INSTITUTE OF AGRICULTURAL RESEARCH

ETHIOPIA

PROSPECTS FOR HORTICULTURAL DEVELOPMENT AND RESEARCH WITH
PARTICULAR REFERENCE TO VEGETABLE CROPS

Report prepared for the Government of Ethiopia
by the Food and Agriculture Organization of the United Nations
acting as executing agency
for the United Nations Development Program

based on the work of
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INTRODUCTION

In accordance with the Plan of Operation of the UNDP Special Fund Project "Institute of Agricultural Research" which became operational in February 1966, the Food and Agriculture Organization of the United Nations appointed Mr. H. D. Tindall as consultant on vegetable production.

Mr. Tindall served on the Project from 1 to 27 April 1969 (Appendix I).

His terms of reference were:

To visit the main areas, actual and potential, of commercial fruit and vegetable production in Ethiopia and, in consultation with the Manager of SF Project ETH-7 and his team, draw up a plan for research work in these fields that would provide a basis for future development.

Owing to the relatively limited time available, it was not possible to visit all the areas in which horticultural crops are grown and the observations made are, therefore, based on information obtained only from the main production areas visited.

Acknowledgements

FAO wishes to extend its thanks to Ato Worqu Mekasha, General Manager of the Institute of Agricultural Research, for arranging the itinerary and for helpful discussion. Sincere gratitude is also expressed to the staffs of the Institute of Agricultural Research, the Ministry of Agriculture, the College of Agriculture, Alemaya and the Agricultural Institutes at Ambo and Jimma for their cooperation and willingness to provide information.

Ato Seyoum Solomon and Ato Asnake Woldeab were of great assistance in many ways during the travels; they showed much resourcefulness and ability on many occasions.
1. GENERAL COMMENTS

1.1 Consumption of Vegetables

The internal consumption of vegetables, per head of population, is lower in Ethiopia than in many other African countries; this is due to the somewhat unique and traditional food habits of many sections of the population.

There is, for example, an excessive consumption of carbohydrate in the provinces where "enset" (Ensete ventricosum) is a major item of diet, but a lack of calorie-producing foods in North Eritrea. The quantity of legumes normally consumed is insufficient to maintain an adequate protein balance.

Although there are indications that the rate of consumption of vegetables may improve, any appreciable increase is likely to occur only as a result of a rapid expansion of population linked with a wider appreciation of the nutritional value of vegetables. A drastic lowering in the retail prices of most locally grown vegetables is also imperative.

1.2 Objectives of a Horticultural Programme

One of the main objectives of any national programme of horticultural development should be the production of an adequate quantity of high quality vegetables and fruits for internal consumption. Since supplies to local markets may be regarded as reasonable, although linked with exorbitantly high prices, efforts towards improvement should be concentrated on raising quality. This may be partially accomplished by the introduction of new cultivars suited to the climate of the various producing areas. Attention could also be given to improving cultural techniques, in anticipation of a presumed increase in local demand. This may also serve to lower retail prices, although there are several other factors involved (see section 6).

Individuals in the private sector, also cooperative societies, should be encouraged to embark on commercial vegetable production for export. A growing export industry has already been established by foreign firms and individuals in perishable items such as sweet and hot peppers, egg plant, green beans and various spices, and it may be possible to induce Ethiopian nationals to initiate similar enterprises. The possibilities of developing an export trade in cut flowers should not be overlooked.
Although no direct encouragement can be given by the Government to vegetable exporters, these enterprises may serve as a stimulus to intending producers of export crops, although there would be competition for the most rewarding markets. The initiation of services such as those provided by the Ethiopian Airways for freight cargoes illustrates the kind of facility which must be available if any increase in the volume of horticultural crops exported by air is contemplated by either individuals or cooperative societies. Financial assistance to the latter group may initially be necessary for equipment, land and labour.

The value of vegetable products imported and exported is given in Appendix II. The export of vegetables such as tomatoes, garlic and frozen vegetables rose from 1964-1967, while that of green peas, onions and assorted fresh vegetables declined.

It is important to identify suitable markets. Previous outlets have been seriously curtailed as a result of political changes, and export by sea is difficult and uncertain. Air transport to parts of Saudi Arabia would appear feasible, and other neighbouring countries should not be disregarded as possible importers of Ethiopian vegetables, either fresh or processed. Crops which have a relatively large volume and limited value are suitable only for internal consumption, except for possible local exports by road, and it is only the high value produce which merits the expense incurred in air freight.

1.3 Literature

There is a scarcity of published work on horticultural crops in Ethiopia. Literature seen by the consultant is listed in the References. However, an appreciable amount of unpublished or unavailable work has presumably been carried out by the Ministry of Agriculture, the Haile Selassie I University, colleges of agriculture and other organizations, and there are indications that the volume of such reference material will appreciably increase during the next few years. More publications of an applied nature are urgently needed to assist with the work of training extension officers and in teaching horticulture as a subject in both Diploma and Degree courses.

1.4 Limiting Factors

Climatic factors and soil do not appear to limit the production of vegetables. Conditions in most areas are good; the main problems are, therefore, lack of market outlets, the existence of traditional constraints on price reduction and the difficulties of transporting produce from provincial producing areas to consuming areas such as Addis Ababa.
2. ENVIRONMENTAL FACTORS AFFECTING VEGETABLE PRODUCTION

2.1 Soils

The composition of the soils of the various experiment stations is being investigated by the Institute of Agricultural Research, and the general nature and characteristics of most of the soil types on which horticultural crops are grown is already known. Soil type and constitution do not appear to be a limiting factor in any of the vegetable producing areas. Most of the minor deficiencies which occur can be corrected by the application of methods of intensive cultivation.

2.2 Water

Vegetable production is dependent almost entirely upon the availability of irrigation water, since production throughout the year is generally desirable with most crops which are not sensitive to seasonal variations in temperature or excessive rainfall. Dry season cultivation of vegetables without some form of irrigation is very limited.

Most of the production areas visited either had adequate irrigation water, or a potential water supply during the dry season.

2.3 Temperature

Although day temperatures appeared to be relatively high throughout the year, and particularly in the dry season, this does not materially affect the range of crops which can be grown in Ethiopia. Most temperate type vegetables in cultivation were seen to thrive well, and only temporary mid-day wilting of Brassicas and other large-leaved crops was observed. In some areas, the diurnal variation in the day-night temperature range was probably conducive to the growth of many temperate type crops. Only those crops requiring relatively constant high temperatures, such as okra, do not thrive in areas subject to low night temperatures.

The topographical variation in Ethiopia is very marked and the variation in temperatures occurring at different elevations has considerably influenced the range of crops grown.
3. CULTURAL PRACTICES

High quality crops are produced in many areas; in others the lack of quality may be regarded as a reflection of the cultivation methods rather than as limitations imposed by the imbalance of environmental factors.

3.1 Soil Preparation and Planting Systems

Smallholdings are entirely dependent on manual cultivation, and the soils of the intensively grown crops in the Addis Ababa area are prepared with hand labour only. Large-scale commercial production of crops such as sweet pepper depends on tractor cultivation, usually with disc ploughs and harrows. Between these two extremes, the preparation of land is largely by animal-drawn ploughs, usually of a primitive type. Traditional customs of land tenure are the main barrier to mechanization.

Many crops of short duration are grown on the flat, the soil being cultivated to give a fine tilth. This system is used particularly with pepper in areas of moderate rainfall, where the crops are established in the rains and come to maturity during the dry season.

With dry season cultivation, where furrow irrigation is usual, the crops are planted at the sides of ridges 8-12 cm high; access paths are left at intervals. Rotational cropping is practised by progressive growers; also intercropping using short and long duration cultivars of two different types of crop.

3.2 Seed sowing and transplanting

On the College Experiment Stations at Alemaya and Debre Zeit, vegetable seedlings are raised in seed boxes; commercial growers usually use raised seedling beds for all crops which require transplanting.

In areas where new crops were being introduced some errors in method were observed, i.e. carrots were being transplanted. Some large-scale commercial holdings devoted mainly to pepper production relied mainly on direct drilling, but there appeared to be a need for transplanting machines so as to economise on seeding rates and ensure uniformity of growth.
The practice of successional sowings to extend the period during which crops are available for market was not widely practised; this was unexpected, since most commercial producers aim at supplying markets over as long a period as possible.

Traditional systems of shading transplanted seedlings with lath or woven grass screens are widely used by small-scale producers.

