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FIFTY YEARS OF HORTICULTURAL RESEARCH IN UGANDA - A PRELIMINARY REPORT.

I. Introduction.

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- 1. Beans - White Haricot
- - French
- - Lima.
- 2. Peas (Green or Garden)
- 3. Groundnuts.

III. Herbs, condiments and spices.
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- 2. Cardamon
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- 3. Other Fruits - Pineapple, Strawberry, Passion Fruit others.

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- 1. Indigenous
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Part II of the thesis, which it is intended will form the subject of a later seminar, will attempt a critique of the methodology of crop introductions and subsequent research using the factual information in Part I to illustrate the discussion in Part II. Those familiar with Tothills' "Agriculture in Uganda" and contributors to the revised 2nd Edition, which has just gone to press, will no doubt see some overlap and similarily of subject matter. This is rather unavoidable as the sources of information have been the same, although I must admit that at the beginning of the study I was unaware that this classic work was being rewritten and brought up to date. I have tried to avoid repetition of the 1st Edition, although for the sake of continuity this has been to some extent unavoidable. As already said, this paper is still a very preliminary presentation only, time having precluded a more orderly presentation. However the format for considering the research done on each crop will finally be as follows:

1. Botany - Botanical name and description.
2. Introduction and History of Development.
3. Varieties tried and Genetic Improvement by Plant Breeding and Selection.
4. Agronomy
   a) Planting dates
   b) Plant populations i.e. spacing
   c) Fertilizer trails
   d) Cultivation practices, including mechanization
   e) Pest and disease control
   f) Inter-actions to the above variables.
5. Harvesting and Storage - post-harvest physiology.
6. Processing
7. Additional information required before development can begin.
8. Recommendations.

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INTRODUCTION

This is still a very incomplete and preliminary Part I of what will be expanded into substantially a two part thesis on horticultural research and potential in UGANDA. The thesis arose . out of an assumption which can be summed up by words found in the preamble of the Kenya Horticultural Society's Handbook:

> "much information still lies hidden for future workers to find. Much has already been found, but it has been lying in different papers, in different places, and in people's heads. A book in which it is gathered together is greatly needed".

It was argued that Uganda like Kenya, had a high horticultural potential and that here too research had been carried out but that results had lain hidden and forgotten like Uganda's potential. On the other hand of course, it was also concivable that Uganda had made little progress in this field because of the different histories of the two countries. Kenya, with its large population of European planters and associated estates had made different demands on the Agricultural Research Division than had the largely native-agriculture orientated neigbouring Uganda with its very few expatriate planters and estates.

Part I of the thesis threfore will be discriptive of the experimental work which has been carried out in Uganda on horticultural crops which at this stage should perhaps be defined as:

> "Crops whose production requires high investment, using resources intensively to obtain a high quality and high value product".

However, there are many crops such as tea and coffee which although they fit into this definition, are worthy of much more detailed attention than a work of this kind could give them. It is therefore to these crops which are popularly called 'minor' that attention will chiefly be given.

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Unfortunately, the following as yet does not necessarily fit into the above format.

LEGUMES

1. Beans
   - French
   - White Haricot

) Phaseolus vulgaris

Beans have long been an important food crop in Uganda, mixed varieties traditionally being grown together, sown broadcast. Thomas (1940) states that "the classification of varieties is extremely difficult and many native varieties appear to be some - what intermediate between Phaseolus lunatus and P. vulgaris". Of the French bean, P. vulgaris, three types are found growing in Uganda:-

1) Bush types, these are generally low yielding and susceptible to disease but they are quick to mature and are suitable for interplanting.

2). Semi-climbers, These are of intermediate character and show variable resistance to disease.

3). Climbers, these are heavy yielders, over 2000 lbs/acre have been recorded; they are generally highly disease resistant. However, they are slow to mature and less convenient to manage.

There was very little research carried out on this important food crop until after the Second World War but intensive investigations did not begin until 1960 when a research programme was initiated at Kawanda aimed at producing a bean acceptable, in the dried form, as a local food. In this form, because of its low value, it holds no interest as a horticultural crop. However the programme was soon expanded to look into the possibility of producing a variety of bean suitable for export and bound for the canning industry where it would be turned into a "baked bean". The type that is required by Heinz and other firms is a small white bean known as the white haricot. It was realised

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from the beginning that for successful production in Uganda, the bean must not only have the required seed characteristics but it must also be disease-resistant, especially to rust and anthracnose diseases, and it is these considerations which have influenced the programme to date.

Several varieties of haricot bean have been introduced into Uganda for trial at Kawanda. One of these, Mexico 142, known in Uganda as No.212, is a variety selected in Tanzania for rust resistance which produces a bean suitable for canning. A second, known as No: 234 was introduced into Uganda by Leakey from Rwanda. It is a variety selected int the Congo by the Belgian Research Organisation I.N.E.A.C. and is a variety popular on the continental European market . In 6 x 6 Latin Square variety trials at Kawanda by Mukasa in 1965 six varieties of haricot beans were tested, including No. 234, with No:212 as control. Of the six varieties, two suffered severely from anthracnose infection, no symptoms were observed on No:234 and there was only slight localised infection on the other varieties which appear to be resistant. However there was considerable pod damage by the caterpillar of **Maruca testulalis** in this 1st rains trials.

No. 212 was tested for the first time in district trials in 1965, being tried at 14 centres plus 5 prison farms. Its performance i in all trials was quite good.

Although this variety yields very highly it has not proved to be locally acceptable. However, if development capital was available to provide grading and packing facilities it would seem that an export potential existed to supply the canning trade. Breeding work is still in progress at Kawanda to produce better yieldings varieties and there is every reason to expect that this will be successful.

AGRONOMY

The information I have on beans still remains very incomplete but as yet I am unaware of any agronomic studies which have been carried out specifically on haricot varieties. Most of the spacing trials have been done on Banja 2, a bush type and on Kawanda 35,

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a semi climber, as is No. 212, therefore having at least some relevance. Trials started in 1959 and concluded in 1965 showed that with bush types the yield quite consistently increases with seed rate. However for semi-climbing types (this can also be expected to apply to No.212) varieties have a wide compensating capacity and therefore are not as sensitive to spacing as the bush type varieties Mukasa gives the recommended spacings as:

24" x 3" for hand planting

26" x 3" for mechanical planting

although from the foregoing this is obviously more critical for bush varieties than semi-climbers.

As regards pest and disease control, this may be supposed to be equally applicable to all varieties. At Serere full control of bean fly (Melanagromyzus spp.) has been reported using aldrin or dieldrin seed-dressings and other pests have been controlled by routine spraying of the crop.

Trials with No.212 have shown it to be both resistant to rust (Uromyces appendiculatus) and to anthracnose.

Storage of harvested beans still presents a problem, large losses occuring each year due to weevil damage. Before this crop can be developed for export, work is required on mechanical drying and efficient storage, perhaps with fumigation. Little is known of this crops response to fertilizer or its suitability for mechanical harvesting and an economic appraisal is at this stage not possible. Much time, energy and money has gone into investigating beans as a food crop, but work still needs to be done if this crop is to develop past the"potential crop" stage and into an export crop. French Beans in their nature green pod stage are well known as a vegetable. They are exported in small quantities to the U.K. from November to May when prices are high. Small unreplicated variety trials have been carried out on many vegetables both at Kawanda and in Kigezi. These trials have resulted in varieties suitable for high and low altitudes being recommended and have taken into consideration:

1) Yield

2). Pest and disease resistance

Recommendations also include suggested spacings and fertiliser applications together with approximately yields to be expected and time to maturity.

Recommendations from these "ad hoc" trials are quite adequate for the small vegetable grower although more empirical data is required for production on a commercial scale. As this type of production is severely limited at the moment and the market is very small it is perhaps desirable that such information as is required for this specialised crop should be obtained by the commercial growers themselves. However, other beans such as broad beans and 'LIMA' (butter) beans (P. Lunatus) may have canning potential and these could well be looked at if the market situation is suitable. As early as 1935 there were enquiries from a Canadian firm asking about the possibility of growing Lima beans in Uganda. Samples of P. Lunatus sent from Bukalasa were said to be of the exact type required but this outlet does not seem to have been persued.

Peas, (Pisum sativum)

As a food crop peas are of importance only in Kigezi being introduced it is said, from Ruanda. As a horticultural crop they have not attained any significance, the peas always being rather hard. The variety 'Tall Alderman' is however recommended for over 5000 ft: as yet no recommendation can be made for a suitable variety for lower altitudes but trials are still in progress at Kawanda.

Ground nuts (Arachis hypogaea.)

Most of the experimental work on groundnuts has been done at Serere. Unfortunately, as yet I have not had access to the Serere files so I have had to rely heavily on

the mostly widely grown nut suitable both for the high grade nut trade and for oil extraction. Much of the early agronomic work is therefore still relevant. As early as 1915 experiments were being carried out on this crop and yields of 856 lbs/acre of unshelled nuts was stated to be a fair average for Teso district (1000 lbs/acre of shelled nuts can now be expected as a minimum).

During the thirties introductions of new varieties continued and selection for high yielding varieties was begun. As the result of many spacing and cultural trails it was noted that close spacing increased yields although at very close spacings the increased yield was offset by the higher seed rate. Recommended seed rates at the end of the thirties was 100 lbs/acre. Broadcasting was recommended tobe continued as the extra labour costs involved in sowing in rows was not justified by the returns. Experiments were also carried out on grass mulching and delayed weeding results showing that a complete crop or crop and weed cover lowered the incidence of rosette virus disease. During the forties and into the fifties selection work continued together with agronomic studies and a start was made on studying rosette disease.

In 1954 interest was shown in the crop for use on mechanised farms, prices at that time being high enough to cover a considerable degree of mechanization. Unfortunately the Department had no major experimental farm in a groundnut growing area for although they had always been an important crop at Serere, the soil is not really suitable, being too heavy.

Planting trials were therefore carried out at Serere and at the Special Development Section's Busoga Farms. Results suggested that satisfactory, although possibly not optimum yields could be attained from 28" rows with 3" spacings within the rows. Increased yields were also obtained using 'Agrosan' seed dressing.

or summaries in the Annual Reports and elsewhere for information. In particular, mention should be made of an excellent summary by Tiley (1963) of work up to that date.

Groundnuts were probably introduced by the early Arab traders as they were already established at the time of the first European arrivals. The variety then grown was probably of the pale brown - kernelled spreading type still grown under local names today Numerous other varieties have since been imported by the Department of Agriculture, this being done very actively particularly in the twenties and thirties. The varieties fall into two groups:

1. Bunch Varieties, these have an erect growing habit and mature quickly, 100 - 110 days.
   e.g. Valencia - Red
   - White
   Spanish - Bukene
2. Spreading varieties, these have a prostrate or semi-prostrate habit and are slower to nature, 120 - 130 days. e.g. Mwitunde.

Amongst these introductions the red Valencia rapidly gained popularity because of its quick maturity and today largely super-seeds the spreading types in most areas.

