CTA - Seminar Proceedings

Post-harvest management of tropical fruits and ornamentals in the Caribbean region

Trinidad, 18 - 22 November 1991

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POST HARVEST MANAGEMENT TROPICAL FRUITS AND ORNAMENTALS IN THE CARIBBEAN REGION

(Trinidad, 18-22 November 1991)

Sponsored by

The Technical Centre for agricultural
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TECHNICAL SESSION IV

OPENING SESSION

Chairman: Harold Patterson, *CARDI, Trinidad & Tobago*

CHAIRMAN'S ADDRESS

Mr Harold Patterson
Caribbean Agricultural Research and Development Institute, Trinidad & Tobago

Minister of Food Production and Marine Exploitation, Dr Brinsley Samaroo; The Executive Director of CARDI, Mr Calixte George; Mr Tiberman Narain of CTA; Professor Lawrence Wilson, Dean of the Faculty of Agriculture, UWI; Dr Ronald Barrow, Chief Technical Officer with the Ministry of Food Production and Marine Exploitation; Other Distinguished Members of the Head Table; Members of the Diplomatic Corps; Distinguished Invited Guests; Participants; Colleagues; Ladies and Gentlemen;

I would like to welcome you on behalf of the Trinidad & Tobago Unit of CARDI to this the eighth in the series of seminars sponsored by CTA and CARDI. Previously seminars covered a wide area of topics such as Agricultural Research Policy held in Trinidad, Agricultural Diversification in Barbados, Livestock Feeds and Forages in Jamaica, Improvement of Banana and Citrus through Phytosanitation in St. Lucia, Acid Soils in Guyana, Tick-borne Diseases and By-product Feeding in Antigua last year, and The Role of the Small Farmer in Agricultural Development just last week in Belize. At this, the eighth, we'll be having "Post-harvest Management of Tropical Fruit and Ornamentals in the Caribbean Region". I am sure there will be a wealth of information that the participants will take back to their respective countries and I wish you all success.

Now I have the privilege of introducing the first speaker to address you this morning, Mr Calixte George, the Executive Director of CARDI. Mr. George is a graduate of the UWI, and Reading University in the UK where he did a Master's in Soil Science. Mr. George assumed the role of Executive Director just over a year ago. Previously, he had a distinguished career both in the technical and administrative fields. As a Research Officer with the Government of St Lucia, an Agronomist with the WINBAN Research Unit, as Project Manager for the CARDI/USAID Small Farm Cropping Systems Project and the CARDI/USAID Farming Systems Research and Development Project. Mr George was also Deputy Executive Director of Research and acting Executive Director. He brings a wealth of experience to the job of Executive Director and is very well qualified to address you.

Mr George will now formally welcome you on behalf of CARDI.

WELCOME FROM CARDI

Mr Calixte George
Executive Director

Mr Chairman; Honourable Minister of Food Production and Marine Exploitation, Dr Brinsley Samaroo; the Faculty Dean of Agriculture, UWI, Professor Lawrence Wilson; Dr Ronald Barrow, Deputy Chairman of CARDI's Board of Directors; Distinguished Guests; Ladies and Gentlemen:

I wish to welcome you on behalf of CARDI to this Seminar on Post-harvest Management of Tropical Fruit and Ornamentals in the Caribbean. As we are all aware the Caribbean is currently a high-cost producer of the traditional commodities such as sugar and bananas and all the governments of the region are anxious to move away from the monoculture that has been with us since colonial times. In this regard there are new policies and programmes both nationally and regionally towards diversification of the agricultural sector and it is within this context that this seminar was conceived.

CARDI is an autonomous institution with a mission "To contribute to agricultural development through the generation and transfer of appropriate technology that benefits the Caribbean people". One of its mandates is to co-ordinate agricultural research in the region and this seminar is but one such activity towards helping the Institute to fulfil this particular mandate. Within CARICOM, and specifically the OECS, the diversification effort focuses on extra-regional markets. Because these are technologically demanding, there is urgent pressure in the region to ensure that the technologies of production and post-harvest management are available to complement national and regional strategies for expanded production and marketing. As the region accelerates its diversification of the agricultural sector and increases production of fruits, vegetables and root crops as well as ornamentals, issues of product loss, handling and quality assurance will assume greater importance in both domestic and export market places. There is increasing appreciation that the production, harvesting methods, storage, packaging, handling, grading and transportation, particularly of fruits, vegatables and ornamentals for extra-regional markets, must receive some priority attention.

Given CARDI's regional mandate coupled with the need to implement the various components of its Strategic Plan and also the growing importance of post-harvest technology to the development of the region's agricultural sector, the Institute has defined its role in post-harvest technology research, development and transfer. As a result, sometime ago we commissioned a team to develop a strategic plan for the Institute that will take into consideration the development and transfer of improved handling and post-harvest techniques, particularly for fruits and vegetables. The team was requested to collate information and make an assessment of the current programmes as well as to determine the future requirements in the area of post-harvest technology. The result of this was the development of a strategic plan. Some of the issues that arose from this plan I would indicate in a minute.

The team was a mixed one in the sense that we had persons from within the Institute and one of the participants (actually now in this seminar) from the Natural Resources Institute of the United Kingdom. The Mission sought a lot a information from regional and national development plans. They interviewed users and regulators of the agro-chemicals that were used in food technology and they also looked at the question of the transfer of information from the researchers to the users of that technology, particularly those involved in the huckster trade as well as some of the private individuals involved in the export of fruits and vegetables.

What came out of this review was that there was a need to strengthen the regional capability in research, development and transfer of technology to minimize the losses in the established horticultural crops and to facilitate the easy diversification into new export commodities. It was noted also that many regional and national institutions had undertaken work during the past several years but that generally these remained poorly resourced in a number of areas and that there was very little transfer of the technology that was being developed. There were specialized units, for example in some of the larger countries like Trinidad & Tobago and Jamaica, but there has been very little transfer of the research done in those areas to other parts of the region. We also discovered that there was a wealth of unpublished information in that particular area which needed to be accessed for the potential users.

The University was identified also as having significant research facilities and research capabilities in that particular area and there was need for accessing that resource and putting it to optimum use. We have also, as a result of that exercise, identified the Windward Islands Banana Research Unit as perhaps a model for research and development in that particular area since we felt that it was led by industry – it was market-driven – and that there were immediate mechanisms for the transfer of research results to practical situations in the Windward Islands.

So that the Institute as a result of that exercise became pro-active in terms of implementing some of the recommendations that arose. One was that we needed to develop post-harvest technology within the Institute and currently we are in the process of identifying a Caribbean person to work within that particular area because we already have expertise from the UK.

The other thing that we have been able to do in that regard is accessing information particularly from countries that have been involved in that area of work and particularly in respect of Trinidad & Tobago and Jamaica.

This present seminar too is an example of the central role that CARDI has to play in terms of networking and getting information from various sources whether they be regional or whether they be international. This is a very good example of the need for developing more of this kind of workshop so that the region can benefit, not only from our own expertise but also from that of the international scientific community. In that regard CARDI and CTA are committed to the dissemination of information on appropriate technology for the benefit of the ACP countries in general and CARDI and the Caribbean in particular. We have been very pleased to have been associated with CTA over the years. We have had several joint seminars and as the Chairman indicated earlier, this year we have in fact organized two seminars with CTA. One of which just ended in Belize on The Role of Small Farmers in Agricultural Development. So this current seminar is the second this year. CARDI also serves as the Regional Branch Office for the CTA and we are looking forward to continued co-operation in the area of information dissemination and transfer.

I sincerely hope that your deliberations on this important topic of post-harvest management of tropical fruits and ornamentals will be productive. I wish to thank you for accepting our invitation to participate in this seminar and I also wish to thank the seminar Steering Committee for the hard work in organizing it and wish you every success for a fruitful seminar.

Thank you Mr Chairman.

WELCOME FROM CTA

Mr Tiberman Narain
Technical Advisor

Mr Chairman; Dr Samaroo, Minister of Food Production and Marine Exploitation; Mr Calixte George, Executive Director of CARDI; Distinguished Guests; Ladies and Gentlemen.

On behalf of the Director of CTA it gives me great pleasure to welcome you to this seminar on the Post-harvest Management of Tropical Fruit and Ornamentals in the Caribbean Region which has been jointly organized by CTA and CARDI. The collaboration between CTA and CARDI is indeed exemplary. I think you have heard the Executive Director also saying that it has been strengthened constantly during the past years. CARDI chooses the seminar topics. We leave the choice to CARDI as it is aware of the subjects which are most pertinent to the region. I was going to list all the pertinent subjects on which seminars have been organized but, Mr. Chairman, you have already done that so that saves me some time.

In 1989, the topic chosen was Agricultural Diversification. That seminar was held in Barbados and underlined the importance of exporting agricultural produce as a prominent feature in promoting diversification of agriculture. The link between that seminar and the present one is that this one lays particular emphasis on the post-harvest management of tropical fruits and ornamentals, an area of tremendous concern for two items which could contribute significantly to the export potential of ACP member states of the Caribbean region.

Mr Calixte George has already mentioned that this year two meetings have been scheduled, the first one in Belize held 1-14 November and the present one being held now. The steering committee of CARDI has prepared a comprehensive programme of meetings for the week and I am certain that it would provide ample opportunity for participants to interact and define guidelines for the better management of post-harvest tropical fruits and ornamentals so that sales will rise and result in increased revenue.

CTA is not new to you present here. However I would like to describe broadly the salient characteristics of the Centre and the role it has in assisting CARDI especially working with access to information on agriculture and its dissemination. For those of you who are not very much aware of CTA, the acronym CTA itself can cause a problem as it is the French acronym for the Technical Centre for Agricultural and Rural Co-operation which in French is Centre Technique de Coopération Agricole et Rurale. It was established in 1983 after the negotiations of the Second Lomé Convention between the European Economic Community and the African Caribbean and Pacific Group of States. The Centre is, I quote from the Convention, "at the disposal of the ACP States to provide them with better access to information, research, training and innovations in the sphere of agricultural and rural development and extension". The present Convention – the third one – stresses the role of the Centre as being one to stimulate the development of ACP States' own capabilities as regards to production, acquisition, processing and dissemination of scientific and technical information. It also underlines the integration of scientific and technical information in agricultural development strategies. The gradual setting up of decentralized information networks at national and regional levels and the necessity of updating scientific and technical information to cater for the needs of those in charge of development, research, extension and training programmes. In collaborating with CARDI and its various representations in the Caribbean States, the needs of ACP States in the region are identified and a programme of activities drawn up. The objectives of the programme are to support the regional and eventually the national information services so that they are better able to handle requests on agricultural documentation and information within their own countries.

In order to launch this programme, CTA has devised a programme comprising firstly the organization of short training courses for students of information units. Secondly, supplying reference books. Thirdly, providing research scientists with selective information on specific areas of agricultural research. Fourthly, providing access to data bases combined with the supply of abstract reports of primary documents and fifthly, supplying equipment. It is the hope of CTA that these activities will enable many questions to be answered within the region itself and thus reduce the load being handled at CTA headquarters.

In the area of support research, CTA provides the possibility of information exchange with colleagues working on the same topic through participation in meetings (such as this one) and networks formed as a result of the meetings. I think the Executive Director Mr Calixte George referred to this important role that meetings and networks could play in the dissemination of results of research. Also having access to references and documentation.

Similarly support is provided to extension through the supply of publications, participation in workshops, the exchange of news and production of audio/visual aids.

Mr Chairman, Honourable Minister, it is not my intention to give you a full account of all CTA activities. I would like to thank Dr Sam Parasram, Dr Muller, the Chairman of the Steering Committee, its members and all those who have been involved in preparing this meeting. I am confident that the programme has been well studied and that discussion papers and deliberations will be included in the Proceedings. CTA and CARDI are very keen to publish Proceedings of meetings which we organize jointly, not only for the benefit of those here but also for those who have not had the privilege of being present at our meetings. I am certain that these Proceedings will be of interest not only to the Caribbean region but also to the Pacific Islands, the Indian Ocean Islands and the countries in Africa.

Mr Chairman I would like to thank the Honourable Minister, Dr Samaroo, for having graciously accepted to address this Opening Ceremony. His presence adds special value to the meeting.

Finally, I would like to thank all resource persons and participants for having responded so positively to our invitation to the seminar and I wish you every success.

OPENING ADDRESS

Dr Brinsley Samaroo
Hon. Minister of Food Production and Marine Exploitation. Trinidad & Tobago

Mr Chairman; Distinguished Members of the Head Table; Representatives of Regional and International Organizations such as IICA, CTA, CIRAD, CARDI; Your Excellency the High Commissioner for India; the General Manager of the Agricultural Development Bank; Farmers' Organizations; the Media; Distinguished Delegates from the Caribbean and outside of the Caribbean; Ladies and Gentlemen; Friends:

I would like to specially recognize Mr Narain, who is the representative of CTA at this particular seminar that we are having, for two reasons. First of all he comes from an island state, Mauritius, very similar to our own but more significantly because he knows that Trinidad & Tobago has applied to become the permanent international headquarters for CTA and I hope that he will be so impressed by what he sees here *vis-`a-vis* organization and what he sees about the society generally that when he goes back to Holland he will put in a good word for us so that we can win in that intense competition in which we are now involved with a number of other countries for the location of the CTA headquarters.

I am delighted to welcome you to Trinidad &Tobago and in particular to this 5-day seminar on Post-harvest Management of Tropical Fruit and Ornamentals in the Caribbean Region which I am sure will have significant importance for the region's agricultural programme.

In many of our Caribbean countries, agriculture is the main foreign exchange earner and in many other Caribbean countries it is the highest employer. The total import bill for food items in Trinidad &Tobago, as in the rest of the Caribbean, remains unreasonably high. As the nations of the Caribbean now face conditions of greater stringency in the management of our economies, we have no choice but to reduce this high import bill. Every effort now has to be made to increase our production of marketable and exportable fresh fruits, vegetables, root crops, ornamental shrubs and flowers Or, we can put it differently in the words of Mr Calixte George this morning: "that every effort has to be made towards diversification from traditional crops as rapidly as possible if we are to avoid social and economic dislocation in the whole region". The re-activation of the agricultural industry in the Caribbean brings hope for increases in economic development, social progress and a greater measure of self-sufficiency for Caribbean people. In this re-activation however, it is essential that we use a multi-faceted approach in addressing the many issues that confront us in order that we realize the goal of a brighter future for agriculture. For too long agriculturists the world-over have focused considerable attention and resources on improvements in production technology for increasing yields but, it seems to me, without sufficient concern for the very many post-harvest issues that come up. It is therefore very pleasing to see that your conference focuses precisely on this major dimension of the agricultural industry.

Your programme indicates that an integrated approach to the subject of post-harvest technology will be taken and that discussions will be focused on subjects ranging from pre-harvest management through to post-harvest management and marketing considerations. I congratulate the organizing committee of this seminar for taking cognisance of all the various stages in the life of fresh produce from farm to retail in order to ensure that a full and comprehensive understanding of the subject would be made available to participants.

That integrated approach extends to other areas because we see in the programme that there will be regional experiences given by people from outside of Trinidad – Martinique, Costa Rica, Barbados and the

OECS. So that is another dimension of the integration that I hope you will successfully achieve in this seminar.

I see also a third dimension of that integration in that the contributors of papers, the people who are sitting on the panel and the organizing committee consist not only of academics (who we seek too often to organize these conferences) but that you have people from outside, people who have some experience, such as Chase Foods, such as the Aveys, Ice Connection and a number of other people who have real experience of what happens in the outside world and can therefore add to those of us whose experience is limited mainly to academia.

The post-harvest handling of fresh horticultural commodities including fruits, vegetables, root crops, herbs, spices, ornamentals, shrubs and flowers is an integral component of any marketing system. For us in the Caribbean however, it takes on special importance as we seek to penetrate a highly competitive export market having strict quality requirements for what they import. The export from the Caribbean of fresh horticultural commodities to foreign markets remains an attractive and lucrative means of disposal of produce and an area which I believe merits special attention from two points of view.

In the first place the value of horticultural exports from the Caribbean region has increased considerably over the last 5 years or so. To give an example of what has happened in Trinidad & Tobago, such exports have risen from TT$2.7 million in 1986 to TT$5.2 million in 1989, representing an increase of almost 200 per cent. This therefore represents a viable opportunity for our entrepreneurs to access more and more the export market.

The second of point of view which must be carefully studied concerns the many challenges which face this export thrust and again Mr George mentioned most of them. I shall simply be repeating what he said. In order to capture and keep the export market, we need to meet the challenge of supplying high quality produce in dependable quantities and at competitive prices while conforming to the specific standard requirements of the importing country. In this regard we must try to develop and sustain a reputation for reliability in supply and excellence in quality in order to create, keep as well as expand those markets. We of the Ministry of Food Production therefore, have a special interest in the post-harvest management of crops as it relates to the solution of our export problem.

So as we contemplate methods of maintaining the post-harvest quality of agricultural products, we must devise also techniques to prolong shelf-life and the storage conditions for such products. You ought also to consider and make recommendations to our various Caribbean governments on matters such as the necessary improvements in air and sea transport, packing and packaging technology, harvest and handling procedures as well as quarantine controls that would be necessary.

I think you should understand, and I think Professor Wilson would bear me out on this, that in so many of the meetings where Ministers of Agriculture meet – and we meet two or three times for the year – we look for these reports because, as you know, Ministers are busy people who do not have the time to do all the research, and many of the officers are quite busy also. So we depend on reports from people like yourselves and therefore I want you to give importance to what you are doing for the reason that the Caribbean governments are listening and are looking for ideas from people such as yourselves.

Never forget that the end product of all your deliberations is the providing of information to the farming community in the region. They are your major target and the improvement of their condition must be a constant beacon. We have to exercise our minds continuously in devising ways and means of translating the results of your findings to this very large and very important segment of our population.

Mr Chairman, Ladies and Gentlemen, this seminar represents our Caribbean willingness to discuss our common problems and to share our resources in arriving at possible solutions. We must resolve to work together in building an impeccable reputation for that same Caribbean region to which we belong as producers and exporters of high quality agricultural produce. I am confident that the areas to be covered in this seminar will improve the knowledge of the participants in the analysis and application of its agricultural problems and that such analysis will eventually be of benefit to all our countries – those of us who belong to CARICOM and those who belong to the wider Caribbean area.

I wish you therefore every success in this seminar and I hope that the sharing of information during the course of this week will serve to teach us and allow us to improve our profits which after all is the bottom line that we are all striving for. So it now gives me great pleasure to declare this seminar open and I wish you success in your entire deliberations.

Thank you very much.

KEYNOTE ADDRESS

Professor Lawrence Wilson
University of the West Indies, Trinidad & Tobago

Chairman Patterson; Hon. Minister of Food Production and Marine Exploitation, Dr Brinsley Samaroo; Deputy Chairman of the Board of CARDI, Dr Ronald Barrow; Executive Director of CARDI, Mr Calixte George; CTA Technical Adviser, Mr Tiberman. Narain; Chairman of the Conference Steering Committee, Dr Gordon Muller; Your Excellency the High Commissioner for India; Members of the Diplomatic Corps; Invited Guests; Colleagues; Friends; Ladies and Gentlemen; and particularly participants from the region and from overseas.

First of all let me take this opportunity to thank CARDI, including the distinguished member of the Governing Body, Hon. Minister Samaroo, for inviting me to give the Keynote Address at this most important conference on Post-harvest Management of Tropical Fruits and Ornamentals in the Caribbean Region.

It is not often in the Caribbean that academics give feature addresses in the presence of the Minister. We are in a new era. I interpret this signal honour and privilege as a recognition of the efforts of the University of the West Indies (UWI) to improve Tertiary Education, Training, Research and Development, or what we refer to as TETRAD, in the areas of post-harvest biology, technology and management. These efforts are pursued in the Faculties of Agriculture and Engineering in the service of theb food and agriculture sectors of CARICOM states contributing to the UWI.

Therefore, it is with a great sense of humility and gratification that we note that at least 12 of the presenters of conference papers are graduates of the UWI Faculty of Agriculture.

My address this morning will be centred around three themes.

In theme number one I should like to explore briefly what has happened to the global initiative to reduce post-harvest losses of food towards alleviation of malnutrition and hunger in the 1970s and 1980s.

In the second theme I shall proceed to discuss the genesis of the new initiatives for diversification of the Caribbean agricultural sector in the direction of tropical fruit and ornamentals.

Finally, I shall treat with the prospects for expansion of production and marketing of tropical fruit and ornamentals in the Caribbean region,

The post-harvest losses initiative

Although the Food and Agriculture Organization (FAO) had advocated that more emphasis should be placed on post-harvest technology as long ago as 1947, it was not until the 1970s that the potential of post-harvest technology to solve the world food problems was recognized. This recognition emerged from the realization that because the volume of agricultural output at the farmgate is determined by pre-harvest practices, it is not possible to increase the availability of this output to the consumer unless reduction of losses at the post-harvest stage could be effected.

Indeed, the analysis continued by noting that estimates of global post-harvest losses, through quantitative and qualitative deterioration, were at least 10-20 per cent but that estimates of global food shortages were well below 10 per cent.

The analysis led to the Kissinger Policy Initiative at the UN Assembly in 1975 to reduce post-harvest losses by 50 per cent by 1985.

In turn, this initiative locked us into research and development programmes for post-harvest loss prevention in the 1970s and 1980s. Unfortunately, this initiative was based on three false premises:

- The assumption that increased food availability through loss prevention would lead to increased food consumption by the hungry did not materialize.

- As Martin Greeley puts it, total physical losses of grain of 20 per cent in many cases turned out to be "wildly exaggerated guestimates".

- Losses in perishable food staples (for example root and tuber crops, plantains and cooking bananas) were often much higher than 20 per cent and sometimes reached 50 per cent. And, as it is now realized, these commodities are major staples for more than 600 million people in developing countries in the humid tropics.

The conventional wisdom now is that the older, more conservative approach of applying cost-reducing post-harvest technologies for commodity quality enhancement in the market place is more likely to achieve the global objectives of increasing food availability and at the same time reducing chronic food problems in developing countries. But support for such efforts has been drastically reduced since 1985. Characteristically, the food problems in developing countries are still with us in the 1990s, alongside estimates of food surpluses and evidence of protected markets in developed countries.

I relate this sequence of events Chairman, simply to indicate how dangerous it could be for small developing countries to follow apparently reasonable global trends in thought in the area of agriculture and food security. I shall return to this sub-theme later.

Genesis of the diversification initiative*

The genesis of the new initiatives for diversification of the Caribbean agricultural sector originated in the economic turmoil of the 1980s. In June 1989, the International Food Policy Research Institute (IFPRI) in Washington accounted for the global economic turmoil by the interacting effects of:

- The second oil price shock versus depressed commodity prices.

- High real interest rates versus the rapid growth of Third World debt.

- Distorted internal prices in developing countries versus grossly unbalanced public budgets.

In addition, slower growth in developed countries in the 1980s further reduced the potential for trade in developing countries. And the current danger is that growth is now permanently reduced in developed countries due to the maturity of their economies. If this is so, then the predication of growth in developing countries on the import demand of developed countries is a serious miscalculation.

In Trinidad and Tobago too, like in many other oil-exporting developing countries, we learnt the difference between growth and development; the former characterized by easy reversibility, the latter by irriversibility, grounded in societal advancement.

As UWI economist Dennis Pantin would say: the Valley of Debt could be a very dark place. And unfortunately, the Valley is also being visited by others of our CARICOM neighbours.

As the scenario unfolded in the mid-1980s, there was one hopeful sign – the increasing volume of international trade in horticultural products. Accordingly, world trade in cut flowers, cut foliage and plants increased by 15 per cent over 1981 to 1985, when it amounted to some US$2.5 billion. Moreover, the share of the trade captured by developing countries increased to 6.0 per cent for plants, 16.4 for cut foliage and 23.0 for cut flowers, or an average of 15.4 per cent for all floricultural products. It is interesting to note that the European Community accounted for 36 per cent of the trade, the United States for 22 and Canada, Switzerland and Japan together for about 9 per cent.

The performance of fruit and vegetable exports from developing countries faired even better than floricultural products. Thus, over the period 1983 to 1985 developing countries captured 37 per cent of the world horticultural trade, valued at US$9.0 billion. Accordingly, at a time when foreign exchange earnings were urgently needed to pay for rising imports and debt service and the outlook for traditional agricultural exports was not encouraging, it is understandable why a policy of diversification into tropical fruit and ornamentals was pursued as an alternative agricultural contribution to economic growth and development in the Caribbean.

But our experience in the 1980s with horticultural products was not always a happy one. Thus, although exports of cut foliage and more recently orchids and anthuriums from Jamaica and Trinidad & Tobago show promising features, let us not forget the salutory lessons of Spring Plains and Halse Hall in Jamaica with winter vegetable exports to North America and of Barbados with sweet pepper and papaw exports to Europe.

However, more importantly, we should examine very carefully the notion that growth and development in developing countries could be driven by import demand for horticultural products in developed countries, especially as such demand is attenuated by:

- the small proportion of the horticultural products trade now commanded by non-traditional tropical products
- intense competition from developing exporting countries for commonly-produced products, e.g. vegetables
- tariff and non-tariff trade restrictions.

On the latter point, it is interesting to note that the price differential between import and domestic prices could range from 22 to 180 per cent for fruits. And as we know from past experience, processed products can face higher tariff restrictions. But there is also a wide range of other non-tariff restrictions including:-

- Quotas, voluntary export constraints and variable levies
- minimum price systems and countervailing taxes and duties
- technical specifications (especially health restrictions), strict labelling and packaging specification
- transportation difficulties, currency exchange rates and varying government policies.

What then is the potential for tropical fruit and ornamentals and how can post-harvest management of these commodities contribute to the profitability of these promising but perishable commodities? Are we well advised to pursue this global trend?

Prospects for post-harvest management - tropical fruit and ornamentals

The prospects for tropical fruit and ornamentals in the Caribbean depend almost entirely on their capacity to contribute to growth and development in Caribbean societies and economies. In this respect, I supported the position of John Mellor, the former Director General of IFPRI, when he stated at the 1989 International Centre Week in Washington that "Growth is seen as largely the product of technological development that raises factor productivity; which, in turn, is the product of growth of human capital for productive purposes".

This means that demand must be driven much more by domestic forces than by foreign imports. The principal function of agricultural growth is to provide that effective demand for overall growth through cost-reducing technological change, especially if high growth rates and broad societal participation in the processes involved are desired. Two domestic forces concerned with tropical fruit and ornamentals are relevant in this respect:

- Production for the foreign export market

- Production for indigenous, captive and ethnic markets including tourists and overseas nationals.

And the outputs of the human capital which will generate these forces include:

- the husbandry skill and educational accomplishments of rural people.

- The output of educated leaders and trained manpower from our institutions of professional and para-professional training

- the function of these trained personnel in input and product markets in the private sector as well as in policy formulation, implementation and evaluation in the public sector.

- The output of our researchers in terms of cost-reducing technologies and management skills.

Competitive production for export markets

Nurul Islam of IFPRI estimated in January 1990 that total horticultural exports from developing countries, that is to say fruit and ornamentals, could increase at a rate of 1.6-3.4 per cent by the year 2000, that is US$12-15 billion (at 1983/85 prices) compared with US$9 billion in 1983/85. However, as mentioned before, there will be severe competition for this market already constrained by large country dominance both from developing and developed countries. Thus, Islam in 1989 reported that the top four exporters in many individual products accounted for 80-100 per cent of total developing country exports. For pineapples, Honduras, Cote d'Ivoire, Brazil and the Philippines accounted for 84 per cent of exports. The question is: how can small developing countries like those in the Caribbean penetrate such export markets? Do we follow this trend?

In April 1990, Islam further reported as follows:

"Thirty-one countries accounted for almost 90 per cent of developing country horticultural exports by 1985. The highly specialized infrastructure required for export of individual crops, the difficulty of entering new export markets and economies of scale, all serve to limit the number of countries exporting each crop as well as the number of crops exported by each country".

I pose the questions:

- What tropical fruit and ornamental commodities have we in the Caribbean targeted for export? Have we considered collective approaches?

- What research has been done on features of the world trade in these commodities?

- What research has been done on their production, marketing and exporting?

- What infrastructure has been put in place towards generating such exports?

I dare say that the answer to most of these questions is "very little." However, fortunately, the human capital to provide answers to many of these questions is in place. What is needed is the policy framework and the resources to pursue the answers.

Additionally, I submit, that the policy framework must allow for broad participation in the selected industries and the application of cost-reducing technologies and management skills to effect efficiency and competitiveness in the industry and stimulation of domestic demand for growth of the economy.

On the brighter side, the rate of increase in consumption some tropical fruit has been unprecedented. For example, mango imports into the UK have more than trebled over the last 8 years and papaw imports increased 10-fold. It is "market niches" such as these that must be exploited by the Caribbean region. But the R&D effort for this pursuit must surpass that earlier applied to sugar, cocoa, banana and citrus.

Production for the local market

The most important factors affecting demand for tropical fruit and ornamentals on the local market are:

- population growth and location
- the level and distribution of income.

Thus, as economic opportunity becomes limited in rural areas the urban population shift becomes more pronounced. In 1960, 20 per cent of developing country population lived in urban areas. In 1970, this increased to 30 per cent and it is estimated that the urban population will reach 40 per cent by the year 2000. In many countries of Latin America and the Caribbean, this percentage figure has already been exceeded. As this urban shift progresses, the direct traditional marketing of fresh fruits, ornamentals and vegetables within the same geographic area is no longer possible. In turn, the separation creates the need for transport, improved handling and packaging techniques and for storage. In other words, the commercialization of post-harvest activities becomes a necessary component of distribution and marketing. Let me repeat this.

Also, as incomes increase, consumers will demand better service towards enhancement of commodity quality, for example in sorting, grading, pre-packaging, labelling, pricing and market display. Accordingly, producing for the local market could assume a greater complexity and in time will require greater skill than that required on the export market. This is so because of the greater direct involvement of producers and marketeers in the system for delivery of produce to the consumer. In this way, production in the local market could be a most potent domestic force for development, not only in itself but also in the training of producers for operation in the export market.

In Trinidad & Tobago for example, the development along the East-West Corridor has led to considerable increase in the quantity and quality of the demand for fresh fruit and vegetables as well as for increases in the services associated with the marketing of these commodities. Thus, the establishment of several roadside outlets, increased allocation of space and refrigerated displays to perishables in grocery outlets and conglomerization of supermarkets into chain stores have all contributed to improvement in the marketing services delivered. In turn, these activities have led to growth in the export sector, for example for hot peppers, where such exports were not previously contemplated.

To conclude, Chairman, like Mellor, I submit that the optimism for developing countries in the 1990s derives from the fact that throughout the turmoil of the 1980s human capital continued to increase and institutional structures were steadily improved. Indeed, the wide participation of institutions in this conference both from public and private sectors is an indication of that optimism in the Caribbean Community.

Recently however, there has been a disturbing decrease in the number of agriculture students registered in the Faculty. This could mean that continued growth in human capital is in jeopardy. Undergraduate registration reduced from 363 in 1988/89 to 257 in 1991/92. Our 1990/91 graduation class was only 84, but the projected demand for graduates for a revitalized agriculture sector could be as high as 303 professionals and senior technicians annually to the year 2000. Outputs of junior technicians and skilled workers are also in decline.

But the available human capital must also be harnessed towards specific goals concerned with the production of tropical fruit and ornamentals for:

- the foreign export market

- the indigenous and captive markets in the Caribbean and the ethnic markets overseas.

This production must be characterized by:

- cost competitiveness
- the highest quality
- regular availability.

And such characteristics can only be achieved by pre- and post-harvest cost-reducing technologies for quality enhancement of products delivered to the consumer.

Chairman, these principles must be applied to traditional and non-traditional commodities alike – to bananas as well as to anthuriums. And such technologies are beginning to emerge. For example, experiments with nutrient utilization in high density annual banana cultivation using tissue culture-derived propagules as planting material are in progress in St Lucia and in Trinidad. And we are also considering application of Anti-Sense biotechnology for modification of the activity of enzymes controlling fruit ripening and quality in mango and banana.

We have the capacity for rapid micro-propagation of anthuriums and protocols for breadfruit will be available in the near future. Our Continuing Education Programme in Agricultural Technology (CEPAT) and Department of Extension stand ready to disseminate the technologies to practitioners. But we should note that many farmers and entrepreneurs are ahead of the researchers in the exploration of these new areas of horticultural development.

Let me conclude by applying Mellor's paradigm for development to the horticultural sub-sector as follows:Growth in the horticultural sub-sector is seen as largely the product of pre- and post-harvest technological development, that raises factor productivity; which, in turn, is the product of growth of the human capital for productive horticultural purposes.

The Faculty of Agriculture of the University of theWest Indies stands ready to assist in the continued generation of that capital.

Thank you.

VOTE OF THANKS

Dr Gordon Muller
Chairman, Conference Steering Committee

Mr Chairman; Honourable Minister; Distinguished Colleagues of the Head Table; Special Invitees; Participants; Ladies and Gentlemen:

I believe that we have had the best start to this seminar that we could anticipate through the presentations this morning. Mr George and Mr Narain managed in their welcoming remarks to put the seminar in context. They made some relevant comments about post-harvest management and the need and the concern for the region. Minister Samaroo urged us to take action and to make recommendations for action to the Ministries of Agriculture in the region and I think we need to heed that call Professor Wilson, I believe, did an excellent comprehensive analysis of the world and regional situation in relation to the post-harvest management of horticultural crops. I think that I can do no better than to ask you to join me in giving them a special round of applause in appreciation of their presentations this morning.

We have had the good fortune of having a number of co-operating and collaborating agencies involved in this seminar: certainly the CTA which has had an on-going relationship with CARDI; the Government of the Republic of Trinidad & Tobago, the Ministry of Food Production specifically and the Ministry of Environment and National Service; IICA, whose director is with us this morning; the Horticultural Society. Also we have had good support from private enterprise and the farming community and I think we would like to recognize their particular support of this effort this week.

Thirdly I want to thank the presenters in advance of their contributions. They have been extremely willing to participate in the seminar. Some of these negotiations took place by telephone, some by telefax and I have been very heartened by the willingness which people displayed over the last several weeks when we were discussing the programme. I want to pay specific thanks to those persons who agreed to present papers during the week.

I have also had the good fortune of working with an excellent Steering Committee and all the members of the committee I believe are here this morning. The work was not restricted to developing the programme and contacting speakers and presenters but there was also a great deal of creativity and I want to draw particular attention to the floral and fruit display on this side of the room which was done courtesy of the Ministry of Environment and National Service and is the particular effort of one member. I do not want to be invidious but I think I should mention Mrs Indra Furlong-Kelly who co-ordinated the display which you see.

The Committee also thought that the participants should get some flavour of Trinidad & Tobago while they are here and hopefully the cultural presentation this evening will show you the different facets of culture in Trinidad&Tobago Also the field trip on Wednesday will give the participants some sense of the agricultural development and the status of post-harvest management in this Republic.

Participants were drawn from regional Ministries of Agriculture. We also took the opportunity to invite representatives of scientific associations and the farming community in Trinidad & Tobago so that we have, I think, a very useful mix of practitioners, of exporters, of policy makers and planners and this I think augers well for the rest of the week.

I see the media is represented in full force this morning. I want to pay special thanks to them – both the print and the electronic media.

Special invitees, I would like to thank you for coming to be with us this morning. I was interested to note that in the audience there are at least two people whom I recognize who are not in any way associated with post-harvest management or crop production. They are both livestock people and this is probably a good sign – maybe there is going to be some cross-over. It is good to see them here this morning.

Finally I would like to thank the management and staff of CARDI who supported this effort as they have all the other efforts in the CTA seminars. Some of our staff who are not here this morning or who are not in the audience at the moment have been working extremely hard to make sure that all the arrangements are in place and I would like for you to pay special thanks to all of them

Thank you very much.

It is with deep sorrow that we announce the untimely death in May 1992 of Dr Gordon Muller who as Chairman of the Conference Steering Committee did so much to make this conference a success — The editors

TECHNICAL SESSION I

Chairman: Harold Patterson, *CARDI, Trinidad & Tobago*

THE ROLE OF THE AGRICULTURAL DIVERSIFICATION CO-ORDINATING UNIT OF THE ORGANIZATION OF EASTERN CARIBBEAN STATES

C Bully
OECS Agricultural Diversification Co-ordinating Unit, Dominica

Background

Member countries of the Organization of Eastern Caribbean States (OECS) have been pursuing to varying levels, programmes in agricultural diversification that generally focus on:

- increasing export earnings through increased volumes of traditional crops and the introduction of non-traditional crops

- promoting import substitution and replacement, and ensuring domestic food security

- facilitating linkages with other sectors, particularly tourism and agro-industry.

Programmes in the Windward Islands have been more intensive in the area of production for export, while in the Leeward Islands, domestic food supply and linkages with the tourism sub-sector have been more predominant (with the exclusion of St. Kitts/Nevis where sugar exports are still a major contributor of foreign exchange earnings). Accordingly, sectoral contributions vary widely between countries as demonstrated by the contribution to GDP. Thus using the available 1987 figures, this represented 29.3 per cent in Dominica, 21.7 per cent in Grenada, 17.1 per cent in St Vincent and the Grenadines, 14.1 per cent in St Lucia, 4.6 per cent in Antigua & Barbuda, 10.3 per cent in St Kitts/Nevis and 4.3 per cent in Montserrat

In June 1985, at a meeting of the Caribbean Group for Co-operation in Economic Development (CGCED), the subject of Agricultural Diversification in the OECS sub-region as a whole was seriously addressed for the first time. At this meeting, a decision was taken that the Canadian International Development Agency (CIDA) would play a lead role in developing a proposal for Agricultural Diversification in the OECS. In 1987, CGCED received and reviewed the CIDA report and decided upon a course of action.

In 1988, the Heads of State of the OECS countries met in St. Lucia to discuss agricultural diversification. The main outcome was a request to the Caribbean Development Bank (CDB), the Inter-American Institute for Co-operation on Agriculture (IICA), and the Caribbean Agricultural Research and Development Institute (CARDI) to put together a programme on agricultural diversification.

The programme developed comprises commodity specific and supportive projects, sector policy recommendations and specific activities designed to foster joint marketing. It was recommended that the programme be co-ordinated through a Co-ordinating Unit that would monitor all activities, function as the nerve centre of the Programme and use the information flows to give direction and impetus to programme implementation.

Main elements of the OECS programme

Commodity-specific projects for promotion of commercial production.

The commodities selected by representatives of Ministries responsible for Agriculture for inclusion in the programme at the initial stages are in two categories as follows:

Commodities being extensively produced and traded:

- breadfruit
- mango
- plantain
- hot pepper
- sweet potato

Commodities with good potential:

- pineapple
- soursop
- carambola
- papaw
- passion fruit

In the development of the commodity-specific projects, a commodity system approach is being promoted. This approach considers all states from pre-production to final consumption.

Supportive projects

There are several "common" areas to all the commodity projects, which are essential for their effective implementation. These common actions cannot be justified economically by considering any single commodity but can be justified in the context of the overall programme. These actions comprise the Supportive Projects as follows:

- nursery infrastructure
- germplasm bank
- strengthening the commercial capabilities of Embassies/Consulates in major importing countries
- input supply
- agricultural zoning
- support to farmer organizations
- credit for production and export
- market development
- market information systems

Joint marketing

A key consideration of the programme is to work towards joint marketing. The Co-ordinating Unit is working towards achieving a high level of co-operation among the OECS exporters. This aspect of the programme will not be successful unless the exporters exhibit trust in each other, confidence in the programme and a willingness to work together and share information,

Critical in these efforts are the following:

- programme co-ordination
- standardized grading system
- standardized packaging and labelling
- regional/sub-regional market intelligence and information systems
- improved transportation.

Sector policy recommendations

A number of sector policy issues remain to be addressed and require urgent attention if the diversification effort and the joint marketing approach are to be successful. These issues range from those that relate to production, such as land tenure, agricultural zoning, production incentives, protection from larceny, to marketing issues and the establishment and enforcement of grades and standards, intra-regional trade etc.

The OECS Agricultural Diversifcation Co-ordinating Unit

In December 1989, the OECS Agricultural Diversification Co-ordinating Unit (ADCU) was formally launched in Dominica. The Programme Co-ordinator and the Marketing Co-ordinator were appointed in October 1989

The Unit is required to undertake the following activities in the implementation of the programme:

- establish contacts with national Ministries of Agriculture and individuals responsible for the co-ordination at the national level

- establish contacts with national marketing boards, the Caribbean Agricultural Trading Company (CATCO), private exporters, etc.

- examine the existing trade of individual private exporters and develop mechanisms for improvement

- examine the transportation situation, in particular identify bottlenecks for commodities other than bananas

- discuss with appropriate marketing authorities, the logistics for the joint marketing approach in agricultural trade and develop, where possible, mechanisms for achieving this

- identify constraints that should be addressed in member states in order to facilitate the implementation of the programme

- determine for commodities to be included in the programme, the best method of moving them from farm sites to the consumer, to ensure the best quality. This involves reduction of post-harvest losses, packaging, transportation, transit storage, etc.

- develop and maintain a market intelligence system.

Essentially, the Unit is required to address issues of expanding the production base of non-traditional agricultural produce, the zoning and rationalization of production, domestic food supply and food security, intra and extra-regional trade issues and opportunities, and to promote effective linkages with other sectors, particularly the tourism and industry sectors.

In so doing, the Unit has responsibility for supervising the implementation of regional projects and for co-ordinating actions of member countries and agencies. More specifically, the Unit will:

- be responsible for the development of the feasibility studies needed to implement the programme;

- support the negotiations of the OECS and/or member countries with donor agencies, when so required

- supervise the implementation of regional projects to ensure proper co-ordination of activities

- monitor the implementation of the programme and prepare the necessary reports for countries, donor agencies and the OECS Secretariat

- liaise with donor agencies, co-operating agencies and member countries.

The Unit's headquarters is in Dominica, with a field office in St Vincent and the Grenadines. The Unit was strengthened with the appointment of a Marketing and Intelligence Officer and an Agricultural Economist in 1990. Both these officers are located in Dominica. The field office in St Vincent houses the Marketing Co-ordinator who holds direct responsibility for activities in St Vincent and the Grenadines, besides his specific responsibilities in marketing. Secretarial support is provided in both offices. The Unit receives direct technical support from the Economic Affairs Secretariat (EAS) of the OECS.

Co-ordination of diversification programmes and the Unit's work is effected through a Management Advisory Committee that has representation from donor and support institutions, OECS member governments and farmer organizations.

Funding of the Unit comes from member government contributions and donor institutions. The estimated total cost of the programme is US$35,000,000. To date donor funding has been received from:

- CDB – Technical Assistance Project
- USAID – Tropical Produce Support Project
- BDDC - funding of UK market studies
- EDF - funding for OECS country profiles.

In addition it must be recognized that agencies such as IICA, CARDI, UWI, FAO, UNDP and FTC provide invaluable support in areas of technical assistance and technology transfer.

Programme implementation

Given the particular concerns of OECS governments for the situation that may arise in their traditional markets for bananas and sugar as a result of the Single European Common Market come 1992, and the trade pacts that are in the making in North America, the programme has been directed to give urgent attention to marketing of non-traditional agricultural export crops and all its attendant requirements. A specific mandate given by the governments was that opportunities for joint marketing of OECS produce should be explored. The WINBAN model and its successes in the joint marketing of Windward Islands bananas was suggested as a possible mechanism for achieving the joint marketing.

The other concern that needed to be addressed was that of determining the crops with sufficient volumes to sustain a joint market effort as well as the opportunities that exist for increasing marketable yield in the short term. Production and marketing issues therefore both require early attention in the implementation of the programme. Clearly a number of issues in both of those areas require attention. These include:

- size of production unit and land tenure patterns
- agricultural zoning and productivity
- production technology and transfer
- consolidation of production and promotion of marketing units
- production/marketing inputs and credit
- market infrastructure and transportation
- produce grades and standards
- product and market intelligence /information
- market development.

The ADCU therefore, in developing the implementation strategy was required to undertake assessments of the agriculture sectors of all member countries that would inform on the current levels of production, exports and marketing arrangements (including a review of marketing boards) that were already in place. With funding from the EEC/EDF country profiles on the agricultural sector of all member countries were undertaken.

Additionally, as a function of the co-ordination and monitoring responsibilities of the Unit, the Work Programme of CARDI and IICA were reviewed and the work being undertaken in technology generation and transfer as these pertained to the target crops determined. Special focus was given to the work being undertaken by IICA in its programme on Strengthening Farmer Organizations in the OECS. This programme was considered critical in the strategy for promotion of the production and marketing units that would under-pin the joint marketing programme. The developments that were already occurring with the establishment of an Inter-Island Steering Committee of Farmer Organizations in the OECS being supported by IICA were particularly encouraging.

Evaluation of the target markets was also a necessary initial exercise in the implementation of the programme. Special attention was therefore given to the UK.market, it being the major export market for OECS non-traditionals. UK market studies that assessed the markets for ethnic commodities, off-season fruit and vegetables, and exotics were undertaken and export potentials for the target crops determined. Assistance in this exercise was provided by the British Development Division in the Caribbean (BDDC) and undertaken in the UK by the Natural Resources Institute (NRI) of the Overseas Development Administration (ODA). The second phase of this work is presently being undertaken by NRI and will provide further support to the market intelligence system through price monitoring and quality assessment services.

Finally in completing this evaluation process, it was necessary to review the existing marketing arrangements in member countries, both public sector (i.e. marketing boards) and private exporters, to ascertain the opportunities for joint marketing and the arrangements that need to be put in place in achieving this. WINBAN, given its responsibilities to the banana industry and the pressures that the industry is anticipated to face in the market place come 1992, was not in a position to provide the umbrella organization of the joint marketing of OECS produce as originally anticipated. The alternative available to the OECS was therefore to look at the organization already set in place by governments to develop marketing in the agricultural sector, namely the Caribbean Agricultural Trading Company (CATCO) and strengthen and re-oroganize it as required to meet the specific needs of the OECS in the marketing of their agricultural produce.

From these preliminary assessments, it was realized that the following would need to be addressed:

- Present volumes of any of the products being promoted are so small that impact on the market and effective penetration will only occur if a reputation of reliable supply of high quality produce is developed. Increasing competition from Central and South American countries and the wider Caribbean (Dominican Republic and Puerto Rico) in particular, and cross-overs from the traditional ethnic markets to wholesalers and supermarket chains makes this situation of greater concern. The strategy of "niche" marketing therefore requires to be more aggressively developed.

- Costs of production of a number of the products were generating prices that were more competitive in many instances.

The major contributor in the implementation of the programme to date has been the assistance being provided to the OECS by USAID through the Tropical Produce Support Project (TROPRO). This project was initiated practically at the same time that the ADCU was instituted and has been able to provide the Unit with the necessary funding to give it a definite presence in the sub-region, given the support it is able to provide.

The TROPRO project has as its stated purpose "to increase the regional and local capacity to market non-traditional agricultural products, including post-harvest handling and quality control of exportable production from OECS member countries."

The project is being implemented under four modules, namely:

- Production support
- Post-harvest handling
- Transportation
- Market information

The ADCU and CARDI are the primary project guarantees, with CATCO given responsibilities for the market aspects of the project under a sub-contract arrangement.

The following are being addressed in this project:

Production support

This module is being implemented by CARDI, with special support from an Israeli team of production experts, provided under a US/Israeli Co-operative Agreement Programme.

The focus of work is on field interventions through agronomic trials and demonstration plots in fruit tree production and orchard management directed at short-term actions that will generate increased marketable yield and quality of product. Avocado, mango, breadfruit and passion fruit are presently receiving attention. Programmes in varietal selection and standardization, through top-working of 'non-commercial' varieties, are being undertaken as well as introduction of irrigation and water management technology that will provide for increasing production periods and off-setting seasonality in production.

Post-harvest handling

This is considered a most critical area in the development of the export drive of this diversification programme. It is here that major deficiencies occur in the production system and post-harvest handling of crops presently constrains the marketable outputs that allow for the effective penetration of our production into the target markets. This module therefore attempts to address these constraints by providing through technical assistance support for training and the conducting of trials in the following areas:

- enhancement of product quality
- establishment of grades and standards
- development of mechanisms of enforcement of grades and standards
- packaging design
- packing-house technology
- refrigeration and storage.

Transportation

The need of an efficient and effective transportation system for both intra-regional and extra-regional movement of produce is recognized as one of the major constraints to marketing of the OECS produce. The high perishability of those products demand that transportation to the market place be done as quickly as possible and in stable storage environments.

This module provides assistance to the OECS in establishing a reliable transport service, both sea and air. Some assistance in development of transit hubs and facilities is being provided.

Market intelligence

This module will address the constraint of inadequate market services that provide for knowledge and information on prices; reliable brokers; changes in market conditions; packaging and presentation requirements; guides to standards, grades and qualities; entry regulation to target markets; etc.

The market information system is presently being installed in the ADCU Dominica office and has already provided price information and market analysis to exporters and Ministries of Agriculture.

The project has been providing substantial training to technicians, producers and exporters in the areas of production technology and post-harvest handling of target crops. A number of regional workshops/seminars has been conducted in collaboration with CARDI, IICA and UWI/CEPAT. A useful demonstration of the co-ordination that can be achieved among agencies/institutions in delivery of services with a common focus.

The actions in marketing and post-harvest development are being undertaken through a Joint Regional Marketing Programme. This programme aims at increasing the confidence of growers, exporters and receivers; improving standards; and assisting in the development of a viable private sector enterprise. Through this initiative, the project will attempt to link its trials and training programmes to commercial shipments. By demonstrating correct grading, testing new types of packaging and systematically inspecting market arrivals, the programme will contribute to the goal of the project to increase the exports of OECS non-traditional agricultural producer by 100 per cent.

The market trials will be conducted through CATCO and have the following specific objectives:

- Test packaging materials and upgrade where advisable
- Develop and apply appropriate export standards to all shipments
- Develop adequate quality control procedures which are sustainable
- Test and evaluate ocean containers and locker facilities and air transportation systems and facilities
- Promote OECS agricultural produce in the market place
- Encourage close co-operation between exporters, grower associations, marketing boards and CATCO
- Provide practical, commercial-scale training to growers, packers and exporters.

The programme will accommodate specific trials in post-harvest treatments, new packaging, promotion of new products (varieties), changes in standards and any other relevant investigation related to the improvement of volumes, quality and presentation of export.

The following crops are targeted in those commercial trials:

plantain	breadfruit	melon
avocado	pumpkin	dasheen
mango	hot pepper	ginger
eddoe		

Conclusion

The overall Diversification Programme is still in its initial stages of implementation. A number of the production support projects, in particular, needs attention. Efforts to date have been directed to the organizing of marketing, the promotion of joint marketing and the increasing of volume of exports, both regionally and extra-regionally,

A number of policy issues require to be resolved. In the context of the theme of this workshop, the need for the early establishment of grades and standards for produce and packaging and the necessary legislative instruments for enforcement (as now pertains to the banana industry) are urgently required. Product identification/differentiation in the market place through promotion of an OECS/CARICOM trade mark also appears necessary as the export marketing thrust, both regional (especially in the opportunities for promotion through the tourist industry) and extra-regionally accelerates.

I am confident that the task ahead of us is not insurmountable. We in the OECS are fortunate to have farmers who have already been exposed to some extent to the discipline of production, the understanding of proper harvesting and post-harvest handling in the field that has had to be maintained in the banana industry. We need to build on this experience and apply it with equal force to our non-banana produce as our efforts in the diversification of our agricultural sector in the OECS are intensified.

TECHNICAL SESSION II

Chairman: Ronald Barrow, *Ministry of Food Production, Trinidad & Tobago*

Rapporteurs: Dandridge Joseph, *Ministry of Agriculture, Antigua*

Earl Thomas, *Ministry of Agriculture, St Kitts*

INITIATIVES IN THE POST-HARVEST MANAGEMENT OF FRUITS AND ORNAMENTALS IN BARBADOS, BELIZE, GUYANA AND JAMAICA

Ena C Harvey
CASSE Consultants Ltd., Barbados

The Caribbean region has been described by many as having 'great potential' with respect to the production and marketing of agricultural produce. Throughout the region, attempts are being intensified to translate the much touted 'potential' into increased production and increased earnings, particularly hard currency earnings.

The role of good post-harvest management in the realization of this potential is receiving more and more attention as the requirements on international markets become increasingly sophisticated and demanding.

In the Caribbean Community (CARICOM) countries which are not members of the Organization of Eastern Caribbean States (OECS) there is also increased focus on private sector involvement in the total diversification effort.

Barbados

The developments in post-harvest management of fruits and ornamentals are spearheaded by the Ministry of Agriculture, Food and Fisheries, through its projects in crop agronomy, and through collaborative projects with various institutions which include the Caribbean Agricultural Research and Development Institute (CARDI), the Inter-American Institute for Co-operation on Agriculture (IICA) and the Caribbean Agricultural Trading Company (CATCO). The IICA office in Barbados has worked with the Ministry in the development of fruits such as carambola and mango.

The Barbados Marketing Corporation (BMC) operates an export packing unit which handles the purchase, post-harvest handling, packaging and shipment of non-traditional commodities. Current initiatives at the unit involve the optimization of operations to achieve greater efficiency and expansion of the current produce exported in response to market demand.

The major objective of CATCO is to improve the marketing of regionally produced commodities through co-ordinated and aggressive marketing strategies. The company is currently receiving assistance in institutional development under the USAID-funded Tropical Produce Support Project (TROPRO). CATCO's experience in export marketing of Caribbean produce has recently been documented in a handbook on *Product specifications and post-harvest handling for fruits, vegetables and root crops exported from the East Caribbean.* This book was published with financial assistance from USAID and the CARICOM Export Development Project (CEDP).

Fruits

A recent development in Barbados has been the introduction of tissue-cultured Grand Nain banana and its cultivation with drip irrigation. The two private-sector companies involved have reported yields ranging from 80 to 110 tonnes per ha. Apart from the staggering yields, the tissue-cultured plants are easy to manage because of the convenient height of the plant and the strength of the rooting system, both of which lead to greater wind resistance. The fruits are high in quality with respect to the fruit size, flavour and handling ability (thicker, hardier skin). Barbados is adequately supplied with ripening rooms for bananas. Tomatoes and avocadoes are also ripened for distribution on the domestic market.

Ornamentals
The area currently allocated to the production of floricultural crops is 23.5ha broken down as follows:

Gingers	11
Heliconia	6.5
Anthurium	3
Foliage	0.5
Mixed chrysanthemums	2.5

Of the 20 growers involved in the industry, only three are actually exporting. One producer of spray and pot chrysanthemums ('Floreat', a joint venture between Barbadian and Canadian private sector companies), will be initiating exports to Canada this year.

The Barbados Horticultural Society, which has over 300 members, recently received financing from the Inter-American Development Bank (IDB) for the development of cut flowers for export. The project, which extends from 1989 to 1994, is aimed at the establishment of a group of flower producers who will receive support through the provision of credit for farm inputs, the establishment of a packhouse, infrastructural support and institutional strengthening. The project is being handled by the Agriculture Venture Trust (AVT) which is also attempting to provide secure export markets through the establishment of a distribution office in Miami.

The floriculture industry is currently receiving assistance through the FAO of the United Nations and the Ministry of Agriculture, Food and Fisheries. Under this programme, a marketing consultant, an anthurium expert and an orchid expert have already provided technical assistance to Barbadian growers and exporters. Crops of major significance are anthurium, heliconia and orchids.

Belize

Agriculture is the largest contributor to the national economy of Belize, employing one-third of the work force and generating approximately 50 per cent of the GDP. Sugar constitutes 60 per cent of current total exports, with the remaining 40 per cent comprising orange and grapefruit concentrates, bananas, mangoes, rice and honey.

The Government of Belize has indicated that the development of the agricultural potential through diversification into the production of export commodities, is its first priority. The major constraints to the diversification effort are:

- The lack of infrastructure, particularly cold storage facilities
- the lack of all-weather roads

In the specific case of citrus, the major constraint is the continual disputes over prices and consequent heavy fruit losses during prolonged negotiations. For banana, the industry is hampered by low production, shortage of management, high shipping costs and lack of available credit.

Some progress is being made with respect to these constraints with the recent approval of a Caribbean Development Bank (CDB)-financed project aimed at the improvement of farm access roads and storage and marketing facilities.

One company which specializes in non-traditional agricultural crops, particularly fruits, is the Belize Agri-Business Company (BABCO).

BABCO was established in 1986 as a private non-profit research and development institute. Its focus is applied research for commercial agriculture and since its inception it has successfully contributed to the development of an export-oriented 'Solo' papaw industry which yielded a total of 840 tonnes of exportable fruit having an estimated value of $0.9 million.

At present, its main activities are centred around:

- The identification and development of potential export crops.
- The commercialization of selected crops.
- The provision of technical assistance and consultancy services in production, post-harvest

handling and marketing of various non-traditional crops.

Programmes are conducted by way of on-farm trials with co-operating farmers and test marketing trials. Commodities currently under review include ginger, carambola, pineapple and mango. Other crops in BABCO's programme are lychee, passion fruit, guava and avocado.

During the first three years of operation, BABCO developed technological packages for the production, post-harvest handling and marketing of vegetables which included squash, cucumber, bell and hot peppers, cantaloupe, snapbean and onion The guidelines developed in these tech-packs are followed by the farmers. BABCO has also developed a data bank on cost of production and commodity market prices.

With respect to future developments, BABCO intends to establish itself as a reputable packer, shipper and marketer of fresh fruit and vegetables. It will provide an outlet for farmers' produce which will be produced under BABCO's supervision. The company also intends to undertake joint ventures with farmers and potential investors.

Another private company, the Caribbean Tobacco Company Ltd. (CTC) is also involved in the agricultural diversification effort. CTC is a wholly Belizean owned subsidiary of G.A. Roe Sons Group (also wholly Belizean owned) which is essentially a manufacturing company making cigarettes and several types of aluminium and glass structures. The company runs a farm of just over 400ha producing beef cattle, citrus and cut flowers. The citrus is mostly of the Valencia variety and is shipped to Belize processing plants for juicing. The cut flowers consist of varieties of heliconia and ginger lilies. These were originally grown for export to Miami and later Houston, but export proved unprofitable and production is now confined to supplying the small but increasing domestic demand.

Guyana

Despite chronic economic problems and severely depleted infrastructure, agricultural production is steadily increasing, and notably so in the non-traditionals which have registered an increase of 131 per cent over the past 5 years. The export of non-traditionals, particularly citrus and pineapple, has recently increased in response to a high demand in Trinidad and Barbados. The production of pineapple increased from 7,900 tonnes in 1987 to 11,200 tonnes in 1989 – approximately 3,500kg are shipped to Barbados weekly for sale on the local fresh fruit market.

The major thrust for the growth of non-traditional exports is being provided by the 'New' Guyana Marketing Corporation (NGMC), which is no longer directly involved in trading, but which supports the efforts of private-sector entrepreneurial groups such as ANTEG (Association of Non-Traditional Exporters of Guyana) and other traders.

To date, the NGMC has undertaken:

- training in post-harvest technology to exporters and extension personnel
- package development
- sea transport shipping trials
- establishment of a small root and tuber packing house as a service facility for exporters

The NGMC is currently implementing a project to investigate the technical and marketing requirements to assist market expansion of citrus and pineapple. Post-harvest issues being investigated include varietal characterization (Sugar Loaf, Montserrat, Antigua Black), assessment of genetic variability, and control of physiological and pathological disorders. The project will also include investigations on sea freighting, package development and post-harvest management.

The NGMC is supported by the National Agricultural Research Institute (NARI) which is currently investigating tissue culture production techniques for root crops, plantain and pineapple.

Carambola is also being considered for export development and work is currently being conducted with the IICA office in

Guyana on improvement of the total system for production, harvesting, post-harvest handling, transportation and marketing of both fresh carambola and processed products.

With respect to developments in floriculture, the inadequacy of freight and transportation arrangements, both internally and externally, severely limit Guyana's ability to exploit the tremendous potential of its natural flora . Recent initiatives have focused on the development of 'natural' resorts featuring the various types of tropical flowers and ornamental foliage indigenous to Guyana.

Jamaica

The agriculture export sector in Jamaica showed significant growth in 1990 with earnings totalling US$161.3 million, the highest level for the past 10 years. The improvement in the sector during 1990 is attributable to other considerable recovery from the effects of Hurricane Gilbert and also the very positive response by farmers to the incentive framework, especially for export crops, which has been developed over the past 7 years. There have also been significant developments in the areas of production, applied post-harvest research and technology adaptation. Worthy of note is the establishment of three organizations - the Agricultural Export Services Project (AESP), the Rural Agricultural Development Authority (RADA) and the Jamaica Agricultural Research Programme (JARP).

The Agricultural Export Services Project (AESP)

The AESP was established in 1990 with grant funds of US$10 million from USAID and matching funds of US$8.85 million from the Government of Jamaica and private sources. The project, which will run for 7 years (until 1996), has as its objective the increase of exports of traditional and non-traditional crops in Jamaica. This objective will be achieved through the development of agricultural technology and management systems in production, packaging and marketing of export crops. The beneficiaries of the AESP will be small and medium-scale farmers, as well as private sector agencies and organizations involved in agricultural export.

The project encompasses activities in three main areas:

- *Export production sub-projects:*
  These sub-projects are aimed at small to medium-scale farmers and will deal with production, harvesting and implement-ation of post-harvest technology.

- *Production and post-harvest export services:*
  Public sector agencies are the targets in this component. Sub-projects will focus on the provision of extension services and the delivery of practical skills training.

- *Export sub-project design and management services:*
  In this category, institutions with a track record in agricultural export assistance will be facilitated in undertaking feasibility and marketing studies and research, as well as short-term management and applied technical assistance.

Under a Condition Precedent, all of these sub-projects will undergo an Environmental Impact Assessment (EIA) before any funds are committed.

Rural Agricultural Development Authority (RADA)

The AESP works in close collaboration with RADA which was established as a statutory body, legislated to provide an efficient extension service to small farmers in particular, and to participate in the formulation and implementation of rural development projects with a view to stimulating and facilitating the development of agriculture in Jamaica.

RADA is currently working on a Hillside Agricultural Project, the main objective of which is to increase productivity and expand the acreage of vegetables, root crops and legumes, while preserving the environment so as to ensure sustainable production in the watershed area of the Parish of Clarendon.

The project has so far, assessed the factors causing post-harvest losses in the area and is currently implementing recommended harvesting and handling techniques on a pilot scale. Work is also being carried out on improved field handling and packaging, provision of transport vehicles, the establishment of organized marketing arrangements, and the development of cottage industries.

Jamaica Agricultural Research Programme (JARP)

JARP was established under a USAID grant 3 years ago to provide adaptive and applied research support aimed at increasing 'productivity and production capacity of poor small farmers'. Its priority areas of interest are 'ethnic' local food crops, fruit, ornamentals and farming systems.

During 1990, some 35 project proposals were received, and of these, 21 were approved. Nineteen projects have been implemented over the past 3 years with collaboration from the University of the West Indies. Four collaborative projects with the private sector have been drafted and approved.

JARP played a key role in the confirmation of the presence of Papaw Ringspot Virus Disease in Jamaica, and collaborated with growers and the government in instituting a programme to restrict the spread of the disease.

Specific developments in post-harvest management of fruits and ornamentals include the following:

Papaw and mango
In the export of the Solo variety of papaw, treatment and packaging equipment is currently in operation. Trials have also been successfully carried out on sea-freighted papaw shipments and plans are being made for full-scale commercial shipments. For mango, hot water baths have been developed for the treatment of Tommy Atkin and Keitt varieties for the European market. The mangoes are washed in chlorinated water before being given a hot water treatment at 55°C for 5 minutes. A fungicidal dip is combined with the hot water treatment for the prevention of stem-end rot infection.

A hot water treatment for fruit fly infestation (46°C for 70-90 minutes) is also being investigated.

Banana
The banana industry has developed a mini-pack technique which is essentially a field-packing operation. Bunches are dehanded, selected, drained, dipped in fungicidal solution, and packed in cartons for export.

An innovation in export marketing was recently implemented by the Banana Export Company, which was successful in securing a market in Europe for approximately 5,000 tonnes of banana that fell below the selection criteria for the British market.

Ornamentals
The area currently allocated to the production of floricultural products is about 313ha made up as follows:

anthurium	42.5
red ginger lily	52.5
pink ginger lily	8
heliconia	71
gerbera	1
leather leaf fern	44.5
roses	2.5
birds of paradise	10
miscellaneous foliage	81

Projects of major interest are orchids, anthurium, spray chrysanthemums and foliage plants. Tremendous strides have recently been made in orchid production and technology.

The increase in area under leatherleaf fern from 17ha in 1989 to the present figure of 44.5ha is largely due to the recent establishment of a 28ha farm by a US investor.

There are approximately 85 growers and 26 of these actually export floricultural products.

The most urgent problem in the floriculture industry in Jamaica is the restoration of confidence in the banks and the growers. The Agriculture Credit Bank, which in the past has already disbursed over US$40 million, has been delaying its decision to lend very large sums needed for soft loans after Hurricane Gilbert. Many growers are utilizing loan funds at interest rates of up to 33 per cent and none have reached the critical economic size in any one product to make floricultural production and marketing commercially feasible.

Existing infrastructure and support services

As part of its groundwork for the expansion of the agro-processed goods sector, Jamaica Investment Promotions (JAMPRO) is working with experts from the United Nations Industrial Development Organization (UNIDO) to secure supplies of agricultural raw materials at economic prices. To this end, JAMPRO has been encouraging entrepreneurs to plant crops such as papaw and mango and works closely with RADA.

The Ministry of Agriculture, through its Produce Inspection Division, routinely carries out inspections of all produce at all points of exit from the country (wharf, airport and post office). Inspections also take place in the field and at packing houses. Ten per cent of large cargo shipments is examined randomly and phytosanitary certificates, as well as any additional declaration documents, are issued where required.

The Agricultural Export Complex was established in 1986 with financial assistance from the World Bank, USAID and FAO to promote the export of agricultural products and stimulate production, primarily through the provision of services to exporters. The two main facilities provided to the exporters are fumigation facilities and cold storage/holding facilities. The fumigation facilities consist of two export fumigation chambers, a vacuum fumigation chamber for imports and a pre- and post-fumigation storage building.

The two fumigation chambers, which have dimensions of 6m x 6m x 3m (108m^3 or 4,000 cubic feet), can each hold 12 tonnes of produce when filled to 80 per cent capacity or 800, 20kg boxes. The rooms were constructed in accordance with USDA specifications and were approved by the USDA. Each has a built-in electronically controlled safety device, a hot water heating system, and an efficient exhaust system.

The post-fumigation storage building is designed to provide ambient storage conditions with natural ventilation. It is also equipped with extraction fans to cool and remove any residual fumigant. All openings are insect-proofed with mesh wire.

There are five cold storage units with individual controls that are adjustable for temperature and relative humidity. The units are classified as follows:

- Fruit and vegetables - 30-40 tonnes

- Flowers and foliage - 1,000 boxes

The facility also houses a produce inspection area where samples are taken for examination. Plug-in systems for refrigerated trucks are also available for use by exporters.

Bibliography

De Freitas P. 1991. Jamaica: Looking for the market niche. CANABUSINESS May 1991 pp 11-12.

De Freitas P. 1991. Great possibilities in Guyana if... CANABUSINESS May 1991 p 13.

Lawrence J. 1991. Status of post-harvest activities of fresh Produce in Jamaica with reference to export and food losses of small farmers. A paper presented at Roundtable on the Reduction of Post-harvest Fruit and Vegetable Losses through the Development of the Cottage Industry in Rural Areas in CARICOM Countries. November 1991.

Muller G , Reid R and Proctor FJ. 1990 Strategic review of post-harvest technology of horticultural crops in the Caribbean. Report of a Joint Mission by the Caribbean Agricultural Research and Development Institute and the British Development Division for the Caribbean. CARDI, Trinidad & Tobago. 111p.

Ramsammy P. 1989. The carambola in Guyana. Proc. Inter-American Soc. Trop. Hort. 33 12-23.

Ramsaroop B. 1989. Cut flowers, foliage and ornamental plants from Guyana. 4th International Floriculture Seminar Transcripts. Selected Papers, Pathfast Publishing.

EXPORT OF VEGETABLES AND FRUITS: INITIATIVES IN MARTINIQUE AND GUADELOUPE

P Daly
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Aubergine (Eggplant)

Aubergines were first grown in Martinique in 1965, initially for the North American market, using the Pompano Market and Florida Market varieties.

Growers turned very quickly to the French market, for commercial reasons, because of ignorance of phytosanitary regulations, of distribution networks and of pricing structures on the North American markets, and because of inadequate sea and air links between the United States and the French West Indies.

Martinique alone exported 10,000 tonnes between September and June 1972. Between 1973 and 1980 the production output fell to 5,000 tonnes on both islands in the French West Indies, Martinique and Guadeloupe. It subsequently fell steadily until 1982 in Martinique and 1988 in Guadeloupe.

What problems arose, and why this fall in output?

The American market looks for shiny black oval-shaped fruit (Pompano Market and Florida Market) weighing about 450g each, whereas the French market prefers elongated fruit weighing between 250 and 350g and dark violet or shiny black in colour (Violette Longue and Violette de Barbentane).

These varieties were exported during the first years, but were not well adapted for health reasons.

Main pest problems
On the Caribbean islands, the choice of varieties also depends on the relative threat from certain pests, mainly bacterial wilt due to *Pseudomonas solanacearum*, and fruit anthracnose (*Colletotrichum gloesporioides*)

The humid islands and seasons favour both diseases. With the exception of smectite clays (magnesian vertisols and calcareous magnesian soils), all soils are subject to *Pseudomonas*, and anthracnose affects each area of each island.

We have had to create a resistant variety for Martinique and Guadeloupe. At the present time, and since 1975, only Kalenda is on the market. The fruit is elongated, resistant to anthracnose, and the plant is only tolerant to bacterial wilt when the attack is not too heavy and when cultural practices are good. The Institut National de la Recherche Agronomique (INRA) is working on more resistant hybrid varieties which will be tested in July 1992. The producers of aubergine were banana farmers located in humid areas where bacterial wilt is very virulent. One important part of the acreage was destroyed each year.

Other pests
The most recent problem arising in 1985/86 was *Thrips palmi*.

Work carried out in Martinique has lead to the use of a control method which improves the situation but which does not give perfect results. For the local market, which is not very fussy, integrated pest management without the use of Thrips-specific pesticides gives crops in which 50 per cent of the fruit bear some suberised traces caused by this insect. For exportation it is possible to have unmarked fruit with a smooth shiny black epidermis by treating the soil with Vydate® (oxamyl) microgranules from the nursery stage, and every 3 weeks after planting-out, in compliance with the phytosanitary legislation.
This product also protects the crop against several piercing-sucking insects specific to aubergines, such as *Polyphagotarsonemus*

latus, *Liriomyza* sp. and *Corynetaica planaris*.

One problem remains, which is that of the whitefly (*Bemisia tabaci*). Integrated pest management is not possible with this insect; only a few non-specific insecticides can be used at the moment.

Diseases
Some diseases may appear during the crop cycle, either in the field or during the transport of crops for export.

The most frequent are fruit rots due to *Phytophthora parasitica*, *Erwinia carotovora*, *Choanephora cucurbitacearum* or *Corynespora melonis*.

The humid regions are particularly contaminated and, these fungi and bacteria being ubiquitous, the primary centres are many and impossible to control in regions where crops, uncontrolled fallow and woodland intermingle.

Crops in the drier regions, especially in the south of Martinique or in Grande Terre in Guadeloupe, give better harvests. Even in these regions, however, preventive treatment ensures a better sanitary control. This is an important point which is in general insufficiently taken into account in the West Indies.

Overall pest control should therefore be very carefully considered.

To summarize, the success of aubergine crops for export presupposes effective sanitary control. This remark can be extended to all vegetable crops.

The development of research in this field is therefore absolutely essential But research results are not sufficient. Training farmers, technicians and farm workers is just as necessary, for we have in the Caribbean an agricultural population with little training, having experience only of growing crops such as sugar cane and banana, except for some areas in Trinidad and in Barbados.

The history of melon growing in Martinique and Guadeloupe and the technico-economic characteristics of this crop

Melon growing in Martinique and Guadeloupe goes back many years. Some ecotypes from imported seeds were grown in the south of the island (Sainte-Anne) in Martinique and in Grande Terre in Guadeloupe as a rain-fed summer crop for local consumption (July and September).

As soon as irrigation was made available for food crops, banana replaced sugar cane in the valleys with deep soils in the south-east of the island, and there was subsequently diversification into vegetable crops as soon as suitable varieties were shown to be worthwhile.

As early as 1975, the Chilton variety of melon was distributed for the local market. The advantages of this American cantaloupe musk-type variety are its resistance to splitting and to fungal diseases, such as powdery mildew (*Erysiphe cichoracearum*), mildew (*Pseudomonas cubense*) and gummy stem blight (*Mycospherella melonis*), and its relatively constant refractometric index.

The initial producers had no experience of vegetable growing (they were sugar cane or banana growers, or cattle raisers) so this variety suited the possibilities existing at that time – limited specialized technical knowledge and the absence of any organized export channels.

Melons for export

It was in 1985 that the first producers of cantaloupe melons for export appeared.

Their origins
For many years, melon-growing in France had been limited to the summer months. It was extended to the springtime with the building of tunnels and unheated greenhouses.

French producers sought to extend the growing period by first of all using new methods, and then by physically moving further and further south. As part of this strategy, some became interested in Africa (Senegal in particular) and especially in the French Overseas Departments (Guadeloupe, Martinique and now Reunion),

Their move to these regions has enabled them to supply melons in the off-season, thereby keeping their customers. The characteristics of these growers are:

- Good melon growing techniques, used by growers who have been specializing in melons in France for many years

- a production-marketing continuum, ensuring the arrival of the melons on the market in the best possible conditions and an involvement of the sellers, ensuring that they look for the best prices and maximum sales

- various links (partnerships, supply contracts) with local farmers, enabling a technology transfer in the best possible conditions.

The growing region
In Martinique and Guadeloupe, the melon growing region is characterized by clay soils (50 per cent smectite clays). In some areas these are on limestone substrates (with a pH of about 7-7.5), but in some cases on old volcanic substrates (with a pH of 6-6.5), with a good chemical balance.

Rainfall varies from 1200 to 1500mm per year, with a heavy rainfall concentrated between August and December. The region is fairly windy and less contaminated by insects than the sheltered leeward coast.

It is suitable for melon-growing and it is possible to get good quality fruit from January to May/June.

Its closeness to the port and the airport, and the reasonable road network ensure rapid transit from the production plots.

For the south of Martinique, which is looking to renew its economic activity, melons are a cash crop which is well worthwhile.

Growing systems
Melon growers are sometimes owners of their plots (some small producers), but more usually they are tenants on the large farms devoted to cattle-raising in Martinique or sugar cane in Guadeloupe.

They can therefore change their plots within an area which is large enough to limit the development of phytosanitary problems (fungal diseases and insects), mainly in Martinique.

Growing techniques
The variety used, Alpha, has been known in the tropics for some years. The cantaloupe group is less well-suited than others to the tropics,however, with good growing techniques, a high quality harvest is possible in the dry season. The Alpha variety, despite its tendency to give large fruits at the end of the growing period (April/May when temperatures rise from 22°C, the average minimum temperature in December/January, to 24-25°C in May/June and after), is considered satisfactory.

Mulching and localized fertilization techniques are used by the growers.

The ratio of evaporation (measured in a Class A tank) to the needs of the plant has been estimated, making it possible to specify the growing coefficients at different stages of the cycle: rooting, setting, vegetative growth, swelling, harvest.

Pruning is reduced to a minimum – limiting the length of shoots in the pathways.

Refrigeration of the fruit after harvest and sorting and transport in refrigerated lorries to the departure airport ensures that quality is maintained; the temperatures used are satisfactory.

A drop in the temperature of the fruits to 13°C is obtained by placing them in refrigerated storage for 8-10 hours at 10°C, or 4 -6 hours at 5°C. It would seem that the length of storage should not be more than 2-3 days. On the third day there is a loss of firmness and a yellowing of the skin and spots appear on the epidermis.

Diseases
Up to now in the south of Martinique and in Grande Terre of Guadeloupe there has been no damage nor the appearance of virus disease. Some fungal diseases, such as gummy stem blight and powdery mildew, are likely to appear and cause damage. Mildew is especially to be feared in the early growing season. There are quite a few effective chemicals (contact and systemic pesticides).