3.3 Spacing and Planting Density

Planting distances for vegetables were generally adequate, but some crops, including those grown on experiment stations, were incorrectly spaced. Trials and experiments are necessary to ascertain the optimum planting distances for many of the widely grown commercial crops. Also more information is required on the most suitable periods for sowing and planting in the different climatic areas. This is linked with the need for data on the duration of the growth period and time to maturity of different cultivars of crops which are likely to be suitable for export.

3.4 Fertilization

The use of fertilizers on vegetable crops is limited in most producing areas, reliance being placed on the addition of animal manure to retain soil fertility. Since adequate supplies of manure are available at comparatively low cost in most producing areas, the fertility of the soils in the areas visited appeared to be adequate. Deficiencies were rarely observed in vegetable crops, although they were frequently seen on fruit trees, particularly citrus.

Owing to the high cost of imported fertilizers, it is doubtful whether a wider use of artificial fertilizer should be advocated, but should commercial production become more widespread, it will be necessary to supplement organic manure with compound fertilizers if yields are to be maintained at a satisfactory level.

3.5 Plant Protection

Very little evidence of serious outbreaks of pests or diseases was observed. Many growers, particularly those involved in large-scale production, were familiar with insecticides such as DDT, BHC and malathion; also fungicides such as Bordeaux mixture, and used these fairly frequently. More recently developed types of pesticide were rarely seen.
Leaf fungi such as Septoria, Peronospora, Phytophthora and Erysiphe were observed to attack plants of the Solanaceae and Cucurbitaceae, but rarely were crops seen to be affected to the extent of rendering the produce unmarketable.

The absence of diseases such as bacterial wilt (Pseudomonas solanacearum) and nematodes appeared remarkable, particularly in areas where peppers and tomatoes had been grown in successive seasons without any strict rotation.

Although many diseases which were not seen may become more prevalent during the wet season, plant protection did not appear to be a factor preventing the further development of vegetable cultivation.

There is, nevertheless, a need for more information on the life histories and cycles of insects and diseases which attack vegetable and fruit crops, so that recommendations can be made on the application of preventative and control measures.

3.6 Irrigation

Sprinkler irrigation systems are in use on experiment station farms, but furrow irrigation is generally used by both large-scale enterprises and small-scale producers. The techniques involved in furrow irrigation are well understood in all areas visited and, although the frequency of irrigation and the quantities applied were somewhat arbitrary, few crops appeared to be subject to water stress.

Most of the large commercial holdings visited had adequate water reserves, although it was obvious that more strict supervision of water rights will become necessary as intensive crop production increases; water requirements for irrigation purposes are likely to come into competition with the domestic and industrial needs of the expanding urban areas.

In some areas, particularly Alemaya, the salt content in the irrigation water may lead to crop injury. No definite information was available, and although saline or alkaline soils were not seen, there is probably a need to investigate the effect of salt accumulation in soils in some areas which are subject to frequent irrigation during the dry season.
3.7 Weed Control

In many of the areas visited, annual weeds, including many grass species, were competing with young plants for nutrients and water. Traditional hand methods of weed control are widely used, and the application of herbicides was extremely limited. On intensively cropped smallholdings there is no apparent justification for a change from the accepted methods of weed control, but on large commercial plantations there is a potential need for the introduction of herbicides as a means of reducing production costs.

More information must be gained on the annual and perennial weeds occurring in the areas of active commercial production of vegetable crops, accompanied by experimental work to investigate the effectiveness of commercially available types of herbicide.

3.8 Soil Conservation

In the Harar and Asmara areas, there are good examples of the practical application of the techniques of soil conservation by contour terracing and contour planting, but in many other parts of the country the problem of soil is extremely serious (Pereira, 1968).

Vegetables are normally grown on the relatively flat alluvial soils occurring at the bottom of valleys where there is less need to conserve soil, but there are many upland areas suitable for the development of annual crop production where soil conservation should be considered as a priority measure.

Mulching, to conserve soil and promote the growth of vegetable crops in other ways, is not apparently practised to any appreciable extent. The reasons for this are not obvious, since there is normally no shortage of suitable organic material during either the dry or wet seasons.
4. CROPS IN CULTIVATION

Visits were made to the vegetable market and retail shops in Addis Ababa; also to market gardens near the capital and in the areas included in the itinerary (Appendix I).

The crops commonly grown are listed in Appendix III. No attempt has been made to divide them into kitchen garden or commercially grown crops, since almost all of those included were offered for sale in either the markets or retail shops.

4.1 Cultivars

In many of the areas visited, the quality of the crops grown was of a high standard, but in some instances the cultivars chosen were unsuited to the climatic environment. This was partly due to a preference for established sources of seed, despite the indifferent performance of the cultivars supplied, and also to a lack of contact outside Ethiopia with seed firms able to supply seeds of cultivars adapted to a tropical environment. Also, in some instances, vegetable growing was a comparatively new activity, and experience with the performance of a wide range of cultivars had not been gained by the grower or supervisor of the project.

Although many of the vegetables which grow well in Ethiopia are normally regarded as "Temperate" or "European" vegetables, cultivars which are adapted to a short daylength and high temperatures are essential for optimum results. Seeds which fulfill this requirement can be obtained from firms in neighbouring countries such as Kenya, and the U.S.A., although some cultivars from European sources are not unduly sensitive to daylength and will give excellent results in sub-tropical and tropical conditions.

A list of cultivars which have been found to be well suited to the conditions existing in the Alemaya area is given in Appendix IV. Many of these are from the U.S.A., although successful results have recently been obtained from seeds supplied from Kenya.

4.2 Introduction of New Cultivars

Although it was not possible to ascertain the true names of the cultivars grown by individual market gardeners, the range appeared to be limited to relatively few well established cultivars which had given satisfactory results in specific areas. There is, however, a need to explore more fully the performance of some of the new high-yielding cultivars of commercially popular vegetables; to achieve this objective, the establishment of adequately supervised trials of cultivars in different climatic zones is essential.
Such trials should assess not only the general vigour, quality and yield of the introduced cultivars, but should also aim at an assessment of disease and pest resistance, response to fertilizer application and varying irrigation regimes. Performance should be compared with that of established cultivars and at least three successive crops should be studied before any definite recommendations are passed to the individual grower through the Extension Service.

4.3 Seed Production

The purchase of seeds from neighbouring countries is an acceptable expedient to make valid comparison with the performance of cultivars which are already grown in Ethiopia, but reliance on outside sources of seed is not a viable long-term policy.

Several regions of the country are favourable for seed production, such as the highland areas near the capital for the "Temperate" or "European" types of vegetable and lowland areas with elevations of 300 to 800 m for the growing of temperature-sensitive crops such as okra, egg plant and sweet pepper.

A vegetable seed production project would require the supervision of a qualified plant breeder, but the capital outlay for buildings and equipment would be minimal. Glasshouses would not be necessary, unless specialized breeding programmes were undertaken, since most of the crops could be grown in field conditions. Mobile tygan or nylon mesh screens could be used for small areas of crop requiring isolation from insects.

A food technologist will be required to investigate the problems relating to canning and processing, since most of the local technical expertise on this subject has been developed in the commercial sector.

The adoption of forms of processing other than canning, such as dehydration, drying and preserving, should also be investigated. These techniques can be applied to some vegetables and fruits, particularly those with a seasonal harvesting period.

The exports of frozen foods have recently increased; this is a potentially important development which could be actively investigated by a food technologist.
5. PROCESSING

New export outlets for vegetable crops may be difficult to arrange in the immediate future, owing to political and other considerations, and since the internal rate of vegetable consumption is not likely to rise rapidly, the canning and processing of local produce is a possible alternative to stimulate an increase in production.

The canning of carrots, beans, peas, beetroot, tomato paste and other vegetable products is already an established commercial practice in the Asmara area, and this produce should sell at a lower price than that of similar imported goods.

Although the cost of importing sheet steel for the assembly of cans is expensive and the installation required for a canning plant will require an appreciable amount of capital expenditure, consideration should be given to the possibility of establishing one or more relatively small government-sponsored canning factories, capable of dealing with a variety of vegetables and fruits. These should be financially profitable if commercial methods of organization and supervision are employed.

In addition to the vegetable products already being canned, consideration should be given to the local production of fruit juices from citrus, also canning citrus and other fruits for which there is a good demand in Europe.