The principal growing areas are Busoga and Teso. A large proportion of the crop is consumed as food, some is retained for seed and the remainder was formerly sold for oil extraction. As early as 1919 groundnuts were being exported for extraction, amounts fluctuating widely according to subsistence surpluses. However at the end of the fifties world prices for nuts suitable for the edible nut and confectionary trades were high and the Director of Agriculture expressed concern that Uganda had not taken advantage of this boom and was still exporting spasmodic quantities for low priced oil extraction only.

This is the turning point of the history of the crop in Uganda and it is from this point that my interest in the crop really begins. However, the variety red Valencia as yet is still

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Following the Director of Agriculture's exhortation in 1960 an intensive breeding programme was started at Serere. At the same time a pilot scheme was started in Busoga which included grading of the kernels for export and guaranteed prices to growers. The breeding programme to select suitable varieties for this specialised trade began under Tiley, a collection being made of varieties grown in Uganda and elsewhere. The intension was to make single plant selections of promising lines and to multiply these up in comparison progeny rows followed by limited hybridization and progeny testing. Along side this breeding programme confirmatory trials on important agronomic practices e.g. planting date, spacing of (a) bunch, (b) spreading varieties, seed dressings, spraying against leaf spot and aphids,, (to control rosette) harvest date range etc. were to be conducted.

The Director was requested to provide the latest information on the type of nut required by the trade so that selections of characteristics known to be desirable could be made.

Field staff suggested that the most important needs were for suitable varieties, seed dressings, control of leaf spot and applicability of fertilizer treatments. A machine was also considered to be urgently needed to pluck the nuts from the haulms, especially in the case of Spanish varieties, and simple enough for use on peasant farms.

Variety trials were therefore begun in earnest in 1961 and results from these first rains District trials from 1961-63, chiefly in Eastern and Northern regions at 24 centres, using 9 different varieties , generally confirmed earlier variety testing that Spanish types can outyield valencia varieties which in turn are considerably better than spreading varieties at most centres. Mwitundo a spreading variety yields slightly less than Valencia under conditions of moderate rosette attack but is relatively high-yielding when infection is heavy.

In 1961 observation trials at Kawanda did well. It was therefore decided to investiage crop agronomy in this wetter area of Uganda and it was planned to establish trials based on Tiley's 1961 results.

In 1963"Mani Pintar"was introduced and outyielded all other varieties at centres with average to good soil fertility. Unfortunately, studies on kernel size and grading percentage made at Serere from 1961 - 63 indicate that in Uganda the highest proportion of gradable nuts, grading at not more than 75 per oz, are given in the Valencia and Mwintude varieties. Kernels of spreading types and of Mani Pintar, though often large, are very variable in size and those of Mani Pintar are of irregular shape. Spanish kernels are normally the most uniform in size and shape but grade poorly except in crops from high fertility soils. Spanish varieties are also susceptible to attack by Cercospora leaf spot, and this may well inhibit full kernel development.

Until 1967 the recommended variety for highest gross return whether for oil or for confectionary was still therefore the red valencia type, represented by the bulk of several strains known as B1 at Serere but of which numerous lines exist throughout the country. In areas prone to heavy rosette attack, the resistant Mwitunde while on soils of Valencia might be substituted by the partially/fertility and high under high standards of management the Spanish and Mani Pintar varieties could be grown with advantage.

Yields trials of introduced bunch varieties and of Serere selections have continued using B1 (Valencia) B 239 (Spanish) and Bukene (Spanish) as standards. In 1966/67 all the introductions outyield the standard varieties indicating that further breeding and introduction of new varieties is still required. Breeding work at the moment is concentrating on producing crosses intended to produce short-term brown skinned lines suitable for export. Selection is based on early maturity and brown colour of nuts. Although other kernel qualities have not been worked out

it is definite that selections which give bigger kernels also have lower yields. In future, kernel size will be looked at when assessing for selections. Trials have also been in progress on introduced spreading varieties, using Mani Pintar as a standard. This variety out-yielded all others although its kernels were small. 'Chalimbana', an introduction from Malawi showed promise, yielding well with good sized kernels. Spanish single plant selections are in trial against Bukene and so far selections have given increased yields together with greater kernel size.

Spacing Trials at Serere between 1961 - 1963 by Tiley confirmed earlier trials that spacing is important both in bunch and spreading varieties. Generally speaking a very close spacing of 1' rows with seeds planted 1 inch apart in the rows gave the best results but the high seed rate makes this very expensive. It is therefore interesting that the lowering of yield by widening the space between the rows to 2ft is not serious provided that the intra row spacing does not exceed 3-4 plants per foot.

Close planting was found practical as it reduced the incidence of rosette.

Effect of spacing on rosette infection on B 239 (Serere selection)

1st rains, Serere, 1961.
Rosette count at 8 weeks,
mean of 5 plots. (nos of plants/plot not given)

Spacing between rows	Seed / ft			
	12	6	3	1.5
1'	20	49	132	127
1.5'	23	46	137	122
2.1'	28	71	90	165
2.4'	16	62	90	162
3.0'	33	55	112	182

Effect of Spacing on Gross Yield of B 239

Ist rains, Serere, 1961 lbs/acre unshelled nuts

Spacing between rows	Seeds per ft			
	12	6	3	1.5
1'	1120	1199	979	912
1.5'	1510	1220	797	656
2'	1476	799	722	380
2.4'	987	803	680	405
3.0'	1013	704	438	283

As a result of these experiments to determine optimum spacing with regard to yield, kernel quality and incidence of rosette recommendations have been made for the main varieties grown as to spacing and seed rate when rosette attack is likely to be heavy or light and when seed is grown in rows or broadcast, etc.

Planting date was shown to be of great importance in the 1961-63 Serere trials. Nuts planted at the break of the rains (in the 3rd week of March in 1961) yielded slightly over 2000 lbs/acre unshelled nuts. Nuts planted 3 weeks later yielded 500 -1500 lbs depending on variety and a further 3 weeks delay reduced yields in certain cases to 200lbs. Records of time to maturity from time of planting to lifting at Serere and Kawanda showed that nuts mature generally from 10-20 days earlier at Serere than at Kawanda. Valencia types mature before the Spanish types which mature before the spreading types, the semi-erect maturing last of all.

Fertilizer effect has only recently been studied, early trials giving variable results. However, a large-scale programme of fertilizer trials was started in 1961 and at Serere the importance of phosphate, lime and potash was demonstrated. More than 100 pairs of small plots were laid down on farmers' land throughout the Eastern region to test superphosphate.

An overall average gain from this simple treatment was in the order of 280 lbs/acre of unshelled nuts. However, results were very variable.

Stephens and Harrop 1966, recommended 1-2 cwt granular Tororo single superphosphate per acre should be broadcast over the soil and worked in shortly before planting. The application can conveniently be made just before the final seed bed preparation. 1 cwt of singles has been found to increase yields by up to 200 - 500 lbs fresh nuts per acre (i.e. 100 - 250 lbs dry nuts in shell).

However as well as requiring fertilisers themselves, groundnuts have a residual beneficial affect on the soil and are therefore of importance as a rotational crop. It has been calculated that the residual effect is equivalent to 1 cwt Ammoniun sulphate/acre. At Serere experiments have shown that groundnuts will also respond to organic manures. In these trials the manure is applied to a crop earlier in the rotation and this practice is usually recommended in other countries as opposed to applying it direct to the groundnuts. In the Permanent Manurial Experiment where manure is applied every 3rd Year to a continuous cropping regime groundnuts grown 2 years after every application of 10 tons of manure (i.e. after cotton , sorghum, cotton) have given an average increase of 340 lbs unshelled nuts/acre. (av. of 8 crops) The actual response has varied with season but does not show any particular trend as the manurial treatments have increased. Repeated applications at the rate of 20 and 30 tons/acre do lead to further increase in yield but these are variable and it is not considered economic to go to these higher levels. In fact in the Fertility Experiment, manure applied every 5 years to cotton, with groundnuts grown in the following season, have shown very worthwhile yield increases; with applications of 2½ and 5 tons/acre. After the 5th application increases of about 500lbs and 700 lbs per acre from the lower and higher rates respectively have been obtained. Earlier dressings have given smaller effects but the experiment shows that manure becomes increasingly beneficial. Applications of lime on the Permanent Experiment only increased the yield by 90 lbs /acre and were therefore not considered economic.

A good crop of valencias was grown with irrigation at Kasese but a variety trial in 1963 yielded similarly to dryland trials elsewhere.

Storage of Seed

As a result of seed-dressing trials at Serere 1961 - 1963, Tiley after using numerous chemicals, recommended a thiram-lindane dressing for seed after shelling to assist both in temporary storage before planting and in improvement of emergence. Some mercurial products were found to be good but are too poisonous to be recommended. It has been found that seed stored in pods for 18 months or longer will retain its viability but germinates slowly. Valencia and Spanish types will germinate immediately after harvest but the long term varieties have a dormancy period of approximately 60 days. Shelled seed has retained good germination capacity up to 6 months. After shelling, with or without seed dressing, in absence of insect damage.

Trials in which the nuts were shelled by machine prior to planting, both hand and mechanically operated, have given satisfactory germination provided the machine is properly adjusted for each variety.

Pests. There are no serious pests except Aphis Craccivora which is the chief vector of rosette virus. Colonies develop from airborne alates in the growing season particularly from May onwards and under dry air conditions. Control of the vector has been attempted at Kawanda and Serere using seed-dressings and sprays of menazon , BHC and formothion. Both menazon and BHC gave good control of the aphid and treated plots had less rosette than controls, but formothion was significantly worse. At harvest menazon plots outyielded all others and had significantly more Grade I kernels. Spraying trial are still continuing.

Diseases

Rosette is the only disease of major importance in Uganda and is endemic throughout the country. It is a virus disease which is spread by an aphid vector and its occurance has, in the past, had a decisive influence on planting practices. Its epidemiology has been largely worked out in other countries but Storey (1962) worked on the disease in Uganda for a time. It has long been known that close-spacing reduces the incidence of rosette, but the mechanism of this controlling influence on degree of infection and spread of the disease has never been satisfactorily explained.

A breeding programme is now in progress at Serere to produce rosette-resistant lines. Preliminary selections have been made but these have been low yielding. Introductions of resistant plants have been made from Malawi and tested against the Serere resistant selection No. 295. However in the 1966/67 trials no variety was significantly different in yield to No. 295 and all varieties showed high rosette resistance. From previous low yields and similar yields of the introduced varieties it can be said that rosette resistance has a close linkage with low yield. No variety was markedly better than No. 295 in seed size. A crossing programme aimed at short-term rosette resistance with better yields than the existing varieties is now under-way. It is now apparent that yield deterioration as breeding progresses will have to be reversed by back crossing on to high yielding parents. When a high yielding resistant variety is produced then previous experimental spacing results to conteract rosette may well become irrelevant. However, the present spray trials against the aphid vector of rosette may throw some light on the problem.