Pests
There are some pests that can cause problems. Attacks are not systematic, but are always to be feared, so pest control has to be organized. The Institut de Recherches Agronomiques Tropicales et des Cultures Vivrières (IRAT) advocates integrated pest management which is replaced by rational chemical control if one or other of these pests poses a real problem.

The main pests are:

- *Thrips palmi* which can be controlled by two systemic products – Vydate® and Marshall® – applied to the base of the plant. Unfortunately they are not authorized for use on vegetable crops in France.

- Whitefly (*Bemisia tabaci*), which is not adequately controlled by leaf treatment with Zolone®, Talstar® or Selecron®.

NTN (which will be available in 1992 under the name Confidor®) has shown itself to be effective on both pests as a leaf spray.

However, insect pest control is far from adequate.

Nematodes
On these very clayey soils (50 per cent clay), where up to now cultivation has been fairly extensive (one melon harvest per year and sometimes once every 2 years on the same plot), root-knot nematodes have not as yet posed any problem.

Growth cycle and yields
The cycles are fairly rapid:

- Sowing to planting out (growing in blocks)	15 days
- Planting out to first harvest	45-50 days
- Harvests	15-21 days

For cantaloupe varieties, the number of fruit per plant is low – one to three depending on the season and usually one or two. Yield depends above all on the density and the average weight of the fruit. Marketable yield varies between 5 and 8 tonnes per acre, the average being between 6 and 7.

Post-harvest techniques
They are simple but must be stictly applied.

Washing
The fruits are washed in water to clear them of soil. The work is done by hand, or on large farms in automatic washers.

A first sorting (pick-off) is executed at this stage. The injured fruits, or fruits with unsuitable shapes, are taken out.

Sorting
Fruits for export are separated from the ones for the local market (too ripe; with slight disformities; too big; with slight cracks). On average 20 per cent of the harvest is 'picked out'.

The exportable fruits are divided in three classes: first choice or Extra or Must, second choice, third choice. The criteria for selection are: cleanliness of the skin, ripeness, ugar content and shape.

Grading
The fruits retained for export are graded for size either by hand or with a mechanical sorter. The grade is related to the number of fruits that can be packed in a bag.The standard size of the bags is 60cm x 30cm x 15cm.

The grades range from 6 to 14:

- Grade 6: the fruits are large – more than 1.5kg. These are especially for the Italian market

- Grades 12 and 14: the fruits are small and they are directed to the markets with wide distribution such as supermarkets or hypermarkets.

Palletization
The bags with fruits of same grade are collected on wooden pallets to facilitate the manipulation by fork-lift truck.

One pallet can hold 80 bags. These pallets are joined four by four on cargo pallets. The fruits are stacked quickly after the bagging in a cold room (6 to 8°C), and transported to the airport in a refrigerated truck (10 to 12°C). At the airport, after the customs formalities, the pallets are stacked in a cold room until departure.

Marketing constraints

Identification of the product

The objective is to persuade the customers not to consume just any fruit, but to refer to a brand, a label in which he will have confidence. In France and European countries the brand 'Philibon' is widely known.

Strict quality control must be undertaken at the packaging plant. Quality is absolutely essential to retain the customers.

The fruits in the bags must be homogeneous for each class. However, the produce is naturally heterogeneous, in skin colour, in maturity, in shapes and sizes and in sugar content. We have heterogenity between plots and the supervision of the techniques used is very different from one farmer to another.

The sorting operations must ensure a likeness between all the fruits for shipping overseas. The limits of this operation are determined by the heterogeneous behaviour of plant material depending on climatic conditions and unpredictable harmful events.

Reducing the time between harvesting and marketing

This point is very important for cantaloupe, because the production areas are far away from consumer areas. Two days are necessary between harvest and market. Shipping must be daily; a break of a link in the chain makes organization of the channel difficult.

Planning of planting dates and harvest dates must be strict because a pile-up at the packaging station would mean storing a great quantity in the cold room and then fruits would be landed at the market in a mature state, causing a drop in value. The pressure on the sales organization after packaging would then be very strong.

Determining and assuring quality

The criteria to determine the quality of melon fruits are numerous: cleanliness of the skinwhich should be yellow or silver coloured; sugar content; flavour; flesh colour; taste. Some of them have a subjective character - only the refractometric point can be considered as a real measure.

The costs (production costs, transport costs).in Martinique and Guadeloupe are very high For that reason the product is destined for an off-season market for which quality is the prime concern.

If the quality is to be achieved by severe sorting, it is above all else determined in the field by the cultural practices employed.

Irrigation influences the yield and seems to increase the sugar content for the medium sizes. Fertilizing is also a cause of good or medium quality (potassium decreases cracks in the fruits; a magnesium/potassium ratio within the range 0.14 and 0.33 leads to higher sugar content; spraying with phosphorus anhydride increases the flavour).

Pests, diseases and physiological accidents alter the sugar content.

The harvest point is very important when we have to export. The refractometric index is below the quality stage four days before maturity; two days before it becomes acceptable.

For export the fruit is harvested at this stage of pre-maturity in order to ensure good quality after the time of shipping.

The signs of the right stage for harvest are:-

- turning of the colour
- wilting of the leaf just over the fruit
- cracks near the fruit stalk

At harvest time, the fruits must be guarded from the sun and put under shade. The best harvest time is in the morning when the temperature of the fruits is not so high.

ACTIVITIES AT THE CENTRE DE CO-OPERATION INTERNATIONALE EN RECHERCHE AGRONOMIQUE POUR LE DEVELOPPEMENT (CIRAD)

J J Baraer
CIRAD, Guadeloupe

I will be very brief about the post-harvest activities of the Centre de Co-opération Internationale en Recherche Agronomique pour le Développement (CIRAD) in relation to the fruit crop sector in the French West Indies

Our institution is very much concerned with the relationships of the productive sector in our islands. This means that our post-harvest activities are limited to attending to the requests of our partners. At this time, the only request is on banana.

However, a lot of work has been done in the French West Indies from 1970 to 1980 in this sector, when the private sector and the government authorities were showing an interest in diversification programmes.

Research was done on the following fruits:

Avocado

This research was done in Martinique and the main topics were:

- Choice of simple criteria for the determination of harvest time
- Definition of parameters of temperature and ventilation for containerized sea transportation
- Selection of packages for transportation under refrigerated conditions
- Post-harvest techniques of waxing fruits

All this work allowed Martinique to play a significant part in supplying the European market. Unfortunately, work had to be stopped when exports became no longer significant. Exports only stopped for marketing reasons and not for technical ones; lack of competition and lack of varietal diversification.

Tahiti limes

This work was also done in Martinique. The main areas of investigations were:

- Choice of criteria for determination of harvest time
- Thinning techniques, with chemical products
- Choice of grading, sizing and sorting lines for exportation
- Choice of waxes
- Choice of boxes for air and sea transportation
- Development of degreening techniques for the local market.

As far as for avocado, work stopped with the disappearance of Martinique as an export origin to Europe.

This was due mainly to marketing difficulties too: new sources were more competitive - Brazil, Central America and West Africa.

Mango

Research was done in Guadeloupe from 1975 to 1982 on the following:

- Easy criteria for determination of harvesting time for export

These simple investigations would allow for easy marketing on the European market.

Papaw

The same research topics as for mango were addressed for papaw in Guadeloupe during the same period. Now constraints like bacteriosis have impeded further development of this crop.

Other post-harvest research

During 1980/85 various investigations in post-harvest management were made:

- In France for the most fundamental work – Fruit post-harvest physiology
- In West Africa for more practical work on pineapple, mango and papaw
- In the Indian Ocean, Reunion Island, Madagascar and Mauritius, for litchi and mango.

It is obvious that all these results as well as those already developed earlier in the Caribbean, are at your disposal if you need them.

Banana

In conclusion I would like to tell you something about our researches on post-harvest aspects of banana. Our main problem is one of quality so we are working on the following:

- developing new techniques of harvesting: cable-way; trailers equipped with trays; field packing
- adapting the packing houses with emphasis on sanitary requirements
- testing new fungicides on post-harvest treatments
- testing fungicides which allow a pre-harvest treatment in accordance with EEC requirements
- studying the adaptation of boxes

Let me coclude by saying that a restructuring is on the way for our fruit department in the Caribbean. Frm 1992, we will try to have a more coherent, and I hope more efficient, approach:

- In Martinique research will be done on pineapple, citrus and fruit diversification
- Guadeloupe will focus on banana and also fruit diversification

In that way, teams of researchers, with technical support, will be reinforced in order to have three main centres – Banana, Pineapple and Citrus – with wider scope at the regional and international level.

Thus it will be possible again to undertake activities of fundamental research and development on post -harvest matters in co-operation with other organizations or institutions which already support the fruit sector in the Caribbean.

PRODUCTION, POST-HARVEST MANAGEMENT AND EXPORTATION OF TROPICAL FRUITS IN COSTA RICA

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Ministry of Agriculture, Costa Rica

General aspects

The agricultural sector has always been of vital importance in the Costa Rican economy since colonial times and is the result of a series of factors related to the social structure which developed over several years. Agriculture has been closely linked to the economic, political and social development of the country.

Since the eighteenth century a rudimentary economic structure and a family orientation towards self-sufficiency in products such as corn, wheat, sarzaparilla, cocoa, tobacco, cotton, potato, sugar cane, plantain etc. was organized in Costa Rica. These products were planted using basic production techniques and very simple implements. Later the cultivation of cocoa and tobacco failed through diverse circumstances and so did the family production structure which was replaced by a very sophisticated model of production geared for foreign trade. Years later in 1820, the initiation of coffee exports definitely marked a development of the Costa Rican economy.

Since that time and until a few years ago, the economy was based on an agricultural export model depending on five basic products – coffee, meat, banana, sugar and cocoa. At the end of the 1980s and under a governmental policy, tending towards the diversification of production in order to reduce the vulnerability of the economy, other products became important in the export ambit, among which one can mention ornamental plants, flowers, pineapple, mango, macadamia, melon and strawberry.

Although the agricultural exports comprise coffee and banana principally, other products have also been sources of foreign exchange for the country which is very important from all points of view for the Costa Rican economy.

Problems of post-harvest management of horticultural crops

The development of agriculture in Costa Rica has been in response to two principal imperatives:

- to feed the local population
- to provide, through the sale of products, the purchasing power to subsidize other vital necessities.

However, in the last decade following other imperatives to produce for export, several products showed an acceptable income and favourable external marketing conditions.

The foregoing will promote areas of growth of alternative products and sources of income. But this development of production for export has taken place without adequate knowledge of the techniques of post-harvest management and this in some cases has diminished competitiveness in the European and North American markets. It also necessitated the generation and transfer of technology in post-harvest management techniques, with the objective of obtaining high quality and large commercial volumes of products to maintain the market and increase the income from the products involved in the activities of export of perishables.

It is known that fruits and vegetables are perishable products that continue to metabolize even after harvest. The useful life of a perishable agricultural product depends on biological and environmental factors which, if not adequately managed, will accelerate the speed of the processes which cause deterioration. If one adds to these the effects of inadequate practices and conditions of harvest, transport and storage on the volume of our fruits, losses ranging from 22 to 78 per cent are experienced.

This results in weight loss, excessive ripeness, mechanical damage, rotting and shrinking. In our country, during the early years of the 1980s, not many studies identified the causes and quantified the post-harvest losses. For this reason research is now being done this area.

The little work done has generated information which does not give all the elements necessary to understand the post-harvest issues of some products. There is not enough information to help in guiding technical policy and economic decisions towards reducing the losses in perishable products. Recognizing the importance of such information on post-harvest handling, in 1990 an arrangement was made between the Ministry of Agriculture and Livestock and the University of Costa Rica, Laboratory of Research and Service in Post-harvest Management, to contribute to the objective of finding ways of improving the conditions of production and marketing of perishable agricultural products, for the internal as well as the export market.

Principal research in tropical fruits

Fresh and processed tropical fruits are in great demand in the international market and in Costa Rica production of tropical fruits has great possibilities as an important source of foreign exchange. One of the first pieces of work done in Costa Rica concerning post-harvest problems of six tropical fruits was done by Arauz and Mora in 1983. An abstract follows:

> In this study, the post-harvest problems of avocado, soursop, mango, melon, papaw and pineapple in Costa Rica were analysed.
>
> Information about post-harvest handling, quality problems and production technology was obtained from a poll among fruit growers and middle men.
>
> Post-harvest losses were: soursop, 75 per cent; mango, 44.3 per cent; avocado, 35.0 per cent; melon, 32.0 per cent; papaw, 29.8 per cent; and pineapple, 18.8 per cent.
>
> A model relating overall post-harvest problems was designed to elucidate research priorities. The priority list was melon, papaw, pineapple, mango, soursop and avocado.
>
> The main source of post-harvest problems in Costa Rica was deficient field practice due to the lack of knowledge of the fruit growers on fruit quality aspects. It was also shown that inadequate handling during the marketing process increases the loss. The establishment of quality standards for the local market was regarded advisable.

In 1986 Arauz and Umana made a survey of post-harvest diseases of mango in Costa Rica. The following is an abstract of their report, Diagnosis and Incidence of Mango Post-harvest Diseases in Costa Rica:

> A survey on mango post-harvest diseases in Costa Rica was performed on a randomized sample of different cultivars in the principal production areas. Pathogenicity of the fungi found was determined. A bacterium of the genus *Pseudomonas* was also found to be pathogenic.
>
> The average anthracnose (*Colletotrichum* sp.) incidence was 85.7 per cent on the fruit sample during 1982 through 1984. During 1984 the incidence of the diseases caused by the other fungi was determined as follows:
>
> *Lasiodoplodia* sp. - 10.4 per cent
> *Pestalotia* sp. – 3.3 per cent
> *Aspergillus* sp. – 1.0 per cent

Other research done in Costa Rica in the area of post-harvest management of fruits and ornamentals includes:

- Durán and Mora (1987) Diagnosis of post-harvest diseases of papaw in Costa Rica. I. Experiments of pathogenicity.

- Durán and Mora (1987) Diagnosis of post-harvest diseases of papaw in Costa Rica. II. Quantification and epidemiology of the diseases of the fruit.

- Durán y Mora (1987). Variability in symptomology of anthracnose (*Colletotrichum* sp.) in papaw during the post-harvest period in Costa Rica.

- Demerutis (1991). Diagnosis of post-harvest management and determination of losses in orange and papaw destined for the national market.

- Saborio (1990). Preliminary diagnosis of post-harvest losses in pineapple for export.

- Cerdas (1990). Preliminary diagnosis of post-harvest losses of mango for export.

Current research

The following research is being carried out by the Post-harvest Laboratory (Ministry of Agriculture and the University of Costa Rica) in Costa Rica.

Mango (*Mangifera indica*)

Title: Improvement of the post-harvest technology of mango for export

Objective: To improve the post-harvest management of mango for export - from harvest to destined market

Sub-project 1
Identification and quantification of physical and chemical changes of four commercial export varieties of mango related with the physiology of the fruit.

Sub-project 2
Identification and quantification of the causes of deterioration of mango.

Sub-project 3
Reduction of post-harvest losses in mango due to staining by latex.

Sub-project 4
Evaluation of the effect of pre-cooling on the quality of mango.

Sub-project 5
Evaluation of the effect of quarantine treatment measures on the quality of mango.

Papaw (*Carica papaya*)

Title: Improvement of the post-harvest management of papaw for national consumption.

Objective: To reduce the post-harvest losses of papaw for national consumption by using several methods - heat,chemical and physical - to combat anthracnose and an improvement in the type of packaging.

Sub-project 1
The effect of hot water at different temperatures and duration of treatment on the development of anthracnose and the quality of papaw fruit.

Sub-project 2
Effect of hot water treatment or cold water in combination with chemicals on the development of anthracnose in papaw.

Sub-project 3
Effect of the application of hot water and chemical products in combination with wax on the development of anthracnose in papaw.

Sub-project 4
Evaluation of the use of packaging for transport of papaya in the national market.

Pineapple (*Anana comosus L.*)

Title: Evaluation of post-harvest management and factors of deterioration in pineapple (*Ananas comosus* L. var Cayenna Lisa y Champaca) for export from the North Zone of Costa Rica.

Objective: To evaluate the post-harvest management for export of the pineapple variety Cayenna Lisa y Champaca .

Sub-project 1
To identify and quantify the causes of deterioration of pineapple for export in the North Zone of Costa Rica.

Sub-project 2
To analyze the characteristics of the internal quality of pineapple for export, produced in the North Zone of Costa Rica.

Rambutan (*Nephelium lappaceum*)

Title: Diagnosis of the post-harvest management of rambutan (*Nephelium lappaceum*)

Objective: To develop a study of post-harvest management of rambutan for identification and quantification of the principal causes of post-harvest losses of this fruit.

For this work to be realized research needs to be conducted on harvest and from post-harvest through to vendors – conditions of transport, conservation treatments, pack-aging, packaging materials etc.

Avocado (*Persea americana L.*)

Title: Analysis of quality and post-harvest behaviour of avocado (*Persea americana* L) for export.

Objective To analyze and evaluate the behaviour of avocado in the post-harvest stages, coming from the different zones of Costa Rica.

Economic aspects of production and exportation of tropical fruits in Costa Rica

Since the diversification of agriculture for export was started, much attention has been paid to the role of tropical fruits for external markets. This has increased every year.

In 1984 the export figures were 394 and 14,204 tonnes of melon and pineapple respectively. In 1989 the figures were 2,180 and 55,992 tonnes for melon and pineapple respectively and for papaya, 919 tonnes.

These trends in the volume of exports of tropical fruits are shown in Figure 1.

In order to appreciate export activity of tropical fruit reference is made to Figure 2 which shows for example that for pineapple in the year 1985, we received US$6,360,000 but in 1991 this value increased by 457 per cent to US$35,471,000.

Fig. 1. Exports of tropical fruit from Costa Rica

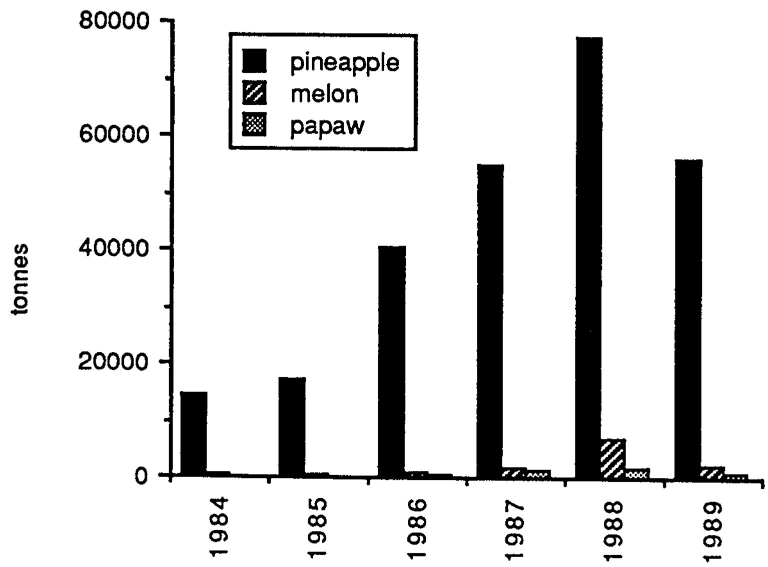
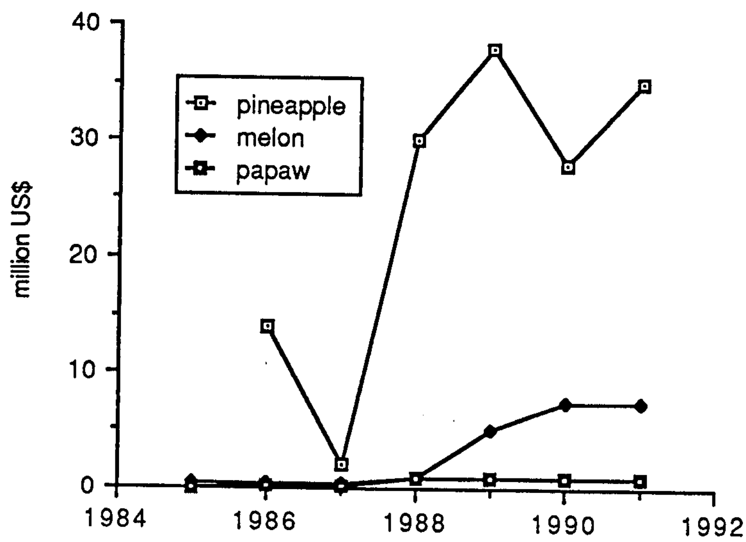


Fig. 2. Value of tropical fruit exported from Costa Rica



INTEGRATED POST-HARVEST MANAGEMENT: CONSIDERATIONS FROM PRE-PRODUCTION TO CONSUMPTION

Felicity J Proctor
Natural Resources Institute, United Kingdom

Successful horticultural industries require vertical integration from pre-production planning to the point of retail sale. The roles of the commercial and public sectors should be clearly defined and responsibilities of the different players understood and implemented. A weak link in the production/market chain will negatively impact on the industry. Strategic planning for a market and recognition of the roles and responsibilities of the players facilitates intervention in the post-harvest manage- ment of commodities as well as in decision taking in investment into physical infrastructure. These issues are presented together with a forward look to changes and trends in the market place which will potentially impact on post-harvest systems.

Tropical fruit and the ornamentals' industries in the Caribbean differ greatly both between the two crop groups and within them. The tropical fruit industry has gained significant experience through the operations of the banana industry in the Windward Islands, and the citrus and banana industries in Jamaica. These industries and to some degree those of the ornamental industries specifically in Jamaica, offer many lessons to be learnt for the non-traditional tropical fruit and the emergent ornamentals programmes of the region. The markets for produce grown in the region are as diverse as the production base itself. This paper will focus on some of the issues which arise in integrating post-harvest management into the complex production and marketing matrix within and outside of the Caribbean region.

Production/market context

The production base for non-traditional commercial fruit, for example mango, avocado, plantain, passion fruit and soursop, ranges from individual growers maintaining a few trees/stands for family and local use to small cash crop enterprises focusing on the regional markets. Over the past 10 years there has been increased focus on the exploitation of extra-regional market opportunities, principally those of North America and the European Community. The production base for these markets has been drawn largely from small scale production and often from within mixed farming systems.

The initiatives and actions have been largely production rather than market driven and almost without exception operated without a strategic production and market plan at all market levels. The extent of vertical integration of the players in the production/market chain is low. These characteristics negatively impact on the technical and economic feasibility of establishing effective post-harvest management systems within the present structure. Some of the features of the current production/market scenarios are given in Tables 1 and 2.

The differing demands of the markets mean that for the Caribbean region to effectively develop and maintain robust industries the producers and traders should consider the extent to which their industries wish to be dedicated to a particular market and thereby to establish the post-production management and infrastructure, including the level of vertical integration, necessary to meet those specific demands.

Table 1 Features of the local and regional markets

Market	Features
Local	• small volumes per transaction • delivery/sale same day • limited demands on quality, selection and packaging • daily/weekly market options • all year round markets • limited external competition • mixed produce consignments/sales • many growers/traders • short transport distances • limited infrastructure requirements • low technology • low capital investment • low risk • no/limited formal planning • vertical integration generally not required
Regional.	• small-medium volumes per transaction • 2-5 days harvest to market • product quality/price differential • competitive market • mixed and single commodity consignments • moderate infrastructure eg packaging, transport • low-medium technology • time scheduled transport • 2-3 week commercial transaction period • vertical integration desirable • forward planning desirable

Table 2 Features of the extra-regional market

- volumes influenced by transport mode usually moderate-high
- less frequent transport
- limited transport destinations
- longer transport distances
- highly competitive
- high demands on quality and packaging
- communication infrastructure required
- physical infrastructure required including packinghouses
- temperature management etc.
- international commercial skills
- high technology
- 4-8 week commercial transaction period
- forward planning essential
- vertical integration highly desirable/essential

Vertical integration of export industries

To assess technical intervention and develop post-harvest management systems it is therefore necessary to see the technology as an integral part of the market-driven production/marketing scenario. Investment and commitment cannot be made without integration; why, for example, should a grower spend time and effort in implementing proper production practices and careful handling of the product to find that subsequent stages of the chain cancel out these efforts?.

Table 3 lists the key players in the private sector and itemizes their main contribution towards the operation of the industry.

In addition to the direct commercial sector's involvement there are a number of players in the indirect commercial sector including credit/investment banks, suppliers of seed, plant material, chemical and machinery as well as services.

The public sector also plays a critical role in providing support and services to the industry (Table 4).

Without integration of the commercial sector with the necessary support from the public sector, expanding horticultural industries cannot be sustained nor is an environment created whereby a meaningful post-production management system can be effected.

Table 3 Role of the key private sector operators in horticultural industries

Activist	Role
Producer	• cost effective crop production • supplier of volume and quality to predetermined schedule • adoption of acceptable farming practice including integrated pest management • proper field handling/harvesting • prepare and pack product • provide information
Exporter	• pack and prepare product • arrange transport • maintain linkages with producer/importer • exchange intelligence • seek and establish market opportunities • finance enterprise
Importer/ wholesaler	• arrange clearance and distribution • determine retail/wholesale market channels • onward sale of product • store and transport • provide market intelligence, advise on legislative issues
Retailer	• provide market intelligence • advise market trends including legislative demands • sell product • consumer information • product promotion

Table 4 Role of the key public sector operators in horticultural industries

- market intelligence
- produce inspection/quality/ phytosanitary/pesticide research, development and extension
- licensing grower, exporter, trader
- foreign exchange provision
- export receipts
- credit
- infrastructure
- freight negotiation
- tax policy
- pricing control
- exchange rate control

Post-production management and technical considerations in the market chain

Commodity constraints

Tropical fruit and ornamentals are living tissues high in water content and very diverse in morphology, composition and physiology. There are a number of biological factors involved in their deterioration. These are summarized below:-

- metabolic changes; these include the natural respiration process, compositional change and ethylene production changes which occur during ripening and senescence and can increase the commodities susceptibility to mechanical damage and disease.
- mechanical damage; perishable products are highly susceptible to mechanical injury which can occur at any time from the point of harvest to the point of consumption. Injury can detract from the product's appearance and increase the potential for infection by disease.
- disease and pest attack; this can seriously affect the products market acceptability and is a common problem with most horticultural crops.

Many environmental factors affect the rate of reduction in product quality including: temperature, water vapour pressure deficit, relative humidity, atmospheric composition i.e. ethylene, oxygen and carbon dioxide, and light. Post-harvest practices can influence the commodities response to the environment; these include curing, waxing, packaging, cleaning and fungicide treatment.

Treatments which might involve manipulation of the environment include packaging, relative humidity control, temperature control, regulation of air movement, ventilation, modified atmosphere, removal of ethylene and sanitation.

Individual commodities have different inherent lives after harvest. They may differ in their response to the environment and can be subjected to one or more of the environmental manipulations listed above to the advantage of extending their storage and transport life as well as influencing the final quality of the product at the retail level.

Table 5 outlines the main operational stages in the production/ market chain and summarizes technical strategies which need to be taken into consideration at each stage of product handling.

Table 5 Technical considerations at each stage of handling for export

Stage	Technical considerations
Pre-harvest	• environmental factors • pest and disease management • cultivar suitability for production and market • pesticide management
Harvest	• maturity or stage of ripeness • harvest method/time • harvest tools • prevailing weather conditions • labour skill
Field handling	• availability of shade/temperature management • availability and type of field containers • time schedule harvest to market • field curing of bulbs and tubers • labour skill • condition of farm roads and vehicles • quality control
Grading and post-harvest handling	• definition of grading requirements and • post-harvest treatment needs • facilities and equipment • chemical and wax treatments • fumigation • precooling and temperature management • public health issues • quality control
Packaging	• design of suitable container • selection of suitable material • avoidance of overpacking • selection of optimal transport mode

Table 5 Technical considerations at each stage of handling for export (continued)

Stage	Technical considerations
Transport	• correct stowage/stacking/palletization • protection of vehicle from prevailing weather • protection from impact • temperature/atmosphere management • air ventilation
Distribution	• suitable storage and temperature management • quality control • selection/repacking • pre-packing
Ripening	• optimal ripening conditions • distribution at correct stage

Investment in infrastructure

Whilst there are many issues of good practice which are fundamental to product quality assurance (Table 5), it must be anticipated that at some stage in an industry, investment will be made in physical infrastructure. In addition to field boxes and transport systems, which are not addressed in detail in this paper, temperature management and packhouse equipment are two of the main areas for capital investment.

Temperature management

The lower the product temperature, provided it is above the critical chilling temperature for a given product, the longer the storage and transport life. This method of maintaining the product's inherent life involves product temperature management from the time of picking through to consumption. The careful management of storage and transportation conditions are of reduced value if the product has been left for a number of hours in the sun i.e. in the field, or chilled on a cold night on arrival in the recipient market.

Temperature management from farm level through to the consumer does not automatically imply the need for fully integrated refrigeration; many highly successful fruit handling operations exist with an incomplete temperature management chain. Attention, in such circumstances, being paid to time scheduling and optimizing on using low-cost "cooling systems", i.e. harvesting at the coolest time of the day and the use of shade at all stages along the handling chain. Integrated temperature management with the use of refrigeration is almost always essential for the ornamentals industry, and is gaining increased importance in fruit industries for the international trade.

For long distance transport or storage of more perishable commodities and when a high quality is required in the market, produce should be pre-cooled prior to cool storage or transport. A number of precooling techniques are available; these differ in their efficiency, commodity suitability and commodity flexibility (Table 6). In general, air cooling and forced air cooling systems are the most flexible. For effective use of any pre-cooling system its suitability and feasibility should be reviewed in the context of the entire handling chain. Pre-cooling and cool storage requirements are quite different and should therefore be considered as two separate operations. Produce destined for export should be held under cool storage for the shortest possible time; either to enable it to reach the required carrying temperature and/or to accumulate an adequate volume for export.

Table 6 Cooling methods for tropical fruit and ornamentals

Cooling method	Products cooled	Comments
Evaporative cooling wet	Non-chill sensitive products	• low cost equipment • mobile equipment • need for temperature differential between and dry bulbs
Ice cooling	Some fruits, melons	• rapid • limited to commodities which can tolerate contact with ice and water • requires water-resistant containers
Room cooling	All produce	• relatively slow • uneven cooling
Forced air cooling	Ornamentals, soft fruit, fruit	• versatile • efficient • uniform
Hydro-cooling	Some fruit, e.g. melons, bread-fruit	• rapid • produce must tolerate contact with water
Vacuum cooling	Some ornamentals	• rapid

As most of the Caribbean fruit and ornamentals commodities are susceptible to chilling injury, these commodities are usually transported at 7°C or above. Guidelines on optimum storage or shipping temperatures are available from a range of published sources together with an indication of the anticipated storage life. However attention should be paid to the need to validate these data against specific varieties produced under potentially differing production conditions and throughout the season of export.

Facilities for selection and grading

Facilities are required for selection, grading and packing. These can range from a simple airy shed supplied with water and tables and operated on a labour-intensive system, to a very sophisticated, capital-intensive packhouse with a full complement of appropriate plant and services. Either extreme or intermediate scale facility could be appropriate to a given circumstance; factors influencing the choice include:

- stage of development of the industry
- volume of exports
- capital availability
- technical and managerial expertise available
- number and dispersion of production areas
- product requirements.

The facilities may be located in or near to the production areas, or near to export points. There may also be more than one stage of selection.

Locations in or near production areas have various advantages, including:

- avoiding unnecessary carriage of reject produce and incurring the associated costs
- ensuring packaging in "safe" market containers early in the marketing chain and thus minimizing damage
- providing a focal point for the industry in the production areas, which might also incorporate supplies of inputs and of services such as extension support.

However, there are a number of disadvantages, including:

- larger aggregate investment compared with a centralized facility
- variable produce quality by individual facility
- problems associated with dispersion such as supervision, produce inspection, transport, scheduling etc.

Thus with one centralized facility the advantages and disadvantages are, by and large, reversed compared with the smaller dispersed facilities. Choice between concentration and dispersion will be country and export industry specific. There is, however, a strong argument for avoiding investment in large packhouse plants in the initial stages of development of an industry particularly until the responsibilities and roles of the various commercial players are fully recognized.

The building design can play a critical role in its ease of operation; points to consider include:

- layout in the context of range of operations
- level of flexibility
- building design features in the context of temperature management
- provision or otherwise of raised loading and unloading bays
- protected overhang for vehicles/-product protection
- size, type and number of doors
- provision of services, e.g. water, power.

Operations carried out in a packhouse include: delivery, unloading, washing, post-harvest treatment, selection, grading, packing and stacking or palletization. The decision as to whether or not all the above operations are carried out and the level of mechanization required are dependent on one or more of the following:

- commodity type
- volume throughput
- length of operating season
- market requirements
- cost structure of the market
- labour costs, availability and skill.

One major investment that is likely to be required regardless of scale and location of a packhouse is that of field containers.

A packhouse itself may have ancillary operations or needs in addition to that of product preparation for market; such support and general facilities might include:

- storage area for field containers
- storage area for market containers
- office facilities
- engine room/repair workshop
- cold storage and pre-cooling facilities.

Regardless of the level of operation, good management and the development of skills of the packhouse labour remain essential pre-requisites to an efficient operation.

Future trends and changes in the market place

A number of trends are showing in the extra-regional markets which will impact on the pre- and post-harvest management of tropical fruit and ornamentals.

Increasing competition from high quality suppliers

The growing consumer interest in the market for tropical fruit and ornamentals has increased the level of commercial activity from historically high quality supplier sources including USA, Australia, parts of South/Central America and South Africa. There is increasing interest in commitment to vertical integration and long-term investment and it is possible that these regions may take advantage of their comparative advantages as suppliers to the international market.

Increasing consumer awareness in environmental/health issues

The consumer, with a concurrent response from the retailers/importers/distributors and backed by increasing activity through legislation, is demanding tighter controls of pesticide usage. The implications of this are that some registered chemicals may no longer be able to be used in the future and that the lowering of current permitted pesticide residue levels may be expected. Codes of practice for pesticide use are now in place in many EC countries. These will of necessity force closer integration between the producer and the market place.

Legislation and consumer demand will place increasing pressure on the use by export industries and retail distributive trades of packaging which is suitable for re-cycling.

Public health

Increased attention in recent years has been drawn to bacterial and other contamination of food including horticultural crops specifically those in use for pre-prepared foods. Many retail multiplies are now requiring packhouse operations to work towards meeting standards of hygiene more generally adopted by food processing industries both in their design and operation. This trend will, with time, potentially impact on tropical fruit suppliers and should therefore be taken into account when designing infrastructure.

Tropical fruit ripening – integrated management

Vertical integration in the banana industry enables the commercial shipment of preclimacteric fruit and their subsequent controlled ripening and distribution. Increasingly importers/distributors are meeting the demands of retailers to supply other climacteric fruit such as avocado and mango, in a condition which is fit, or near fit, for consumption at the point of retail sale.

This further enforces the need for integration of producer, transporter and distributor as well as requiring that the product is capable of being ripened in a uniform manner. Variations in harvest maturity, wax application, wrapping and packaging material can influence the subsequent efficiency of fruit ripening.

Expanding role of multiple retailers

The multiple retailers are expanding their share of the retail market throughout the EC; in the UK this now represents 50 per cent of retail distribution. The demands set by multiples on their suppliers are high not only in terms of quality of product but also reliability of supply, volume and delivery schedule. Once a product is established as a retail multiple item it is expected to be available to the consumer every day of the retail calendar. Import/wholesale suppliers to multiples increasingly wish therefore to deal with sustainable, reliable and volume suppliers of products, as well as suppliers who also can guarantee to meet their wider quality requirements.

New products/new technologies

Concurrent with the expanding international market for tropical fruit and ornamentals, there is a demand for new and innovative products. Efforts are being made worldwide to identify and commercially develop new product lines with market potential. Opportunities exist for further development of indigenous and introduced tropical species.

Key technologies which will impact on international trade and sources of supply are genetic manipulation to develop and select new and improved plant material, the development of alternative techniques to chemical treatment for insect pest and disease control, and the commercialization of systems for extending the transport and shelf-life of products through the use of modified and controlled atmosphere systems and improved temperature and environment control in conventional refer shipping. These latter technologies will potentially enable an expansion of the sea-freight industry and thus offer further openings for suppliers of volume lines of tropical fruit and ornamentals to the major world markets.

Reference sources

Hardenburg R G, Watada A E and Wang C Y. 1986. The commercial storage of fruits, vegetables and florist and nursery stocks. USDA Handbook 66 130pp

Kader A A, Kasmire R F, Mitchell F G, Reid M S, Sommer N F and Thompson J F. 1985. Post-harvest technology of horticultural crops. University of California, Co-operative Extension 192pp

McGregor B M. 1987. Tropical production transport. USDA Agriculture Handbook 668 148pp

Mitchell F G, Guillon R and Parsons R A 1972. Commercial cooling of fruits and vegetables. California Agricultural Experimental Station. Extension Service Manual No 43 44pp

Paull R E. 1990. Post-harvest heat treatments and fruit ripening. Post-harvest News and Information 1(5): 355-363

Proctor F J. 1989. Major export marketing aspects for tropical horticultural products. FAO ESC:ECDC/TTHP AP 89/14 17pp

Proctor F J. 1990. The European Community market for tropical fruit and factors limiting growth. Acta Horticulturae 269: 29-39

Proctor F J and Caygill J C. 1985. Ethylene in commercial post-harvest handling of tropical fruit. In: J A Roberts and G A Tucker (eds) Ethylene in Plant Development:. London: Butterworths. pp 317-332

Sharples R O. 1990. Future direction for horticultural post-harvest technology. Post-harvest News and Information 1(3):191-194

DISCUSSION: SESSION II

Question:
Was the post-harvest research carried out on soursop in Costa Rica continued?

D. Saborio (Ministry of Agriculture, Costa Rica):
Yes. Soursop post-harvest research was continued.

Question:
What control measures accepted by USDA were carried out by Costa Rica?

D. Saborio :
Hot water treatment of mango at 50-55^{o}C. This is also done to papaw in Costa Rica to control anthracnose.

Question:
What would make the marketing of perishable produce take off?

E. Harvey (Casse Consultants Ltd., Barbados):
Quality, volume and consistency will cause Caribbean produce to sell on the international market.

Comment:
It was said that there is need for integration and market drive and not production drive.

L. Daisley (CARDI, Dominica):
Did Mr Mohammed in fact say that CEPAT was going to do international courses? If so, why?

M. Mohammed (UWI, Trinidad):
CEPAT has conducted courses in post-harvest technology at the national, regional and international levels - these will continue. These courses are structured to address the problems encountered among producers and traders.

Comment:
All the literature that I have read, especially the economic literature, has indicated that the real problem of agriculture in the Caribbean, has been that it is geared to primary production. Is this view outdated and or backward?

Answer:
The problem of Caribbean agriculture is the quality of produce exported.

Comment:
Farmers only get about one-tenth of the selling price.

Comment:
Caribbean producers are not yet geared to take on extra-regional export of agricultural produce because of the various problems involved, e.g. inconsistency of production, transportation etc.

E. Harvey:
Why is the University duplicating resources when there are so many food laboratories in the Caribbean?

M. Mohamed:
Because of the programme, the University scientists have to carry out research and teaching. For this they cannot depend on other institutions for the use of their laboratories.

Question:
Is there any floriculture in Martinique and Guadeloupe?

Answer:
There is export of flowers, to France only, from Martinique. The floriculture in Guadeloupe is not developed for export.

Question:
Is there any side-effect in the use of charcoal as a medium for anthuriums?

D. Raj Kumar (Phoenix Farms Ltd.,Trinidad):
Charcoal is excellent for anthuriums but the use of sawdust is bad because it decays and damages the roots of the plant.

Question:
Is it important to prune anthuriums?

Answer:
It is not good to prune plants because diseases could be spread from one plant to another from the pruning tool. It should be done only in the cases where there is mechanical damage.

Question:
How feasible would it be for small farmers to get into cut flower production with little resources?

Answer:
Small farmers are sometimes recommended not to get into cut flower production due to the high initial cost and the commitment that is needed to make sure it is done properly.

Question:
What do you think of copyright?

Answer:
Varieties of Caribbean anthuriums are not patented as in Holland and Hawaii, but sooner or later growers in the Caribbean will have to do this

This raises the question of paying royalties.

A Medlicott (Fundacion Hondurena de Investigacion Agricola, Honduras):
It is good to pay royalties because a person can benefit by getting new and improved varieties developed by the producer.

S. Skeete (Ministry of Agriculture, Barbados):
Was any work done in the 1940/50s on post-harvest technology in the region?

M Mohammed:
Yes. There has been work documented in *Tropical Agriculture* on post-harvest technology during that period.

TECHNICAL SESSION III

Chairman: Lennox Daisley, *CARDI, Dominica*

Rapporteurs: Pamela Collins, *CARDI, Trinidad & Tobago*
Noel Munroe, *Department of Agriculture, Bahamas*

SOCIO-ECONOMIC ASPECTS OF SMALL-SCALE COMMERCIAL PRODUCTION OF FRUITS AND ORNAMENTALS INCLUDING THE ROLE OF WOMEN

J Seepersad and A Rajack
The Univerity of the West Indies, Trinidad & Tobago

As we were thinking about the topic, two recent articles in the newspapers came to mind that has a bearing on the subject for discussion. One from page 22 of the *Express* of November 14, 1991 states "Japanese prefer less work than more money". The second had to do with protests by farmers in a certain area in France, long known for a particular type of cheese. That industry was likely to be undermined by the opening up of certain trade barriers. Although the economic threat was an important consideration, a certain amount of pride was also at stake; they were likely to lose something that they have been proud about and which perhaps gave them a sense of rich traditions and cultural heritage.

Both these articles remind us first, that economic considerations are not the only ones that motivate people; they have many personal goals other than profit maximixation. Second, asking persons to shift from one area of activity with which they have been long involved to a new area should not be taken lightly since there are all kinds of ramifications. We are, therefore, particularly pleased to see that an opportunity has been provided at this meeting for looking at a broad range of issues – the social and cultural as well as the economic.

Small-scale farming – Conceptual issues

Definition

Much of the small-scale production of fruits and ornamentals would most likely involve small-scale farmers and thus, we need to define small-scale farming. "Small-scale" is obviously a relative term depending on:

- which country one is referring to
- what enterprises are involved
- the size of investment or income generated from the operation.

Thus, a small-scale operation in orchids covers a much smaller area of land than a small-scale citrus cultivation or even vegetables, and it may involve considerably higher levels of investment. Again, 100 acres of citrus may be considered large-scale in some countries, but quite small-scale in others. Two important traits that generally characterize small-scale farms are:

- They are generally family farms.
- They operate with limited resources.

These two traits will now be discussed.

Family farms

Hildebrand (1983) of the University of Gainesville, a well-known name in Farming Systems Research, defines family farms as: "Those which are first a home rather than first a business. Decisions are made from the point of view of the home. A farm is not a family farm by this definition if business decisions are made independently of family considerations. Rather the well-being of the home and family override profit considerations".

We agree with that in essence but we would prefer to say that "activities of the farm and home are closely interrelated; decisions about either the farm or home are made in the context of how one affects the other". Of course, we are sure you can think of exceptions and there are different degrees for which those definitions are true, depending on the extent to which a farm operates as a family farm or a business concern. But, in general, it is important to recognise the strong link between the farm and the home.

Limited resources

Again we are dealing with a relative term, since farmers will insist, quite correctly, that they all possess limited resources. However, the point here is to emphasize the real operational factors that cause or influence small-scale farmers not to adopt certain technologies which to the experts would offer increased economic benefits to them. The older view of small farmers at the extreme was that they are resistant to change, and they are not as smart or intelligent as the others. Thus perhaps, it is a waste of time to concentrate on them for the introduction of new enterprises or modern technology and the like.

Although that view or notion still prevails in certain quarters, another perspective, if one attempts to see the situation from their point of view, is that the so-called "resistance to change" is really a rational response to the circumstances which they, the small farmers face. One of the major considerations in explaining their adoption behaviour is the quantity and quality of resources they possess or to which they have access. Improving their situation, or providing a greater level of resources to them would, no doubt, make them more "responsive" to new technology.

Some small-scale production may not fit the characteristics above, especially with reference to ornamentals. Small-scale production may be carried out by persons on a "part-time" basis but access to certain resources may not be a severe constraint nor would the income from the enterprise be critical to family income. Such persons may include, for example, the wives of businessmen, lawyers, doctors and others of high "socio-economic" status.

A related consideration here is to what extent are the technologies scale-neutral? Many are better suited to large-scale commercial production and, therefore, not "appropriate" to small-scale farmers/-producers with a certain level of resources.

Implications of selected factors on small-scale production

Family farm orientation

In the family farm situation where there is a strong link between the farm and the home, considerations relating to risk become paramount. The first concern would be to have a level of income and food supplies that would ensure survival and security. Thus, the tendency would be for small-scale farmers to stick with the "known" or "proven" in terms of the technology they use,the markets that are available and the skills they have.

There would be the tendency to have diversified operations to spread their risks and to ensure the production of some staple food supplies. The other side to this practice, however, is that this results in the creation of smaller enterprises which militates against economies of scale. Much of the small-scale production of fruits comes from such diversified operations. Also, the fact that there are many different types of enterprise means that less time is available for the management of each enterprise than would be available to managers of large-scale, commercial and specialized farms. Very few small-scale producers can afford to be full-time managers since they also provide labour. Certain types of enterprise dealing with ornamentals demand high levels of management and small-scale producers may be at a disadvantage in this situation.

Income

In the small farmers' situation, the enterprises either singly or in combination, should provide a pattern of cash flow and, of course, total family income that would meet the households demands. Long-maturing crops may be avoided unless income can be earned in the short-term by interplanting them with quick maturing crops which will give an immediate income.

Land

There are several aspects relating to land that are important. First, the **amount** and **quality** of land is a key issue. Where limited good quality land is available, the tendency would be to go for short-term crops. Longer maturing fruit crops are not likely to offer the same prospects for farm income as vegetables and root crops. Of course, ornamentals can also be an economically viable enterprise, but other factors could pose problems.

Land tenure also needs to be considered. Insecure forms of tenure would discourage the introduction of long-term enterprises such as tree crops or those which require certain types of costly infrastructure , e.g. farm roads, greenhouses, irrigation facilities, etc.

The proximity of the land to the homes of the producers could also affect their choice of enterprises. With fruits, praedial larceny could be a serious problem and so producers will not be inclined to grow this crop if their land is too far away from their homes, making it difficult to supervise on a regular basis.

Labour

The small-scale family may have a good pool of family labour from which to draw. This is an advantage when considering ornamentals which will generally have a greater demand for labour than fruits. However, certain specialized skills will be needed which farm families may need to acquire.

Capital

The small-scale farm family in general operates with low levels of capital. In many cases, too, they are not able to access adequate credit due to lack of the required collateral. The production of certain types of ornamentals needs substantial capital and high levels of investment and thus the small-scale producers will be at a distinct disadvantage in this situation.

The ratio of fixed to variable resources is also different. Large commercial farms have an abundant capital basis and additional resources of most kinds can be purchased when needed. In a small farm this is not the case; a high proportion of the resources is fixed for the farm.

Access to technical information

Particularly for ornamentals, technical information may not be easily available from public agencies although more and more training courses are now being offered. Such information is largely provided through various associations (e.g. Horticultural Society, Orchid Society) which are not now, or likely to be, well patronised by the small-scale producer. Thus, government extension and research departments and other support institutions will need to be better equipped to service the research, information and other needs in those non-traditional areas.

Alternatively, or in addition, one can look at "contract farming" approaches. For example, an agro-processor may contract suppliers for certain products while providing technical advice and assisting with inputs to ensure adequate supplies of a certain quality. Cost recovery approaches involving fees for service for high value commodities could also be explored. However, the cost recovery approach could result in a bias in the provision of information to those who can afford the fees and small-scale producers may be neglected.

Access to specialized inputs

Certain enterprises as in the case with some ornamentals, require specialized inputs such as fertilizers and pesticides which may not be available from local supplies. Adequate supplies of planting material may also pose a problem. Those inputs and planting materials will thus have to be imported directly from abroad which will only be profitable for large-scale commercial operations.

Export considerations

Although there is a significant local demand for certain fruits and ornamentals, this could be met in many instances by a few large-scale producers coming on the scene. Thus we will have to look further towards the export trade. New market sources have to be located and networks for sale and distribution put in place. There are stringent quality standards and strict deadlines. In addition, those who are already engaged in marketing overseas have expressed the need to "police" their produce. Thus export marketing will likely prove an insurmountable hurdle to the small-scale producer acting on his/her own.

Where there is a large number of small-scale producers, a "co-operative" approach to purchasing inputs and marketing may offer viable alternatives. Governmental and other agencies could also play a useful role. Two examples that quickly come to mind, though not specifically in the area of fruits and ornamentals, are drawn from Montserrat and Nevis. In Montserrat, the Ministry of Agriculture plays the lead role in "production co-ordination" for specified crops so that supplies are in tune with demand. In Nevis, the Ministry of Agriculture has helped to organize farmers to produce certain vegetables for a large hotel. The ministry plays a key role in the provision of technical advice, in assisting with the necessary inputs, and in the marketing process

Role of women

With the strong link between the farm and home in the family-farm situation, the interlocking roles of the family members need to be clearly understood. New enterprises and technology must not work to the detriment of specific family members or marginalize them. Small-scale production of ornamentals however offers some income generating opportunities to women – it can be done on small portions of unused lands around the home and still give a reasonable income. However, this should not be at the expense of crops in the "kitchen garden" that play an important role in the family's diet in many small farm situations.

Women constitute much of the labour force in the fruit processing industries. As those industries expand, the demand for their labour will increase. Again, the implications of this trend needs to be carefully considered so that the net effect is the improvement of women and their families. Specific areas such as appropriate training and satisfactory working conditions must be given special attention.

Attitudinal/cultural variables

While the previous sections have covered broad factors that are embedded in the socio-cultural context of the Caribbean, this section will look briefly at some other specific attitudinal variables relevant to the small-scale production of fruits and ornamentals. For example, traditionally, the cultivation of flowers has been the woman's role. In many circles, it may continue to be "relegated" to the domain of women, and men may not view it as a worthwhile "agricultural"pursuit. Similar sorts of cultural perceptions will have to be overcome as regards certain types of fruits, where in the traditional systems they were grown mixed with other crops or on borders. For example growing mango in pure stands will necessitate re-orientation in the way of thinking about the cultivation of mangoes.

Conclusion

The paper has examined a number of socio-economic and cultural issues related to the small-scale production of fruits and ornamentals with specific reference to the Caribbean context. While there are many hurdles to be overcome for the successful development of small-scale enterprises in those areas, they also represent opportunities for improving the levels of income and the well-being of small-scale producers. The presentation provides a framework for examination of those issues and points to broad directions that may be fruitfully pursued.

Information sources

Publications

Caribbean Food Crops Society. 1986. Prceedings of the Twenty-Second Annual Meeting. Volume XXII. Saint Lucia, August 25-29, 1986

The Horticultural Society of Trinidad and Tobago. 1990. Flower Show Annual.

Resource persons

Braithwaite, R A I , Senior Lecturer, Department of Crop Science, The University of the West Indies, St Augustine, Trinidad and Tobago; President, The Horticultural Society of Trinidad and Tobago.

Roberts-Nkrumah, L, Lecturer, Department of Crop Science, The University of the West Indies, St Augustine, Trinidad and Tobago.

Reference cited

Hildebrand, P. 1983. Economic characteristics of small-scale, limited resource family farms: Implications for technology. Working Paper, Institute of Food and Agricultural Sciences (IFAS), University of Florida, USA

OPPORTUNITIES AND CONSTRAINTS TO THE PRODUCTION OF CUT FLOWERS AND ORNAMENTALS

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Opportunities

The opportunities for cut flowers and ornamentals will be discussed with respect to:

- World trade
- Europe
- North America (USA and Canada)
- Japan

and with respect to the major flowers of interest.

The world flower trade statistics show excellent prospects for floricultural products in the 1990s:

- World imports of greenhouse and nursery products, including cut flowers, cut foliage, live plants and bulbs are expected to reach US$10 billion by 1995

- World imports of cut flowers doubled in the last 6 years and are projected to be US$3 billion in the 1990s

- World imports of cut decorative greens are up 100 per cent in 4 years

- US imports may increase faster in the 1990s than floriculture imports into other major markets of Europe

Some of the reasons for these increases are:

- Greater year-round availability of products

- Large diversity of products available

- Expanded advertising in the USA

- Increasing number of retail florists and supermarkets carrying flowers

Excellent market opportunities exist in North America, Europe and Japan for dendrobium orchids, oncidiums and other tropical orchids, and anthuriums. The demand for orchids is high across all markets. In the USA the demand is increasing at a rate of 28 per cent per year and prices are up for hybrids, whites, pastels, long (50cm and over) sprays and large blooms. In Europe, total market size is estimated to be US$100 million by the mid 1990s. The major factors which will exert a positive influence on the trade will be the new varieties from Thailand, the use by florists in combination with other flowers and the increasing need for long shelf-life.

Limited market opportunities exist for tropical foliage and heliconia in both North America and Japan and the market opportunities for ginger and heliconia are limited in Europe. The cost of transport will be a critical factor in successful shipping of heavy heliconia and ginger blooms to Europe from the Caribbean. The key factors in successful marketing of heliconia are:

- Selection of good varieties which bloom at periods during which specific colours are required by the importer

- Packing in boxes which can support the weight of the product and protect from chilling injury.

- Careful and informative labelling

- Promotion and training of the users of the product.

There are reports of oversupply of red ginger in the US market. The market for Birds of Paradise is well supplied by California, Costa Rica, Mexico and Jamaica and no large increases in demand are expected. Across all markets, the demand for decorative cut foliage is very diverse and ever-changing. Opportunities exist for clean, good, long foliage in small amounts.

World trade of anthurium

Anthuriums are produced in a number of tropical regions including Hawaii, Jamaica, Mauritius, Ivory Coast, Trinidad, Dominican Republic, as well as greenhouses in the Netherlands, Germany and Italy. The export market is dominated by Hawaii, the Netherlands, Jamaica and Mauritius.

Despite considerable costs of transportation and distances involved, there is extensive world anthurium trade. In 1990, Hawaii shipped to Japan; Mauritius shipped to the US; Jamaica shipped to Japan and the US as well as Italy. Its movement is financially feasible since there is a world-wide shortage and the price is strong.

In the early 1990s, two major changes will affect competition for the world anthurium market. The first will be geographical diversification of growing locations, a process already started in the 1980s. The second is the application of new technology and the vast experimentation with varieties.

The net result is that by the late 1990s most of the growers will be large, well-financed, well-managed organizations, providing the world markets with an array of new anthurium colours and types at prices competitive with other "luxury" flowers such as spray orchids and roses. This should coincide with greatly increased demand from all major markets created by better distribution, better marketing and raised customer awareness of anthurium flowers.

Anthurium market characteristics - Europe

The major supply for anthurium in Europe comes from the Netherlands. The Netherlands is also the largest centre for research and hybridization of new varieties which are propagated there in tissue culture laboratories. The three-dimensional "Dutch-style" packing is the market standard and distribution is controlled by the Flying-Dutchman network of trucks throughout nearby countries as well as by air.

Anthurium production, imports and consumption in Europe

In 1989 the area devoted to the production of anthuriums for Europe consisted of 60ha in the Netherlands (up 10 per cent from the year before); 10ha in Italy (new production owned by the Dutch near San Remo); 2ha in the Canary Islands (more being planted); 2ha in Madeira (more being planted); 2ha in Germany (new); 2ha in Portugal (for production in 1991); and 20ha in Mauritius (many being renovated in 1989; total to increase to 28ha). The Dole Corporation in the Philippines is also investing heavily in anthurium and orchid production.

Total production in the Netherlands was estimated at 25 million stems in 1989 (up from 15 million in 1987). Summary export statistics from Holland do not identify destinations for shipments of anthurium but Germany, Italy and France are known to be important markets. The Netherlands supplies over 80 per cent of European consumption and with new Dutch investment in Italy and Mauritius, this proportion will increase.

Mauritius production in 1991 was estimated at 10 million stems (up from 3.3 million in 1987).

Hawaii had traditionally shipped anthuriums to Europe – in the 1970s the largest market for Hawaii was Europe and not the United States nor Japan as it is today – but with both the problems of acceptance of the Hawaiian-style packing and the declines in production caused by disease, shipments from Hawaii to Europe have decreased. Hawaii shipped 0.4 million anthurium stems to Italy in 1989 – down from 1.6 million in 1987 and 0.8 million in 1988.

Anthurium consumption growth in Europe

Limited statistics are available but anthurium consumption is estimated to be level and at best increasing at the rate of 3-4 per cent in Europe with the increases being seen mainly in Germany, Italy and Spain.

In Europe, the anthurium is generally regarded as an exclusive, expensive and "artificial-looking" flower. Current trends in flower consumption across Europe are for "more natural looking, softer summer flowers" and as such, anthurium sales comprise less than 1 per cent of the total sales of products for most of the importers in the trade.

Increased market share for anthurium may be possible by bringing it into the realm of the "ordinary flowers". In this respect, the use of medium, small and mini anthurium flowers, presented in bouquets of three to five blooms with some green foliage and sold in supermarkets and other retail outlets, represents a niche opportunity that may be well worth exploring. A major limitation for this niche would be the competition faced by flowers as an item in the supermarket, with lack of skills of supermarket personnel and lack of infrastructure for holding anthurium flowers on display.

Supermarket sales of cut flowers are very successful in Switzerland where the MIGROS company controls 50 per cent of the market.

European consumer preferences in anthurium

European retailers prefer the packing done in the Netherlands, or similar operations, where 8-20 individual inflorescences are put into water pics (phials) taped into white trays with three-colour printing, carefully cushioned with shredded white paper and then sent. This packing (described by some as a way of shipping air) ensures that each anthurium arrives in perfect condition. Quality expectations of consumers are very high in Europe and having a perfect product provided by the Dutch growers has made consumers in most countries resistant to purchasing anthurium packed in the dense packing style characteristic of Hawaii, the Caribbean or Mauritius.

Colour preferences vary throughout Europe. Italy has a marked preference for orange. The rest of Europe is fond of red, scarlet and the whole array of pastels from coral pink to creamy white.

Grades and sizing of anthuriums in Europe

Anthuriums in Europe are graded not only according to flower size but also according to the stem length. The following are the normal grades and the packing per box.

Flower size (cm)	Minimum stem length (cm)	Number per box
15 and over	50	8
13 to 15	45	12
11 to 13	40	16
9 to 11	35	11
8 to 9	30	15
7 to 8	25	18
6 to 7	25	21

As with other flowers, anthuriums, in order to conform to Class I (Export class) at the flower auctions in the Netherlands, must meet the following criteria: absolute freshness; pest and disease free; free of pesticide or other residue; fault free; stems are straight; stems are strong enough to support the flower.

The International Trade Centre UNCTAD/GATT Market News Service price reporting system consistently reports prices of anthuriums sold in Europe from the Netherlands as twice that of anthuriums from Mauritius, the Ivory Coast or other sources. This premium for the Netherlands product reflects not only larger size blooms and more marketable varieties, but high quality specialist packaging as well.

Some characteristics of specific European markets

Italy
The market for anthuriums in Italy is decreasing compared to what it was 10 years ago. Italy is however still the major European market for anthuriums. The majority of anthuriums exports to Italy goes to markets in Rome and southern Italy. Importers in northern Italy currently receive anthuriums from Dutch producers (either directly or via the auctions) by the 'Flying Dutchman' trucks. There is good potential for development of the northern Italian market.

France
The demand for anthuriums in France is low and decreasing, primarily because it is regarded as an expensive, sensitive and specialist flower. Economic problems in France have also adversely affected the consumer expenditure allocated to flowers.

Germany
The per capita consumption of flowers in Germany in 1990 was the highest for all of Europe – 130DM. In general, the demand for anthuriums is on the increase but in terms of total volume is still less than 1 per cent of total sales of many of the major importers.

The major limitations of the Caribbean-style pack are:

- the high number of flowers per box
- type of packing (compared to the Dutch pack)
- lack of exact grading by variety

An increase in market demand may be possible through improvements in packing with respect to the number of flowers per box and specification by variety.

Legislation will come into effect in December 1991 in Germany, and across Europe when it becomes a single market, concerning the disposal of all packing materials used with flowers. At present in Germany, such materials cannot be burnt or dumped into refuse pits or landfills. Importers therefore have to return all packing materials to their suppliers.

The packaging materials used by the Dutch pack are comprised mainly of non-biodegradable materials which makes disposal a virtual nightmare. The biodegradable materials used by Caribbean exporters may well prove to be a competitive advantage in the years to come.

Holland
Anthuriums from the Caribbean face severe competition from Dutch suppliers in Holland. Entry into the market is possible via two main channels:

- The Auction
- Importers

Sale to importers (versus direct sale on the clocks) appears to be a better option for Caribbean exporters in view of the costs involved in presenting flowers on the auction and more importantly, in view of the fact that the flowers **must be packed and presented in the Dutch style.**

Since it is almost economically impossible to air-freight flowers packed in the Dutch style from the Caribbean, an agent in Holland would have to be hired to repack the flowers before they can be presented on the clock. (This may be feasible only in the winter when Dutch production is low and a grower maybe willing to undertake such a service).

The steps involved in selling on the auction clock are summarized as follows:

1. The company applies for a permit from the Board of the Auction by filling out an application form. Approval takes 2-3 weeks from submission of the form and is granted on the basis of the quality of the crop. Quality is classified as: Good; 1B (slightly infected); D2 (poor); Reject

   Auction quality control inspectors as well as clock inspectors check all flowers.

   For the Caribbean where the quality is difficult to judge (because of distance), a temporary permit is issued and quality checked after shipment is made.

2. The flowers must be landed at Aalsmeer. If landed elsewhere, the exporter pays for the cost of forwarding agents which may be 100 Dutch guilders per shipment plus 1-2 guilders per box (these prices vary with the size of the shipment).

3. A number of charges are applied for preparation of the flowers for sale on the clock. The major ones are:

    - Auction commission of 7.4 - 9.4 per cent of the clock sale
    - Commission of 2 guilders per unit for each unit sold
    - Commission of 0.45 per cent of value of sale for promotion and research
    - Charge of 0.25 guilders for the use of buckets
    - Handling cost (which includes receiving, un-packing, preparing for the clock, as well as gassing and disposal of rejects) of 0.02 guilders per stem.

The main advantage of selling on the clock is that payment is remitted within a week after the sale.

UK

The prospects for increased sales of anthuriums in the UK seem grim at present due mainly to the low demand for the flower and to the general effects of the recession on spenditure allocated to flowers. The general trend in the UK is towards "summer flowers - country gardens - natural-looking flowers". Anthuriums are regarded as an exclusive, expensive and artificial-looking flower which is purchased mainly for special occasions or by a limited sector of the population.

In addition, the infrastructure for the handling of tropicals is limited; there are no tropical coolers or warm storage facilities (either in importers' facilities or in Covent Garden).

The UK lags far behind the rest of Europe with respect to per capita consumption of flowers and the potential for development of the anthurium market is great. Development of this market would, however, involve tremendous costs in promotion and advertising which would be difficult for any one supplier to finance.

Anthurium market characteristics – North America

Anthuriums are the second most important tropical flowers consumed in the United States after Dendrobium and other tropical spray orchids when measured by value.

US production of anthuriums

Hawaii produced almost all of the fresh cut anthurium consumed in the United States. The severe decline in the industry caused by bacterial blight has been the major cause for successful entry of Jamaican producers who are expected to be shipping six million blooms to the United States market in 1995. Industry sources indicate however that Hawaii is managing its bacterial blight and will be coming on to the market with new resistant varieties. Hawaii is also breeding more varieties with the 'tulip-type' conformation which seems to be one of the trends of the 1990s.

Average prices for anthuriums are affected by the amount of each grade proportionally that are shipped. The price is influenced by the type of sale (does the grower or importer sell it to the wholesaler, a supermarket, a retail florist or an individual consumer ?) and whether the blooms are shipped to a distant point (Hawaiian blooms to Boston; Jamaican blooms to California).

The following data give some indication of comparable returns to the Hawaiian grower versus the importer/distributor of Caribbean anthuriums in Miami:

Price per unit including box charge in cents

	1986	1987	1988	1989	1990	1991 (est.)
Caribbean	.32	.36	.47	.50	.52	.75
Hawaiian	.40	.41	.42	.52	.65	.75

Colour preferences for anthurium in the United States

Consumers prefer clear red, clear light pink (without overtones of peach, shrimp or coral), bright whites and creams with a red edge, melon green and obakes. For the weddingsseason (June through late summer) white and pale true pink are traditional. Orange and cream appeal very little to the US consumer and then mainly for use in the autumn. Red and white are important from December through to February with red being the traditional flower colour for Christmas and for Valentine's Day.

Anthurium bloom size preference in the United States

Most wholesalers, retailers and supermarkets prefer to have medium or large anthuriums. Though efforts have been made to push smaller sizes in the supermarkets, they have not been successful principally because of their shorter vase life. The extra-large blooms are very expensive because of the extra packing involved and are mainly used on the East Coast in the shops in New York or on the West Coast in Los Angeles and San Francisco.

Anthuriums are graded by size of flower. Size is defined as the average of length and width. The grades are:

Grade	Inches
Extra Large	Over 6
Large	5-6
Medium	4-5
Small	3-4
Miniature	2-3
Peewee or corsage	Under 2

Quality requirements of the United States market for anthuriums

Cartons are lined with impervious polyethylene sheeting of adequate length and width so that when packed the sheet can be folded over to prevent the moisture of the dampened flowers and newsprint from dampening the box itself. Dampened newsprint is used to line the carton and shredded newsprint is used to cushion spathes that are arranged in rows facing opposite directions. Each individual spathe is wrapped and tucked with unprinted newsprint or other white paper.

Flowers are misted then covered with more damp, shredded newsprint and then further layers of spathes and shredded paper until the carton is filled. The folded soft paper liner or newsprint liner is then brought up the slides and folded over the top and the polyethylene sheet is stapled. The carton is then closed, securely taped, tied or strapped and labelled with the contents. This is known as the standard Hawaiian pack and is a method (unlike the method of packing used in the Netherlands) where many flowers can be put in one box. This packing density cuts down on freight costs but does, to some extent, allow the inflorescences to suffer more damage in transit.

The North American market (both United States and Canada) are used to receiving the anthurium packed in the dense packing method. Wholesalers, retailers and individuals expect to take the time necessary to carefully unpack the flowers, taking the stems out individually to reduce creasing or breaking. Since flowers are in short supply, small blemishes caused in transit are ignored.

One of the Hawaiian farms has developed a patented cluster paddle pack – 28in (70cm) paddles with a dozen flowers, each paddle slipped within a printed plastic sleeve within one master carton (see below) – which is a slightly less dense packing method and received well in the market. Several Jamaican farms are also experimenting with packing fewer flowers per box, particularly of the large Dutch varieties with overlapping lobes that suffer more in transit in the normal dense pack.

Nonetheless, though efforts are being made to improve packing by lessening density or rearranging the flowers, the dense pack is the industry norm in the United States and any small flaws that are a consequence of this packing are ignored by the consumer. This is apt to continue for several years to come or until such time as anthurium supply is abundantly greater than demand. It is doubtful if this will happen any time in the next decade.

Box requirements for anthuriums in the United States

There are no specific requirements for box size or quality in the United States; nonetheless, the standard dimensions of the trays frequently received from Hawaii are:

- 40in x 7in x 3.5in (100cm x 18cm x 9cm) with six per master carton

- 40in x 11in x 3.5in (100cm x 28cm x 9cm) with four per master carton

The dimensions of the standard master carton are 43in x 23in x 11in (109cm x 58cm x 28cm). The number of flowers per tray varies and is always a multiple of 12 so that they can be sold by the dozen when packed for the retail or individual customer. When sold to large retailers and wholesalers, the trend is to pack in multiples of five.

The flower market in Japan

The following information has been extracted from the ITC Publication, *Fresh cut flowers: A study of the market in Japan* (1991).

Japan constitutes a huge market for flowers. It is the seventh largest importer in the world for fresh cut flowers. Total imports reached 14.9 billion yen in 1989.

The main flowers imported are :

- Freesia
- Tulips
- Lilies
- Roses
- Nerines
- Chrysanthemums

The Netherlands is by far the largest foreign supplier of fresh cut flowers in Japan in terms of value. New Zealand, Singapore, Australia and the USA are the other main suppliers.

With respect to consumer preferences, chrysanthemum is the most popular flower followed by the carnation, rose, gypsophila and statice. Colour preferences differ from those in most other countries. The main preference appears to be for white, followed by pink and pale purple.

Market access

The Japanese market is noted for its stringent requirements in terms of freshness and uniformity of colour and size. The flowers must be absolutely free of insects, pests and diseases. Every shipment is thoroughly inspected upon arrival in Japan.

The major obstacles to imports are:

- Zero-tolerance policy

  Japan's Plant Protection Service rejects even insects that are abundant in the country without producing scientific evidence on the kind of damage they have caused or might cause to local agriculture.

- Problems at Tokyo airport and other points of entry

  Narita Airport is congested and exporters frequently complain about low efficiency and poor co-ordination between different authorities which lead to persistent delays in the clearing of incoming perishable cargo. The situation is aggravated by the limited cold storage facilities available and their high cost.

- Cost and speed of fumigation

  Fumigation of rejected shipments is carried out by private operators appointed by the authorities. The cost of fumigation is around three times the customary rates at other international airports. Same-day fumigation is not guaranteed.

PRODUCTION OF BREADFRUIT (*ARTOCARPUS ALTILIS*) IN THE EASTERN CARIBBEAN

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Breadfruit has been grown in the Caribbean for almost 200 years since the introduction by Bligh in 1793. St Vincent and Jamaica received the first plants and now this crop is found in all territories within the Eastern Caribbean. It has been used as a carbohydrate source for man and animals and is prepared in many ways – boiling and roasting being the most popular. Other uses include felling the tree for timber and the production of flour from the pulp (Matthews *et al.* , 1986) and confectionery from the male inflorescence. The breadfruit tree seems particularly well adapted to conditions in the Windward Islands, even surviving hurricane damage to recuperate and produce within 2 years. Although the potential of this crop has been promoted in the past (Leakey, 1977; Ferguson, 1980) it has only recently received wider attention. This is partly so because breadfruit is now viewed as a diversification option in the Organization of Eastern Caribbean States (OECS) where the potential for joint marketing exists. The discussion that follows excludes the less popular seeded form of breadfruit known locally as 'chataigne' or 'breadnut'.

Pre-production

Propagation

Shoots emerge from roots that are damaged or exposed. These shoots are transplanted with a section of the parent root in the traditional method of propagation. Multiple shoots appearing from root sections can be each rooted to give several plants per root cutting. This technique of rapid multiplication is used routinely at propagation stations in Trinidad.

Cultivars

The cultivar distinction most reported is the core (or 'heart') colouration – 'white heart' or 'yellow heart' (Thompson *et al.*, 1974; Passam *et al.*, 1991; Newell, 1990).

However in St Vincent wide variation occurs and many local types are recognized. It is unclear how many of these are true cultivars.

Some of these are described (Table 1) and related to types seen in other islands (Table 2). The 'creole' or 'ordinary' is the most common breadfruit grown but this may represent a group rather than a single cultivar.

The St Lucian 'White' and Dominica's 'Yam Pain Blanc' appear similar in that the flesh colour is not truly white but cream and they retain the same colour upon boiling. The yellow-fleshed types such as the 'Creole' and 'Kashee' tend to deepen in colour upon boiling.

Table 1 Characteristics of breadfruit cultivars in St Vincent

Local name	Description
Waterloo	Large fruit, white flesh, spiny surface
Kashee	Medium-sized spiny fruit, yellow flesh, wrinkled leaf
Cocoabread	Large fruit, yellow flesh, wrinkled leaf
White or Massa	Medium-sized fruit, white flesh, small spines, heavy latex flow
Creole	Medium sized fruit, yellow flesh
Captain Bligh	Small fruit, yellow flesh, leaf lobes widely spaced

Table 2 St Vincent breadfruit types and their equivalents found in Dominica, Grenada and St Lucia

St Vincent	Dominica	Grenada	St Lucia	Description
Creole	Yam Pain Common; Yam Pain Jaune	Greenskin; Small	Bois Pain; Ordinary	Medium-sized fruit; yellow flesh
	Yam Pain Blanc		White	Light green skin; cream flesh unchanged after cooking
White		White		Medium-sized fruit; white flesh; small spines; heavy latex flow
Kashee		Pika		Medium-sized spiny fruit; yellow flesh; wrinkled leaf

Production

Breadfruit is unsystematically intercropped with banana and other crops and receives low priority in all the territories. Trees are planted on any terrain but in dry areas tend to be close to a water course such as a river. In Montserrat they occur in steep sided gorges called 'ghauts'. Maintenance practices on trees are generally lacking although trees benefit when the intercropped banana or cocoa is weeded or fertilized. Tree age may be as high as 80 years but on any holding a range of size and age may occur. Mature trees tend to be about 20m tall and have a canopy spread of about 10m. Despite this tree size few farmers prune breadfruit and when they do it is generally to provide light for the intercrop.

Trees generally give two crops per year and some farmers claim to get three crops in some years. Harvesting of the main crop may begin as early as May and end as late as October. Harvesting of the second crop can begin as early as November and end as late as March. It takes approximately 80 days from anthesis to export maturity. Mature trees yield 60-240 fruits in the main season. The second crop generally yields fewer and smaller fruit. Farmers' estimate of yield per year is 410-450 fruits per tree.

Few pest and disease problems are experienced by farmers. These are listed as follows:

- Fruit distortion associated with corky depressions which some farmers refer to as 'bee sting' or 'beetle bite'.

- Fruit rot occuring on the surface of the fruit, referred to as 'gall'.

- Fruit rot occurring at the peduncle insertion.

- Tree decline reported by farmers in Trinidad, Grenada and Dominica. This is thought to be associated with decline in nearby trees of avocado, cocoa or pois doux (*Inga* sp.). Weir *et al.* (1983) in their review mention *Rosellinia* sp. as the causal organism.

Harvest

Several factors are considered in determining the stage of maturity for harvest. These factors are fruit size, skin texture, presence of latex on the surface of the fruit, fruit colour and stage of harvest period. Fruits tend to become lighter green, have a smoother skin texture and exude latex with maturity. Fruits not fully mature, a stage referred to as 'three-quarters full' is preferred by most exporters.

Breadfruit is exported by airfreight and is normally harvested early in the morning of the same day it is to be shipped. Some farmers in St Lucia do the harvesting in response to quota allocations from exporters.

The 'pick and catch' method is preferred in Dominica, Grenada and St Vincent. Two types of harvesting rods are used: one with a forked end or a knife attached, the other with a net or bag attached. These are called 'gollet' and 'cali', respectively, in St Lucia. The 'pick and catch' method allows for harvest of 4–5 fruits per minute with damage losses of less than 5 per cent reported by exporters. The 'pick and fall' method is faster at 7–8 fruit per minute but harvest damage may be 10–15 per cent even on soft ground.

Post-harvest

Selection after harvest eliminates fruit with blemishes, bruises or fruit of unacceptable maturity. Reject rate is generally 10–20 per cent. In St Lucia farmers are paid EC$0.50–1.50 per fruit depending on availability. The price paid in other Windward Islands ranges from EC$0.35–0.50 per fruit or EC$0 22–0.33 per kg. Farmers are not paid for reject fruit.

There is much variation in how fruit is handled by exporters in the Windward Islands. The alternative practices are as follows:

Fruit collection
- Fruit collected in polypropylene (feed bags) or jute bags
- Fruit collected in crates

Transport to packhouse
- In bulk on open trucks
- In refrigerated vans

Post-harvest treatment
- Fruit stalk cut flush
- Fruit stalk cut to 2.5cm
- Fruit stalk not cut
- Fruit precooled in water with ice
- Fruit precooled in running water
- Fruit washed in water only
- Debris cleaned from crevice at peduncle insertion
- Debris not cleaned from peduncle insertion

Boxing
- Boxing done in field
- Boxing done at the packhouse
- Breadfruit box used – 12 pack (20kg box weight)
- Banana box used – 6 or 8 pack (12kg box weight)

'Semperfresh' coating and shrink wrap have been tried but their use has been discontinued. One exporter ships fruit individually enclosed in polyethylene bags with crushed ice.

Recommendations for breadfruit post-harvest handling in the Caribbean are now available (Medlicott, 1990).

Marketing

Fruit is available on the local market almost year-round retailing at EC$0. 50 per fruit in season and up to $2.00 per fruit off-season.