To verify the viability of this proposal, a survey of potential export outlets, together with an assessment of the extent to which internal consumption could be increased, will be necessary. This could involve the services of an agricultural economist for a short period. Coudert (1969) gives the dates of possible export of crops to Europe, including fruits and vegetables.
6. ECONOMIC FACTORS AND MARKETING

6.1 Introduction

The limited internal demand for vegetables has apparently favoured the establishment of extremely high retail prices for most classes of temperate-type vegetables. Labour costs are relatively low and growers whose main market is Addis Ababa have not yet adopted techniques such as overhead irrigation and the use of fertilizers, which could involve them in expenditure of capital. It was not possible to ascertain the extent to which transport costs influenced the retail prices; but for local growers in the Addis Ababa area these could not be exorbitant owing to the short distances involved in transporting produce from the holdings to the market.

The quality of the produce displayed, particularly in the Addis Ababa market, was good, and rather higher than that of many other African countries, but this did not appear to justify the excessive prices charged for many items.

No information could be obtained concerning the prices paid to growers, but it seems unlikely that they were receiving excessively high rates from the wholesale traders, who, in many cases, were also retailers. From information gained from some retail traders, they may either visit holdings and purchase produce from the grower direct, or have regular contact with individual producers who supply them with required items, usually at fairly short notice.

Some retailers have their own market gardens. There appeared to be no formal "contract growing" procedure established between wholesalers and producers in the Addis Ababa area, although this existed elsewhere, i.e. Asmara, where the emphasis was on the export of perishable produce, the local retail trade being relatively limited.

One of the main reasons given for the excessively high retail prices was that most of the dealing in fresh vegetables is in the hands of one group of traders, mainly belonging to the Guragehie tribe. They appeared to control the retail price by mutual agreement, there being no official government regulations applicable to price or quality control. Further investigation of this subject is essential, since no statistical information on production, transport and marketing costs is available.
6.2 Contract Growing Schemes

This practice of contract growing schemes has become established in the larger commercial enterprises, such as those concerned with the extraction of colour pigments from peppers and other crops and the export of fresh vegetables, particularly sweet peppers, to Europe and neighbouring African territories. The growers in these schemes receive regular advice on cultivations, their seed and fertilizer requirements are supplied on favourable terms and many members of such schemes have been able to purchase their own machinery with advances made by the purchasing firm. The success of one such contract scheme may be assessed by the fact that there is now a waiting list of applicants from several parts of the country wishing to take part.

This marketing system is a fairly advanced one, and although at present it has a limited application, being concerned only with large-scale undertakings, it should be possible to extend the practice to the less sophisticated small-scale commercial producer. The existing schemes may well be taken as viable examples of this type of production and marketing, and the experience gained applied to similar units.

6.3 Cooperative Societies

The only effective cooperative venture seen which was concerned with vegetable selling and distribution was the Cooperative Producers Society at Alema, originally sponsored in 1964 by the College of Agriculture as the Cooperative Marketing Research Project. A wide range of vegetables is handled by the Society, including lettuce, carrot, leek, beetroot, Irish potato, local onion, sweet pepper, globe artichoke, celery, parsley, pumpkin, cabbage and green beans. Fruits such as grapefruit, mandarin, lime and banana are also purchased. The members, numbering 600, transport their produce to the Society's packing installation, where it is washed, graded and packed for dispatch. Produce is required on two days in the week. At present, the main outlet is Djibouti, the Society having a contract with the French military forces there. The members are paid for their produce on a monthly basis, the prices they receive being slightly higher than the local market prices which are ascertained by a weekly survey. The Cooperative supplies seed and fertilizer, the costs of which are deducted from payments made to members. This type of venture could, with advantage, be initiated in other parts of the country where there is an outlet for local produce. Contracts could be arranged with hotels, restaurants and other commercial or government organizations which have fairly regular demands for supplies of fresh vegetables and fruit.
Associated with this Society is the Crop Irrigation Scheme, also at Alemeiya. Many of the members of this Scheme also belong to the Cooperative Producers Society. The 32 members of the Irrigation Scheme are at present producing crops of Irish potatoes, tomatoes and cauliflower, but difficulties are likely to arise if crops surplus to the requirements of the Cooperative Producers Society are grown. The only alternative to this situation may be the initiation of a small canning plant at Alemeiya and a concentration by the growers on crops which are suitable for canning or preserving.
7. PRODUCTION AREAS AND POTENTIAL DEVELOPMENTS

This section of the report is based on brief visits to the areas listed. More information is needed to qualify some of the statements included below.

Addis Ababa

A large vegetable growing area, within a few miles of the capital, supplies many of the perishable crops sold in the markets and retail shops. Both the growing and marketing of this produce appears to be monopolized by the Guraghe tribe, whose members are hard-working and generally possess a good commercial outlook. A wide selection of crops is grown, including cabbage, spinach, beet, kale, lettuce, beetroot, carrots and potatoes. During the rainy season, emphasis is placed on root crop production.

Comments on the marketing problems arising from the existence of this virtual monopoly have already been given. Until some form of price reduction or control is achieved for produce sold on the Addis Ababa market, possibilities for stimulating any increase in production are limited. The introduction of cooperative societies concerned with both production and marketing is desirable, but will be difficult under existing conditions.

Ambo and Guder

The prospects for encouraging vegetable production in the Ambo and Guder areas appear limited; there was little evidence of interest in any horticultural crops except grapes and citrus.

Bako

Good possibilities exist for developing large-scale production of sweet peppers and maize. Garlic grows well in the area and production could be stimulated as a potential export crop. Many other kinds of vegetables grow well in the Bako area, but transport is a limiting factor.

Debre Zeit

Despite the comparatively good road service to Addis Ababa, there does not appear to be much interest in horticultural crops in the Debre Zeit area, although there are a few good holdings and tomatoes are produced successfully.
Woliso and Chibbo Valley

Tomatoes are grown by small-scale producers. These were not staked and some crops were diseased and possibly affected by sun-scorch. The most interesting crop of the area was Solanum muricatum (Melon pear). This could be a possible crop for export to Europe, since it commands a good price and supplies appear limited at present.

The large-scale commercial plantation in this area, devoted mainly to pepper cultivation, was well managed with adequate equipment for soil cultivation, seed sowing, weed control and irrigation. As this relatively new plantation becomes more established, it may be possible to encourage local farmers to cultivate peppers and to follow this example on a modified scale. The formation of a cooperative society for marketing the produce would be a logical sequence of any such development.

The growing of perishable vegetables for Addis Ababa markets has little prospect, owing to the relatively high cost of transport as compared with that of areas closer to Addis.

Awash River

The Awash River area is receiving considerable attention by various Ministries and there are signs that agricultural development is not being neglected; the results of the Institute for Agricultural Research at Kolka Werer will stimulate this progress. The soils of the area are fertile, but the development of irrigated vegetable crop production is unlikely to be profitable, with the possible exception of crops which can be transported with special packing, i.e. maize, French beans, onions, peppers and peas.

Citrus, pineapple and other fruit trees should do well.

Harar

The distinguishing characteristics of Harar province are a high standard of cultivation of existing crops, linked with a remarkable development in soil conservation techniques. The main crop until recently was "Khat" (Catha edulis), the cultivation of which is declining rapidly due to the imposition of restrictions by countries which were traditionally importers of this stimulant.

Diversification, leading to the establishment of an alternative crop, or preferably crops, is urgently needed in the area, and it is likely that the soil and climatic conditions are conducive to the successful growth of a wide range of annual and perennial crops.
The topography requires that any replacement crop for khat should be adapted to intensive cultivation on fairly small holdings.

The selection of a replacement crop is less a cultural problem than an economic one, since it is essential to choose an exportable commodity which gives adequate financial return without requiring capital investment by the grower in processing equipment. Should processing be required, and if other conditions are optimal, the organization of a cooperative processing plant may prove a solution.

An oil- or protein-producing crop would appear to be an appropriate choice, and consideration should be given to the initiation of field trials with selected annual crops such as soybean, peas and other legumes, sesame and sunflower.

Coffee is already established as a perennial crop and is suitable for growing on contour terraces in small plots, but the expansion of the area under coffee is not likely to improve the financial position of the growers significantly. Olive, castor oil bean and other oil-producing crops such as "Aciutuno" (Simaruba glauca) should be considered as potential perennial crops. The development of a fruit crop industry should be actively pursued. Citrus, guava, passion fruit, bananas, mangos and pineapples are possible fruit crops. Avocado pear is already established in the area and shows a satisfactory growth under local conditions. Mature trees were observed to be bearing extremely heavy crops; these were "West Indian" selections and it would be desirable to introduce "Mexican" cultivars for trial.