The major remaining problem facing groundnuts production in Uganda is the occurence on samples of nuts of the fungus Aspergillus flavus which produces the carcenogenic toxin, aflotoxin. Such soil-borne infections can be avoided by careful harvesting procedures aimed at quick drying. These are obviously difficult to

to enforce and good facilities are not always available. A number of plot grading schemes have recently been introduced aimed at overcoming this and other faults.

Condiments and Spices

Ginger

Nearly all the ginger in commerce comes from one specis, Zingiber officinale Roscoe with the exception of Japanese ginger which is Z.Mioga Roscoe. The ginger is derived from the rhizome or underground stem of the plant, which is cultivated as an annual crop and propagated vegetatively. Information on the original introduction of ginger into Uganda is lacking but it is probably one of the numerous crops introduced by Arab traders.

It was noted by G.W. Nye (1940) that as a commercial crop ginger was nowhere grown in Uganda but that a few roots were to be found in most native compounds in Buganda, Busoga and parts of Western Province. It was used as condiment but also as a medicine and occasionally surplus fresh rhizomes were sold to local Asian traders. Two varieties were recognised in Buganda, Kiboko and 'Nganda' differing only slightly, both being small wrinkled rhizomes quite unsuitable for export. A third variety was large and plump, but also very rare, and as no planting material could be made available at Bukalasa this variety was never worked on. Observation plots of ginger planted around 1910 at the Kampala Plantation never did well and so at the beginning of the thirties ginger was tried at Bukalasa, both 'Kiboko' and Nganda' types being tested. In 1931 a small trial plot yielded at the rate of 7,749 lbs per acre but this seems to have been a freak result as subsequently Bukalasa was found to be too dry for ginger. The crop required 12 months to come to maturity there and yields were low, around 2,800 lbs per acre compared with yields of 4, - 6,000 lbs in Jamaica.

Importations from Ceylon, Nigeria and Sierra Leone in the 1930s were tested at Bukalasa but they all suffered severely from drought . Samples of prepared dried ginger rhizomes sent to the Imperial Institute proved unsatisfactory, their value being put well below that of West African. With the high freight charges from Uganda it seemed unlikely that ginger would ever be of any commercial value to Uganda.

Little experimental work has been done on this crop other than the early observation trials at Bukalasa. However, when prices for ginger suddenly rose half way through 1960 due to the failure of the Mauritius crop. Buganda farmers chiefly in Mpigi Division seemed to have little difficulty in expanding production just as suddenly . An average of 1/- per lb. was paid to farmers, and they were encouraged to bring in their ginger for sale by broadcasting current prices over the radio. During the latter 5 months of 1960, 23 $\frac{3}{4}$ tons were exported at an average price of 1/50 per lb, and over the year this crop was probably worth approximately £6,500 to farmers.

The variety Large Canton' was the type preferred and although comparatively rare in Uganda, around 15 tons of this variety alone was exported to Nairobi in 1961. Contrary to general expectation that this mass encouragment would lead to a position of oversupply with a subsequent fall in price, just the reverse situation occured. Supply never caught up with demand and prices did not fall but continued to rise. In 1961 Uganda Food Products, the Spice and Curry dealers began to fly ginger to their London shop twice a week and other Kampala buyers found that far from flooding the market farmers were nto bringing in enough. Exporters found that, quality for quality, Uganda could compete successfully both in Nairobi and in London. The marketing officer of Buganda estimated that in 1961, 45-50 tons of ginger was exported from Maria Mitala Parish, Mpigi alone, the estimated total export being put at around 150 tons.

By January 1962 prices had reached Shs 1/75 per lb for large canton'. However, by the end of the year prices dropped just as suddenly to 70-75 cts and Rea, A.O. Mpigi estimated that some 209 bags (14 tons) only were sold in Kampala.

In 1963, although supplies were sufficient to meet local demand little was exported, the Young Farmers Clubs in Butambala being the only large producer. Growing has tended to remain specialised in Mpigi Division and prices have remained fairly steady until very recently.

Agronomy

The experimental work done on this crop is almost nil and would have been even less but for the interest and enthusiasm for this crop shown by Rea, A.O. of Mpigi Division at the time of high prices.

Several small fertilizer trials have been run by Kawanda with the object of finding the effect of N.P. and K on the crop. These have been established on farmer's plots in Buteyangera and Butambala Counties, Mpigi in 1965,1966 and 1967. However, due to the distance of these plots from Kawanda and attendant lack of supervision, the plots in each set of experiments were neglected, over run by weeds and generally gave inconclusive results. Two small plots in Butambala county planted by Rea yielded at the rate of 4,520 lbs and 4,640 lbs/acre of green ginger over a growing period, March to November and gave some indication of the sort of yields that can be achieved. At the beginning of 1967, Leakey planted a trial of 'Large Canton' at Kabanyolo to test the effects of N and P. Unfortunately his plots were inadevertantly ploughed in and the trial has never again been repeated.

In 1965 some Jamaican ginger was imported and a trial was established at Namyoya to compare it with the local varieties; I have found no record of results.

World Markets for Ginger

(Taken from Reports of the Tropical Products Institute, London).

Ginger enters world trade in four distient forms, which to a limited extent are inter convertable.

(1) Dried Ginger, this is the most important form.It consists of rhizomes, dried in their country of origin and later ground to form the well known spice.

(2) Ginger oleo-resin, this has ginger's pungent properties as well as containing an essential oil which is extracted from the ground rhizomes using volatile solvents. It is used in pharmaceutical products and for purposes for which the spice is also used. A non-pungent essential oil can be obtained from the rhizomes by steam distillation. This is used for flavouring foods and soft drinks and as a modifier in perfumes and toilet waters.

Main sources are India, Nigeria, Sierra Leone and Jamaica. Jamaican ginger is generally considered the best because of its delicate odour and flavour and its clean - peeled export condition.

Supplies of the dried rhizomes form of ginger have been steadily increasing,those from Jamaica and Sierra Leone being replaced by Nigeria and India, these latter two countries having a definite advantage in that they have large home markets as well as export outlets. Ginger in this form is subject to great price fluctuations depending on the demand-supply position. According to an F.A.O. Report, dry ginger will not keep under ordinary conditions in tropical climatesfor more than 6 months after harvest and is therefore difficult to stock pile unless by importers.

Since 1962, Sierra Leone and Nigerian ginger has been handled by a Marketing Board in an attempt to stabilize prices.

3. Preserved Ginger, this is used mainly for jams, sauces and pickles, confectionary and baking and by essence manufactures. Small amounts are sold retail in jars and some is made into crystallised ginger. The main supply of this type of ginger is from China via Hong Kong. Mauritius ginger is considered by some to be also suitable for preserving but no attempt appears to have been made to start an industry there.

Ginger is now also being grown and preserved in Queensland, Australia and is regarded as being comparable to the Chinese.

Attempts have also been made in Puerto Rico and India to cultivate a preserving ginger and a Chines 'type has successfully been isolated at an Indian Research Station. Price fluctuations are less for this form of ginger as it can readily be stored in its country of origin. Demand remains steady at around 2,400-2,500 tons imported into the U.K. annually, where the demand is almost entirely for ginger preserved in syrup for the food processing industry. Dry preserved ginger and crystallised ginger do not travel well, tending to sweat or ferment. The ginger which is grown in China is cultivated in the moist rich, alluvial flats of the Canton Delta, often in rotation with rice. During growth it is given heavy dressings of liquid manure and is harvested at an earlier age than if intended for dried ginger. The Chinese type is therefore less pungent and has large fleshy hands loose in texture with widely separated fibres.

However, there have been increasing difficulties in getting fresh ginger from China, and Hong Kong is increasingly using Taiwan ginger. Hong Kong is also being affected by increased labour and freight costs and new sources would therefore be welcomed. It should be remembered that exports from Commonwealth countries would enter the U.K. duty free.

4. Fresh Ginger, this is used for culinary purposes. The main sources were formerly Hong Kong and Mauritius but supplies are coming increasingly from countries such as India, Nigeria and Ghana, which have big home markets. Good keeping quality is

is of more importance in this type of ginger than flavour or appearance.

The Present Market Situation as regards Uganda

A. T.P.I. Memo on dried Uganda ginger rhizomes considered that it would be suitable as the dried spice for blending with other gingers for use in mixed ground spices i.e. that it was of fairly low quality. It was also considered a suitable source of ginger oil or of ginger oleo-resin by solvent extraction. It should perhaps be noted that all these products are open to price speculator and therefore suffer from fluctuating returns. However, samples of dried Uganda ginger sent to the States and U.K. in 1967 received favourable comment and ten tons as per sample were requested immediately at £ 216/ton or 50 cts / green lb. Unfortunately, as so often happens with test samples, a ten ton consignment was not available but there appears to be a definite potential market. The question is, how big is that market? The trade in Uganda ginger is almost exclusively in its fresh (or green) form.

A number of Kampala firms have exported green ginger to the London market for a number of years, the demand being for about 10-20 tons per month. Sendings tend to be seasonal , from around December to May, to avoid peaksendings, particularly from Mauritius but also from Nigeria and Ghana. All exports from Uganda are by air and therefore very expensive. Other competitors are able to send by sea at much lower rates and without quality being impaired. The sea journey from the West African Coast takes only 5 days and although considerably longer from Mauritius, loss of quality can be avoided as the carefully packed boxes can be put directly on the ship. Uganda ginger on the other hand, if it was to travel in this way would have to be railed to the coast prior to packing into the ship and, with all the delays such a journey implies, quality would doubtless be greatly reduced. Uganda Food Products were perhaps the first to air freight ginger to the U.K. in 1960 at the rate of 4000 kilos (4 tons) per month for 5 - 6 months of the year. They received 50 - 80 cts per lb

c.i.f. London, of which they paid 40 - 70 cts per lb to growers. Other firms later exported through Uganda Food Products, Lennox Bros. and others. However, in 1968 exports by the firms stopped as being unprofitable and I am aware of only one remaining exporter, Morjaria Bros. They still send ginger mainly from March to May, for which they receive 1/- per lb delivered Entebbe. Success, where other have failed is attributed to the fact that the brother on the London end takes orders, paid in advance on an agreed price, and informs his brother of his requirements. Other exporters send 'exporter's risk' on a consignment basis and are dependent on fluctuating market prices and on the honesty of their agents. This firm exports in the region of 20 tons/annum over a 6 months period Besides exports to U.K, there has formerly been a big export of fresh ginger to Nairobi, especially from 1960 onwards. It is the 'Kiboko' and 'Large Canton' types which are apparently preferred. Kampala traders quote anything from 25 cts to 1/- per lb as the price they are prepared to pay growers for their greeen ginger but most seem to expect a profit of only 10 cts /Lb. on their Kenya sales. Surprisingly the Kampala retail price is higher than that in Kenya. One Kampala trader, who quoted the Nairobi delivered price as 45 cts/lb, growers being paid 25 cts/lb, was retailing ginger in his own shop at 80 cts/lb., presumably to a small but inelastic demand.