Exporters reserve cargo space on airlines and ship fruit to various destinations. Specific standard requirements have emerged as the market has grown in sophistication. This information is summarized in Table 3.

Export volume has been small but steady (Table 4) . However most exporters feel that the export market though limited, has not yet been fully exploited. This market is also thought to be growing.

Table 3 Destination, transport and market requirements of breadfruit exported from the Caribbean.

Destination	Airline	Market requirements
UK	Air BVI*/BA	Roasters mainly; clean fruit; 3/4 full
Miami	LIAT* Amerijet BWIA, AA	Uniform size/box; small (1kg) preferred; clean fruit; 3/4 full
Toronto	LIAT*, BWIA Air Canada	Mixed sizes allowed; clean fruit
New York	BWIA AA	Roasters mainly; large clean fruit
Holland	LIAT* BWIA	Fruit weight of 2kg; 3/4 full
Virgin Islands	Domtrav Airways	No specific requirement

* Transshipment only

Table 4 Export of breadfruit (tonnes) from some Caribbean countries, 1985/1990

	1985	1986	1987	1988	1989	1990
St Lucia	992	833	809	867	1,137	674
Dominica	0	23	24	38	24	83*
St Vincent	94	NA	NA	NA	NA	98*
Barbados	25	NA	65	66	123	NA
Grenada	NA	1,415	1,429	1,400	NA	115*
Trinidad	NA	NA	NA	NA	NA	26

NA = not available * estimated

Sources: Ministry of Agriculture statistics
Caribbean Agricultural Research and Development Institute (CARDI)/
British Development Division in the Caribbean (BDDC)
Post-harvest Review Report (CARDI/NRI)

Major constraints and proposed actions

Farmers and exporters were interviewed and the following constraints were discussed:

- *Difficulty of harvest.* This refers to the height of trees, the risk in climbing when trees are wet, the length of time to harvest and the high rate of losses due to harvest damage. The short-term solution is the modification of harvesting methods and pruning for height control. These investigations are being conducted by the St Lucia unit of CARDI.

- *Unavailability of cargo space during peak harvest periods.* Exporters estimate that only 20 perc ent of total production is harvested at all. Recent arrangements with airlines were mediated by consultants operating under the West Indies Tropical Produce Support Project (TROPRO) to make more air cargo space available.

- *Short shelf-life of breadfruit.* This is exacerbated by the lack of proper storage facilities at airports, particularly for transshipped freight. Several facilities are to be constructed with funding from the TROPRO project. Research studies have indicated options such as waxing (Maharaj and Sankat, 1990), freezing partially cooked slices (Passam *et al.*, 1981) or vacuum-packing and flash-freezing (Newell, 1990). Full processing to crisps or flour is also possible. Studies on fruit physiology and storage behaviour continue at the UWI campuses in Barbados and Trinidad.

Conclusion

Breadfruit is currently becoming more important in the Eastern Caribbean than it was in the past. Farmers give low priority to cultural practices. for this crop while exporters deal with harvesting and post-harvest aspects in various ways to maintain fruit quality. Constraints of harvesting, availability of cargo space and short shelf-life are being addressed and some possible solutions are available.

References

Ferguson T U. 1980. Breadfruit: a potentially important food crop in the Caribbean region. A paper presented at a seminar on Research and Development of Fruit Trees (other than Citrus).

Leakey C L A. 1977. Breadfruit reconnaisance study in the Caribbean region CIAT/Inter-American Development Bank.

Maharaj R and Sankat C K. 1990. Refrigerated storage of the breadfruit and the effect of waxing, packaging and storage in water. Proc. 1990 International Winter Meeting of the American Society of Agricultural Engineers 30pp.

Matthews R F, Bates R P and Graham H D. 1986. Utilization of breadfruit in the tropics. Proc. Inter-American Soc. Trop. Hort. 30:83-94.

Newell J M. 1990. Effects of vacuum-packing and flash-freezing on shelf-life of breadfruit slices, cassava bammy, and sweet potato pudding mix. Proc. Inter-American. Soc. Trop. Hort. 34:119-123.

Passam H C, Maharaj D S and Passam S. 1981) A note on freezing as a method of storage of breadfruit slices Tropical Science 23(1):67-74.

Thompson A K, Been B O and Perkins C. 1974. Storage of fresh breadfruit. Trop. Agric. (Trinidad) 51(3):407-415.

Weir C, Tai E and Weir C. 1983 Fruit tree crop production in the Caribbean. Barbados: Caribbean Development Bank.

DISCUSSION: SESSION III

D McAllister (Federal Export Ltd, Trinidad & Tobago):
Could you expand on the subject of marketing since it is so important for small producers?

J Seepersad (UWI, Trinidad & Tobago):
In the paper we have tried to provide a basic framework to deal with this and other issues. Other participants may wish to respond to this question in detail.

K Sooknanan (Ministry of the Environmenet, Trinidad & Tobago):
Our small farmers have had the experience of exporters such as CATCO paying very low prices for quality produce. Do you have any suggestions for improving marketing for the small, part-time farmer when the middleman is reaping maximum profits?

J. Seepersad:
Bad marketing experiences do slow down the adoption process. Many ornamental producers are doing their own marketing but other things need to be put in place to facilitate the small-scale producer.

C. Bully (ADCU, Dominica):
One small-farmer approach used in the OECS is the consolidation of production units into farmers' associations with a common focus – either location of production or commodity.

Politicians tend to be apprehensive about the power-base this provides in rural areas but it does help in technology transfer and marketing efforts. Agencies should recognize and use such groups more often,

Also developments in eco-tourism should be considered. Tourists are interested in seeing our production systems. For example, banana boxing in St Lucia. This is an opportunity for small farmers through associations, to link in with product identification and promotion.

E Harvey (Casse Consultants Ltd, Barbados):
Women are used throughout the post-harvest system. It is thought that they have more patience, more ability to grade and to concentrate. Operators need to take this into account. For example, by providing transport (as is done in Dominica) to allow women time to deal with their domestic duties and by providing training at night, as was done for processors in St Kitts. Systems should be planned around considerations such as these.

J Foley (Waitrose Ltd, UK):
I see parallels between the Caribbean experiences and the early evolution of small growers in the UK. The large buyers put in demands for coolers etc., so growers joined co-operatives to meet these demands. Some of these suffered because growers sold elsewhere even after making a commitment to the co-operative. There is a place for both large and small producers who co-operate and government agencies can play a part in supporting their efforts.

D. Raj Kumar (Phoenix Farms Ltd, Trinidad & Tobago):
Many people producing breadfruit also produce bananas which are equally perishable. Why don't we use the same handling techniques?

L. Andrews (CARDI, St Lucia):
Farmers don't consider breadfruit as a regular crop. They put in no inputs. All the work is done by the exporter using harvesting crews who overdo pruning exercises etc. It probably also has to do with the small size of the market and the lack of regularity of marketing.

D Raj Kumar:
Are the economics of production being looked at?

C Bully:
We have costs of production which can be provided later.

E Harvey:
With so many names of breadfruit, how do we overcome this problem when it comes to developing labels and presentation for export?

L Andrews:
Most fall into the creole group and could be specified as such. As marketing gets more sophisticated, we may supply specific kinds for certain markets such as Cros

Marble if the importer requires a small breadfruit?

A. Whitwell (NRI, UK):
Is breadfruit an economic crop?

L. Andrews:
Yes. Comparative costs have been done which show that it is favourable.

A. Whitwell:
The damage done to breadfruit - did a beetle cause it?

L. Andrews:
Yes. Beetle bites are common on breadfruit.

E. Harvey:
Can breadfruit be utilized in any other way?

L. Andrews:
Dried breadfruit can be used in the cottage industry. This will cut down on imports. It can be used for geriatrics.

G Pollard (UWI, Trinidad & Tobago):
Breadfruit tissue culture is presently going on at the UWI. Tissue culture would have been done in Jamaica but another organization was already doing it.

L. Daisley (CARDI, Dominica):
If we are market-led we may go into monoculture of whatever cultivar the market dictates. In Ireland famine took place for that reason.

I Kosto (CARDI, St Lucia):
What is the price of a Dutch anthurium per unit? What is the minimum for low standard flowers?

E Harvey:
The price varies but Dutch prices are higher than any other.

A Whitwell:
There is no such thing as a low standard anthurium accepted on the Dutch market. The price varies from US$1.00 to $7.00 per flower.

I. Kosto:
Do the Dutch export to the USA?

E. Harvey:
The Dutch do not export directly to USA - only through buyers who may stop in the USA. Most USA anthuriums come from Jamaica, Costa Rica or Hawaii.

TECHNICAL SESSION IV

Chairman: Majeed Mohammed, *UWI, Trinidad & Tobago*

Rapporteurs: Vicente Chen, *Ministry of Agriculture, Belize*
Kelly Patrick, *Ministry of Agriculture, Grenada*

HOT WATER TREATMENT OF MANGOES - THE JAMAICAN EXPERIENCE

Darla M Robinson
Ministry of Industry, Production and Commerce, Jamaica.

Heated water is effectively being used in Jamaica against anthracnose and stem end rot infections There is no hot water treatment for fruit fly sterilization at present. The best treatment found for export varieties of mango with regards to fungal infections was 55°C for 5 mins. This is rendered more effective with 1000 or 500ppm benomyl (fungicide). This treatment increases shelf-life and enhances ripening to a more even tone.

Mango (*Mangifera indica*) orchards cover at least 600ha in Jamaica, producing in 1991 about 434,000kg of exportable mangoes. Mango, although not a traditional export crop, is a good foreign exchange earner with potential for expansion.

Today, more and more farmers are seeing the feasibility of mango production both as fresh fruit for local and export markets as well as for processing.

Mangoes like any other tropical fruit crop are perishables and hence susceptible to insect and microbial infestation. Treatments have been developed over the years to reduce the post-harvest losses induced by these pathogens.

Often mangoes of good cosmetic appeal and delicate fragrance at packaging are discarded on reaching their destination. The criteria for rejection includes discovery of symptoms for:

- anthracnose
- stem end rot
- West Indian fruit fly.

A single discovery could jeopardize the whole shipment.

Presently in Jamaica we are using hot water treatment for control of fungal infection. However, it is not being used against West Indian fruit fly as this treatment is stipulated by the Environmental Protection Agency (EPA) of the United States and we do not export to the United States but to Canada, the United Kingdom and other European countries.

Hot water treatment for control of anthracnose and stem end rot

Some of our Jamaican mangoes exported to the European markets are rejected due to the heavy infestation by anthracnose and stem end rot. To counter this loss, the hot water treatment was introduced.

Anthracnose caused by the fungus *Colletotrichum gloesporiodes* is considered in Jamaica as the most important disease affecting mango. The fungi causes destruction of flowers, reduction of fruit set, and poor fruit appearance, hence reducing marketability of the fruit. The first manifestations of the infection appear as very small brown/black spots that rapidly enlarge becoming black areas. As the disease develops, the foci of the infection merge to form big blotches covering the entire surface of the fruit.

The affected areas usually crack and sink slightly as decay occurs. Anthracnose does not usually affect the edibility of the fruit as the problem is confined to the peel during early stages of the diseases. It is however seen that in later stages the decay penetrates the flesh to shallow depths.

Stem end rot on the other hand is caused by the fungus *Diplodia natalensis* and is less prevalent than anthranose in Jamaica. This disease however causes more extensive damage. Infection begins at the pedicle and spreads downwards, sometimes covering the whole fruit. Unlike anthracnose this fungus not only attacks the fruit surface but also the fruit pulp. This disease therefore causes the entire fruit to be destroyed and rendered inedible.

Since anthracnose and stem end rot markedly affect the marketability of the ripe fruits, post-harvest control of the diseases to retard fungal growth without damaging the fruit has been researched. In Jamaica we use hot water treatment for control of these diseases together with a fungicide benomyl (Benlate®).

At the post-harvest laboratory, we have been conducting experiments on some of the export varieties – Tommy Atkins, St Julian and East Indian.

Table 1 shows the results of the various treatments.

Hot water treatment for the USA

The West Indian fruit fly, *Anestrepha obliqua* is the only fruit fly that attacks mango in Jamaica. There are two other species found in Jamaica, *Anestrepha suspensa* (Caribbean fruit fly) and *A. ocresia*.

Anestrepha obliqua causes appreciable losses to farmers unless properly controlled by pre-harvest treatments. Losses result mainly in the early, late and out-of-season crops. Our Jamaican farmers therefore apply stringent pre-harvest treatments that reduce the incidence of fruit fly infestation in their mangoes.

A survey done by the entomologist in the Ministry of Agriculture showed that the highest density of the fruit fly population tended to be in urban areas, for example Kingston and St Andrew. Other parishes of note were St Thomas and St Catherine.

With the ban in 1987 of ethylene dibromide (EDB) as a fumigant for quarantine treatments against fruit flies, hot water treatment as stipulated by the Environmental Protection Agency (EPA) of the USA was introduced as the alternative. This alternative allowed Jamaica along with other Caribbean islands to export mangoes to the USA.

To date in Jamaica we are not exporting mangoes to the USA. This is due in part to the fact that the hot water facility as outlined by the USDA's protocol has not been constructed.

In March/April 1987 the initial stages of hot water treatment in Jamaica commenced. Breeding of the West Indian and Caribbean fruit flies were done at Bodles Research Laboratory, Ministry of Agriculture, St Catherine.

Hog plums (*Spondia lutea*) were collected daily from various sources all over the island in order to collect maggots that would pupate. Collection of pupae was a far more difficult task than expected since batches of fruits, which were heavily infested visibly, yielded comparatively few pupae.

The modified laboratory at Bodles facilitated extensive field work and flies were successfully oviposited in papaw (*Carica papaya*) fruits. Hurricane Gilbert struck on 12 September 1988 and resulted in a substantial disruption of all project activities. Laboratory tests which were scheduled for the mango season the following year could not begin on time and the season was unexpectedly short.

The time that elapsed in getting the laboratory re-established to a functional state, resulted in the development and acceptance of the technology for hot water treatment of mangoes from our zone. Jamaica was now able to export mangoes to the USA without having to develop the hot water treatment. One point to note was that the USDA provided a protocol that was to be adhered to strictly by exporters.

Since Mexico was already on the way using hot water treatments for export into the USA, some of our mango exporters decided to make a visit there. They visited four farms presently using the facility. Their feedback was that the trip was well worthwhile in that they were able to see the two systems for hot water treatment (batch and continuous systems) at work.

Table 1. Effect of various treatments on mangoes for export from Jamaica

Year	Treatment	Storage	Effect on: anthracnose	stem end rot	ripening
1986 (Julie)	1. 50°C/5mins 2. 52.5°C/5mins 3. 55.0°C/5mins 4. 57.5°C/5mins 5. 60.0°C/5mins 6. Control	19°C 85-90%RH for 10 days; then 10 days at ambient temp.	Trts.1 & 6: no retarded growth Trts. 2 & 4: medium Trt. 3: light Trt. 5: discarded	NA	Trts. 1 &6: slowest to ripen Trts. 2–4: ripen with even tone (yellow) around same rate Trt. 5: discoloured after 2 days
1989 (Tommy Atkins)	1. 55°C/5mins	13°C 86–93% RH for 14days; then ambient	60% light	14%	Trts. 2, 3 & 6: uneven ripening tone
	2. 500ppm Benlate®		72% medium	30%	
	3. 1000ppm Benlate®		68% medium	28%	Trts. 1, 4 & 5: better yellow tone on ripening
	4. 55oC + 500ppm Benlate®		40%light	6%	
	5. 55°C + 1000ppm Benlate®		20% light	4%	Trts.2, 3 & 6: slower rate of ripening than 1, 4 & 5
	6. Control		90%		

They were able to identify the one most suited to the Jamaican situation, the batch system of operation , which was also the cheaper of the two.

This was the situation with regards to setting up the facility, but with regards to temperature and length of time of immersion, Jamaica was told to look to Haiti. Haiti's research had developed the conditions for treatment of their variety 'Francis'. Since Francis is not grown in Jamaica and different varieties have to be treated differently we would have to do research on our export varieties.
The question of whether Jamaica should adapt the technology and export to USA or continue to use the European Community for their exports was proposed to JAMPRO – Jamaica Investment Promotions corporation. The answer was that they chose to stick with the European and other markets.

This decision was based heavily on the feasibility of setting up such a facility. At present it would cost anywhere between US$200,000 and US$500,000 to construct. No one grower would want to meet such a cost. If a mango growers' association was formed to finance such a facility, then the location of plant to farm would pose a new difficulty since Jamaican mangoes are grown all over the island.

Another reason against exporting to the USA is the price per carton for mangoes. The price in the EEC is much higher and the countries require no special quarantine test performed on their imported mangoes. Even though there is an additional cost for air/sea freight, Jamaican producers or exporters prefer this market.

For export it will be advantageous to have a variety of export markets. And even though Jamaica has been realizing greater returns from trading with the European countries, it is in our best interest to have a ready alternative.

Conclusions and recommendations

For anthracnose and stem end rot

Generally, we have found that for export, the fruit should be picked at a mature green stage with about 1cm of stalk as this reduces the exudation of latex and limits the incidence of stem end rot.

During harvesting and subsequent handling, bruising should be carefully avoided. Prior to storage, fruits should be dipped for 5 mins in hot water at 55°C since this delays anthracnose development during storage. In cases of heavy infestation benomyl at 1000 ppm is advised to be added to the hot water dip.

For optimum storage, a cold storage temperature of 12.5°C and 90 per cent RH are recommended. Under these conditions fruits are kept in marketable condition for up to 3 weeks. The preferable ripening temperature range is 18–21°C as these fruits develop a more attractive skin colouration than at higher temperatures.

For export to the USA:

Although to date a treatment facility for fruit fly has not been established and all that exists is keen interest. Jamaican mango growers/exporters should make a keen effort to keep abreast with technological changes in hot water treatment as stipulated by the USDA.

Reference

Prinsley R T and Tucker G. 1987. Mangoes - a review. Commonwealth Science Council.

POST-HARVEST PEST PROBLEMS OF TROPICAL FRUITS AND ORNAMENTALS IN THE CARIBBEAN REGION

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The status of the main pests causing post-harvest losses to fruits and ornamentals in the Caribbean region is discussed. Fruit flies of the *Anastrepha* complex are most important, infesting many commodities. The relative significance of visible and unseen pests and of permanent and removable blemishes is emphasized for all crops considered. Regional pests cited in quarantine restrictions are noted. Present control technologies and priority areas for future research are discussed.

A wide range of tree crops and ornamentals are cultivated throughout the Caribbean region. This overview considers the more significant economical and biological problems which occur in this large area.

Tropical fruits and ornamentals are perishable commodities. Post-harvest handling and management is directed towards minimizing the time between on-farm harvest and consumer purchase. It is rare for storage pests to become a problem, particularly as shipment often occurs at low temperatures. However, many pre-harvest pests have a greater or lesser effect on the post-harvest quality and marketability of fruits and ornamentals and ultimately on the profitability of their production.

Post-harvest expression of pest problems

The nature of the damage and/or losses after harvest can be divided into three main categories, each of these sub-divisible into two.

Quarantine pests

- Economically treatable, e.g. fruit fly. The presence of the pest does not necessarily curtail the market.

- Not economically treatable, e.g. mango seed weevil. The recorded presence of the pest curtails the market.

Pests causing damage

- Usually visible at harvest, e.g. fruit-piercing moth. Affected fruit can be removed, maintaining quality at the market.

- Usually invisible at harvest, e.g. fruit fly. Affected fruit can reach the market, reducing confidence in the producer.

Pests causing blemish

- Removable blemish, e.g. sooty mould. A cost penalty for washing is incurred but market quality is maintained.

- Permanent blemish, e.g. mite or thrips russetting. The produce fetches a lower price due to reduced quality.

Some pests may cause damage in more than one category.

Post-harvest pests of tropical fruit

Those pests with a wide host range will be considered first, and then those primarily limited to one or a few of the main fruit crops.

Fruit flies

Background
Many tropical fruits are susceptible to infestation by one or more fruit fly species (Diptera, Tephritidae), and their economic

importance is increasing as Caribbean farmers diversify into producing a wide range of tree crops. Fruit flies cause post-harvest losses by infestation of mature fruit (often not seen until after shipment) and they limit markets through their quarantine significance. Latin American and Caribbean countries produce over 35 million tonnes of fruit annually, of which 20 per cent is estimated to be directly affected by fruit flies (Schwarz *et al.*, 1989).

Thirty-one species of fruit fly have been recorded from tropical fruits in the Caribbean region (CPPC, 1991), of which 15 are considered of economic importance. These are *Ceratitis capitata*, the Mediterranean fruit fly, *Toxotrypana curvicauda*, the papaw fruit fly, and 13 species of *Anastrepha*, which are listed in Table 1. Of these, *C. capitata* and six species of *Anastrepha* (Table 1a) are cited in regional quarantine regulations.

Anastrepha obliqua has the greatest geographical distribution and the widest host range of the Caribbean Tephritidae. It has been recorded from Argentina to Texas and across many of the Caribbean islands, though notably Grenada and St Vincent are fruit fly-free. In Texas, the main hosts are citrus, mango and guava, whereas in Trinidad, Cuba and Guyana, citrus is not attacked. Mango is the favoured host in Dominica, St Kitts and Montserrat, but it is apparently not infested in St Lucia and Trinidad. Guava and *Spondias* spp. are preferred hosts in many countries. Despite its importance, most of the literature about this species refers to survey records and there is little reported on the biology and life history of *A. obliqua*. Some biological control measures have been reported (Bennett, 1963), and Aluja (1987) studied its host range in Mexico.

Anastrepha ludens is widespread on the mainland borders of the Caribbean Basin but has not yet been reported from the islands. It is an important pest with a wide host range. There have been several United States Department of Agriculture reports on this pest over the years (Darby and Kapp, 1934; Baker *et al.*, 1944) and it was more recently studied in Belize by Houston (1981) Malavasi *et al.* (1983) studied *A. fraterculus* on various host trees in Brazil and *A. striata* has been investigated in Costa Rica (Hedstromand Gonzalez, 1987). However, there are few reports on the biology of the Sapotaceae fruit fly, *A. serpentina*, despite its widespread distribution through the tropical Americas, on the Caribbean islands bordering South America and in Dominica.

Control

Considerable resources have been utilized in researching and controlling the major temperate fruit flies *Ceratitis* spp. and *Dacus* spp. Pre-harvest control has been based round sterile insect techniques (SIT), pheromones and nutrient lures, combined to a greater or lesser extent with chemical insecticides. Protein hydrolysate lures effectively attract *Anastrepha* spp. flies and can be coupled with trapping or pesticides. Robacker *et al.* (1990) and Robacker and Garcia (1990) have studied fruit-based attractants for *A. ludens*. However, no SIT facility is available for the Caribbean states. Pheromones have been identified and studied for *A. ludens* (Robacker and Garcia, 1990) and *A. suspensa* (Nation, 1990), and work has concentrated on those species threatening the United States.

World-wide, Tephritid larvae are attacked by over 82 species of parasitoids (Wharton, 1989), of which 44 are known to have been released in biocontrol programmes and 20 have established. Potential parasitoids of *A. obliqua* were released in Dominica by Bennett (1963) and although these and/or indigenous parasitoids can be found, they do not exert adequate control.

Fumigation of produce with ethylene dibromide (EDB) for the post-harvest control of fruit fly is no longer possible. Considerable research into alternative methods is being carried out by exporting countries. The leading contenders are hot water and hot air treatments. Gamma irradiation has potential but can damage fruit and may meet consumer resistance.

Table 1a Anastrepha species of quarantine significance in the Caribbean region.

Species	Main hosts	Other hosts	Countries
A. fraterculus	Star apple, guava	Other fruits	T & T., S. A.
A. grandis	*Passiflora*	Citrus	S. A., Mexico, USA
A. ludens	*Annona*, papaya, citrus, mango	Sapote, mamey, pomegranate, avocado, roseapple	C. A., Mexico, USA
A. obliqua	*Citrus, mango, guava, *Spondias*	Cashew, mamey, *Annona*, cherry, carambola	S. A., C. A., Caribbean, Mexico,USA
A. serpentina	*Annona*, sapodilla, star apple	Citrus, mango, *Spondias*, guava, avocado	S.A., C. A. & N. America, T & T, Dominica, Neth.Antilles
A. suspensa	Sapote, citrus, star apple	Guava, *Spondias*, other fruits	Cuba, Dom. Rep., Haiti, Jamaica, Puerto Rico, USA

* Host range varies in different countries

Table 1b Other *Anastrepha* species of economic significance in the Caribbean region.

Species	Main hosts	Other hosts	Countries
A. bahiensis	Guava	*Spondias*	Trinidad & Tobago
A. distincta	Star apple	Mango, others	T & T., S. America
A. dissimilis	unspecified fruits		Guyana, Haiti, S. A. America
A. ethalea	*Passiflora*		Trinidad & Tobago
A. insulae	unspecified fruits		Cuba, Dom. Rep.
A. ochresia	unspecified fruits		Cuba, Dom. Rep., Jamaica, Puerto Rico
A. striata	Guava	Mango, citrus, avocado	S. & C. America, Mexico, Neth. Antilles, T & T

Fruit-piercing moths

Background
Adult moths of the genus *Gonodonta* (Noctuidae) have a stout proboscis and pierce mature fruit to feed. Surface blemishes and secondary rots result. Three species of economic importance have been reported. *G. lecha* and *G. pyrgo* attack mangoes in Belize, and the latter species has been reported from Trinidad. *Gonodonta clotilda* is an important pest of annona, mango and guava in Venezuela. In Dominica in 1963, Bennett (1963) reported the loss of thousands of Washington Navel fruits due to fruit-piercing moths, because of late harvesting.

Control
These are indigenous moths and presumably natural enemies are present. Problems usually arise from agricultural activities disrupting the ecosystem, in particular if the larval food plants, which are often weeds, increase. Specific control recommendations are unavailable.

Damaged fruit can be recognized at harvest and discarded. No post-harvest treatment is possible.

Homoptera

Background
White flies, aphids, scale insects and mealybugs can directly infest a wide range of fruits or cause soiling and sooty moulds from honeydew deposits. Some species have a very wide host range whilst others are economically important on only one crop.

Ceroplastes floridensis (Coccidae) has been reported on citrus, mango and Barbados cherry fruit from the Antilles and Trinidad & Tobago. *Planococcus citri* (Pseudococcidae) infests citrus, soursop, mango and avocado across the Caribbean.

Aleurocanthus woglumi (Aleyrodidae) and *Toxoptera aurantii* (Aphididae) are widely distributed on many crops across the region. They are usually found on the leaves, but produce honeydew causing sooty mould on fruit.

Control
The technology for biocontrol and chemical control of these pests is well understood and has been detailed in many publications (e.g., King and Saunders, 1984; Morse and Bailey, 1983).

Post-harvest cleaning removes sooty moulds and although scale may not wash off, such infestations of fruit are rarely massive.

Post-harvest pests of citrus

Background
The pests identified by CPPC (1991) and Whitwell (1991) as responsible for post-harvest losses to citrus are listed in Table 2. Fruit flies are the most serious pest. The significance of *Gymnandrosoma* (Tortricidae) in Dominica is unclear as it has not been studied since Fennah (1941). Mites and diseases, separately or together can cause considerable permanent blemishes.

Control
The control of blemish on citrus is well researched and understood and primarily depends on good management. Spray combinations and timings are critical for success.

Post-harvest pests of mango

Background
Fruit flies, moths, beetles and birds are recorded as directly damaging mango fruit (Table 3a). Fruit flies are major mango pests, but the development of acceptable post-harvest treatments could lead to a relaxation of quarantine restrictions, which are the primary constraint on regional trade. The mango seed weevil, *Sternochetus mangiferae* (Curculionidae), is a more serious pest although it does not effect the post-harvest quality of most mango varieties. Other pests recorded affecting mango fruit quality are listed in Table 3b.

Control
Pre-harvest fruit fly control programmes could reduce infestation levels significantly for local trade and secondary processing. However, breaking the quarantine barriers is dependent on internationally acceptable post-harvest control measures.

Table 2 Pests of post-harvest significance to citrus

Pest	Countries reported	Nature of damage
	Primary damage &/or quarantine	
Anastrepha *Ceratitis* [Tephritidae]	South America Central America Caribbean	Larvae feed in mature fruits causing secondary rots and infestations
Gymnandrosoma sp. [Tortricidae]	Dominica	Larvae infest oranges
	Secondary damage	
Drosophila	Widespread	Secondary infestation
	Major blemish	
Polyphagotarsonemus latus [Tarsonemidae]	Guadeloupe, Martinique Dominica, Trinidad & Tobago	Silvering of fruit
Eriophyes citricolor *Phyllocoptruta oleivora* [Eriophyidae]	South America Central America Caribbean	Bronzing of fruit Silvering or bronzing of fruit
	Minor blemish	
Ishnaspis longirostris [Diaspididae]	Caribbean	Can feed directly on mature fruit
Planococcus citri [Pseudococcidae]	Caribbean	Can feed directly on mature fruit
Ceroplastes floridensis [Coccidae]	Windwards, Leewards, Trinidad & Tobago	Can feed directly on mature fruit
Coccus acuminata [Coccidae]	Dominica	Can feed directly on mature fruit
	Removable blemish	
Aleurocanthus woglumi [Aleyrodidae]	Central America Caribbean	Leaf/stem feeders causing sooty mould
Toxoptera aurantii [Aphididae]	South America, Caribbean, Central America	Leaf/stem feeders causing sooty mould
Lepidosaphes beckii [Diaspididae]	Dominica	Leaf/stem feeders causing sooty mould
Unaspis citri [Diaspididae]	South America, Caribbean, Central America	Leaf/stem feeders causing sooty mould
Aspidiotus destructor [Diaspididae]	South America, Caribbean, Central America	Leaf/stem feeders causing sooty mould

Table 3a Primary pests of post-harvest significance to mango

Pest	Countries reported	Nature of damage
	Primary damage &/or quarantine	
Anastrepha *Ceratitis* [Tephritidae]	South America Central America Caribbeanand	Larvae feed in mature fruits causing secondary rots infestations
Sternochetus mangiferae [Curculionidae]	Barbados, St. Lucia, Martinique, Dominica, Guadeloupeimpossible.	Larvae infest seeds. Controlled by sanitation. Eradication Quarantine pest
Gonodonta clotilda	Venezuela	Adults feed on mature fruit
G. lecha	Belize	Food plants not recorded
G. pyrgo	Belize, Trinidad & Tobago	in Trinidad
Chalcolepidius virens [Elateridae]	Grenada	Feeds on fruit. Found on jackfruit in Dominica
Macraspis tristis [Scarabeidae]	Dominica	Feeds on flowers and fruit
Lobiopa insularis [Nitulidae]	St Kitts/Nevis	Also attacks guava in Grenada
Birds	Barbados	Several species reported

Table 3b Secondary pests of post-harvest significance to mango

Pest	Countries reported	Nature of damage
	Secondary damage	
Drosophila melanogaster	Barbados and elsewhere	Secondary infestation
	Major blemish	
Insulaspis insularis [Diaspididae]	Barbados	Fruit bronzing
	Minor blemish	
Ceroplastes floridensis [Coccidae]	Windwards, Leewards Trinidad & Tobago	Sometimes found on fruit as well as on leaves
Ishnaspis longirostris [Diaspididae]	Caribbean	Sometimes found on fruit as well as on leaves
Coccus hesperidum [Coccidae]	Dominica	Sometimes encrusts fruit
	Removable blemish	
Aleurocanthus woglumi [Aleyrodidae]	Central America Caribbean	Leaf/stem feeders causing sooty mould
Toxoptera aurantii [Aphididae]	South & Central America Caribbean	Leaf/stem feeders causing sooty mould
Planococcus citri [Pseudococcidae]	Caribbean	Leaf/stem feeders causing sooty mould

There is no effective means of eradicating mango seed weevil, or of disinfesting fruit after harvest. Field sanitation can rapidly reduce infestation levels to below 5 per cent. Post-harvest treatments with gamma irradiation have been attempted, but there is a very fine balance between 100 per cent weevil mortality and fruit disfigurement.

Post-harvest pests of avocado

Avocado does not usually suffer serious post-harvest losses from pests, though infestation by fruit flies is recorded. Localized outbreaks of *Heliothrips haemorrhadalis* cause surface russetting. This is often associated with population outbreaks during dry periods and also considerable leaf bronzing and drop. Chemical control of thrips is straight forward. *Selenothrips rubrocinctus* feeds at points of contact between adjacent fruit. The resulting lesions can be serious in themselves, but on an estate in north-east Dominica, a secondary infection by *Colletotrichum* on Lula variety, growing in a moist microclimate, resulted in total surface hardening and cracking and discard of the entire crop over several successive years (Whitwell, 1991). Whitwell also recorded *Amorbia* sp. larvae scarring the fruit surface. Damage is not sufficiently common to warrant control measures. Table 4 lists the main pests reported from the region.

Post-harvest pests of soursop

These are listed in Table 5. The most serious are the seed-feeding larvae of Eurytomid wasps. The group was recently reviewed by Grissell and Schauff (1990) who renamed *Bephratelloides maculicollis*, *B. pomorum*. Control measures have been investigated by McComie (1987). Infestation was reduced by bagging, but serious mealy bug infestations and fungal problems resulted.

Post-harvest pests of other tree crops

Table 6 lists some of the recorded economic pests of post-harvest significance on other tropical fruits. The more recent diversification tree crops are clearly under-represented in the literature. Research on these new cropping systems and control of post-harvest losses will no doubt develop to address the problems of the larger producers. However, pests at present are usually a minor source of losses and areas such as post-harvest handling and packaging may be more important.

Implementation of IPM technologies in tropical fruit crops

Fruit flies

The main problem in the Caribbean is the *Anastrepha* complex. Control is presently possible through several techniques.

Optimization of biological control
The unnecessary use of broad spectrum insecticides should be avoided, particularly in the period preceding fruit maturation. This is easily achieved with mangoes but may be more difficult with citrus if specific acaricides are not available. The crop protection needs of other tropical fruit crops are too localized and variable for general recommendations to be made.

Good orchard management will greatly reduce the incidence of fruit fly. Tephritids usually attack overripe fruit, and harvesting at maturity but before ripening will reduce the available habitat. This could be difficult with citrus if the brix is still low or the best marketing period is later. Greany *et al.* (1987) manipulated grapefruit ripening with gibberellic acid to reduce attack by *Anastrepha suspensa*. Fallen fruit should be collected and buried under at least 15cm of well-compacted soil. Alternatively, it can be fed to livestock, or sheep, pigs or cattle can be kept in orchards, minimizing labour demands on the farmer.

Birds and fruit bats are often reported as fruit pests. However, they generally only feed on ripe fruit which should have been harvested but has been missed or is inaccessible. They are therefore removing fruit fly habitats, and as they select soft spots, are often directly killing the larvae. Requests that birds or bats should be controlled must be very carefully scrutinized to avoid exacerbating fruit fly

Table 4 Pests of post-harvest significance to avocado

Pest	Countries reported	Nature of damage
	Primary damage &/or quarantine	
Anastrepha *Ceratitis* [Tephritidae]	South America Central america Caribbean	Larvae feed in mature fruits causing secondary rots and infestations
	Major blemish	
Heliothrips haemorrhadalis [Thripidae]	St Lucia, Dominica, Martinique, Trinidad & Tobago	Fruit russetting
	Minor blemish	
Amorbia sp [Tortricidae]	Dominica	Fruit scarring
	Removable blemish	
Aspidiotus destructor [Diaspididae]	Antigua Trinidad & Tobago	Leads to sooty mould
Planococcus citri [Pseudococcidae]	Trinidad & Tobago	Fruit soiling

infestations and possibly other pests as well.

Trapping
Protein hydrolysate bait in McPhail traps is effective in reducing fruit fly numbers, but it is labour-intensive and the bait needs to be changed every 2 or 3 days in a tropical climate. If orchards are surrounded by indigenous alternative hosts such as guava, re-infestation can overwhelm trapping.

Chemical control
To rapidly decrease adult fly populations, spraying mixtures of protein hydrolysate bait and pesticides, such as malathion, are well proven. Although aerial application may be economic over large estates, control operations over the difficult terrain and small farms common to many Caribbean islands would have to be centrally managed and financed.

Fruit-piercing moths

Control is best achieved by keeping the adult population low through removing the larval food plants, or spraying them shortly before the attacked fruit matures. Any locally available pesticide active against Lepidopteran larvae would be effective. Sprays on the crop itself would be ineffective as the pest only makes contact whilst feeding. Damage would be reduced only minimally and fruit would be contaminated just prior to harvest.

Homoptera

Control measures will vary depending on the situation and recommendations are best made by local officers. In moist climates such as Dominica, entomophagous fungi effectively control many homopterous pests.

Table 5 Pests of post-harvest significance to soursop

Pest	Countries reported	Nature of damage
	Primary damage &/or quarantine	
Anastrepha [Tephritidae]	South America Central America Caribbean	Larvae feed in mature fruit causing secondary rots and infestations
Bephratelloides cubensis [Eurytomidae]	Curacao, C. America, Cuba, Florida, Hispaniola, Jamaica	Larvae infest seeds where they pupate. Adult emergence leaves holes causing secondary infections
Bephratelloides maculicollis [Eurytomidae]	Venezuela, Colombia, Dominica, St Kitts, Guyana, Trinidad &Tobago	Same as above
Bephratelloides paraguayensis [Eurytomidae]	Paraguay, Barbados	Same as above
Bephrata ruficollis [Eurytomidae]	Panama	Same as above
Cerconota anonella [Oecophoridae]	Dominica, Dominican Republic, Fr. Guiana, Suriname, Trinidad, Venezuela.	Fruit malformation, secondary infections and infestations. Significant pre-harvest losses
	Secondary damage	
Drosophila	Widespread	Secondary infestation
	Minor blemish	
Archegozetes [Acari]	Barbados	Sometimes feed on fruit
Ceroplastes denudatus [Coccidae]	Antigua Barbuda, St Vincent & the Grenadines	Sometimes feed on fruit
Philedra [Coccidae]	Colombia, Mexico, USA	Sometimes feed on fruit
[Membracidae]	Grenada, Trinidad &Tobago	Sometimes feed on fruit
	Removable blemish	
Aspidiotus destructor [Diaspididae]	Dominica	Leaf/stem feeder causing sooty mould
Aphis citricolor [Aphididae]	Dominica	Leaf/stem feeder causing sooty mould
Planococcus citri [Pseudococcidae]	Caribbean	Leaf/stem feeder causing sooty mould

Table 6 Pests of post-harvest significance to selected tropical fruits

Pest	Countries reported	Fruit
	Primary damage &/or quarantine	
Anastrepha *Ceratitis* [Tephritidae]	South America Central America Caribbean	Larvae feed in many fruits causing secondary rots and infestations
Toxotrypana curvicauda [Tephritidae]	S. & C. America Trinidad & Tobago	Papaw
	Secondary damage	
Drosophila melanogaster	Barbados and elsewhere	Secondary infestation of many fruits
	Minor blemish	
Lobiopa insularis [Nitulidae]	St Kitts/Nevis	Guava
Coereba flaveola [Bird]	Barbados	Papaw
	Removable blemish	
Aleurocanthus woglumi [Aleyrodidae]	Central America Caribbean	Papaw

Post-harvest pests of citrus

The Tarsonemid and Eriophyid mites that cause bronzing and silvering of citrus fruit, and the scale insects that feed on the fruit surface can be readily controlled by well-organized IPM programmes. Different pests predominate in different environments and the literature.

Post-harvest pests of mango

Pre-harvest fruit fly control methodologies are relatively simple and well understood. The tools available to the farmer depend on which species is being targeted. Post-harvest treatments have a high capital cost and must be stringently managed. Such facilities would have to be centrally financed and operated, to service small farmer production.

Mango seed weevil can be readily controlled by encouraging the collection and destruction of all mango seeds in or near orchards.

Post-harvest pests of avocado

Fruit blemishes can be minimized by good cultural practices, particularly in regard to tree density and pruning, to prevent unfavourable micro-climates within the orchard. A closed canopy should not be allowed to develop. Secondary infections are then less likely to follow insect attack. Farmers should be trained to recognize thrips. Normal chemical control procedures for these pests will counteract outbreaks, though application to tall trees is difficult.

Post-harvest pests of soursop

At present no reliable IPM technologies have been developed for controlling *Bephratelloides* infestations.

Research requirements on tropical fruit crops

Fruit flies

The economics of large-scale fruit fly control in the Caribbean needs to be investigated. Although eradication is theoretically possible on the smaller islands of the Antilles, such effort may be unjustified. The mountainous terrain and wide dispersion of alternative hosts would impact on the time-scale and costs of such an operation. Studies would have to include present and future trade in fresh produce and the quarantine effort required to keep islands fruit fly free.

The local control of fruit fly must be based on good biological and life history data of the pest species. This is largely unavailable for the Caribbean states. The variable host range of *Anastrepha obliqua* in different countries needs to be explained. Effective spray techniques cannot be perfected without a firm knowledge of the spatial and temporal distribution of target species.

Farmer expansion into new tree crops such as carambola, star apple, sapodilla, etc., is likely to increase the number of species of fruit flies of economic importance. The general crop protection needs of these crops are not sufficiently understood and should be studied before farmers are disillusioned by the problems.

Fruit-piercing moths

Crop losses associated with these pests need to be quantified. Studies should include several seasons as annual differences are reportedly marked.

Studies of *Gonodonta* were last reported by Todd (1959). It is essential that the larval food plants of the economically important species are identified.

Homoptera

A better understanding is needed of the biological control agents and mechanisms, which undoubtedly vary across the Caribbean.

Where chemical control is unavoidable, application technology must be refined, particularly on the more exotic tree crops where the distribution of fruits within foliage and foliage density could reduce the effectiveness of spray targeting. For example, sapodilla can be seriously affected by sooty mould, but whether pre-harvest actions can minimize the problem is largely unknown.

Post-harvest pests of citrus

Basic research is not required. However, the economics of blemish management, particularly on small farms needs to be improved. The use of VLV and ULV spray techniques may be of benefit.

Post-harvest pests of mango

Further research is required on optimizing post-harvest disinfestation procedures.
Biological studies of *Sternochetus* are needed to identify its flight capacity and resting places.

Post-harvest pests of avocado

It is important to identify the conditions that give rise to population outbreaks of thrips. Reliable prediction will enable fruit blemishes to be minimized

Post-harvest pests of soursop

The economics of soursop production need careful investigation to clarify the relevance of pest management. Initial research on the seed-feeding wasps should examine the reasons for the marked differences in infestation encountered on different islands and within countries.

Ornamentals

Ornamental plants are either marketed alive or as cut foliage and/or flowers. Any pest that reduces the appearance of the product is effectively a post-harvest problem. Foliage and flower feeders can be devastating, and scales, aphids and mealy bugs can curtail marketability.

This is a very large subject, involving many plant species grown under a very wide range of environmental conditions. The pest complex will vary with area, season and management practices. A broad overview of the Caribbean situation is given below.

At least 60 pest species are recorded from the Caribbean region as being of economic importance on ornamentals. Over half (35 spp.) are hemiptera, of which 21 are scale insect and eight mealy bugs. Ten species of thysanoptera, nine lepidoptera and four dipteran pests are known. Orthoptera and Coleoptera often feed at night and can be serious. Ants often infest nectar-abundant flowers and post-harvest disinfestation may be required to maintain customer acceptability.

These problems need to be responded to as they arise, as the best solutions are likely to be location specific. Similarly, research needs will arise on a country by country basis.

Conclusions and recommendations

The main post-harvest pest of the Caribbean region is the *Anastrepha* fruit fly complex due to its wide geographical distribution and host range. Other pests may be of a particular problem to specific crops either as quarantine pests, (e.g., mango seed weevil), or for the damage they cause (e.g., soursop wasps).

The preferred actions to reduce post-harvest losses will be governed by the economics of production and marketing. Produce of high value will warrant pre-harvest IPM programmes and/or post-harvest treatments. In other cases secondary processing in the producer country will be the optimal compromise.

Areas of research have been identified and need to be addressed.

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References

Aluja M. 1987. A survey of the economically important fruit flies (Diptera: Tephritidae) present in Chiapas and a few other fruit growing regions in Mexico. Florida Entomologist 70(3):320-329

Baker A C, Stone W E, Plummer C C and McPhail M.1944. A review of studies on the Mexican fruit fly and related Mexican species. USDA Miscellaneous Publication No 531

Bennett F D. 1963. Report on investigations on *Anastrepha mombinpraeoptans* Sein in Dominica, November-December 1963. CIBC (unpublished report) 3pp.

CPPC. 1991. Data base for plant protection services in the Caribbean. Caribbean Plant Protection Commission Port-of-Spain, Trinidad: FAO/RLAC:

Darby H H and Kapp E M. 1934. Studies on the Mexican fruit fly, *Anastrepha ludens* (Loew). USDA Technical Bulletin 444 20pp.

Fennah R G. 1941. The 'orange moth' of Dominica, B.W.I. Trop. Agric. (Trinidad) 19(4):73-79

Greany P D, McDonald R E M, Shaw P E, Schroeder W J, Howard D F, Hatton T T, Davis P L and Rasmussen G K. 1987. Use of gibberellic acid to reduce grapefruit susceptibility to attack by Caribbean fruit fly *Anastrepha suspensa* (Diptera: Tephritidae). Tropical Science 27:261-270

Grissell E E and Schauff M E (1990) A synopsis of the seed-feeding genus *Bephratelloides* (Chalcidoidea: Eurytomidae). Proceedings of the Entomological Society of Washington 92(2):177-187

Hedstrom I and Gonzalez I. 1987. Vertical distribution of guava fruit flies, *Anastrepha striata* Schiner (Diptera, Tephritidae), in Costa Rican lowland guava orchards: implications for monitoring attempts. Tropical Pest Management 33(4):287-289

Houston W W K. 1981. Fluctuations in numbers and the significance of the sex ratio of the Mexican fruit fly, *Anastrepha ludens* caught in McPhail traps. Entomologia Experimentalis et Applicata 30:140-150

King A B S and Saunders J L. 1984. The invertebrate pests of annual food crops in Central America. London: Overseas Development Administration 166pp.

Malavasi A, Morgante J S and Prokopy R J. 1983. Distribution and activities of *Anastrepha fraterculus* (Diptera :Tephritidae) flies on host and non-host trees. Annals of the Entomological Society of America 76:286-292

McComie L D (1987) The soursop (*Annona muricata*) in Trinidad: its importance, pests and problems associated with pest control. Journal of the Agricultural Society of Trinidad and Tobago 87:42-55

Morse J G and Bailey J B (eds). 1983. 1984-1986 treatment guide for California citrus crops. Cooperative extension leaflet 2903, Division of Agricultural Sciences, University of California. Berkeley, California: University of California

Nation J L. 1990. Biology of pheromone release by male Caribbean fruit flies, *Anastrepha suspensa* (Diptera: Tephritidae). Journal of Chemical Ecology 16(2):553-572

Robacker D C and Garcia J A (1990) Responses of laboratory-strain Mexican fruit flies, Anastrepha ludens, to combinations of fermenting fruit odor and male-produced pheromone in laboratory bioassays. Journal of Chemical Ecology 16(6) 2027-2038

Robacker D C, Tarshis Moreno A M, Garcia J A and Flath R A. 1990. A novel attractant for Mexican fruit fly, *Anastrepha ludens*, from fermented host fruit. Journal of Chemical Ecology 16(10):2799-2815

Schwarz A J, Reyes J, Villesenor A, Liedo P and Gutierrez J. 1989. Fruit fly control in Latin America: Research and training coordination. In: Cavalloro R (ed) Fruit flies of economic importance 87. Proceedings of the CEC/IOBC International Symposium. Rome 7-10 April 1987. Rotterdam: A A Balkema pp 525-532

Todd E L. 1959. The fruit-piercing moths of the genus *Gonodonta* Hubner (Lepidoptera, Noctuidae). Agricultural Research Service USDA 52pp.

Wharton R A. 1989. Biological control of fruit-infesting Tephritidae. In Cavalloro R (ed) Fruit flies of economic importance 87. Proceedings of the CEC/IOBC International Symposium. Rome 7-10 April 1987. Rotterdam: A A Balkema pp. 323-332

Whitwell A C. 1991. The Dominica orchard crop management and research project. Pest and disease management. Final report. Chatham, England: Natural Resources Institute 126pp.

MANAGEMENT OF POST-HARVEST DISEASES OF TROPICAL FRUITS AND ORNAMENTALS IN THE CARIBBEAN REGION

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Severe post-harvest losses in tropical fruit crops do occur as a direct result of post-harvest diseases in the Caribbean. Post-harvest diseases such as anthracnose (*Colletotrichum gloeosporioides*) and stem end rot or soft rot (*Botryodiplodia theobromae*) have been responsible for limiting productivity and export quality of produce. The accumulative losses due to these diseases also inhibit development of the fruit sub-sector in the region. Anthracnose, a serious disease on non-traditional export fruits such as mango, papaw and avocado, exhibits the phenomenon of quiescence or latency. On infection the symptoms and development of disease are not seen until the fruit ripens or matures. This type of infection is also found in anthurium in the field. Quiescence is not fully understood hence management strategies for control have proven difficult and/or uneconomical. Stem end rot or soft rot unlike anthracnose is much more easily controlled. Recent studies show that management strategies for anthracnose should include pre-harvest (i.e. in the field) treatments in combination with those of post-harvest.

This presentation focuses on the management of post-harvest diseases of non-traditional export fruit crops – mango, avocado and papaw. Much emphasis has been placed on these crops during the past 8–10 years in the Caribbean in order to earn valuable foreign exchange. Promotion of these regionally grown crops can also form a part of an import substitution programme. Severe losses in tropical fruit crops as a direct result of post-harvest diseases have proven a significant factor in limiting productivity and export quality of produce, and also inhibit development in the fruit sub sector. FAO (1991) recently reported a conservative estimate of an annual loss of 40 per cent of all horticultural crops due to post-harvest damage in the Caribbean and Latin American region. In addition, the Caribbean suffers from the disadvantages of small-scale production, inadequate application of advanced technologies, inconsistent volume and quality of produce, lack of suitable and timely transportation etc. (Hrapsky *et al.*, 1985).

Tropical fruit crops and ornamentals (cut-flowers) have been identified as part of crop diversification throughout the region in the 1990s. The success of the crop diversification thrust lies partly in the application of improved production technologies, joint marketing, infra-structural development and transportation. Post-harvest diseases are often inextricably linked to the relative efficiencies of the various components of crop production and a marketing system.

Anthracnose (*Colletotrichum gloeo-sporioides*) exhibits the phenomenon of quiescence in which symptoms and the development of disease on fruits, and also in ornamentals, do not become apparent until the produce ripens or matures (blooms) and the various rots occur during storage or in transportation. These quiescent or latent diseases have not yet been fully understood, hence their management has proven difficult and sometimes uneconomical.

However stem end rot or soft rot (*Botryodiplodia theobromae*) of fruit crops is also found to be an important group of post-harvest diseases in the tropics, and experience has shown that stem end rots can be easily controlled.

This presentation will highlight some of the issues relating to the management of two important groups of diseases on fruits and ornamentals in the region. Issues of research and development of technology will also be discussed.

Diseases of mango (*Mangifera indica*)

Mango anthracnose

Anthracnose has been reported in the tropics and sub tropics in crops including mango, avocado, papaw etc. In mango, the disease causes severe problems at different stages of crop growth – it causes blossom blight and may lead to severe losses in fruit set as well as subsequent quiescent infections of fruits (Jeffries *et al.*, 1990). Anthracnose exhibits the phenomenon of quiescence or latency, i.e. the fungal pathogen ceases advancing after it penetrates the cuticle and progression of disease symptoms are seen only after the fruit matures and ripens.

Quiescence exhibited by a few fungi has attracted an enormous amount of research worldwide and to date this phenomenon is still not fully understood. It has recently been suggested that a pectinolytic enzyme is blocked by some inhibitors found in immature fruits. In avocado, diene (1-acetoxy - 2 -hydroxy – 4 - oxoheneicosa – 12, 15 - diene) an anti-fungal compound has been shown to be an inhibitor of the pectinolytic enzyme of the fungus (Plumbley *et al.*, 1991).

Symptoms

Disease symptoms are not usually seen nor fully developed at the time of harvest. Mango is a climacteric fruit and as such the fruit matures and ripens after harvest, and the typical anthracnose symptoms become evident.

The symptoms of *Colletotrichum* spp. are about the same for all hosts. The differences may lie in the duration of the period that the appressorium takes to germinate or in the time the fungus remains relatively restricted within living cells before causing gross tissue damage (Dodd and Jeffries, 1989). During infection of mature papaw by *C. gloeosporioides* penetration of the cuticle was observed 3–4 days after inoculation with the resultant manifestation of the disease lesions only after 5 days (Chau and Alvarez, 1983). In mango the process is more rapid and infection can be seen after 24 hours (Jones and McDonald, unpublished). Angular or sub-circular depressed lesions can be found in leaves, stems and immature blossoms. When the disease is manifested in blossoms it is referred to as blossom blight stage. Fruit production is then seriously affected. Severe symptoms appear on leaves and stems causing destruction of large areas, often beginning from the leaf margin. Later infections produce depressed lesions on young fruit which usually result in fruit drop as distinct from normal physiological fruit drop. The anthracnose disease occurs at the base of the ovary rather than at the peduncle (McDonald, unpublished). On larger fruits infections usually develop further until ripening, when dark sunken lesions appear. In many cases, the eruption of pink, slimy spore masses can be seen in the centre of the lesion.

Management stategies for control

Pre-harvest

The epidemiology of anthracnose caused by *Colletotrichum* needs to be studied before any effective control strategy can be developed in the field. The agro-ecology of each specific location should be taken into consideration and also the mango cultivars for which the control is being developed.

Julie cv. is the mango grown for the export trade in the region. This cultivar has its own peculiar phenological characteristics. Julie cv. can bloom with panicle emergence three to four times before fruit set. The tree sheds its inflorescences repeatedly before there is fruit set. Only after studying the epidemiology of the disease can effective control be achieved in the field, i.e. pre-harvest. Timing of sprays is crucial in preventing disease spread. In Australia, mancozeb is applied every 14 days between panicle emergence and fruit set in addition to copper oxychloride being applied every 3 weeks. These fungicides are alternated on a monthly basis from fruit set until harvest. In total the crop receives around 13 spray applications. The treatment is especially effective in wet spring sessions (Fitzell and Peak, 1986). In Florida, Mc Millan (1973) showed that benomyl with a surfactant gave excellent control of anthracnose and was superior to the protectant fungicides when applied at monthly intervals until 30 days before harvest. Further work by Mc Millan (1984) showed that benomyl and thiophanate methyl were the most effective treatments on Irwin cv., giving over 35 per cent disease-free fruits. A sticker was applied to the spray mixture. Spraying began at the panicle stage of growth with applications repeated weekly until fruit set after which fortnightly sprays were then given until 2 weeks prior to harvest. It should be noted that there have been reports of benomyl tolerant strains of *C. gloeosporioides* in Florida (Spalding, 1982).

Many of these recently devised spray programmes necessitate between 10 and 15 applications during a single season even though some would be unnecessary, especially in drier years. Fitzell and Peak (1986) have developed a programme of supervised spraying based on a disease forecasting model. In Dominica, CARDI's plant pathology research currently on-going is also developing a model for disease forecasting and at the same time tracing disease inoculum over the phenological growth phases of Julie mango cv. It is intended to finally develop data for a rationalized spray programme. Dodd *et al.* (1990) reported the development of a rationalized spray programme for the control of anthracnose on Carabao mango cv. in the Philippines. Five fungicide applications, one pre-bloom, one at flowering, two post-blossom and one pre-harvest were used and a range of fungicides compared. Benomyl, captafol and mancozeb all provided adequate control in the spray programme increasing fruit set per inflorescence by 55–80 per cent compared to untreated controls (Pordesimo, 1982). In Malaysia the use of combined spray applications of mancozeb, the insecticide dicrotophos, and a foliar fertilizer gave excellent control of mango anthracnose and boosted final yields when used at intervals of 7–10 days from the beginning of flower bud formation (Kwee and Chong, 1985). Some pre-harvest spray programmes for control of anthracnose are summarized in Table 1.

Post-harvest

Because most post-harvest diseases begin in the field, control measures must also begin in the field (Alvarez and Nishijima, 1978). It is necessary to control anthracnose in tropical fruits during transport and ripening. Post-harvest treatments along with pre-harvest spray programmes are essential components of disease control measures (Eckert and Ogawa, 1985).

Hot water dips either alone or incorporating a fungicide have gained popularity for the control of anthracnose, particularly in mango. The objective of any hot water dip should always aim at selecting a sufficiently high temperature and the correct duration of the dip so as to destroy the pathogen without incurring obvious fruit damage. The physiological state of maturity of fruits is another factor that needs consideration (Segarra-Carmona *et al.*, 1990).

Mango is generally harvested in the mature green stage and can be stored for 2–3 weeks at 10–12°C before ripening. Several treatments have been researched over the years to control post-harvest development of anthracnose with varying degrees of success (Table 1; Jeffries *et al.*, 1990). Hot water dips alone can significantly reduce anthracnose but fruit can show signs of heat damage (Spalding and Reeder, 1972). Julie mango cv is sensitive to high temperatures and certainly loses its lustre after heat treatment on several occasions (McDonald, unpublished). A number of fungicides have been tested as dip treatments including benomyl, which was found to be more effective against quiescent infections of anthracnose in hot water than cold water. This was related, according to Muirhead (1970), to the thicker mango cuticle acting as a barrier to fungicide ingress compared with the thinner cuticles of banana or papaw. Recently, prochloraz in hot or cold dips has proved effective against anthracnose but not stem end rot. Other fungicides used successfully with certain mango cultivars include thiophonate-methyl (Castro *et al.*, 1985) and hot imazalil (Spalding and Reeder, 1988).

Trials using gamma irradiation to control mango anthracnose have led to the conclusion that incorporation of a hot fungicide dip was necessary to improve on control afforded by irradiation alone (Thomas, 1975; Broderick and Thord-Gray, 1982; Pordesimo *et al.*, 1980).

These studies in post-harvest control have highlighted the varying degrees of success obtained with similar treatments on

Table 1 Pre-harvest spray programmes used in the control of anthracnose of tropical fruit

Country	Fruit	Pesticides	Number of sprays	Spray timing
Australia	Mango[a]	Mancozeb + copper	13	Panicle emergence onwards
Australia	Avocoado[b]/ Mango[a]	Prochloraz + copper (applied strategically)	Variable but - signficantly reduced in dry years	Panicle emergemce onwards
Hawaii	Papaw[c]	Mancozeb/benomyl/ chlorothalonil	Wet weather: 7–14 days Dry weather: 14–30 days	Fruit set onwards
Malaysia	Mango[d]	Mancozeb + insecticide (+ foliar fertilizer)	Every 10 days	Flower buds onwards
Philippines	Mango[e]	Mancozeb/chlorothalonil + copper + insecticide	5	5 sprays from induction to fruit set
South Africa	Avocado[f]	Benomyl/captafol	2	-

Source: Jeffers et al. (1990)

[a] Fitzell and Peak (1986) [b] Fitzell (1987) [c] Alvarez and Nishijima (1987)
[d] Kwee and Chong (1985) [e] Pordesimo (1982) [f] Darvas and Kotze (1987)

Table 2 Post-harvest treatments used in the control of mango anthracnose

Treatment	Reference
Scrubbing with 1% NaOCl	Pordesimo & Deang (1983)
Hot water dip (50–55°C for 3–10min)	Thompson (1987)
Hot benomyl dip (500–1000ppm)	Thompson (1987)
Hot/cold prochloraz dip (400–1000ppm)	Le Roux and Wentze (1984)
Hot imazalil (1000ppm)	Spalding and Reeder (1986)
Hot water + 20k RAD irradiation	Spalding and Reeder (1986)
Hot water + 75k RAD irradiation + wax	Thomas (1975)
Hot benlate/iprodione (100 ppm) + 75k RAD irradiation + waxing	Broderick and Thord-Gray (1982)

Source: Jeffries *et al.*(1990)

Like roses (Parups and Voisey, 1976) and gerberas (van Meeteren, 1978) anthuriums can suffer from 'bent neck' (Akamine, 1976). This is not a growth response like the geotropic bending of *Alpinia*. In rose 'bent neck' is associated with lack of lignification of vascular tissue and in gerbera with incomplete stem development. Similar studies have not been done with anthurium but it seems that 'bent neck' is not simply a function of immaturity and is associated with exceptionally wet weather around harvest time. If the neck of the peduncle of an anthurium flower is too weak, and this is not difficult to assess pre-harvest, the flower should be left on the plant until it firms up. 'Bent neck' of anthurium cannot be corrected post-harvest.

Time of harvest

The longevity of some cut flowers is closely correlated to carbohydrate status at harvest and thus flowers cut late in the afternoon last longer than those cut in the morning (Rogers, 1962). This effect has been noted with leafy cut flowers such as roses but not with leafless cut flowers such as gerbera. There is no information at this point for anthuriums although it is reasonable to assume there might be some effect because of the leafy nature of the spathe. However, senescence of anthurium flowers does not appear to be associated with carbohydrate depletion (Paull *et al.*, 1985).

Harvest process

Despite the fact that anthurium flowers appear so robust they are rather easily mechanically damaged. In Hawaii, the force of rain, even under polypropylene shadehouses, is a major cause of mechanical damage to developing flowers. Mechanical damage itself is the major cause of unmarketable flowers in Hawaii (Hara *et al.*, 1989).

When picking flowers workers tend to gather an ever-increasing bunch of flowers. This can result in damaged flowers as they rub together; the surface of the mature spadix can be rough and hard enough to abrade the surface gloss of the spathe. To minimize damage at harvest, pickers should not hold too many flowers at one time and an arbitrary limit of around 10 flowers is often set.

Flower stems should be cut as long as possible. Although the vase life of anthuriums with artificially shortened peduncles is increased (Akamine and Goo, 1972), aesthetics and market requirements dictate a relatively long stem. Also, the basal portion of the stem may be deliberately cut off at various stages of post-harvest handling. In Hawaii, there is a minimum export standard for stem length based on the size of the flower (Anon., 1972).

To minimize water loss from the freshly harvested anthurium flowers, they should be quickly placed in water in the shadehouse. A variety of containers is used at this stage. Some growers use trays of old soft drink bottles so that each flower is placed in water physically separated from the others. This can help reduce mechanical damage. Alternatively, old paint cans, plastic buckets and other containers may be used.

Irrespective of the container being used it is important that fresh clean water be used for each harvest. The containers themselves should be kept scrupulously clean and regularly disinfected to prevent the build-up of bacteria. The bacteria of concern here are not specifically anthurium pathogens like *Xanthomonas* or *Pseudomonas* but ubiquitous and essentially non-pathogenic micro-organisms. Bacteria (and yeasts) are a major cause of vascular blocking of cut flower stems which increases water stress and accelerates senescence (Mayak, 1987; Paull *et al.*, 1985).

Assessment of anthurium vase life

In applied studies on cut flower vase life it is not uncommon to find that both the criteria and environmental conditions used are not clearly stated or are rather ill-defined. This makes it very difficult for comparisons to be made between individual studies. It is increasingly held that 'vase life' should reflect the useful life of the flower in the consumers' home and exclude time spent intransit through the marketing chain. The most relevant of the applied studies therefore include a real or simulated shipping period before commencement of vase life measurement. However, even these studies tend implicitly to assume that the consumer acquires the flower almost different mango cultivars (Hatton and Reeder, 1965). This reinforces the view that the appropriate post-harvest treatments will have to be selected for individual mango cultivars and possibly even for the same cultivar in different environments.

Stem end rot

Stem end rot of mango is primarily a post-harvest disease and arises from poor harvesting techniques. The disease usually occurs at the stem end, especially when the fruit peduncle (stem) is cut shorter than 0.5cm. However the greyish-white water soaked necrotic lesions can also be seen on the parts of the fruit other than the distal end. The leakage from the stem end as a result of too close a cut so as to rupture the epidermis of the fruit or from natural cracks found in the fruit cause spread of the infection. Sometimes the anthracnose fungus along with (*B. theobromae*) are isolated from the same lesions or necrotic spots found on the fruit. Those necrotic lesions eventuate into blotches or soft rots in other parts of the fruit surface. The infected fruit stored under poor conditions can deteriorate into a mushy mess in a few days.

Management for control

Stem end or soft rot damage in mango can be reduced by proper methods of harvesting ensuring that the stem is not cut too close to the epidermis - not less than 0.5cm. Rupturing of the fruit should be avoided so as to cause no leakage from the stem end. Hot benomyl dips (500–1000ppm) have been shown to be an effective means for controlling soft rot in storage.

Diseases of avocado (*Persea americana* Miller)

Avocado is of recent planting in the Caribbean, moreso on a commercial scale. The extra-regional market for avocado has grown by some 75 per cent during the mid-1980s (1982–86) over the previous period 1979–80 (La Gra and Marte, 1987).

Anthracnose

The etiology of *Colletotrichum gloeosporioides* in avocado is similar to that in mango. Infection can begin in mango during the growing season but remains quiescent until the fruits ripen. Avocado fruits are harvested at the pre-climacteric stage and as the ripening process begins typical anthracnose symptoms emerge on the fruit surface.

Symptoms

Typical small dark brown to black lesions less than 2mm appear on the fruit surface at harvest; during the ripening period some 5–7 days after harvest lesions develop larger than 2mm which sometimes coalesce to form much larger sunken lesions covering the fruit surface. These lesions often lead to soft rots and very often pink slimy masses of conidia emerge from the centre of the necrotic spots.

Management strategies for control

Several post-harvest dips of several fungicides have been recommended –thiabendazole, prochloraz, benomyl and imazalil at varying concentrations (500–1000ppm).

Stem end rot

Here again the stem end rot or soft rot in avocado follows the same sequence of morphological changes as stem end rot or soft rot of mango. The locus of disease always seems to be at the stem end thus giving rise to the name of the disease.

Symptoms

Greyish-whitish soaked lesions can first be seen at the stem end where rupture of the epidermis of the fruit easily occurs at harvesting. Soft rots seem to develop as the fruit ripens and reaches full maturity in storage, Temperatures of 10–12^{o}C seem to inhibit disease development.

Management strategies for control

Hot water dips of benomyl and storage at 10–12^{o}C are recommended.

at 42°C. The double dip treatment provides excellent control of post-harvest diseases of papaws when coupled with regular field fungicide sprays.

A number of chemicals have been tested as post-harvest fungicide treatments to supplement orchard sprays. Either benomyl or thiabendazole is effective as post-harvest treatment. The most common post-harvest treatment for surface and air-shipped papaw is thiabendazole applied at 4–8g per litre with carnauba wax (Alvarez, 1980).

Ornamentals

Anthurium (cut flower), as previously mentioned, has been identified as another effort in the overall crop diversification thrust to increase foreign exchange earnings. The cut-flower industry is a fledgling sub-sector in most parts of the region with the exception of Jamaica where the industry can be considered as established.

Anthracnose can infect leaves and spathes of blooms both in the field and after harvesting. Here again the disease begins in the field and infection of blooms resulting in the unmarketability of the produce during intransit and shipment.

Symptoms

Infection on stems and leaves can be seen as dark brown to black lesions. Sub-circular or angular spots appear on the lamina of leaves and can cause destruction of the total leaf surfaces, very often beginning along the margin of leaves.

Symptoms of necrotic spots can appear in the spathe in the field or during intransit and shipment.

The spadix can also be infected. The bloom is rendered unsuitable for marketing and has to be disregarded.

Management strategy for control

Control is solely by spraying in the field to reduce inoculum load. Sanitation must be strict to avoid spread of disease. In Dominica, Trimiltox Forte® at 2g/l seems to give good control in the field.

References

Alvarez A M. 1980. Improved marketability of fresh papaya by shipment in hypobasic containers. Hort Science 15:517–518.

Alvarez A M and Nishijima W T. 1987.. Post harvest diseases of papaya Plant Disease 71:681–686.

Alvarez A M, Hylin J W. and Ogata T N.. 1977. Post harvest disease of papaya reduced by bi-weekly orchard sprays. Plant Dis Rep 61:731–735.

Broderick H T and Thord-Gray R. 1982.. Research report of the South African Mango Growers Association In: Proctor F J and Sharples R O (eds) Aspects of applied biology Wellesbourne, UK: Inst Hort Research 20:49–56

Castro J V, Sirgist J M, Bleinroth E W, Yokomizo Y and Carvalho P R N. 1985. Effect of post harvest application of fungicides on control of anthracnose in mangoes In: Proctor F J and Sharples R O (eds) Aspects of appliedl biology Wellesbourne, UK: Inst Hort Research 20:49–56

Chau R F and Alvarez A M. 1983. A histological study of anthracnosoe on *Carica papaya* Phytopathology 73:1113–1116.

Dickman M B, Patol S S and Kolattukudy P E. 1983. Effects of organophosphorus pesticides on cutinase activity and infection of papayas by *Colletotrichum gloeosporioides*. Phytopathology 73:1209–1214.

Dodd J C, Jeffries P.and Jeger M J. 1989.. Management strategies to control latent infection in tropical fruit. Aspects of applied biology 20:49–56.

Eckert J W and Ogawa J M. 1985. The chemical control of post harvest disease: sub tropical and tropical fruits. Ann Rev Phytopathology 23:421–454.

FAO 1991. Newsletter on technical co-operation network on food crops production FAO Regional Office for Latin America and the Caribbean. 18 September 1991.

Fitzell R D and Peak C M. 1986. Management strategies for control of anthracnose and bacterial black spot in Northern New South Wales Proceedings CSIRO First Australian mango research workshop 1984 pp. 253–257.

Hatton T T and Reeder W F. 1965. Hot water as a commercial control of mango anthracnose. Caribbean Region, Amer Soc Hort Sci. 81:76–84.

Hrapsky A, Weber M and Riley H. 1985. A diagnostic prescriptive assessment of the production and marketing system for mangoes in the Eastern Caribbean. A working paper. Dept. of Agric Economics, Michigan State Univ., Michigan.

Jeffries P, Dodd J C, Jeger M J and Plumbley R A. 1990. The biology and control of *Colletotrichum* species on tropical fruit crops. Plant Pathology 39:758–773.

Kwee L T and Chong K K. 1985. Diseases and disorders of mango in Malaysia. Kuala Lumpar, Malaysia: Tropical Press.

La Gra J and Marte R. 1987. The fruit sub-sector in the Windward Islands: diagnosis – strategy – action. St Lucia: Inter-American Institute for Co-operation on Agriculture Publication Office

Muirhead L F. 1981. Post harvest diseases of tropical and sub tropical fruits : Aspects of applied biology. 20:49–56.

McMillan R T. 1973. Control of anthracnose and powdery mildew of mango with systemic and non-systemic fungicides. Trop Agric (Trinidad) 50:245–248.

McMillan R T. 1984. Control of mango anthracnose with foliar sprays. Proc Florida State Hort Soc 97:344–345.

Plumbley R A, Prusky D and Kobiler I. 1991. The relationship between antifungal diene levels and quiescence of *Colletotrichum gloeosporioides* in avocado fruits subjected to treat-treatment (in press; Plant Pathology).

Pordesimo A N. 1982. Development of programmed spray application for the control of anthracnose In: Aspects of applied biology 20 pp 49–56.

Segarra-Carmona A E, Franqui Rosa A, Ramirez-Ranos Lucas V, Santiago L R and Torres Rivera C. 1980. Hot water dip treatments to destroy *Anastrepha obliqua* larvae (Diptera: Tephritidae) in mangoes from Puerto Rico . T. Agric University ofPuerto Rico 74 :441–447.

Spalding D H. 1982. Resistance of mango pathogens to fungicides used to control post harvest diseases. Plant Disease 66:1185–1186.

Spalding D H and Reeder W F. 1986. Decay and acceptability of mangoes treated with combinations of hot water imazil with gamma radiation. Plant Disease 70:1149–1151.

Thomas A C. 1975. Gamma irradiation – An answer to the mango grower's prayer. Aspects of applied biology 20 49–56.

POST-HARVEST MANAGEMENT OF TROPICAL CUT FLOWERS

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This paper is primarily concerned with anthuriums. For information on *Dendrobium* orchids the reader is referred to the paper by Jingwei Dei and Paull (1991) and to references therein. There is very little information about the post-harvest handling of other tropical cut flowers of export interest in the region.

Anthuriums are one of the better studied tropical cut flowers. There are probably two main reasons for this. The first is that, like *Dendrobium* orchids and unlike for example *Alpinia* and *Heliconia*, anthurium cultivation requires a rather large capital investment in a growing structure and beds from which growers seek to maximize returns. Growers thus tend to lobby for and encourage research and development work. The second reason is the major importance of the cut flower anthurium industry to the economy of Hawaii. Although the number of anthurium flowers exported from Hawaii declined by 43 per cent between 1985 and 1989 as a result of bacterial blight, their wholesale value declined only by 17 per cent to $6.8 million. An industry of this size justifies considerable local research and extension support, the written results of which dominate the world literature on anthurium production in the tropics.

This paper is in five sections. The first section discusses some factors which need to be considered at harvest. The second is a review of what is known about the post-harvest physiology of cut flower anthuriums. The third section describes the results of work aimed at extending their post-harvest life. In this section I will draw attention to the deviation between what can be done to extend post-harvest life of cut flower anthuriums and what is done in commercial floricultural practice. In the fourth section I will briefly discuss some consequences of specialization in the marketing chain and how this might affect the implementation of technology designed to improve post-harvest life of tropical cut flowers. Finally I will give some indication of the need for further research work.

The anthurium flower at harvest

Stage of development:

The anthurium 'flower' of commerce is botanically an inflorescence in the form of a spadix subtended by a colourful heart-shaped spathe, a modified leaf. The spadix comprises about 300 individual botanical flowers. Spadix maturity, and hence maturity of the commercial 'flower', is indicated by a change in colour and texture related to stigma receptiveness of individual botanical flowers. The proximal botanical flowers mature first with development progressing towards the tip of the spadix over a 3–4 week period depending on temperature.

Anthurium flowers have maximum potential vase life when the spadix is three-quarters to fully mature (Kamemoto, 1962; Kalkman, 1983). Once the flower is harvested, about a further 10 per cent of the botanical flowers open but to all intents and purposes the appearance of the commercial 'flower'"is unchanged by this process.

The spathe of the anthurium flower is sufficiently developed for flowers to be harvested before optimum maturity of the spadix. Early picking may be commercially attractive for a grower to maximize the number of flowers shipped for sales peaks such as Valentine's Day and Easter but there is inevitably a reduction in vase life. To prevent too great a loss of quality in situations like this the Hawaiian industry has set a minimum export standard which requires the spadix to be at least one-third mature (Anon., 1972).

immediately after shipping; this is not usually the case.

In considering the post-harvest performance of the anthurium 'flower' one has to consider characteristics both of the spadix and spathe. Paull (1982) has detailed criteria for assessing the post-harvest life of the anthurium flower. (Table 1)

Paull (1982) considered that anthuriums had come to the end of their useful vase life when:

- the spadix condition was rated at 4
- the spathe blueing was rated at 3
- loss of spathe gloss was rated at 4

(see Table 1).

Physiology of senescence of cut flower anthuriums

Senescence of cut flowers is a sequence of changes involving alteration of membrane chemistry, an increase in respiration, loss of membrane integrity and, ultimately, excessive and irreversible water loss (Mayak, 1987). Wilting of cut flowers is a typical indicator of the end of vase life.

The physiological changes occurring during the post-harvest senescence of cut anthurium flowers has been studied in Hawaii by Paull *et al.* (1985). They noted first a decline in respiration up to Day 4 post-harvest and then relatively little change until Day 8. Between Days 8 and 12 there was a 250 per cent increase in respiration when another plateau occurred before respiration again rapidly increased. This general pattern is commonly seen in cut flowers and has been likened to the climacteric respiration of some fruits (Halevy and Mayak 1979; 1981).

Ethylene production was below the limit of detection of the equipment used by Paull *et al.* (1985). In other senescing flowers, ethylene production has three phases: i) a low steady rate; i) an increase to maximum; iii) a decline to a low rate. An increase in carbon dioxide production similar to that reported for anthurium and correlated with the second phase of ethylene production has been reported for carnation (Maxie *et al.*, 1973). While ethylene is a naturally occurring plant growth regulator it is also an important environmental pollutant and its exogenous presence induces autocatalytic production by cut flowers. Anthurium is known to be relatively insensitive to exogenous ethylene but its effects have not been properly studied.