Vegetable cultivation on the alluvial valley soils, where there is adequate water, would present few problems, but the limitation would be the lack of suitable transport and marketing facilities. Non-perishable root crops could, however, be given trial, and also onions. Onion cultivars with large flattened bulbs such as "Early Cape Yellow Flat" have good storage qualities if correctly matured, and this crop would presumably command a good price in Djibouti or Saudi Arabia. The establishment of a large-scale onion industry, preferably organized on a cooperative basis, would be one stage towards crop diversification.

To assess the performance of these proposed crops, a field trial station should be established to assess the potential usefulness of annual crops grown in the Valley soils and of perennial crops for upland conditions.
Alemaya

Alemaya is the only provincial area of those visited in which vegetable production has become firmly established as a local industry. The Alemaya market was well supplied with vegetables such as sweet corn, local shallots, bulb onions, leeks, beetroot, lettuce, carrots, cabbages, cauliflower, celery, squash, Irish potatoes, garlic, globe artichoke, sweet and hot peppers, sweet potatoes, dwarf French beans and tomatoes, all of good quality. The market is well established, supplied by local growers working on either a part-time or full-time basis.

The presence of the College of Agriculture and the Cooperative Producers Society is a factor which has given active encouragement to the development of this industry, and it is probable that further expansion of market gardening in this area could be promoted if adequate outlets for produce can be found. A local canning industry would partially solve this problem.

Erer Gota

Apart from the vegetables grown on the Haile Selassie I Prize Trust Farm, production in this area is limited and an extension of the cultivation of annual food crops does not appear to be warranted owing to the lack of transport and limited market outlet.

Jimma

Established crops in the Jimna area, apart from the traditional one of coffee, are maize and pineapples; though it might be possible to develop vegetable production, the level of consumption of vegetables is low and the prospects of exporting fresh vegetables from the district are poor.

The production of fruits would present few technical difficulties since the soils are generally fertile and there is adequate rainfall in most of the province; but the problems associated with transport and marketing are considerable. One pineapple plantation has already been established in the savanna area; the cost of a fruit of "Smooth Cayenne" at this farm is Eth.$ 1.50 and these fruits command a retail price in Addis Ababa of Eth.$ 2.50 1/.

Tea cultivation in the higher rainfall areas could probably prove successful, but trials would be required to select suitable cultivars. Acceptance of the crop by local smallholders would involve a considerable extension programme.

1/ Eth.$ 1 = US $ 0.40103
The occurrence of two indigenous or naturalized spice plants, *Aframomum kerarima* and *Piper longum*, in the rain forest at an elevation of 1,700 to 1,800 m could lead to the development of a minor local industry if the economic value of the fruits could be assessed and compared with the costs of collection and drying. Large-scale planting of one or both of these crops would be a logical future development if initial attempts to promote these crops for export were successful. Coriander (*Coriandrum sativum*) is another herb which grows well in the Jimma area.

**Asmara**

The export of fresh and processed vegetables from Asmara is well established and there are indications that both the volume and value of these exports are increasing, despite the recent increase in air freight charges from Eth.32 cents/kg to 80 cents/kg. One commercial firm recently exported 12,000 kg of sweet peppers in one month; this can be regarded as an indication of the volume of air freight exports.

Some wholesale dealers and exporters have their own farms and others rely on regular supplies from known sources, and there does not appear to be any real shortage of vegetables in the province. The quality of the perishable vegetables for local sale by the wholesalers was variable, but this could be due to the selection of the better quality produce for export to Saudi Arabia and other nearby countries. The fruits and vegetables produced by small-scale growers and offered in the open market were, however, of good quality, particularly the onions and tomatoes. One fruit of squash displayed for sale weighed 30 kg.

Vegetables regularly exported by air include sweet and hot peppers, egg plant and French beans. Others which are only available in certain seasons include melon and squash. A proportion of the local produce is supplied on contract to the nearby U.S. air base; items required have to meet definite specifications.

Many vegetables are produced some distance from Asmara. There is, for example, an onion-growing area at Keren which is 100 km from Asmara, but this was not visited. Garlic produced in this area is of good quality and could presumably be developed for export. Previous consignments sent to Europe were apparently satisfactory, but the export of this commodity has ceased and no serious attempt has been made to revive it.
Large-scale commercial plantations exist near Asmara; one at Ghinda was concerned mainly with the production of tomatoes, sweet peppers and egg plant. The crops were irrigated by a sprinkler system.

No visits to small-scale growers were possible, but one progressive commercial grower on a medium-sized holding had effectively developed a system of intercropping a wide variety of vegetables between fruit trees, mainly peaches. The vegetables were all grown from seed from the U.S.A., imported annually, and the vegetables were exported through a wholesaler to Saudi Arabia.

Although most of the recent vegetable production in Asmara has been sponsored by large-scale commercial interests, there is nevertheless an effective production of good quality vegetables by private individuals operating on a small-scale. The productive capacity of these growers could be stimulated by advice on the growing of new cultivars and the application of improved growing techniques. The establishment of a cooperative system of marketing would also be an advantage.

To obtain adequate information on the behaviour of new cultivars in the area, a trial and observation station should be established, possibly on a Ministry of Agriculture station.
8. TRAINING AND EXTENSION

Many of the extension officers appointed by the Ministry of Agriculture have been trained to Diploma level by the Agricultural Institutes at Ambo and Jimma. These have recently become separate institutions, teaching a 2-year course in general agriculture; they were previously linked by a common syllabus and provided preliminary training for the College of Agriculture at Alemaya. There is an in-service training period, after the award of the Diploma, before final acceptance by the Ministry for a permanent appointment.

Students taking these Diploma courses in future years may be given the opportunity of remaining for a third year of study in a specialization subject such as animal husbandry and crop production. Horticulture should be considered as a subject for specialization, if this proposal is approved.

8.1 Colleges and Institutes

Horticulture is a relatively minor subject in the curriculum of both Institutes, although both have adequate land and facilities for teaching horticultural science and the practical applications of both fruit and vegetable cultivation.

Training of horticultural extension workers will become increasingly important if the recommendations made in this report are accepted, and the possibility of instituting special courses in horticultural subjects, linked with the application of visual aids and other extension techniques, should be considered. Suitable training could be given at the College of Agriculture, Alemaya, which is sited near an existing market gardening industry and where facilities for horticultural training are already well established.

For degree standard graduates of Alemaya who wish to become specialist officers in horticultural extension work, a special postgraduate course could be instituted, and for non-graduate technical field staff a more applied course could be arranged at Alemaya, recruitment being from Diploma students from either Jimma or Ambo Agricultural Institutes. Both courses would also be available as in-service training courses for established staff of the Ministry of Agriculture.

These courses could be of 3 to 6 months in duration, and would include an appreciable proportion of basic extension methods training in the curriculum, in addition to adequate emphasis on the techniques used in modern horticultural crop production in tropical and sub-tropical areas.
The initiation of any such course would depend on the degree to which the Ministry of Agriculture can support this proposal, since this Ministry would be concerned with the employment of students who successfully completed the courses.

8.2 Extension Programmes

It was not possible, in the time available, to hold discussions with the Extension Department of the Ministry of Agriculture, and only limited contact was made with extension officers in the field.

The pursuit of an active research programme by the Agricultural Research Institute is of high priority, but this should also be accompanied by a well organized and technically equipped extension service. Most of the horticultural development in Ethiopia is in the commercial sector and is concerned mainly with the export of fresh and frozen vegetables, spices and the production of crops for canning and other forms of processing. Most of the firms and large-scale individual growers concerned in this form of enterprise have their own technical staff and extension workers to advise on sowing planting dates, fertilizer application, plant protection, quality standards and grading of produce. They also provide seed of cultivars which give an acceptable yield and quality under local conditions. It was apparent that many of these large-scale producers were, nevertheless, willing to receive technical comments from the Ministry Extension Service staff and it was assumed that cordial but unofficial contact was maintained between the Ministry field staff and the technical supervisors of commercial estates.

Small-scale producers, however, appeared to have little contact with Ministry extension staff; this situation is probably due to a shortage of extension workers in the areas visited. The degree to which horticultural extension work has been developed in Ethiopia could not be readily ascertained, but it appears to be limited; preference has had to be given to the development of agricultural crops such as cereals (Ethiopia, 1968).