One trader who has been exporting to Kenya for the last 10 years estimated the total sendings to Kenya as 4-5 tons weekly. This trade tends to be seasonal although some traders do try and send all year round with peak supplies come during the rainy seasons . Kenya also imports from Mauritius, mainly from October to March, the ginger being packed in standard 50 lb boxes. But as one trader rather despairingly remarked, nothing from Uganda is standardised and so of course is not so acceptable or so competitive.

Uganda not only exports ginger but also imports it as the dried ground spice, from India at around 2/- per lb. At first sight this would seem to be a ridiculous situation and one which could easily be remedied by processing ginger to the ground stage in Uganda. However on closer examination it becomes obvious that Indian growers are prepared to accept much lower returns to their effort than are the farmers of Uganda. In the processing of ginger, which requires boiling in lime water followed by long sun-drying, 80% of the fresh weight is lost This means that 5 lbs of fresh ginger are required to give 1 lb. of dried ginger. If an average price of say 50 cts per lb is assumed for the sale of the fresh product (and this is not at all unreasonable) then a sale of 5 lbs. would bring returns of Shs 2/50 as against the 1/50 per lb. that Uganda Food Products would be prepared to pay for the dried product. Uganda dried ginger, at current prices for fresh ginger, can give no returns in competition with the imported Indian spice.

One very recent and rather worrying development in Kenya has been the new licensing laws which have deprived many Asian traders of their rights to trade. Additionally, I understand, no Asian, even with a licence, is any longer allowed to deal in fresh fruit and vegetables. As a result of this, trade has been severely ditrupted, traditional contacts have been lost and those that remain are unwilling to buy in large quantities at least, because of the uncertainty of their tenure. In January, one firm alone dropped from its usual sending of 50 bags (7500 lbs) per month, to 10 bags. When normal trade is once again ressumed under African traders it is thought that they will be less concerned to cater for Asian tastes than the previous traders and it may well be that ginger will cease to be imported into Kenya from Uganda, at least not in such large amounts as formerly. Some high priced alternative outlet for Uganda ginger would therefore seem even

more desirable now than even a few months ago.
Leakey has repeatedly advocated developing a small-scale local industry using locally produced ginger and locally produced sugar cane, the end product being sugar-preserved ginger. As already said, new sources of this type of product would be welcomed by the trade,prices are fairly stable, travelling properties are good and there is no product deterioration in transit. Small samples of locally prepared preserved ginger have received very favourable comment from the trade and this line would indeed seem worth persuing.

However, it still remains to be said that very little is known, in real terms,of the requirements of Uganda ginger as a commercially grown crop, or of the returns which can be expected from it.

Turmeric.(Curcuma longa)

This is in actual fact not a spice but a vegetable - -dye, Saffron of commerce. It is used mainly as an ingredient of curry powder, giving it its characteristic colour.
Its cultivation is similar to that of ginger , the rhizomes also being the valuable part of the plant. Thomas (1940) records that the plant was occasionally planted by Asians and natives and the rhizomes used locally in curries.

It has been stated in the 'Crop Production Programme 1960' and subsequently, to be grown quite extensively in Buganda and Bunyoro, in small plots. Estimated local demand in 1960 was thought to be equivalent to 400 tons of green rhizomes annually In the latest publication however no guide is given as to total internal requirements. As turmeric is one of the crops whose production is to be encouraged to meet local demand this would seem rather an unfortunate omission. Uganda Food Products, the largest curry powder manufacturers, with a self-estimated 75% share of the market, use 5 tons of turmeric a month. This they import from India and Pakistan at 1/50 per lb for dried rhizomes.

The main difficulty to expanding production, even to meet local demand is that, as yet no way of successfully processing the local product has been found to be economical. Uganda Food Products worked on this problem together with Makerere in 1960 but were never really successful. The rhizomes have to be washed and scraped in a revolving drum, boiled in lime water and sun-dried for several weeks. The rhizomes then need to be polished in a special machine which so far no one has been unable to be produced locally. Uganda Food Products would be prepared to pay 1/80 - 2/80 per lb. for the dried rhizomes (although it costs them only 1/50 per lb to import). They consider that the processing, as for ginger, would not be remunerative on a factory scale, too much space and labour being required but they suggest that it woul still be profitable to the grower. This is highly questionable however unless the opportunity cost of the farmer's labour and outlets for the fresh rhizomes are both nil. As with ginger on 80% weight loss occurs in processing which would seem to make processing highly unprofitable.

Cardamomum (elettaria cardamomum)

The cultivation requirements of this spice in its countries of origin have been found to be an average temperature of 72° F, an average rainfalll of 120" and shade by moist mountain Jungle. A rich loamy, even swampy soil is required. The first harvest can be expected 5 years after planting, the plant having a production life of about 8 years, when replanting is necessary. In Ceylon and India, the main sources of supply, there are two main harvesting periods annually but small quantities can be obtained at 2 month intervals. The valuable part of the plant is the seed, the seed capsules being snipped from the stem with scissors just before maturity. The fruits are than cured by:-

1) Slow sun-drying on mats, bursting of the capsules is to be avoided.

2) Artificial gentle heating on trays in kilns.

The seed are then sometimes bleached using sulphur fumes. Sun-drying is cheaper but prices are lower than for good kiln-dried seeds. 1250 lbs of green fruits, kiln-dried, give 135 lbs dried capsules i.e. more than an 80% loss in weight. Seeds were first introduced into Uganda in 1934 from Amani Research Station, Tanzania. They germinated well and started flowering and fruiting satisfactorily but no further mention is made of them.

In 1960 there was a sudden revival of interest in condiment and spice crops and a spate of new introductions followed. Agricultural Enterprises Ltd., imported seed and the following year importations of rhizomes from Ceylon and seeds from the Cardomom Research Station, India were planted. 376 plants were subsequently transplanted into a cleared area in the forest at 2 ft by 2ft spacings to be used as a supply of planting material. Early growth was promising although as could be expected, there was evidence that heavy forest shade and well distributed rainfall are essential for good growth. An observation plot is still maintained at Kituza.

Pepper, (Piper nigrum)

This spice comes from a creeping perennial vine indigenous to the moist,hot lowland forests of Ceylon, South India and Malaya Both 'Black' and 'White'peppers are the product of the same plant the former being the ground whole dried fruit or pepper corn whilst the latter is produced by removing the black outer coat before grinding. For successful cultivation the pepper vine is said to require moist heat with shade together with an evenly distributed rainf rainfall.

Although this discription can hardly be said to apply to Uganda's climate, the closely-related African black pepper(cubebs) grows very well in Uganda and this has led to the introductions. The first introduction was as seed from Ceylon in 1913 but germination was poor and the plants died off when potted up. In 1932 seed was received from the Gold Coast which germinated well and 100

plants were subsequently potted up. Seedlings were transplanted both to the Botanic Gardens, Entebbe, and to the Kampala Plantation in 1933 and put against Hevea rubber trees.

Unfortunately all the vines at Kampala died but those at Entebbe made strong growth and flowered profusely although no fruits were formed. In 1960, interest revived and selections of seed from Ceylon, Zanzibar, India and the West Indies were introduced to try this crop in the wetter areas of the country, it being considered that previous introduced varieties had not been of the best type. The aim is primarily to supply local demand. Annual importations of pepper are difficult to assess as this product does not appear separately in the Trade Reports. Probably the largest importer, Uganda Food Products, imports from India, Singapore and the Middle East in the region 1 ton per annum. According to yields obtained in the most climatically suitable areas of production, this could be supplied by about 2 acres of vines planted at the recommended spacing of 7 ft by 7 ft! As yet there is no indication as to how successful pepper cultivation will be in Uganda.

In India and Ceylon vines are propagated by cuttings which give small crops in the third year of planting although the vines do not come into full bearing until the sixth or seventh year. When propagation is by seed, the time to come into bearing is even longer. Certainly on the face of it, it would seem that the local demand is neither large enough, nor the growing conditions suitable enough, to make pepper cultivation in Uganda an attractive proposition.

Vanilla (Vanilla planifolia)

Vanilla of commerce is extracted from the fruits, (pods or beans) of a vine belonging to the orchid family and indigenous to Mexico. The vine , rooted in the soil, has a natural tendency to climb by means of adventitious aerial roots, clinging to natural or artificial supports. Clusters of up to 15 flowers bloom over

a period of a month in ones and twos per day, and if pollinated successful will develop rapidly into beans which achieve their full size in 4- 8 weeks. However, the beans will take a further 10-12 months to ripen, depending on weather conditions. When the correct stage of maturity is reached the beans are then cured prior to extraction and it is as cured beans that they are exported, the vanilla extraction being carried out in the importing country. Vanilla has always been subject to violent price fluctuations on the world market and over the years prices have ranged from as little as 6/- per lb to 94/=. Artificial Vanillin was first produced about 1891 from eugenol but it has not until the 1920s that this synthetic vanilla was produced commercially, making Vanilla cultivation even more of a precarious occupation. However , following recent legislation in the U.S.A. on the use of syntheti s in food products, / natural Vanillin has / once again been in demand.

Vanilla cuttings were first introduced into Uganda from Ceylon in 1912 and made good growth at Entebbe. In 1920 a small plot was established at the Kampala Plantation and pollination and other experiments were carried out. Commercial production was started to a limited extent; the crop apparently growing well on an Asian owned estate near Entebbe. Samples of cured pods from this estate were forwarded to the Imperial Institute, London, together with a sample from the Kampala Plantation in 1931. The beans were said to be of low quality with a poor aroma, low vanillin content , overdried, undersized and poorly graded. However the Vanilla was subsequently developed on the Entebbe Estate. More attention has given to pollination, no more than 6-8 pods being allowed to develop per flower cluster, and more care was taken with curing. This resulted in a much improved product, which in the late thirties was realising prices of up to 15/- per lb compared with the 3/6d. per lb. at which the largest pods had been valued

in 1931. Production on a limited scale developed, and during the fifties varied between 1,300 and 6,400 lbs per year. Prices, although slightly lower, tended to keep pace with those of Madagascar and Seychelles Vanilla, the world's two major producers. This crop rose very rapidly to a position of some importance in Uganda when, in 1959 the first crop from a large new planting on a commercial estate happened to be available at the same time that disastrous weather conditions in the Indian Ocean much reduced normal world supplies. Due to high prices for the pods there was a considerable increase in planting, especially by non-estate small-holders. One Muganda is reported to have sold planting material worth 1,200/- to a European estate near Masindi. However, it was found in general that African small-holders failed to cure the beans properly, resulting in over-dried or mouldy beans being produced of low vanillin content.

Curing is a long and labour-consuming operation, taking up to 2 - 3 months to sun-dry the pods and it is only too easy to lose the entire crop during this long process. In an effort to get over the poor quality of small-holder beans, an outgrower's scheme was started on A.E.L's Salama Estate in 1960, beans being processed centrally. By 1962, 10 farmers had planted 300 vines and by the end of that year both farmers and vines had doubled. By 1963, 60 acres of vanilla were being grown at Salama although shortage of cuttings made expansion slow. However, by 1965 prices had fallen, farmers lost interest due to delays in payment and plantings were drastically reduced. As regards research, little has been done outside the two main estates, Salama and the Uganda Company's Lubowa Estate. When prices were good in 1960 there was a certain amount of planting, by the Department of Agriculture, at Kituza and Mukono with a view to conducting some agronomic studies. Planting material was multiplied as rapidly as possible but when in 1965, the Experimental Committee considered proposals for observation trials on this crop it was decided that these would serve no useful purpose unless a certain market could be assured for Uganda Vanilla for at least five years. Assurance was also required that the economics of the drop would justify the research time spent on it.