Paull *et al.* (1985) found that spathe colour, spathe tissue pH and ammonium ion concentration changed more or less simultaneously. The change in spathe colour was the first visible sign of senescence and occurred shortly after respiration began to increase around Day 8. The experimental cultivar was 'Ozaki Red' and the colour change observed was the development of a blue cast to the spathe. This colour change was also associated with an increase in total anthocyanins but the ratio of the two principle anthocyanins did not alter. Spathe tissue pH initially showed little change but then increased at about the same time that spathe blueing was observed. The concentration of the ammonium ion in spathe tissue showed a similar pattern.

Although these events occurred apparently simultaneously their sequence was thought to be: i) the release of the ammonium ion from amino acids produced as a result of protease activity which caused ii) a change in cytoplasmic pH which possibly caused iii) a change in the colour of the major anthocyanin pigments from red to blue. Blueing was accentuated by copigmentation with released phenolic substances and it may be that the main effect of pH change was to augment copigmentation rather than an effect on anthocyanin per se. Whatever their precise relationship these changes are consistent with a general reduction in membrane integrity and increased oxidative activity.

Anthurium flower senescence did not appear to be due to a shortage of carbohydrate; although the amount of tissue starch decreased by 25 per cent the amount of total free sugars did not change significantly and there was no net movement of sugars from one part of the flower to another.

Table 1 Criteria for evaluation of useful vase life of anthurium

Score	Rating scale
	Visual spadix conditions
1	No blemishes
2	Spadix tip showing slight discolouration – browning
3	Spadix tip showing definite discolouration, slight separation of individual flowers of the spadix
4	Tip definitely browning and drying out but less than 10% of the total length affected
5	Tip necrotic and dried out with more than 10% of the total length affected
	Spathe discolouration – blueing
1	None : fresh harvest appearance
2	Slight: less than 5% blueing
3	Moderate: 5–10% blueing
4	Severe: greater than 10% blueing
	Spathe condition – gloss
1	No loss: high gloss fresh harvest appearance
2	Slight loss: not objectionable
3	Moderate loss: slight gloss remaining
4	Severe loss: no gloss, wilting of spathe lobes

Source: Paull (1982)

Paull *et al.* (1985) concluded that, ultimately, anthurium flower senescence was caused by water stress due to excessive water loss and blocking of the vascular system of the peduncle which prevented water uptake. Although water loss is the inevitable consequence of senescence changes in membrane permeability, the effect of water stress on the flower is compounded by vascular blocking. Paull *et al.* (1985) did not determine the nature of the blocking for anthurium. Vascular blocking of roses has been shown to be caused both by micro-organisms in the vascular system near the cut end of the stem and by gums higher up the stem (Lineberger and Steponkus, 1976).

Prolonging the post-harvest life of cut flower anthuriums

There is a variety of treatments which can be applied to anthurium cut flowers to prolong their post-harvest life. These can be divided into chemical and physical treatments. An important difference between them is that chemical treatments do not on the whole require the investment in infrastructure that is necessary for physical treatments.

Chemical treatments

It has been known for many years that the vase life of cut flowers is improved by various chemicals dissolved in the vase water. So called flower preservatives are usually blends of sugar, a chemical with antibiotic properties and other ingredients such as free radical scavengers which mop up some of the more destructive products of oxidative changes (Goszczynska and Rudnicki, 1988). There is a variety of commercial flower preservatives on the market increasingly with formulations specific to a range or even to a single cut flower but there is no formulation specific for anthurium.

Chemical treatments can be used at various stages of the post-harvest handling of anthuriums:

- pre-shipment conditioning or hardening
- pre-shipment pulsing or loading
- post-shipment conditioning or hardening
- holding or vase solutions

Pre-shipment conditioning or hardening
Pre-shipment conditioning is a treatment applied to the flowers by the grower before they are packed.

Akamine and Goo (1975) tested a number of commercial flower preservatives and some other chemicals in a pre-shipment conditioning trial on anthurium. The trial involved holding cut flowers in various solutions for 6 or 7 days after which they were packed in moist shredded paper and held for 1 day to simulate shipping. The flowers were then unpacked and, except in one treatment, the base of the flower stem was re-cut before the flowers were placed in tap water. Flowers were kept until the end of their useful vase life and the results, summarized in Table 2, showed that pre-shipment conditioning could effectively double vase life of anthuriums.

The premise of this piece of work was that there may be situations where growers would need to hold flowers for a number of days before shipping. In practice, anthurium flowers are usually packed within 24 hours or so of harvest and such pre-shipment conditioning is not routinely practiced commercially.

An exception to this generalization occurs in the case of one particular Dutch cultivar called Koraal which has an enlarged and fasciated spadix. This cultivar is commercially desirable because of its unique characteristics but has a very short vase life. Conditioning this variety with a proprietory universal flower preservative improves vase life and commercial acceptance.

Pre-shipment pulsing or loading
Pulsing is distinct from conditioning treatments of the type just described in that it is a relatively short treatment but it is similarly designed to be effective even when flowers are placed in plain tap water after shipping.

Table 2 Effect of pre-shipment conditioning treatment with commercial flower preservatives on vase life of anthurium flowers

Treatment sequence	Vase life (days)
Everbloom® 6 days --> 1 day pack --> stem cut --> water	6.9
Control: water 6 days --> 1 day pack --> stem cut --> water	3.7
Floralife® 6 days --> 1 day pack --> stem not cut --> water	6.9
Water control	3.7
Roselife® 7 days --> 1 day pack --> stem cut water	7.8
Water control	2.9

Source: Akamine and Goo (1975)

Sucrose is often the main ingredient of pulsing solutions which may be used to increase the carbohydrate status of cut flowers. The sucrose concentration in pulsing solutions varies between 5 and 20 per cent or sometimes more depending on species. Pulsing time is between 12 and 24 hours. As mentioned previously, carbohydrate depletion does not appear to be a limiting factor in anthurium vase life. Sucrose pulsing did not increase anthurium post-harvest life (Akamine and Goo 1975; Paull *et al.*, 1985).

Other pulsing treatments involve the use of silver salts, either silver nitrate or a silver thiosulphate complex.

Silver salts are effective bactericides and also act as ethylene antagonists. Silver nitrate is rather immobile in cut flower stems and remains at the application site (the term 'impregnation' is sometimes used for silver nitrate treatment for this reason) but the silver thiosulphate complex appears to be readily translocated (Kofranek and Paull, 1974; Veen and van de Geijn, 1978).

Paull and Goo (1982) investigated the effect of silver pulsing on anthurium. Before pulsing treatment, the basal 2cm of the anthurium flower stem was removed in air. Stems were treated in a 3cm depth of pulsing solution. The stems were then rinsed in deionised water and the flowers packed in moist shredded paper and held for 3 days to simulate shipping. On unpacking, the basal 2cm of the flower stem was removed in air and the flowers placed immediately in distilled water. The results are summarized in Table 3.

A 40-minute pulse with 4mM silver nitrate or silver thiosulphate increased the vase life of anthurium by at least 40 per cent An increase up to 60 per cent was obtained by extending the silver nitrate treatment time to 60 minutes. Silver treatment attenuates some of the physiological changes occurring during senescence. The increase in respiration was delayed: spathe pH remained rather constant; the increase in the ammonium ion concentration was lessened and delayed.

Silver nitrate was most effective at extending the vase life of fully mature flowers (47 per cent increase) but also increased the vase life of half mature flowers (31 per cent increase), the youngest tested. It was important to treat the flowers within 12 hours of harvest.

The beneficial effect of silver nitrate was not lost when the basal 2cm of the stem was re-cut after the simulated shipping period. Further, the benefit of silver nitrate treatment was actually lost if the stem was not re-cut. This is in contrast to the response of other flowers where it is specifically recommended that silver nitrate treatedflower stems are not re-cut. A further interesting result with anthurium was that when anthurium stems were cut in air, flowers had a longer vase life than when they were cut under water. It is normally recommended that cut flower stems are re-cut under water to prevent air embolism in

Table 3. Effect of various pre-shipment pulsing treatments on vase life of anthurium flowers

Treatment *	Vase life (days)
$AgNO_3$ --> 3 day pack --> deionized water	21.5
Ag $(S_2O_3)_2^{3-}$ --> 3 day pack --> deionized water	18.5
Control: no treatment --> 3 day pack --> deionized water	13.25

Source: Paull and Goo (1982)

* silver nitrate and silver thiosulphate both pulsed for 40 minutes at 4 mM

the vascular system. It would seem to be unimportant whether anthurium flower stems are re-cut under water or in air, the latter being more convenient in practice. A similar result has also been obtained with *Dendrobium* (Jingwei Dai and Paull, 1991).

Vase life extension of anthurium as a result of silver nitrate pulsing was thought to be due to a combined effect of antimicrobial activity and reduction of ethylene-related wound responses. Both of these factors could lead to blockage of the vascular system and reduce water uptake by anthurium cut flowers. Silver nitrate did not reduce the initial wound ethylene production peak but did prevent further autocatalytic ethylene production (Paull and Goo, 1985)

Another method of improving the water relations of cut anthurium flowers is to reduce flower transpiration. The spathe is a modified leaf and while it has only six to seven stomates per mm^2 on its lower surface as compared with 30–40 stomates per mm^2 on the lower leaf surface (Higaki *et al.*, 1984) a water loss resulting in a less than 1 per cent fresh weight loss results in a visually detectable loss of spathe gloss (Paull, 1982). Water loss from an anthurium flower is greater from the spadix than the spathe; 50–60 per cent of water loss from an anthurium flower is from the spadix, 20–40 per cent from the spathe and 10–20 per cent from the stem (Paull and Goo, 1985).

Watson and Shirakawa (1967) were the first to show that the application of a layer of wax could reduce water loss from anthurium flowers. More recently, Paull and Goo (1985) tested the efficacy of a range of commercial waxes which reduced water loss and improved vase life. There were large differences in the effect of wax formulations. Most had relatively little effect but the most effective doubled vase life from 18 to 36 days. The best treatment was a preparation of carnauba wax, derived from the leaves of the Brasilian wax palm, *Copernica cerifera.*

Carnauba wax imparts a high gloss to the spathes of anthurium flowers. A similar effect can be obtained by application of mineral oil which is sometimes commercially practiced but apparently without an increase in vase life.

Commercial application of chemical treatments

The silver pulsing and waxing treatments discussed above can each double the vase life of cut flower anthuriums. Yet neither treatment is standard commercial practice. Why?

One reason is the increased cost in terms of materials and labour to treat the flowers. The use of silver nitrate pulsing is awkward to implement in packhouses not designed to accommodate the process. Also, photo-oxidization of the silver nitrate solution results in black precipitates which can stain workers' hands and packing materials.

However, the main reason why these treatments are not used is that normally there is no commercial advantage to be gained from them. With the possible exception of situations where anthurium flowers are harvested with an inherently short life as a result of early picking or poor pre-harvest conditions, their post-harvest life is quite adequate.

Paull and Goo (1982) noted that there was considerable variation in the post-harvest life between different batches of the same cultivar of anthurium. Their samples of the Hawaiian cultivar 'Ozaki Red' had a post-shipping vase life ranging from a low of 7 days to a high of 44 days for untreated flowers, i.e. treatment controls. These differences were attributed to undetermined differences in pre-harvest conditions. 'Ozaki Red' is not inherently a particularly long-lived anthurium cultivar. A 7-day vase life, however, compares favourably with many other cut flowers while almost no other cut flower has a 44-day vase life (see Table 4). Most commercial anthurium growers reckon on a 2–3 week post-shipping vase life for their flowers.

Table 4. Vase life of selected cut flowers after distribution

Cut flower	Vase life (days)
Gerbera	11.4
Rose	10.7
Carnation	9.4
Tulip	5.3
Chrysanthemum	12.8
Lilium	7.4
Iris	3.2
Freesia	9.5

Source: Bent (1991)

Physical treatments

In addition to, or sometimes complementary with, chemical treatments cut flowers may be subject to alteration of their physical environment through management of temperature or atmosphere.

Temperature management

Shadehouse temperatures are higher than desirable for maximum shelf life of cut anthurium flowers and even when harvested in the cool of the day, anthurium flowers are likely to have a fairly high field heat. Cooling flowers retards the metabolic processes involved with senescence but too low a temperature reduces vase life through chilling injury. Anthuriums have been reported to suffer chilling injury when exposed to 2°C for as little as 1 hour (Shirakawa *et al.*, 1964) but anthurium vase life is reduced at higher temperatures than this. Akamine and Goo (1981) suggested that 13°C was ideal for storage of anthuriums and Paull (1987) found that 14–17°C was optimum depending on cultivar.

Because of the difficulty in adjusting the temperature of boxed flowers, anthuriums should be pre-cooled before packing. The impossibility of adjusting each cultivar to its optimum temperature in a commercial situation will mean that a compromise temperature will have to be determined. The term pre-cooling is sometimes used a little loosely but properly refers to a forced cooling process that rapidly brings the temperature of the flowers down to the desired level. Ideally, the packed flowers should then be maintained at the optimum temperature.

Atmosphere management

As an alternative to temperature management, atmosphere management can be used to extend the post-harvest life of cut flowers. Three types of atmosphere management are recognized: i) controlled atmosphere; ii) modified atmosphere; and

iii) low pressure storage (Goszczynska and Rudnicki, 1988). Only controlled atmosphere storage has been tried for anthurium.

Controlled atmosphere storage involves regulation of, mainly, oxygen and carbon dioxide concentrations within the storage chamber. Temperature is usually also controlled. Akamine and Goo (1981) found that anthurium flowers could be stored for up to a week at room temperature under 2 per cent O_2 with no loss of vase life.

Commercial application of physical treatments

The commercial application of temperature and atmosphere management requires investment in infrastructure. Unlike chemical treatments, the benefits of physical treatments accrue only as long as the treatment is maintained. It is frequently stated that the benefits of a treatment at one part of the marketing chain can be undone by maltreatment at another and this is particularly true of physical treatments.

Controlled atmosphere storage is nowhere used for shipping cut flower anthuriums. Most growers do not practice any form of cooling of their flowers although the practice of washing flowers in water to remove dirt probably removes a certain amount of field heat. However, a primitive form of controlled temperature storage is effectively practised.

A not infrequent complaint from anthurium growers and producers of other tropical cut flowers is that shipments are put at risk from damage by high or low temperatures during shipping by being left out on airport tarmacs. While damage has been caused in this way, the method of packing anthuriums that is practised in Hawaii, Mauritius and in Trinidad & Tobago results in the shipping boxes having a reasonable thermal inertia.

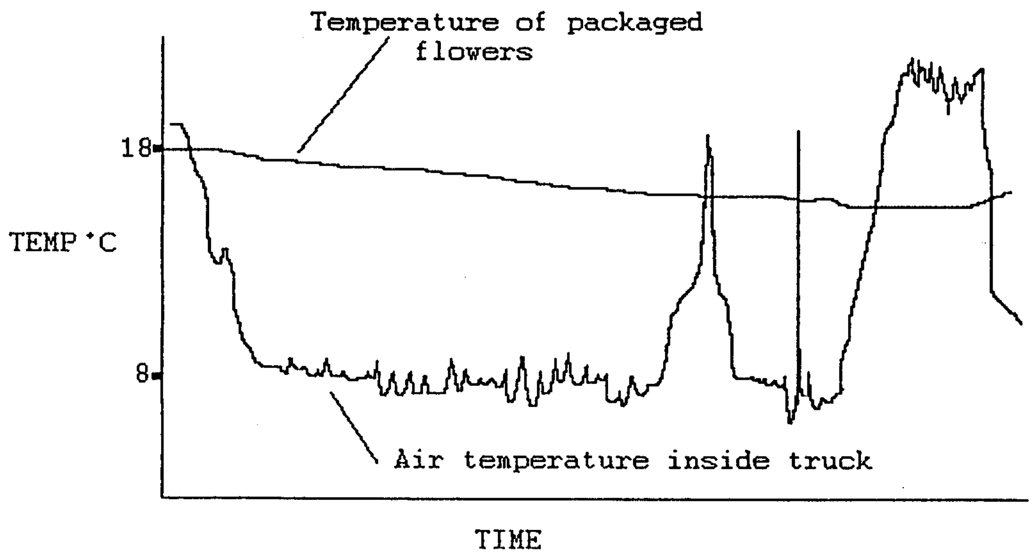
There are some differences in packing techniques from grower to grower as they respond to customer requirements, availability of packing materials, cope with difficult-to-pack cultivars, or introduce mechanical aids to packing. In general terms, anthuriums are shipped in corrugated cardboard boxes packed in damp but not wet shredded paper surrounded with a polythene sheet and then several layers of newspaper. A dozen or so of these boxes are then placed inside a master box. A fair amount of insulating air is therefore trapped inside a box of anthuriums. When shipping during winter to destinations where outside temperatures may be close to or lower than $0^{o}C$, the newspaper layers are often replaced with thin foam plastic sheets for extra insulation. Figure 1 shows how a sealed box of flowers tends to resist temperature changes.

Figure 1 clearly shows that the temperature of the flowers are effectively not influenced by the temperature of the truck. Thus there was no particular benefit from the use of the trucks cooling system but neither was there damage done when the temperature increased rapidly at least for short periods. This clearly shows the value of effective precooling of flowers as well as the importance of packaging. If the temperature of cut flowers is reduced to the optimum before they are packed, the very nature of the pack will tend to resist deleterious temperature changes. Ideally of course there should be provisions for proper controlled environment facilities at all stages of the marketing chain for cut flowers.

Post-shipment conditioning or hardening

Although cut flower anthuriums are packed in damp shredded paper when shipped from countries like Hawaii, Mauritius and Trinidad & Tobago, the shipping period is technically a period of dry storage. There is inevitably some water loss from flowers during this period and flowers are partially wilted or water stressed on arrival. Excessive water stress can accelerate senescence (Mayak, 1987) and so it is important that flowers are promptly rehydrated in a post -hipment conditioning step. With anthurium this is achieved by cutting about 2cm from the base of the stem, again this can be done in air, and floating the flowers for a period in clean, fresh water at 15–20^{o}C. Depending on the degree of partial wilt this conditioning treatment may last anything from 0.5 to 2 hours and the flowers should recover their original fresh weight (Akamine and Goo, 1975 and1981; Nowak and Rudnicki, 1990; Mayak, 1987). Following the original work of Akamine and Goo (1975) tap water only is used for this conditioning rather than cut flower preservative solutions.

Figure 1. Change of air temperature in a sealed box of flowers in the centre of a refrigerated truck travelling from Holland to Italy (about 100km.) Redrawn from Bent (1991)



Prolonged total immersion is not recommended for some other flowers, e.g. *Dendrobium* (Jingwei Dai and Paull, 1991) and it may therefore be necessary to provide written information to wholesalers or retailers on this point. This can be achieved with a small information flyer placed inside boxes during packing.

Holding or vase solutions
As mentioned already there is a variety of commercial flower preservatives, three of which - Everbloom®, Floralife ®, and Roselife®, - have been specifically recommended for anthurium but any so called 'universal' formulation is satisfactory.

Consequences of marketing chain specialization

The highly specialized nature of the marketing chain has been mentioned elsewhere (Harvey, 1991). This specialization has resulted in differences of perception of the relative importance of various features of the cut flower product. (Table 5.)

Table 5 shows clearly that there is no agreement on the ranking of product features. For example, growers perceive that their pre-treatment of cut flowers is the most important factor influencing 'quality' but others in the marketing chain rank this as rather unimportant. In reality grower pre-treatment is very important but this is not appreciated through the marketing chain. This example shows the potential for increasing co-operation along the marketing chain by raising the awareness of the importance of cut flower treatment at each 'link'.

Cut flower vase life is lost along the marketing chain and Table 6 reflects the situation in Holland where flowers are sold at auction before passing to wholesalers. Most growers in the Caribbean are shipping direct to wholesalers and are closer to the next link in the chain than if they were selling at auction. There is thus a good opportunity for regional growers to be pro-active in educating their wholesale customers. Regional growers have the possibility of raising awareness about the importance of pre-shipment conditioning and also of post-shipment handling to maximize vase life. It may also be possible to get information through to florists where most of the vase life is lost and who may be less aware about the special temperature needs of tropical cut flowers as opposed to temperate flowers with which they are used to dealing. This educational job is

Table 5 Assessment of importance of treatment and product characteristics in relation to quality at six points in the marketing chain

Product feature	Grower	Auction	Wholesaler		Retailer	
			Dutch	Foreign	Dutch	Foreign
Pre-treatment by grower	1	7	6	8	5	8
Free of insects	2	1	3	2	2	2
Freshness	3	3'	2	1	3	1
Packaging	4	1	7	6	7	7
Maturity	5	3	1	4	4	4
Uniformity/firmness	6	5	4	3	6	6
Strength	6	6	5	5	1	3
Cultivar	8	8	8	6	8	5

Source: Bent (1991) Scoring: 1 = very important; 8 = unimportant

Table 6 Relative loss (%) of vase life in the marketing chain [1]

Product	Grower	Auction	Wholesale	Retail shop
Gerbera	6	4	9	14
Rose	5	2	9	13
Carnation	2	1	2	10
Tulip	9	6	14	18
Chrysanthemum	4	3	6	12
Lilium	4	4	8	17
Iris	10	4	12	20
Freesia	4	2	8	13
Average	5.5	3.25	8.5	14.6
Chain time	0.5 days	0.5 days	1 day	2 days

Source: Bent (1991) 1 values expressed as a percentage of the maximum vase life

essentially part of marketing, an area in which regional growers are rather weak.

Future needs

The inherently long vase life of anthuriums and the work already done in Hawaii suggests little need for further work on post-harvest treatments on this crop. There is evidence that in contrast to the commonly grown *Anthurium andraeanum* Hort. cultivars,those of the Trinidad or Caribbean Pink (*Anthurium* x *ferrierense*) have a rather short vase life. The Trinidad or Caribbean Pink is a complex series of hybrids with potential for selection and breeding of novel types suitable for export. Using local germplasm there is an opportunity to develop anthurium cultivars differentiated from those currently in general commerce. In this regard there is a need to conserve regional anthurium genetic resources. It would probably be necessary to implement vase life extension technology to exploit selections from the current population whereas future breeding programmes would include vase life as one of the selection criteria for new cultivars.

Recent work on *Dendrobium* orchids (Jingwei Dai and Paull, 1991) suggests an approach to the post-harvest management of this crop that needs to be adapted to commercial practice.

In contrast to both the above crops there is much work necessary on the other tropical cut flower crops. Heliconias stand out as having the greater potential particularly because of their great diversity in which the region has rich resources. The market for heliconias is undeveloped and it is not clear yet which of the many cultivars have a long-term commercial future. A determining factor in this regard will be improved vase life which can be achieved in two ways. Firstly by the development and application of vase life extension technology to existing cultivars. It is important that such technology be directed primarily at pre-shipping treatments (it is difficult to influence behaviour further down the marketing chain) and that research incorporates a simulated or, ideally, a real shipping period. Secondly by the breeding of new cultivars and in this regard there is a need to conserve regional heliconia genetic resources.

References

Akamine, E K. 1976. Post-harvest handling of tropical ornamental cut crops in Hawaii. HortScience 11:25–127.

Akamine E K and Goo T. 1972. Relationship between physical charact-eristics and vase life of anthuriums. Hawaii Farm Science 21:9–10.

Anon. 1972. Regulation No. 2. Flowers and Foliage. Sub-section 1.1 Anthuriums. Hawaii State Department of Agriculture. Division of Marketing and Consumer Services.

Bent E. 1991. Keep quality in cut flowers – a close look at temperature, ethylene and bacteria. Flora Culture International 1:11–13.

Goszczynska D M and Rudnicki R M. 1988. Storage of cut flowers. Horticultural Reviews 10:35–62.

Halevy A H and Mayak S. 1979. Senescence and post-harvest physiology of cut flowers, Part I. Horticultural Reviews 1:204–236.

Halevy A H and Mayak S. 1981. Senescence and post-harvest physiology of cut flowers, Part II. Horticultural Reviews 3:59—43.

Hara A H, Nishijima W T, Bushe B C.and Sato D M. 1989. Mechanical injury -Primary type of unmarketable anthurium flowers in Hawaii. HortScience 24 :846–847.

Harvey E. 1992. Opportunities and constraints to the production of cut flowers and ornamentals. Proc. seminar on Post-harvest Management of Tropical Fruits and Ornamentals. Port of Spain, Trinidad. 18–22 November 1991

Higaki T, Rasmussen H P and Carpenter W J. 1984. A study of some morphological and anatomical aspects of *Anthurium andraeanum* Lind. Research Series 030. Hawaiian Institute of Tropical Agriculture and Human Resources.

Jingwei Dai and Paull R E. 1991. Effect of water status on dendrobium flower spray post-harvest life. Journal of the American Society for Horticultural Science 116:491–496.

Kalkman E C. 1983. [Mature-cut anthuriums last longer.] Vakblad voor de Bloemisiterij 38:69–71.

Kamemoto H. 1962. Some factors affecting the keeping quality of anthurium flowers. Hawaii Farm Science 11:2-4.

Kofranek A M and Paul J.L. 1974. The value if impregnating cut stems with high concentrations of silver nitrate. Acta Horticulturae 41:199–206.

Lineberger R D and Steponkus P L. 1976. Identification and localisation of vascular occlusions in cut roses. Journal of the American Society for Horticultural Science 101:246–250.

Maxie E C, Farnham D S, Mitchell F G, Sommer N F, Parsons R A Snyder R G and Rae H L. 1973. Temperature and ethylene effects on cut flowers of carnation *Dianthus caryophyllus L.).*

Journal of the American Society for Horticultural Science 98:568–572.

Mayak S. 1987. Senescence of cut flowers. HortScience 22:863–865.

Nowak J and Rudnicki R M. 1990. Post-harvest handling and storage of cut flowers, florist greens and potted plants. London: Chapman and Hall 210pp. ISBN 0 412 37350 5.

Parups E V and Voisey P W. 1976. Lignin content and resistance to bending of the pedicel in greenhouse grown roses. Journal of Horticultural Science 51:253–259.

Paull R E. 1982. Anthurium *(Anthurium andraeanum* Andre) vase life evaluation criteria. HortScience 17:606—07.

Paull R E. 1987. Effect of storage duration and temperature on cut anthurium flowers. HortScience 22:459–460.

Paull R E and Goo T T C. 1985. Ethylene and water stress in the senescence of cut anthurium flowers. Journal of the American Society for Horticultural Science 110:84–88.

Paull R E, Jung Chen N and Deputy J. 1985. Physiological changes associated with senescence of cut anthurium flowers. Journal of the American Society for Horticultural Science 1210:156–162.

Shirakawa, T. Dedolph R R and Watson D P. 1964. N-6-benzyladenine effects on chilling injury, respiration and keeping quality of *Anthurium andraeanum*. Proceedings of the American Society for Horticultural Science 85:642–646.

van Meeteren U. 1978. Water relations and keeping quality of cut gerbera flowers. I. The cause of stem break. Scientia Horticulturae 8:65–74.

Veen H and van de Geijn S C. 1978. Mobility and ionic form of silver as related to longevity of cut carnations. Planta 140:93–6.

Watson D P and Shirakawa T. 1967. Gross morphology related to shelf-life of anthurium flowers. Hawaii Farm Science 16:1-3.

REFRIGERATED STORAGE OF BREADFRUIT AND THE EFFECT OF WAXING, PACKAGING AND STORAGE IN WATER

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Breadfruit (*Artocarpus altilis*) is marketed and consumed in the Caribbean Islands in the mature, green, firm and unripe state. It is a climacteric fruit of extreme perishability. In a storage trial lasting 25 days, the post-harvest behaviour was determined of the fruit in refrigerated storage at 16 (61), 12 (54) and 8°C (46°F) and under ambient (28°C or 82°F) conditions. Four treatments were used: normal air storage (control), storage of individual fruits in water, packaging in polyethylene bags and waxing. Fruits held under ambient conditions were stored for up to 8 days. During storage, physical (weight, volume, specific gravity. and firmness), chemical (total soluble solids, pH and moisture) and sensory (skin and flesh colour, acceptability based upon firmness and odour) changes were evaluated. Under ambient conditions air-stored fruits ripened rapidly showing considerable changes and were unacceptable by the fourth day. Fruits stored in water showed a slight delay in the ripening process, however they increased in weight and volume, showed a rapid decline in pH with off-odour development by the fifth day. Waxing in particular and packaging to a lesser extent extended the shelf-life of the fruit under ambient conditions to 1 week. In refrigerated storage, the ripening process was delayed as the storage temperature was lowered, however severe chilling injury occurred as browning of the fruit's skin. This was the limiting factor. Waxing in particular, and to some extent packaging and storage in water alleviated this behaviour. Waxing appears to be the treatment of choice, with the potential to extend the marketable shelf -ife to 18 days at 16°C (61°F).

The breadfruit (*Artocarpus altilis*) is a very popular fruit in the islands of the Caribbean. The mature, green fruit is used for cooking – either boiled, baked, fried or roasted. Breadfruit is well-known for its poor keeping qualities, as fruits ripen and soften within 2–3 days of harvest. In the Caribbean, such ripe, sweet fruits have no commercial value, as only mature, green fruits of a firm texture are purchased by consumers. The high perishability of the breadfruit not only results in losses during local marketing, but severely restricts its export potential to overseas markets having Caribbean and Asian communities, e.g. Toronto, New York and London.

Despite its importance, little post-harvest storage research has been carried out on this crop. Breadfruits exhibit a respiratory climacteric and Biale and Barcus (1970) reported that detached fruits show a high rate of respiration peaking to a value greater than 3ml CO_2 per kg per hr (48.04 x 10^{-6} cu ft CO_2 per lb per hr), 5 days after harvest. Matthews *et al.* (1986) noted that there is a lack of simple, suitable methods for preserving the fruit in the fresh form. A traditional method of breadfruit storage employed by small farmers in the Caribbean consists of immersing the fruit under water at ambient temperature (28–30°C or 82–86°F). Thompson *et al.* (1974) reported that storage in water prolonged the shelf-life for approximately 1 week, after which time the fruit started to split and softening was observed. They also noted that under ambient, Jamaican conditions (28°C or 82°F) fruits softened completely in 2–4 days; at 12°C (54°F) fruits softened after 8 days while at 7°C (45°F) softening was greatly delayed but the skin colour of the fruit changed from green to dull brown 2–3 days after storage. Mariott *et al.* (1979) reported that one of the principal problems associated with breadfruit storage is abnormal skin browning. The storage of breadfruits in polyethylene bags has been reported to delay the ripening and softening process (Mariott *et al.*, 1974; Passam *et al.*, 1981; Thompson *et al.*, 1974).

Objectives

The overall goal of this study was to determine the elements of an appropriate post-harvest system for handling and storage of the breadfruit so as to enhance its shelf-life and extend its marketability, particularly to export markets. Specific objectives were therefore:-

- to characterize the post-harvest behaviour at different refrigerated storage temperatures (8 [46], 12 [54], 16 [61] and 28°C [82°F]) through measurement of the physical, chemical and sensory changes which affect its marketability.
- to examine the above-mentioned behaviour of waxed and packaged fruits, as well as fruits stored in water.

Materials and methods

An experimental storage trial was designed and conducted for mature, green breadfruits of the 'Yellow-heart' variety commonly grown in the island of Trinidad. Fruits were carefully harvested by a tree climber from a single tree, approximately 20m (65ft) tall. Fruits were caught at the bottom of the tree in a large, woven polyethylene bag by a catcher. Damaged fruits were rejected. Fruit maturity was assessed by the large fruit size, large segment size and green colour, with the exudate from the cut stem also being noted and used as a criterion for fruit selection. Fruits were transported from the field to the storage laboratory in plastic field crates and chipped ice was placed over fruits to provide some pre-cooling during transport. On arrival at the laboratory fruits were assigned a number previously determined from a random number table and were labelled. Fruits were individually washed using running tap water and their individual weights measured when submerged in water and suspended from a bottom-loading electronic balance (Sartorious Model 1216 MP) and using a sinker. These data were used in calculating the fruit's initial volume and specific gravity (s.g.). Fruits were then pre-treated by dipping for 2 minutes in a fungicidal solution of 0.05 per cent benomyl, maintained at room temperature (28°C). Subsequent to this treatment, fruits were air-dried using an electrical blower to remove residual surface moisture, and then the individual fruit weight in air was measured using the electronic balance.

Seventy-two breadfruits averaging 1.2kg (2.65lb) in weight and with a standard deviation of ±0.2kg (0.44lb) were divided into four storage treatments as follows:

Treatment I – 18 fruits stored in air (control); three to be stored at 28°C (82°F; ambient), and five each at 16 (61), 12 (54) and 8°C (46°F).

Treatment II – 18 fruits stored in water; three at 28°C (82°F), and five each at 16 (61), 12 (54) and 8°C (46°F).

Treatment III – 18 fruits to be individually packaged in sealed polyethylene bags – 27cm x 40cm (10.6in x 15.7in); 100 gauge – with three stored at 28°C (82°F) and five each at 16 (61), 12 (54) and 8°C (46°F).

Treatment IV – 18 fruits brush-coated with a 'Fresh Mark FM-51V' undiluted wax; three stored at 28°C (82°F), and five each at 16 (61), 12 (54) and 8°C (46°F).

For refrigerated storage, three 'walk-in' storage rooms were used – two Forma Scientific at 8 (46) and 12°C (54°F) ±0.5°C or 0.90°F and one Bally at 16°C (61°F) ±1.5°C or 2.7°F. Fruits to be stored in water were kept individually in pails of 15 litre (0.53ft^3) capacity with the water initially pre-cooled in the 'walk-in' refrigerated rooms.

For fruits stored under ambient conditions and where the self-life was expected to be short, fruits were stored for a maximum of 8 days during which time pre-determined, previously randomly selected fruit, were sampled for the measurement of physical, chemical and sensory characteristics on Days 4, 5, and 8.

On each sampling day therefore, four fruits (one from each treatment) were analysed. Refrigerated stored fruits were held for a maximum of 25 days, and fruits were sampled from each treatment. On each sampling day therefore, an additional 12 fruits (four treatments; three temperatures) were analysed from refrigerated storage. At the beginning of the storage trial, three fruits were analysed for initital quality.

Analysis consisted of the determination of weight and volume loss in storage, calculated as a percentage from the initial and final (on removal from storage) individual fruit weight and volume. From the mass:volume ratio, s.g. was also determined. The firmness of the fruit, with the skin removed, was measured by a digital penetrometer (Koehler, model PNR10), using a cone and an added weight of 50g (0.11lb). The depth of penetration of the cone into the fruit was automatically measured after 5 seconds and reported in millimetres. Moisture content determinations of the breadfruit were made by drying a 20g (0.044lb) sample of the sliced pulp at 76°C for 48 hours. Total soluble solids (TSS) was measured using a refractometer (Atago, type T) and a 1:1 dilution of the blended breadfruit pulp. This diluted pulp was also used for pH determination using a glass electrode (Analytical Measurements, model 707).

Subjective determinations were also made of the fruit's skin and flesh colour, odour and acceptability based upon firmness to the touch of the skin.

Skin colour was rated based on changes to the initial green colour of the skin as follows: 1 – deep green; 2 – light green; 3 – green with 25-50 per cent yellow; 4 – over 50 per cent yellow and slight browning; 5 – predominantly brown.

Flesh colour was rated based on colour changes of the fruit's flesh as follows: 1 – white to cream; 2 – cream; 3 – pale yellow (25–50 per cent); 4 – yellow (> 50 per cent); 5 – brown.

Acceptability ratings based upon firmness to the touch of the fruit were: 1 – hard and very acceptable; 2 – medium hard and acceptable; 3 – initiation of softening and partially acceptable; 4 – medium soft and unacceptable; 5 – very soft and unacceptable.

Odour ratings were based upon the development of off-odours emanating from the fruit as follows: 1 – no off-odour, 2 – slight off-odour; 3 – strong off-odour; 4 – intense off-odour.

Results and discussion

The physical, chemical and sensory effects on the breadfruit of duration of storage (time), storage temperatures and storage treatments were determined from the experimental data using analysis of variance.

Weight loss in storage

The percentage loss in weight of breadfruits in storage was significantly affected by storage time ($p < 0.001$), temperature ($p < 0.001$) and treatment ($p < 0.001$).

As shown in Figure 1, the loss in fresh weight of fruits stored in air (treament 1 - control) increased almost linearly with storage time and averaged 2.64, 0.62, 1.77 and 1.16per cent per day at 28 (82), 16 (61), 12 (54) and 8°C (46°F),respectively. The comparatively low weight loss obtained at 16°C can be attributed to the design of the 'walk-in' refrigerated chamber used. This was fitted with a low velocity evaporator ideally suited to perishable crop storage and a high relative humidity environment was also obtained (> 95 per cent).

Waxing and packaging (Treatments III and IV) reduced weight losses compared to control fruits with average values of 1.43, 0.20, 0.44 and 0.32 per cent per day obtained for waxed fruits at 28 (82), 16 (61), 12 (54) and 8°C (46°F) respectively. Comparative values for packaged fruits were 0.81, 0.12, 0.10 and 0.09 per cent per day.

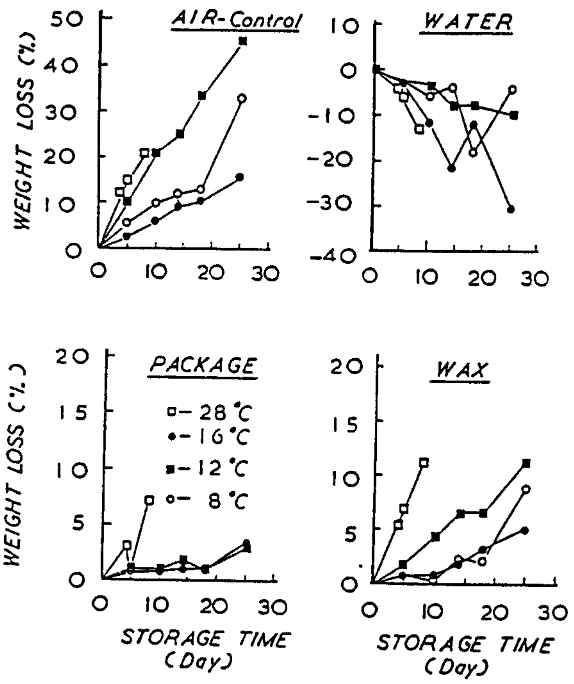

Figure 1. Weight losses of breadfruits in storage

For fruits stored in water (Treatment II) there were significant weight gains at all temperatures, particularly at the higher storage temperatures of 28 (82) and 16°C (61°F). Fruits stored in water at 28 (82), 16 (61), 12 (54) and 8°C (46°F) showed estimated weight gains of 1.57, 1.14, 0.41 and 0.35 per cent per day, respectively. These weight gains are attributed to the uptake of water by the fruit's tissue. Thompson (1974) reported that fruits stored in water at 12–13°C (54–55°F) gained weight at 0.9 per cent per day during a 15-day storage period.

Generally, as the storage temperature was lowered weight losses were reduced for Treatments I, III and IV. Storing fruits under refrigerated conditions significantly reduced weight loss compared to storage under ambient conditions.

Change in volume

Changes in volume of stored breadfruits were significantly affected by storage time ($p < 0.05$), temperature ($p < 0.001$) and treatment ($p < 0.001$).

Under ambient storage conditions there was a rapid decline in volume or shrinkage of fruits with estimated average losses per day of 3.46, 0.89 and 0.71 per cent for control, packaged and waxed fruits respectively. In refrigerated storage, waxed fruits showed higher losses in volume compared to packaged fruits (Figure 2) with average losses estimated at 0.10, 0.31 and 0.12 per cent per day at 16 (61), 12 (54) and 8°C (46°F) respectively, compared to corresponding values of 0.06, 0.05 and 0.05 per cent per day for packaged fruits. As shown in Figure 2, in the earlier period of the storage trial packaged fruits showed small increases in volume while in the later period volume losses occurred. The initial swelling action of packaged fruits was accompanied by small losses in weight as previously reported and this phenomenon may therefore be attributed to an accumulation of gas within the fruit, e.g. CO_2.

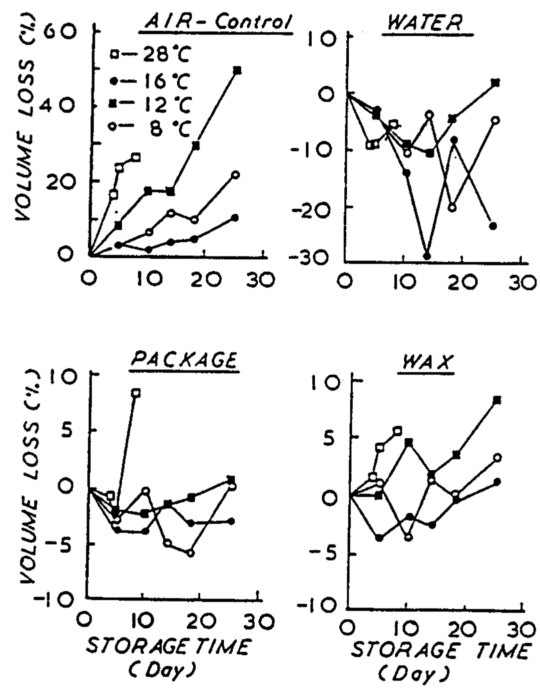

Figure 2. Volume losses of breadfruits in storage

For fruits stored in water under both ambient and refrigerated conditions there were increases in volume (swelling) as indicated by the negative values for average volume losses which were estimated at -0.74, -0.89, -0.07 and -0.35 per cent per day at 28 (82), 16 (61), 12 (54) and 8°C (46°F) respectively. This increase in volume was due to fruits absorbing water, increasing in weight as previously discussed, and increasing in size. As shown in Figure 2 while an increase in volume was shown in the first period of the storage trial, this was generally followed by shrinkage; this being noticeable after 14 days in storage. Thompson (1974) reported that storing breadfruits in water resulted in splitting of the epicarp. While this was not observed here, the behaviour is clearly related to the water uptake and swelling action of the fruit.
The s.g. of the breadfruit at harvest and prior to storage averaged 0.84. During the storage trial, only ambient stored fruits in air (control) showed any major changes in s.g. The s.g. increased to 0.94 by the fifth day of storage. This may be explained by the relatively high losses in volume (shrinkage) which accompanied the losses in weight.

Moisture content

There was a small treatment effect ($p < 0.05$) on the moisture content of stored fruits. Prior to storage the moisture content of fruits averaged 75.2 per cent (wet basis). Treatment means for the duration of the storage trial were 77.2, 76.5, 75.4 and 73.1 per cent for fruits stored in water, waxed, packaged and control fruits respectively. These results are not surprising and are consistent with the weight gains of water-stored fruits and the desiccation of air-stored fruits.

Fruit firmness

Fruit firmness was measured by the cone's penetration depth into the peeled fruit flesh and reported in millimetres. Significant differences in fruit firmness were obtained treatment ($p < 0.001$) and temperature ($p < 0.001$). Under ambient storage conditions, packaged fruits exhibited a significant delay in softening, when compared to fruits stored in air, water, or waxed fruit (Figure 3). This behaviour is attributed to the modified atmosphere conditions created by packaging and the subsequent delay in the ripening and softening rates.

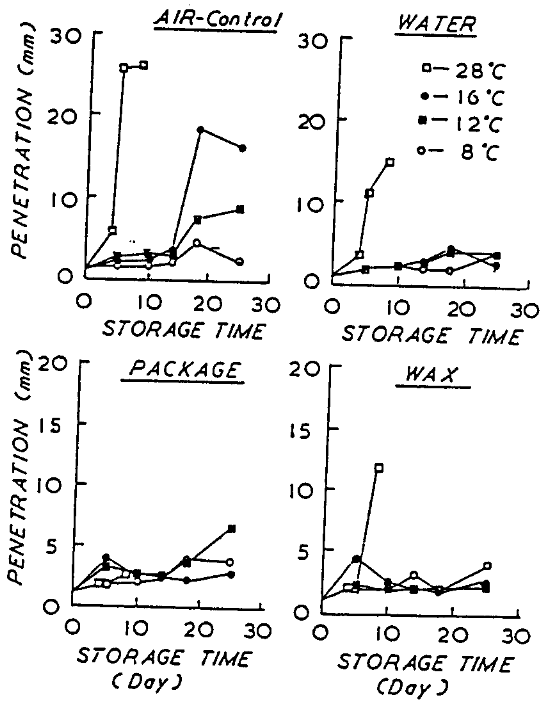

Figure 3 Fruit firmness as measured by a penetrometer, of breadfruits in storage.

Figure 3 also shows that in refrigerated storage, and for all treatments there were significant reductions in the rate of fruit softening. For fruits stored in air, as the storage temperature was lowered to 8°C (46°F) from 28°C (82°F), fruit firmness was increasingly maintained. However beyond 14 days in storage, softening increased rapidly with this being most noticeable at 16°C (61°F). These results show that breadfruits may be kept in refrigerated storage for up to 2 weeks at 16°C (61°F) beyond which time ripening and fruit softening commence. The increase in fruit softening after 14 days at this temperature may be associated with the climacteric rise in the fruit's respiration.

Packaging, waxing and storing fruits in water all maintained fruit firmness in refrigerated storage beyond the 14 days associated with control fruits. While the delay in softening of packaged breadfruits stored in refrigeration has previously been reported (Thompson *et al.*, 1974; Mariott *et al.*, 1979; Passam *et al.*, 1981), these results also show that waxing delayed the softening process. Passam *et al.* (1981) noted that waxing using a 7.5 per cent 'Sta-fresh' wax reduced weight loss of breadfruits in storage but did not affect the time for softening. In these trials waxed fruits behaved similarly to packaged fruits or fruits stored in water, i.e. fruits held under a modified atmosphere environment. The wax used and its level of application therefore appeared to have also altered the fruit's storage environment with favourable results. Despite the uptake of water by breadfruits stored in water, and the subsequent increase in moisture content, such fruits remained firm in refrigerated storage indicating a delay in the ripening process.

Soluble solids

Under ambient conditions (28°C or 82°F) fruits stored in air (control) showed rapid increases in total soluble solids (TSS) compared to fruits stored in water, packaged or waxed fruits (Figure 4). Thompson (1974) reported that fruits stored under ambient (28°C or 82°F) conditions, accumulated no soluble solids for the first 3 days after harvest, but after 4 days levels of the order of 15 per cent were found. A reduction in the rate of change of TSS accumulation was observed under refrigerated storage for all treatments when compared to ambient stored fruits. Additionally, as the storage temperature was lowered, for all treatments a decline in the accumulation was consistently observed, and at 8°C (46°F) there were very little changes in TSS from an initial value of 5 per cent. Thompson (1974) noted that at 2.5°C (36.5°F), breadfruits accumulated little soluble solids either during storage or when removed to ambient conditons. From linear regression analysis, average changes in TSS per day for fruits at 16 (61), 12 (54) and 8°C (46°F) were 0.25, 0.19 and 0.01 per cent per day respectively when stored in air; 0.23, 0.04 and 0.01 per cent per day respectively for fruits stored in water; 0.28, 0.16 and 0.06 per cent per day for packaged fruits and 0.04, 0.04 and 0.00 per cent per day respectively for waxed fruits. Again the wax coating appeared desirable as it inhibited the ripening rate of fruits and the subsequent development of sugars to a greater extent than packaging or storing fruits in water.

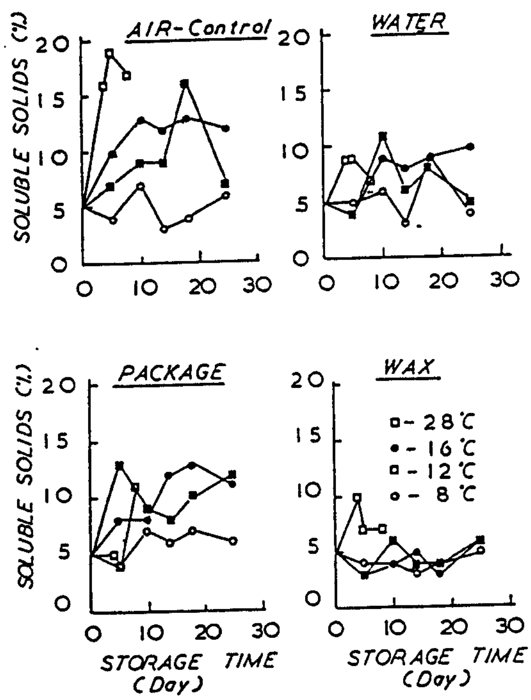

Figure 4 Total soluble solids levels of breadfruits in storage.

pH

The pH level of breadfruits prior to storage averaged 6.1, and during storage this was significantly affected by storage time ($p < 0.001$), temperature ($p < 0.001$) and treatment ($p < 0.001$). Figure 5 shows that there was a general decline in pH values with storage time for all fruits, under both ambient and refrigerated conditions. pH is inversely related to the acid content of fruits and is of importance as a measurement of the active acidity in fruits, influencing flavour and palatability (Raganna, 1977). Unlike most other fruits on ripening, breadfruits exhibit decreases in pH, a behaviour observed for bananas

(Agillon *et al.*, 1987). Wills *et al.*, (1981) noted that bananas attained the highest levels of acids on ripening implying a decrease in the pH. Fruits stored in water under ambient conditions exhibited a drastic fall in pH when compared to the other treatments. This behaviour possibly implies that there was anaerobic fermentation occuring at this temperature for fruits stored in water, with an increase in acid production. In refrigerated storage, fruits held in air and water exhibited faster rates of pH decline when compared to the other two storage treatments, with this effect being most noticeable after 14 days in storage, particularly at 12 (54) and 16^{o}C (61^{o}F) (Figure 5). This is probably an indication of the onset of ripening. The average declines in pH per day for these fruits were 0.06, 0.06 and 0.02 for air storage and 0.08, 0.06 and 0.02 for water storage at 16 (61), 12 (54) and 8^{o}C (46^{o}F) respectively.

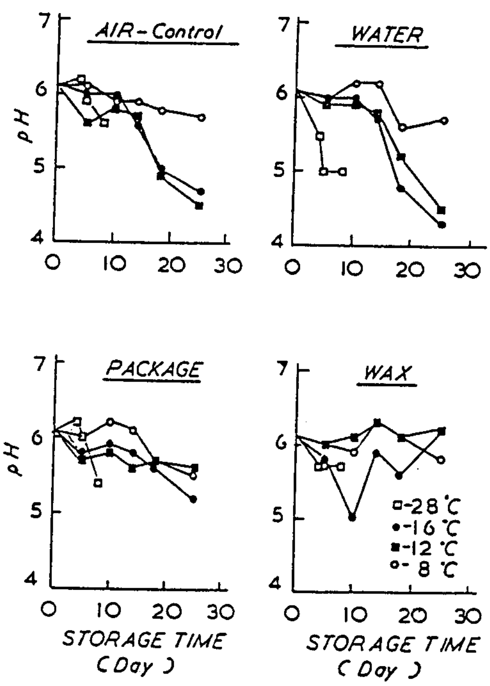

Figure 5 pH changes in stored breadfruits.

Waxed fruits exhibited smaller changes in pH values throughout the storage trial when compared to packaged fruits. Average pH decline per day for packaged fruits were 0.03, 0.02 and 0.02 at 16 (61), 12 (54) and 8^{o}C (46^{o}F) respectively while the corresponding values for waxed fruits were 0.01, 0.01 and 0.01 respectively. Waxed fruits particularly those at 12 (54) and 8^{o}C (46^{o}F) therefore showed little tendency for ripening during refrigerated storage (Figure 5).

Skin colour

The colour of the skin of the breadfruit in storage was significantly affected by storage time ($p < 0.001$), temperature ($p < 0.001$) and treatment ($p < 0.001$). The colour rating values of the breadfruit skin increased with storage time for all fruits under ambient and refrigerated conditions showing a change in the colour of the skin from green (rating of 1) to brown (rating of 5).

As with most climacteric fruits, the obvious, visible sign of ripening is loss of the green colour and an increase in the yellow pigment of the skin. Under ambient (28^{o}C or 82^{o}F) conditions, fruits stored in air and water rapidly changed in skin colour, showing a score of 4 after 5 days in storage. This change can be associated with normal ripening of the fruit. Packaging and particularly waxing delayed ripening under ambient conditions as the green skin colour was largely maintained during the 8-day storage period.

Under refrigeration, fruits stored in air and water at 8^{o}C (46^{o}F) showed abnormal, rapid browning within 5 days of storage when compared to the rest of the storage treatments (Figure 6). As the storage temperature was increased to 16^{o}C (61^{o}F), skin browning appeared less severe, but nevertheless there appeared to be a clear relationship between fruit exposure time for browning to occur and storage temperature, i.e. the higher the storage temperature, longer exposure times were permissible. For fruits stored in air (control), the colour score peaked to a value

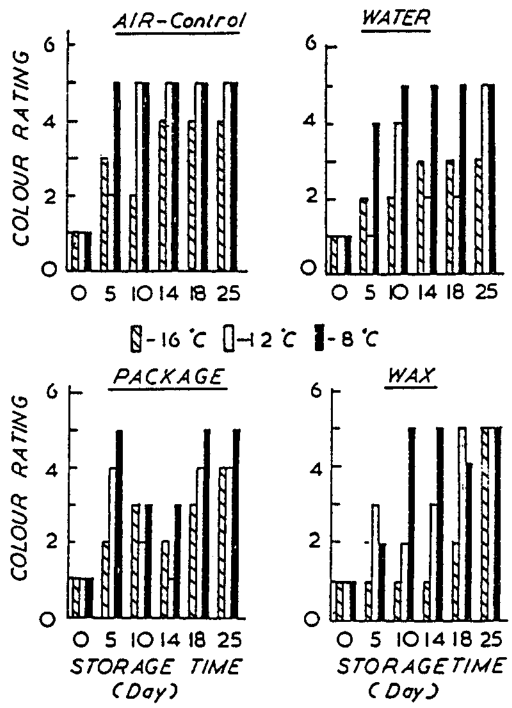

Figure 6 Colour changes of breadfruits in storage

of 5 after 5 days in storage at 8°C (46°F), while at 12°C (54°F), this occurred after 10 days. At 16°C, a colour score of 4 was found after 14 days in storage. Skin browning therefore appears to be a symptom of chilling injury, and Thomson (1974) reported that breadfruits stored below 12°C (54°F) showed symptoms consistent with chilling injury described for other tropical fruits.

Fruits stored in water showed similar trends as for fruits stored in air, however colour development was comparatively delayed.

Packaging and waxing of breadfruits in refrigerated storage resulted in impairment of skin colour development and browning when compared to control (air) and water-stored fruits. However, the exposure time/storage temperature relationship still prevailed. The browning symptom of chilling injury was therefore reduced by these treatments since waxed and packaged fruits stored at 16°C (61°F) maintained their green colour for at least 14 days in storage. Packaging and waxing limit the fruit's supply of O_2 and increase the CO_2 content surrounding the fruits and these modifications affected the fruit's susceptibility to skin browning. Modified atmosphere storage has previously been reported to reduce chilling injury, for example the general grey discolouration of the mesocarp of avocadoes (Scott and Chaplin, 1978). Grierson (1971) reported that waxing alleviated chilling injury of grapefruits but not of limes. Control of moisture loss in fruits has also been reported to alleviate the symptoms of chilling injury (Couey, 1982), although this cannot explain the behaviour of breadfruits stored in water.

Flesh colour

Under ambient conditions waxed fruits showed no increase in flesh colour rating, from an initial value of 1 (white/cream) just prior to storage. When compared to the other storage treatments at 28°C (82°F), fruits stored in air (control) showed a greater development in internal colour (yellowing), as mean scores over the 8-day storage period were 3.0, 2.8, 2.3 and 1.0 for fruits stored in air and water, and packaged and waxed fruits respectively. These scores are representative of the rate of ripening of fruits in ambient storage, as the development of the yellow flesh colour is normally associated with ripening fruits.

In refrigerated storage and over the 25-day storage period, waxed and packaged fruits showed little development of flesh colour as mean scores of 1.7 and 2.2 were obtained respectively, when compared to fruits stored in air and water with mean scores of 4 and 2.5 respectively. Waxing and packaging effectively delayed ripening. Storage temperatures between 8 and 16°C (46 and 61°F) did not appear to have any significant influence on flesh colour development.

Odour

Under ambient storage conditions a slight development of off-odours was detected for waxed and packaged fruits on the eighth day of storage. However by the fourh day of storage, fruits stored in air and water had already exhibited such signs. Fruits stored in water developed a strong off-odour by the eighth day of storage, and this may have resulted from fermentation of such fruits, as previously noted.

Under refrigerated storage conditions water-stored fruits consistently developed off-odours by the 10th day, at all-temperatures. This development was slightly more intense compared to fruits stored in refrigerated air (control) or packaged fruits. Odour formation is a result of volatiles liberated on ripening of fruits and is influenced by fruit maturity.

Acceptability

Under ambient storage conditions, fruits stored in air and water softened rapidly, and were unacceptable by the fifth day of storage, as acceptability ratings, based upon firmness to the touch, peaked to 5 and 4 respectively. These results are consistent with those of the penetrometer readings given in Figure 3.

For fruits held in refrigerated storage, Figure 7 shows that packaged and waxed fruits remained hard and very acceptable for the duration of the storage trial, i.e. 25 days. These results again demonstrate the delay in the ripening process with such treatments under refrigerated storage. Fruits stored in refrigerated air (control) and water began to show signs of softening and unacceptability by the 14th day of storage.

rapid decline in fruit firmness with fruits becoming medium soft and unacceptable by the fourth day after harvest. It is also characterized by a marked increase in soluble solids content, from 5 to 16 per cent by the fourth day, rendering such fruits sweet and unacceptable. Storage of fruits in water under ambient conditions – a traditional method of fruit preservation – marginally reduces the rate of ripening.

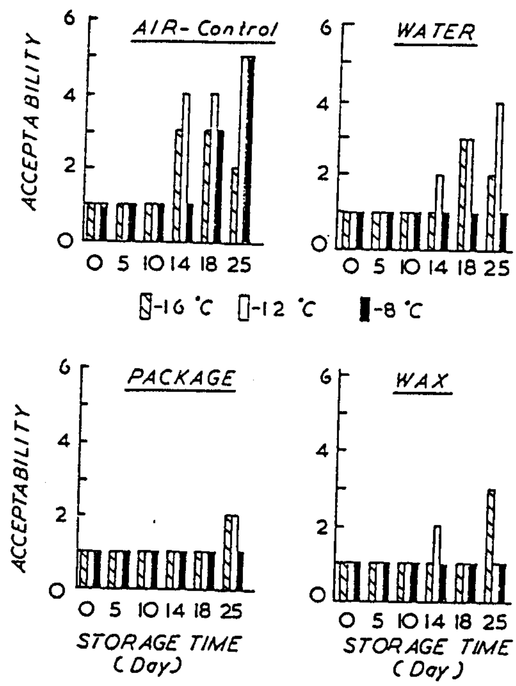

Figure 7 Acceptability of breadfruits based upon fruit firmness in refrigerated storage.

Conclusions

Breadfruit, unlike many other fruits, is consumed in the Caribbean in the unripe stage, i.e. mature green, firm and unsweet. Storage of breadfruits under ambient, tropical conditions is problematic as ripening proceeds immediately and rapidly rendering such fruits unacceptable within 4 days of harvest.

Ripening of naturally (ambient air) stored fruits manifests itself in terms of weight and volume losses (shrinkage) averaging 2.64 and 3.46 per cent per day respectively, an increase in s.g. from 0.84 to 0.94 and a

However such fruits show a marked decline in pH by the fifth day of storage – from 6.1 to 5.0 with the development of off-odours. Its acceptability as a storage method by small farmers is probably due principally to the economic benefit of increases in weight (and volume) of fruits when stored under such conditions. On the other hand, waxing in particular, and packaging to a lesser extent, delay ripening under ambient (28°C or 82°F) conditions and fruits can remain marketable through such treatments for 1 week.

Refrigerated storage of breadfruits delays the ripening process and reduces weight and volume losses. At 16°C (61°F) and by the 14th day in storage however, untreated fruits stored in air show all signs of accelerated ripening, viz. increases in fruit softness, decreases in pH and increases in soluble solids content. Refrigerated storage of breadfruits in water is again limited by off-odour development after 10 days in storage. However even at 16°C (61°F) and more dramatically at 8 (46) and 12°C (54°F), breadfruits stored in air show chilling injury manifesting itself as browning of the fruits' skin. This is the limiting factor in refrigerated storage. At 8 (46), 12 (54) and 16°C (61°F) browning is practically complete after 5, 10 and 14 days respectively. As with many other fruits which show chilling injury, the air exposure time/storage temperature relationship is therefore apparent.

At the three refrigerated storage temperatures waxing in particular, and packaging to a lesser extent, delayed the ripening process through maintenance of fruit firmness, soluble solids content and pH for at least 18 days in storage. More importantly however waxing delayed the symptoms of chilling injury compared to untreated fruits which when stored at 8 (46), 12 (54) and 16°C (61°F) showed complete browning after 10, 18 and 25 days respectively.

Packaging and storage of fruits in water also alleviated the signs of chilling injury, though to a lesser extent than waxing, with these results suggesting that storage of breadfruits in a modified atmosphere environment can retard chilling injury. There is therefore potential for controlled atmosphere storage. In terms of refrigerated storage, waxing appears to be the treatment of choice and noting the chilling injury behaviour, such fruits should still be in a marketable condition after 18 days in storage at 16°C (61°F). Little evidence was seen in these storage trials of any major post-harvest decay due to fungal infections.

Acknowledgements

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References

Agillon A, Artes L A and Lizada M C . 1987. Some physico-chemical and physiological changes in 'Latundan' and 'Lakatan' bananas subjected to modified atmosphere storage. ASEAN Food Journal 3:117–123.

Biale J.B. and Barcus D E. 1970. Respiratory patterns in tropical fruits of the Amazon basin. Trop. Sci. 12:93–104.

Couey H M. 1982. Chilling injury of crops of tropical and subtropical origin. Hort. Science 17:162–165.

Grierson W. 1971. Chilling injury in tropical and subtropical fruits. IV. The role of packaging and waxing in minimising chilling injury of grapefruit. Proc. Trop. Reg. Amer. Soc. Hort.Sci. 15:76–88.

Mariott J, Perkins C and Been B O. 1979. Some factors affecting the storage of fresh breadfruit. Sci. Hort. 10:177–181.

Matthews R F, Bates R P and Graham H D. 1986. Utilisation of breadfruit in the tropics. In: Interamerican Society for Tropical Horticulture. Proceedings of an International Conference, San Jose, Costa Rica. 30:83–89,

Passam H C, Maharaj D S and Passam S. 1981. A note on freezing as a method of storage of breadfruit slices. Trop. Sci. 23:67–74.

Raganna S. 1977. Manual of analysis of fruit and vegetable products. New Delhi: Tata McGraw-Hill

Scott K J and Chaplin G.R. 1978. Reduction of chilling injury in avocados stored in sealed polyethelene bags. Trop. Agric. (Trinidad) 55:87–90.

Thompson A K, Been B O and Perkins C. 1974. Storage of fresh breadfruit. Trop. Agric. (Trinidad) 51:407–415.

Wills R.H, Lee T H, Graham D, McGlasson W B.and Hall E G. 1981. Post-harvest – an introduction to the physiology and handling of fruit and vegetables. United Kingdom: Granada Publ. Co.

REFRIGERATED STORAGE OF THE CARAMBOLA

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Carambola harvested at the stage of mature green with the first signs of yellowing were stored at 5, 10, 15 and 28°C (ambient) conditions. Some fruits were wrapped with a 60 gauge stretch film. The trial lasted for 10, 9, 6, and 3 weeks for fruits stored at 5, 10, 15 and 28°C respectively. Fruits in refrigerated storage showed reduced weight and volume losses compared to ambient stored fruits. These ranged from 0–5 per cent and 0–10 per cent for refrigerated, packaged and unwrapped fruits respectively. Moisture content ranged from 92.5 to 89.0 per cent and 91.5 to 86.4 per cent for packaged and unwrapped fruits respectively. Fruit firmness was maintained in storage as the temperature was lowered, particularly at 5 and 10°C, and also by packaging. Titratable acidity expressed as per cent oxalic acid declined with storage time and temperature and ranged from 0.3 per cent for freshly harvested fruits to 0.08 per cent for over-ripe fruits . Total soluble solids (TSS) values ranged from 11.5 per cent (fresh) to 7.0 per cent (ripe). Colour development proceeded with time in storage and fruits developed their normal, bright yellow colour at 10, 15 and 28°C. At 5°C, colour development was impaired after 5 weeks in storage. Packaging did not retard colour development. Anthracnose disease can limit the fruit's visual acceptability at 28, 15 and 10°C to 2, 4 and 7 weeks respectively. Fruits at 5°C showed a browning disorder which may be associated with chilling injury. Storage at 10°C for 5 weeks appears best for fruits for the fresh market, but for processing storage at 5°C may be tolerated for up to 10 weeks.

The carambola (*Averrhoa carambola* L) commonly called the 'five finger or 'star fruit' is an exotic fruit that is quickly gaining recognition and appeal. A report by Campbell *et al.* (1985) stated that there were 24ha of orchards in Florida with an additional 28ha planned. In Australia, the carambola industry has been reported to be well established in Queensland (Watson *et al.*, 1988). In Trinidad & Tobago there is also considerable interest in this fruit, both for the fresh fruit and processing markets.

Grierson and Vines (1965) reported that in a trial with carambola from Florida, fruits stored at 21°C were in good condition for 2 weeks, for nearly 3 weeks at 16°C and lasted 4 weeks at 10°C. Vines and Grierson (1966) reported that respiration curves for carambola fruits stored at 16°C and 21°C showed the respiratory climacteric, with the average pre-climacteric rate of respiration being 20mg CO_2 per kg per hour at 16°C. Lam and Wan (1983) reported that the carambola was a non-climacteric type fruit since, while the respiration rate increased with time for fruits stored at 20°C, no sharp rise in CO_2 production was detected during the period when the fruits changed from green (unripe) to orange (over-ripe). Oslund and Davenport (1981) also reported that the carambola is a non-climacteric fruit. Kenney and Hull (1986) stored 'Fwang Tung' and 'Arkin' cultivars in refrigerated storage with and without sealed polyethylene bags, and reported that at 7°C storage without using polyethylene bags did not significantly influence quality, and cold damage was observed for both cultivars when stored at 4°C. Campbell *et al.* (1989) reported that 'Arkin' and 'Golden Star' carambolas can be stored most effectively at 5°C for about 7 weeks. No chilling injury was reported.

The objectives of this study were to determine the post-harvest behaviour in refrigerated storage of carambola grown in Trinidad, with and without packaging, with a view to recommending an appropriate storage condition.

Materials and methods

Carambola fruits of the sweet variety which originated from Taiwan were used in this study. Fruits were manually harvested, ideally at the stage of mature green with the first signs of yellowing, from a small, commercial plantation at the La Gloria Estate, New Grant, Trinidad. Because of the limited availability of fruits of the sweet type, some fruits were harvested somewhat after the desired stage. Fruits were large and averaged 155g in weight, with overall dimensions averaging 110mm in length and 65mm in cross-section. On arrival at the laboratory, fruits were de-stemmed, washed, inspected and damaged fruits rejected and sound fruits air-dried. Fruits were placed singly, and in pairs on Styrotex trays (15cm x 20cm). One hundred and fifty two trays were prepared, and of these 50 per cent were film-wrapped (60 gauge Filmco green produce wrap stretch film) and heat-sealed using a table model wrapper. Packaged and unwrapped fruits were placed on shelves in three 'walk-in' refrigerated coolers with temperatures set at 5, 10 and 15°C, with the relative humidity maintained between 85 and 95 per cent. Some fruits were also stored under ambient (28°C) conditions. At the end of each week four trays were removed from storage at each temperature as follows: Tray 1 containing two fruits, packaged; Tray 2 containing one fruit, packaged; Tray 3 containing two fruits, unpackaged; Tray 4 containing one fruit, unpackaged. Trays with a single fruit were opened if previously packaged and left to ripen under ambient conditions. Trays with two fruits were used for measuring the physical, chemical and sensory changes which occurred in storage.

For the non-destructive tests associated with weight and volume changes in storage, a number of additional packaged and unpackaged fruits were stored at each temperature. All fruits were weighed in air and water before storage. These fruits were used at weekly intervals to measure such changes and then returned to storage.

Fruit flesh firmness was measured by a penetrometer (Stanhope-Seta, Model No. 1700/1719) using a pointed cone weighing 50g, and with a penetration time of 5 seconds. Total soluble solids (TSS) content was measured with an Abbe refractometer. Titratable acidity with the values expressed as per cent oxalic acid was determined by the AOAC (1984) method.

Decay was rated on a scale of 1 to 5 as follows: 1 – no sign of decay; 2 – trace, spotting now showing up (1–10 per cent of fruit affected); 3 – slight (10–25 per cent); 4 – moderate (25–50 per cent); 5 – severe (>50 per cent). Skin colour was monitored using ratings developed by Wan and Lam (1984) as follows: 1 – green; 2 – green with traces of yellow; 3 – more green than yellow; 4 – more yellow than green; 5 – yellow with slight green; 6 – yellow; 7 – yellow with some brown flecks; 8 – brown.

The data obtained from this study were analysed by the analysis of variance method (ANOVA). The trial lasted 10, 9, 6 and 3 weeks for fruits stored at 5, 10, 15 and 28°C respectively.

Results and discussion

Weight and volume changes

Weight loss of carambolas in storage was significantly affected ($p < 0.001$) by storage time, temperature and treatment (Figure 1). Weight loss increased with time, and while for refrigerated stored fruits without packaging this ranged from 0 to 10 per cent, with packaging weight loss was reduced to 0–5 per cent over the duration of the storage trial (up to 10 weeks at 5°C).

Weight loss was significantly reduced by refrigerated storage compared to ambient storage. Under refrigerated storage fruits showed an unexpected behaviour in that those at 5°C exhibited the highest losses in weight. This may be explained by the differences in the relative humidity of the atmospheres in the three chambers, with the 5°C chamber exhibiting the lowest. These results for weight losses are in general agreement with those reported by Campbell *et al.* (1987), showing 6.7 and 4.4 per cent for tissue-wrapped boxed 'Arkin' fruits at 10 and 5°C respectively after 44 days.

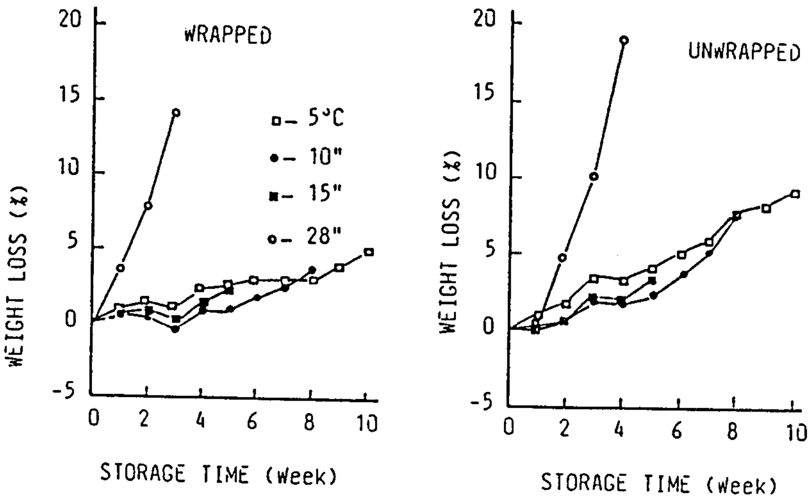

Figure 1 Weight loss of wrapped and unwrapped carambolas stored at four temperatures

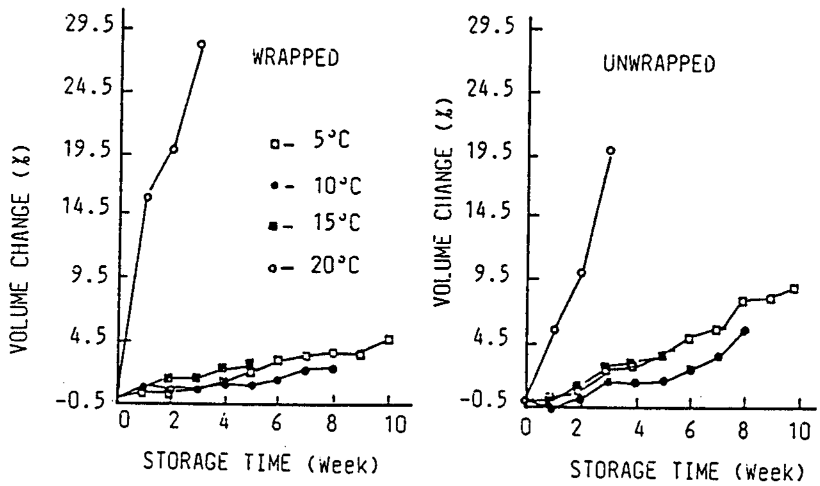

Figure 2 Shrinkage of wrapped and unwrapped carambolas stored at four temperatures

Volume change or shrinkage was significantly affected ($p < 0.001$) by storage time and temperature. These results (Figure 2) tended to follow the same trends as weight losses. However, while unpackaged fruits appeared to show a marginally higher loss in volume compared to packaged fruits, this difference was not statistically significant. These results, together with observations of stored fruits indicate that shrivelling is not a major parameter in carambola storage under refrigeration. The effect of packaging on the reduction of shrivelling was only apparent under ambient storage (28°C). The low levels of weight and volume losses, together with observed shrivelling indicate that the waxy cuticle and thick skin of the carambola is an effective barrier to transpiration.

Moisture content

Packaging affected the moisture content of stored fruits, as those which were packaged tended to maintain their moisture content levels, compared to unpackaged fruits which showed declining moisture contents. However the differences were very narrow for packaged and unpackaged fruits, being in the range of 92.5–89.0 per cent for packaged fruits and 91.5–86.4 per cent for unpackaged fruits, over the 10-week storage period. These results are in agreement with those previously reported on weight loss.

Fruit firmness

Fruit flesh firmness was significantly affected by storage temperature ($p < 0.001$), storage time and packaging ($p < 0.01$). These results are shown in Figure 3. For all fruits, as the storage temperature was lowered, fruit firmness was maintained particularly at 5 and 10°C. Packaged fruits appeared to show slightly reduced softening rates, compared to unwrapped fruits, with this being most noticeable at the higher storage temperatures. At the lower storage temperatures of 5 and 10°C, fruit softening appeared to commence after 6 weeks in storage, explaining a significant ($p < 0.01$) time–temperature interaction.

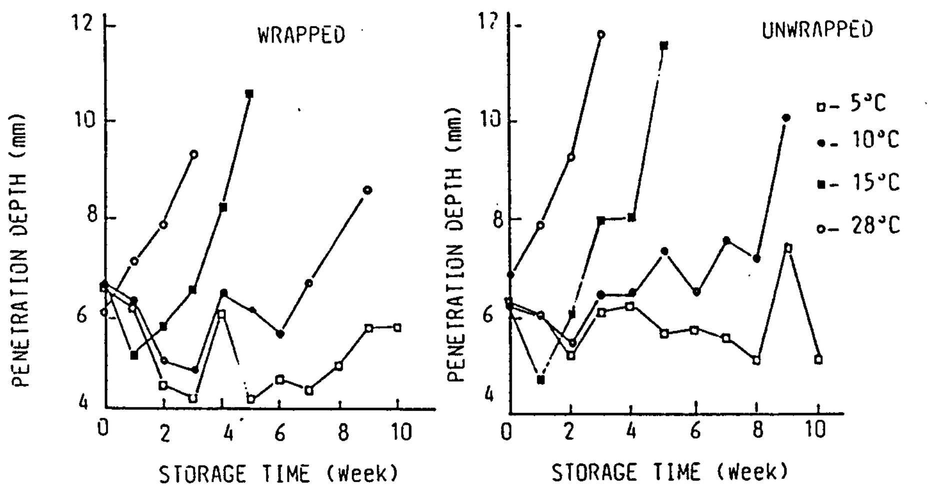

Figure 3 Firmness (measured by a penetrometer) of wrapped and unwrapped carambolas stored at four temperatures

Solids: acid ratio

Total soluble solids (TSS) appeared to decline in storage for both packaged and unwrapped fruits, with this being particularly noticeable at 28 and 15°C. . Values ranged from 11.5 to 7.0 per cent. Wan and Lam (1984) reported that soluble solids fluctuated within a narrow range of 8.6–9.1 per cent for fruits stored between 5 and 20°C.