With an expanding population, however, and an increasing need to conserve foreign currency, it is essential to encourage the production of horticultural crops in areas which are climatically suitable and where there is ready access to markets. This objective can only be achieved if fully trained horticultural extension workers can be assigned to the important producing areas.
9. RESEARCH

Although primarily concerned with research on agricultural crops, the Institute of Agricultural Research is involved in several projects which include crops of horticultural importance such as citrus, bananas, Irish potatoes, peppers, maize and beans. Coffee may also be regarded as a horticultural crop when grown on an intensive scale. The introduction of a wide range of cultivars of Coffea arabica for observation at Jimma is an example of the valuable work being done by the Institute.

The current research programme also has several components which are of direct importance to many of the proposals made in this report, for example the soil fertility investigations and fertilizer experiments which are under way at various experiment stations; also the work of the entomologist and pathologist, which will add to the application of improved plant protection techniques to many crops of horticultural importance. The testing of many agricultural crop cultivars, including introductions from other countries, has been an important part of the work of the Institute, and a further extension of this testing to include horticultural crops would be desirable.

The valuable work being carried out on crop irrigation and cultural practices generally has great importance for horticultural crop cultivation, particularly citrus, and the extension of this work to annual and perennial horticultural crops is essential if any promotion of the production of these crops is contemplated.

Many of the projects proposed under "Recommendations" appear to fall directly within the scope of the Institute and should also be acceptable as being applied research or development.
10.5 **Publications (1.3)**

Qualified staff should be encouraged to write leaflets and short papers on topics with which they are familiar. Reviews and revisions of previous work, much of which is not now available, would be invaluable in adding to the reference and teaching material for both academic and field workers.

10.6 **Applied Research, Field Trials and Experiments**

The following should be investigated as soon as staff and facilities become available (not arranged in order of priority):

(a) irrigation requirements of vegetable and fruit crops (citrus irrigation research is already in progress) (3.6);

(b) the feasibility of using sprinkler irrigation in areas with limited water resources (3.6);

(c) the development of mechanization in horticultural crops, particularly annual crops grown on a commercial scale (3.1);

(d) plant population studies on annual horticultural crops to determine optimum spacing with established systems of cultivation (3.3);

(e) investigation of the period from sowing to maturity, as well as yield/hectare for crops grown in specific areas, in order to forecast export potential (3.3);

(f) continuation of the accumulation of data on pest and disease occurrence and control, with particular reference to vegetable and fruit crops (3.5);

(g) survey of weed populations in cropping areas, and experiments on the use of herbicides (3.7);

(h) plant introduction and the assessment of the suitability of introduced cultivars in selected cropping areas. Indications of the crops which merit specific consideration are given in Appendix III (4.1 and 4.2);

(i) the establishment of seed production stations in the highland and lowland areas (4.3).
10.7 Cooperative Societies

Cooperative societies for the production and marketing of horticultural crops should be established (6.2 and 7).

10.8 Specific development projects and investigations recommended for the areas discussed in section 7 should be established. These are concerned mainly with the introduction of new crops and techniques; there should also be considerable emphasis on increased extension work (8.2). Crop diversification in the Harar province is considered to be particularly important.

10.9 The aspects of horticultural research and development which could be undertaken by the Institute of Agricultural Research are many, and include the initiation of cultivar trials, fertilizer, irrigation and cultural practices experiments.

Additional investigations and research which would logically fall within the province of the Institute are referred to in paragraph 10.6 and in section 9.

10.10 Close liaison should be maintained between the Institute and the Ministry of Agriculture on all problems and developments of mutual interest; interchange of staff wherever appropriate is recommended as a means of consolidating mutual interests.
REFERENCES


DAGHATCHEW YIRGOU. 1967 Plant diseases of economic importance in Ethiopia. Experiment Station Bulletin No. 50. College of Agriculture, Debre Zeit, Haile Selassie I University.


HILL, B. G. 1963 Some common agricultural insects of Ethiopia, and their control. Experiment Station Bulletin No. 23. Imperial Ethiopian College of Agricultural and Mechanical Arts, Haile Selassie I University.


SIEGENTHALER, I. E. 1966 Useful plants of Ethiopia. Experiment Station Bulletin No. 14, Vol. 1. Imperial Ethiopian College of Agricultural and Mechanical Arts, Haile Selassie I University, Jimma Experiment Station.

TAYE BEZUNEH 1965 A progress report on vegetable variety trials. Experiment Station Bulletin No. 38. College of Agriculture, Debre Zeit, Haile Selassie I University.

YAGER, L. A. 1966 Celery and celeriac. Experiment Station Miscellaneous Bulletin No. 19. Imperial Ethiopian College of Agricultural and Mechanical Arts, Haile Selassie I University, Dire Dawa.
April 4th Visit to Holetta Research Station and Agricultural Institute at Ambo

5th Visit to vineyards of H.R.H. Ras Imru, H.E. Ras Meafin Selesh; also the orchard of the Agricultural Institute at Guder

6th Research Station at Bako and orchards of Ato Kebtimer and Swedish Mission

7th Vegetable and fruit farms in the Addis Ababa area; also vegetable markets and produce stands of supermarkets and shops

8th Visit to the vineyard at Dukem, the Debra Zeit Experiment Station and vegetable farms in the area; orchards and vegetable growing areas along the Awash river, including Lij Elias farm

9th Vegetable farms near Sebeta and the orchard at Meta Abo; vegetable and fruit farms at Wolisso

10th The Ghibbo valley and the farm belonging to Ato Getachew Wolde Emanuel

11th Farms at Tibila and Nura Era

12th Visit to Abadir and Metehara farms

13th Research Station at Melka Werer

14th Visit to Awara Melka farm

15th Miesso and Aso Teferrri, Hirna and visit to the farm of Fitawrari Teklehawariat

16th College of Agriculture, Alemaya; also Vegetable Producers' Cooperative and market at Alemaya

17th Visit to orchards at Harawe and the Bisidimo Farm

18th Visit to the farm at Eror Gota

19th Travel from Dire Dawa to Addis Ababa
April

20th    in Addis Ababa
21st    Visit to Nutrition Institute; discussion with Institute staff
22nd    By air to Jimma, visiting Research Station and Agricultural Institute
23rd    Visit to pineapple plantation at Gojob valley
24th    By air to Asmara; visit to local markets and wholesale firms
25th    Visit to Elaberet plantation
26th    Visit to Ghinda area
27th    Departure of H. D. Tindall to Rome

(Lake Awasa area and Rift Valley not visited by H. D. Tindall)
APPENDIX II

QUANTITY OF ETHIOPIAN EXPORTS OF VEGETABLES AND FRUITS

<table>
<thead>
<tr>
<th>Commodity</th>
<th>1964 (kg)</th>
<th>1965 (kg)</th>
<th>1966 (kg)</th>
<th>1967 (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Fruits</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oranges</td>
<td>172,920</td>
<td>67,540</td>
<td>66,806</td>
<td>103,105</td>
</tr>
<tr>
<td>Mandarins or tangerines</td>
<td>518,213</td>
<td>562,544</td>
<td>428,511</td>
<td>613,835</td>
</tr>
<tr>
<td>Lemons</td>
<td>507,465</td>
<td>577,870</td>
<td>652,947</td>
<td>1,064,541</td>
</tr>
<tr>
<td>Bananas</td>
<td>12,151,020</td>
<td>12,653,898</td>
<td>15,362,187</td>
<td>17,755,765</td>
</tr>
<tr>
<td>Fresh fruits, other</td>
<td>1,261,818</td>
<td>925,417</td>
<td>837,428</td>
<td>866,324</td>
</tr>
<tr>
<td>Fruit juices</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td><strong>Fresh vegetables</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fresh tomatoes</td>
<td>104,262</td>
<td>137,020</td>
<td>45,103</td>
<td>144,635</td>
</tr>
<tr>
<td>Green peas</td>
<td>n.a.</td>
<td>71,400</td>
<td>409,750</td>
<td>40,000</td>
</tr>
<tr>
<td>Garlic</td>
<td>267,401</td>
<td>-</td>
<td>123,036</td>
<td>281,830</td>
</tr>
<tr>
<td>Onions</td>
<td>293,525</td>
<td>62,346</td>
<td>61,421</td>
<td>98,383</td>
</tr>
<tr>
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<td>4,691,845</td>
<td>-</td>
<td>7,497,179</td>
<td>4,744,414</td>
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<tr>
<td>Frozen vegetables</td>
<td>-</td>
<td>-</td>
<td>209,760</td>
<td>662,655</td>
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VALUE OF ETHIOPIAN EXPORTS OF VEGETABLES AND FRUITS