Agreement was reached to survey Vanilla growing on estates and small farms in order to find out just what kind of research was required. At the same time, a technical pamphlet was to be prepared dealing with the culture and economics of the crop.

Experimental work had, in the meantime, fortunately been progressing on the estates, especially at Lubowa. As a result of investigations over a number of years, recommendations can now be made on most aspects of Vanilla culture, such as choice and spacing of shade trees, bringing of the vines into flower, successful pollination proceedure and control of pod quality, the correct maturity stage for picking etc. But most important of all, the hazzardous curing process has been completely replaced at Lubowa by a revolutionary new mechanical curing and drying process. This technique was devoloped by McCormicks' of America after intensive research both in Uganda and in the States. This resulted in the establishmnet at Lubowa, of a vanilla factory, the only one of its kind in the world and a joint venture between McCornicks and the Uganda Company. The curing and drying process, which by traditional methods could take up to four months, now takes four days. Five men, the factory's maximum labour requirements can handle 1 ton a week of pods where traditionally fifteen men for approximately eighteen weeks would be required for a crop of the same size. Additionally, it has been shown that beans cured at Lubowa have a higher Vanillin content than those cured by conventional methods. With the hazzards of sun-curing and marketing removed, this has proved to be an

ideal small-farmer crop if the farmer and his family are prepared to do the labour themselve. There are two periods of intense activity March/April and September/October, but for the remainder slight slashing of weeds etc. is all that is required. Profitability is quoted as Shs 3,600/= per acre gross for any farmer who can maintain a production of 1 lb. green beans/ vine/year and this is expected to rise to 4,600/= per acre per annum when production expands at the factory.

McCornicks now purchases most of the plant's output, potentially 5 tons / week with present equipment, but with ample space for expansion.

Salama Estate still maintains 54 acres of Vanilla which is hand-cured by the traditional sun-drying method. In 1966, 2436 lbs of cured beans were exported, this dropping to 1,712 lbs in 1967 and 311 lbs in 1968 (the latter being due to hail damage at pollination time.) The World Market price for Vanilla at the moment is 27-30/- per lb at which price it is an attractive proposition, especially for an outgrower supplying to the Lubowa Factory.

Capsicums (Solanaceae)

There are numerous cultivated varieties, the naming of which appears to be very confused, but most have probably been derived from the following species:-

1. C. minimum /Birds Eye/
   Fruits are small and erect (Busoga type.) /Chillie/

2. C. fructescens /Goat or Spur Pepper/
   C. annuum /Capsicum or pod-Pepper./
   Pods are 3-4" long /Red or Chillie Pepper/

3. C. grossum /Green, Sweet, Bell or Bull-nosed Pepper/

C. grossum, although related to the smaller, pungent chillie-peppers, can be distinguished from them by the large, quite pungentless, hollow, succulent fruits These are round or oblong, much indentated, 3-5ins. in diameter and varying from deep green to orange, bright red etc depending an their stage of ripeness. When the ripe fruits are dried and ground they form Paprika of Commerce. This sweet or green pepper is not regarded as a spice but as a vegetable, and therefore will be discussed later.

Chillie or Chillie pepper is the general name usually given to the hot, pungent types of Capsicum. They usually enter trade as red sun-dried pod - like fruits which may be ground to give Chillie-powder which may in turn be mixed with other ground spicies to form Cayenne Pepper.

Chillies were already well established in Uganda at the time of Lugard's visit, he notes them as being particularly common in Busoga. They have always been considered a native crop, the fruits commonly being collected from semi-naturalised plants around the homesteads and in the banana gardens when prices are attractive enough. At times of high prices chillies have been planted quite expensively as a pure crop, but acreage, like price has always been subject to violent fluctuations, e.g.

Export Value	Year	Acres
£ 12,408	1913	10,000, in Busoga
£ 6,847	1919	173
£ 52,768	1922	2,163, of which 1,000 was in Mengo
£ 58,660	1923	18,795, 1,000 in Mengo 10,000 in Entebbe
£ 2,935	1925	3,530

In 1922, chillies were Uganda's third most valuable export, contributing 4.3% to the total value of export earnings. In 1923 they had dropped to fourth place and contributed only 2.45% to the total, whilst by 1924, this had dropped to only 0.9%. The reason for this, besides the obvious one of falling prices, was the rapidly increasing earnings from cotton.

Chillies are a dirty and unpleasant crop to pick, the fruits setting up a severe irritation of eyes and hands etc. and it is only at times of high prices that farmers can be induced to pick the crop, which otherways receives no input of any kind.

Uganda chillies are very pungent and therefore popular on the World Market, especially in the U.S.A. But as with so many of Uganda's exports, consignments are erratic in quality and, being unsorted, are of variable size and often mixed with large amounts of extraneous matter, needless to say this does not add to their popularity.

Little experimental work has been done on the crop, perhaps chiefly because the erratic prices have made it seem unlikely that the returns to research effort would ever be large or worth while.

In 1921 and 1922 at the time of high prices small trials were planted out at Serere, Bukalasa and Kakumiro, Mubende. Two varieties were tried, the small common variety from Busoga and a large red variety from India. Both grew successfully at Serere, seed sown broadcast in the open germinated well and seedlings were subsequently transplanted into bananas. The large-fruited indian variety was found easier to pick and had less of an irritant effect than the local Busoga type. Only one picking was made, most of the crop being left because of shortage of labour. This one picking yielded at the rate of 1,000 lbs/acre from a $\frac{1}{4}$ acre plot. By this time prices were again ebbing and no further

work was recorded until 1934 when seeds of two types of (large and small-fruited) Japanese chillies (said to be a variety of C. annuum) were imported from the U.K. There is now no distinctive recognised between these two types, except that they are either small or large i.e. they are not considered as distinct types. These seeds were sown at the Kampala plantation and although germination was not good samples of the dried fruits were later sent to London for evaluation. Both large and small fruits, when crimson, received very favourable comment, being valued at 40-45/- and 55/- per cent respectively.

Yearly sowings and selections of good large and small-fruited plants continued at the Kampala plantation into 1936 after which time no further mention is made of these trials. It is probable that the work was abandoned when the Kampala Plantation closed down at the end of the thirties.

Tittle further interest has since been taken in this crop.

The research needs of this spice seem not to be large.

Certainly, as far as agronomic practices are concerned, the crop seems to cultivate itself quite happily and with satisfactory results. Without any research expenditure at all much could be done to raise the crop's immediate value by a simple size-grading scheme which would at the same time eliminate broken fruits and extraneous matter. It seems unlikely that this crop will ever be completely free from price fluctuations but it seems that Uganda chillies have intrinsically desirable and marketable characteristics. If to this world renowned reputation for attractive pungency could be added that of consistant high quality, Uganda could produce a chillie which, in effect, was largely protected from substitution and which would be far less prone to the violent price fluctuations common on the open market.

There is one research priority however which is very pressing, and that is to alleviate the unpleasantness of picking. In this way supplies would be more constant and this would also help to iron-out price variations. At the moment very few farmers would contemplate growing chillies on a large, intensive scale as picking labour would be too difficult or too expensive to find. Indeed,

a common method employed is to uproot the whole plant, ripe and unripe fruits being threshed off together. This would perhaps be permissable if the plant-breeders could develop selections where all the fruits ripened together. Alternatively selections could be made for plants with readily detachable and therefore less irritating fruits. On the other hand, it would probably be much cheaper and just as effective to try and encourage the use of gloves in picking!

There is also scope for encouraging the use of the larger-fruited chillies which are easier and less irritating to pick.

As well as a good export potential there is also a local market for chillies but the size of this is difficult to assess In 1967 for example, as well as exporting £95 829 worth of chillies to overseas markets, (mainily U.S.A., Canada and U.K) Uganda exported chillies to Kenya worth £5,222. However in the same year £470 of Malaysian chillies were imported into Uganda together with £2,092 of Kenya chillies and £874 of Tanzanian. This rather paradoxical situation arises of out economic pressures. Uganda Food products alone, for example, imports 5 tons of dried chillies per month from Arusha and Kenya for use in curry powder, simply because they are far cheaper than the local ones. The expensive Masaka chillies are used when high quality is desired, as in the case of the whole dried fruit being sold. They would prefer to buy local chillies if economic, and in fact they will in future buy 10 tons a month, their total requirement, from the Stephen Carr - initiated "Church of Uganda School-Leavers' Scheme" near Hoima,Bunyoro. They are prepared to pay 60 cts per lb for these well dried and graded chillies. There is a Limited Market for chillies sold in their fresh, green state. Sereral firms have air-freighted these to London from time to time. Uganda Food Products used to export at the rate of 1,000 kilos per week, receiving 60 cts/lb c.i.f. London, but because production was erratic and quality ununiform, and with strong competition from Kenya, they stopped exporting this product. However, together with other firms they still export to Tanzania and Kenya, finding a ready and obviously lucrative market. There is now only one remaining Uganda exporter of fresh chillies to U.K.

A final word about yields. 300-400 lbs per acre is that given in the 1967 Crop Production Programme as an average figure which can be expected. By comparison, yields of 2,000-3,000 lbs/acre of dried chillies are expected in India as a minimum.

Other Herbs, Spices and Condiments have been tried in Uganda from time to time but without a great deal of success. The early work is summarised in Tothill (1940).

More recently there have been observation trials of a large number of herbs, many of which have been found to grow well in Kigezi. The local demand is not large and export possibilities are not exciting.

Senna observation plots were planted at Serere in 1964 and samples of pods and leaves were sent to Messrs. J.J. Coleman Ltd. for assessment. The samples received a good report and further seed supplies were therefore sent to 28 centres for further observation trials. Germination was generally poor and at 5 centres germination did not take place at all. Trouble has also been repeatedly experienced by losses from disease in the seedling stage.

Senna is regaining favour for use, in an encapsulated form, as a laxative. Apparently consumer companies are currently keen to develop production and one firm offered financial assistance for research on the crop in Uganda but this was turned down by Government.

Drug Plants: Research on local drug plants is currently actively in hand at the Uganda Natural Chematheropeutic Research Unit, Kampala. Investigations are still at an early stage and as yet recommendations of potentially valuable drug plants can not be made.

Essential Oils

These are volatile oils found in several thousand plant species all over the world. They derive their collective name from an earlier belief that the oils were essential to the plant. The currently accepted theory holds the opposite view that they are toxic substances produced by the plant as a bi-product of general metabolism, being then isolated from the plant tissue by layers of dead cells.