Titratable acidity expressed as per cent oxalic acid declined significantly with storage time and temperature. Packaging did not affect this parameter. Values ranged from 0.3 per cent for freshly harvested fruits, to 0.08 per cent for 3-week -old, ambient stored, over-ripe fruits. At 5 and 10°C the decline in acidity was not as pronounced. Wan and Lam (1984) reported that titratable acidity levels of fruits declined significantly in storage after 1 week, with no significant changes observed after this time. Values ranged from 0.29 per cent to 0.15 per cent.

The solids:acid ratio initially 34, was significantly affected by storage time and temperature ($p < 0.001$), with packaging having no effect.At 10, 15 and 28°C this value increased with time (Figure 4), with this being most rapid at the highest temperature. There was also a significant time–temperature interaction ($p<0.001$) and it is noted that at 5°C little change was observed in this parameter for the duration of the storage trial (10 weeks). These results demonstrate the effect of low temperature storage on the suppression of ripening.

Decay, colour, flavour and chilling injury

Colour development of fruits in storage was significantly affected by storage time and temperature ($p < 0.001$). Packaging did not affect colour development. At 28, 15 and 10°C, fruits attained their full, normal, attractive yellow colour (a rating of 6)

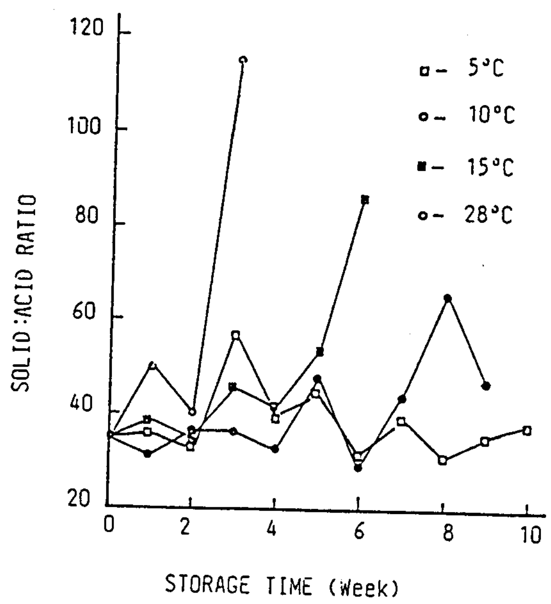

Figure 4 Total soluble solids:titratable acidity ratios ofcarambolas stored at four temperatures.

after 1, 4 and 6 weeks respectively. Storage beyond this time resulted in the development of brown flecks. At 5°C, carambolas never developed their full colour even to the end of the 10-week storage period. At best, a rating of 4 was achieved, i.e. more yellow than green. On removal from storage and when ripened under ambient conditions, fruits stored at 5°C developed normal colour after being held up to 5 weeks in storage. Beyond this time however, fruits stored at 5°C and removed to ambient conditions never developed their full, bright yellow appearance, but were dull with distinct signs of greeness maintained. Vines and Grierson (1966) obtained the changes from green to yellow for carambolas stored at 10 and 15°C for up to 17 days. Campbell *et al.* (1989) reported that after 44 days in storage, carambolas stored at 10°C were noticeably more yellow than those stored at 5°C. This is in agreement with the current findings. However it was also noted that fruits from either storage temperature did not lose their capacity to undergo normal colour development when warmed to 23°C. This is not in agreement with observations of fruits stored at 5°C in this study. Wan and Lam (1984) reported that unripe carambolas when stored for 7 weeks at 5°C were dull green or turned to a dull yellow colour on further storage for 3 days at 20°C. This is the experience of this study, i.e. the inability of mature, yellowing but unripe fruits to develop their normal bright, yellow colour after protracted storage at 5°C. On the other hand, Wan and Lam (1984) reported that ripe fruits stored at 5°C for 7 weeks appeared yellow after three additional days at 20°C. Fruit maturity at harvest therefore appears important in this respect.

Stretch film packaging used in this study did not retard colour development associated with ripening, a somewhat surprising result, as modified atmospheres normally delay the ripening process. This may be attributed to the non-climacteric nature of the carambola. Wan and Lam (1984) using sealed 0.04mm thick polyethylene bags, found that such packaging was effective in retaining the green colour of the carambola when stored at 20°C. This difference may be attributed to the differences in physical characteristics of the stretch film used in this study.

Decay of stored fruits was affected by storage time ($p < 0.001$) and storage temperature ($p < 0.01$). Packaging had no effect on this parameter. At 28, 15 and 10°C, fruits appeared acceptable (slight decay) up to 2, 4 and 7 weeks respectively in storage. Decay was characterised by depressed, brown or black water-soaked areas followed by visible, orange-coloured spores. This rot was identified as anthracnose disease caused by *Collectotrichum gloeosporioides*. At 10°C, no signs of decay or abnormalities were observed on fruits stored for up to 5 weeks.

At 5°C, the type of decay or disorder observed was different from that at the other higher temperatures. It started off as browning on the edges of the ribs, and as time progressed, small superficial, slightly depressed brown spots developed. The browning and spotting became more severe with time. Wan and Lam (1984) described a similar disorder with unripe fruits stored at 5°C for 7 weeks, and attributed this to chilling injury. Campbell *et al.* (1987) maintained that carambolas stored at 5 and 10°C for 44 days showed no apparent chilling injury signs. Kenney and Hull (1986) noted that cold damage was observed in fruits stored at 4°C but Campbell *et al.* (1987) attributed this to fruit desiccation.

Carambolas with and without packaging possessed an acceptable flavour in storage for up to 5 weeks at 10°C, compared to 2 and 1 week for fruits held at 15 and 28°C respectively. Freshly harvested fruits had the most acceptable flavour, and fruits stored at 5°C appeared to maintain this characteristic for the entire 10-week period. This result is consistent with the solids:acid ratio for fruits stored at 5°C and shown in Figure 4.

Conclusions

If the carambola is to be consumed as a fresh fruit, then the optimum storage condition appears to be 10°C. At this temperature mature green fruits can be stored for 5 weeks, ripening in storage to their attractive bright, yellow colour, without marked decay and possessing acceptable flavour.

As a fruit destined for processing, the storage temperature may be lowered to 5°C. At this temperature fruits may be stored for as long as 10 weeks without appreciable loss in flavour. However colour development will be impaired and unsightly surface discolorations may be present representing possible signs of chilling injury.

Stretch-film packaging had a marginal, beneficial effect on reducing weight loss, shrivelling and the maintenance of fruit firmness in storage. However it is not critical to the storage of the carambola fruit as ripening was not markedly inhibited by its use. The waxy cuticle of the fruit is an effective natural moisture barrier.

Acknowledgements

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References

AOAC. 1984. Official methods of analysis of the Association of Official Analytical Chemists, Williams S (ed). 14th ed., Virginia, USA: Association of Official Analytical Chemists Inc.

Campbell C W, Knight R J and Olszack R. 1985. Carambola production in Florida. Proc. Fla. State Hort. Soc. 98:145–149.

Campbell C W, Huber D J and Koch K. 1987. Post-harvest response of carambolas to storage at low temperatures. Proc. Fla State Hort. Soc. 100:272–275.

Campbell C W, Huber D J and Koch K. 1989. Post-harvest changes in sugars, acids, and color of carambola fruit at various temperatures. Hort Science 24(3):472–475.

Grierson W and Vines H M. 1965. Carambolas for potential gift fruit shipments. Proc. Fla. State Hort. Soc. 78:349–353.

Kenney P and Hull L. 1986. Effects of storage condition on carambola quality. Proc. Fla. State Hort. Soc. 99:222–224.

Lam P F and Wan C K. 1983. Climacteric nature of the carambola (*Averrhoa carambola* L) fruit. Pertanika 6:44–47.

Oslund C R and Davenport T L. 1981. No climacteric in the star fruit (*Averrhoa carambola* L) Hort Science 16(3):60.

Vines H M and Grierson W. 1966. Handling and physiological studies with the carambola. Proc. Fla. State Hort. Soc. 79:350–355.

Wan C K and Lam P F. 1984. Biochemical changes, use of polyethylene bags and chilling injury of carambola (*Averrhoa carambola* L) stored at various temperatures. Pertanika 7:39–46.

Watson B J, George A P, Nissen, R J.and Brown B I. 1988. Carambola: a star in the horizon. Queensland Agricultural Journal 114(1):45–51.

POST-HARVEST AND MARKETING PROBLEMS OF FRUIT IN BARBADOS

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The major post-harvest diseases affecting fruit in Barbados are of fungal aetiology while there are few pests of international importance. Many of the problems which affect the marketing of fruit occur at pre-harvest stages. Improper harvesting and handling techniques account for many losses as well. The problems in marketing vary depending on the specific markets. However the entrance to, and security of, export markets depend on a continuous volume of homogenous quality and this has been a problem. Development of processing markets has been limited by unreliable supply of produce. A serious problem on the local fresh market has been the competition offered by imported fruit. There are also some general problems which relate to the market system and its capabilities.

Barbados lies within the humid tropics, its climate being influenced by the north-east trade winds. Precipitation, the most variable climatic factor, fluctuates annually, seasonally, as well as within the island.

Soils in Barbados are mainly limestone-derived and many of them display vertisol properties. However, in one area which is called the Scotland District, the soils have a distinctly non-calcareous nature. These silty clays are often slightly acid, but contamination by coral colluvium often raises the pH above 7.

The main export crop of Barbados is sugar cane, but recent problems in marketing of this crop have spurred a drive towards a diversification programme. Fruit production has been cited as one of the sub-sectors for increased development.

Fruit production

Fruit production in Barbados up to the late 1970s was characterized by scattered 'backyard' type operations. This later evolved into more organized mixed orchards and within recent years there has been a trend towards pure stand orchards.

Though a wide range of fruit is grown in orchards on the island some species have been given priority attention with regard to research and extension. The ongoing Fruit Crop Development Programme focuses on the fruit shown in Table 1

Table 1 Fruits of interest in the Fruit Crop Development Programme in Barbados

Fruit	Botanical name	Purpose
Barbados cherry	*Malpighia glabra* L.	Processing
Mango	*Mangifera indica*	Fresh
Avocado	*Persea americana*	Fresh
Guava	*Psidium guajava* L.	Processing
Passion fruit	*Passiflora edulis.* f. *flavicarpa*	Processing
Grapefruit	*Citrus paradisi*	Fresh/processing
Papaw	*Carica papaya*	Fresh
Breadfruit	*Artocarpus altilis*	Fresh
Carambola	*Averrhoa carambola*	Fresh/Processing
Plantain	*Musa* cvs	Fresh/Processing

Table 2 Fruit planting (ha) in Barbados during the period 1975/89

	1975/84			1985/89		
	Gov't	Private		Gov't	Private	
		com.	non-com.		com.	non-com.
Avocado	-	0.4	35.6	4.0	6.4	43.2
Mango	1.6	4.8	52.8	3.2	23.6	73.2
Citrus	5.6	2.8	90.0	2.0	16.4	-
Cherry	4.0	0.4	12.0	43.2	20.0	22.0
Guava	10.0	-	5.2	4.0	7.6	9.2
Carambola	-	-	-	1.2	-	-

Since work was intensified in the early 1980s, over 120ha of fruit orchard have been established. Table 2 shows the respective share of the different species in this figure. Much of this production is still rain-fed, although irrigation has been widely introduced to the island for vegetable crops.

Marketing arrangements

Apart from the large amount of fruit which goes directly from producer to consumer, the marketing system consists of the following channels:

- Hawkers (hucksters) – 40per cent of market
- Wholesalers
- Supermarkets
- Hotels and restaurants

There are three main marketing organizations involved in fruit marketing. These are the Barbados Marketing Corporation (BMC), The Agricultural Commodity Trading Company (ATCO) and the Caribbean Agricultural Commodity Trading Company (CATCO).

The BMC, a statutory board, typically handles very little of the market (less than 10 per cent) but has played a major role in cherry exports. ATCO, which is the marketing arm of the Barbados Agricultural Society, has been active in purchasing and distributing non-sugar commodities. Papaws and breadfruits have been exported to the United Kingdom through CATCO on a significant scale.

The handling of export produce through the BMC has been greatly enhanced by the introduction of the Export Packaging Unit. This facility, which operates as a pilot unit, provides containers to farmers for proper handling and uses a refrigerated truck for storage and transportation of perishable export produce to the airport.

A new processing plant began operation in the late 1980s and has been set up to process cherries, guavas and passion fruits among other produce. There are also some 16 processing companies operating, three of which are making products from bananas and plantains.

Post-harvest problems

Pests and diseases

The major post-harvest diseases affecting fruit in Barbados are mainly of fungal aetiology. With respect to mango and papaw, *Colletotrichum* is frequently responsible and this has prompted the use of hot-water treatment for the latter fruit in large-scale operations. The various crops have been affected by post-harvest diseases as follows:

Crop	Post-harvest diseases
Guava	Fruit rot (*Colletotrichum* sp.) Fruit rot (*Rhizopus* sp.)
Papaw	Fruit rot (*Colletotrichum* sp.) Phytophthora
Citrus	Fruit rot (*Colletotrichum* sp.) Fruit rot (*Penicillium* sp.)
Avocado	Fruit rot (*Botryodiplodia* sp.)

Most of the diseases which occur in storage are directly due to factors operating at pre-production, production and harvesting stages. The diseases are often brought over from the field and/or were present in a sub-clinical form prior to harvest.

Few pests have been observed to affect fruit post-harvest. Rodents are responsible for large losses of fruit in storage, though these losses are difficult to quantify. Hawkers (hucksters) often suffer high losses since fruit produce is often stored in inadequate facilities. Unfortunately little research has been done on the control of these larger pests in agricultural environments.

Improper harvesting, handling and transportation

Most of the problems at this stage are due to improper techniques. Many persons still pick fruit without the use of appropriate harvesting aids. The mechanical damage so inflicted often predisposes the fruit to fungal rot. This problem is more acute for taller crops such as mango and for tender fruit.

Incorrect handling is also practiced widely. Very often it is not through ignorance of the right procedure, but rather an effort to cut costs. 'Feed bags' (made of polypropylene) and 5-gallon buckets are readily available and are used for handling many fruit. For example, in the early stages of cherry exports, these white 5-gallon buckets were used. The result was that because of the relative height of the bucket the fruits at the bottom were inadvertently processed into juice during the transportation phase. Since then a different kind of container has been used.

Many fruits also have their shelf-life reduced considerably due to failure to prevent them from absorbing 'field heat'. Although there is a recent change towards 'cool chain' transportation for export crops, a lot of fruit produce is still transported at ambient temperature. This goes a long way towards reducing the quality of fruit for local markets.

Pre-harvest factors which affect marketing

Varietal selection

Heterogeneity in characteristics often complicates the local marketing process and may preclude changes for exploring export markets. A notable example on the local market is carambola, where mixtures of acid and sweet fruit have been known to create a negative reaction on the fresh market. Fortunately consumers have quickly learnt that the acid types are well suited for drink making.

Papaw marketing has also been affected, especially on the export market. Despite an ongoing selection effort, very often the fruits were not of the appropriate size. Selection for tolerance to bunchy top has also increased the overall yields on the island. However, the proper management of the crop has been critical to this success. The problem of 'catface', also of genetic origin, has often been found in the field.

For mango, varietal resistance to anthracnose varies considerably. Since anthracnose is a very important disease, selection of the appropriate cultivar is critical to the production.

Site selection

Some species are particularly susceptible to wind-scarring. Carambola has proved to be one of these. Other crops such as avocado, mango, guava and even citrus have been observed to suffer this damage and though such fruit may not be rejected on the local market they are unlikely to be accepted on extra-regional markets.

Variations in the nutritional status of soils have also introduced disorders in fruit (especially papaw). Often the juice quality of citrus fruit has varied, seemingly depending on this same factor. To this extent a knowledge of the previous history of the field and soil analysis would be useful to avoid irregularities in nutrients that might affect fruit quality.

Problems due to nature of production

Besides the earlier-mentioned problems of scattered and heterogenous production, there is also the constraint of seasonality of production. This problem has affected most of the crops but is most acute for crops such as lime, which respond readily to moisture. This usually results in a very low price for limes during the normal bearing season. Lack of irrigation per se is a problem which affects the quality of fruit. Citrus fruit in particular often have fruit at different stages on the tree and fluctuations in water supply cause serious variations in quality. An effort has been made to alter this trend generally by the introduction of irrigation. The problem of seasonality has also been tackled by the introduction of off-season varieties of some of the crops.

Biological and nutritional problems

For all the major crops there are a number of biological and nutritional factors which affect the quality of the fruit and thus have implications for the marketing of the fruit. Table 3 shows the important problems for the major crops in Barbados.

Problems of specific markets

For ease of analysis and presentation a number of markets are differentiated in this paper as each one of these demands a specific treatment. The distinction is as follows:

Fróm farm to:

Packing and processing
There is little information on the volumes of fruit handled by processors and on the whole these facilities are limited. The main problem at this stage is a vicious circle which prevents the development of agroprocessing, i.e. insufficient fruit production causes processors to be unable to develop and this precludes them from offering contracts to farmers for the development of fruit crops. Recently a processing plant has been set up with a view to processing cherry, guava and passion fruit among other produce. Small cottage industries have developed over the years but their production fluctuates considerably. Very often the price at which they have to buy the fruit is too high for processing. One such group which is currently out of operation is the 'Bajanne' producers.

Fresh fruit market
General descriptions of channels are shown in Figure 1 but little information on volumes is available. There are imperfections in the market at the farm gate as well as at the retail point. Buyers set the price at the farm and again at the retail market. Bargaining in the market place is almost unheard of, perhaps due to a limited amount of fruit being available or maybe because sellers are not close together in one market building. This situation however gives way to more competitive pricing when fruit are plentiful.

Public markets do not play a very significant role in the market system of fresh produce. Very little produce is sold from within these buildings. This may be because many of the vendors, especially of imported fruit, practice more aggressive marketing in high traffic areas such as bus-stands and main streets. Consumers often have no need to go to the market building. Within recent times, also, larger quantities of local fruits are being sold in the bigger supermarkets.

The problem of praedial larceny tends to complicate the marketing process since stolen fruits are sold at prices which bear no reflection to normal market prices. Another source of competition for fruit vendors who concentrate on local fruit is the trend towards the sale of imported fruit such as grapes and apples. While this activity has generated income to the persons who sell them, the share of the consumer's income which is spent on these

Table 3 Pre-harvest factors which have implications for marketing fruits in Barbados

Crop	Problem	Effect on marketing Internal	External
Cherry	Sooty mould complex		+
	Cherry weevil	+	+
	Bird damage	+	+
Mango	Snowscale		+
	Anthracnose	+	+
	Seed weevil	export limitation	
Citrus	Scale insects		+
	Mites		+
	Melanose		+
	Anthracnose	+	+
	Fruit split	+	+
Papaw	Mites	indirect	+
	Aphids	+	+
	Anthracnose	+	+
	Phytophthora	+	+
	Bunchy top	+	+
	Excess potassium	+	
Avocado	Mites		+
	Thrips		+
	Anthracnose	+	+
	Water imbibition	+	
	Scab		+
Guava	Scab		+
	Sooty mould complex		+
Soursop	Anthracnose	+	+
Carambola	Wind scarring		+

fruit is no longer available for purchasing local fruit. This problem will require careful attention in the development of local fruit production. It may be that these fruits are convenient to eat in public and replacements for these should be developed for the future.

From packing and processing to:

Export

Exports of processed fruits are very small and consist mainly of fruit flavourings and preserves. Many of these exports are to CARICOM countries.

Exports have been done for cherry, breadfruit and papaw on a significant scale. The biggest problem facing these export ventures has been in maintaining a volume of homogenous quality. For example, the Japanese market for cherries was lost after quotas could not be satisfied. In addition, the 'red only' specification made the harvest and post-harvest operation more complicated. Similarly, a

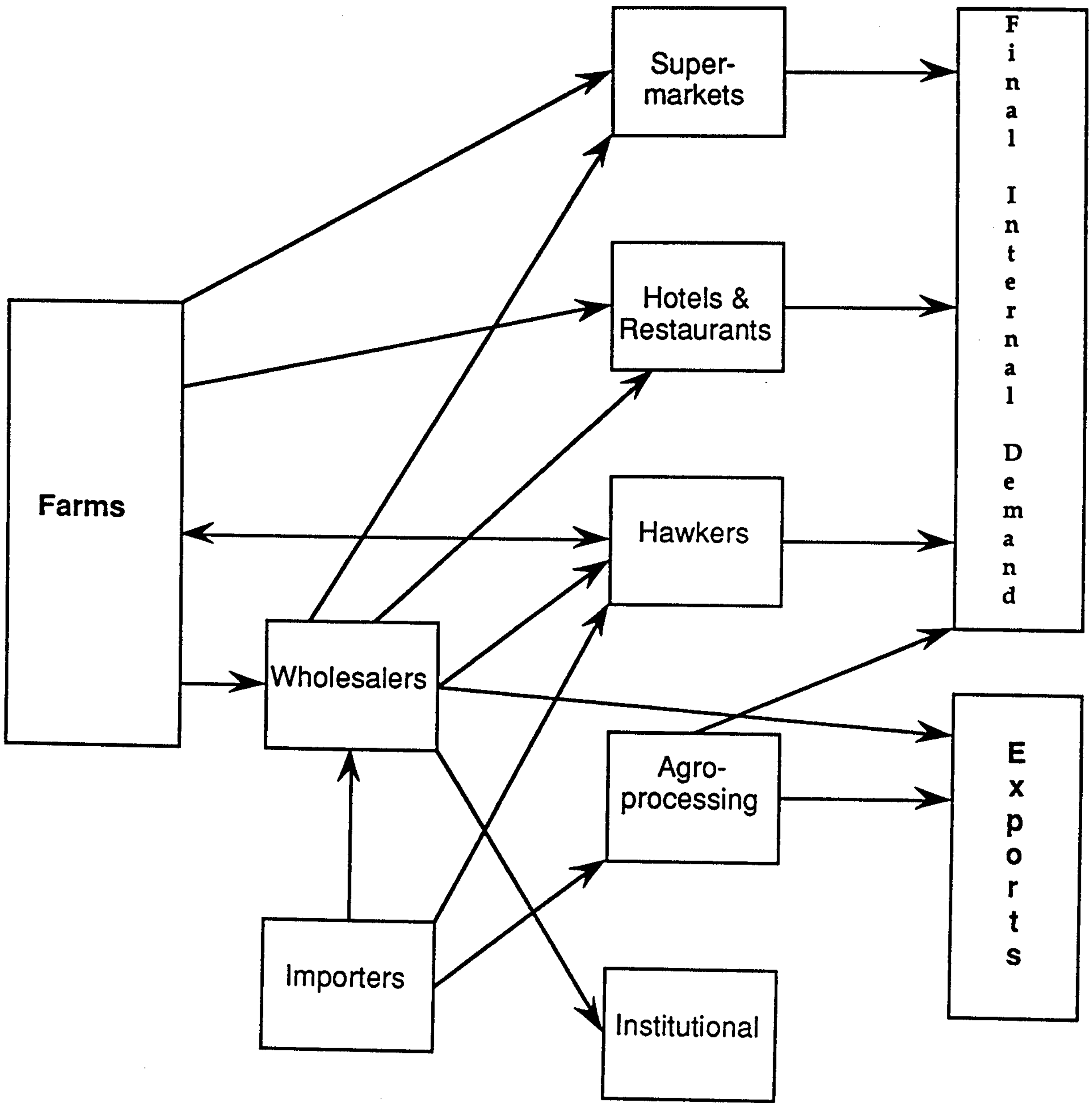


Figure 1 Marketing channels for fresh fruit in Barbados

Source: Estefanell *et al.* (1987)

high rejection rate was obtained for papaw on the export market because of variation in size. In this situation many of the papaws ended up on the local market. With these volumes of fruit being channelled to the local market, many smaller papaw growers withdrew from the market.

In the case of breadfruit, although exports are still done the collection is quite difficult because the trees are highly scattered.

Local consumption
Most of the processed fruits are consumed locally. The potential for the use of local fruit in flavouring ice cream and beverages seems to be under-exploited since imported concentrate is still widely used. This may be because the supply of local produce may also not be sufficiently competitive to offset the use of imported concentrate.

Imports

There seems to be little information on volumes of intra-regional trade. However, because of the mode of operation (transportation, handling, storage), it is likely that there are many losses incurred. This trade, which is mostly handled by hawkers (hucksters), has however been able to supply adequate amounts of fruit to consumers in Barbados over the years.
Some suppliers from other CARICOM countries have been sufficiently successful in their trade to be able to offer tough competition to local suppliers of grapefruit. This has proved to be a problem to some local grapefruit growers. The solution of such a problem seems to lie in the policy-making within the CARICOM context. It is possible, too, that innovations in local marketing strategy might allow for the sale of local produce even when fruits are imported.

It has been noted previously that imported fruit such as apples and grapes offer competition to local fruit. Local production and import trends show no clear relationship. In fact the imports appear to be more closely related to the production season of the exporting country (mainly USA) and the peak consumption periods of Christmas and the tourist season.

General market problems

The development of fruit and on the whole the agricultural diversification programme has been seriously constrained by the persistence of problems in the marketing system. The following problems have been noted to be affecting fruit marketing in Barbados:

- Absence of a clearly defined marketing plan.
- An apparent lack of a clearly defined role for the public sector *vis-à-vis* the private sector in the marketing system.
- Undesirably high levels of spoilage and wastage.
- An inadequacy or lack of marketing and storage facilities.
- A relative lack of processing facilities.
- A relatively low demand for local fruits.
- The absence of a clearly defined pricing policy which is consistent with the overall agricultural policy.
- The failure of producers to appreciate the needs of the consumer.

Conclusions

On the basis of the problems outlined in this paper it would seem that much more attention needs to be given to the post-harvest and marketing aspects of fruit production. In the development of diversification programmes, marketing considerations must be prominent in the planning process from as early as the pre-production phase. The number of problems which occur pre-harvest is per se a strong justification for this realization.

Future development will depend on a guaranteed supply of fruit of the appropriate quality. This will require the use of irrigation and the development of suitable germplasm. For extra-regional markets the problem of sustained supply could also be approached in the process of regional integration. This may not be as distant as it seems since there are already 'mentions' of a Caribbean network for fruit.

Bibliography

Jones J, Thomas O and Skeete S. 1986. Country paper – Barbados. Proceedings of a seminar on Pests and Diseases as Constraints in Production and Marketing of Fruits in the Caribbean. Barbados, 29 September – 3 October 1985 Trinidad & Tobago: Inter-American Institute for Co-operation on Agriculture. ISSN 0253-4746

Estefanell E, Marie R and Skeete S. 1987. Background paper on fruit crop development. A paper prepared for a seminar on programme planning for agricultural diversification.

Harvey E, Marie R and Medlicott A. 1990. Harvesting and post-harvest handling of papayas in the Caribbean. Bridgetown, Barbados: Inter-American Institute for Co-operation on Agriculture. ISSN 0534-5391.

Ministry of Agriculture. 1987. Credit and marketing in the Agricultural Diversification Programme – An overview. A paper prepared for the seminar on Programme Planning for Agricultural Diversification. Barbados 21–22 February 1987. Barbados: Planning Unit, Ministry of Agriculture.

DISCUSSION SESSION IV

A Malins (CARDI, Dominica):
I would be interested to hear more about your hot water treatment equipment. What design are they, and whose, and how efficient are they?

D Robinson (Ministry of Industry, Jamaica):
There are four in Jamaica. Three private operators had enough capital to invest in good equipment and to work along with an engineer. Assessments show these are very good. The one which is smaller and cheaper is the most inefficient.

I Kosto (CARDI, St Lucia):
Did you check the economics of treatment?

D Robinson:
No. I was not involved with setting up the equipment.

A Medlicott (Fundacion Hondurena de Investigacion Agicola, Honduras):
Are you aware that Benlate®has been withdrawn as a post-harvest treatment? The manufacturers themselves, not governments, have decided the risks are too great although it is still approved for pre-harvest treatments.

C Harris (Ministry of Agriculture, Dominica):
Is any one agency checking out designs and operation of treatment equipment or is everybody doing their own thing?

D Robinson:
There isn't any one person or agency doing that.

A Medlicott:
Basic designing and evaluating have been done in the USA - for example, at the University of Miami, for long-term treatment against fruit fly. Information can be obtained from these sources.

I Kosto:
A hot-water treatment plant is available in St lucia and could be used as a pattern.

L Andrews (CARDI, St Lucia):
Mr McDonald mentioned about heavy rainfall not causing tear staining. If you have dew formation, do you get it?

F McDonald (CARDI, Dominica):
High humidity is an important factor in anthracnose infestation.

D Raj Kumar (Phoenix Farms Ltd, Trinidad & Tobago):...
Conncerning Mr Whitwell's reference to thrips leading to rust in avocado, was this problem overcome?

A.Whitwell (NRI, UK):
No. The problem was not solved. We looked at almost mature severely damaged fruit. We found scarlet mite (*Tuckerella* sp.) and thousands of empty egg cases.

Two acaricide treatments were made (Ethrin® and Dicofel®). The mites lived at points of physical contact of the fruits even after treatment. Surface blemishes, which eventually led to totally unmarketable produce, developed at these points. Samples sent to the International Mycological Institute indicated *Colletotrichum*.

A. Malins:
In Dominica, thrips damage seems to have a varietal association. In Lula this may be due to the tree shape and the fact that it is difficult to penetrate the tree canopy with spray treatments.

E Harvey (Casse Consultants Ltd, Barbados):
Has the cooking and eating quality of breadfruit been tested?

R Maharaj (UWI, Trinidad & Tobago):
There is no difference in the quality and taste of both fresh and stored breadfruit.

E Harvey:
Is stem length in breadfruit important after harvest?

C Sankat (UWI, Trinidad & Tobago):
The presence of some stem is very important. The absence of stem can pose problems in breadfruit.

E Harvey:
Is there bursting of breadfruit stored in water?

C Sankat:
Yes.

A Medlicott:
Are there any effects of ethylene in storage?

C Sankat:
Breadfruit placed with other fruits in storage led to ripening. On the other hand, on pallets without other produce there was less ripening.

A Whitwell:
What produce is associated with rodent damage?

S Skeete (Ministry of Agriculure, Barbados):
Mango, papaw, passion fruit and almost every fruit harvested for market.

TECHNICAL SESSION V

Chairman: Barton Clarke, *CARDI, St Lucia*

Rapporteur: Melissa O'Garro, *Department of Agriculture, Montserrat*

EFFORTS TO IMPROVE THE POST-HARVEST TECHNOLOGY OF MANGOES AND HELICONIAS

A Mootoo
Ministry of Food Production and Marine Exploitation, Trinidad and Tobago

Efforts of the Post-Harvest Unit of the Research Division of the Ministry of Food Production and Marine Exploitation, Trinidad & Tobago, to improve the post-harvest technology of mangoes and heliconias are discussed. For mangoes a training manual which addresses varieties and variety selection, harvest, grading and standardization, packhouse operations, transport and storage, diseases and disorders has been published in collaboration with the Inter-American Institute for Co-opeation on Agriculture. Low temperature studies and alternative storage techniques attempted at the Postharvest Unit are reported and the promising potential use of calcium chloride dips on shelf-life extension of 'Julie' mangoes is discussed. A report of a study undertaken to assess the effects of preservative solutions on the keeping quality of *Heliconia psittacorum* 'Golden Torch' is also presented.

The Post-harvest Unit of the Research Division of the Ministry of Food Production and Marine Exploitation in Trinidad was established about 8 years ago in an effort to address and attempt to improve the post-harvest technology of perishable commodities including fruits, vegetables, root crops and ornamentals. I shall focus this presentation on some aspects of the work conducted with mango from the fruit category and heliconia from the ornamental category.

Mango

The mango has been viewed as a commodity with good potential both for the domestic and export markets but its market potential is seriously limited by its high perishability which results in much wastage. Strategies employed to improve the post-harvest technology of mangoes have included both training and research components.

Training

Publication of a training manual entitled *A manual of post-harvest handling systems for perishable food crops. No. 001. Mango (Mangifera indica L.).* This publication was done in collaboration with the Inter-American Institute for Co-operation on Agriculture (IICA) and it addresses the following aspects of a post-harvest handling system for mangoes:-

- Varieties and variety selection
- Harvest
- Grading and standardization
- Packhouse operations
- Transport
- Diseases and disorders.

Trials conducted at the Post-harvest Unit for the publication of this training manual included the fabrication and testing of a picking pole equipped with collection bag, cutting blade and extendable rod for harvesting mangoes. It was found to be easy and efficient to use and there was no damage to fruits. It has been recommended as an excellent improvement to some of the current harvesting methods including throwing stones, shaking trees and beating branches.

Preliminary investigations were also undertaken with the use of 'semperfresh' (fruit surface coating) as a means of extending the shelf-life of mangoes and it was found to have variable effects depending on fruit variety. Ripening was retarded and shelf-life extended in 'Haden' and 'Long' mangoes but there was no visible effect on fruits of the 'Tommy Atkins' variety.

Research

Low temperature studies

Low temperature storage is probably the most widely used method of extending the storage life of perishable commodities. However, its use is limited with mangoes as many studies (Saucedo *et al.*, 1977; Wardlow and Leonard, 1936) have indicated a critical minimum storage temperature below which fruits develop chilling injury. The dilemma seems to be that the temperatures at which chilling injury does not occur would not be adequately low to keep mangoes in a pre-climacteric stage. It would therefore, be necessary to establish critical threshold temperatures for particular varieties of mango as well as to develop techniques to overcome the chilling injury disorder.

Results of low temperature storage trials conducted at the Postharvest Unit with 'Julie' mangoes are summarized in Figures 1 and 2 and Table 1. Colour development (Figurel) and textural softening (Figure 2) were retarded in fruits held at 7°C and 12°C compared to fruits held under ambient conditions. Upon removal from low temperature to ambient conditions, fruit previously held at 7°C underwent rapid softening becoming a 'watery mass' by the 14th day. Fruits previously held at 12°C softened at a slower rate attaining a soft, acceptable texture by the 14th day. Visible chilling injury symptoms were not observed in fruits held at 12°C but were discernible in fruits held at 7°C on the eighth day and became progressively more acute on removal to ambient conditions (Table 1) being characterized by peel discolouration and scald-lesions. Fruits held at 12°C for 8 days ripened with significantly ($P<0.05$) lower organoleptic qualities than fruits held continuously under ambient conditions but were considered to be acceptable by a five-member organoleptic panel; while fruits held at 7°C for 8 days underwent abnormal ripening and were unacceptable for consumption.

This study indicates that despite the retardation of ripening processes of 'Julie' mangoes at 7°C and 12°C, exposure to these temperatures significantly reduced organoleptic acceptability of fruits. Since chilling injury was not observed in fruits held at 12°C, and such fruits ripened with acceptable quality, this temperature may be used for retarding ripening and senescence of 'Julie' mangoes.

Alternative storage techniques

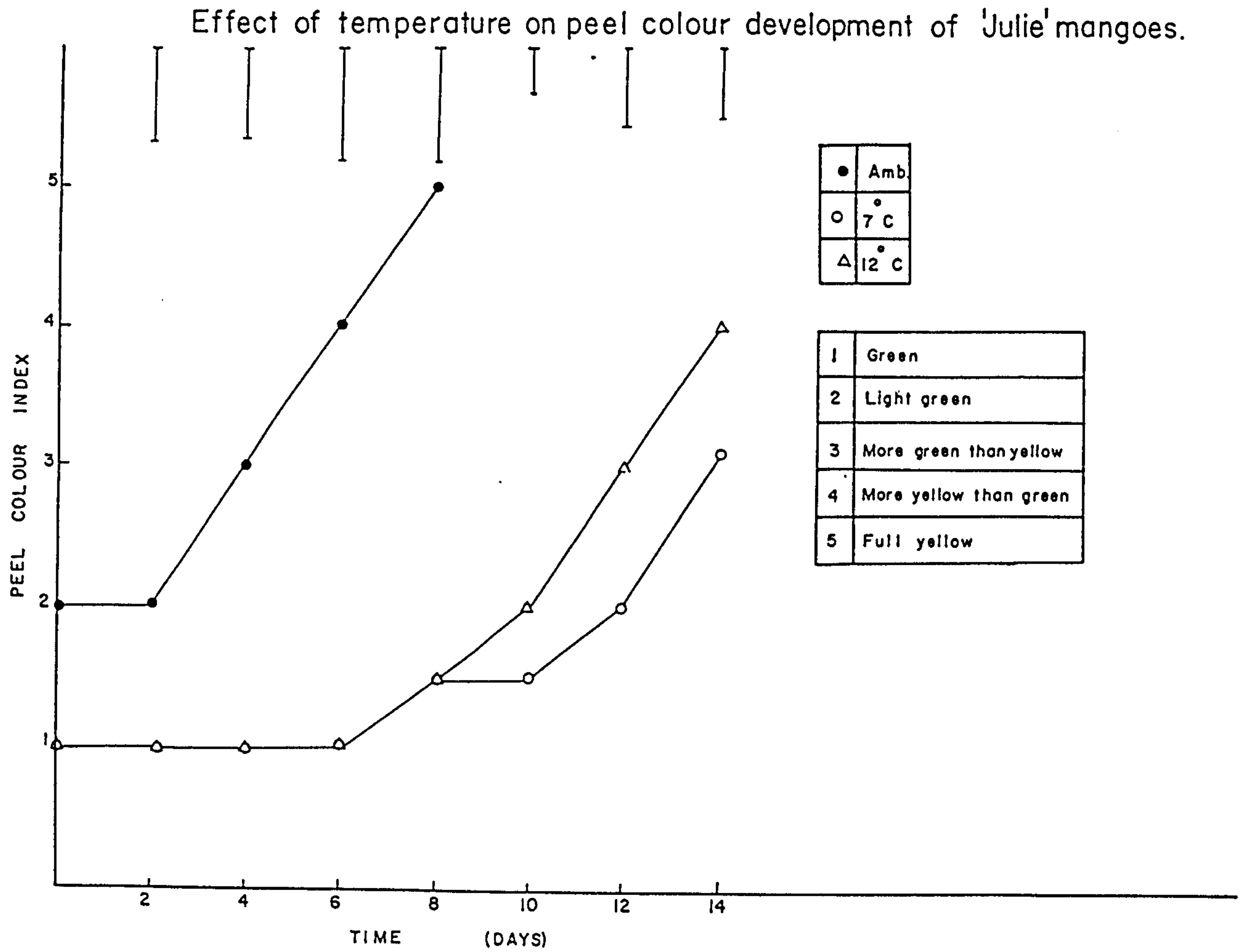
The chilling sensitivity of mangoes at low temperature storage conditions as well as the large capital outlay required for post-harvest refrigeration have prompted the search for alternative storage techniques. Two such alternatives have been attempted at the Postharvest Unit.

Modified atmosphere (MA) storage

Various forms of modified atmosphere storage have been investigated with mangoes but have yielded inconsistent responses (Chaplin, 1986).

'Julie' mangoes were individually bagged in sealed polyethylene bags to create a commodity-generated modified atmosphere and held under ambient conditions. Results are summarized in Figures 3 and 4 and Table 2. Colour development (Figure 3) and textural softening (Figure 4) were retarded in bagged versus unbagged fruit. By the eighth day, bagged fruits began to soften with no corresponding development of colour and by the 12th day bagged fruits were green and oversoft supporting the finding of Chaplin *et al.* (1982) who reported inhibition of chlorophyll degradation and carotenoid synthesis in bagged 'Kensington' mangoes. Table 2 illustrates that the total soluble solids content was significantly ($P<0.05$) lower in bagged versus unbagged fruit suggesting that the conversion of starch to sugars is inhibited under MA storage. The decline in titratable acidity was also retarded in bagged versus unbagged fruit. This resulted in an extremely low sugar:acid ratio in bagged compared to unbagged fruit. This ratio is known to be an important

Figure 1.



Effect of temperature on peel colour development of 'Julie' mangoes.
PEEL COLOUR INDEX
TIME (DAYS)
1
2
3
4
5
2
4
6
8
10
12
14
Amb.
7°C
12°C
1 Green
2 Light green
3 More green than yellow
4 More yellow than green
5 Full yellow

Figure 2.

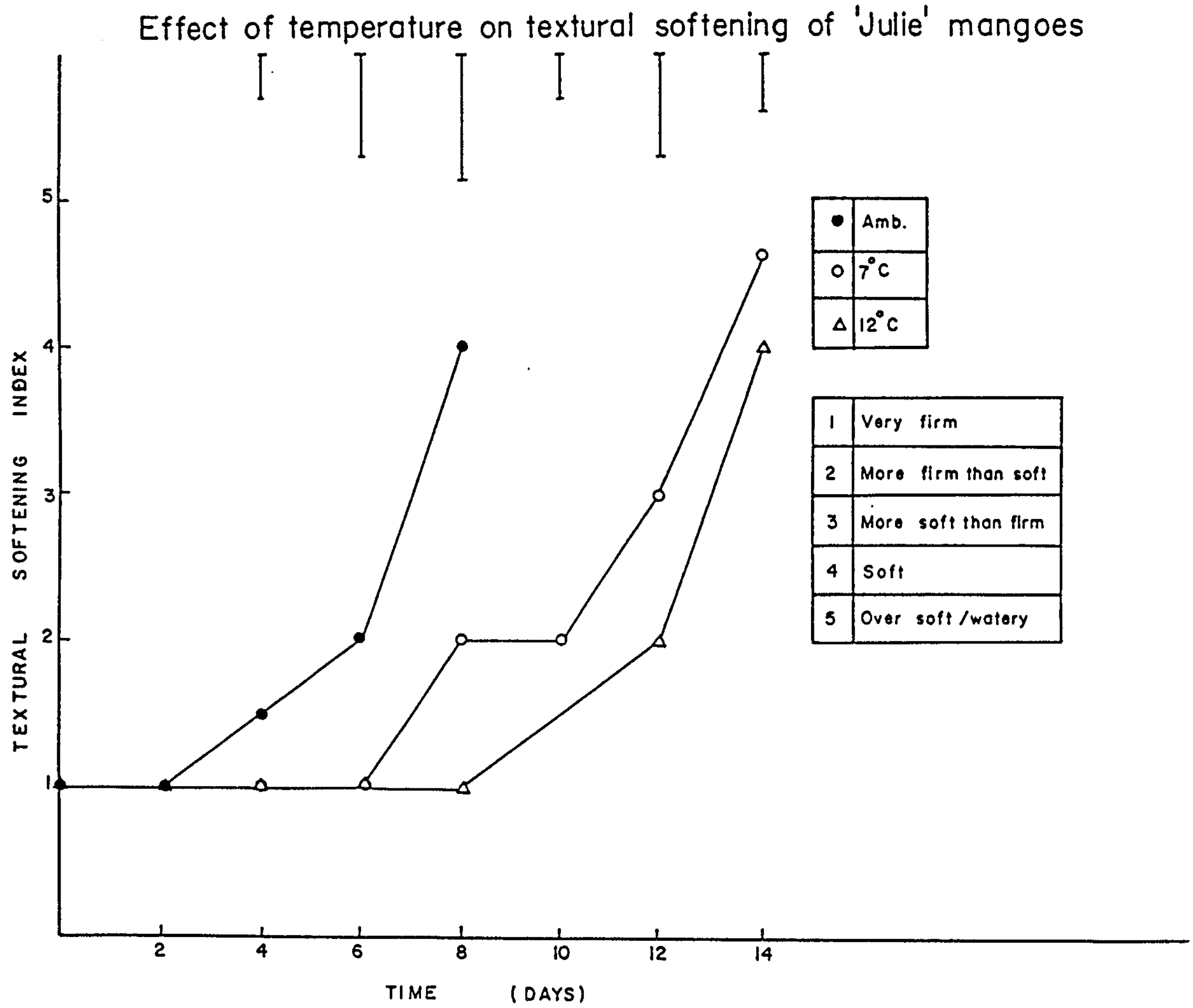

Effect of temperature on textural softening of 'Julie' mangoes
TEXTURAL SOFTENING INDEX
TIME (DAYS)
1
2
3
4
5
2
4
6
8
10
12
14
Amb.
7°C
12°C
1 Very firm
2 More firm than soft
3 More soft than firm
4 Soft
5 Over soft /watery

Table 1:

Effect of temperature on development of chilling injury symptoms and organoleptic quality of 'Julie' mangoes

Time (days)	Treatment	Chilling index (Hedonic scale 1–5)	Appearance (Hedonic scale 1–5)	Taste (Hedonic scale 0–5)	Odour (Hedonic scale 1–5)	General (Hedonic scale 0–5)
	7°C	1.7 ± 1.3	3.3 ± 0.5	1.0±0.6	1.0± 0.25	1.6± 0,4
8	12°C	0	3.6 ±0.5	1.7 ±0.6	1.5± 0.25	2.3 ± 0.8
	Ambient	0	4.0 ± 0.6	4.5 ± 0.3	4.8± 0.25	4.2 ±0.2
14	7°C	3.8 ± 0.9	1.0 ±0.4	1.5 ± 0.2	1.5 ±0.4	1.0 ±0.6
	12°C	0	3.0 ±0.5	4.2 ± 0.3	3.0 ±0.5	3.4± 0.6

Values represent means ± S.E. of 5 replicates

Hedonic scales: Chilling index: 1, nil; 5, very severe
Appearance: 1, very poor; 5, excellent
Taste: 0, unpalatable; 5, very good blend of sugar and acid
Odour: 1, fermenting ; 5 excellent fruity odour
General: 0, very poor; 5, excellent

Figure 3

Effect of modified atmosphere on
peel colour development of 'Julie' mangoes

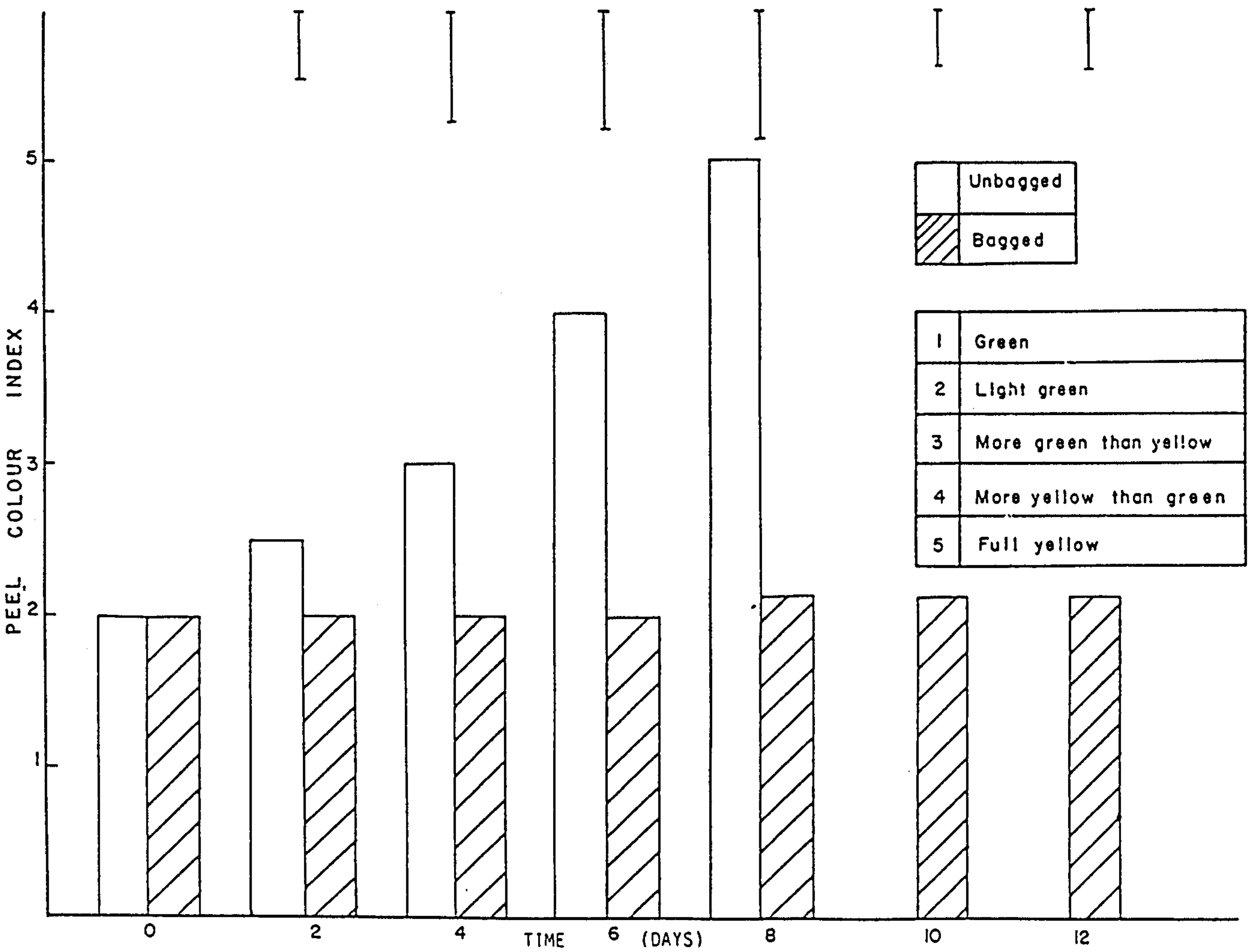


Figure 4

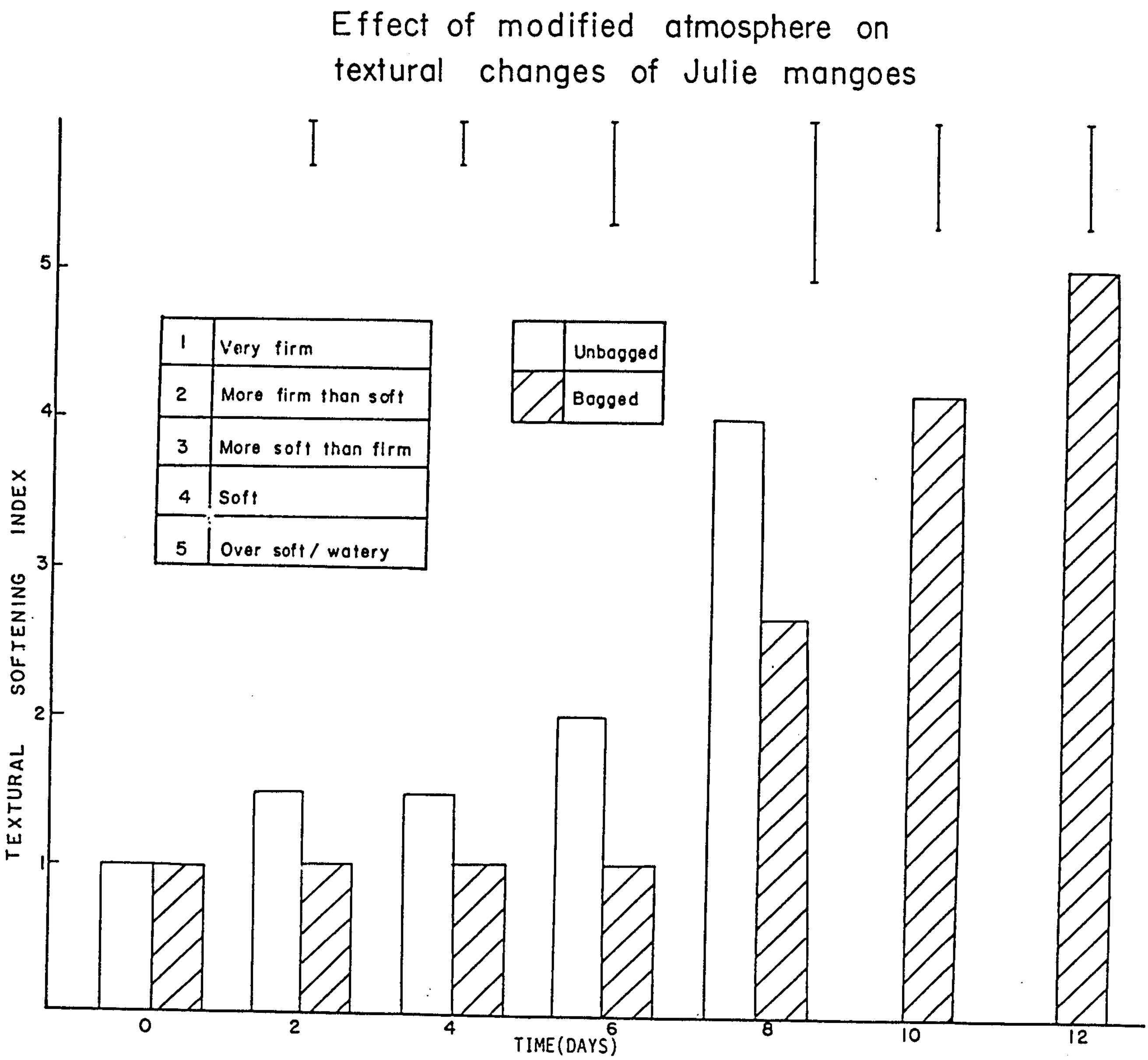

Effect of modified atmosphere on
textural changes of Julie mangoes
TEXTURAL SOFTENING INDEX
1 Very firm
2 More firm than soft
3 More soft than firm
4 Soft
5 Over soft / watery
Unbagged
Bagged
TIME(DAYS)
0
2
4
6
8
10
12
1
2
3
4
5

Table 2. Effect of modified atmosphere storage on quality characteristics of Julie mangoes

Time (days)	Treatment	Total soluble solids (TSS) (° brix)	Titratable acid (TA) (ml 0.1 N NaOH)	TSS: TA	% Fruits with fermenting odour
6	Unbagged	17.5 ± 0.5	8.2 ± 1.0	2.3 ± 1.4	0
	Bagged	12.6 ± 0.5	18.9 ± 1.7	0.81 ± 0.66	42.8
12	Unbagged	Treatment discontinued – advanced senescenceE			
	Bagged	14.6 ± 1.3	15.5 ± 1.3	1.0 ± 0.4	100

Values represent means ± S.E. of 5 replicates

determinant of eating acceptability of mango fruit (Satayan *et al.* 1986) and bagging would therefore, be expected to have serious deleterious effects on eating quality.

The presence of fermenting odour was discernible on the sixth day and by the 12th day all bagged fruits emitted fermenting odours indicative of fermentative decarboxylation with the formation of aldehyde and alcohol end-products. This suggests that by the sixth day in MA storage, carbon dioxide concentrations had increased and/or oxygen concentrations decreased to levels which cause anaerobic respiration in 'Julie' mangoes.

The data indicate that MA storage of Julie mangoes under ambient conditions may not be a promising method of storage life extension.

Use of calcium chloride dips

Calcium compounds have shown promise in the quality retention of fruits and vegetables (Shear, 1975; Huber, 1983) by maintaining firmness, reducing respiratory rates and ethylene evolution (Poovaiah, 1986), and decreasing storage rots (Conway and Sams, 1984).

Investigations were undertaken to assess the efficacy of calcium chloride dips at five concentrations (0, 2, 4, 6 and 8 per cent) on the quality, characteristics and shelf-life of 'Julie' mango. Colour development (Figure 5) and textural softening (Figure 6) were significantly ($P<0.05$) retarded in calcium-treated fruits compared to the control. The organoleptic ratings of calcium-treated fruits were significantly ($P<0.05$) higher than that of control (Table 3) with the low organoleptic ratings of untreated fruit resulting from high incidences of rotting, anthracnose infection and over-softening compared to calcium-treated fruits which maintained firm texture and good external appearance. Shelf-life was extended in calcium-treated versus untreated fruits. Fruits dipped in 6 and 8 per cent calcium chloride solution had a mean shelf-life of 14 days compared to a mean shelf-life of 4.5 days in untreated fruit (Table 3).

Despite the higher calcium concentrations of both pulp and peel tissues of fruits dipped in 8 compared to 6 per cent calcium chloride solutions, the shelf-lives and organoleptic ratings of these treatments were not significantly ($P<0.05$) different. This indicated that the optimum concentration of calcium chloride for shelf-life extension and quality retention of 'Julie' mangoes is 6 per cent.

Figure 5.

Effect of postharvest treatment of calcium chloride on colour development of 'Julie' mangoes. Vertical range bars indicate LSD at P ≤ 0.05

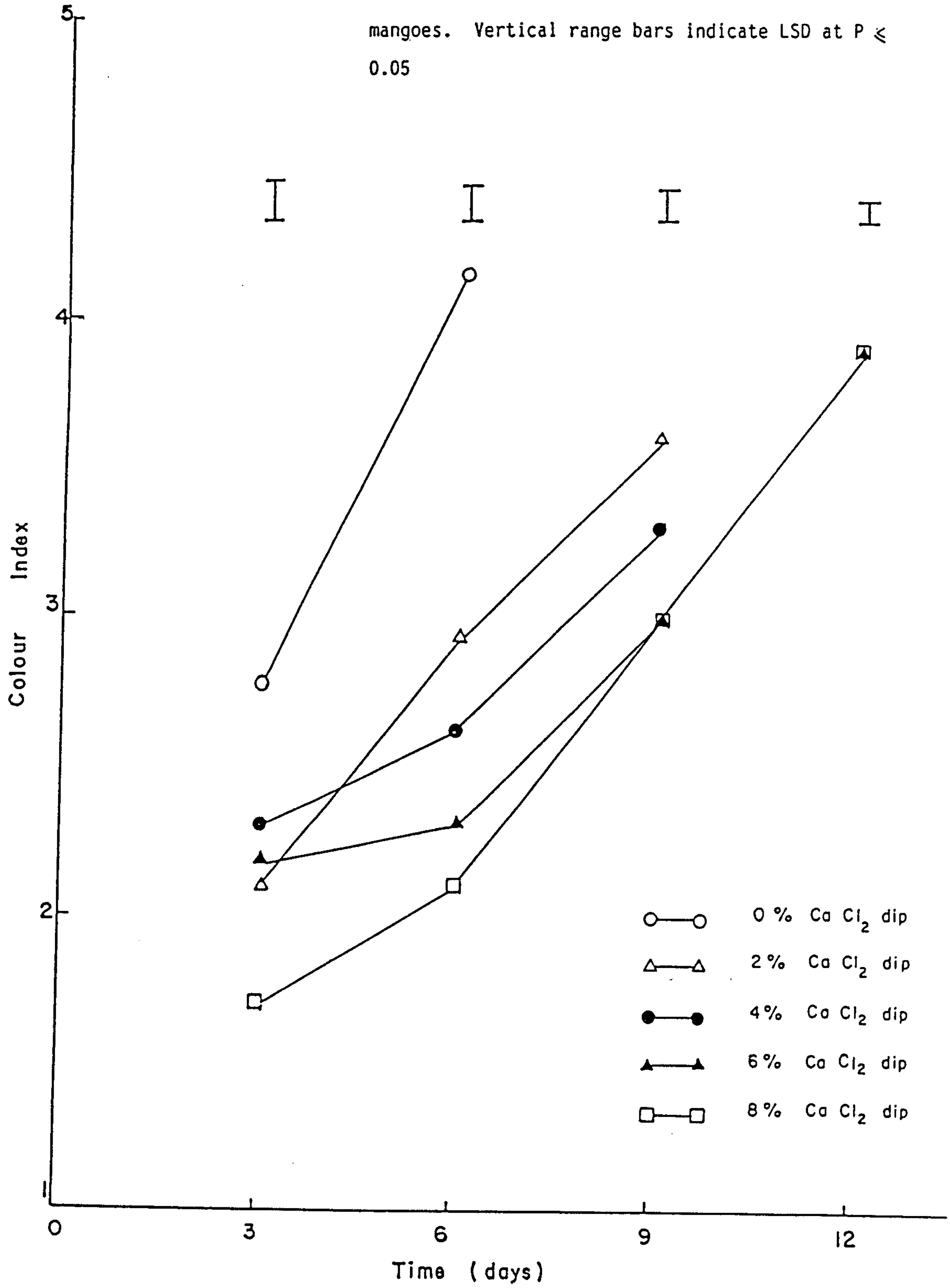


Figure 6. Effect of postharvest treatment of calcium chloride on textural softening of 'Julie' mangoes. Vertical range bars indicate LSD at $P \leq 0.05$

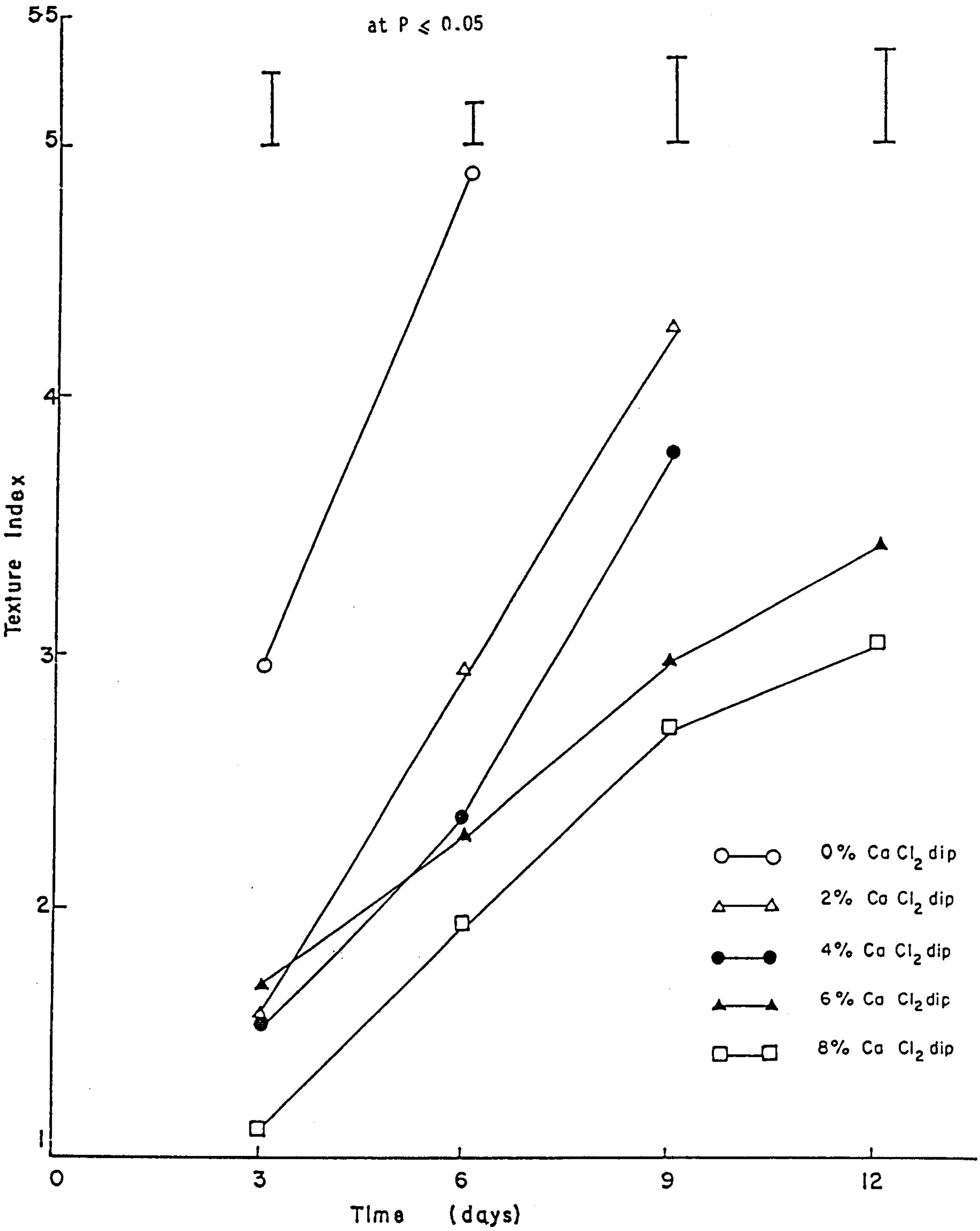


Table 3. Effect of post-harvest dips of calcium chloride on shelf-life, calcium content and oganoleptic rating of 'Julie' mangoes.

Treatment (% $CaCl_2$)	Shelf-life (days)	Peel Ca content (mg/100g dried tissue)	Pulp Ca content (mg/100g dried tissue)	Organoleptic rating (hedonic scale, 0–5)
0	4.5 a	188.3 a	134.2 a	2.4 a
2	8.6 b	657.2 b	329.2 b	3.1 b
4	9.4 b	696.0 b	336.7 b	3.3 b
6	14.6 c	867.5 c	550.4 c	4.6 c
8	14.8 c	1027.7 d	730.0 d	4.7 c

Hedonic scale: Organoleptic rating: 0 – very poor; 5 – excellent

Mean values in the same column followed by different letters are significantly different at the 5% level by Duncan's multiple range test.

Heliconia

Expansion in the international trade of ornamentals and the continuing interest in the cut flower industry in the Caribbean region has increased the need for optimum post-harvest technology of ornamental crops but there remains a paucity of documented information on post-harvest studies of tropical blooms.

The use of preservative solutions to promote the quality and prolong the life of cut flowers has been known for many years and has become standard practice for florists operating in the more developed parts of the world. A study was undertaken to investigate the comparative effects of five preservative solutions on the keeping quality of *Heliconia psittacorum* 'Golden Torch' which is considered to be a tropical bloom with good potential for domestic and export markets.

The preservative solutions used were as follows:

A Tap water

B Deionized (DI) water

C 1.5 per cent sucrose in DI water

D 1.5 per cent sucrose; 250ppm hydroxyquinoline citrate (HQC) in DI water

E 1.5 per cent sucrose; 250ppm HQC and 5ppm kinetin in DI.water.

Fresh weight loss (Figure 7) and bract senescence (Figure 8) were significantly ($P<0.05$) higher in blooms held in solutions C and D compared to blooms held in solutions A, B and E. Senescence of the peduncle (Figure 9) was enhanced in blooms held in solution D and on the eighth day discolouration was observed both from the cut end of the peduncle as well as from the base of bracts whilst blooms held in the other solutions showed low levels of discolouration only from the cut end. By the 14th day peduncles from all treatments displayed discolouration from the base of the bracts but this was significantly ($P<0.05$) greater in blooms held in solution D. The vase livestissue) of blooms held in solutions C and D were significantly ($P<0.05$) shorter than blooms held in solutions A, B and E (Table 4).

Water quality is known to influence longevity of flowers. For most blooms, deionized water is considered to be superior to tap water which is considered to be of variable composition with respect to

Fig. 7

The effect of preservative solutions of fresh weight loss of H. psittacorum 'Golden torch'.

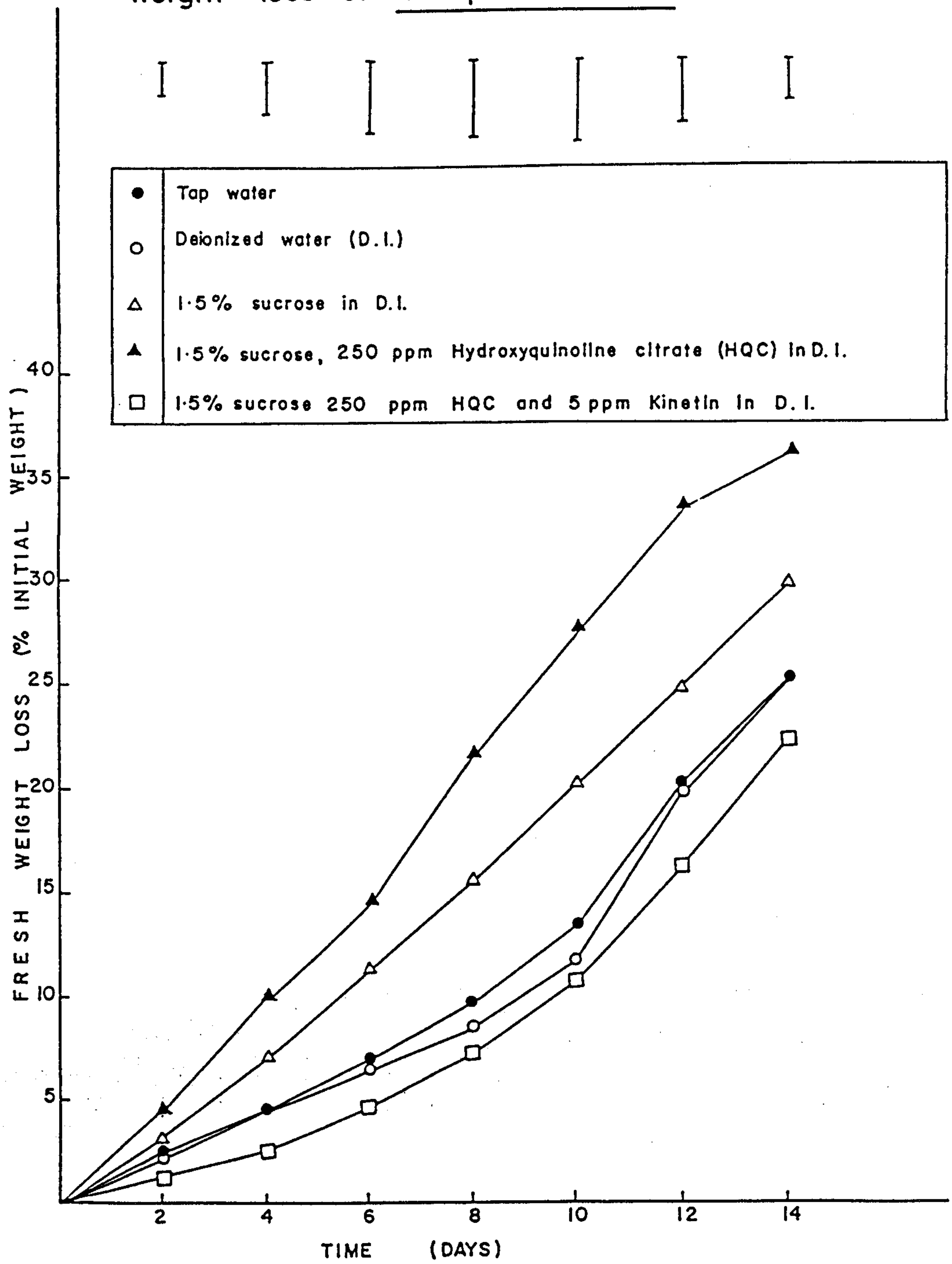


Fig. 8

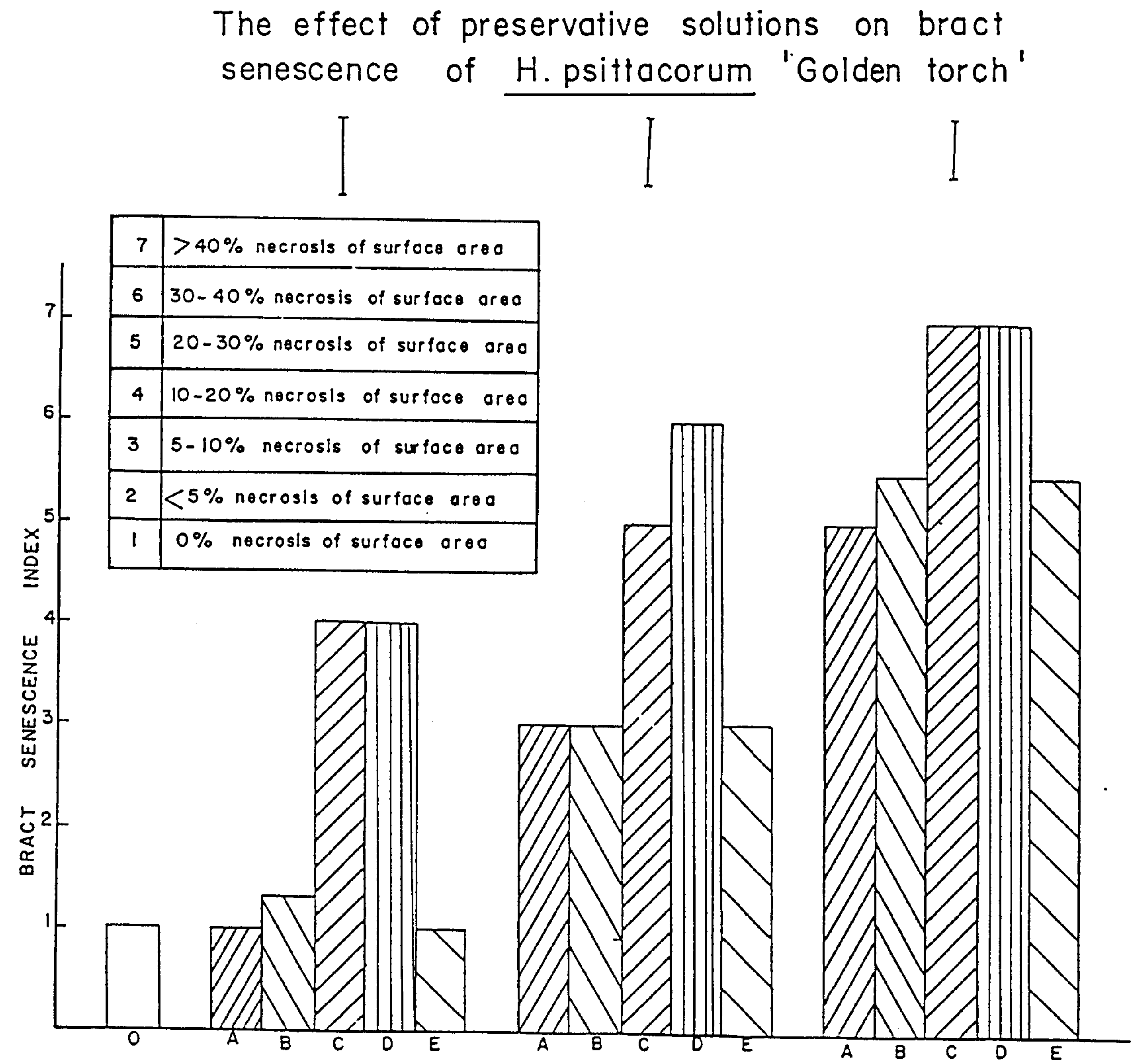

The effect of preservative solutions on bract senescence of H. psittacorum 'Golden torch'
7 >40% necrosis of surface area
6 30-40% necrosis of surface area
5 20-30% necrosis of surface area
4 10-20% necrosis of surface area
3 5-10% necrosis of surface area
2 <5% necrosis of surface area
1 0% necrosis of surface area
BRACT SENESCENCE INDEX
1
2
3
4
5
6
7
O
A B C D E
A B C D E
A B C D E

Fig. 9

Effect of preservative solutions on peduncle discolouration of H. psittacorum 'Golden torch'

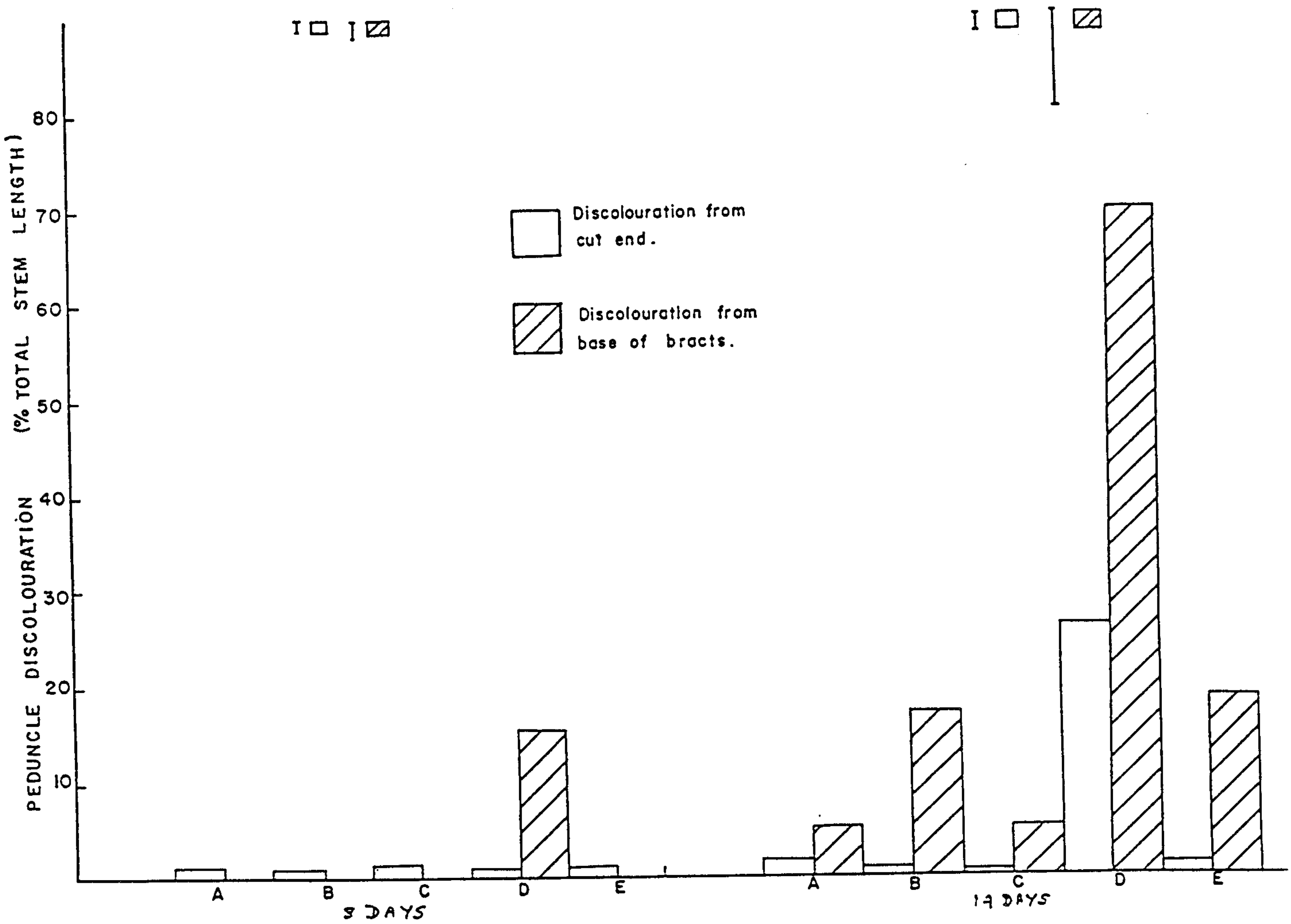


Table 4. The effect of preservative solutions on vase life of *Heliconia psittacorum* 'Golden Torch'

Treatment	Mean vase life (days ± S.E).
Tap water	7.5 ± 1.25
Deionized (DI) water	7.0 ± 1.15
1.5% sucrose in DI water	4.0 ± 0.96
1.5% sucrose; 250ppm HQC in DI.water	3.5 ± 0.57
1.5% sucrose, 250ppm HQC and 5ppm kinetin in DI water	8.0 ± 0.52

HQC = hydroxyquinoline citrate

acidity, total dissolved solids and specific ion toxicity (Halevy and Mayak, 1981). These data suggest that deionized water is not advantageous over the local supply of water in its effects on bloom senescence and vase life of *H. psittacorum* 'Golden Torch'.