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Fruits</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oranges</td>
<td>71,990</td>
<td>23,640</td>
<td>23,386</td>
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<tr>
<td>Mandarins or tangerines</td>
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<td>188,503</td>
<td>145,504</td>
<td>216,886</td>
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<tr>
<td>Lemons</td>
<td>133,331</td>
<td>142,652</td>
<td>150,588</td>
<td>251,880</td>
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<td>Bananas</td>
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<td>4,561,260</td>
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<td>Fresh fruits, other</td>
<td>462,459</td>
<td>353,677</td>
<td>318,932</td>
<td>324,370</td>
</tr>
<tr>
<td>Fruit juices</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>279</td>
</tr>
<tr>
<td><strong>Fresh vegetables</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fresh tomatoes</td>
<td>25,995</td>
<td>31,274</td>
<td>11,528</td>
<td>37,005</td>
</tr>
<tr>
<td>Green peas</td>
<td>n.a.</td>
<td>15,287</td>
<td>107,383</td>
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</tr>
<tr>
<td>Garlic</td>
<td>74,718</td>
<td>-</td>
<td>32,496</td>
<td>164,426</td>
</tr>
<tr>
<td>Onions</td>
<td>62,263</td>
<td>16,458</td>
<td>16,310</td>
<td>36,387</td>
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<tr>
<td>Other fresh vegetables</td>
<td>1,177,154</td>
<td>-</td>
<td>1,784,762</td>
<td>1,266,309</td>
</tr>
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</table>

n.a. = not available

Source: Annual Trade Statistics, Customs Head Office, Addis Ababa
### QUANTITY OF ETHIOPIAN IMPORTS OF VEGETABLES AND FRUITS

<table>
<thead>
<tr>
<th>Commodity</th>
<th>1966</th>
<th>1967</th>
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<tbody>
<tr>
<td>Fruits</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oranges</td>
<td>609,806</td>
<td>266,008</td>
</tr>
<tr>
<td>Mandorins, tangerines or clementines</td>
<td>-</td>
<td>17,700</td>
</tr>
<tr>
<td>Apples</td>
<td>50,400</td>
<td>127,778</td>
</tr>
<tr>
<td>Grapes</td>
<td>1,493</td>
<td>32,410</td>
</tr>
<tr>
<td>Other fresh fruits</td>
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<td>871,841</td>
</tr>
<tr>
<td>Dates, fresh</td>
<td>14,626</td>
<td>3,328</td>
</tr>
<tr>
<td>Dates, dried</td>
<td>1,316,631</td>
<td>1,547,431</td>
</tr>
<tr>
<td>Raisins, dried</td>
<td>500,129</td>
<td>242,650</td>
</tr>
<tr>
<td>Currants, dried</td>
<td>76,688</td>
<td>15,300</td>
</tr>
<tr>
<td>Other dried fruits</td>
<td>251,139</td>
<td>49,758</td>
</tr>
<tr>
<td>Fruits, candied</td>
<td>32,589</td>
<td>4,104</td>
</tr>
<tr>
<td>Jams and marmalades</td>
<td>297,494</td>
<td>152,365</td>
</tr>
<tr>
<td>Fruit juices</td>
<td>100,914</td>
<td>191,883</td>
</tr>
<tr>
<td>Tomato juice and extracts</td>
<td>143,163</td>
<td>62,938</td>
</tr>
<tr>
<td>Canned fruits and nuts, others</td>
<td>206,752</td>
<td>374,454</td>
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<tr>
<td>Fruits and nuts not fresh, others</td>
<td>262,582</td>
<td>43,951</td>
</tr>
<tr>
<td>Vegetables</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Potatoes</td>
<td>-</td>
<td>600</td>
</tr>
<tr>
<td>Garlic</td>
<td>-</td>
<td>1,100</td>
</tr>
<tr>
<td>Onions</td>
<td>102,102</td>
<td>138,514</td>
</tr>
<tr>
<td>Other fresh vegetables</td>
<td>95,394</td>
<td>30,126</td>
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</table>

Source: Annual Trade Statistics, Customs Head Office, Addis Ababa
### VALUE OF ETHIOPIAN IMPORTS OF VEGETABLES AND FRUITS

<table>
<thead>
<tr>
<th>Commodity</th>
<th>1966</th>
<th>1967</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Eth.$</td>
<td>Eth.$</td>
</tr>
<tr>
<td><strong>Fruits</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oranges</td>
<td>232,599</td>
<td>103,927</td>
</tr>
<tr>
<td>Mandarinis, tangerines or</td>
<td></td>
<td></td>
</tr>
<tr>
<td>clementines</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Apples</td>
<td>29,920</td>
<td>75,700</td>
</tr>
<tr>
<td>Grapes</td>
<td>1,448</td>
<td>18,054</td>
</tr>
<tr>
<td>Other fresh fruits</td>
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</tr>
<tr>
<td>Dates, fresh</td>
<td>9,326</td>
<td>1,256</td>
</tr>
<tr>
<td>Dates, dried</td>
<td>383,493</td>
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<tr>
<td>Raisins, dried</td>
<td>312,740</td>
<td>166,967</td>
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<tr>
<td>Currents, dried</td>
<td>43,860</td>
<td>9,860</td>
</tr>
<tr>
<td>Other dried fruits</td>
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</tr>
<tr>
<td>Fruits, candied</td>
<td>30,312</td>
<td>10,266</td>
</tr>
<tr>
<td>Jams and marmalades</td>
<td>162,799</td>
<td>144,600</td>
</tr>
<tr>
<td>Fruit juices</td>
<td>117,908</td>
<td>182,460</td>
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<tr>
<td>Tomato juice and extracts</td>
<td>137,362</td>
<td>66,133</td>
</tr>
<tr>
<td>Canned fruits and nuts, others</td>
<td>184,262</td>
<td>344,806</td>
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<tr>
<td>Fruits and nuts not fresh, others</td>
<td>224,953</td>
<td>46,811</td>
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<tr>
<td><strong>Vegetables</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Potatoes</td>
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<td>110</td>
</tr>
<tr>
<td>Garlic</td>
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<td>200</td>
</tr>
<tr>
<td>Onions</td>
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</tr>
<tr>
<td>Other fresh vegetables</td>
<td>119,504</td>
<td>21,927</td>
</tr>
</tbody>
</table>

Source: Annual Trade Statistics, Customs Head Office, Addis Ababa
NOTES ON VEGETABLES IN CULTIVATION

A. Crops of major commercial importance

TOMATO (Lycopersicon esculentum)

Cultivars grown include "Moneymaker", "Oxheart", "Marglobe", "Ponderosa" and unnamed selections of Italian plum tomatoes.

Diseases: Septoria sp.; early blight, Alternaria solani; late blight, Phytophthora infestans; leaf mould, Cladosporium sp.
No bacterial wilt (Pseudomonas solanacearum)

Pests: aphids and caterpillars (Heliothis sp.)

Plants are sometimes supported but frequently remain unstaked. Plants grown in hot regions sometimes show fasciation of flowers and fruits; also sun scald. Pollination is sometimes difficult with imported cultivars.

SWEET PEPPER (Capsicum annum)

Widely grown in lowland areas, an important export crop in fresh state; also in dried form for colour extraction. Yields of 8 quintals (800 kg)/hectare. Grown without irrigation in many areas. Local cultivar: "Maracco", introduced cv: "California Wonder".

Virus infection observed in many areas. No bacterial wilt seen.

HOT PEPPER (Capsicum frutescens)

Cultivation very similar to that of sweet pepper. Local selections and cultivars widely planted. Vigorous export industry in dry state for colour extraction. Some export of fresh fruits.

"SHALLOTS" (Allium ascalonicum)

The local selection of shallot is red-skinned and oval in shape, grown widely in many parts of the country and found in most markets. Some growing plants were considered to resemble A. fistulosum.

ONIONS (Allium cepa)

Large oval or flattened bulbs, mainly white-skinned, were seen in Addis Ababa and other markets, up to 10 cm in diameter, resembling "Early Cape Yellow Flat", produced in the Holetta area. Red-skinned cultivars seen in Asmara; also "Texas Grano".
**CABBAGE** (*Brassica oleracea*)

Introduced cultivars of the "Copenhagen Market" and "Enhouizen Glory" type of large drumhead cabbage widely grown on a commercial scale, sold for Eth.20c/kilo. Outer leaves often removed to expose large white heads. Red-leaved cultivars successfully grown in many areas, but do not appear to be popular. Leaf spot (Septoria?) observed at Alamaya.