Essential oils are not true oils as commonly understood, main constituents being the terpenes, unsaturated alicyclic compounds which have little or no smell themselves, but act as carriers for other aromatic "smelly" compounds such as alcohols, esters, aldehydes and ketones.

Most of the essential oil-producing plants contain a complex admixture of many different, although chemically related compounds, that gives a natural essential oil its particular characteristics and value. It is for their smell, for use in perfumes, that essential oils are prized. In recent years, some of the commoner constituents of essential oils have been isolated and synthesised, a few of them on a commercial scale e.g., 'eugenol' of clove and cinnamon oils and 'Geraniol' of geranium oil. It would seem that in future, where such constituents can be synthesised easily and cheaply, 'synthetic smells' will dominate, at least on an industrial scale, albeit mixed with at least some natural oils. But for those oils which are valued for the subtleties which their minor constituents contribute and which will remain too expensive to synthesise, at least for a long time to come, there will remain a demand .

Extraction is possible by a number of methods.

1) Distillation, either from a water suspension of the plant tissue or by steam distillation, i.e. steam being passed through a dry charge of plant material; the volatile constituents in both cases pass with the steam into a receiving vessel where they are condensed and later separated.
This can be a relatively crude process.

2) Solvent extraction, in this process, dating from 1878, petroleum ether or other low-boiling solvents are commonly used. A percolate with the mascerated plant tissue is distilled at low temperatures, usually under vactuum, the 'smell' constituents coming over with the solvent which is then removed. When this process is used to extract spices, an oleo-resin results.

Enfleurage, a process known to the ancient Egyptians, involve extracting the essential oil into a solid or semi-solid fat by mixing it with the fresh plant material. The fat is then extracted by a solvent such as alcohol This process is little used today.

A summary of the early work on essential oils in Uganda can be found in Tothill (1940), and indeed little else remains to be said. Trials on many essential oil plants started in 1929 at the request of a British firm, the Chemistry and Botany sections of the Research Division collaborating. Many samples of many oils were sent to the Imperial Institute for evaluation but because of discouraging reports this work was discontinued in 1934 as being uneconomic.

Lemon Grass Oil (CYMBOPOGAN Spp)

There are two types of lemon grass oil, being produced from two different species of grass:

1. C. Citratus or West Indian Lemon Grass. This is not known in the wild state. The oil has an odour inferior to that of Cochin lemon-grass and the citral content is lower.
2. C. flexuosus, East Indian or Cochin Lemon Grass, this occurs wild in India and its oil has always attracted a higher price than the West Indian.

Besides the use of lemon-grass oil in perfumery, the oil is also valued for its citral content. In late 1940, Hoffman La Roche and Company, Switzerland, synthesised Vitamin A using the citral of lemon-grass oil as the starting material and this is now used as the citral source in the commercial production of Vitamin A. The only requirement of an oil so used is that its citral content should be not less than 75% by the ' Bisulphite Method'. Lemon-grass oil remains the only essential oil which has ever been produced in Uganda on a commercial scale.

Around 1900, Cymbopogan citratus was introduced from Kew and by 1907, 50 acres near the lake at Entebbe had been cleared of bush and planted with the grass as a tsetse control measure In 1908 the Government purchased a small still and erected it near the lake shore. A 600 lb charge of fresh grass was found to yield 26 ozs of oil. In 1909, over 1000 lbs. of oil were exported but consignments were uneven. Prices ranged from 2/3d to 2/8d, good East Indian oil in this year being 2/8d. In 1910 a further 1,000 lbs of oil was exported, valued at £72, and the industry was taken over by a commercial firm. However after a few years the industry lapsed.

Trials were ressumed in 1929 and reports from the Imperial Institute on samples of the oil were favourable. In simple trials to determine the effect of distilling fresh or dried material it was found that the dried material gave the greatest yield of oil. Trials to evaluate the effect of rust (Puccinia Cymbopogonis) on the grass showed that the disease had no appreciable effect on the yield of oil or its quality. Samples sent to the Imperial Institute in 1931 and 1932 both contained over 75% of citral. At this time it was thought that 25-30 tons per year of Ugandan oil would find a ready market, the Cochin oil being largely in the hands of speculators and therefore unpopular. In 1935 a large area of grass was planted at Kampala and showed that at least 30 lbs of oil per acre could be expected twice a year even on poor soil. Because of the interest shown by several commercial firms a trial was established at Arua. The yield of fresh grass after 9 months was found to be twice that at Kampala after 6 months, 105 lbs of fresh grass yielded 0.77 lbs of oil i.e. almost double the Kampala yield, and $\frac{1}{100}$ acre plot gave 284 lbs of fresh material as compared with 152 lbs at Kampala. Between 1936 - 38 trials progressed to determine the best cutting intervals which would give the greatest yield of grass and oil per acre. Cutting intervals of three months, six months and twelve months were tried. Results favoured six monthly cuts as this gave higher yields of oil with higher citral content; drying the fresh material for one week before distillation also raised the yield of oil. However it was considered at that time that it was not economic to produce lemon-grass oil in Uganda unless the c.i.f. London price was 3/- or more. As this price was only rarely reached, and then only briefly, it was decided to discontinue this work.

Interest did not revive until 1957 when the Uganda Development Corporation requested the Botanic Gardens, Entebbe, to propagate several thousand clumps of lemon-grass for planting at Salama. Samples of the Entebbe oil were subsquently sent to Hoffman La Roche, Switzerland, the Company which manufactures Vitamin A.

The citral content by the 'Bisulphite Method' was found to be 76%, all other specifications being met in every way. They expressed interest in receiving an offer when / sizeable quantities were available. A.E.L. therefore went ahead with plantings at Salama Estate, as a result of which the following information because available:

Spacings of 2 ft x 1 ins. at Salama and 1 ft x 3 ins. at Entebbe both proved successful but closer spacings could be tried to reduce erosion and leaching. In good soil at Salama the rate of multiplication of the stocks was 20-25 times in 9 months.

Propagation is by "splits", from which the upper grass and lower root pieces are removed prior to planting.

Cutting is usually with a sickle. The point of cutting does not seem to matter (although the 1929 Experiments showed the oil from the butts to be inferior in smell and citral content.)

Mechanical mowing could be introduced without difficulty.

Mulching gave no increase in yields of oil or citral

Intervals between harvest, at Salama, normally between 60-70 days throughout the year, the grass being cut when 2ft to 2ft 6ins high. The first cut is made 120 days from planting. Provided the grass is cut regularly, rust and browning are at a minimum except in dry weather. Long spells of dry weather considerably reduces the yield of oil but browning and rust have little effect.

Yields

Spacing 2' x 1" Planting date: 27-8-57

	Harvest Date	After x months	Yields in lbs/ acre of grass	Yield of oil in lbs/ acre	Av. citral %
Control	27-8-57	Nil	5,720	25.2(0.44%)	74.6%
(Drought)	9-10-57	1½	2,740	15.4	77.2%
	3-1 -58	4¼	13,930	34.9	75.9%
	27-3 -58	6	12,600	39.5	77.4%
	23-6 -58	9	16,820	55.0(0.33%)	78.5%
	27-8 -58	12	13,500	43.5	79.1%
	11-11-58	14½	11,740	44.7	80.1%

The highest yield for a single cut per year is clearly obtained after 9 months, the highest yearly yield being obtained by cutting from 3-4 times per annum. Citral content is seen to increase with age; the economics of cutting will therefore largely depend on the price differential buyers are prepared to pay for oils of higher citral content. The Uganda species of lemon-grass has anyway a lower potential for citral production than has the East Indian or Cochin lemon-grass, C.flexuosus. Therefore in 1964, when prices for this oil were high, it was decided at Government/Agricultural Enterprises liasion committee meeting, to import seed of this superior species from India. Seed received later in the year was planted at Kawanda and came to maturity in 1967. Representative portions of grass, when distilled gave a yield of 0.34% of oil. Tropical Products Institute analysis showed the oil to have a citral content of 93.2%, an exceptionally high figure. A later sample contained 85.9% citral and had the richness of odour typical of Cochin (East Indian) lemon-grass oil, the citral content also being considered as very satisfactory. Unfortunately, prices had by this time fallen again and experimentation and production were taken no further But now at least there is a supply of high quality planting material available in Uganda. If the price again rises it should not be too difficult for advantage to be taken of this, but production will always be of a speculative nature, suitable only for growers with sufficient resources to bring the crop into rapid production before prices again fall. Mechanization would seem a very apt and profitable way of doing this.

Geranium Oil (Pelargonium species)

"Geraniol", the major constituent of this essential oil is now synthesised cheaply on a commercial scale and has largely replaced the natural oil. Formerly, a cheap type of geranium oil was obtained from a species of Cymbopogan, only the much more expensive kinds being obtained from various Pelargonium species. Pelargoniums occur in the wild state in certain fairly dry regions of South Africa and it is from plants grown under dry conditions

that the best oil is derived.

In 1929 it was noted by Uganda's Botanist that many tons of geranium oil were exported from Reunion annually and he thought it it possible that the plant cultivated there (P.capitatum) might well be suited to Uganda conditions. The species grown at that time for essential oil production were:

France - P. radula

Algiers - P. roseum, P.odoratissimum, P. fragrans, P. capitatum.

Reunion - P. capitatum, P.graveoluns.

Those Distilled at Grasse, France, - P.Capitatum, P.radula var. 'roseum' and perhaps P.odoratissimum.

However, so many hybrids have been produced that there has always been some confusion as to names of species and varieties. Indeed introductions into Uganda of what were supposedly P.Capitatum, the most important of all the species grown were later indentified as P.radula and still later, found to produce an oil identical with that of P.graveolens grown in Kenya. But this may well be a case, as so often happens in essential oil production, of climatic and biotic factors having far more influence on the quality and composition of the oil produced than have the varieties or species used. Most of the Pelargorium species used in commercial production have been tried in Uganda from time to time but never with any notable success. Reports from the Imperial Institute, London, have repeatedly stated the Uganda oils to be similar in physical constants to the high -priced Algerian and Bourbon(Reunion) oils, but to be definitely inferior in odour. They have been valued only as equivalent to the 'Mawah' oil produced in Kenya i.e. 10/- - 14/ per lb. This again supports the suggestion that factors other than varietal ones have an over - riding influence on the composition of the oil. It must be said however that, with the exception of one introduction of seeds of plants distilled at Grasse, all introductions were made from other than the important centres of production,mainly from Kew. Because of frequent

Because of frequent hybridization and confusion in the naming of species and varieties, it could well be that those plants tried in Uganda were never of the exact type grown commercially in other areas. Additionally, apart from recent U.D.C. trials at Masindi, all trials have been conducted within the 'fertile crescent', yet the best geranium oil is known to be derived from plants grown under fairly dry conditions.

In the early work on geranium it was found that cuttings were hard to root. those from mature wood being more satisfactory This experience has been borne out by the U.D.C. and Uganda Company trials in 1963. Cuttings rooted poorly and in both cases the plants later died out; no further work has since been done on th on the crop.

