ft.</td>
<td>1½ ft.</td>
<td>Dec.1940</td>
<td>Feb.1941</td>
<td>50 lbs</td>
<td>6000 lbs</td>
</tr>
<tr>
<td>Cauliflower</td>
<td></td>
<td>1½ ft.</td>
<td>Jan.</td>
<td>Mar.</td>
<td></td>
<td>50 lbs</td>
<td>150 lbs</td>
</tr>
<tr>
<td>Salad beans</td>
<td></td>
<td>1½ ft.</td>
<td>Dec.</td>
<td>Feb.</td>
<td></td>
<td>50 lbs</td>
<td>150 lbs</td>
</tr>
<tr>
<td>15/ Tomatoes Patchol</td>
<td>On ridges, the tomatoes &amp; the patchei being on the same ridge.</td>
<td>3 ft.</td>
<td>3 ft.</td>
<td>May and Nov.1940</td>
<td>Oct.1940 and Feb.1941.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
ACKNOWLEDGEMENTS.

In conclusion the writer wishes to express his thanks to Professor Harrison, Professor Cheesman and Professor Hardy for their help with the agriculture, the botany, and the chemistry of the problem. Thanks are due also to Mr. L. J. C. Evans for providing the writer with cultivation sheets of maize and pigeon pea crops during the past few years.