The addition of a carbohydrate supply to water taken up by cut flowers has been reported to enhance longevity in a number of cut flowers (Marousky, 1969; Bravdo *et al.*, 1974; Halevy and Mayak, 1974). Hydroxyquinoline citrate (HQC) is also a commonly used ingredient in many preservative solutions as it is known for its broad spectrum bactericidal and fungicidal properties and its ability to reduce physiological stem blockage (Halevy and Mayak, 1981). Both these ingredients had deleterious effects on the vase life of *H. psittacorum* 'Golden Torch' and enhanced the process of senescence. Deleterious effects of sugar have also been reported with *Oncidium* orchids (Yong and Ong, 1979) and daffodil (Nichols, 1975); deleterious effects of HQC were observed in chrysanthemums (Gladon and Staby, 1976) and Gypsophila (Katchansky, 1979).

There is relatively limited use of growth substances in preservative solutions except for some limited use of cytokinins; the best results were obtained with carnations in which longevity was promoted, the sensitivity to ethylene was reduced and the burst in ethylene production delayed (Eisinger, 1979).

The addition of kinetin to the preservative solution also containing sucrose and HQC improved the longevity and delayed the senescence of *H. psittacorum* 'Golden Torch' above tap or deionized water.

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References

Mango

Anon. A manual of postharvest handling systems for perishable food crops. No. 001. Mango (*Mangifera indica* L.). IICA Misc. Publ. No. A2/TT-87-001. Inter-American Institute for Co-operation on Agriculture [Res. Div. Post-harvest Publ. No. 001].

Chaplin G R. 1986. Postharvest physiology of mango fruit. Proceedings First Australian Mango Research Workshop. Cairns, Queensland, November 1984. Australia: Commonwealth Scientific and Industrial Research Organization (CSIRO)

Chaplin G R, Scott K J and Brown B I. 1982. Effect of storing mangoes in polyethylene bags at ambient temperature. Singapore S. Pr. Ind. 10(2):84–88.

Conway W S and Sams C E. 1984. Possible mechanisms by which postharvest calcium treatments reduce decay in apples. Phytopath. 24 :208–210.

Huber D J. 1983. Role of cell wall hydrolasses in fruit softening. Hort. Rev. 5:169-171.

Poovaiah B W. 1986. Role of calcium in prolonging storage life of fruits and vegetables. Food Tech. 40:86–89.

Satyan S H, Chaplin G R and Willcox, M E. 1986. An assessment of fruit quality of various mango cultivars. Proceedings First Australian Mango Research Workshop. November 1984. Melbourne, Australia: Commonwealth Scientific and Industrial Research Organization (CSIRO)

Saucedo C V, Torres E and Lakshminarayana S. 1977. Effect of refrigerated temperatures on the incidence of chilling injury and ripening quality for mango fruit. Proc. Fla. State Hort. Soc. 90:205–210.

Shear C B. 1975. Calcium related disorders of fruits and vegetables Hort. Sci. 10:361–365.

Wardlow C W and Leonard E R. 1936. Storage of West Indian mangoes. Imperial College of Tropical Agriculture (ICTA) .Memoir Publ. No. 3.

Heliconia

Bravdo B, Mayak S and Gravrieli Y. 1974. Sucrose and water uptake from concentrated sucrose solutions by gladiolus shoots and the effect of these treatments on floret life. Can. J. Bot. 52:1271–1281.

Eisenger W. 1977. Role of cytokinins in carnation flower senescence. Plant Physiol. 59(4):707–709.

Gladon R J and Staby G L. 1976. Opening of immature chrysanthemums with sucrose and 8-hydroxquinoline citrate. Hort. Sci. 1(3):206–208.

Halevy A H and Mayak S. 1974. Transport and conditioning of cut flowers. Acta. Hort. 43:291–306.

Halevy A H and Mayak S. 1981. Senescence and postharvest physiology of cut flowers. Part 2. Hort Rev. 3:59–143.

Marousky F S. 1969. Vascular blockage, water absorption, stomatal opening and respiration of cut 'Better Times' roses treated with 8-hydroxquinoline citrate and sucrose. J. Amer. Soc. Hort. Sci. 94:223–226.

Yong M C.and Ong H T. 1979. Effects of chemicals applied to cut stalks on the shelf life of *Oncidium* Goldiana flowers. Orchid Rev. 87(1035):292–295.

A CONSUMER PREFERENCE STUDY ON THE POST-HARVEST QUALITY OF HOT PEPPERS EXPORTED FROM TRINIDAD AND TOBAGO TO RETAIL OUTLETS IN CANADA

M Mohammed, L A Wilson and P I Gomes
The University of the West Indies, Trinidad & Tobago

Export of fresh hot peppers (*Capsicum, frutescens* L.) from Trinidad & Tobago to foreign markets, namely Europe and North America, has experienced phenomenal growth in the past 4 years (Stewart, 1988). Export to Canadian markets increased from 33,803kg in 1986 to 122,900kg in 1990 (Trinidad & Tobago Export Development Corporation Overseas Trade Newsletter, 1991). To sustain growth and expansion of hot pepper exports in this highly competitive and international business climate, a simultaneous emphasis on consumer purchasing habits and preferences among retail outlets is required. Fletcher *et al.* (1990) indicated that consumer attitudes and perceptions towards products are crucial information to a successful marketing system. Awareness of its importance in the current and future economic environment led to the initiation of this study to examine consumer preferences and buying habits of hot pepper retail sales at outlets in Canada.

Several authors - Peters and Waterman (1982), Prince (1990), Heskett (1987), Garvin (1983), LaLonde *et al.* (1988) - examined the impact of improvements to consumer preferences and services on the perishable industry as a competitive strategy to display high quality produce to attain repeat sales. Information on consumer purchasing needs, services and quality perceptions regarding external and internal characteristics of a product forms the interface between sellers and buyers for market transactions and distribution strategy (LaLonde 1985). In the export trade of hot peppers where producer or exporter and retailer and consumer are far apart, effective communication of desired consumer-related purchasing behaviour is of utmost importance but often lacking. The end result is that exporters and retailers may lose their competitive position, not only due to inferior product quality, but also because they fail to offer the required services and quality characteristics of the product relevant to the needs of the consumer. Information of these needs has not been reported in the literature. Since hot pepper export to Canada is a relatively new venture, with obvious potential, it is imperative that exporters have information to guide them in effective decision making aimed at improving both profitability of operation and quality of service to overseas retailers and consumers.

The first objective of the study was to identify and describe the Canadian consumer views at different retail outlets concerning quality, services offered, buying habits and preferences of hot peppers exported from Trinidad & Tobago. A second objective was to determine consumers expectations and needs that must be satisfied to make export marketing of hot pepper a success so that recommendations for improving sales at Canadian retail markets could be made.

The overall hypothesis is that development of this information would allow exporters to focus on post-harvest techniques to enhance product quality considered most important by their customers thereby improving distribution effectiveness in hot pepper export marketing trade.

Research methodology

From the list of 24 Trinidad & Tobago hot pepper exporters compiled by the Export Development Corporation (EDC) in 1988, the names and addresses of their respective importers from two locations in Toronto, Canada were sought. These locations were

Malton and Scarborough. A letter was sent to each importer, indicating the objectives and goals of the consumer preference survey on hot peppers and the need to locate retail outlets where the crop is marketed. Positive replies were obtained from nine importers. They submitted names, addresses and telephone numbers of 14 and 12 hot pepper retail outlets in Malton and Scarborough respectively. From these, three roadside markets, three farmers' markets and three supermarkets were selected at random in each location.

The selected retail outlets were informed 2 weeks prior to initiation of interviews about the survey and its objectives. Interviews were completed by the researcher at these selected retail outlets from August to mid-September 1989. For each outlet in Malton and Scarborough, six hot pepper consumers were randomly selected and interviewed. Total number of interviews amounted to 108 in both locations.

Interviews were limited to consumers who made regular purchases at these outlets. The questionnaire was designed to gather consumer information on frequency of purchase, preference for selecting particular retail outlet, personal characteristics of respondents, quantity normally purchased, levels of post-harvest losses, nature of losses, remedies to reduce losses and quality perceptions as they relate to hot peppers displayed for sale originally imported from Trinidad.

Interviews were conducted every day across all outlets in both locations between 09.00–11.00h or 05.00–8.00h. Interviews were kept very brief, typically 10–12 minutes since respondents were doing something else at the time, e.g. shopping or visiting other business outlets nearby. Overall, 72 per cent of those approached agreed to be interviewed. The responses were statistically compared among locations in the three retail outlets using either a chi-square test or ANOVA.

Results

Characteristics of retail market consumers

There was no significant difference in percentage consumers shopping at each of the three retail outlets according to sex at either location. Similarly, there was no specific age groups of consumers dominating in any of the three retail outlets.

In both locations, but moreso at Malton than Scarborough, consumers showed more inclination to shop at supermarkets compared to farmers' or roadside markets (Figure 1). Roadside markets were least popular at both locations (Figure 1).

Consumers were asked to estimate the average number of visits to retail outlets to purchase hot peppers. Visits to supermarkets were two and five times more than to farmers' or roadside markets respectively in Malton (Figure 2). At Scarborough visits to supermarkets were twice as many compared to farmers' or roadside markets (Figure 2).

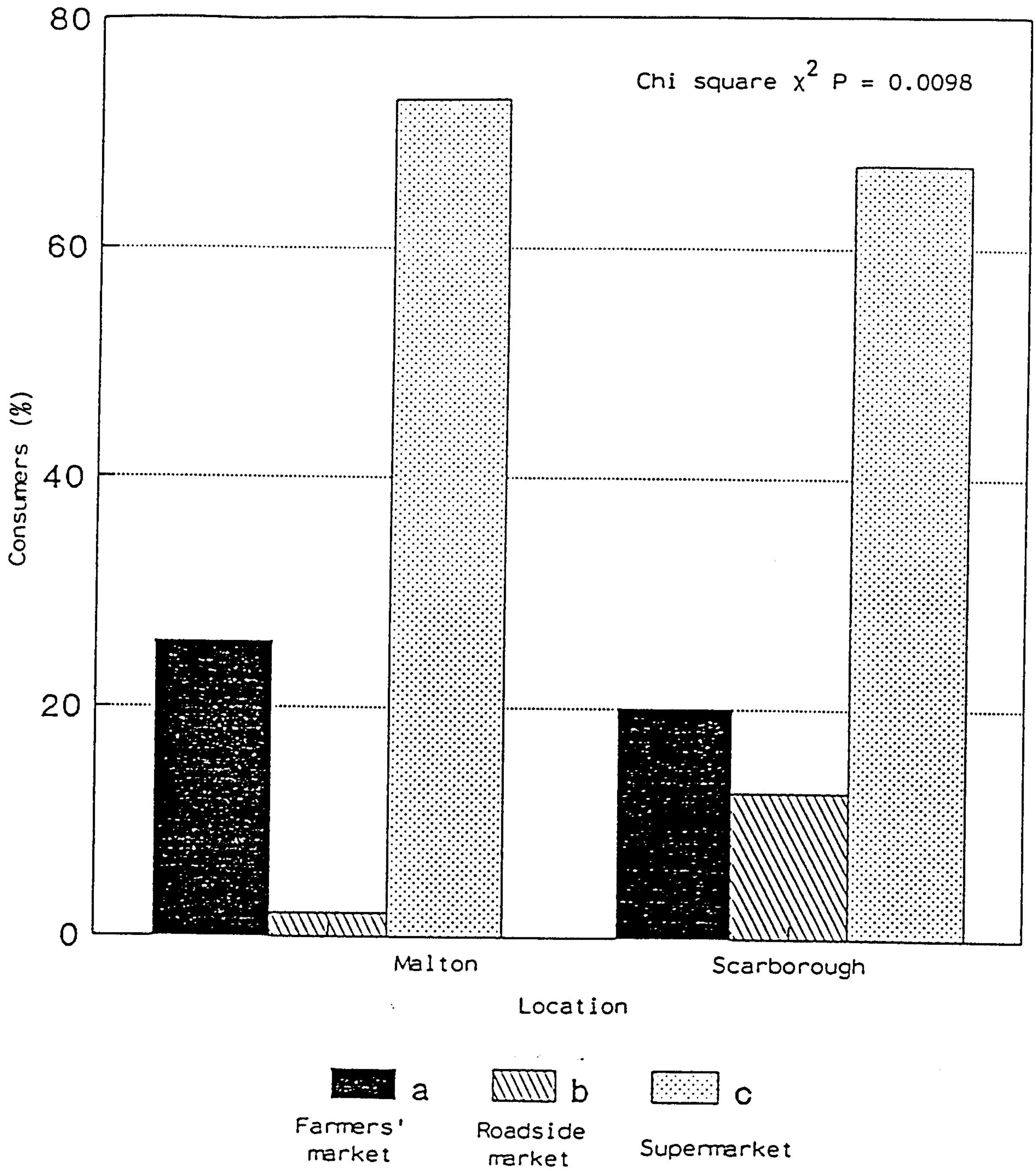
The quantity of hot peppers actually purchased weekly at retail outlets was also asked of the consumer. Consumers in all retail outlets preferred to buy hot peppers in small quantities. Thus significantly more consumers ($P < .05$) made 0.5–1kg hot pepper purchases compared to the other weight categories shown in Figure 3.

Data were analysed to examine the effect of consumer income levels on preference according to retail outlet. In each retail outlet the majority of consumers were from the low-middle income category (Table 1). Here supermarket consumers were significantly ($P < 0.05$) more than roadside and farmers' market consumers respectively (Table 1). More ($P < 0.05$) hot pepper consumers in middle-income categories frequented roadside than farmers' or supermarket retail outlets respectively (Table 1). Although only 7.9 per cent of supermarket consumers were from middle-high income categories, this was still significantly higher ($P < 0.05$) compared to consumers from the other two outlets (Table 1).

Consumer shopping practices

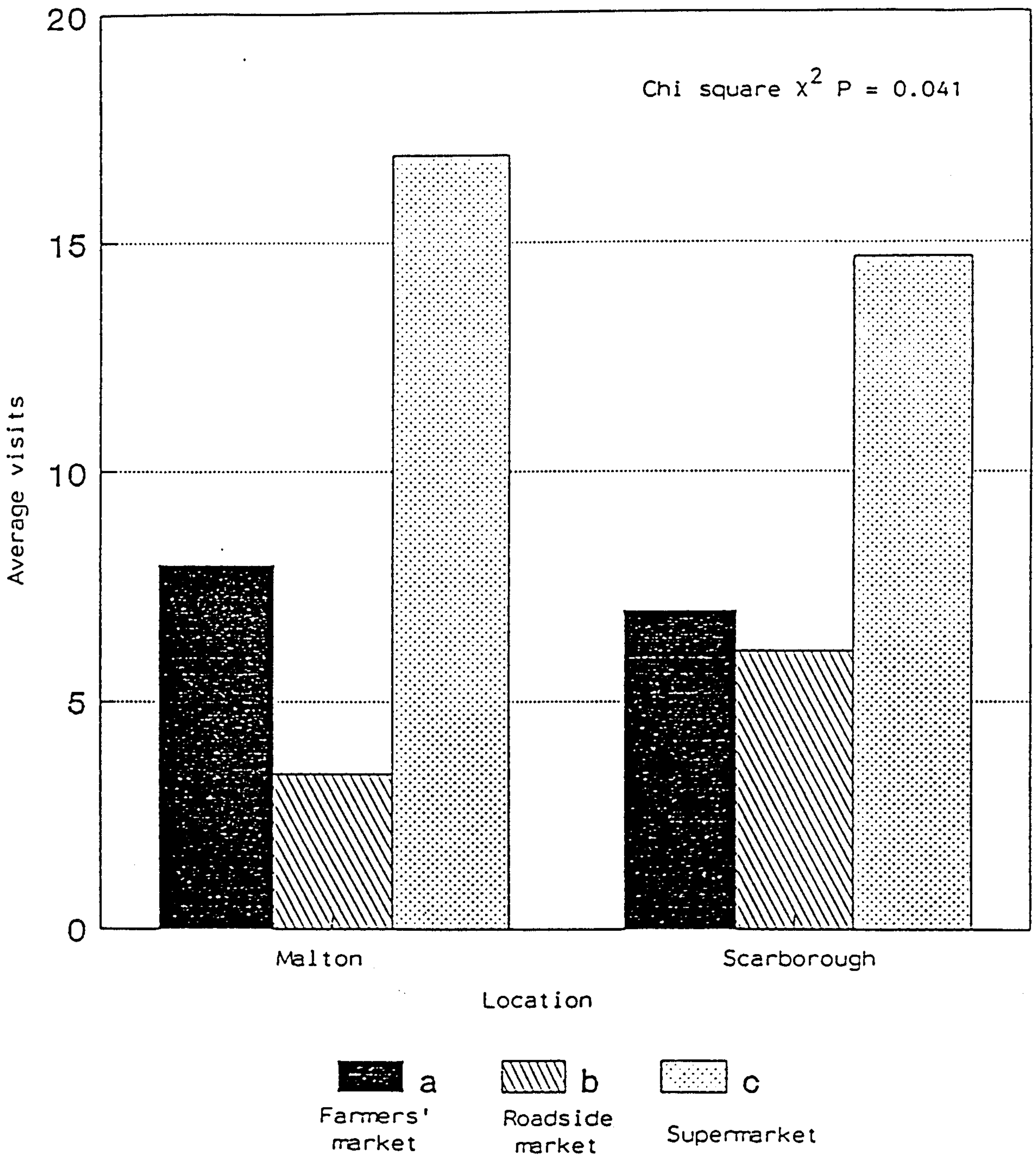
Tables 2, 3 and 4 indicate the reasons consumers gave for purchasing hot peppers at farmers', roadside and supermarkets

FIGURE 1



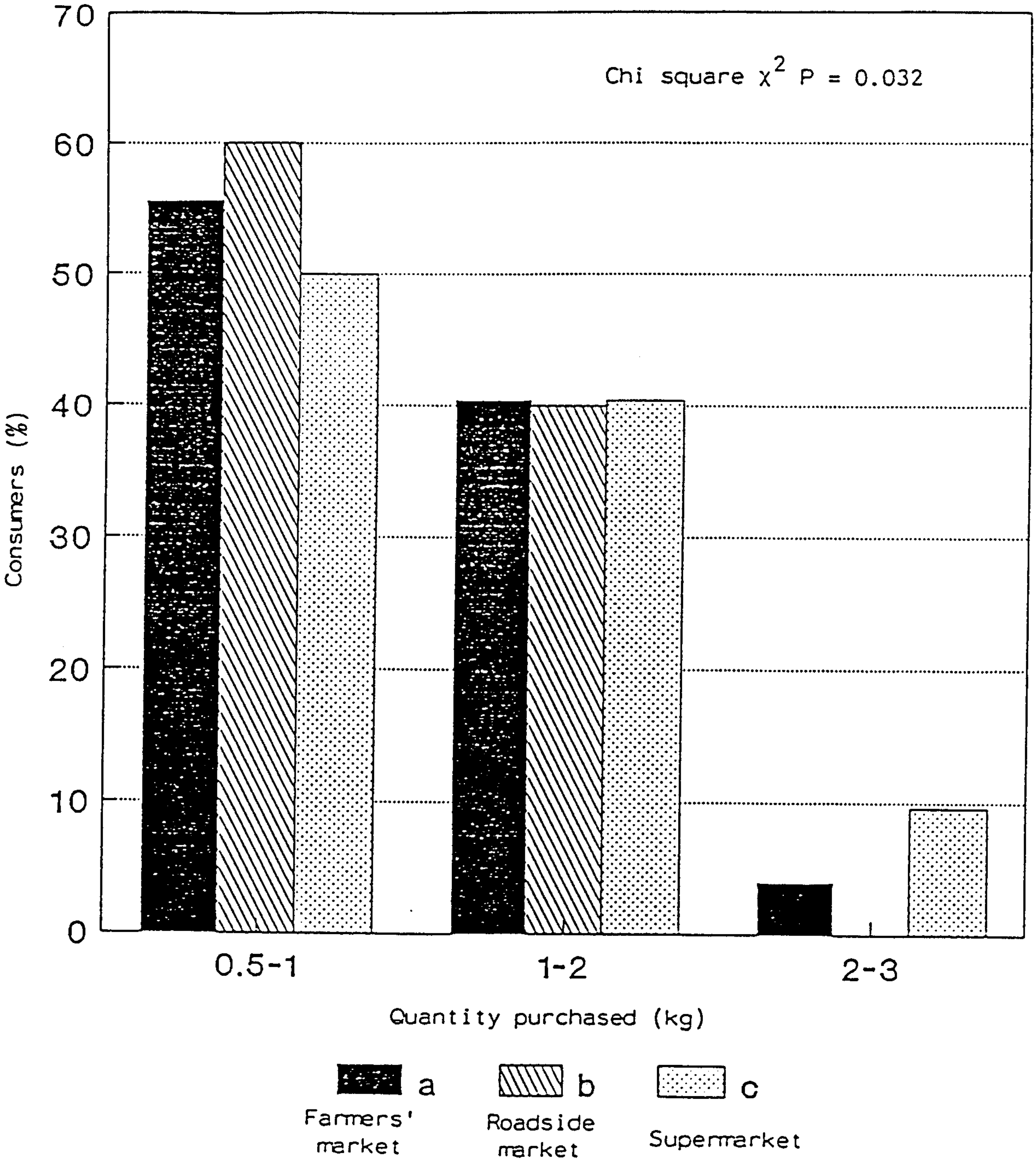
Percentage hot pepper consumers with purchasing preferences according to retail market outlets in Toronto, Canada, 1989

FIGURE 2



Average number of visits by consumers to purchase hot peppers at retail according to location in Toronto, Canada, 1989

FIGURE 3



Percentage consumers with weekly purchases of hot peppers at retail outlets in Toronto, Canada, 1989

Table 1 Income of consumers by type of retail market outlet in Toronto, Canada, 1989

Income per annum (Can. $)	Consumers (%)*		
	Farmers' market	Roadside market	Supermarket
Low - less than 15,000	15.7	11.6	9.8
Low - Middle 15,000 - 30,000	45.4	39.1	56.0
Middle 30,000 - 45,000	9.2	28.1	18.6
Middle - High 45,000 - 60,000	1.8	1.1	7.9
Refused to answer	28.4	20.1	7.7

*Chi-square x^2 = 13.73, d.f. = 6, significant at 0.05 level

Table 2 Important reasons given by consumers for preference to purchase hot peppers at farmers' market by location category in Toronto, Canada, 1989*

Reasons	Consumers in farmers' market (%)**	
	Hot peppers	
	Malton	Scarborough
Convenience	66.1	72.4
Freshness	60.2	55.4
Quality	44.4	40.2
Price	24.6	31.9
Sorting and grading	10.4	15.7
Appearance	22.9	22.0
Packaging	27.1	23.9
Attractive display	29.9	33.9
Friendly atmosphere	37.4	44.1
Clean environment	33.2	40.4
Flexible shopping hours	17.6	14.4
Do own selection	33.9	39.1

* Percentages sum up to more than 100% due to multiple reasons given by consumer
**Chi-square X^2 = 20.97, d.f. = 11, significant at 0.05 level.

Table 3 Important reasons given by consumers for preference to purchase hot peppers at roadside market by location category in Toronto, Canada, 1989*

Reasons	Consumers in roadside market (%)** Hot peppers	
	Malton	Scarborough
Convenience	44.9	51.1
Freshness	40.4	37.2
Quality	51.1	56.1
Price	60.1	72.2
Sorting and grading	30.6	27.1
Appearance	27.7	22.2
Packaging	10.7	12.3
Attractive display	11.7	14.3
Friendly atmosphere	27.7	31.6
Clean environment	33.9	36.4
Flexible hours	37.1	30.2
Do own selection	41.1	40.0

*Percentages sum up to more than 100% due to multiple reasons given by consumers
**Chi-square $X^2 = 21.10$, d.f. = 11

Table 4 Important reasons given by consumers for preference to purchase hot peppers at supermarkets by location category in Toronto, Canada, 1989*

Reasons	Consumers in supermarkets (%)** Hot peppers	
	Malton	Scarborough
Convenience	77.6	79.2
Freshness	60.1	67.3
Quality	48.1	52.1
Price	37.1	40.1
Sorting and Grading	55.6	61.2
Appearance	22.1	30.0
Packaging	40.1	37.7
Attractive display	42.1	42.0
Friendly atmosphere	55.6	51.2
Clean environment	67.1	77.1
Flexible hours	30.1	28.4
Do own selection	10.4	11.9

*Percentages sum up to more than 100% due to multiple reasons given by consumers
**Chi-square $X^2 = 22.01$, d.f. = 11, significant at 0.05 level.

retail outlets at the two locations in Toronto. For farmers' market consumers in Malton and Scarborough, convenience and freshness were given priority to quality (Table 2). In the case of roadside markets in both locations, price, quality and convenience were the three most important reasons (Table 3). However, more roadside market consumers gave these reasons from the Scarborough as against the Malton location (Table 3). Noticeable differences in reasons for hot pepper purchases were apparent among supermarket consumers; for example while most selected convenience, the second most important reason was clean environment from consumers in both Malton and Scarborough (Table 4). More supermarket hot pepper consumers from Malton indicated that apart from the two reasons outlined above, freshness, sorting and grading or friendly atmosphere were also important (Table 4).

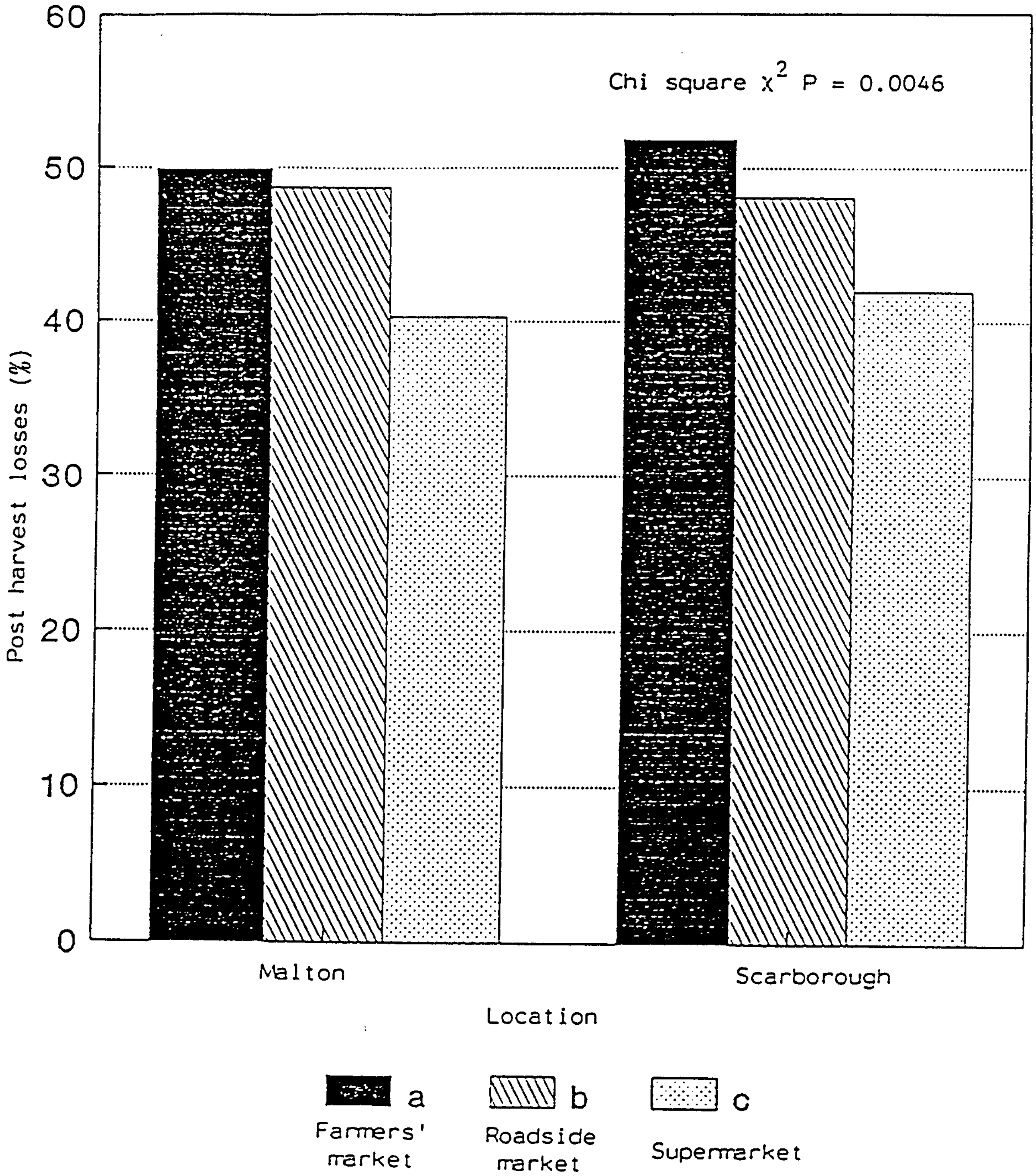
Types of post-harvest damage

Post-harvest losses on a weekly basis experienced by consumers in Malton and Scarborough were significantly lower ($P < 0.01$) from supermarkets compared to either of the other two retail outlets. (Figure 4). However, the nature of the losses accounted for bruising as the major type of damage at each retail outlet. This was obtained from evaluations made by interviewer and consumer (Tables 5, 6 and 7). Both assessments also showed that bruising was significantly lower ($P < 0.01$) at supermarkets than farmers' or roadside markets (Tables 5 and 6). Shrivelling and softening were also significantly lower ($P < 0.01$) at supermarkets compared to the other two retail outlets indicated for both assessments in Tables 5 and 6. Heat and chilling injuries were evaluated differently by interviewer and consumer. Consumers in roadside and farmers' markets detected no symptoms of chilling injury but 17.6 per cent reported this from their shopping experience at supermarkets (Table 6). Interviewer assessment of chilling injury at supermarkets was significantly higher ($P < 0.01$) than that reported by consumers (Tables 5 and 6). Interviewer assessment of heat injury was consistently higher at all three retail outlets than consumer assessment (Tables 5 and 6). Both assessments indicated decay to be significantly less at supermarkets than either of the other two retail outlets (Tables 5 and 6). When consumers were questioned as to what they perceived could be done to minimize damage of hot peppers displayed at retail outlets, the majority of farmers and roadside market respondents claimed better sorted and graded produce (Table 7). Educating buyers and sellers were regarded more highly by farmers' and supermarket consumers than roadside market consumers. Better care in handling was a notable solution among 75 per cent of all consumers (Table 7). Consumers were very sensitive to the use of more chemical sprays as no one interviewed felt this was a useful solution. More ($P < 0.05$) farmers' market consumers felt that washing dirt and mud from fruits could reduce post-harvest damages and losses compared to those from the other outlets (Table 7). More refrigerated displays were considered by a higher ($P < 0.05$) percentage of consumers frequenting roadside and farmers' markets than supermarkets (Table 7). Significantly more ($P < 0.05$) respondents interviewed from roadside markets attributed less exposure to sun and rain as a solution to minimize damage compared to farmers' or supermarket respondents (Table 7).

All consumers interviewed at supermarkets indicated that post-harvest damage mattered a great deal (Table 8).

At each retail outlet as income levels increased, the percentage of consumers indicating their willingness to pay higher prices for better quality produce increased as well (Table 9). At each income level more supermarket consumers ($P < 0.05$) responded positively on the suggestion to pay higher prices if confronted with better quality produce than farmers' or roadside market consumers (Table 9).

FIGURE 4



Per cent post harvest losses sustained by consumers based on weekly purchases of hot peppers at retail outlets in Toronto, Canada, 1989

Table 5 Types of post-harvest damages (%) of hot peppers evaluated by interviewer during display at retail outlets in Toronto, Canada, 1989*

Types of post-harvest damages	Post-harvest damage (%)**		
	Farmers' market	Roadside market	Supermarket
Bruising	55.1	66.4	41.6
Cracking	10.9	21.2	10.4
Softening	40.4	44.6	26.1
Over ripe	10.4	15.9	11.6
Immature	35.6	39.9	30.0
Shrivelling	49.9	56.6	39.9
Out of shape	19.9	29.6	20.4
Chilling injury	6.6	4.7	27.0
Heat injury	21.0	23.7	19.7
Decay	34.4	39.1	20.0

*Total percentages adds up to more than 100% because individual fruits have multiple types of damages
**Chi-square X^2 = 39.91, d.f. = 18, significant at 0.01 level.

Table 6 Evaluation of post-harvest damages as perceived by consumers (%) for hot peppers from purchases at retail outlets in Toronto, Canada, 1989*

Types of post-harvest damage	Consumers (%)**		
	Farmers' market	Roadside market	Supermarket
Bruising	64.1	60.6	50.4
Cracking	10.2	20.1	10.0
Softening	37.0	55.1	26.6
Over ripe	0.0	0.0	4.5
Immature	17.2	21.1	20.6
Shrivelling	48.6	52.3	40.1
Out of shape	0.0	10.4	0.0
Chilling injury	0.0	0.0	17.6
Heat injury	2.1	1.0	0.0
Decay	40.0	35.1	19.4
Don't know	0.0	6.0	9.0

*Total percentages adds up to more than 100% because individual fruits have multiple types of damages

**Chi-square $X^2 = 36.42$, d.f. = 18, significant at 0.01 level.

Consumers' quality perceptions

Consumers at all retail outlets, ranked heat or pungency as the most important quality factor when purchasing hot peppers (Table 10). Apart from hotness or pungency, farmers' market consumers looked for shelf-life, flavour and quality as the next set of most important quality factors. Roadside market consumers pointed out colour, shelf-life and absence of blemishes, while supermarket consumers suggested flavour, shelf-life and colour (Table 10). Lowest rankings were ascribed to nutritional value by farmers' market consumers. Variety of produce had the lowest rank by roadside and supermarket retailers (Table 10).

Consumers were asked to rate the quality of hot peppers displayed and purchased at retail outlets. More supermarket consumers from both locations rated hot pepper quality as good compared to those shopping at farmers' or roadside markets (Table 11). A similar finding was recorded for farmers versus roadside market consumers (Table 11). Hot pepper quality rated as fair was reported by more consumers shopping at roadside compared to either farmers or supermarkets outlets respectively (Table 11).

Table 6 Evaluation of post-harvest damages as perceived by consumers (%) for hot peppers from purchases at retail outlets in Toronto, Canada, 1989*

Types of post-harvest damages	Consumers (%)**		
	Farmers' market	Roadside market	Supermarket
Bruising	64.1	60.6	50.4
Cracking	10.2	20.1	10.0
Softening	37.0	55.1	26.6
Over-ripe	0.0	0.0	4.5
Immature	17.2	21.1	20.6
Shrivelling	48.6	52.3	40.1
Out of shape	0.0	10.4	0.0
Chilling injury	0.0	0.0	17.6
Heat injury	2.1	1.0	0.0
Decay	40.0	35.1	19.4
Don't know	0.0	6.0	9.0

*Total percentages adds up to more than 100% because individual fruits have multiple types of damages

**Chi-square X^2 = 36.42, d.f. = 18, significant at 0.01 level.

Table 7 Consumers (%) perceptions of post-harvest practices that could reduce damage for hot peppers in retail outlets in Toronto, Canada, 1989*

Types of post-harvest damage	Consumers (%)**		
	Farmers' market	Roadside market	Supermarket
Improved sorting and grading	89.6	90.7	48.6
Less exposure to sun and rain	17.4	60.2	0.0
More refrigerated displays	66.4	67.2	46.0
Better care in handling	75.2	77.4	75.9
Washing dirt and mud	60.4	44.3	38.1
More chemical sprays	0.0	0.0	0.0
Educating buyers and sellers	90.2	76.2	88.4
All of the above	60.0	71.0	64.3

*Percentage sum up to more than 100% due to multiple answers given by consumers
**Chi-square X2 = 25.68, d.f. = 14, significant at 0.05 level.

Table 8 Consumers' response (%) to the degree of importance of post-harvest damage sustained at retail outlets in Toronto, Canada, 1989

Types of retail outlets	Consumers (%)			
	Does not matter	Hardly matters	Matters somewhat	Matters a great deal
Farmers' market	0.0	1.0	7.7	91.3
Roadside market	0.0	1.0	9.4	89.6
Supermarket	0.0	0.0	0.0	100.0

Table 9 Percentage consumers in retail outlets in Toronto, Canada, 1989, wishing to pay higher prices for better quality hot peppers by income level

Income per annum (Can. $)	Consumer (%)					
	Farmers'* market		Roadside** market		Supermarket***	
	Yes	No	Yes	No	Yes	No
Low - less than 15,000	44.0	56.0	66.6	33.4	80.0	20.0
Low - Middle 15,000 - 30,000	60.0	40.0	72.2	27.8	86.1	13.9
Middle 20,000 - 45,000	77.6	22.4	75.0	25.0	100.0	0.0
Middle - High 45,000 - 60,000	70.9	29.1	76.0	24.0	98.0	2.0

*Chi-Square X^2 = 10.71, d.f. = 3, significant at 0.05 level
**Chi-Square X^2 = 10.92, d.f. = 3, significant at 0.05 level
***Chi-Square X^2 = 10.63, d.f. = 3, significant at 0.05 level

Table 10 Quality factors consumers look for when purchasing hot peppers at retail outlets in Toronto, Canada*

Quality Factors	Hot pepper consumers (%)					
	Farmers	Rank**	Roadside	Rank	Supermarket	Rank
Colour	70.1	4	85.5	2	70.1	4
Shape	44.3	9	44.2	9	31.1	10
Size	65.7	5	51.1	8	41.1	9
Hotness/Pungency	92.1	1	90.0	1	89.6	1
Flavour	75.6	3	70.1	6	80.4	2
Variety	40.1	10	25.6	11	26.1	11
Nutritional value	30.1	11	37.3	10	47.6	8
Pesticide residue	60.4	7	60.2	7	61.1	6
Absence of blemishes	51.4	8	77.2	4	55.4	7
Shelf Life	84.1	2	80.1	3	77.3	3
Firmness	62.9	6	71.1	5	66.1	5

*Percentages sum up to more than 100% due to multiple reasons given by consumers
**Ranking scale 1-11: 1 = most important, 11 = least important

Table 11 How consumers (%) in different locations rate the quality of hot peppers purchased at retail outlets in Toronto, Canada, 1989

Retail outlets and quality ratings	Hot pepper consumers (%)	
	Malton	Scarborough
Farmers' market*		
Excellent	0.0	0.0
Good	42.1	36.9
Fair	20.8	31.6
Poor	27.1	31.5
Roadside market**		
Excellent	0.0	0.0
Good	31.1	28.8
Fair	41.2	47.7
Poor	27.0	23.5
Supermarket***		
Excellent	2.5	3.1
Good	75.6	74.9
Fair	6.3	8.8
Poor	15.6	13.2

*Chi-square X2 = 8.10, d.f. = 3, significant at 0.05 level

**Chi-square X2 = 9.21, d.f. = 3, significant at 0.05 level

***Chi-square X2 = 10.21, d.f. = 3, significant at 0.05 level

Discussion

In previous consumer preference studies Jack and Blackburn (1984), Eastwood *et al.* (1986),Brooker *et al.* (1987), Kezis *et al.* (1984), Lockeretz (1986), Beattie *et al.* (1983) and Buitenbuys *et al.* (1986) indicated that quality was the most important criterion considered by a produce buyer. In this survey, hot pepper quality was not similarly prioritized at any of the three retail outlets at either location in Toronto, Canada (Tables 2, 3, 4). Two major conclusions could be drawn from this. Firstly, consistent supply of sub-standard quality hot peppers upon arrival at terminal markets in Canada from Trinidad & Tobago apparently encouraged consumers to look for quality factors which are more intrinsic than extrinsic in nature. Consumers felt hotness or pungency, flavour and inherent shelf-life as more critical factors than those attributes of extrinsic importance such as size, shape, colour or firmness, etc. (Table 10). The demand for Trinidad & Tobago hot peppers at Canadian retail outlets is a reflection of the belief that they are more pungent compared to those obtained from other sources. (Stewart 1988).

Secondly and also related to the first explanation was the fact that the majority of consumers interviewed were from the same ethnic origin comprising mainly Caribbean and Asian immigrants. Cook's (1990) examination of the impact of the growth of ethnic population on product diversity within the produce department of foreign retail outlets suggests unique challenges to growers, exporters and retailers, with particular reference to post-harvest requirements relating to packaging, temperature, storage and handling requirements. Ethnicity, in the context of consumer demand was also elaborated by Joy (1987) who discussed the strong affinity ethnic groups have for their traditional foods and their tendency to look first to their countries of origin to fulfil their needs.

Nutritive value, as an intrinsic quality factor however, was selected by less than 50 per cent of the consumers in each retail outlet and therefore given a lower ranking compared to other intrinsic quality factors (Table 10). While this is probably because nutritive value is often generalized as a hidden quality factor (Arthey, 1975; Jen, 1989) it may also be an overall deficiency in information resulting in a lack of consumer awareness of hot pepper nutritive values.

Despite the sacrifice consumers showed for specific intrinsic at the expense of extrinsic quality factors, it was obvious from the data presented in Table 8 across all retail outlets that post-harvest losses mattered a great deal. These findings justified the claims made in Table 10 on shelf-life as an integral aspect of consumerism and its overall ranking within the first three reasons outlined in Table 10 confirmed this. Awareness among growers and exporters at the supply end and brokers and retailers at the receiving end of the export marketing system could cause consumer demand for these three quality characteristics to result in mutual economic benefits to both sides. To achieve this the following recommendations are necessary.

Growers and exporters will have to access cultivars with high pungency, flavour and shelf-life. Thus breeding programmes should focus more on these quality criteria than just appearance, shape and firmness. Efforts to investigate whether post-harvest handling and treatment will influence changes in pungency, flavour and shelf-life taking into consideration the duration, time and conditions from harvest to overseas retailing should be investigated. Post-harvest techniques to enhance quality of hot peppers, e.g. modified atmosphere storage, effects of post-harvest dips to control pathogen and improve membrane integrity should be researched. In other studies, Henneberry and Willoughby (1989) agreed that post-harvest investigations relevant to consumer quality perceptions such as shelf-life ought to be conducted in relation to varietal selection and breeding (Sarris 1984; Carter and Nuckton, 1987) and post-harvest experimentations (Ruyan *et al.*,1986).

Consumer purchasing habits and behaviour varied more between retail outlets than location. Exporters therefore needed to target retail outlets that catered to the needs of their consumers and which in turn is most attractive in encouraging consumers to make repeat purchases (Hopkins and Bailey, 1970). Supermarket outlets in both locations were most successful in achieving this. They secured the highest number of consumer visits per week (Figure 2), with the most preference for shopping there (Figure 4) and attracted the greatest percentage of consumers belonging to the higher income brackets who were willing to pay more for better quality produce (Table 9). Such information on consumer preferences and buying habits is vital to all involved in decision-making strategies for export and import trading activities. Hot pepper exporters could increase their profit margins by trying to penetrate more supermarket outlets. Supermarket retail outlets, on the other hand, could utilize low-cost post-harvest technology inputs to enhance quality requirements in order to increase the flow of consumers as well as their purchasing power.

Approaches supermarket retail outlets undertook to attain the level of success outlined above included:

- Implementation of a sorting and grading system.
- Utilization of refrigerated display at all times and subsequent monitoring of temperatures and, relative humidity to maintain fresh appearance of produce.
- Prepacking in small consumer units such as 0.5–1kg bags in preference to larger units.
- Providing a clean shopping environment
- Friendly atmosphere.

The outcome of the above accounted for the greater frequency of visits and preference to supermarkets versus other retail outlets (Figures 2 and 4). Analysis of the data supported these claims further since a significantly higher percentage of supermarket as against roadside or farmers' market consumers had the following favourable attributes: display of better quality produce (Table 11); the lowest level of post-harvest losses (Figure 4); the lowest level of bruising which was identified by consumers and interviewers respectively as the major type of damage with a potential for causing losses (Tables 5 and 6) and the lowest level of damage pertaining to other quality attributes such as softening and decay (Tables 5 and 6).

Furthermore, supermarket retailers were able to supplement the above with the implementation of other consumer services which were used as a competitive strategy similar to those outlined in studies reported by Peters and Waterman (1982), Heskett (1987) and Prince *et al.* (1990). Services relative to the maintenance of product quality were product availability throughout the seasons, product discounts on special days of the week, advertising and coupons for product discounts.

Pesticide residues on produce was not interpreted as a factor relating to quality enhancement by consumers. Up to 61 per cent of consumers in each retail outlet considered pesticide residues as detrimental to produce quality, and although ranked sixth or seventh in Table 10, there was ample evidence in Table 7 to support McCracken *et al.* (1989), Henneberry *et al.* (1989), Blane (1990), Cook (1990), Armbruster (1990), Preston and McGuirk (1990) and Muller *et al.* (1991) about consumers safety concerns associated with chemicals and pesticide residues in foods. The likely effect of this on the demand for government intervention to regulate pesticide content in vegetables with the potential of significantly shifting comparative advantages were also discussed (Gahr, 1988). The future expansion of export trade in fresh hot peppers could be jeopardized if local producers and exporters fail to minimize the use of pesticides to control the more recent experiences in Trinidad & Tobago with thrips and mites infestations that resulted in drastically reduced yields (Jones, 1988). Alternatives such as biological control or organic farming as well as biotechnology products would therefore have to be given priority in research and development programmes (Greene and Zepp, 1989). Already, according to Armbruster (1990) biopesticide and genetically engineered pest-resistant fruit and vegetable varieties of other crops are currently under development.

Grades and standards appeared to be critical solutions to alleviate post-harvest damage to farmers and roadside market consumers rather than supermarket consumers (Table 7). Less refrigerated displays and the need for improved product sanitation contributed to these differences (Table 7). It could also explain the differences in consumer choice to shop at these outlets (Figure 1) as well as the low percentages of consumers opting for sorted and graded produce as reasons for shopping at farmers and roadside markets versus supermarkets (Tables 2, 3 and 4). Sorted and graded produce ought to reflect consumer-desired quality characteristics (Armbruster, 1990) but the data analysed in Table 10 showed that the combination of quality attributes in hot peppers was viewed differently by consumers in the three retail outlets. This raises the question according to Moulton (1989) of the adequacy of grades to foster competition and meet consumer needs.

The emergence of clearly defined types and contrasting consumer retail outlets in this survey appear to co-exist in both locations in Toronto, Canada. These represent the quality-conscious consumer who is demanding high quality produce commensurate with changes in income levels (Table 9) and the value-conscious consumer who is looking for price and quality (Table 3). However, two major yet seemingly divergent consumer trends, convenience-seeking and the link between intrinsic consumer-desired qualities and health and safety concerns will require an integrated approach in food marketing and post-harvest technology. Understanding consumers will be a critical factor in integrating both in an effort to develop efficient target market approaches. This, according to Cook (1990) would require extensive data collection of consumer preferences and purchasing behaviour in a properly co-ordinated information management system.

In order for exporters to tap fully the potential for increased consumption of hot peppers in Canadian retail outlets, the emphasis must be on pungent cultivars with consistent quality levels to achieve maximum shelf-life and retention of flavour components for both quality-conscious and value-conscious customers. Matching post-harvest techniques with the needs of consumers at each retail outlet and developing more innovative and aggressive merchandising strategies would have positive results.

References

Armbruster W J. 1990. Fresh product quality, food safety and environmental concerns, J. Food Distribution Res. 11(1):75–83

Arthey V D. 1975. Quality of horticultural products. London: Butterworth Press, 288pp.

Beattie B B, Kavanagh E E, McGlasson W B, Adams K H, Smith E F and Best D J. 1983. Fresh market tomatoes: a study of consumer attitudes and quality of fruit offered for sale in Sydney 1981-1982, Food Tech in Australia, 35(10):450454

Blaine M S. 1990. The changing consumer environment for food service - restaurants, J. Food Distri. Res. 21(1):63–74

Brooker J R. 1985. An assessment of the structure of fruit and vegetable marketing in Tennessee, Res. Rpt. 85-04. Agr. Expt. Station, U. of Tennessee, Knoxville, 37pp.

Brooker J R, Eastwood D B and Orr R H. 1987. Consumers' perception of locally grown product retail outlets. J. Food Distr. Res. 19(3):99–107

Buitenhuy N C, Kezis A S and Kerr HW. 1983. Consumer purchasing habits, acceptance and preferences, for direct marketed small farms horticultural commodities in Maine, Expt. Station Bull. 797, Maine Agri. Expt. Station, U. of Maine, Orono, 21pp.

Carter H O and Nuckton CF. 1987. Marketing California's speciality crops: worldwide competition and constraints, Agricultural Issues Centre, University of California, Davis, 1987

Cook R L. 1990. Evolving vegetable trading relationships: The case of Mexico and California, *J.* Food Distr. Res. 21(1):31–45

Eastwood D B, Orr R H and Brooker J R. 1986. Consumer stated preference for fresh fruits and vegetables, U. of Tennessee Agri. Expt. Stat. Res. Rep. 86-96 46pp.

Fletcher S M, McWatters K H, Anna V A.and Resurreccion V A. 1990. Analysis of consumer attitudes toward new fried food prepared from cowpea flour, J. Food Distr. Res. 21(2):75–83

Gahr W. 1988. Food safety and quality: A research agenda for competing in the world marketplace in: (eds. Clancy, K.L.) Consumer demands in the marketplace: Public policies related to food safety, quality and human health, Washington DC: Resources for the Future, 215–228

Garvan D A. 1983. Quality on the line, Harvard Business Rev. 61:65–73

Greene, C. and Zepp, G. (1989) Changing pesticide regulations: A promise of safer produce, *National Food Rev.* 12 (3) 12-16

Henneberry S R and Willoughby C V. 1989. Marketing inefficiencies in Oklahoma's produce industry: Grower and buyer perceptions, J. Food Distr. Res. 20 (2):97–109

Heskett J L. 1987. Lessons in the private sector, Harvard Business Rev. 65(2):118–126

Hopkins D S and Bailey E L. 1970. Customer service: A progress report, New York: The Conference Board.

Jack R L and Blackburn K L. 1985. Effect of place of residence on consumer attitudes concerning fresh produce marketed through direct farm markets in West Virginia, West Virginia University Agricultural and Forestry Experiment Station. Bull. 685 36pp.

Jen J J. 1989. Chemical basis of quality factors in fruits and vegetables: An overview In: Jen, J J (ed) Quality factors of fruits and vegetables chemisitry and technology, American Chemical Society, 1–12

Jones M. 1988. Post-harvest pests affecting quality of hot peppers. Proc. seminar on Post-harvest Handling of Hot Peppers, Inter-American Institute for Co-operation on Agriculture Technical Events Series, ISSN 0253-4747 pp. 32-35

Kezis A S, King F R, Toensmeyer U C, Jack R and Kerr H W. 1984. Consumer acceptance and preference for direct marketing in the Northeast, J. Food Distr. Res. 38–46

LaLonde B J. 1985. Customer service, In: Robeson J F (ed) The Distribution handbook, National Council for Physical Distr. Mqt. New York: The Free Press pp. 235-256

LaLonde B J, Cooper M C and Noordewier T G. 1988. Customer service: A management perspective Oak Brook, Illinois: Council of Logistics Mqt.

Lockeretz W. 1986. Urban consumers' attitudes towards locally grown produce, Amer. J. of Alternative Agri. 1(2):83–88

McCrackeren V A and Marotz C C. 1989. Consumer potato demand. J. Food Distr. Res. 1–13

Moulton K S. 1989. Issues in the marketing of fruits, vegetables and free nuts, Amer. Agr. Law Assoc. Conv. Hdbk. 19 pp. 1–12

Muller H R, Byrne P J and Toensmeyer U C. 1991. Consumer opinions concerning fresh produce for Eastern Shore Countries, Maryland and Virginia, J. Food Distr. Res. 22(1):120–121

Peters J T and Waterman W H. 1982. In search of excellence, New York: Harper and Row.

Preston W P and McGuirk A M. 1990. Food safety risks and consumer behaviour, J. Food Distr. Res. 79–85

Prince T L, Tayama H K and Grabner J R. 1990. Supplier services and their importance to floral retailers in the Midwestern United States, HortScience 25(3):356–358

Runyan J L. 1986. Determining commercial marketing andproduct opportunities for small farm vegetable growers, USDA Res. Rpt. No. 1146, AMS , Washington, DC 10pp.

Sarris A H. 1984. World trade in fruits and vegetables: Projections for an enlarged European Community, USDA.Economic Res. Serv. Foreign Agr. Econ. Rep. 202 Washington, DC : USDA

Stewart V. 1988. Export potential of hot peppers In: eds. Rafael R E and Mohammed M (eds) Proc. seminar on Post-harvest Handling of Hot Peppers, The Farmers' Training Centre, Centeno, Trinidad, pp. 89-95

Trinidad & Tobago Export Development Corporation. 1991. First quarterly report January–March 1991; Overseas Trade Newsletter.

ORNAMENTAL HORTICULTURE IN COSTA RICA

J Gamboa
IICA, Costa Rica

The activities of ornamental horticulture in Costa Rica are important as part of the export drive for new traditional products, both as a source of diversification for the country and for the generation of employment. It is a relatively recent activity in the country but in the last few years has improved rapidly with the support of private entrepreneurs, the government, international organizations and universities.

Ornamental horticulture as an export activity began around 1973 with several small entrepreneurs. It received a notable boost at the end of 1984 as can be seen from Table 1.

Table 1 Area(ha) cultivated with ornamentals in Costa Rica in 1984 and 1990

	1984	1990
Ornamental fruits	900	3,500
Cut foliage	84	600
Traditional flowers	45	150
Tropical flowers	0	150
Total	1,029	4,350

Similarly the exports have been increasing annually as shown in Table 2

Table 2 Exports of ornamentals in Costa Rica (in millions of Colones)

	1986	1990
Ornamental plants	13.1	27.2
Flowers	5.8	11.9
Foliage	4.9	19.2

The ornamentals that are cultivated in Costa Rica can be divided into four groups (based on conditions of cultivation, market and post-harvest management) namely:

- Ornamental plants
- Traditional flowers
- Cut foliage
- Tropical flowers

Ornamental plants

In this group are placed the plants which are cultivated and offered to the consumers in 'pots' and can last for several months.

A great variety of these are cultivated in Costa Rica and used mainly as plants for interior decoration. The major percentage of the cultivated plants are dracaenas namely: *Dracaena fragrans* (cv. Massangeana; cana india) *Dracaena marginata*, Yucca elephantipes (para cana), *Dracaena deremensis* (cvs Jannet Craig, Warneckii), *Dracaena sanderiana*, *D. godseffiana*, Aglaonema (vars. Silver Queen, Maria), *Dieffenbachia* spp., *Peperomia* sp., *Scindapsus aurens* (cvs. Golden Pothos, Marble Queen).

These plants are all tropical requiring temperatures between 18 and 30^{o}C. They tolerate high rainfall and need artificial shading for cultivation. In Costa Rica these are cultivated at altitudes ranging from 0 to 1200m.

Traditional flowers

In this group are included roses, carnations, chrysanthemums, gerberas and gypsophilas. These are cultivated under semi-transparent covers to protect them from heavy rains and high temperatures.

Generally they require night temperatures of 8–14°C and day temperatures of 20–25°C). They are grown in altitudes of 1,500 to 2,200m.

Cut foliage

Included here are the foliages that are used with the traditional flowers. At international level, the most widely used foliage is helecho hoja de cuerpo (*Rumhora adiantiformia*). For cultivation it requires artificial shade, a good supply of water, night temperatures from 12 to 16°C and day temperatures from 10 to 25°C. In Costa Rica it is cultivated between 1,000 and1,600m.

Tropical flowers

This group includes *Heliconia* spp.; *Alpinia purpurata* cvs. Red Ginger, Pink Ginger; *Musa* spp., etc.

These require high temperatures, rainfall and humidity. No shading is required. Well defined short dry periods are advantageous.

These flowers are used in arrangements with foliages such as *Dracaena* spp., *Cordyline* spp. *Pandamus* sp.and others. In Costa Rica they are cultivated in the low Atlantic zone up to 400m.

Commercialization

The sale of ornamentals from Costa Rica is directed to different markets as follows :

Product	Market		
	USA	Europe	Japan
Ornamental plants	x	x	x
Traditional flowers	x		
Cut flowers		x	
Tropical flowers	x		

Major use is made of the USA market partly due to geographic proximity and the low cost of freight. The Japanese market is far and produce is sent by sea.

The commercial system of ornamentals is very complex, but in general one can distinguish the following aspects:

- The supply to nurseries and florists is handled by 'brokers' or commission agents who operate in Europe and the United States of America. The nurseries are able to contact the broker who deal with Costa Rica and other countries and function as receivers and distributors.

- For the other part, in Costa Rica there are various levels of commercialization in ornamentals

  Exporters: companies which function like receivers and buy products from the farms to supply to the brokers.

  Producers/exporters producing and exporting their own production.

  Producers/exporters who also buy from other companies to make up orders.

  Producers: this group does not export; they are small producers who supply exporters and/or other companies.

Flowers are mass cultivated and consigned; prices are not fixed, and are set according to how best one can sell. In ornamental plants, public sales have fixed prices for buying and selling but frequently the seller adjusts prices to current selling demands.

In no case are sales automatic and generally require the backing of a good buyer.

Development of ornamentals in Costa Rica

Costa Rica has made ornamental horticulture an activity which is important to its economy for various reasons as follows

- Climatic conditions

  A very important characteristic is that Costa Rica, in spite of being a relatively small country has a wide range of climatic conditions. Altitudes vary from sea level to 3,800m which gives ample opportunity for a wide range of temperature.

On account of two systems rainfall: one with a definite dry period – 6 months of rain and 6 months without – and the other with rainfall lasting practically all year with only small defined periods of dryness.

Moreover, along with the previously noted factors, there are many diverse conditions of light and relative humidity. The combination of all these climatic conditions makes an ample variety of microclimatic conditions to which one can adapt a great many different ornamentals.

- Government incentives

  The government provides a series of incentives for the entrepreneurs who work with ornamentals, such as an export contract for 12 years, with exemption from taxes on some inputs, rent and certificates of tax duties (CAT).

- Ornamentals cultivated for export are included in the programme 'Incentives for the Caribbean Basin'.

- State institutes, the private sector and universities support this initiative with research and extension thus increasing knowledge of the products.

The outputs of this effort are described in several documents written on flowers: Cultivation of carnations, roses, chrysanthemums, gerbras, gypsophilas, *Dracaena deremensis*, agloanema, *Dracaena maroinata*; technical bulletins on flowers and ornamental plants; and scientific articles on research done.

Post-harvest management

In general, the post-harvest management allows many people to compete in a very exacting market. Good post-harvest management begins with a good system of production which gives a good product, that is less likely to suffer with defects from the system of production.

The differences in the amount of post-harvest management needed are quite large depending on the product, as well as on its perishability.

Research

I would like to mention some general aspects of the group of ornamentals, which I am researching.

Ornamental plants

Not very perishable – require partitioned rooms with temperatures between 15 and 18°C; do not tolerate exposure to sunlight or temperatures below 12°C and may suffer chill damage. They can be kept up to 8 days with good management without suffering deterioration.

Traditional flowers

This group includes the most perishable products, and they require careful post-harvest management. For example, roses are the most perishable of all. They have to be cut between 6 and 8am, put in water immediately, taken to the packing room for selection and packing, and rapid cooling. The ideal is that from cutting to reaching the consumer, not more than 24 hours should elapse. In general, these flowers are kept between and 1 and 3°C post harvest.

Traditional cut foliage

These products are less perishable. The ferns can last for 30 days from cutting to reaching the final consumer. Post harvest they are held at a temperature of 3°C.

Tropical flowers

These do not have a long post-harvest life. They last for a shorter time than carnations and chrysanthemums. They have the inconvenience that they are voluminous. They are held at temperatures of 15–18°C post harvest.

Costa Rica has made great advances in the cultivation of ornamentals. But still we would like many aspects to be resolved – problems of production, post-harvest management and markets. This would necessitate research and solid action of the producers in order to succeed. It is a complex business and requires great competence.

DISCUSSION SESSION V

I Kosto (CARDI, St Lucia):
Dr Marte: What was the type of soil? How did you determine that the problem was an excess of chlorine? It is possible that the problem could have been caused by any other micronutrient since Cl is very easy to flush out of the soil

R Marte (IICA, Trinidad & Tobago):
Four applications of fertilizer were to be applied. This didn't happen so the plant developed a stress factor resulting in a shortage of micronutrients. Chlorine analysis showed 5 per cent (2 per cent tolerance level). As a result some farmers destroyed their crops.

S Skeete (Ministry of Agriculture, Barbados):
I would like to make the following cmments:

I feel that the attitudes of the farmers were a serious problem. Farmers were willing to spend the whole day in the field if a consultant was present but not if the officer went visiting by himself.

There were not enough staff resources to monitor programmes

A number of national institutions are involved in transfer of technology. Since officers are involved in too many programmes, there should be some co-ordination between the institutions and the officers so that information transfer would be more efficient.

L Daisley (CARDI, Dominica):
Was the Ministry of Agriculture or CARDI involved in papaw production? Was any cost analysis carried out?

R Marte:
Actual involvement was with IICA and CATCO but the Ministry and CARDI were aware of the project.

Yes: I would go into papaw production.
Yes: Cost of production was carried out and itwas showed to be feasible.

F Proctor (NRI, UK):
Where will Barbados go now in terms of commercial papaw production?

R Marte:
The Government is involved in the initial stages of the projects. About 40 small farmers are interested in getting into papaw production.

A Malins (CARDI, Dominica):
Ms Mootoo: Did you test more than one type of film?

What type of bag did you use?

What is the next step in calcium chloride research?

A Mootoo (Ministry of Food Production, Trinidad & Tobago):
Bags were obtained locally. The film characteristics are best suited to the climatic situations. Work was done in calcium chloride on 'Buxton Spice' and 'Julie'. Results were poor on the Buxton Spice. Julie was promising in terms of fruit colour, and texture was firm. The techniques is however limited as a commercial practice.

A Mc Intyre (CARDI, Dominica):
How were the purple and red pigments accommodated in your experiment?

A Mootoo:
Pigment was not looked at - only pulp colouration.

E Harvey (Casse Consultants, Barbados):
Please give some more information on dips for mango. Is the use of 'Semperfresh' promising?

A Mootoo:
We found that in Long mango and Haden there was retarded colour development; results with Tommy Atkins were promising..

A Malins:
Semperfresh has been found to retard colouration in L ong mango. Fruits often soften without changing colour. There is no documented effect of Semperfresh.

D Constantine (Constantine Consultancy, UK):
Was the vase life of heliconia checked in water after the different treatments?

A. Mootoo:
No.

L Daisley:
Costa Rican farmers complain that Hawaii had lobbied to introduce a tax on flowers entering the United States. Did this lobbying work and what impact did it have on the Costa Ricans?

J Gamboa (IICA, Costa Rica):
Costa Ricans do not pay taxes on flowers.

There is an incentive reward given to farmers for perishables – 50 per cent to USA and 40 per cent to Europe)

L Daisley:
Are there some incentives in Trinidad?

Answer:
No: Only in cocoa, coffee and coconut are the farmers assisted.

D Constantine:
Mr Avey: What temperatures are you cooling your flowers at? Does the airway bill include the number of stems included in the shipment?

H Avey (Kairi, Trinidad & Tobago):
About 6°C. Packing rooms are at 70–72°F. One master carton contains 72–288 stems. These are not recorded on the airway bill.

A Medlicott (Fundacion Hondurena de Investigacion, Honduras):
Mr Mohammed: I found differences in the shelf-life in hot pepper from different islands. Have you noted any such differences?

M Mohammed (UWI, Trinidad & Tobago):
I only did work in Trinidad. However it could be as a result of cultivar and/or handling.

TECHNICAL SESSION VI

Chairman: Frances Chandler, *CARDI, Barbados*

Rapporteurs: Everard John, *Ministry of Agriculture, St Vincent & the Grenadines*
St Clair Williams, Ministry of Agriculture, Nevis

MANAGEMENT AND ORGANIZATION FOR THE EXPORT INDUSTRY: A CASE STUDY OF BANANAS IN THE WINDWARD ISLANDS

E D Reid
WINBAN Research and Development Division, St. Lucia

Forty years ago, the Banana industry in the Windward Islands was entirely different from what it is at present. The industry was fragmented with those islands then growing bananas having individual arrangements for the export of their fruit. Although, from the early 1950s, fruit was sold to a single company, the arrangement with each of the producing islands was separate and distinct.

Within each producing island, the need for a body to co-ordinate and collect production and provide support services to the banana farmers was recognized quite early. This led to the formation of private growers' associations, the Dominica Banana Association (1934), St Lucia Banana Association (1934), St Vincent Co-operative Banana Association (1934) and in Grenada, the Grenada Agriculturist Union provided this co-ordination. These bodies were reorganized on a number of occasions, firstly, to make them more accountable to their members and, secondly, to give the respective governments a formal role in their direction. Thus, the St Vincent Banana Growers' Association (SVBGA) came into being in 1953, the St. Lucia Banana Growers' Association (SLBGA) in 1954, the Grenada Banana Co-operative Society (GBCS) also in 1954, and the Dominica Banana Growers' Association (DBGA) in 1959. These have remained substantially the same since, with the exception of the DBGA which was relegated to a grower representative role, and a new institution, the Dominica Banana Marketing Corporation (DBMC) was formed in the mid 1980s to provide services and market bananas..

With the advent of Geest in the Windwards in 1953, as a producer, shipper and marketer of bananas, the market for Windward Islands bananas was 'solidified' in the UK, where the islands and other colonial states had preferential access.

Geest entered into agreement with all the growers' associations to purchase all export quality fruit produced. In 1956, the Windward Islands' governments met to discuss common problems relating to the banana industry. This led to the formation of the Windward Islands Banana Growers' Association (WINBAN) in 1958, an institution charged with the joint marketing of bananas from the islands and the provision of hurricane insurance coverage and technical services to banana farmers.

With the formation of WINBAN, Geest now needed to negotiate with one instead of four separate growers' associations. The contracts negotiated over the years reflected the Windward Islands' growing interest in the marketing of bananas; they were no longer contented to simply grow and supply bananas to Geest. WINBAN chose to maintain its interest in the exported fruit until it was sold in the UK.

The success of the banana industry may be assessed by the growth in production from less that 5,000 tonnes in the early 1950s to over 277,000 in 1990. Figure 1 shows the individual island's and total Windwards exported production for the period 1960 to 1990. The relative production levels for the islands for the period 1986 to 1990 are presented in Figure 2. It is evident that St Lucia has been the highest producer and Grenada the lowest. In the last 2 years, St Vincent has surpassed Dominica in output, although the latter had traditionally been the larger producer. An estimated 23,000 farmers on 14,000ha were involved in banana production in 1988. However, as is evident in Figures 3 and 4, the industry comprises mainly small producers who

FIGURE 2

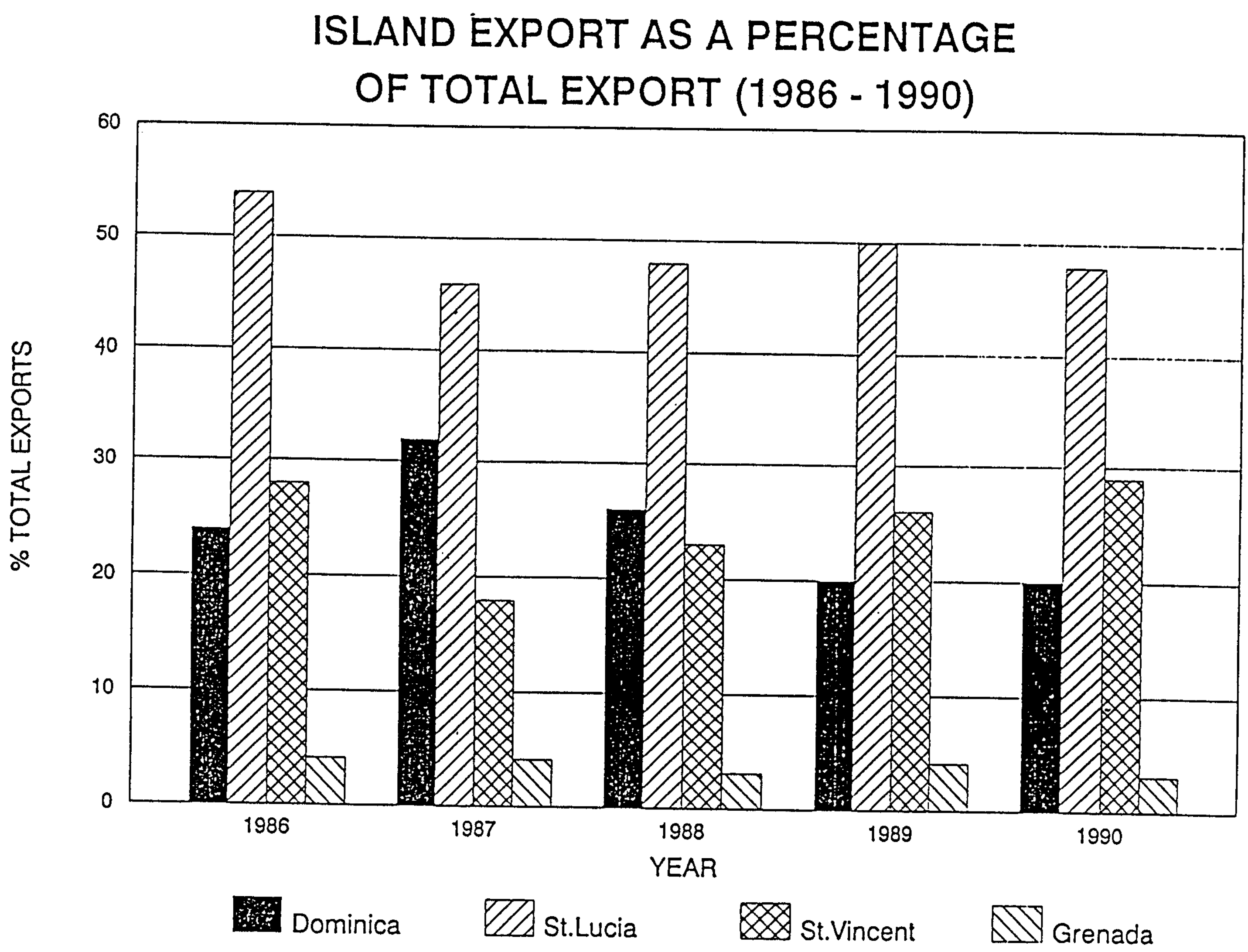
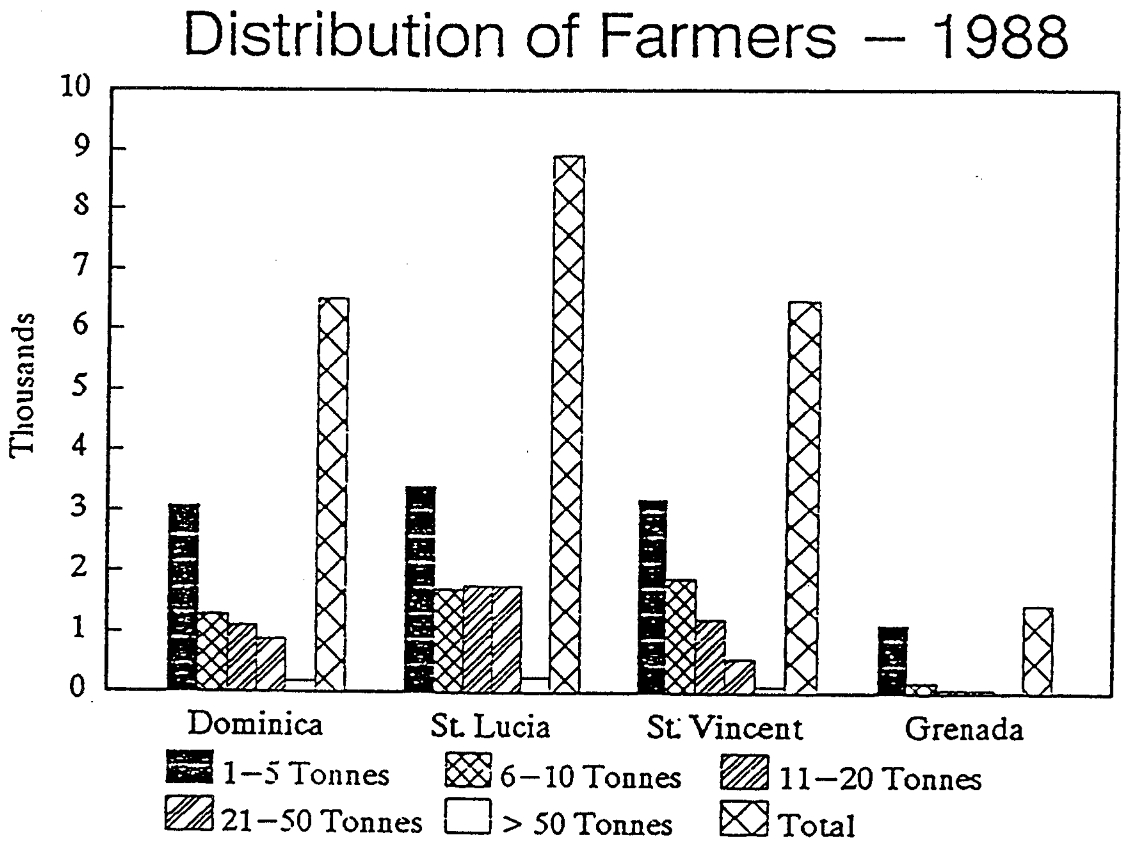
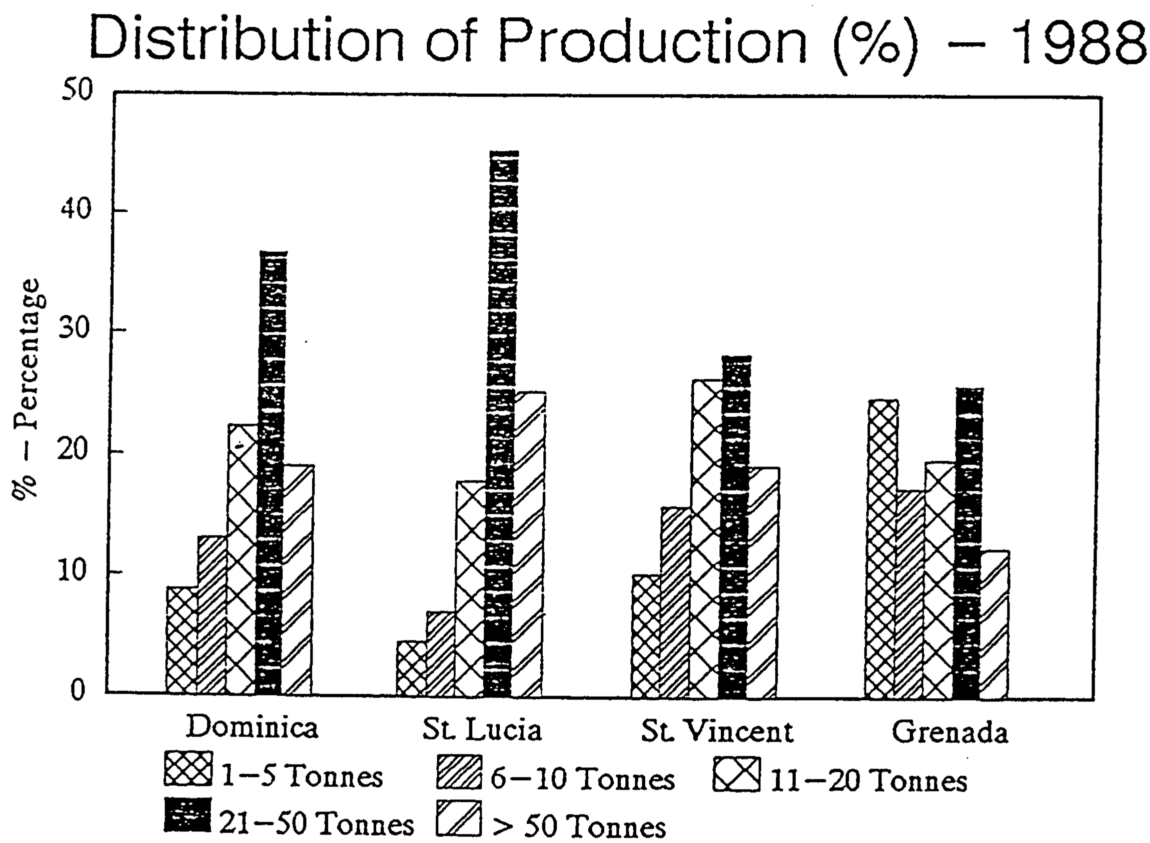

ISLAND EXPORT AS A PERCENTAGE
OF TOTAL EXPORT (1986 - 1990)
% TOTAL EXPORTS
0
10
20
30
40
50
60
1986
1987
1988
1989
1990
YEAR
Dominica
St.Lucia
St.Vincent
Grenada

FIGURE 3



Distribution of Farmers – 1988
Thousands
0
1
2
3
4
5
6
7
8
9
10
Dominica
St. Lucia
St. Vincent
Grenada
1–5 Tonnes
6–10 Tonnes
11–20 Tonnes
21–50 Tonnes
> 50 Tonnes
Total

FIGURE 4


Distribution of Production (%) – 1988
50
40
30
20
10
0
% – Percentage
Dominica
St. Lucia
St. Vincent
Grenada
1–5 Tonnes
6–10 Tonnes
11–20 Tonnes
21–50 Tonnes
> 50 Tonnes

contribute only approximately 30 per cent of total production. Figure 5 shows that the Windwards enjoyed over 50 per cent of the United Kingdom market in 1990. Over the last 6 years the export earnings from banana have been substantial, and, as is evident in Figure 6, have increased substantially over the past 5 years. By any account, the Windward Islands banana industry has grown into 'big business' contributing over EC$387m to the Windward Islands' economies in 1990, in equivalent foreign exchange earnings (Table 1).