Yields of 2 tons /acre of fresh material are quoted for Spain, the oil yield, under favourable conditions, being 0.1.% i.e. approximately 5 lbs of oil. Early trials in Uganda of P. radula yielded at the rate of 21 lbs of oil per acre on a single cut, three cuts a year being possible. The size of the trial plots other than being 'large' is not recorded.

Patchouli Oil (Pogostemon species)

This oil is used as a fixative in most perfumes and has no synthetic substitute. The oil is obtained from dried and fermented stems and leaves distilled in their country of origin. Tradition-ally, the best oil was obtained from Singapore patchouli, Pogostemon patchouli, an inferior oil being obtained in Java from P. heyneanus. Unfortunately it was plants of this inferior type which were introduced from Ceylon in 1929, although this was not known at the time. The physical constants and odour of Samples sent to the Imperial Institute in 1931 and 1932 were found to agree with those of the inferior Java oil and the original plants were therefore abandoned.

Seven plants of P. patchouli were then introduced from Singapore in 1933. These were repeatedly attacked by Pythuim species (a fungal disease)causing considerable die back but by 1935 419 lbs of fresh material was obtained, fresh and fermented leaves, on distillation giving 300 ccs of oil. The samples, forwarded to the Imperial Institute, received favourable reports, it being thought that they would find a limited market in competition with poorer grades of Singapore and Seychelles oil. At that time there was a plentiful supply of all grades of patcholi oil on the world market, interest in production in Uganda therefore waned.

Since Worl War II there have been intermittant difficulties in obtaining Indonesian supplies of patchouli oil whilst the market has been expanding rapidly due to increased sales of men's toiletries. The Indonesian/Malaysian crisis has increased these difficulties and prices have been rising since 1964. The crop is known to respond well to irrigation and the time would seem ripe for further introductions of P.patchouli although the pithium problem would have to be solved before commercial production could be contemplated.

Vetiver(Vetiveria zizanoides)

This oil is extensively used in high class perfumes, its persistent odour making it valuable as a fixative. It has no synthetic substitute thereby commanding as steady demand at between 50-60/- per lb for first quality oil. Dried roots were formerly exported to Europe for distillation of high quality oils. But more recently producer countries have distilled their own commercial oils, of lower quality than the European but selling at much lower prices. Java produces the best quality oil, a slightly poorer grade coming from Reunion (Bourbon oil). Vetiver was introduced with other essential oil plants in 1929 and was multiplied up rapidly. A trial plot dug up 7 months after planting yielded at the rate of 772 lbs of dried roots per acre (A yield of approximately 1,700 lbs per acre is exported in areas of commercial production.) Samples sent to the Imperial Institute for distillation and evaluation yielded 1.2% of oil on steam distillation.

Compared with 3.3% from other parts of the Empire and 4% from Java. Although the physical constants of the oil agreed with those of the European and Reunion distilled oils, its odour was not considered equal to that of the commercial oil from Reunion.

A further sample sent in 1933 yielded 1.8% of oil and it was considered that it equalled, in quality, that distilled in Europe from imported roots. However there was very little demand for this high-priced oil as commercial Java and Bourbon oils could be obtained for 25/= and 15/= per lb. respectively. It was pointed out that the quality of the oil was likely to fall if distilled in Uganda before export, distillation being a long and difficult process.

Samples sent for evaluation in 1935, from a red-leafed variety introduced from Kenya, received similar comment, that the oil had a very satisfactory odour and was commercially inferior or equal to Bourbon oil. Yields at 1.2 - 1.6% oil were still very low comparing unfavourably with Java industrial yields of 2 - 3 %. It was thought that if Uganda could sell the oil for a profit at 15/- per lb, then it would be safe to encourage production.

It was therefore agreed to put down a 1 acre plot at Kampala in 1938. Unfortunately there is a gap in the Botanist's records from 1939 - 1945 whilst he was on military service and no mention is made in the Annual Reports of this trial. The Kampala Plantation was in any case closed down in 1940.

In 1967, U.D.C. took a fresh interest in the production of this oil and a sample of dried roots was submitted to the Tropical Products Institute at their request. The oil content was found to be only 0.8% compared with 1.2 - 1.8% of previous samples. From the first trials of vetiver in Uganda a yield in the order of 1,400 lbs/acre of dried roots is indicated i.e. a yield of just over 11 lbs of oil /acre.

This compares unfavourably with Java industrial yields of 33-50 lbs of oil /acre. It must also be remembered that the Uganda oil has never been of the best quality and its commercial potential does not therefore seem to be exciting, its production advantage in Uganda being nil.

Other Essential Oil Plants

Tuberose, (Polianthese tuberosa)

Tuberose oil is contained in all high quality perfumes and is one of the most expensive of the essential oils. The demand is small and steady, there being no synthetic substitute. In 1930 a large plot of this was established at the Kampala Plantation and grew well. However, enflourage trials in 1933 were unsuccessful, being crude, and experiments with this plant were discontinued. This is one of the essential oil plants which has not had a fair trial in Uganda. Now that solvent extraction using petroleum ether has become widespread in the preparation of this oil, it deserves another try in Uganda.

Ylang-Ylang Oil (Canangium odoratum)

This is used in high grade perfumes; a second-grade oil which is a mixture of fractions, is known as Cananga Oil is less valuable. Traditionally the oil is separated from the charge of flower-heads by steam distillation but extraction with cold petroleum ether is now recognised as a satisfactory alternative. There is no big supplier of ylang-ylang oil, supplies formerly coming from the Philipines and Java etc. Where it is native. In these areas it is estimated that an acre planted with some 150 trees yields 3,000 lbs of flowers. 200 lbs of flowers are required to produce 1 lb. of essence. Plants are readily raised from seeds or cuttings and are said to come into bearing in their third year.

FRUITS

Citrus

Included in this well-known family are the sweet and sour orange, lemon, lime, grapefruit and mandarin or tangerine. Propagation is either by seed or by budding of good quality named varities onto more vigorous root stocks such as Sour Orange or Rough Lemon. For commercial production this latter method is used exclusively, much more control over quality being obtained in this way.

Introductions of citrus into Uganda began around 1900 when seeds of oranges, limes and lemons were received. These grew and fruited well, some of the better quality oranges being grafted onto other (unspecified) stocks. The plants raised in the early days were mainly from seed but they fruited abundantly and gained rapid popularity. They became widely distributed as a result of annual free issue of fruit trees from the Government Plantations at Entebbe, Kampala, Bukalasa, Teso and Toro and certainly in Buganda most native compounds contained one or two trees.

From 1929 onwards consignments of budded trees of good quality named varieties, were received from such places as South Africa, Ceylon and Australia. By 1935 the following wide range of budded varieties were established at Entebbe, Kampala and Bukalasa:-

Oranges: 'DU ROI;' 'WASHINGTON NAVEL', GOLDEN-BUCKEYE','PINEAPPLE', 'VALENCIA LATE', 'JAFFA', 'ST.MICHAEL',(BLOOD) 'MEDITERRANEAN SWEET'.

Lemons : 'LISSON', 'VILLA FRANCA'

Limes : 'WEST INDIAN' TAHITIAN', 'EAST INDIAN'.

Grapefruit: 'MARSH'S SEEDLESS', 'ROYAL', 'HATSU', 'NIPARU'.

Tangerines:'BEAUTY OF GLEN RETREAT', 'EMPEROR', 'JACOB'S IMPROVED THORNY'.

Plants introduced into Uganda from Singapore in 1934 were considerably slower to come into bearing; those established at Kampala, although making vigorous growth, had still not flowered by 1945. But according to Leakey (1967) there are some beautiful specimen Canangium trees on the Kampala golf course. He estimates that sufficient flower material is currently available to obtain samples for evaluation. Ylang-ylang oil is noted for its composition and qaulity being very greatly influenced by the environmental condition in which it is grown, evaluation of a Uganda-grown sample would therefore be an essential preliminary to production.

Notes on other essential oil plants tried Uganda from 1929 - 1934 can be found in Tothill (1940), further work on them being negligible.

In this year considerable trials were laid down at Entebbe and Kampala, these named trees being used as bud-wood for grafting onto seedling Rough Lemon, Sour Orange and Pomelo stocks. These were, with the exception of the tangerines, initially very succes- successful. Unfortunately subsequent growth on Pomelo and sour Orange stocks was poor, most of the plants became chloratic and stunted and finally died. By contrast , trees on Rough Lemon stocks made vigorous growth and it was concluded that this would in future be the most valuable stock for Uganda. Although it was known that scions on Rough Lemon frequently produced coarse fruit, it was considered that due to Uganda's land-locked position the export of citrus would never be large and this factor would never therefore be important.

These budded trees were subsequently planted out at Serere, Entebbe and Kawanda; by 1942 the citrus at Kawanda had started to fruit. Early indications suggested that none of the budded sweet orange varieties would produce fruits superior in quality to those of the local seedling , the budded trees being less vigorous and shorter-lived. Only budded grapefruit and Seville oranges were found to do well at Kawanda and by 1945 the Botanist's verdict was still that Uganda seedlings oranges were superior to any named variety that had been tried; "Washington Navel' was found to be poor whilst 'Valencia Late', a variety recommended for the tropics, was little better. None of the budded tangerines and oranges at Kawanda were as sweet as the seedlings, which, although slower to come into bearing, after 5 years were much larger and thereafter longer lived.

Distribution of fruit trees was still continued from Serere and Entebbe, although by now a charge had been introduced. The citrus were still largely propagated from seed, the few budded trees going to institutes and to fill gaps in the experimental orchards. Experimentation was almost entirely limited to observation and subjective assessment of fruit quality. Yield records were not kept and certainly at Kawanda, the orchard was not well maintained. It was also very poorly sited, drainage left much to be desired and the trees could not have been

helped by a road being cut through the orchard soon after establishment.

In 1954 the citrus at Kawanda was found to be heavily infested with the nematode, TYLENCHULUS semipenetrans, and this was later demonstrated at Entebbe but not at Serere.

Also in the same year, 'Quick Decline or 'Tristeza' virus was verified in Uganda. Because of eelworm and virus problems, citrus distribution from Serere was temporily suspended, seedlings at Entebbe were destroyed and seeds beds fumigated. Dead and dying trees at Kawanda were left as before.

Seedlings trees at Serere

In 1955, with the exception of limes, the trees did not appear to be very susceptible, all varieties were bearing quite well when suitably situated although it was thought probable that every tree was infected.

Grape-fruit, all trees showed severe stem-pitting and external uneveness of the bark although the disease did not apparently affect the vigour and cropping, good crops of fair sized fruit being regularly obtained from trees 20 years old.

Sweet Oranges, the disease was found not to affect this species at Serere.

Tangerines, Die-back and poor cropping occured in many trees although trees under good conditions showed little die-back and had fair crops. It seemed debatable that the disease was causing trouble.

Lemons. 3 out of the 4 trees appeared symptomless, the fourth showed severe wood-pitting.

Limes, showed severe wood-pitting, very reduced vigour, off-season flowering and fruiting etc.