**LOCAL CABBAGE or KALE** (*Brassica napo-campestris*)

Widely grown and popular in most areas; the leaves are harvested and the plant is treated as a short-lived perennial. Stems and leaves have a red pigment, flowers and seeds are produced only at high elevations. Has been provisionally identified as a tri-generic cross between *B. napus* x *B. nigra* x *B. oleracea*.

This plant has apparently been in cultivation in Ethiopia for a considerable period.

**DWARF and CLIMBING FRENCH BEANS, GREEN BEANS** (*Phaseolus vulgaris*)

Widely grown on commercial scale with irrigation for export to Europe in fresh state from November to March. Few diseases or pests, but crops normally sprayed regularly.

**IRISH POTATOES** (*Solanum tuberosum*)

Grown in many areas, particularly in the highlands, and two crops per year can be produced. Frequently grown as an intercrop between fruit trees; liable to *Phytophthora* in some areas. Tubers are not planted on ridges and are not earthed up. No information on cultivars was available.

**SWEET CORN** (*Zea mays*)

"Golden Bantam" and related cultivars generally grown; these are not particularly successful and new cultivars could be introduced with advantage.

**CARROT** (*Daucus carota*)

This crop is becoming more popular in some areas, i.e. Bako, as a result of recommendations made by the Medical Department. Prices are Eth.40-50 cents/kilo in Addis Ababa markets. Both stump and long-rooted cultivars are grown; this crop appears free from any major pest or disease.
SPINACH BEET (*Beta vulgaris* var. *sisi*la)

Widely grown in Addis Ababa and Asmara areas. Complete plants generally harvested for market, but leaves picked and sold in bunches in Asmara.

EGG PLANT (*Solanum melongena*)

Popular in many areas; round and oval cultivars; generally purple. Most are of American origin.

LETTUCE (*Lactuca sativa*)

Fairly widely grown, but not popular except in the long fast period of the Ethiopian Orthodox Church and in the foreign community. Excellent quality of both "cos" and "cabbage" types produced. "Great Lakes" is grown in Asmara. Prices Eth. 25 cents/kg for cos and 35 cents/kg for cabbage in Addis Ababa. Seeds reported to be produced at higher elevation only, but this appears unlikely.

BEETROOT (*Beta vulgaris*)

Popular in Addis Ababa and Alemaya, little grown elsewhere. Few diseases or pests.

CAULIFLOWER (*Brassica oleracea* var. *botrytis*)

Large heads produced, up to 20 cm in diameter. European cultivars frequently fail to produce heads, since they are sensitive to daylength.

GLOBE ARTICHOKE (*Cynara scolymus*)

Sold for Eth. 60-70 cents/kg in Addis Ababa markets. Not widely grown elsewhere.

LEEK (*Allium porrum*)

Good quality leeks in Addis Ababa and Alemaya. This crop appears to grow very well in many parts of the country.

GARLIC (*Allium sativum*)

Although not widely grown and production is limited to a few areas, this should be considered as a potentially important export crop. Established as a crop at Bako, Nazareth and Asmara.
B. Vegetables of limited economic importance

ENDIVE (*Cichorium endivia*)

Good quality heads, unblanched, found mainly in Asmara markets.

PARSLEY (*Petroselinum crispum*)

Large-leaved "Hamburgh" type common; limited demand.

CELERY (*Apium graveolens*)

Mainly self-blanching cultivars, not earthed up.

CHICORY (*Cichorium intybus*)

This indigenous plant was seen only in Asmara. The leaves are sold in bunches and are not blanched.

SPINACH (*Spinacia oleracea*)

Sold at Eth.50 cents/kg as complete plants, with roots.

BRUSSELS SPROUTS (*Brassica oleracea var. gemmifera*)

Not popular. The plants at Alemarya College were of reasonable standard but rarely seen in the market.

KOHLE RABI (*Brassica oleracea* var. cauliropa)

Extremely small, seen only in Addis Ababa market.

TURNIP (*Brassica rapa*)

White, purple top cultivars seen in Asmara. Rarely encountered elsewhere.

RADISH (*Raphanus sativus*)

Large "China Rose" type seen in Addis Ababa market; good seed production by white-rooted cultivars at high elevations. *Raphanus oleifera* is a potentially useful oil crop.

CUCUMBER (*Cucumis sativus*)

Fairly common in many markets; most cultivars have a rough skin.
OKRA (Hibiscus esculentus)

Grown in lowland regions. Pods harvested when too mature.

SOYA BEAN (Glycine max)

Not common. There is scope for a thorough investigation of the possibilities of making this a crop of major importance in the country.

HARICOT BEAN (Phaseolus vulgaris)

Rarely seen, but possibly used fairly extensively in some areas. A possible crop for export.

LIMA BEAN (Phaseolus lunatus)

Limited quantity in Asmara market.

GARDEN PEA (Pisum sativum)

Fresh pods comparatively rare but found in Addis Ababa markets. Dried seeds also sold. P. arvense appears to be grown in some areas.

ROSELLE (Hibiscus sabdariffa)

Possibilities exist for the development of this plant for the preparation of beverages.

COCOYAM (Colocasia antiquorum)

Grown on a kitchen garden scale in the Jimma area; rarely seen in markets visited, but said to be popular in the southern part of the country.

MELON PEAR (Solanum muricatum)

Fruits oval, seedless, with yellow-violet stripes; plants propagated by cuttings. Seen in the Wolisso and Debre Zeit areas. This could be developed as a potential export crop.
C. Spices, condiments and herbs

GINGIBER (Zingiber officinalis)

Produced mainly in the South and South West provinces. Limited production at the present, but a potential export crop.

CHILLI or SWEET PEPPER and HOT PEPPER (Capsicum annuum and C. frutescens)

Grown in most regions of Ethiopia. A profitable export crop at the present, either in the fresh state for export by air or dried for extraction of colouring pigment.

TURMERIC (Curcuma longa)

Under trial in Jimma area as a potential export crop.

BLACK PEPPER (Piper nigrum)

At present under trial. No details available of performance.

LOCAL PEPPER (Piper longum?)

A possible export commodity. This indigenous species grows vigorously in the rain forest area of Jimma.

CARDAMOM (Afromomum manicata)

Grows wild in Jimma area; possibly useful for export.

ANATTO (Bixa orellana)

Trial plantings have been made with the object of ascertaining the value of the fruit for extraction of pigment for food colouring.

FENUGREEK (Trigonella foenum-graecum)

Has a useful content of an oleo-resin; also a high lysine content.

SWEET BASIL (Ocimum basilicum)

Popular, but generally grown on a kitchen garden scale. Occasionally for sale in markets.

FENNEL, FLORENT (Foeniculum vulgare var. dulce)

Commonly sold in markets, high quality roots offered for sale in Asmara.
ROSEMARY (*Rosmarinus officinalis*)

Only seen in Addis Ababa.

MINT (*Mentha sp.*)

Seen only occasionally.