Table 1. Banana industry contribution to the Windward Islands economy – 1990

	Dominica	St. Lucia	St. Vincent	Grenada
Total domestic exports ($M)	141.6	324.7	210	58.8
Total agricultural exports ($M)	90.4	205.2	157.5	41.3
Banana exports ($M)	79.6	186.9	110.5	10.3
Banana exports as % of agricultural exports	56.2	57.6	52.6	17.5

Source: Govt. Statistical Depts. , Windward Islands.

Organization and management of the banana industry

Objectives

The organization and management systems which evolved with the banana industry were driven by a number of objectives including the following main ones:

- Remunerative prices to the banana grower
- Consistency in quality of production
- Long-term viability of the industry.

In working towards these objectives, the industry has progressed from the very loose structures in the 1950s to the tightly knit and much more efficient ones of the present. The industry leaders recognized that activities towards these objectives were intertwined, and the achievement of any one strengthened the course towards achieving the others, Thus, for example, remunerative prices to the farmer encourage him/her to adopt the recommended practices required to produce a high level and quality of the product. This in turn will further improve prices and spread overheads over a larger production level thus reducing unit costs and strengthening the viability of the industry. The banana business has been a very dynamic one; its performance and farmers' morale being so highly dependent on several factors including prices in the market, exchange rates and climatic conditions, among others.

A consideration of the above objectives and the organizational and management systems which have evolved would provide some insight into what it takes to maintain a viable export orientated agricultural industry.

Remunerative prices to the banana grower

The industry has sought to optimize farmers' prices by adopting measures both to minimize costs and maximize income from the market. It was recognized quite early, and indeed became evident whenever conditions in the market resulted in a substantial decline in farmer prices, that the farmer's interest in maintaining his plantation was strongly related to the level of income received. A poorly maintained plantation results in slippage

FIGURE 5

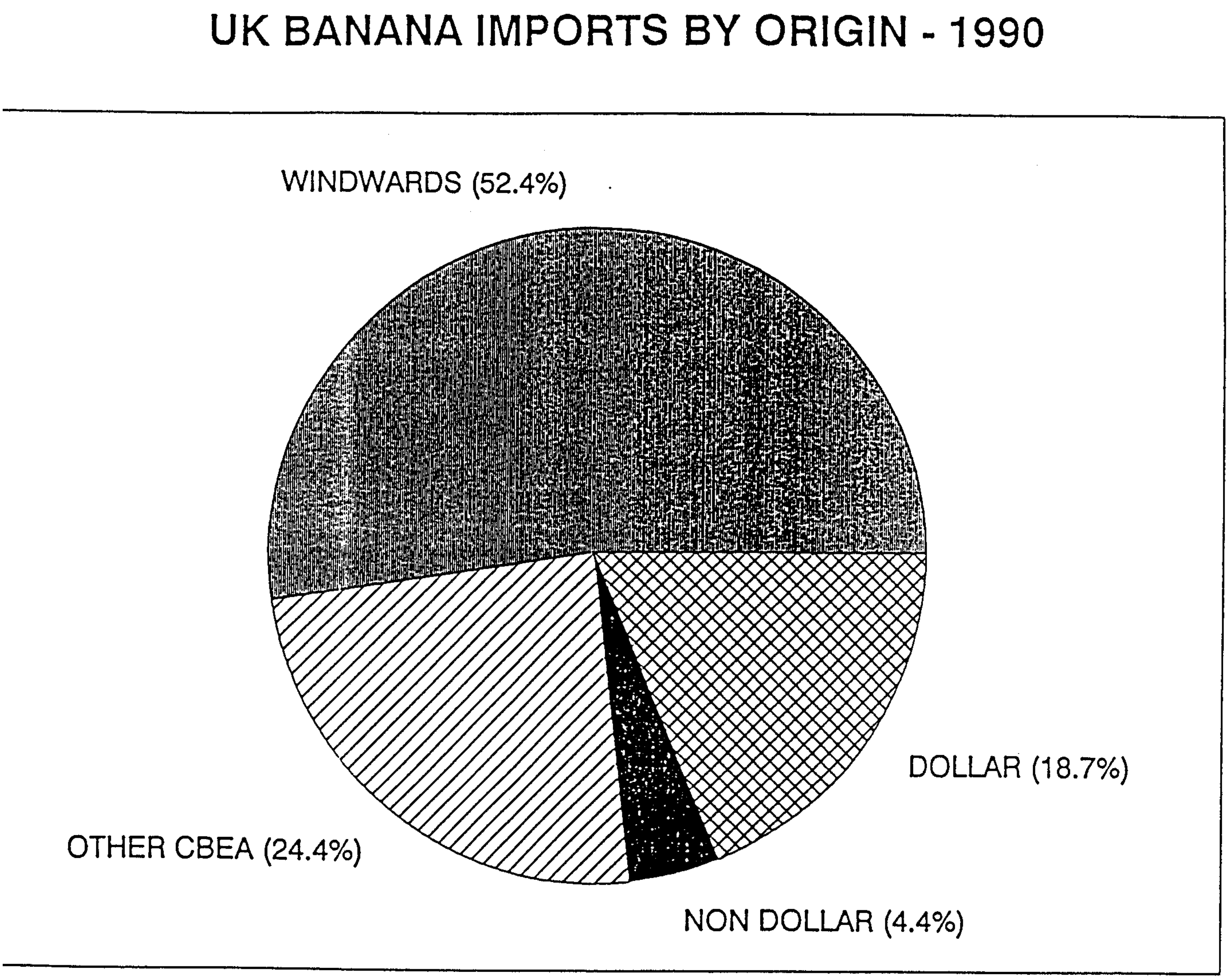
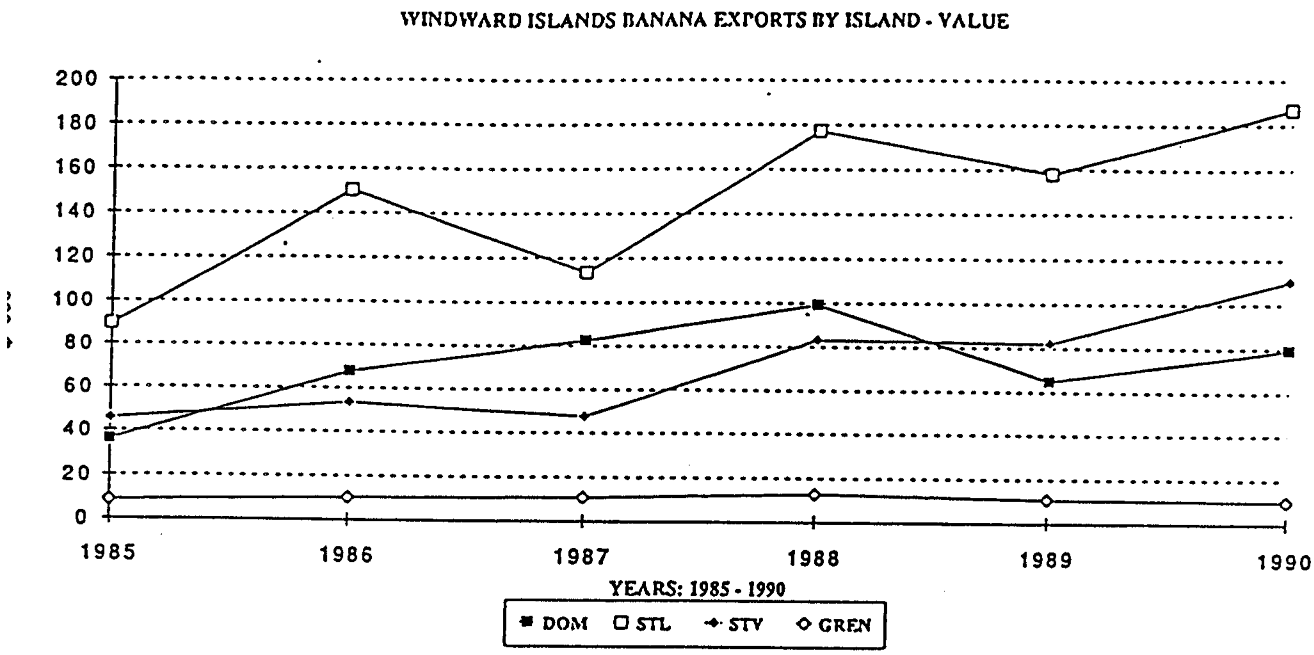

UK BANANA IMPORTS BY ORIGIN - 1990
WINDWARDS (52.4%)
DOLLAR (18.7%)
OTHER CBEA (24.4%)
NON DOLLAR (4.4%)

FIGURE 6


WINDWARD ISLANDS BANANA EXPORTS BY ISLAND - VALUE
200
180
160
140
120
100
80
60
40
20
0
1985
1986
1987
1988
1989
1990
YEARS: 1985 - 1990
DOM
STL
STV
GREN

in both the level and quality of production and is inimical to the continuing viability of the industry. The measures adopted by the Industry include:

- A central institution, the BGA, to purchase inputs in bulk and to offer them on low cost credit terms or for cash to farmers. This results in a lower cost to the farmer than he would have faced at retailers, or should he have imported the items himself. In ensuring that the farmer always has access to the required inputs for production, this BGA retains a cess from each grower's sales based on the weight of fruit sold, and sets this aside for use by the farmer to purchase inputs. The farmer is also allowed credit against his anticipated future earnings, based on his historical production levels.

  This institution is also responsible for receiving bananas from the smaller farmer, close to the point of production, assembling all such fruit and delivering it to Geest at one or the other of the six ports in the Windwards. Doing so minimizes the transportation costs faced by individual growers and takes advantage of the greater cost efficiency of using larger trucks as opposed to pick-ups.

  The BGA also provides services which are most cost effectively handled in a centralized manner to its members, the banana farmers. These include leafspot control, extension, administrative and financial services. By doing so, the cost is held down either by the large scale of the operation or the spreading of the resultant cost over a higher production than is possible at the individual farm level.

  Figure 7 presents the structure of one of the four associations, the SLBGA. The operations aspect of the BGA is emphasized. However, the services offered by the accounts, data processing and inventory control are critical to the performance of the BGA and should not be overlooked.

- Collective marketing of bananas from all islands under the WINBAN umbrella (Figure 8). This minimizes the administrative costs and difficulties of each island separately negotiating marketing contracts with Geest, and offers the strength of their collective production in such negotiations. This translates into lower shipping and marketing costs per unit production to the BGAs and hence the farmer. This strength has enabled the industry to extend its interest to the market and to benefit from the sale of both the green and ripe fruit marketed by Geest.

  The contract between WINBAN and Geest calls for the former to sell to the latter all marketable fruit produced in the Windward Islands. In return, Geest undertakes to market all of this fruit at the best possible prices, and not to market in the UK, bananas from any other source without WINBAN's explicit agreement. The cost associated with the reception, shipping, transportation, ripening (by Geest) and marketing of the bananas, and other fees and allowances due to Geest are deducted from the receipts from all sales and the difference paid to WINBAN. This is then paid to the individual islands in proportion to their tonnage of bananas exported and the relative quality of their fruit. WINBAN may receive a rebate in freight costs in respect of cargo or passengers carried on the Geest ships involved in shipping bananas. Geest's accounts in respect of the banana trade, are open to verification by WINBAN at the end of each trading period

- Centralized funding of research and other technical services required for the adaptation of the industry to continually changing market demand, through WINBAN.

- Centralized insurance coverage of all production units to ensure that resources are available for a rapid recovery of the industry following natural disasters. By spreading the risk across all islands, the cost of insurance to the individual farmer is much reduced, while ensuring an adequate compensation for the damaged crop.

FIGURE 7

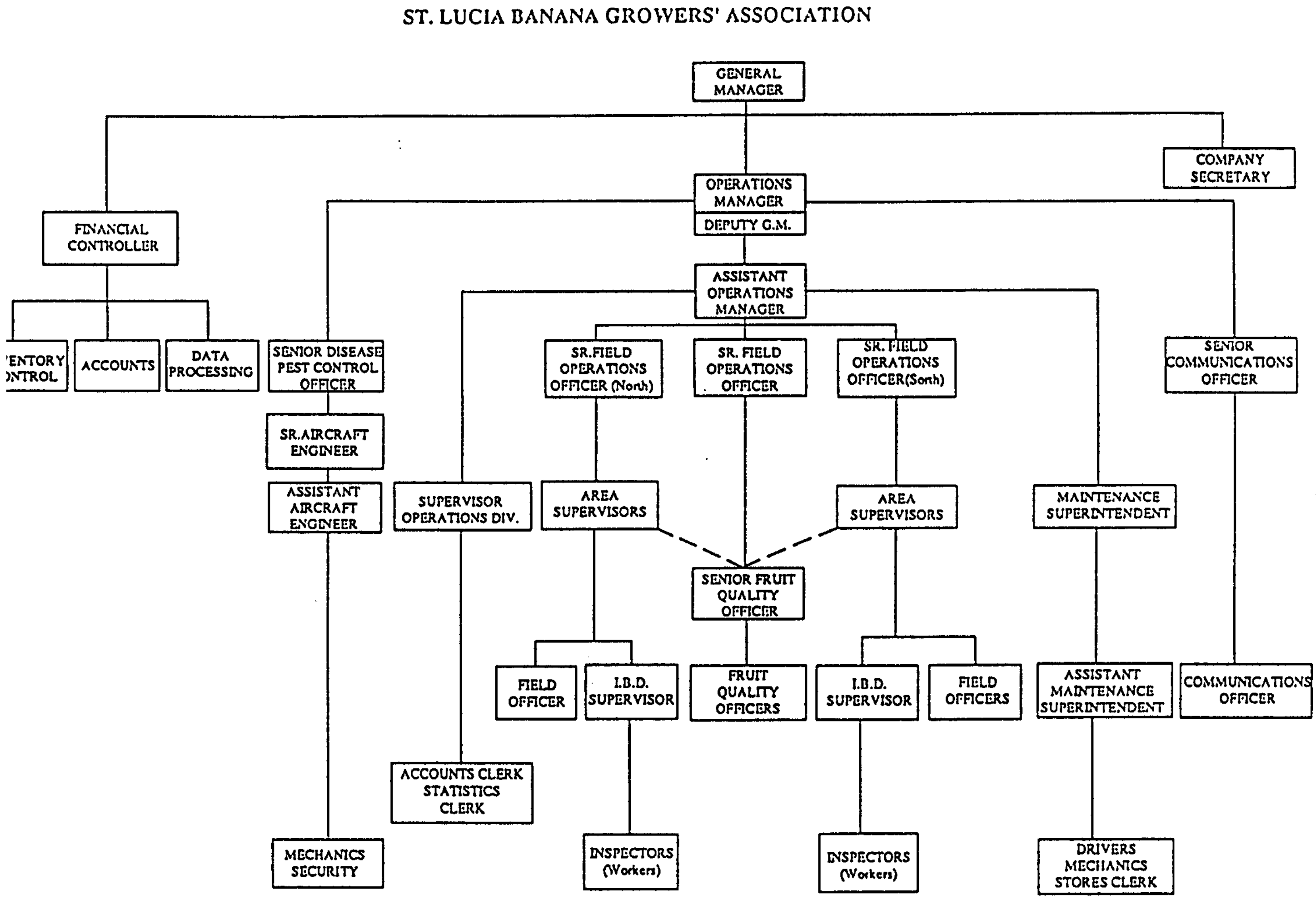
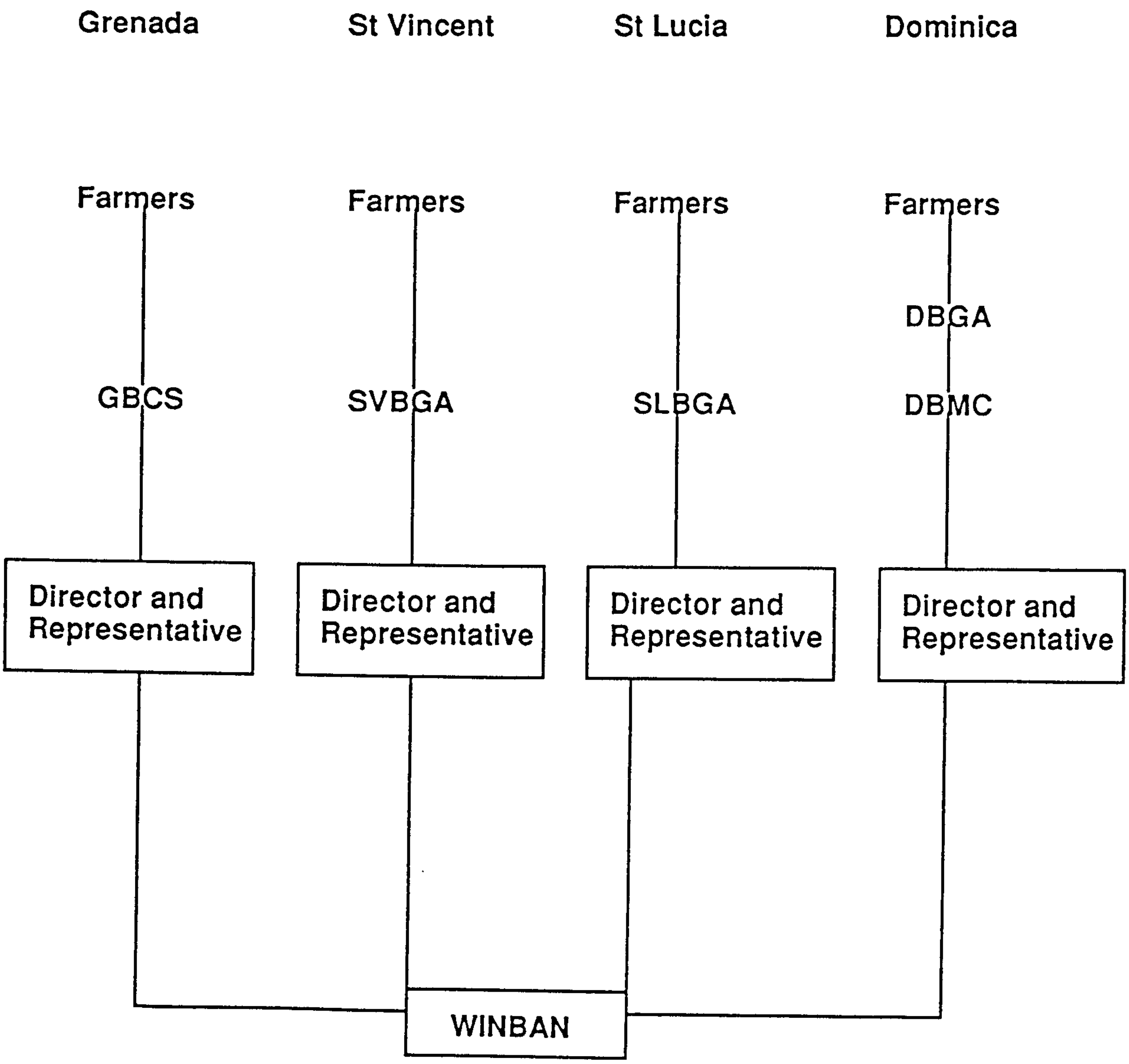

ST. LUCIA BANANA GROWERS' ASSOCIATION
GENERAL MANAGER
COMPANY SECRETARY
OPERATIONS MANAGER
DEPUTY G.M.
FINANCIAL CONTROLLER
ASSISTANT OPERATIONS MANAGER
ENTORY ONTROL
ACCOUNTS
DATA PROCESSING
SENIOR DISEASE PEST CONTROL OFFICER
SR.FIELD OPERATIONS OFFICER (North)
SR. FIELD OPERATIONS OFFICER
SR. FIELD OPERATIONS OFFICER(South)
SENIOR COMMUNICATIONS OFFICER
SR.AIRCRAFT ENGINEER
ASSISTANT AIRCRAFT ENGINEER
SUPERVISOR OPERATIONS DIV.
AREA SUPERVISORS
AREA SUPERVISORS
MAINTENANCE SUPERINTENDENT
SENIOR FRUIT QUALITY OFFICER
FIELD OFFICER
I.B.D. SUPERVISOR
FRUIT QUALITY OFFICERS
I.B.D. SUPERVISOR
FIELD OFFICERS
ASSISTANT MAINTENANCE SUPERINTENDENT
COMMUNICATIONS OFFICER
ACCOUNTS CLERK STATISTICS CLERK
MECHANICS SECURITY
INSPECTORS (Workers)
INSPECTORS (Workers)
DRIVERS MECHANICS STORES CLERK

FIGURE 8 : Structure of the Windward Islands Banana Industry



Consistency in quality of production

The industry has recognized that it is, essentially, market driven. The quality of fruit demanded by the consumer has dictated practices and management systems in ensuring that the Windward Islands are able to dispose of their produce. While the market has been a protected one, there has always been a level of competition between the suppliers to the UK market. Furthermore, in more recent times, the entry of guaranteed levels of 'Dollar' fruit onto the market has highlighted the quality deficiency, primarily inconsistent quality from season to season, of the Windwards' fruit and stimulated further activities to substantially improve the quality of Windward Islands' bananas.

Included in the actions taken in striving towards the objective of assuring consistent quality levels are the following:

- Formation of a separate division within each BGA with the responsibility for monitoring the quality of fruit being produced at the farmer and BGA level, enforcement of quality related regulations and generally to assist farmers to produce the quality of fruit required.

- Development of a system for the purchasing of fruit at Inland Buying Depots (IBDs) and wharves which includes a quality assurance component wherein fruit not suitable for export is rejected, and a quality determination component which provides the basis for paying the grower on the quality of the fruit he offers for sale.

- Passage of a Fruit Quality Act which sets out the prescribed practices for producing, harvesting, processing and transporting bananas, the penalties for contravening any of its provisions and disciplinary and other actions which may be taken by the BGAs to preserve quality. This Act makes provision for the formation of a Fruit Quality Authority which prescribes the practices set out in the Act, and determines actions to be taken to preserve quality.

  The Act also makes provision for the formation of a Fruit Quality (Protection and Control) Committee comprising the BGAs, Geest, WINBAN and the Ministries of Agriculture, to advise the authority on all matters relating to fruit quality. This committee meets regularly to review fruit quality performance and develop strategies for correcting current quality related problems.

- Prescription by the Fruit Quality Authority of the chemicals (pesticides and fertilizers) and dosages which may be used on bananas, whether pre- or post-harvest. Given the sensitivity of consumers to the issue of pesticide use in food crops and on fruit, and the establishment of MRLs of the various chemicals on and in bananas, the industry must be able to control which chemicals are used and in what quantity. Indeed, the new British Food Act of 1990 requires that the producer shows 'due diligence' in its control of chemical usage and of residues on the fruit. In this latter case, Geest regularly collect samples of fruit for residue analysis in order to assure its customers that MRLs are not exceeded.

- WINBAN has responsibility for training and certifying all fruit inspectors and assessors to ensure a common approach to fruit assessment at all inspection points. This fruit is assessed using exactly the same bases in all four islands.

- WINBAN's fruit quality officers monitor quality related practices in the four islands and report their observations to the Fruit Quality Authority. These officers also assist the BGA's fruit quality teams in the training of farmers, especially during implementation of new technologies.

- WINBAN monitors the quality of inputs, especially those used in the packaging of fruit, to ensure they conform to specifications. This is especially important in so far as cartons are concerned as poor compression strength, among other factors, may result in collapse of the box thus giving rise to severe mechanical injury to the fruit.

- Implementation of systems for assessing the quality of fruit produced, both at the local and UK level and at the green and ripe stages, and feedback of the assessment scores to the BGA field team to assist in the extension of recommended practices to farmers.

  These scores are also used to determine the quality profile of the farmer, the price to be paid to him and any disciplinary action which may be necessary, given his historical and current performance.

  The BGAs are also in the process of implementing a field scoring system which will be used, in conjunction with the farmer's quality scores, to determine disciplinary or other actions against defaulting farmers.

- The BGAs have recently implemented a system of payment to each island based on the quality of fruit exported by that island. This system is designed to stimulate the individual BGA to take the necessary actions to ensure consistent and high level of top quality exported fruit.

  Figure 9 presents in a diagrammatic manner, the farmer support system in place in the banana industry. The distinct roles of the two institutions, the BGA and WINBAN, are evident. It is to be noted that WINBAN functions primarily through the BGAs and does not normally liaise directly with farmers. The quality management system shown in Figure 10 has been generally successful, although the quality of fruit exported continue to be below agreed targets, as shown in Figure 11.

Long-term viability of the banana industry

The actions indicated above with respect to prices and quality, are all relevant to the long-term viability of the industry. However, in addition to these, the industry has taken a number of other initiatives to strengthen its prospects for the future including:

- Maintenance of a Research and Development Division to:

  - investigate current and anticipated problems and generate solutions for these

  - develop technologies to improve the cost-effectiveness of banana production in the Windwards

  - assist the BGAs in successfully transferring current and new technologies to banana farmers.

- Recognition of the importance of involvement in the marketing of its produce has prompted the industry to strengthen its market intelligence unit in the UK in anticipation of a higher level of participation in marketing fruit on that and the European markets.

- Participation of farmers in the direction of the industry has been an important feature of the business. Their commitment to the future of the industry would have been quite tenuous had they seen themselves as the 'driven' rather than as 'having a say'. The structure of all the BGAs includes provision for the farmers' representatives to take the lead in directing the banana industry. However, given the States' interest in the ensuring stability, all these institutions have government nominated representatives particip-ating in the decision-making.

Figure 9

FIGURE 9 FARMER SUPPORT SYSTEM

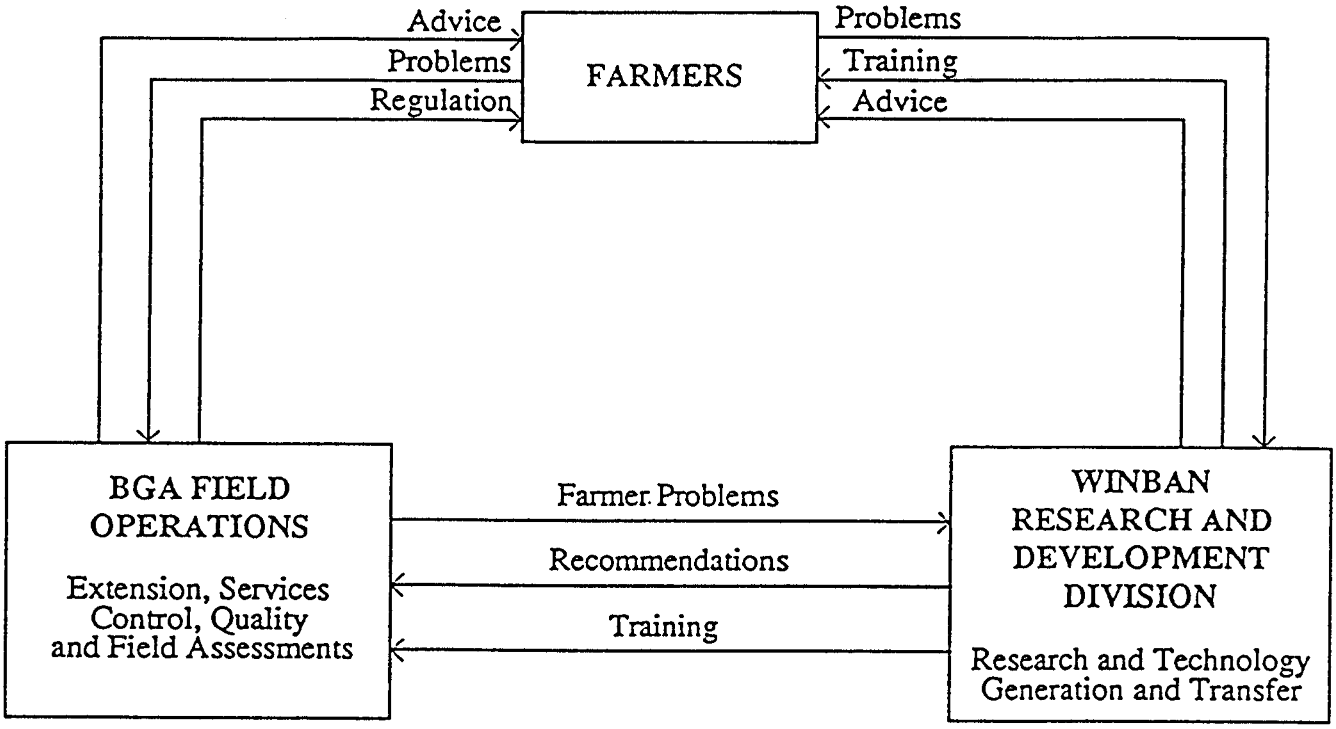


Figure 10

FIGURE 10 QUALITY MANAGEMENT SYSTEM

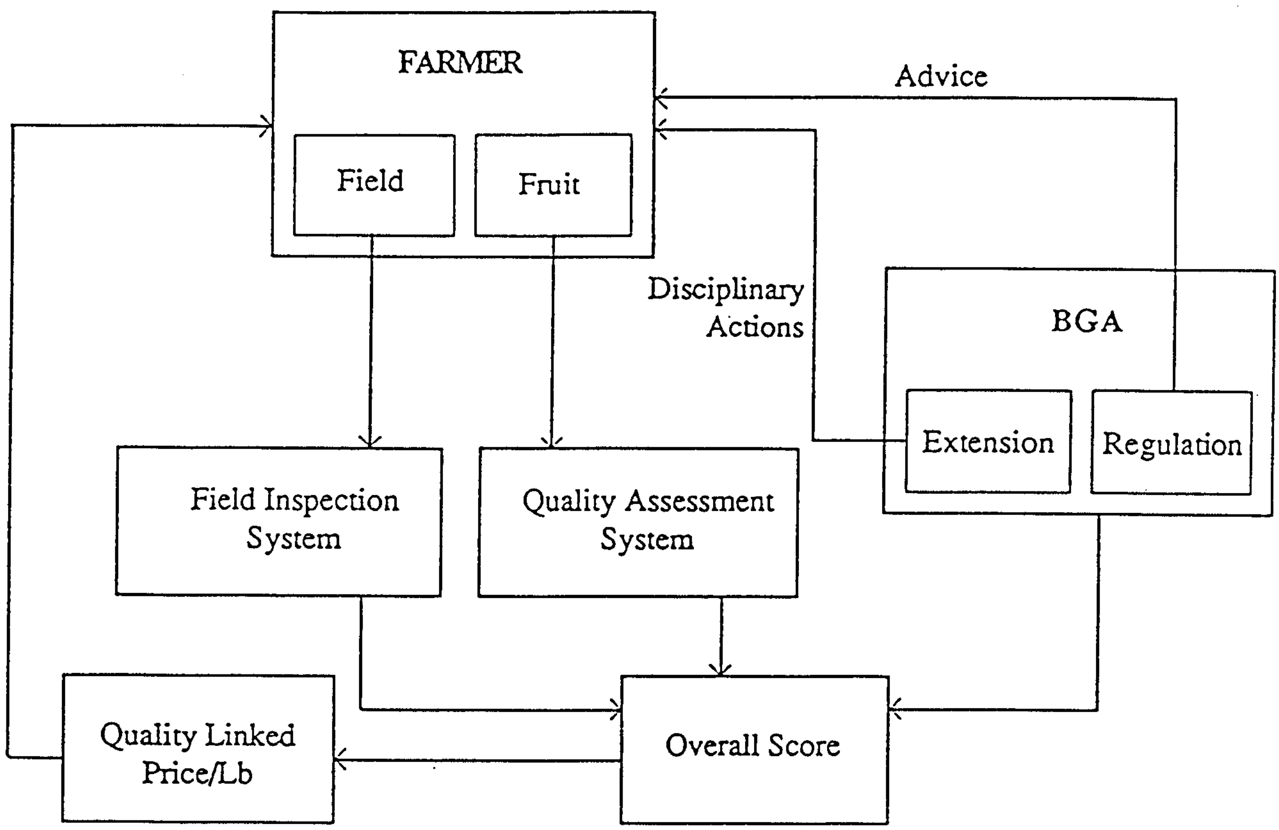
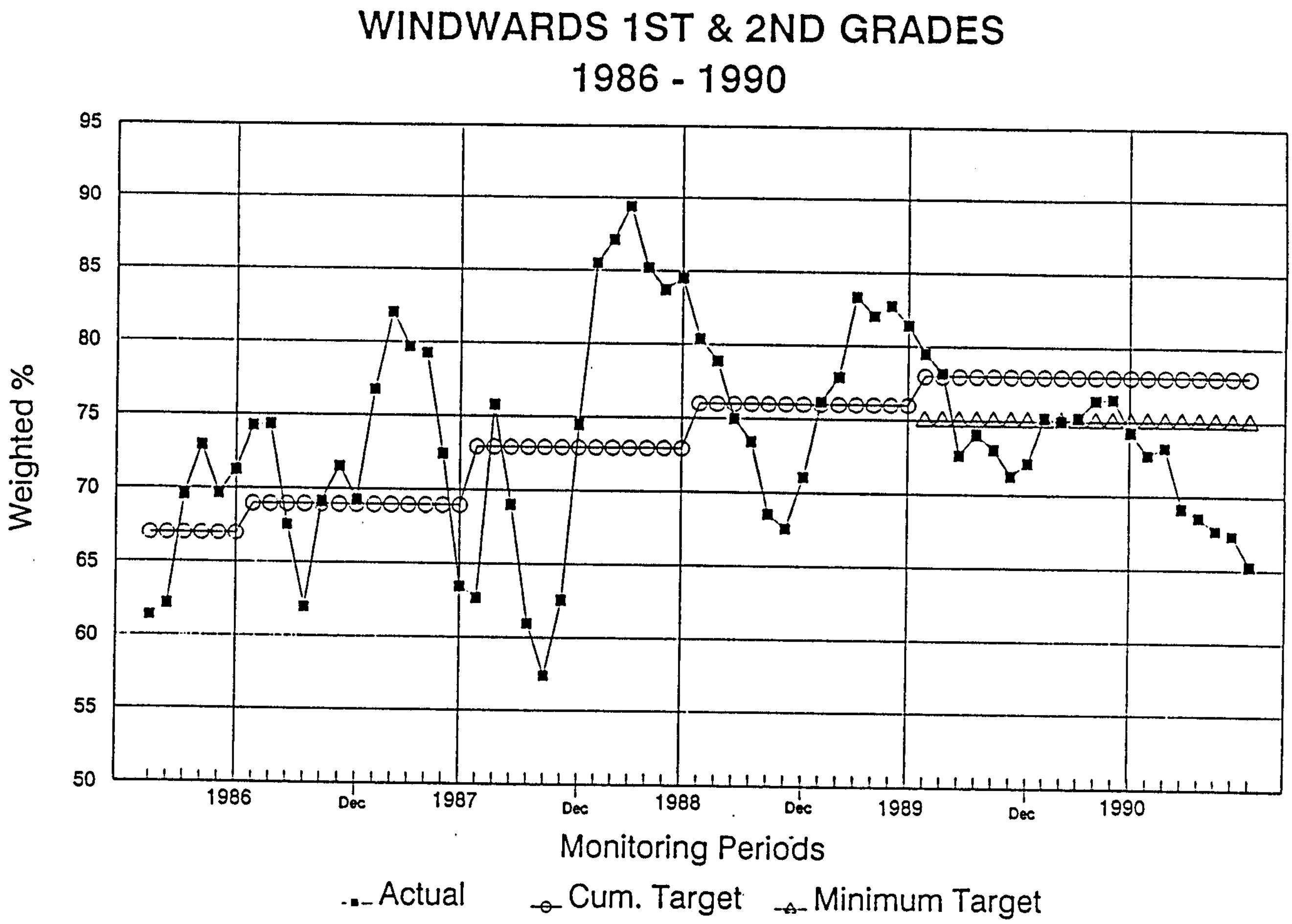


FIGURE 11


WINDWARDS 1ST & 2ND GRADES
1986 - 1990
Weighted %
95
90
85
80
75
70
65
60
55
50
1986
Dec
1987
Dec
1988
Dec
1989
Dec
1990
Monitoring Periods
Actual
Cum. Target
Minimum Target

Lessons learnt

Two of the more important lessons learnt over the more than four-decade history of the banana industry include the following:

- The need to have an acceptable level of farmer income.

  The farmer is central to the industry and his loyalty and confidence are absolutely necessary for its continuing survival. In order to ensure this, it is most important that the farmer receives an acceptable level of income for his toil and that this earning be protected as far as is possible.

  The farmer's income has been protected through:

  - Reducing costs at the farm and industry levels.
  - Increased business income through negotiations with the marketing agent.
  - Price support or stabilization schemes to reduce large swings from season to season,
  - The farmers have been assured access to the inputs required for producing the level and quality of fruit being demanded.
  - The farmers' income and ability to recover from natural disasters have been protected through formation of an insurance scheme.
  - Farmers respond much more to changes in the income than to advice. It had therefore been necessary to link his income to the quality of his fruit and the state of his field and farm practices. Following recommended practices should maximize his income.

- The need to protect the Banana Industry.

  This has been necessary to ensure its long-term viability and the confidence of its members. Actions towards this include:

  - Formation of institutions to provide support services and manage the industry.
  - Market requirements have been determined and appropriate practices put in place to meet them.
  - It has been necessary to take specific actions to ensure that the industry operates (to the extent possible) in a business-like manner. This includes ensuring that the various directorates include the expertise to adequately direct the industry.
  - Very small farms have been shown to be uneconomic and it has been national policy on some islands to prevent larger units from being split into too small ones. In addition, present thinking calls for a minimum farm size to be registered as a new farmer.
  - In addition to the above, it has been recognized that some areas are not suitable for banana production and it may not be cost-effective to provide services there. Such areas may be designated marginal for bananas and fruit not accepted from farmers there.
  - Minimum package of practices for producing bananas being developed. Farmers not implementing these may not be allowed to export their fruit.

Summary

The banana industry has survived through a number of natural disasters and periods of difficult market and climatic circumstances since its humble beginnings in the first half of the century. However, it has weathered all storms, gone through a series of re-organizations and consolidations and remained a viable export business. While the protected status of its primary market has contributed to its survival through the difficult periods, there is no doubt that the organizational structures and management systems which have evolved contributed substantially to its continuing viability. These structures and systems have been developed to assist the industry in achieving its major objectives of good prices to farmers, good and consistent quality of export bananas and its long-term viability.

The continued success of the industry will depend on the extent to which the income and quality objectives are met on a continuing basis. Given the increasing competitiveness of the banana business and the potential for reduced protection on the UK market, the banana industry must further improve the efficiency of its management systems and seek novel methods of reducing costs if it is to remain viable.

EXPERIENCE GAINED BY THE PRODUCTIVE FARMERS' UNION IN THE EXPORT OF FRUITS AND VEGETABLES FROM GRENADA - MAY 1988 to SEPTEMBER 1991

P Francis
Productive Farmers' Union, Grenada

The Productive Farmers' Union was established in 1980 and registered in 1981.

Among its 14 objectives, marketing was not a high priority. In fact to quote from its Constitution (Article 1 Sub-section 6):- "To work in close collaboration with all relevant organizations or bodies to obtain more lucrative and better markets for its members locally, regionally and extra-regionally". Note "To work in close collaboration" - no mention was made of marketing directly by the Productive Farmers' Union (PFU).

However, at one period in its chequered history, which includes a period of dormancy, discussions held with members and other farmers revealed, among other things, that marketing of non-traditional agricultural crops was a strongly felt need.

In an attempt to meet this need the PFU with the help of the Agricultural Rehabilitation and Crop Diversification Project (ARCDP) started working with the Marketing and National Importing Board (MNIB) in 1987 to obtain export markets for these crops. However the PFU found the MNIB at the time to be very unresponsive to the needs of farmers and reluctant to explore markets for a wide range of products.

In 1988 the PFU contacted the Caribbean Agricultural Trading Company (CATCO) and commenced external marketing with them in May of that year.

This activity was difficult and frustrating. Some of the difficulties and frustrations stemmed from:

(i) Lack of experience and expertise in harvesting and post-harvesting techniques on the part of PFU staff and members.

(ii) Absence of basic facilities including washing tanks, scales, field crates, stapling machines etc.

(iii) Lack of operating capital - this is a situation where farmers required almost immediate payment.

(iii) Resulting from (i) above, PFU accepted a price structure from CATCO which was unable to meet all costs (farm-gate price, grading, packing and handling, transportation and levels of rejects). Additionally, CATCO violated agreed terms of payment, e.g. while agreed terms called for payment to be made within 10 days of shipment, CATCO did not make the first payment until after more than 3 weeks. This sort of payment continued sporadically throughout our relationship and was compounded by some of its cheques not being honoured by local banks.

One of the most negative aspects in our dealings with CATCO was the secretive nature of their marketing operations. Throughout our dealings with CATCO, the PFU was never once informed of the price for which its produce was being sold in Europe. PFU shipped the produce at CATCO's request and supplied the information on the shipment to CATCO who did the invoicing to the importer in Europe.

Two more areas worth mentioning are CATCO's refusal to re-negotiate prices for over 1 year in spite of the agreement which provided for a 3-monthly review and their fixing of farm-gate price in discussions with farmers and later paying PFU the same price and claiming that what had been taken by the farmers as farm-gate had really been intended as fob prices (e.g. prices of plantain, egg plant, hot pepper and sweet potato).

There were however, some positive aspects of our relationship for which the PFU is deeply obliged to CATCO.

(i) Training of PFU staff and selected farmers in post-harvest handling, grading and packaging.

(ii) CATCO was highly quality conscious and inculcated in PFU workers and members, the necessity to have high quality produce with good presentation.

(iii) CATCO had the experience and contacts and was therefore able to greatly expand the range of products offered to importers from Grenada.

As time passed our frustrations deepened as time between payments lengthened and dishonoured cheques became more frequent. This resulted in breaks in export as farmers refused to deliver their produce to PFU without payment.

This climaxed in June 1989 when one customer no longer receiving produce out of Grenada contacted PFU to arrange for direct shipment. The prices this buyer quoted for the items he required were between 200 and and 300 per cent above the price paid by CATCO. Today this company is one of our best customers.

This leads us to a new chapter in the life of the PFU - direct marketing. There are many lessons we have learnt and continue to learn from direct marketing.

Unscrupulous buyers

- Buyers who claim high levels of spoilage which we are unable to verify though in some cases circumstantial evidence makes us certain that they are dishonest. For example, two buyers of breadfruit in England having produce shipped on the same pallet on the same flight where one reported arrival of his shipment in very good condition. and the other reported complete spoilage of his shipment but doubled his order for the next week.

- Buyers who present very good bank references with large bank balances as evidence of ability to pay. They commence trading by making prompt payments and building up confidence then subsequently build up large credit and then disappear completely.

Because there are both honest and dishonest buyers and there is a great difficulty in telling them apart initially, there is need for a central reference source which exporters can access for information. This can be built up by all exporters reporting their experiences, good and bad, to a centre either at OECS or at CARICOM level.

On the local level the exportation of fruits and vegetables has shown that there is a high level of rejects and unexportable produce.

Historically most of these products were grown mainly for home consumption with the excess being given away or sold either to traffickers for what is offered or sold at the parish markets. Today this is changing. For example, in 1987 golden apple was sold mostly to traffickers with the larger percentage of the crop going to waste. This year for the PFU, and perhaps for Grenada, golden apple is our best seller on the extra-regional market. Another good seller is our common mango such as Starch, Calivigny, Cheesie etc., which formerly went largely to waste.

With the growing importance of the non-traditional crops such as soursop, bilimbi, genip, french cashew etc., there is the need to develop tech-packs and to provide information to farmers on the cultivation, harvesting and post-harvest handling and transportation and storage of these products.

Another drawback to exporters of fruits is the almost complete absence of orchards in Grenada. This results in serious logistical problems and increases the cost of harvesting and transportation from field to packhouses.

Mention must be made here of the need for some serious effort to be made in the area of agro-processing to take care of the large amounts of produce which cannot meet the standard for the fresh fruit trade, especially on the extra-regional markets.

PFU's experience shows that there is a serious barrier to external trade in the absence of a reliable air transport system at rates which will allow competitive prices on the European or North American markets. As our export data will show there is no trade between the PFU and any other Caribbean island. It is the view of the PFU that the region should explore the possibility of establishing reliable air and sea trading links, both regionally and extra-regionally.

During the short period of trading we have discovered that our non-traditional agricultural crops can play a significant role in enhancing regional foreign exchange inflows as the data in Table 1 show.

Finally because of our involvement in the export of tropical fruits we have experienced the goodwill of both regional and international organizations in providing technical and financial assistance to us and I guess to similar groups in meeting their goal of helping farmers to better their standard of living and enhancing foreign exchange intake. Here mention must be made of the following: HIAMP, IAF, CANFUND, IICA, CARDI, OECS/ACDU and ARCDP.

We hereby express our thanks to them and look forward to further assistance as we strive to build our export capability.

Table 1 Exports of non-traditional agricultural crops from Grenada

Period	Destination	Volume (kg)	Value (EC$)
1988 May-December	England	64,882	58,017
1989 January-December	England	97,364	225,974
	Holland	35,160	196,110
	USA	18,182	42,880
1990 January-December	England	97,049	235,574
	Holland	82,550	200,380
	USA	25,209	59,016
1991 January-September	Holland	97,157	255,144
	USA	28,271	64,799
			1,337,894

THE WESTERN EUROPEAN MARKET FOR FRESH PINEAPPLES - OPPORTUNITY OR MYTH FOR THE CARIBBEAN COMMUNITY COUNTRIES

K Craig
CARDI, Trinidad & Tobago

This study seeks to determine whether there are real opportunities for Caribbean Community (CARICOM) member countries to market fresh pineapples in the lucrative Western European market. The trends in world pineapple production and trade are analysed. It concludes that the Western European market for huge quantities of CARICOM-grown fresh pineapples is more a myth than an immediate opportunity, but that Guyana and Belize have some advantages to successfully solicit overseas investors to make the idea a reality

This study examines world fresh pineapple production and trade but focuses on major Western European importing countries, including their sources of supply. It also analyses the possibility of the Caribbean Community (CARICOM) countries becoming major suppliers.

The study has been undertaken in response to the various discussions, proposals and initiatives that have been taking place within CARICOM in the area of agricultural diversification and also in response to the stated need by countries to increase foreign exchange earnings from non-traditional agricultural exports, because of the poor performance of the traditional agricultural exports.

To provide a basis for making the proposals in this document, world production and trade are examined with the aim of identifying the major producing and importing countries in the world by geographic location as well as by the value of such trade.

The major Western European countries are identified as a key importing group, not only because together they import more than Japan (the largest single importing country) but because of their traditional trading and other linkages with CARICOM and the higher prices offered. The focus is then switched to CARICOM's present production and trade and its possible future production and trade.

By attempting to match CARICOM's future production potential through its resource base and its own trade potential against a slowing Western European Market and significant African production potential, some logical conclusions are developed. The latter give rise to the proposed recommendations.

World production and trade of pineapple

Production

FAO production statistics show that over 60 individual countries, mostly in Africa, Central and South America and Asia, were producing pineapples over the period 1986-1988. Total world production was over 10 million tonnes (Table I) up from 9.3 million tonnes in the 1979/81 period. In 1988, 5.6 million tonnes (52.3 per cent) were produced in the Far East, 2.2 million tonnes (20.3 per cent) in the Americas and 1 million tonnes (9.7 per cent) in Africa.

The data also show that the three major African producers were Cote d'Ivoire with an average annual production of 271,000 tonnes over the 1986 - 1988 period, South Africa with an average annual production of 232,000 tonnes and Kenya with an average annual production of 211,000 tonnes. Table 1 also shows that the three major producers of the Americas were Brazil with an average annual production of 933,000 tonnes over the 1986 - 1988 period, Mexico (297,000 tonnes), and

Table 1. Production of pineapples by major producing countries: 1979/81 and 1986/1988

	1979-81	1986	1987	1988
	(000s tonnes)			
World	9,307	10,005	10,203	10,631
Developing countries				
Africa	971	1,059	1,054	1,035
Latin America	1,589	1,935	2,123	2,153
Near East	4	5	5	5
Far East	5,110	5,139	5,106	5,600
Africa				
Cote d'Ivoire	295	274	274*	265*
South Africa	217	265	267	165
Kenya	177	231*	210*	191*
Latin America				
Brazil	392	826	957	1,016
Mexico	530	293*	306*	293*
Colombia	119	216	228	230(F)
Asia				
Philippines	1,059	2,010	2,059	2,250
Thailand	2,857	1,636	1,510	1,771
India	548	750(F)	780(F)	790(F)

* – FAO unofficial figure (F) – FAO estimate

Colombia (225,000 tonnes). In Asia, the three most important producers were the Philippines (2.1 million tonnes), Thailand (1.6 million tonnes) and India (773,000 tonnes) for the period under review.

Exportation

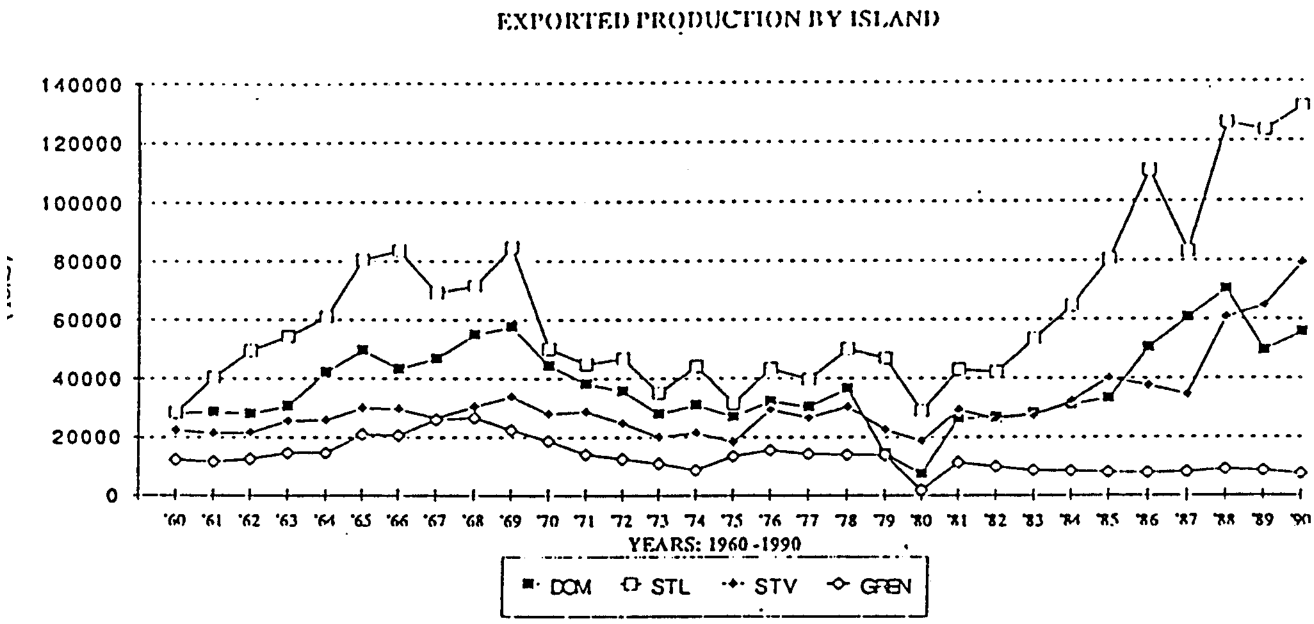
World fresh pineapple exports have averaged 553,000 tonnes over the period 1986/1989. Production peaked in 1987 at about 585,000 tonnes valued at US$195 million (Table 2) with the Côte d'Ivoire (29.6 per cent) and the Philippines (28.5 per cent) being the major contenders in this market.

The Philippines was therefore both the world's largest pineapple producer at 2.3 million tonnes in 1988 (Table 1) and exporter at 154,864 tonnes (Table 2) in the same year. Corresponding 1988 Côte d'Ivoire data showed the production of 265,000 tonnes and the exportation of 149,240 tonnes.

Within Africa, however, while South Africa and Kenya ranked second and third to Côte d'Ivoire in production (Table 1), in 1989 Ghana (7,500 tonnes) ranked second to Côte d'Ivoire in exports, followed by South Africa (3,700 tonnes) and Kenya (2,700 tonnes). It is evident from the data that Kenyan exports fluctuated widely.

The data also show that in 1989 the most important exporters from Latin America were Costa Rica (100,000 tonnes), Honduras (24,000 tonnes), Mexico (10,000 tonnes) and Brazil (12,000 tonnes).

FIGURE 1


EXPORTED PRODUCTION BY ISLAND
140000
120000
100000
80000
60000
40000
20000
0
'60 '61 '62 '63 '64 '65 '66 '67 '68 '69 '70 '71 '72 '73 '74 '75 '76 '77 '78 '79 '80 '81 '82 '83 '84 '85 '86 '87 '88 '89 '90
YEARS: 1960 - 1990
DOM
STL
STV
GREN

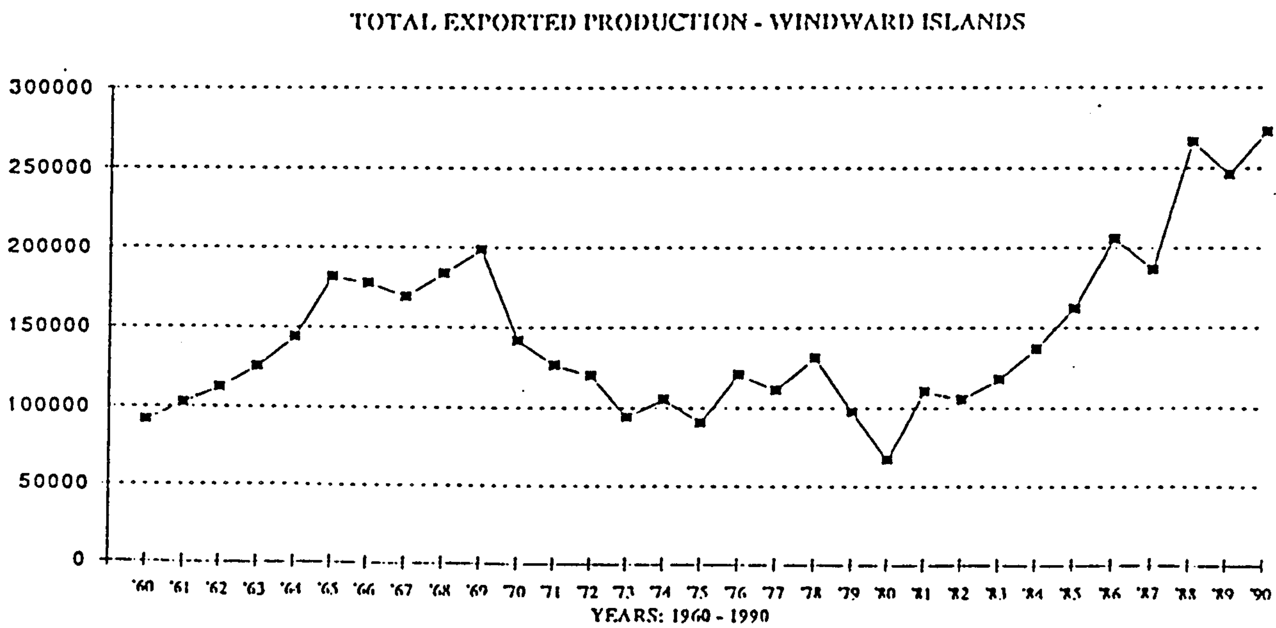

TOTAL EXPORTED PRODUCTION - WINDWARD ISLANDS
300000
250000
200000
150000
100000
50000
0
'60 '61 '62 '63 '64 '65 '66 '67 '68 '69 '70 '71 '72 '73 '74 '75 '76 '77 '78 '79 '80 '81 '82 '83 '84 '85 '86 '87 '88 '89 '90
YEARS: 1960 - 1990

Table 2. Exportation of pineapples by major exporting countries: 1986/1989

	1986	1987	1988	1989	1986	1987	1988	1989
	(tonnes)				(1000 US$)			
World	**533,708**	**584,531**	**547,407**	**545,045**	**164,160**	**194,557**	**178,942**	**173,913**
Developing countries								
Africa	183,354	181,861	177,750	144,926	75,285	72,540	65,147	50,100
Latin America	120,465	145,194	155,144	180,921	33,802	43,954	55,448	63,609
Near East	196	130	210	103	155	69	205	94
Far East	191,896	209,673	179,151	178,168	29,323	41,915	32,160	29,961
Africa								
Côte d'Ivoire	176,433	173,097	149,240	132,240	73,338	70,084	53,000	45,600 *
Ghana	2,600 *	4,000 *	6,000 *	7,500 *	520 *	750 *	1,600 *	1,800 *
South Africa	4,000 *	3,700 *	3,500 *	3,700 *	1,000 *	1,000	880 *	860 *
Kenya	938	911	20,222	2,700 *	483	427	9,145	1,150 *
Cameroon	3,130	2,719	1,002	1,000	802	809	215	220 *
Latin America								
Costa Rica	40,922	54,702	77,379	100,225	14,854	21,538	31,155	39,705
Honduras	28,763	37,237	32,819	24,000 *	10,209	13,217	16,048	11,000(F)
Mexico	18,255	20,671	16,326	9,929	814	918	761	658
Brazil	15,604	15,202	10,806	12,418	4,327	4,425	3,202	3,679
Asia								
Philippines	160,145	167,439	154,864	152,055	20,614	24,458	23,509	23,940
Malaysia	12,289	12,981	13,228	128,658	717	782	779	1,085
China	6,630	10,518	9,126	5,993*	5,275	7,963	7,224	4,343 *
Thailand	18,653	17,747	1,194	472	7,511	8,331	315	131
Europe								
Belgium/Luxemburg	3,595	16,512	13,095	17,848	2,412	11,691	8,820	11,721
Netherlands	11,838	10,375	4,409	4,244	7,627	7,773	7,599	7,551
France	8,040	13,400	8,917	8,504	6,429	11,984	4,411	4,574

Source: FAO Trade Statistics * – FAO unofficial figure (F) – FAO estimate

When re-exports are taken into consideration, the Western European countries of Belgium/Luxembourg, Netherlands and France are of significant importance. Over the period 1987 - 1989 re-exports from these countries averaged over 30,000 tonnes per year, which was significantly higher than the average total export volume from Ghana, South Africa, Kenya and the Cameroon combined.

In terms of earnings, the Cote d'Ivoire has been consistently earning at least 26 per cent of the total value of the world trade. In 1986 its earnings were as high as 45 per cent of the total value of world trade. In 1989 for example, out of a total trade of US$174m the Cote d'Ivoire earned US$46m, Costa Rica, US$4m and the Philippines, US$24m.

Importation

Over the period under review (1986/1989), the total volume of fresh pineapples imported world-wide averaged over 520,000 tonnes per year at an annual average of over US$300m. Of this amount, Japan was the world's largest importer followed by the United States, France, Italy and the Federal Republic of Germany (Table 3).

In 1989, for example, out of a global import figure of 538,000 tonnes, Japan alone imported over 135,000 tonnes (25.1 per cent), the United States 98,000 tonnes (18.3 per cent), France 69,000 tonnes (12.8 per cent) and Italy, the Federal Republic of Germany and Belgium – Luxembourg about 34,000 tonnes (around 6.0 per cent) each. Table 3 also shows the corresponding values of these import figures.

The Western European market

The last three to four decades have seen rapid growth in the range of exotic fruits available in the European Community (EC). Four principal factors have contributed to this growth:

- There has been substantial settlement in Europe of people of diverse ethic origins. These ethic groups have a strong liking for their traditional foods and an import market in fresh fruits and vegetables has developed, mainly outside the traditional trading channels.
- Some formerly little-known fruits have been vigorously promoted and marketed by supply countries. Fruits such as the avocado which was promoted by South Africa and Israel, and the Kiwi fruit promoted by New Zealand, have helped to widen the interest in exotic fruits.
- The indigenous populations have been increasingly inclined to incorporate novel foods in their diet. This has arisen from:
  - the appearance in restaurants of dishes catered by ethic minority groups
  - the ever-increasing range of cooking aids and prepared ethnic dishes for sale in shops and supermarkets
  - interest generated by cookery books, magazines, radio and television on foods and their preparation
  - greater travel abroad.
- More frequent and quicker transport (especially by air) together with improved handling procedures (including sea freighting), has facilitated the growth in imports of highly perishable exotic produce.

The pineapple is perhaps the most widely recognized and accepted of all the exotic fruits. However, it still makes up a relatively small percentage of the world fruit market. It does not appear among the top 200 products imported into Japan, North America and Western Europe (ITC, 1990).

Because of the traditional linkages between Western Europe and CARICOM, the stringencies associated with entry into the US market and the fact that USA has been traditionally supplied by the Philippines, among others, it is reasonable to focus this study on the potential for CARICOM to export into Western Europe.

Table 3. Importation of fresh pineapples by major importing countries: 1986/1989

	1986	1987	1988	1989	1986	1987	1988	1989
	tonnes				1000 US$			
World	**490,652**	**538,971**	**537,191**	**538,244**	**241,443**	**320,268**	**330,692**	**324,660**
Americas								
United States	77,229	80,944	81,736	98,448	18,882	30,197	36,683	50,746
Canada	13,312	14,889	12,687	15,786	5,565	6,238	7,044	7,985
Argentina	16,959	13,240	10,085	11,000 *	4,744	4,421	3,072	3,300 *
Asia								
Japan	144,811	144,678	138,157	135,383	65,159	72,700	72,952	68,090
Singapore	12,497	12,494	13,394	13,026	904	932	1,044	1,103
Europe								
France	67,654	70,788	77,085	68,936	44,880	60,443	61,459	54,703
Italy	27,724	43,645	43,270	36,088	18,975	34,634	36,407	32,677
Federal Republic of Germany	36,341	38,879	37,946	34,175	19,535	24,289	23,020	18,920
Belgium/Luxemburg	13,736	28,142	29,606	33,323	7,345	17,668	18,288	18,542
United Kingdom	19,150	21,279	22,348	20,008	14,857	18,456	18,047	16,747

Source: FAO Trade Statistics

* – FAO unofficial figure

Table 3 shows that the Western European market as a group is by far the largest market for fresh pineapples; larger than that of Japan. When world pineapple trade peaked in 1987 Japan imported about 145,000 tonnes and the five major West European importers (France, Italy, the Federal Republic of Germany, Belgium – Luxembourg and the United Kingdom) together imported approximately 203,000 tonnes. Japan's imports were valued at US$73m (US$503 per tonne) while the West European imports were valued at US$156m (US$769 per tonne).

In 1987, a study of selected European markets was conducted by the International Trade Center (ITC, 1987). The study revealed that the total importation of fresh pineapples into 10 selected countries – France, Federal Republic of Germany, Netherlands, United Kingdom, Belgium/Luxembourg, Switzerland, Austria, Denmark, Sweden and Norway – amounted to approximately 170,000 tonnes in 1986. France, with about 68,000 tonnes, was the leading importer followed by the Federal Republic of Germany (37,000 tonnes), the Netherlands (19,300 tonnes), then the United Kingdom with approximately 19,200 tonnes.

The ITC study, however, did not take Italy into consideration. FAO Trade Statistics show that Italy was already a major importer (28,000 tonnes) and if this country was included, the 11 Western European countries together imported almost 200,000 tonnes in 1986.

Table 4. Importation of fresh pineapples by 11 Western European countries: 1986 and 1989

	1986	1989		
	Quantity (tonnes)	Quantity (tonnes)	(per cent)	Value (US$000)
Total	**198,479**	**222,140**	**100.00**	**165,000**
France	67,654	68,936	31.0	54,703
Italy	27,72436,088	16.2	32,677	
Federal Republic of Germany	36,341	34,175	15.4	18,920
Belgium/Luxemburg	13,736	33,323	15.0	18,542
United Kingdom	19,150	20,008	9.0	16,747
Netherlands	19,337	14,058	6.3	8,437
Switzerland	6,687	6,546	2.9	8,439
Austria	2,872	3,653	1.6	2,540
Denmark	2,607	2,736	1.2	1,644
Sweden	1,640	1,864	0.8	1,721
Norway	731	753	0.3	630

Source: FAO Trade Statistics

This trend was partially continued in 1989 when out of a Western European total import volume of 222,000 tonnes, France imported 69,000 tonnes (31.0 per cent), Italy 36,000 tonnes (16.0 per cent) and the Federal Republic of Germany 34,000 tonnes (15.4 per cent). The Federal Repblic of Germany was however followed by Belgium/Luxembourg with 33,000 tonnes (15.0 per cent), the United Kingdom with 20,000 tonnes (9.0 per cent), then the Netherlands with 14,000 tonnes (6.3 per cent) (Table 4).

The ITC study further pointed out that the Cote d'Ivoire was the largest supplier of pineapples to Europe during that period. In 1986 alone, Cote d'Ivoire exported about 147,000 tonnes of fresh pineapples to the ten markets referred to in the study, representing about 86.0 per cent of their total annual supplies. In addition, it exported about 22,000 tonnes to Italy and 13,000 tonnes to Spain.

Early indications are that in 1990 pineapple production in the Côte d' Ivoire may have fallen by almost 30 per cent from the 1988 figure of 265,000 tonnes. However, it is believed that any production increases by Ghana, South Africa or Kenya would not have been significant enough to displace Côte de Ivoire from being the major supplier to Western Europe in 1990. In this new decade, however, Côte d Ivoire could face a decreasing share of the Western European market as production, quality and reliability of supply increase in those three African countries.

As was mentioned above, three of the Western European countries (France, the Netherlands and Belgium/Luxembourg) are also important because of the role they have played in re-exports into other European countries. It is perceived that this role could only expand as the economies of the Eastern European countries are consolidated.

The following section of the paper will focus on three of these Western European countries; France because it is the largest of the European markets, the United Kingdom because of CARICOM's existing commercial and social ties and the Federal Republic of Germany because of its size and assumed potential for growth.

France

France is by far the largest European importing country of fresh pineapples and the second largest in the world after Japan. French imports of fresh pineapples almost doubled between 1982 and 1985 and peaked in 1988 at about 77,000 tonnes, decreasing to about 69,000 tonnes (US$793 per tonne) in 1989. Early indications are that in 1990, France imported only 56,000 tonnes of fresh pineapples. The ITC study referred to earlier shows that over the 1982-1986 period, Côte d'Ivoire dominated the market and at no point supplied less than 90 per cent of the total imports into France. It has been pointed out in a recent article in the *Courier*, an ACP-EC biomonthly magazine, that more pineapples originating in Cote d'Ivoire are being shipped directly to northern Europe rather than through France.

Fresh pineapple is well-known on the French market and French consumers, unlike those in some other countries, no longer consider pineapple a luxury item. It has, in fact, left the ranks of the exotics and acquired the status of a 'common' fruit (as have the avocado and kiwi) and is frequently consumed as a dessert by the average French family (Delmas, 1991; Kotler, 1988). Figure I explains.

The market may be divided into two broad categories. The first is a small luxury market, consisting mainly of high-quality restaurants and specialist shops. This market segment is supplied with air-freighted 'Smooth Cayenne' fruit mainly from Cote d'Ivoire and is unlikely to develop much further. The second is the regular retail market, supplied chiefly by the Cote d'Ivoire and Cameroon. This market has been growing yearly and is also of the 'Smooth Cayenne' variety.

Fruit of sizes B (1.1–1.5kg) and C and 0.9–1.1kg are preferred. Pineapples of these sizes make up almost 90 per cent of the market and command the highest prices on the regular market.

Prices for Côte d'Ivoire pineapples tend to fluctuate considerably with the size of the shipments. In December, just before the Christmas and New Year holidays, wholesale prices usually reach their peak.

LAUNCH
Small citrus
(Minneola, Temple)
Guava, papaw
Lychee
Passion fruit
Off-season melon
Prepared vegetables
Sweet corn
Okra
Sweet potato

GROWTH
Off-season grape
(black, white, red)
Mango
Lime
Kiwi
Red grapefruit
Nectarine
Prepared produce

MATURITY
Avocado
Lemon

SATURATION
Pineapple
Apricot
Banana
White grapefruit
French bean
Oranges

DECLINE
Coconut
Mandarin
Satsuma
Podded beans

Figure 1. Growth cycle of the market for exotics (Source: Delmas, 1991)

(Products reaching the end of their growth and mature products tend to leave the exotics section to enter the range of basic products e.g., avocado, pineapple, kiwi).

United Kingdom (UK)

It is generally felt within the CARICOM region that the UK market is the largest for fresh pineapples. The data to hand, however, show that this is not so. Although volumes have increased steadily over the years, the UK remains a relatively small Western European importer of pineapples. In fact, Table 3 shows that the UK market was the fifth largest Western European market in 1989.

After having fluctuated at the 5,000 tonnes level in the mid 1970s, imports into the UK suddenly took off in 1979. In 1986, they reached 19,200 tonnes coinciding with the emergence of Côte d'Ivoire as the leading supplier. They UK peaked in 1988 at about 22,000 tonnes, valued at US$18m, but declined in 1989 to 20,000 tonnes, valued at US$17m.

The UK market may be divided into two types. One is the small luxury market, supplied mainly by Kenya and Uganda, with air-freighted and premium-priced large fruits weighing about 2kg each. The varieties supplied to this market included the 'Sugar Loaf' (ODNRI, 1988). These pineapples go to the catering or quality retail trade and are often used for decorative purposes. Between November and January, some high-quality Cote'd'Ivoire and South African fruit, sent by air, also goes to the luxury market. The other type is the popular larger market, supplied mainly by Cote d'Ivoire and South Africa with sea-freighted 'Smooth Cayenne' pineapples. The fruits for this market weigh from 1 to 2kg each.

The London area is the main market, although the fruit is well known throughout the country.

Some years ago, the small fruit from South Africa and Cote d'Ivoire fetched the best prices if they weighed about 1kg each. Larger pineapples were not appreciated. This situation has changed somewhat and consumers have been known to ask for larger fruit of 1.5 to 2kg as they realize that its price to edible fruit ratio is much more advantageous.

The Federal Republic of Germany

While the import volume of fresh pineapples into the Federal Republic of Germany tripled between 1982 and 1986 to reach about 36,900 tonnes, there has since been a slight decrease to about 34,000 tonnes (US$ 557 per tonne) in 1989. As was the case for France and the United Kingdom, Côte d'Ivoire was the dominant supplier in 1986, supplying 93.0 per cent of all imports.

Pineapples are no longer considered a luxury in the Federal Republic of Gerrmany. Their use is gaining in popularity and consumption is expected to increase in the future.

The Carribean Community

Production

Within the Caribbean Community (CARICOM) only Guyana, Jamaica and Trinidad and Tobago are considered to be producing quantities of any significance. FAO (1988) data show Guyana's production at 6,000 tonnes, Jamaica's at 7,000 tonnes and Trinidad & Tobago's at 3,000 tonnes (Table 5).

The United Nations Economic Commission for Latin America and the Caribbean (UNECLAC) records the 1985 pineapple production of Antigua and Belize at 185 and 181 tonnes respectively. ECLAC also records the production of St Vincent and Montserrat at 2 tonnes in 1981 and 1982.

In addition the Dominica-based Agriculture Diversification Co-ordinating Unit (ADCU) records the following:

St Kitts/Nevis (1985)	6 tonnes (produced)
Antigua (1988)	430 tonnes (produced)
Grenada (1988)	27 tonnes (produced)
Dominica (1988)	2 tonnes (exported)
St Vincent (1988)	7 tonnes (exported)

A crude estimate therefore of current regional pineapple production is shown in Table 5.

Table 5. Estimates of pineapple production in the CARICOM countries.

Country	Quantity produced (tonnes)
Antigua & Barbuda	450
Barbados	0
Belize	200
Dominica	6
Grenada	30
Guyana	8,000
Jamaica	8,000
Montserrat	1
St Kitts/Nevis	6
St Lucia	6
St Vincent	10
Trinidad & Tobago	4,000
Total	20,709

With an estimated total CARICOM production of about 21,000 tonnes, the entire region would still be a relatively very small producer even when compared with other Caribbean and Central American countries as illustrated in Table 6.

A study of Tables 5 and 6 shows CARICOM only to be producing more than Guadeloupe, Haiti, Panama and El Salvador. Even with the agricultural diversification programme of the Organization for Eastern Caribbean States (OECS) this situation is not likely to change within the short to medium term, except there are some new production and export initiatives in Guyana (Craig, 1989).