Trees seemed capable of living almost indefinitely in a very weak state, producing a few fruits.

Sour Orange and Rough Lemon, symptomless.

Budded tress at Serere

Stock Sour Orange - Most species showed severe symptoms when on this stock

Rough Lemon - Most species showed marked tolerance on this stock but it was not much good for lime or grape-fruit.

Scion Orange - Intolerant on sweet lemon, sour orange and grapefruit. Tolerant on most sweet orange and rough lemon.

Lemon - Intolerant on sour orange

Grapefruit - Intolerant on both sour orange and rough lemon .

Lime - Somewhat increased tolerance on rough lemon

From the foregoing it was concluded that a mild strain only of the virus existed in Uganda and that its effects were not usually serious when the trees were grown under good conditions. The interaction of virus , eelworm and growing conditions has never been satisfactorily investigated in Uganda. Certainly the trees at Kawanda have always been much more severely affected than those at Serere but there has never been any attempt at Kawanda to grow citrus on a good, eelworm-free site under reasonable conditions of management. It is therefore impossible to attribute causal severity to one or other factor. In 1955, of the 103 trees in the main Kawanda orchard, 39 were dead, 28 moribund and the remaining 36 affected to such an extent that very little palatable fruit was obtained. The symptoms shown by the trees were however so similar to those described at Serere that it was concluded that the Quick Decline Virus was the main cause for debility. The senior Botanist at Kawanda appears to have tended to the belief that whereas a mild strain of virus existed at Serere a much more virulent form was wiping out his trees at Kawanda.

This is possible of course and something which could easily be tested by cross-inoculation. It seems much more likely though that the strains of virus were the same but that eelworm and poor growing conditions together with the virus had resulted in the synergistic symptoms so devastating at Kawanda. That both seedling and budded citrus were capable of good fruit production in other parts of Uganda was indicated in 1955 by the A,O. Bunyoro. Between 1941 - 1946 a wide range of citrus had been planted by him, both seedling and budded (on Rough Lemon) trees. Of the seedlings, all four mandarins fruited well and were very sweet. His four lemons were poor, the four limes had died as had six sweet oranges although two marmalade oranges fruited well. Of the budded trees, most of the sweet oranges were fruiting well and were very sweet: three Tahiti seedless limes and one March's seedless grapefruit also fruited well. Several varieties of oranges were said to be very sour, namely Maltese Blood, St. Michael (Blood) , Jaffa and Ceylon.

It is apparent that he had no virus problem as the budded limes, the most susceptible of the citrus, were fruiting well. In 1954, the Serere Botanist had suggested that efforts should be concentrated on improving the Uganda orange crop, mainly by budding. He proposed that investigations be initiated into stock/scion combinations of all citrus species with special reference to their tolerance to Quick Decline. The Experimental Committee of the Research Division meeting in 1954 decided to drop these proposals until the nutritional aspects of the crop had been studied in detail but recommended that Quick Decline and eelworm should be guarded against by establishing a new nursery at Serere on new land and grafting onto Rough Lemon Stocks.

Twenty-one budded varieties of citrus were consequently planted at Serere to be used as a future source of bud-wood; seedlings of Rough Lemon were also established for use as stocks. Large numbers of citrus trees continued to be distributed each year, the proportion of budded trees gradually increasing. By 1962 10,885 citrus plants were being issued from Serere, of which about 1,000 were budded sweet orange, and administration was becoming cumbersome. It was therefore decided that in future seedlings would be raised in seed boxes, 50 per box.

Each D.A.O would inform Serere well in advance of his District's requirements and on receipt, the seedlings would be planted at suitable centres, e.g. coffee nurseries, and sold from there. Serere would continue with all budding work. From time to time, as supplies of oranges have increased, enquiries have been made a about the possibilities of starting a small juice extraction and canning industry in Uganda.

In 1963 a graduate was sent by the Government, to study the Citrus Industry in Israel and in the following year an Israeli expert was called in to survey the possibilities for such an Industry in Uganda. It was considered that parts of Lango, Teso and North Busoga would be feasible areas for growing citrus. In other areas the lack of cumulative heat would be the limiting factor. It was thought that citrus of fair quality, although not the best could be expected. Grape fruit could reach good quality and good limes and lemons could be produced if disease could be overcome, demand for these anyway being small. He recommended that an Industry should be started planned to meet local demand for fresh fruit with export to neighbouring countries; also supplying a small processing industry. The amount needed for a small plant is 40 tons/day for a 100 days per year.

A Government nursery was therefore established at Kasolwe Busoga, in 1965. Bud-wood of good commercial varieties was imported from Israel and California and seedling Rough Lemon stock were built up. All the trees will be an on Rough Lemon although

it is considered by some that other stocks might be more suitable. Rough Lemon, although resistant to Quick Decline tends to produce coarse fruits. In the U.S.A. stocks such as 'Cleopatra' tangerine have been found to be just as resistant while not having an adverse effect on the fruit. Oranges are anyway not very susceptible to the disease and these will be the most widely grown fruits on the Government Citrus Plantantions. A start has already been made on planting the planned 150 acres of orchards in each of Lango, Teso and Busoga Districts, and as yet budded trees are only available on these Government Plantations. It is visualised that in their final phase, at least some of these plantations will be turned into settlement schemes.

Hereafter should follow a description of other Tree Fruits:- Mango, Avocado, Cashew, Pawpaw and others;
Non-Tree Fruits:- Pineapple, Strawberry, Passion Fruit and others;
Vegeteables:- 1) Indigenous (2) Exotic.
However time precludes anything but the briefest mention, and only those which are currently being investigated will be touched upon.

Pawpaw (Carica papaya)

This tree has long been grown in the wetter parts of Uganda where it is often found in a semi naturalised state. However early research interest was not in the fruit itself, but in the papain which could be extracted from it. Fruit trials amounted to little more than planting over a wide range of areas. Mountain pawpaws have been tried from time to time and although promising in the higher areas, their production has never received any subsequent encouragement. Recently trials have been started under Wurster at Makerere's University Farm with new improved varieties being tried. Of particular interest is the hermaphrodite variety "Solo" which has shown promise in Hawaii; this variety previously tried

at Kawanda proved to be of variable shape and size but of good flavour. The fruit at Kabanyolo is being grown under irrigation The pawpaw is a bulky and to my mind, pleasant but undistinctive fruit which would appear to have little export potential for a land-locked country like Uganda either in a fresh or canned form.

Macadamia Nuts

The Macadamia is a dessert nut indigenous to Australia, where together with Hawaii it is extensively grown. This crop has gained recent popularity in Kenya largely through the efforts of one nursery man who produces Macadomia seedlings. Seedling trees are however unreliable producers and work is currently in progress at Kenya's Horticultural Research Station to propagate selected trees by cuttings but this is a difficult process. Little is known of the Macadamia's cropping potential in East Africa as trees are slow to come into bearing. Trees start fruiting some four years from planting but full bearing is not reached until after about fifteen years.
Costs of establishment in Kenya are given as Shs.1,200 per acre. Returns to the grower are said to be Shs 1 per lb although retail prices of up to 20/- per lb have been quoted in the consumer countries. At the moment demand still exceeds supply but during the next 10 years it can be expected that the extensive plantings in Hawaii and Australia together with those in Kenya will all come into bearing and the position may well be reversed. Because of the wide-spread planting in Kenya, interest has been shown in Macadamia's as a potential crop for Uganda. Accordingly in 1961, two trees were planted at Kawanda and twelve at Kituza although they were given no special attention. The Kituza trees did badly because of poor transplanting. A further batch of 350 seedlings, ex seed from Queensland, Australia, was later planted out, but it is still too soon to assess their potential. The latest trial batch of seedlings have recently been planted by Wurster at the University Farm and are making good growth under irrigation

It will be of interest to watch their progress and the progress of the Kenyan trees in relation to world market prices.

Pineapples (Annas sativa)

No mention will be made of the historical trials. Suffice it to say that 'Smooth Cayenne' is currently in trial at Kabanyolo using a variety of mulches and irrigation versus non-irrigation.

Vegetables

Exotic. A great deal of work has been done a on 'European or Temperate' vegetables in Uganda in the last few years, especially by Will at Kawanda and Scherer in Kigezi. This work has concentrated by 'ad.hoc' trials, mainly on the evaluation of varietal suitability of vegetables for Uganda's various growing zones. In Kigezi, all those vegetable varieties available from seed-firms within East Africa have been tested whilst at Kawanda seeds have also been imported from many other countries. The aim of these trials has been to find varieties suitable in terms of yield, quality, and pest and disease resistance for Uganda conditions. Many hundred varieties have been tested with the result that a comprehensive list exists both for Kigezi and the lower attitudes, of the most suitable varieties of a wide range of temperate and sub-tropical vegetables. These are found in Will's "A Vegetable Growing Guide for Uganda" currently under revision, and Kigezi Vegetable Scheme's Annual Reports. The two controlling factors of vegetable production are day length and temperature. For vegetable growing in Uganda, with a 12 hour day throughout the year , short-day varieties must be selected. For this reason, American varieties are often more suitable than those from the U.K. but in any case, 'early' varieties are more likely to succeed.

Temperature is much influenced by altitude and in the cooler zones of Uganda at 6,000 - 7,000 ft. All temperate vegetables can be grown with relative ease, but rate of growth is slow. Some vegetables , such as garden peas, broad beans and globe artichokes will give economic returns only at heights.

Sub-tropical vegetables on the other hand, such as Egg Plants, Sweet Peppers, etc. are economical only at 4,000-5,000 ft. However, certainly for the amateur gardener or small-scale grower, much can be done by manipulation of varieties and judicial use of sprays to produce vegetables of all types in all zones, especially if irrigation is available.

A small (3/4 acre) market garden costings trial under irrigation is currently being run at Kawanda.

Large scale vegetable production, with its attendant trials by error, is currently undertaken by several estates, mainly Uganda Crane Estates (formerly B.I.C Estates) and K.K. Estates. Small quantities of fresh produce are exported both to Europe and to other East African countries.

Uganda Trade in Fruit and Vegetable Products

1967

Value of Imports from :

	Outside E.Africa	Inside E.Africa (mainly Kenya)
1. Fresh Citrus	£ 589	£ 2596
2. Mangoes		£ 1352
3. Pineapples		£ 2479
4. Other fresh fruit		£ 8139
	£ 589	£14,576 = £15,165
5. Fruit Juices (Passion, Pineapple, Tomato and others		£15,291
6. Plant propagation material (bulbs, seeds, cuttings etc.)	£5,000	£ 13,377
7. Cut flowers		£ 5,766
	£5,000	£19,143 = £24,143

(Continued)

		Outside East Africa	Inside E.Africa (Mainly Kenya)
8.	Potatoes	-	£ 6,5901
9.	Onions	£8,612	£ 61,948
10.	Garlic	£5,637	£3,977
11.	Other fresh Vegetables	-	£48,900
12.	Tomato Puree	£12,957	-
		£27,206	£180,726=£207,932

Grand total of imported fruit and vegetables which could be produced in Uganda = £247,250

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