Other herbs and spices under consideration for export include Coriander (*Coriandrum sativum*), Dill (*Anethumgraveolens*) and Cumin (*Cuminum cyminum*).
**APPENDIX IV**

**VEGETABLE CULTIVARS WHICH HAVE BEEN SELECTED AS BEING SUITABLE FOR GROWING IN THE ALKHAYA AREA**

<table>
<thead>
<tr>
<th>Vegetable</th>
<th>Cultivars</th>
</tr>
</thead>
<tbody>
<tr>
<td>Artichoke</td>
<td>Green Globe</td>
</tr>
<tr>
<td>Beetroot</td>
<td>Detroit Dark Red</td>
</tr>
<tr>
<td>Broccoli</td>
<td>Waltham 29</td>
</tr>
<tr>
<td>Brussels Sprouts</td>
<td>Catskill</td>
</tr>
<tr>
<td>Cabbage</td>
<td>Copenhagen Market, Golden Acre, Drum Head, Danish Ballhead, Mammoth Red Rock</td>
</tr>
<tr>
<td>Carrot</td>
<td>Chantenay Royal, Nantes and Scarlet Nantes Stump Root, Touchon</td>
</tr>
<tr>
<td>Cauliflower</td>
<td>Snowball Early, Snowdrift</td>
</tr>
<tr>
<td>Celery</td>
<td>Summer Pascal, Utah No. 15</td>
</tr>
<tr>
<td>Chinese Cabbage</td>
<td>F₁ Hybrid Kyoto No. 2</td>
</tr>
<tr>
<td>Cucumber</td>
<td>Smoothie, Ashley</td>
</tr>
<tr>
<td>Egg Plant</td>
<td>Long Purple Early</td>
</tr>
<tr>
<td>Endive</td>
<td>Batavian Full-hearted, Deep Heart Fringed</td>
</tr>
<tr>
<td>Leek</td>
<td>Giant Musselburgh</td>
</tr>
<tr>
<td>Kohl Rabi</td>
<td>White Vienna</td>
</tr>
<tr>
<td>Lettuce</td>
<td>Golden State, Big &quot;Boston&quot;</td>
</tr>
<tr>
<td>Melon (Cantaloupe)</td>
<td>Powdery Mildew Resistant, Sweet Globe</td>
</tr>
<tr>
<td>Vegetable</td>
<td>Variety</td>
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<tr>
<td>-----------------</td>
<td>---------------------------------------------</td>
</tr>
<tr>
<td>ONION</td>
<td>Red Creole C.5</td>
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<tr>
<td></td>
<td>Granex Yellow F.1 Hybrid</td>
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<tr>
<td></td>
<td>Eclipse L 303</td>
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<tr>
<td></td>
<td>Bermuda Excel</td>
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<tr>
<td>PARSLEY</td>
<td>Paramount</td>
</tr>
<tr>
<td>PARSNIP</td>
<td>Harris Model</td>
</tr>
<tr>
<td>PEPPER (Sweet)</td>
<td>Yolo Wonder</td>
</tr>
<tr>
<td>PUMPKIN</td>
<td>Small Sugar</td>
</tr>
<tr>
<td>RHUBARB</td>
<td>Victoria</td>
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<tr>
<td>SQUASH</td>
<td>Dark Green Zucchini</td>
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<tr>
<td></td>
<td>Cocozelle</td>
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<tr>
<td>SPINACH</td>
<td>Early Hybrid No. 8</td>
</tr>
<tr>
<td>SWEET CORN</td>
<td>Golden Cross Bantam</td>
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<tr>
<td>SWISS CHARD</td>
<td>Fordhook Giant</td>
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<tr>
<td>TOMATO</td>
<td>V.F.11, V.F.145</td>
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<tr>
<td></td>
<td>Monoymaker</td>
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<td></td>
<td>Ponderosa</td>
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<tr>
<td>TURNIP</td>
<td>Snowball</td>
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<tr>
<td></td>
<td>Purple Top White Globe</td>
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<tr>
<td></td>
<td>Just Right</td>
</tr>
<tr>
<td>WATERMELON</td>
<td>Klondike R 57 Striped</td>
</tr>
</tbody>
</table>

Seeds were obtained from Kirchoff's, Kenya, and the Dessert Seed Co., California, U.S.A.
APPENDIX V

VEGETABLE EXPERIMENTS AT LAKE AWASA

Station belonging to the Ministry of Community Development, staffed by French experts (contract between the Ethiopian Government and the French semi-private firm SATEC under supervision of the French Institute for Tropical Agriculture, IRAT).

Records are kept of all experiments but are not yet published.

No experiments in the fields at the present time; only seed-beds with young seedlings of tomatoes, sweet peppers, lettuce.

Snap beans

Varieties tested: Fin De Monclar 15 t/ha
Fin De Villeneuve
Triomphe de Farcy
Fin De Bagnols

Tomatoes

Difficulties with mildew (controlled with Manet). Some plants showed mosaic.

Varieties tested: Poncette
Marmande
Red Top
Saint Pierre
Native d'Alger

Potatoes (Irish)

Only local varieties planted.

Onions

Varieties tested: Empire, Picota Crystal, White Wax,
Bombay Red, Silver King, Fricotcher,
Copper King, Texas Grand, Yellow Bermuda

Some seed imported from Kenya. Best results obtained with Empire, Silver King, and Yellow Bermuda under irrigation. During the rainy season the following varieties were under trial: Sharon, Empire, Hiemek, Improved, Yellow Grandy, Early Grano, Cipolla Rossa Bruna, Cipolla Bionda, Gigante De Gignicilli, Red Creole.

Crops: 15 to 17 tons per hectare for the best varieties, which were Granex Yellow and Early Grano.
Cucurbitacea

Only moderately good results.

Cucumbers (Ashley)

Experiments with irrigation and staking. Yield 19 metric tons per hectare of marketable fruits.

Zucchini (Cocozelle)

Long Green Bush. With irrigation, 54 metric tons per hectare of marketable fruits. During the wet season, two local varieties were tested.

Cruciferae

Cabbage. With irrigation: Premium Late, Wenningstadt, Copenhagen Market (seed from U.S.A.), Marche De Copenhagen (seed from France)

Wet season: Copenhagen Market, Green Acre

Quintal d'Alsace, De Brunswick, Nantais Matif, Marche de Copenhagen

Golden Acre, Brunswick Imperial (seed from Israel)

Best results obtained with:

Early varieties: Copenhagen Market, Golden Acre, Green Acre
Mid-season varieties: Premium Late, De Brunswick
Late variety: Red Jialt

Yields between 50 and 65 tons per hectare for the best varieties.
Cauliflowers

From 5 varieties tested, 2 only flowered*

Varieties: D'Alger
* Sunblist (Ethiopian variety)
* Master
* Metropole
* Demi Dur

Lettuce

Varieties tested: Golden State, Golden State Alemaya,
Golden State U.S.A., White Boston,
Lorry Queen, Sucrino de Napics,
Raine des Glaces, Val d'Orge,
Cream Buttor, Craquerelle du Midi,
Romaine, Bon Jardinier, May King,
Rinat Hakfar

Yields of the best varieties (in metric tons per hectare):

<table>
<thead>
<tr>
<th>Variety</th>
<th>Yield</th>
</tr>
</thead>
<tbody>
<tr>
<td>Craquerelle du Midi</td>
<td>40</td>
</tr>
<tr>
<td>Romaine</td>
<td>39</td>
</tr>
<tr>
<td>Bon Jardinier</td>
<td>28</td>
</tr>
<tr>
<td>Rinat Hakfar</td>
<td>27</td>
</tr>
</tbody>
</table>

Garden Peas

Gödium damage in wet season. Varieties: Perfection, Lincoln
Yield: 33 tons/hectare

Carrots

Varieties: Oxheart, Tendersweet, Luc, Rouge Court Hative,
Rouge Muscato, Rouge Demi Longue, Longue Lisse de Beaux

Yields: 15 to 30 quintalls/hectare

Personal remarks

The apparently high standard of work may be due to the
supervision of foreign exports.

Varieties often obsolete or totally unknown. Absence of
several commercial ones.

The French seed supplier is not considered to be entirely
satisfactory.

The yields per hectare given are extrapolations from the
actual yield obtained on plots much smaller than one hectare.
ILLUSTRATIONS
Fig. 1. Sweet peppers packed for export by air freight, Asmara.

Photograph: Seymoum Solomon

Fig. 2. Squash gourds in market place showing variation in size and shape.

Photograph: Seymoum Solomon
Fig. 3. Egg plant, oval type, packed for export by air freight.

Photograph: Seymoum Solomon

Fig. 4. Leeks, showing method of packing for export by road or rail.

Photograph: Seymoum Solomon
Fig. 5. Grading and packing lettuce for export, Alemaya Vegetable Co-operative Society

Photograph: Seymoum Solomon

Fig. 6. Irrigation system for cooperative vegetable growing scheme, Alemaya. Area under preparation for planting.

Photograph: Seymoum Solomon
Fig. 7. Cabbages, leeks, onions and other vegetables on display in market.

Photograph: Seymour Solomon

Fig. 8. Commercial tomato plantation, with sprinkler irrigation.

Photograph: Seymour Solomon
Fig. 9. Tomatoes awaiting collection for grading and packing.

Photograph: Seymour Solomon

Fig. 10. Brassica (kale) intercropped between rows of fruit trees.

Photograph: Seymour Solomon
Fig. 11. Shallots, Ethiopia.

Photograph: FAO

Fig. 12. Packed vegetables ready for air shipment.

Photograph: Seymoum Solomon