Table 6. Production of pineapples by major CARICOM and Central American countries: 1979/81 and 1986/1988

	1979-1981	1986	1987	1988
	....	000s tonnes	....	
CARICOM				
Guyana	2	5	6(F)	6(F)
Jamaica	4	7	7	7(F)
Trinidad & Tobago	3	3(F)	3(F)	3(F)
Other Caribbean/Central American countries				
Costa Rica	10	55(F)	60(F)	65(F)
Cuba	16	22	23	22
Dominican Republic	21	42	72	44
El Salvador	19	16	15	17*
Guadeloupe	14	4	4	4(F)
Guatemala	32	44	46	45(F)
Haiti	2	2(F)	2(F)	2(F)
Honduras	33	38(F)	39(F)	40(F)
Martinique	18	30	24(F)	24(F)
Nicaragua	34	38(F)	39(F)	39(F)
Panama	6	14	15	12
Puerto Rico	37	45	55	59

* – FAO unofficial figure (F) – FAO estimate

Exportation

Table 7 shows the value of exports between 1985 and 1989 as recorded by the CARICOM Secretariat. The annual average is about EC$25,000 (US$9,260). Using the 1988 Dominica export figure of approximately 2 tonnes valued at EC$3,696 (US$1,370) , it could be extrapolated that the average export value of EC$25,000 between 1985 and 1989 was equivalent to merely 13.5 tonnes. The information available was not comprehensive enough to ascertain the percentages of intra- and extra-regional exports.

Guyana – the major CARICOM exporter

In addition to the above data, and perhaps even more important, are the data on exports recorded by the New Guyana Marketing Corporation (New GMC). Table 8 shows that in 1986 Guyana exported 271 tonnes of pineapples. This figure increased to 719 tonnes in 1988, decreasing to 665 tonnes in 1990. The 1991 half-year figure was 410 tonnes. Pineapple exports had a domestic value of about G$4m in each of the years 1986, 1988 and 1989. In 1987, the 522 tonnes were valued at G$2m and in 1990 the domestic value of pineapple exports was G$7m. New GMC statistics estimate that the official banking system benefited from pineapple exports worth US$53,000 in 1987 and US$70,000, US$78,000 and US$48,000 in 1988, 1989 and 1990 respectively. The 1991 half-year export volume of 410 tonnes is estimated to have contributed directly US$44,000. New GMC documents suggest that Guyana mainly produces and exports the Montserrat variety which is apparently related to the Queen. The leaves and fruit are spiny the flesh is white but the aroma and flavour are excellent and generally sweeter than the Smooth Cayenne. The total value of Guyana's pineapple exports was therefore as follows (using US $451 per tonne as a basis for calculation): US$235,422 (1987), US$324,269 (1988), US$272,404 (1989) and US$299,915 (1990).

Importation

Table 9 shows that the major importing country has been Barbados which imported 497 tonnes (95 per cent) of Guyana's total pineapple exports in 1987, 663 tonnes (92 per cent) in 1988, and 332 tonnes (50 per cent) and 221 tonnes (54 per cent) in 1989 and 1990 respectively.

In an FAO study, Craig (1989) reported: "Pineapples therefore now rank third in importance in the list of fruit imports (in terms of volume) into Barbados."

In 1988 pineapples (663 tonnes) ranked third in Barbados fresh fruit imports after oranges (1,659 tonnes) and apples (805 tonnes).

In the study referred to, it was also reported as follows:

> "In fact, this ranking from a Barbados import point of view, ought to be considered alongside the fact that from a Guyana export point of view pineapples also rank third, after sugar and rice. It is recognised that it is a distant third; as 1988 export figures are recorded as sugar (170,000 tonnes), rice (132,000 tonnes) and pineapples (719 tonnes). Nevertheless pineapples rank first in relation to Guyana's diversification programme."

In 1987 and 1988 Guyana's market share for pineapples in Barbados was 97.0 per cent and 99.7 per cent respectively (Craig 1989). While no further detailed analysis has been done since 1989, indications are that while the volume of exports into Barbados decreased by 244 tonnes between 1989 and 1990, Guyana has to date maintained its share in the Barbados market place. Reasons offered for the decrease in exports to Barbados include: decreased profitability, high percentage of rejects due to poor quality, alternative export markets (Trinidad) and increased processing activity in Guyana.

Table 9 also shows that Trinidad & Tobago was the second most important importer of pineapples from Guyana between 1987 and 1989. In 1990 however, Trinidad became as important an importer as Barbados as each country accounted for about 50 per cent of Guyana's total exports. It ought to be mentioned too that, apart from this fresh pineapple trade, the importation of pineapple products into Trinidad & Tobago has been on a steady increase.

Table 7. Value of pineapple exports in EC$, 1985/1989

Year	Antigua	Barbados	Dominica	Jamaica	St Kitts	St Lucia	St Vincent	Trinidad & Tobago	Total
1985	--	--	1,202	14,888	360	--	11	4,824	21,285
1986	--	270	2,050	24,644	--	10	--	4,275	31,249
1987	5,016	--	727	9,810	15	80	--	4,583	20,231
1988	3,939	--	3,696	10,465	--	6,820	--	5,992	30,912
1989	6,691	954	1,580	301	--	5,000	--	8,983	23,509

Source: CARICOM Secretariat

-- No recorded exports US$1.00 = EC$2.70

Table 8. Volume and value of Guyana's pineapple exports: 1986 - 1991

	1986	1987	1988	1989	1990	1991 (Jan-June)
Volume (tonnes)	271	522	719	604	665	410
Domestic * value (G$m)	4	2	4	4	7	5
Estimated Bank of Guyana earnings ** (US$000)	NA	53	70	78	48	44

Source: New Guyana Marketing Corporation

* Domestic value is volume exported multiplied by the average wholesale price for each year

** Represents the maximum amount of foreign exchange that exporters were obliged to return to the official banking system. It was calculated by multiplying export volume by a fixed rate per kg. This rate changed over time.

Table 9. Distribution of Guyana's pineapple exports by country and volume

Country	1987	1988	1989	1990
	.... tonnes (% in parentheses)			
Antigua	--	0.7 (0.1)	3.9 (0.7)	0.6 (0.1)
Barbados	497.0 (95.2)	663.2 (92.3)	576.2 (95.5)	332.34 (49.9)
Canada	--	0.7 (0.1)	3.1 (0.5)	0.2 (0.0)
Trinidad & Tobago	25.4 (4.8)	54.13 (7.5)	20.4 (3.4)	331.6 (49.9)
USA	--	--	--	0.6 (0.1)
Total	522.0 (100)	718.73 (100)	603.53 (100)	665.33 (100)

Source: New Guyana Marketing Corporation

While FAO importation statistics show the same trends, the actual figures recorded were higher for both Barbados and Trinidad and in addition St Lucia is recorded as a larger importer than Trinidad & Tobago.

Total CARICOM (Barbados, Trinidad & Tobago and St Lucia) imports as recorded by FAO were as follows: 536 tonnes (1987), 761 tonnes (1988) and 1000 tonnes (1989). The corresponding values were: US$285,000, US$343,000 and US$352,000.

Using the 1988 figures as the basis for comparison, an extrapolation from the FAO data would suggest that CARICOM imports were valued at US$451 per tonne (1988). This compares favourably with the 1989 study (Craig, 1989) in which the Barbados cif value of pineapples was calculated at US$428 per tonne.

Marketing opportunity for CARICOM

Having examined the world trade in fresh pineapples, the Western European market for fresh pineapples as well as the status of pinapple production and trade within the region, it seems quite logical to think of the opportunities that may exist for CARICOM to export into Western Europe.

Demand side considerations

Given the analysis in the production and exports in the previous sections the following conclusions could be drawn:

- While Western European imports (Table 4) continue to increase, they increased by merely 22,000 tonnes between 1986 and 1989.
- The value per tonne of pineapples imported into the five major importing countries in Western Europe decreased from US$769 in 1987 to US$734 in 1989 (Table 3).
- Pineapple imports may have reached the saturation point in France, the major importer (Figure 1).
- Côte d'Ivoire, Ghana, South Africa and Kenya seem to be fully entrenched in the Western European markets and they could expand easily in response to any increase demand in Western Europe.
- There are some market opportunities within CARICOM (Barbados and Trinidad) which may not be fully tapped.

Supply side considerations

Land resource

With the exception of Guyana and Belize, the region has a narrow land resource base, only a small portion of which is arable without restrictions. Ten of the CARICOM Member States are volcanic or limestone-based islands. They are extremely small, with Jamaica being the only one with over 10,000km^2. In contrast to the islands, Guyana and Belize are located in continental South and Central America respectively and comprise 83 and 9 per cent respectively of the combined total land area. The topography of all the states is extremely variable, and the majority of the islands have mostly hilly to mountainous terrain.

The two continental countries of Guyana and Belize have larger land areas relative to their population size, as well as a more favourable topography for agricultural activities, although soil fertility and susceptibility to flooding present significant problems. They are able to sustain a higher population density and allow for relatively greater possibilities for the application of modern technologies (IICA, 1989).

Human resources

Limited human resources within the region also represent a constraint to large-scale pineapple production and export. Population growth in the region has varied considerably from country to country, ranging from real declines in Guyana to annual increases of nearly 4 per cent in St Lucia (World Bank, 1990) . Overall population growth has remained quite low by developing country standards, predominantly because of high emigration, mainly to North America. While emigration has compensated for the high birth rate, it has depleted employable human resources, reduced availability of skilled labour and created a population heavily skewed toward dependent minors (CARICOM, 1988).

Despite the small population, unemployment rates of between 10 and 25 per cent have been reported (World Bank, 1990) It has been observed that activities associated with agriculture including those more pleasant than handling pineapple plants and fruits are not tasks to which CARICOM youth seem eager to take up. Alternative employment opportunities in the tourism, manufacturing or the public sector, generally compound this issue of the availability of relatively cheap labour for agricultural pursuits. The usually densely populated Latin Amercia, African or Asian countries tend to have farm labour available at competitive rates.

The above scenario is however less true for Guyana and Belize. In Guyana, thousands of farmers are accustomed to working with pineapples and will continue to do so once the price is right. In addition Guyana's free market exchange rate has made it very competitive. Belize, like Guyana has a small population base, but like the rest of CARICOM is a high-cost producer. However, Belize is well placed to benefit from Salvadorians and Guatemaleans who are willing to work for lower wages.

Marketing institutions and infrastructure

The one regional marketing company, the Caribbean Agricultural Trading Comapny (CATCO), is a joint venture between the Caribbean Food Corporation (CFC) and the regional private sector which was established in 1981 with the aim to increase the exportation of non-traditional agricultural produce from the region. To date while CATCO has made a significant contribution to the development of non-traditional export niches for the region, its own export volume peaked at about 1,300 tonnes in 1988/89.

The pineapple trade has been limited to very small quantities and took place only within the last year, 1990/91. This was in fact part of the Guyana to Barbados trade already described.

Apart form CATCO, each CARICOM Member State has at least one government-run central market agency which is involved either directly or indirectly in marketing agricultural produce in general, but not pineapples specifically.

Guyana, the major producer and exporter of pineapples, has almost no suitable marketing infrastructure (Abbot, 1986) while the Windward Islands, which together have the biggest fruit marketing infrastructure, are specialized in the marketing of bananas and lack additional land resources to be able to produce both bananas and pineapples in significant quantities.

Other constraints to exporting pineapples from Guyana include: the cost of available overseas transportation, inadequate and too costly internal transportation and the high cost of packaging (New GMC, 1988; Kohls, 1980).

Conclusions

World pineapple production increased by 1.3 million tonnes between the 1979-81 period and 1988. However, the three major African producing countries of Cote d'Ivoire, South Africa and Kenya, together produced 19 per cent less pineapples between 1986 and 1988. Even if African production decreased to the extent that there is a shortage in the European market place, it can be assumed that some of the major exporting countries of Latin America (Costa Rica, Honduras, Mexico and Brazil) and Asia (Philippines, Malaysia, China and Thialand) could easily fill the void as has happened over time with banana and sugar cane among other commodities.

Competition is unlikely to be laidback (Kotler, 1988).

The Western European market for fresh pineapples, which is the largest market of the type, is essentially a market for Smooth Cayenne pineapples at present and is at best close to maturity, given the meagre 10 per cent increase in imports between 1986 and 1989. The 5 per cent decrease in value per tonne for fruit between 1987 and 1989 cannot be considered significant though it is a trend that requires close monitoring. There has been virtually no growth in the French market between 1986 and 1989.

Japan remains the largest single market for fresh pineapples despite a 7 per cent decrease in imports between 1986 and 1989.

While the production and trade in fresh pineapples within CARICOM are relatively small, they are of importance to Guyana, the major producer (8,000 tonnes per year) and exporter (700 tonnes per year) and to Barbados the major importer (300-600 tonnes per year). The regional market for quality fresh pineapples (Barbados and Trinidad), separate and apart from the pineapple product market, could be at the early growth stage; hence regional trading opportunities.

It can also be concluded that only Guyana (215,000 km^2) and Belize (23,000 km^2) are endowed with adequate land resources to allow for large-scale pineapple cultivation without reducing the acreages under other crops. While their small popultions are limitations to major production efforts, Guyana's free market exchange rate (currently about G$115.00 = US$1.00) and Belize's access to cheap labour across the border do give these countries additional advantages. Irrespective of location it is clear that the marketing infrastructure for fresh pineapple exports is lacking and that the variety currently grown by Guyana is not the major seller in Western Europe.

In general it can be concluded that the Western European market for huge quantities of CARICOM-grown fresh pineapples is more a myth than an immediate opportunity.

Recommendations

Pineapples of the several different varieties produced within the region should continue to be exported to the niche markets wherever these exist, including those in Western Europe but not exclusively. Because this niche market is relatively small, it will be most suited to the small exporters who currently exist. This group of exporters would need appropriate guidance in the general area of post-harvest handling (including packaging), to be able to stay in business over time. Available and proposed air shipments out of the region (except for Guyana) are likely to be adequate to export these smaller quantities of produce.

The second and more important recommendation embraces the large-scale cultivation of a marketable variety of pineapple, in Guyana in particular. It is recommended that the relevant agency in Guyana pursue this area vigourously. The initiative of printing a booklet geared to woo foreign investors to produce pineapples in Guyana through a joint venture (or otherwise) for ultimate overseas marketing could only be the first step (New GMC, 1991).

In the Report on the COLEACP Commercial Training Course, Craig (1991) stated that Western European market intermediaries were generally not interested in any production venture (direct or indirect), hence the difficulty with making such a recommendtion a reality.

Such a potential investor would be provided with a large enough incentive as the investments required would include those related to pre-production, production, harvesting and marketing activities (Craig, 1987). This approach is consistent with what Kaimowitz (1991) discovered about Latin American fruit and vegetable exports. At the worse, even if the incentive package is not competive enough for Western European investors (as a result of similar packages from the African and Asian countries) it could offer some opportunities for CARICOM entrepreneurs.

The incentive package should be open to potential Japanese investors as well, because of the size of the market and the strength of the econony. Traditional ties become less important with a sound business deal.

While this study has been confined to pineapples, it is further recommended that the model proposed above should be the basis for any large-scale production and marketing initiative for other commodities under similar circumstances.

Suggestions for further research

An indepth study of the Latin American model, particularly the Chilean experience in fruit and vegetable exportation, should be undertaken as there could be some applications to Guyana and Belize specifically.

In addition, the market for pineapple products within CARICOM should be investigated as there is evidence to suggest that this trade has been growing, between Guyana and Trinidad & Tobago in particular.

References

Abbot J C .1986. Marketing improvement in the developing world, Food and Agriculture Organization, Economic and Social Development Series No. 37 Rome: FAO. pp 108–128

CIDA. 1987. Review of agricultural diversification in the Organization of Eastern Caribbean States (OECS). Canadian International Development Agency.

CARICOM. 1988. Regional agriculture sector programme, 1987-91. Guyana: Caribbean Community Secretariat. 193pp.

Craig K. 1987. Exporting horticultural crops: Prospects and alternative approaches. Guyana: New Guyana Marketing Corporation. 15pp.

Craig, K (1989) Review of the Barbados market for Guyana's produce, FAO Report Project Guy/86/003. Guyana: New Guyana Marketing Corporation. 20p

Craig K. 1991. Report on the commercial training course of the Comite de Laison: Europe, Afrique, Caraibes, Pacifique. Guyana: New Guyana Marketing Corporation. 12pp.

Delmas G. 1991. The fruit and vegetables market in Europe: The case of France. ACP-EC Courier. 129. p. 2

IICA. 1989. Strategy of action for reactivation of agriculture in the Caribbean countries. Plan of joint action for agricultural reactivation in Latin America and the Caribbean. Inter-American Institute for Co-operation on Agriculture. 65pp.

ITC. 1987. Tropical and off-season fresh fruits and vegetables: A study of selected European markets. Geneva: International Trade Center UNCTAD/GATT,. 264pp.

ITC. 1990. Dynamics of exports from developing countries: 1984–1988. Geneva: International Trade Center. 70pp

Kaimowitz D. 1991. Cambio tecnológico y la prodocion de exportaciones agricolas no tradicionales en América Central. Instituto Interamericano de Co-operación para agricultura. 49pp.

Kohls R L and Joseph N U. 1980. Marketing of agricultural products. New York: Macmillan pp. 3-245; 359-395

Kotler P. 1988. Marketing management, analysis, planning, implementation and control. Englewood Cliffs: Prentice - Hall International. pp. 65-404

New GMC. 1988. The problems and prospects of shipping agricultural produce. Guyana: New Guyana Marketing Corporation. 20pp.

New GMC. 1991. Second quarter and half-year performance report. Guyana: New Guyana Marketing Corporation. 14pp.

New GMC. 1991. An investment opportunity in Guyana's agro-food business: Pineapples. Guyana: New Guyana Marketing Corporation. 12pp.

New GMC. 1991. The first five years and the next: 1986-1995. Guyana: New Guyana Marketing Corporation. 14pp.

ODNRI. 1988. The United Kingdom market for fresh exotic fruit. Overseas Development Natural Resources Institute, Bulletin No. 13. United Kingdom: Overseas Development Natural Resources Institute 50pp.

World Bank. 1990. Caribbean regional current economic situation, regional issues and capital flows. Washington: World Bank 100pp.

A CHANGING MARKET

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The objective of this paper is to illustrate the problems and complexities of supplying fresh produce and ornamental flowers and plants from the Caribbean region to the UK which is one of the most sophisticated and demanding markets in Europe.

Unfortunately, my present company does not sell ornamentals and I will be restricting my comments to fresh produce but the principles, methods of distribution and problems are very similar and I hope those interested in this market will be able to relate to them.

You need to be totally committed to the export market if you wish to be successful, create wealth and at the same time contribute to the overall prosperity of the region.

A half-hearted approach is doomed to failure, because the temptation to supply the less demanding domestic market or the developing tourist market will become too great.

Once you start letting your export customers down, all the efforts you put into developing your business will be wasted and nowadays you do not get a second chance.

Therefore, in presenting my paper this morning, I am assuming that the decision to export has already been made and that the commitment is there.

You will appreciate that I am unable to speak on behalf of other UK retailers and some may well disagree with what I am going to say, but I am able to share with you my own views, experiences and the sort of questions I ask as a buyer when I look for a new source of supply.

Now if someone tells me something, as a fairly cynical buyer, I normally like to know something of his background in order to understand his views.

To assist you in this process, I would like to tell you a bit about myself and the company I work for.

I have been in the produce industry all my life, working originally with my father and brother, selling fruit, vegetables and flowers in London, buying from London's premier wholesale market, Convent Garden.

Supermarkets began to make an impact on the more traditional retail outlets in the UK during the 1960s and I joined Waitrose in 1969. Since that time I have worked in all major areas of buying, selling, warehousing and quality control.

Waitrose supermarkets are the food shops of the John Lewis Partnership The company was founded in 1904 when Wallace Waite, Arthur Rose and David Taylor opened a small grocery shop in Acton, West London.

By 1908 Mr Taylor had left and the two remaining partners combined their surnames to create the name under which the company has traded ever since – Waitrose.

In 1937, Waitrose, by then a chain of a dozen grocery shops in London and the Home Counties, became a part of the John Lewis Partnership.

Following experiments with a number of small, self-service food shops, Waitrose opened its first supermarket in Streatham, South London in 1955.

Today Waitrose has around 100 branches and a turnover exceeding £1 billion. In addition to its food shops, the John Lewis Partnership has 22 department stores and manufacturing interests.

In 1990 total sales exceeded £2 billion with fixed assets of over £700 million. The company has 34,000 employees, referred to as 'partners' from the day they join and they are directly involved as co-owners of the business.

All the profits are shared among the partners, after provision for reserves for interest on loans and for fixed dividends on preference shares – primarily in the form of a cash bonus distributed as a percentage of annual pay.

The Partnership aims to run its business efficiently and competitively and at the same time to enable its members to be fully informed about it, to express their views freely, to co-operate in shaping its policies and to share in its rewards. Management is accountable to partners through elected councils and keeps them informed via in-house magazines.

Waitrose currently build supermarkets of between 1,500 and 2,000 m^2 in the south of England,, East Anglia and the southern Midlands. We are particularly strong in fresh foods and wines and I am proud to say that my department leads in terms of sales and profit and indeed occupies the prime position at the entrance to the shop.

We normally sell around 300 items of fresh produce from basic home-produced vegetables to imported fruits and exotics from all over the world and for the last 2 years or so, have included a range of organic fruit and vegetables.

We currently buy from 60 countries world-wide, offering our customers a choice of loose and pre-packed produce, as well as freshly prepared pre-packed and self-service salads from salad counters. We have recently refrigerated our main distribution centre, our delivery vehicles are in the process of being refrigerated and over the next 2 or 3 years all our branches will have up to half the fruit and vegetable department refrigerated to sell at either 5°C (chilled) or 10°C (cooled) according to the needs of the product.

We have always been ready to experiment and examples of innovation in recent years have been new varieties of tomatoes, citrus and apples, beans and mange-tout peas trimmed and packed at source, exotic mushrooms and dwarf vegetables.

One of the first rules of exporting is to know your market and your customer. Until you know the sort of quality and image required for your product to perform well in a highly competitive market place, you cannot begin to sell it effectively.

Changing markets

I am going to show you a short video with clips from the Waitrose archives which illustrate how markets have changed and developed over the years and it ends by bringing you up to date with the supermarket scene in the UK today. It starts at the turn of the century with Mr. Waite, Mr. Rose in London.

You can see from the video how the UK supermarket has evolved over the years. We now have only nine major supermarket groups left, of which Waitrose is one of the smaller if measured in terms of volume.

However, we operate at the top end of the quality market, where being too big can be a disadvantage, because of the limitation on the availability of top quality fruit.

Supermarkets have 94 per cent of the UK grocery market and currently 46 per cent of the fresh produce market, a figure which I predict will rise to at least 60 per cent within 7 or 8 years.

Evolution that affected the supermarket also had its impact on the sources of supply and distribution.

Traditionally, home-grown produce was brought to the wholesale market, such as Convent Garden in London, by the growers and sold by their salesmen to the retailers. Imported produce arrived by sea and was sold on commission by the wholesalers.

Porters were paid to carry the purchases to the buyers' vehicles and very often the porters had to be given an additional payment or a tip to avoid delays.

Supermarket buyers, who purchased significant quantities, bypassed the wholesale market and the system of porterage to deal directly with the growers who in turn delivered their produce to the supermarket's distribution depots rather than the wholesale market.

The wholesalers tried to introduce new working practices such as palletization and the use of forklift trucks, but this was resisted by the Union. This in turn encouraged many of the larger wholesalers to set up warehouses well away from the market and to sell produce from there direct to the supermarkets. It was these progressive wholesalers who evolved into today's large importers of fresh produce such as Geest, Fyffes, Saphir, etc.

Convent Garden still remains a magnet for exotic produce, supplying the London hotel and restaurant chains but most of the smaller independent retailers have now moved to the provincial markets.

Waitrose now buys less than half of one per cent of its turnover from the wholesale market.

Closer co-operation, brought about by the direct trading relationship between the growers and the retailers, had a profound influence of the way the produce industry developed in the UK.

The supermarkets were in direct contact with the end-consumer and by allowing its customers to serve themselves, they very quickly learnt the size and quality of produce their customers wanted from what they left behind.

The grower was now exposed to direct criticism of his produce by the buyer, whereas in the past his comments had been watered down by the market salesman. Rather than taking offence, the progressive grower, who took a pride in his produce, welcomed the constructive criticism. The quality of his produce improved and so did his business.

Progress with the wholesalers/importers was slower, basically because they were more concerned about keeping an exporter happy than satisfying their customers – they did not want to risk upsetting their exporter with adverse comments about his product.

Written specifications were introduced to avoid disputes about acceptable quality; these were subsequently extended to include packaging requirements, labelling requirements, sweetness and flavour requirements measured in sugars and sugar/acid ratios. Temperature controls were introduced requiring field heat to be removed from the product; then came controls on the way the produce was transported. Today other key factors such as what sprays are used and the time of harvest are also being influenced

It will come as no surprise to you to know that many growers fell by the wayside, unable or unwilling to keep up.

Many of the smaller growers joined or formed co-operatives and sought government grants to improve their facilities such as cold stores and packhouses.

Whilst many growers were vocal in condemning the buying power, influence and demands of the supermarket chains, because they were seen to be intruding on their freedom and independence, the reality was a rapidly expanding market, higher standards and higher quality produce.

Whilst margins were tight, the level of trade was growing and it was consistent, which allowed for investment in the future as well as economies of scale. It was certainly better for the grower than risking losses on the wholesale market with commission selling, bad debts and fluctuating demand.

As the produce industry in the UK became more organized the financial institutions started to show an interest in its potential for profit.

They started to purchase companies that were supplying the supermarkets. Many of these companies had been run by traders rather than by professional managers.

The traders knew the produce industry, but lacked the experience to run rapidly expanding, high-tech organizations, capable of understanding and responding to the increasing demands of the supermarket trade.

An example of this is found with produce packaging. In the past growers had only been concerned about getting their produce to market in the cheapest container available. They felt a lightweight cardboard box was sufficient to transport lettuce, packed high on the lorry, quite often with the lettuce carrying the weight of the load rather than the box.

This didn't take into account that after they were delivered to the supermarket's depot, the boxes of lettuce would become part of a mixed cage of produce stacked with many other heavier items and would still have to face a journey of two or three hours from the depot to the store!

You can see from this how important it is to know about the distribution chain your product has to go through.

Distribution and packaging

The next clip of video is designed to give you a feel for the complexities of distribution and how important it is to have good quality packaging.

The footage is now a bit dated, as we no longer accept wooden boxes because of the problems of disposal. Pallet sizes have been standardized in the fruit and vegetable warehouse to 1000mm x 1200mm and the whole warehouse is now cooled to 10°C.

It is important to remember that the ethnic market in the UK is still served to a very large extent by ethnic traders.

The smaller, but expanding supermarket trade is catering for the increasing numbers of people who holiday abroad and try to recapture the flavour of their holidays when they return home.

Supermarkets require a rapid turnover of stock and minimal wastage. This in turn leads to a requirement for smaller quantities to be packed into the boxes than would normally be accepted by the ethnic trader. Examples include okra in 4lb (1.8kg) boxes, root ginger in 5lb (2.25kg) boxes and plantain in 6lb (2.75kg) boxes.

Many UK supermarkets have an element of their home-grown produce packed by the growers into plastic returnable containers, some re-pack imported produce into plastic containers after pre-packing and labelling them in the UK.

I should explain what I mean by pre-packing; loose or bulk produce is packed into bags, punnets and trays before being offered for sale.

Where this is done the law in the UK requires a label to be applied indicating the count or weight of the produce in the pack, together with a selling price. Very often a durability date or the product's anticipated shelf-life is displayed.

With the advent of laser scanning at the supermarket checkout a bar code was also introduced.

On some products we are obliged by law to state the variety and class (quality classification). In other cases, where we may not be required to do so, we may choose to do it if we perceive some marketing advantage. For instance, we may wish to market mangoes by variety in the future.

The pre-packing of produce offers protection, enhanced presentation and with some of the new barrier films creating an internal atmosphere, it can extend the life of the product. Whilst I am satisfied that breathable films are good for the produce, I am more sceptical about the benefits of controlled atmosphere packaging because it needs perfect produce in the first place and very tight temperature controls. Given these two factors, cool distribution should be sufficient to give the product the shelf-life I am looking for.

Pre-packing also enables the seller to encourage larger purchases at a reduced price. If a customer buys a large tub of ice-cream he or she looks for a saving on the price. However, once the purchase is made this saving disappears because the kids raid the freezer and eat more ice-cream. Then another large purchase has to be made, to the benefit of the seller.

The same principle applies to selling fruit. However, to pack something into larger bags or punnets involves an on-cost and the customer wants an incentive to buy the bigger quantities.

Not surprisingly, the supermarket buyer either wants the exporter to bear the packing costs because he benefits from the increased sales, or the buyer tries to get the product packed at source, where labour costs may be lower.

The down-side to packing at source is the effects of the packaging on the life of the produce during transit and the fact that some packaging such as punnets, rather than bags, occupy valuable freight space and are therefore very expensive to handle.

Another constraint to packing at source is the availability of the right sort of packaging materials and plastics. This is a big subject in itself and one that I would like to leave to question time afterwards.

Having said all this, we have been successful in getting dwarf corn packed at source in the Far East and beans and asparagus packed in Africa, the common element being the size of the product involved and its ability to pack into a small container with little wasted space.

The wholesalers I spoke about earlier, who moved away from the terminal wholesale markets to become importers, also started to offer pre-packing facilities at their new premises, allowing bulk consignments to be pre-packed in many different ways to meet the needs of a number of different supermarkets.

The UK growers who had installed packaging facilities on their farms started to look for produce to pack when the home-grown season was over and their packhouses were idle.

They started to import vegetables themselves but often found that the element of wastage after packing was too high and realized that they would have to get closer to the source of the supply to improve their raw material.

This led to many joint ventures between English and Spanish growers of such items as iceberg lettuce, broccoli and salad onions.

The UK grower would often send his agronomist to Spain to assist the grower and a quality controller would follow to oversee the harvest, packing and despatch of the product.

Some UK growers took a financial interest in their overseas partners' businesses.

A number of the larger supermarket groups developed their own technical departments, including agronomists, to research new varieties, monitor the growing operation and oversee all aspects of production and quality control.

This was probably going too far and it is also very expensive for them to send their technicians all over the world, quite often duplicating one another's work.

The UK is currently in the throes of a recession and unfortunately this area was one of the first to suffer as companies were forced to cut back on their staffing to reduce costs.

However, Waitrose has always encouraged its suppliers (be they independent growers, co-operatives, packers or importers), to develop their own technical expertise, research and development programmes and quality assurance packages.

We ourselves retain an agricultural adviser to assist us as well as using and supporting the many excellent research facilities some of which were previously government-funded, such as the National Institute of Agricultural Botany, The Agricultural Development Advisory Service, Campden and Leatherhead Food Research Associations, and Silsoe College for post-harvest technology.

As retailers we give our suppliers the benefit of our marketing experience, showing them the gaps in the market, pointing them to new areas of development. We talk to them about new varieties and growing techniques, but leave them to do what they are good at, which is sourcing the product.

They come back and discuss the problems they have encountered, the costs and other implications of what we want and the project is carried forward in a spirit of partnership.

As growers ourselves, we have a good understanding of the problems and pressures our suppliers face, as well as the levels of investment required whilst still having to remain competitive in today's modern world.

The next video is one we show to new staff in our fruit and vegetable departments to give them a feel for the scale of the operation, the technology used and our approach to some of the sensitive issues such as intensive farming, pesticides and organic growing.

In showing you the development of produce distribution in the UK, I hope to have impressed on you the standards and professionalism currently expected of the growers and exporters hoping to supply British supermarkets, but at the same time I do not want to deter you.

The UK has always been a major importer of fresh produce from all over the world. It could be argued that the British housewife has been spoilt for choice. This results in a very demanding consumer and supermarket buyers charged with meeting those demands.

Every week the buyer will have three or four enquiries from somebody wishing to supply him, but the majority will not have studied their market. They will have no idea about the complexities of modern distribution; however, they will be very quick to tell the buyer how he can make more profit by cutting out the middle man. The exporter wants to supply container loads to just one location. He doesn't understand that a supermarket will own or subcontract a number of distribution depots, spread geographically around the country, within easy striking distance of its branches. He will not appreciate that these depots are purely for transit, where fresh produce passes through in a matter of hours and floor space is at a premium.

He now realizes that he will need a temperature-controlled warehouse with cold storage facilities to hold his produce until it is required. He is expected to provide quality control inspections both in and out of the store, completing quality control reports. He might be asked to pack it in a certain way, label it in a certain way, deliver it on special pallets, under refrigeration, at specific times to a number of depots and within tight time bands. His face drops. He thinks there must be easier ways to make money.

If as a buyer for Waitrose I am interested in his product, I will introduce him to people who can provide these facilities - at a price. He then has the option of selling his produce to them for subsequent resale to Waitrose or to pay for the facilities and include this on-cost in the delivered price to us.

Most decide on the former option, because they can then tap into an even larger market. A good wholesaler/importer will have a number of customers interested in different sizes of fruit from across the range of the crop whereas an individual supermarket may only want one or two sizes. The overseas grower or exporter can also benefit from the technical support and expertise within these companies that I mentioned earlier.

Finally, if a delivery is rejected, these companies are better placed to handle it than the exporter. The load may require re-selection or even stripping of the customer's packaging and labelling before it could be sold on the open market to minimize loss.

The major problem is finding the right partner for the exporter because if the company proposed has conflicting contacts or interests, the relationship is bound to fail.

Supermarkets also use the wholesalers/importers to find suitable sources of supply where a three-cornered relationship can be developed between the source of supply, the intermediary and the supermarket.

Buyer's motivation

It might be useful to take a closer look at this area to see what might motivate a buyer to seek a new source of supply.

The most common motivation is likely to be that he is unhappy with his present source of supply. The quality may not be good enough, the price may not be right or the continuity of supply may be poor. Since today the biggest crime a grower or exporter can commit is to fail to maintain continuity of supply, let us look at that area for an illustration and try to bring it fairly close to home.

We used to purchase some of the best mange tout peas from Central America. Unfortunately for us it was very orientated to the North American market. We favoured longer-term pricing but whenever the North American market was in short supply and the prices returned from there rose, the availability to Europe dropped! The result is that we have now moved our sourcing to Central Africa where we have green field sites, better control of pesticides, new packing facilities and stable, long-term prices.

Whilst on the subject of prices and price stability, computer analysis of wastage several years ago indicated fluctuating prices to be a major cause of shrinkage or wastage. Whilst prices went down in one area and sales up, sales in another area went down and wastage or shrinkage went up!

I am a believer in planned marketing and prefer stable or long-term pricing wherever possible. The guide-lines tend to be: the larger the line, the more competitive it has to be. Therefore, it is in the lower volume, less competitive lines, many of which are exotic or tropical in nature, that we can agree cost prices for 3 or 4 months at a time or even longer.

This does not prevent a feature or promotion being built into the marketing plan.

Marketing boards can play an important part in promotional activity but they need to be reasonably relaxed in their approach and understanding of a company's image and promotional policy. They must not lose sight of the main goal which is to increase sales. What starts off as an incentive to the buyer may become a disincentive if a requirement of funding is a garish logo, totally out of keeping with the image the store is trying to portray.

A good approach is for marketing boards to support the production of the supermarkets' own leaflets, especially where they inform the customer about preparing and using exotic tropical produce.

Another reason for a buyer seeking a new source of supply could be to fill gaps in the supply calendar.

Appendix C consists of a number of charts that cover a wide range of tropical and semi-tropical products sold in the UK during the year, together with some of the major competing countries and when their products are available. Appendix B gives some guide prices for you to gauge for yourselves the viability of exporting some of the main tropical lines from this region.

I do not pretend that the guides and charts are fully comprehensive or that the gaps in supply represent huge markets just waiting to be tapped. However, they may well indicate what **not** to export if the competition is too great.

I would also suggest that you do not limit your thinking to traditional Caribbean exports. There may well be other niche markets you can exploit, some of which could represent large volumes. I am still surprised that Mexico became a major exporter of salad onions to the UK.

Yet another reason for a buyer to seek new growing areas could well be that the location and climate could produce something special in the way of flavour or sweetness.

Some of the best flavoured tomatoes in the world come from island or coastal areas where the sunlight, the high saline levels and other factors all conspire to produce excellent flavours, often with the produce growing under stress on marginal lands. I believe it is possible to turn what is perceived as a disadvantage into a marketing plus.

Over the years many products have been grown for yield rather than flavour. There is no doubt that today's consumer wants this trend reversed. They want food with real flavour.

The challenge is to produce it and maintain yields if possible, if not we will have to settle for lower yields but higher prices.

Quality control

This in turn opens up many new areas of research, not the least of which are what I call simple applied quality control techniques that can be used on the goods received in docks and the warehouses, to measure sugar–acid ratios, potassium or sodium levels etc. Also larger non-invasive on-line systems for ensuring the sweetness and flavour of melons, mangoes, papaw etc. The Japanese are experimenting with exposing apples to near infra-red radiation and analysing the reflected light by computer and relating the data to the apples' sugar-acid content.

I can only pay a premium for flavour when I have the ability to check each and every consignment as it arrives to ensure that I have got what I have paid for with an objective rather than subjective test. Taste panels are not a practical option in a warehouse. I cannot afford to employ my own inspectors to oversee the production world-wide.

This leads us into the area of controls and food safety. There is a tremendous pressure on food retailers in the UK today to ensure that the food they offer for sale is safe and free from contamination such as pesticides. Offenders can be sent to prison for up to 2 years and face unlimited fines. The responsibility for food safety passes back down the supply chain. Each sector is responsible for showing 'due diligence'. A paper warranty is no longer acceptable and checks have to be made on the product and premises.

I hope the next short video gives you a feel for the importance we place on this issue.

I believe this new law will dramatically reduce the buyer's freedom of action and restrict his purchases to those areas and suppliers who can demonstrate control over their product.

We, along with other supermarket groups, have adopted a code of practice for pesticide control produced by the The Produce Packaging and Marketing Association (PPMA) in the UK. A second revised addition of their code will be published early next year.

This requires produce marketing organizations to carry out risk assessments of its sources of supply in order to target its resources in the most effective way. Some of the factors to be taken into account are the supplier premises, storage facilities, staff experience and training, whether the product is traceable back to source, whether or not there is technical supervision of the growing of the crops, whether records are kept of what chemicals have been applied and what those chemicals are.

This may seem to some an almost impossible task but it is one that has to be addressed if you wish to sell your produce to a market which requires safe food.

Where confidence in good safety controls is low, an alternative is to increase the amount of pesticide residue testing. However, this is an expensive option. It can be done in the country of origin, but the purchaser may require reassurance about the quality of the laboratory used. The alternative is for the testing to be done in the UK at the shippers' expense but sometimes this can lead to unacceptable delays.

No-one who knows our industry can expect these changes to be achieved overnight but the longer a source of supply delays in implementing them, the worse its reputation will become.

Packaging

Packaging is another important area which needs to be addressed especially if the Caribbean is to compete on equal terms with other countries. Whilst the packaging must protect the product for transit, it also says a lot about the professionalism of the growers. The next few slides will hopefully illustrate my point.

The last slide showing apple bananas is very interesting because it is a product that grows well in this part of the world. Currently we obtain our supplies from Colombia where the air freight costs are 80p per kg.

Transport

Whilst looking at air freight costs from this part of the world I found the BWIA have a couple of of flights a week via St Lucia with a much more attractive rate of 46p per kg for shipments over 500kg.

As with all island economies, the UK included, links with the outside world are vital.

Air freight, if available at the right price and the right time, is ideal for developing the market for tropical products grown especially for flavour and harvested at a higher state of maturity. The product has to have sufficient value to bear the on-cost and must also be significantly superior to the sea freight equivalent to justify its higher selling price. Melons and pineapples are two air freight possibilities.

The biggest problem with air freight is the competition for space at key times of the year such as Christmas. I no longer buy from a supplier who had my trade for asparagus for several months and then let me down Christmas week.

Probably the only way to overcome the problem is to be sufficiently important to the air line during the rest of the year to get the space at the key time.

Some comparative freight rates are illustrated in Appendix A. Hopefully you will still find them accurate.

Sea freight is by far the most cost-effective way of getting your product to its export market. Puerto Rican mangoes are shipped direct to Felixstowe in 9 days. If you were shipping from Trinidad you would probably have to go via a North American port and add another 7 days to the journey time.

The banana boats from the Windward Islands or Jamaica take 7 days and the bigger vessels due to come on stream in future will carry a reasonable number of containers, which if taken to the packhouse, dramatically reduce the handling damage and provide us with quicker discharge at UK ports.

Temperature-controlled containers are essential for fresh produce. Controlled atmosphere containers are still fairly expensive with a reduced load capacity.

The latest development between 'Freshtainers' and 'BOC' has eliminated the gas bottles, releasing space and making the container easier to service. This development is beginning to look more promising.

Costs are higher than normal but not as high as air freight. Whether they have a role to play in the Caribbean has still to be established.

Provided the fruit has had its field heat removed correctly and is of good quality, a normal temperature-controlled container will suffice. However, the tendency has been to harvest the fruit early and immature as an extra safety margin on the journey. This has done much harm to the trade for such items as mangoes where the first time buyer has been put off by immature fruit.

Whether with the advent of controlled-atmosphere containers, shippers will feel more confident about sending mature fruit remains to be seen.

No matter how sophisticated the method of transport it will not improve the product if that is wrong in the first place.

Therefore the greatest emphasis must be put on developing the infrastructure, facilities and the training of personnel.

Investment priorities

- Improve the availability of field technology, agronomic support, pesticide controls and the training of personnel.
- Ensure facilities are available to remove field heat from the produce quickly and develop post-harvest technology.
- Improve packhouse facilities and quality control and packaging to achieve a better quality presentation.

- Provide cold storage facilities to hold produce in good condition prior to despatch.

- Improve infrastructure for the loading of containers at the packhouses to reduce handling damage.

- Develop freighting infrastructure by air and sea to rapidly transport your produce to its intended market.

If grant aid is available, these are the areas to which I would recommend it goes.

Sometimes aid is directed to subsiding marketing but this can have a disruptive effect on the market place, masking the true cost of supplying the product to the buyer. Whilst its presence may help to develop a market, its subsequent removal does more harm than good, especially where the points I have spoken about this morning have not been addressed.

Summary

The time has come to summarize what I have been telling you. If you are going to export, get to know your market. Decide how you intent to approach it. Establish the right contacts. Be prepared to provide your customers with the quality and presentation they want. A stable price and continuity of trade, even price on tight margins, can be better than speculating on a fluctuating market. Look for the gaps in trade. Seek new opportunities. Concentrate on quality and good flavour. Introduce tight controls on food safety and pesticides. Develop the infrastructure and use grant aid wisely.

I believe the Caribbean has a lot of potential and could expand its export trade for fresh produce and ornamentals. I wish you every success.

APPENDIX A SHIPPING FROM TRINIDAD & TOBAGO

AIR FREIGHT

- Main tourist locations for Europeans in the Caribbean are St Lucia, Barbados, Antigua, Jamaica and Santa Domingo (Dominican Republic)

- Trinidad & Tobago is popular with Canadians and travellers from Northern American states

- The tourist preference causes a shortage of direct flights between European countries and Trinidad & Tobago

- Flights currently direct between UK/Continent and Trinidad

BWIA - Two flights direct and two flights via St. Lucia

- Friday and Saturday: direct to Heathrow
- Sunday and Wednesday: via St Lucia to Heathrow
- Total cargo space: 30 tonnes per week
- BWIA flies mainly Tristars
- Cargo space via St Lucia shared with Trinidad
- Rate for shipments over 500kg, approximately 46p per kg.

BA – Two flights via other Caribbean islands

- Monday and Friday: 3–5 tonnes on each flight
- Currently uplifting flowers at approximately £1.27 per kg.
- Clearly they have little space - currently given to Trinidad
- If demand influenced more space for Trinidad, I would expect rate for produce to be 50–70p per kg.

KLM – Two flights to Amsterdam each week

- Saturday and Wednesday
- Fly 747 Jumbos so appear to have good space
- If horticulture developed in Trinidad, KLM will be favoured to transport flowers to the Dutch auctions
- Currently quoting approximately 80p per kg.

Two other air transport possibilities exist:

- Other Caribbean islands which attract the European tourists obviously have several flights daily. Produce can be shipped to those destinations for forwarding.

- Miami is the hub of air freighting to Europe and produce could be flown from Trinidad for forwarding to Europe.

Conclusion

Air freight is currently extremely tight. However, sufficient for the present needs. The Trinidad authorities will need to address this issue on major produce or flower export development.

Appendix A continued

SEA FREIGHT

Produce is regularly shipped from the Caribbean by sea to the UK and the Continent. Obvious examples:

- Geest bananas from the Windwards (7 days)
- Jamaica bananas (7 days)
- Puerto Rico mango – April to November (9 days).

All sea lines currently do not go direct from Port of Spain, Trinidad to UK/Continent. They call at Northern USA ports to discharge some Trinidad cargo and collect other cargo for Europe, this adds some 7 days to what would otherwise be a 9-day journey time to UK.

I believe if Trinidad & Tobago developed its produce export, then volume could demand direct ships to Felixstowe as with Puerto Rico.

Freight rate and comparison with Puerto Rico:

Container	20ft	40ft	40ft Con Air	
Freight	$2375	$3220	$3530	
+ CAF	15%	15%	15%	529.40
+ BAF	$120	$260	$260	
+ PORT ADDS	$180	$325	$325	
			$4644 =	£2,716.08

The above rates are subject to the terms and conditions of the Witass tariff.

Puerto Rico comparison 40 ft Refer + £2,700

Trinidad & Tobago

Carol Line = Harrison/Hapag/CGM/NedLloyd

Sea freight arrivals Felixstowe every 9-13 days from Port of Spain.

20ft container cost $US 2375 + 120 BAF + 180 port charges } +
40ft container cost $US 3220 + 260 BAF + 325 port charges} 15%
40ft container cost $US 3500 } CAP

P and O containers

Trinidad to West Palm Beach – Port Everglade – Felixstowe

Weekly arrivals all year

23-day transit time, average 30 days

Similar rates to above quotes.

APPENDIX B PRODUCTS

Traditional Caribbean production for local consumption and for export mainly to the ethnic markets:

Product/Guide C & F price - Landed at UK port		
Root crops	-	Yam, sweet potato, eddoe, tannia, dasheen, cassava, cocoa and ginger
Coconuts x 25 £3.50		
Pumpkins x 50lb £12.00		
Hot peppers	-	(Scotch Bonnet variety)
Plantains x 50lb £16.00		
Breadfruit		
Mango x 4kg £4.50	-	Local variety
Papaw x 3.5kg £4.50	-	Long large tropical varieties

Diversification opportunities

Guide C & F prices		
Lychees x 2kg £3.00	-	Early Mauritius variety. Characteristic large fruit, small stone
	-	Best marketing opportunities April-September. (see supply calendar)
Mango £4.50 x 4kg	-	Haden, Tommy Atkins, Kent, Keit varieties
	-	Puerto Rico supply air freight February to March and sea freight April to November
	-	Trinidad production would likely be the same season
	-	Puerto Rico has very high labour costs as a USA island
	-	See supply calendar for all competitors.

Appendix B continued

Pineapple 50p per kg	- Main stream tropical line but sales in decline year on year. This I believe is due to inconsistent eating fruit, green fruit, being sold by retailers in the UK - The market needs fruit 1.5kg each; golden yellow, well-formed skin; clean, pale yellow flesh; sugar content 14–16^{o} - Opportunity to produce all year and supply at above specifications would give Trinidad a good position in the UK market - See supply calendar.
Melons Israeli £7.75/8.25	- Opportunity is to supply over our winter – October to April. Yellow Honydew by sea Galia, Cantaloupe by air/sea - See supply calendar for competition. However, no country has supplied Galia or Cantaloupe consistently over the required period so a real good opportunity for Trinidad.
Papaw £4.50 x 3.5kg	- Opportunity is for sea freight to compete. Brazil currently by air and Jamaica by sea. Variety should be Solo 'Sunrise' or 'Sunset'. This produces fruit approximately 350–500g which are our preferred sizes; pear-shaped - See supply calendar.
Avocados Israeli £4.50	- Opportunity for large tropical variety; market well supplied on Fuerte and Hass from well-established sources Israel — September–April S. Africa — April–September Mexico — August–June
Berries 8 x 250g Straws	- I believe Trinidad & Tobago could, with the right infrastructure and direct freight, grow to supply winter: November - February — Strawberries October - April — Raspberries/blackberries - See supply calendar.

Appendix B continued

Other exotic opprtunities

Guide C & F price			
£3.60	Air/Sea	Passion fruit x 2kg x 48	All year competing with East Africa
£5.88	Air	Grenadillo x 18	All year competing with Columbia
£3.80	Air	Okra x 4 lb	All year competing with Africa
£3.20	Air	Chillies x 4 lb	All year competing with Africa
£11.00	Air	Asparagus x 11lb	Opportunity all year – green variety
£4.50	Air/Sea	Kumquats 2kg	Opportunity all year competing with Israel and South America
£4.00	Air/Sea	Limes 4.5kg	Opportunity all year competing with Israel and South America
£5.00	Air	Mange Tout/Sugar Snap 2kg	Best opportunity November – March competing with Guatemala
£8.00	Sea	Squashes 8kg	October–April competing with USA
£5.00	Air	Physallis 1.5kg	All year competing with Columbia
£6.47	Air/Sea	Apple banana 3kg	All year competing with West Indies
£6.50	Air	Cherimoya 4kg	All year competing with Spain and South America
£7.00	Air/Sea	Carambola x 3kg	All year competing with Malaysia
£7.25	Air	Ramboutan 2kg	All year competing with the Far East
£7.50	Air	Mangousteen 2kg	All year competing with the Far East

APPENDIX C

TROPICAL AND SEMI-TROPICAL PRODUCTS SOLD IN THE UNITED KINGDOM THROUGHOUT THE YEAR AND THEIR SOURCES

COMMODITY	COUNTRY	JAN	FEB	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPT	OCT	NOV	DEC
Asparagus	USA	■	■	■	■	■							
	HOLLAND					■	■						
	FRANCE		■	■	■	■	■	■					
	SPAIN			■	■	■	■						
	ITALY			■	■	■	■						
	AUSTRALIA										■	■	■
Broccoli	USA	■	■	■	■	■	■	■	■	■	■	■	■
	HOLLAND						■	■	■	■	■		
	ITALY	■	■	■	■							■	■
Hot Thin Chillies	THAILAND	■	■	■	■	■	■	■	■	■	■	■	■
Yellow Egg Plant	THAILAND	■	■	■	■	■	■	■	■	■	■	■	■
Water Chestnuts	THAILAND	■	■	■	■	■	■	■	■	■	■	■	■
Rambes	THAILAND					■	■	■					
Grenadillo	COLOMBIA	■	■	■	■	■	■	■	■	■	■	■	■
Pomegranetes	PERU					■	■	■					
	ISRAEL	■							■	■			■
	SPAIN	■									■	■	■
	USA												
Orlanique	JAMAICA	■	■	■	■	■	■						
Babaco	ECUADOR	■	■	■	■	■	■	■	■	■	■	■	■
	GUERNSEY												
Pepino Melon	PERU	■	■					■	■	■	■	■	■
	NEW ZEALAND				■	■	■						
Kiwano's	NEW ZEALAND				■	■	■	■	■				
	SOUTH AFRICA												
Water Melon	EGYPT	■	■	■	■								■
	ISRAEL				■	■	■						
	ITALY						■	■	■			■	■
Coriander	CYPRUS	■	■	■	■	■	■	■	■	■	■	■	■
Colgassi	CYPRUS	■	■	■								■	■
Cherry Tomatoes	CYPRUS	■	■	■	■	■					■	■	■
	HOLLAND					■	■	■	■	■	■		
Tamarind	THAILAND	■	■	■	■							■	■
Turmeric	THAILAND	■	■	■	■	■	■	■	■	■	■	■	■
Sereh	THAILAND	■	■	■	■	■	■	■	■	■	■	■	■
Red Chillies	THAILAND	■	■	■	■	■	■	■	■	■	■	■	■

COMMODITY	COUNTRY	JAN	FEB	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPT	OCT	NOV	DEC
	IVORY COAST												
Pineapples	BRAZIL												
	GHANA												
	KENYA												
	SOUTH AFRICA												
Prickly Pear	BRAZIL												
	MEXICO												
	ITALY												
Physallis	COLOMBIA												
	KENYA												
Squash Butternut	USA												
Squash Turban	USA												
Squash Acorn	USA												
	BRAZIL												
Paw Paw	KENYA												
	SOUTH AFRICA												
	CANARY												
	JAMAICA												
Spring Onions	MEXICO												
	ITALY												
	CYPRUS												
Garlic	MEXICO												
	FRANCE												
	ITALY												
	EGYPT												
Artichokes	ITALY												
	CYPRUS												
	SPAIN												
	FRANCE												
White Aubergine	KENYA												
Tindoori	KENYA												
Karella	KENYA												
Sugar Cane	KENYA												
Annaheim Chillies	KENYA												

COMMODITY	COUNTRY	JAN	FEB	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPT	OCT	NOV	DEC
Babycorn	SOUTH AFRICA	■	■	■	■								■
	THAILAND	■	■	■	■	■	■	■	■	■	■	■	■
	ZIMBABWE												
Sweet Potatoes	SOUTH AFRICA					■	■	■					
	BRAZIL	■	■	■	■	■	■	■					
	ISRAEL	■	■	■	■	■				■	■	■	■
	CANARY ISLANDS	■	■	■								■	■
	BARBADOS				■	■							
Fine Beans	KENYA	■	■	■	■	■	■	■	■	■	■	■	■
	BRAZIL	■	■	■	■	■					■	■	■
	JAMAICA	■	■	■	■							■	■
	ZAMBIA	■	■	■	■								
Ramboutan	THAILAND	■	■			■	■	■	■	■	■	■	■
	INDONESIA											■	■
Tamarillos	NEW ZEALAND					■	■	■	■				
	COLOMBIA	■	■	■	■	■	■	■	■	■	■	■	■
	KENYA	■	■										■
	ZAMBIA	■	■	■								■	■
Sapotilla	THAILAND	■	■	■	■	■	■	■	■	■	■	■	■
Guava	BRAZIL	■	■	■	■	■	■	■	■	■	■	■	■
Eddoes	WEST INDIES	■	■	■	■	■	■	■	■	■	■	■	■
Ginger	WEST INDIES		■	■	■	■	■	■					
	BRAZIL									■	■	■	■
	COSTA RICA	■	■	■									
Tannias	WEST INDIES	■	■	■	■	■	■	■	■	■	■	■	■
Lychees	SOUTH AFRICA	■	■	■									■
	MAURITIUS											■	■
	ISRAEL						■	■	■				
	THAILAND					■	■						
Mangoustan	THAILAND	■	■	■	■	■	■	■	■	■	■	■	■
	INDONESIA											■	■
Passion Fruit	KENYA	■	■	■	■	■	■	■	■	■	■	■	■
	SOUTH AFRICA		■	■									
	BRAZIL	■	■	■	■	■	■	■					
Persimmon Kaki Sharon	BRAZIL			■	■	■							
	ITALY									■	■	■	
	ISRAEL	■	■									■	■

COMMODITY	COUNTRY	JAN	FEB	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPT	OCT	NOV	DEC
Peppers	ISRAEL	■	■	■	■						■	■	■
	BRAZIL	■	■	■	■	■							
	HOLLAND			■	■	■	■	■	■	■	■	■	
	CANARY	■	■	■	■	■							■
	USA												
Strawberries	ISRAEL	■	■	■	■								■
	BRAZIL							■	■	■	■	■	
	FRANCE					■	■						
	SPAIN	■	■	■	■	■	■						
	HOLLAND		■	■	■	■	■						
	KENYA	■	■									■	■
	USA												
Galia Melons	ISRAEL	■		■	■	■	■	■	■	■	■	■	■
	SPAIN						■	■	■	■			
	SOUTH AFRICA	■	■	■									■
Ogen Melons	ISRAEL				■	■	■	■	■	■	■	■	■
	SOUTH AFRICA	■	■	■									■
Jilo	BRAZIL	■	■	■	■	■							
Cranberries	USA	■										■	■
Ugli Fruit	JAMAICA	■	■	■									
Feijoas	NEW ZEALAND						■	■					
Plantain	WEST INDIES	■	■	■	■	■	■	■	■	■	■	■	■
	COLUMBIA	■	■	■	■	■	■	■	■	■	■	■	■
	JAMAICA	■	■	■	■	■	■	■	■	■	■	■	■
Chow Chow	COSTA RICA	■	■	■	■	■	■	■	■	■	■	■	■
	BRAZIL			■	■	■	■						
Yams	BARBADOS		■	■	■								
	BRAZIL	■	■		■	■				■	■	■	■
	JAMAICA	■	■	■	■	■	■	■	■	■	■	■	■
Pumpkins	JAMAICA	■	■	■	■	■	■	■	■	■	■	■	■
	WEST INDIES	■	■	■	■	■	■	■	■	■	■	■	■
	BRAZIL	■	■	■	■	■	■	■	■				
Sweetcorn	SOUTH AFRICA	■	■	■	■								
	ISRAEL	■				■	■					■	■
	ITALY							■	■				
	SPAIN		■	■	■								
	FRANCE							■	■				
	USA	■				■			■	■		■	■

COMMODITY	COUNTRY	JAN	FEB	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPT	OCT	NOV	DEC
Fennel	HOLLAND						■	■	■	■	■		
	ITALY	■	■	■	■	■					■	■	■
	FRANCE	■	■	■	■	■	■	■			■	■	■
	SPAIN	■	■	■	■	■	■	■			■	■	■
Kohlrabi	HOLLAND			■	■	■	■						
	ITALY	■	■	■	■								■
Mooli	HOLLAND			■	■	■	■		■				
	ITALY	■	■	■	■							■	■
Figs	BRAZIL	■	■	■	■	■	■						■
	CYPRUS								■	■			
	FRANCE									■	■		
	TURKEY									■	■	■	■
	GREECE												
Kiwi Fruit	NEW ZEALAND	■					■	■	■	■	■	■	■
	USA	■	■	■	■	■					■	■	■
	ITALY	■	■	■	■	■						■	■
	ISRAEL	■											■
	FRANCE	■	■	■								■	■
	JAPANESE	■	■	■									■
	CHILEAN				■	■							
	CORSICAN												
Kumquats	ISRAEL	■	■	■									
	BRAZIL		■	■	■	■	■						
	SOUTH AFRICA						■	■	■				
	PERU						■	■	■				
	USA	■	■	■	■							■	■
	ARGENTINA												
Limes	BRAZIL	■	■	■	■	■	■	■	■	■	■	■	■
	FLORIDA							■	■	■	■	■	■
	HONDURAS HAITI	■										■	■
	MEXICO							■	■	■			
	SOUTH AFRICA							■	■	■	■		
	KENYA	■	■	■	■	■	■	■	■	■	■	■	■
Loquat	BRAZIL								■	■	■	■	
	SPANISH												

COMMODITY	COUNTRY	JAN	FEB	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPT	OCT	NOv	DEC
Avocado	SOUTH AFRICA				■	■	■	■	■	■	■		
	KENYA					■	■	■	■	■	■		
	MEXICO	■	■	■	■			■	■	■	■	■	■
	USA				■	■	■	■	■				
	ISRAEL	■	■	■	■	■					■	■	■
	CYPRUS	■	■	■	■	■					■	■	■
	SPAIN	■	■	■	■						■	■	■
Coconuts	WEST INDIES	■	■	■	■	■	■	■	■	■	■	■	■
	SANTO DOMINGO	■	■	■	■	■	■	■	■	■	■	■	■
	MALAYA	■	■	■	■	■	■	■	■	■	■	■	■
	SRI LANKAN	■	■	■	■	■	■	■	■	■	■	■	■
	IVORY COAST	■	■	■	■	■	■	■	■	■	■	■	■
	BRAZIL	■	■	■	■	■	■	■					
Carambola	BRAZIL	■	■	■				■	■	■	■		
	THAILAND	■	■	■			■	■	■	■	■	■	■
	ISRAEL		■	■	■								
	MALAYSIA	■	■	■	■	■	■	■	■	■	■	■	■
Aubergine	HOLLAND		■	■	■	■	■	■	■	■	■		
	ISRAEL	■	■	■								■	■
	BRAZIL/CANARY	■	■	■	■	■							■
	ITALY	■	■	■	■							■	■
	FRANCE						■	■	■	■	■		
	SPAIN					■	■	■	■	■			
	CYPRUS	■	■	■	■							■	■
Chicory	HOLLAND	■	■	■	■	■					■	■	■
	FRANCE	■	■	■	■	■					■	■	■
	ITALY	■	■	■	■						■	■	■
Chinese Cabbage	HOLLAND				■	■	■	■	■	■	■	■	
	ISRAEL	■	■	■	■								■
	SPAIN	■	■	■	■								
	ITALY	■	■	■	■								
Iceberg Lettuce	HOLLAND				■	■	■	■	■	■	■		
	ISRAEL	■	■	■									■
	SPAIN	■	■	■	■								■
	USA	■	■	■	■	■	■	■	■	■	■	■	■

DISCUSSION SESSION VI

Question:
To what extent is cost of banana production reduced by removing protection?

E Reid (WINBAN, St Lucia)
Cost of production at present is determined by quality of produce, labour and inputs.

I should stress that 60 per cent of the cost of production is labour. WINBAN is striving for more efficient labour and better rates for produce. The time factor is the constraint because of labour ethics. Thus training of farmers is important. The remaining 40 per cent is shared – 13 per cent to small farmers and 27 per cent to middle and large farmers. However, there is little scope for improvement if farmers are not able to move their yields from 6–7 to 10–12 tons per acre.

Question:
What about plantains for the extra-regional markets.

E Reid
There is good potential for it – in the 80s plantains were transported. At present CARDI is working on plantains. There is also the possibility of exportation of bananas with small fingers.

Question:
How is WINBAN's work programme developed? Whom do they report to and what is their role in the diversification effort?

E Reid:
Programmes are developed from information provided from the farmer level to BGA then to WINBAN who in turn feed back to the farmers through the BGA. WINBAN has scientists, technical persons and farmers who make recommendations and liaise with other organizations.

WINBAN reports to the Board of Governors and individual banana growers' associations.

Diversification has its implications but there is concern about quality and loss of production. WINBAN will provide technical assistance and the use of facilities for increased crop production.

Question:
What products apart from mangoes were shipped to the USA by the Productive Farmers Union (PFU) in Grenada?

P Francis (Productive Farmers Union, Grenada
Hot pepper and golden apples are the main products exported – 20,000lb of golden apples were shipped to the USA and UK last week.

Question:
What is the membership of the PFU and the range of crops exported?

P Francis:
I am not certain since all the village groups which were supposed to be in place are not functioning. However, membership could be in excess of 300.

The range of crops is in excess of 20. However I am unable to list all. Some of them are mango, genip, golden apple, soursop, hog plum and lemon grass stems.

We have been able to use the large amount of golden apple rejects by boiling them to produce a spicy syrup. Soursop is also juiced and made into drink.

Question:
How did the extra-regional trade affect the traffickers+

P Francis:
It did not affect the trade. As a result of this activity, farmers received better prices than before. Govoernment is establishing a 10-acre orchard to enhance production.

Question:
Did the Progressive Farmers Union operate with CATCO on a contract basis?

P Francis:
No. There was only an agreement as they were informed by a representative that they would have to operate on trust and that monies would have to be paid for produce at a later date.

Question:
Does government support the PFU?

P Francis:
Government given support by granting concession on inputs. We are expecting a cooling system for which we will receive a duty-free concession.

TECHNICAL SESSION VII

Chairman: Samsundar Parasram, *CARDI, Trinidad & Tobago*

Rapporteurs: Nerle Robertson, *CARDI, Trinidad & Tobago*
Glenner Robinson, *Ministry of Agriculture, Jamaica*

QUALITY CONTROL AND ASSURANCE IN THE MARKETING CHAIN

Annabelle Malins
CARDI, Dominica

We have heard a lot during this seminar of the word 'quality'. Several papers have illustrated clearly that produce quality cannot be addressed separately from produce production. We have seen an excellent video on papaya production showing all the factors which have to be considered and controlled to build quality into this product.

I want to build on these points about quality by looking at:

- what quality means
- what systems we have for controlling quality
- how we can apply these systems
- what recommendations can be made for future inputs to support the development of quality assurance systems for fresh produce in the region.

It is not the intention of this paper to address the issues of produce standards or national inspection services, important and topical as these are. My paper addresses quality in relation to any individual organization - your company or organization.

Quality of fresh produce

Quality is commonly thought of as the degree of excellence. Different customers have different perceptions of excellence, so quality must best be judged as the customer perceives it.

In general terms quality means giving complete satisfaction – providing customers with exactly what they want, when they want it, at a price they can afford (Department of Trade and Industry 1988).

The customer's quality requirement of a product is often defined by a product specification, the criteria of which are measurable and objective. However, the service element of quality as described in the definition above, should not be overlooked.

The importance of quality

Fresh produce markets around the world are becoming increasingly sophisticated and competitive. All consumers are concerned that they are getting value for money. Hallam and Molina (1988) in their study of the UK market for fresh exotic produce concluded that currently the best competitive devices for an exporting country were quality control, reliability and quantity management. To hold a position in international markets it is essential to supply produce of consistent quality, of defined specification and in a reliable condition at out-turn. Attention must also be paid to phytosanitary regulations and permitted pesticide residue levels for a given market destination (Proctor 1988).

Many Caribbean exporters have not met these increasingly stringent market demands. Quality out-turn assessments of horticultural produce received in the UK from the OECS in February 1991 identified various factors contributing to a poor market image. Assessment of 43 separate commodity consignments showed that poor grading and inadequacies in net weight or count were the most frequently occurring serious defects (Crucefix 1991). Inadequate labelling, chilling injury, insect damage, poor size and maturity were also noted as frequently occurring serious defects. Such problems could be reduced or eliminated by the proper implementation of quality assurance. Quality assurance can contribute not only to achieving quality but also to improving reliability of supply and cost efficiency by preventing failure.

How to achieve product quality

There are many different approaches to achieving quality. In fact, quality is like politics or sex or religion. We all like to think that we understand the subject and we are convinced that our way is right but few like to explain it. Discussions on it are generally short and superficial. The subject gets changed through boredom or embarrassment.

I will begin by addressing the terms quality control (QC) and quality assurance (QA). Is there a difference?

Kramer (1980) defines quality control as the maintenance of quality at levels and tolerances acceptable to the buyer while minimizing costs for the vendor. The definition is not entirely satisfactory as it implies that there is a trade off between the cost of the production process and the quality of the product i.e., the higher the quality, the higher the unit cost. This concept is now disputed in many circles. There is a realization that there are in fact costs associated with poor quality (costs of prevention, appraisal and particularly failure) which can be reduced by a commitment to quality (Modarress and Ansari 1989).

Feigenbaum (1983) describes quality control as a system for the realization and management to specification of the desirable cost quality, performance quality and reliability quality standards for the product.

The term quality control has sometimes been used to mean an inspection process alone (the image of the man in the white hat). If quality control is reduced to inspection and rejection of faulty products, then of course it represents a costly, ineffective method of attempting to achieve quality. The term quality control therefore has negative implications in some circles so that the term quality assurance tends to be preferred.

Quality assurance is a management system which operates as an integral part of the production process. The QA system establishes operational procedures: 'the rules of the game'. Quality assurance systems identify the critical stages in the marketing process at which product quality should be managed or controlled to ensure that quality is built into the product. The system will not involve just QC staff but all staff from the manager to the person who sweeps the floor.

Quality assurance systems are not necessarily integrated into the other management systems of the company. This can cause weakness in the system. There are a number of standards related to quality assurance systems e.g., ISO 900, EN29000 and BS5750 Part 2. Accreditation with these standards shows that the QA system in operation extends throughout the company's activities. A documented QA system is required which demonstrates how a company's policy on quality is implemented from receipt of enquiry to delivery of product.

There are further concepts of managing quality. A term in quite frequent use is Total Quality Management (TQM) or Cost Effective Quality Management. This is more of a company philosophy or company culture and attitude of mind. All parts of the company are involved in the quest for quality including marketing, design, production and service functions. Employee training and involvement such as in creation of Quality Circles, are key factors in TQM. Quality control in its broadest sense is designed into all operations of the company, preventing problems from occurring so that products are 'right first time'.

Developing a quality assurance (QA) system

How do we develop the 'rules of the game'?

- Firstly we must define what quality is required by the customer i.e. the specification. In practice not all customers can readily supply a specification for their requirements. International quality standards can be helpful in developing a baseline specification in the absence of a customer's specification. However, few tropical fruits are currently covered by international quality standards. For example only avocado, citrus and custard apple are covered by EC standards. Some countries (e.g. Jamaica and Trinidad) have mandatory national standards for some of their export produce. Initiatives are being made by CARICOM and the OECS to develop fresh produce standards. Such initiatives should be encouraged since standards help to ensure that the buyer can rely on a certain minimum quality standard and provide a common language for sellers and buyers which facilitates the marketing process.

Medlicott (1990) has described common specifications for 27 fruit, vegetable and root crops exported from the Caribbean. These could be used as outline specifications by exporters.

Table 1 shows some of the quality attributes relevant to a specification for tropical fruit. These requirements cover a far wider range of criteria than a standard.

- The customer's specification requires interpretation to determine how and in what condition the exporter should ship the product since the product will change during shipment. This may require some research input to establish the correct maturity or treatment etc. for the product to withstand the required shipping method.

- A full description of the marketing chain from point of harvest to delivery or shipping will help to identify critical points at which the process requires monitoring or control in order to ensure maintenance of quality for the product concerned. Figure 1 shows a marketing chain for breadfruit (Medlicott 1990) with key factors which require consideration in quality assurance at each point for this product.

Commonly identified critical control points in fresh produce marketing organizations which are illustrated in the breadfruit marketing chain are:

- at source/field
- at receipt at depot/packhouse
- during cooling
- during storage or ripening
- during packhouse operations including grading, selection, treatment etc.
- at packing and labelling
- at final despatch
- during shelf-life.

Source or field control points often require field specifications which outline the quality attributes of the product required at this stage.

Temperature is one of the most vital factors affecting fruit quality, therefore periods of cooling, temperature control or storage are as a rule identified as critical control points for a QA system. The correct functioning and operation of the facilities require monitoring as well as the product itself. Temperature control of produce after despatch is often monitored by use of a temperature chart recorder which can be bought or hired for each journey e.g. Ryan Recorders or Cox Recorders.

Table 1 Quality attributes defined by fresh fruit specifications

Main attribute		Components
Variety		
Condition	-	Clean, intact, sound, free from contamination etc.
Maturity/ripeness		
Skin colour		
Flesh colour		
Shape		
Taste/texture	-	Fibre, brix, acid, etc.
Progressive defects with tolerances:	-	Insects
	-	Damage by pests
	-	Fungal lesions
	-	Bruised fruit
Non progressive defects with tolerances:	-	Soil, dirt
	-	Mechanical damage e.g. splits,cuts
	-	Blemishes e.g. rub marks
Presentation/packing	-	Net weight
	-	Type of box
	-	Count
	-	Size/weight range of fruit with tolerances
Labelling	-	of individual fruit
	-	of box end
Temperature on arrival		
Required storage/shelf-life		
Permitted chemical residues (MRLs) and pesticide usage protocol		
[Additional for processing	-	Flavour, pulp colour, edible yield, porosity and texture of flesh.]

Source: UK trade sources

HARVESTING
(mature green, latex present, smooth surface
hand/trimmer picked, caught, early morning)

TRIMMING OF STEM, FRUIT TURNED DOWN
TO ALLOW LATEX TO DRAIN

CULLING IN FIELD
(removal of undersized, damaged, bruised,
scarred, stemless and overmature fruit)

TEMPORARY STORAGE IN FIELD
IN MESH BAGS OR FIELD CRATES
(under cool shaded area, no direct sunlight)

TRANSPORT TO PACKING HOUSE
(under shaded canopy)

WASHING TO REMOVE DEBRIS AND FRESH LATEX
(110 ppm sodium hypochlorite in water)

FINAL GRADING FOR EXPORT MARKET
(according to size, removal of overmature
fruit and fruit damaged during transport)

PRE-COOLING
(air or cold water at 12-13°C

PACKAGING IN TWO PIECE FIBRE BOARD BOXES
(according to size: net weights of 12 to 16 kg/box)

TEMPORARY STORAGE AT 12°C
(if harvested a day before shipment)

PACKED BOXES TRANSPORTED AND LOADED
INTO AIRCRAFT PALLETS
(provides better ventilation than containers)

TRANSPORT BY AIR TO IMPORTING COUNTRY

UNLOAD AND STORE AT 12 to 14°C
(apart from other ethylene producing produce)

RAPID MARKETING TO RETAIL OUTLETS

Figure 1. A flow diagram of a post-harvest handling system for breadfruit (Source: Medlicott 1990)

- The appropriate objective measurements required at any control point must be identified. The measurements required at each control point will vary, for example cut tests may only be appropriate in the field whereas temperature measurement may be the only test necessary at despatch. Unnecessary product handling for quality assurance purposes apart from being costly can be detrimental to the product. Avoidance of duplicate assessments of the same banana boxes by the Dominica Banana Marketing Corporation (DBMC) has helped to reduce fruit damage for fruit originating in Inland Buying Depots (M. Didier, personal communication 1991).

  The requirement for appropriate instruments which can provide accurate, rapid, simple measure-ments of the key quality parameters must be noted. Commonly used equipment includes eyes, nose, hands, weighing scales, pencil and paper, refractometer, penetrometer, temperature probe.

  Appropriate novel tests and an improved range of equipment may be required to assist in evaluating some quality parameters more objectively e.g. maturity of fruit, internal quality defects, skin colour. Colour charts, calipers or photographs can be useful aids. Calibration procedures are required to ensure correct functioning of measuring equipment.

- The system must describe what should happen when things go wrong i.e. in the event of non-conformance. This is one of the most important components of the QA system. In some circumstances tolerances may be applied or remedial action may be possible. Defective produce must not be allowed to get mixed back in with other produce. Reporting procedures and timing of feedback to management on non-conformance is a vital factor in using the QA system as a cost efficient management tool.

- The information collected should be used to provide a management tool for problem-solving and prevention, cost reduction and quality improvements. The system needs to not only identify the problems but identify the cause so that repetition can be prevented. For example if a package breaks down it may be the fault of the materials or the packhouse staff or the transporters. Each different cause would obviously require a different corrective action.

- All products must be identifiable and traceable – packages should be coded with day of production and packer. This helps to ensure accountability of staff and assists in problem-solving.

- The QA system should also control procurement of brought-in produce, goods or services such as packaging or transport to ensure that they fulfil the requirements.

Implementing a quality assurance system

Quality assurance systems are company-specific because they define how a company operates. The QA system will be tailored to the exact marketing chain employed as well as to the commodity itself. The general steps required to implement a QA system are listed below:

- The first and most important prerequisite in implementing a QA system is to receive commitment from the most senior management and a clear statement by them to their staff of their policy on quality. Without this the system will fail.

  Consider the scenario of a small packhouse. The owner has gone to lunch. Only one of the packing staff remains. The order is five boxes of breadfruit short of what the owner instructed and the transport has arrived to take the boxes to the airport to catch the plane. There are no more breadfruit left except the ones that fell off the pick-up by mistake earlier. These breadfruit have been lying on the ground in the sun for 4 hours. The breadfruit look alright. There are no cuts or breaks on the breadfruit skin. There are just enough to make up the extra five boxes required. What does the packer do? The packer's action will depend almost entirely on how clearly the owner has stated and demonstrated their commitment to quality.

- Develop the system preferably with involvement of staff.

- Implement the system:

  - identify responsibilities of individual staff within the QA system

  - select and train staff for QA inspection or control activities. Train all staff in requirements of the system.

- Carry out continuous appraisal and modifications of the system.

Quality assurance systems operating in the Caribbean

Many exporters of tropical fruits and ornamentals in the Caribbean are small to medium-sized organizations. Management skills are frequently stretched and quality assurance systems are not applied. However, some of the more established industries demonstrate well-developed QA systems. For example, the Dominica Banana Marketing Corporation (DBMC) operates a quality assurance system which illustrates many of the features required of an effective quality assurance system. For example:

- publicly stated commitment to quality from the top of the organization

- carefully drawn up specifications based on the customer's requirements

- routine random sampling and objective inspection of produce with appropriate visual aids

- analysis of quality assessments to allow follow-up action where required

- the ability to trace the producer of every box from the code on the label.

Conclusions and recommendations

Implementation of quality assurance systems are a vital ingredient in establishing tropical fruit and ornamentals export industries. Assistance may be required in a number of areas:

- Training in:

  - the need for quality (training first at management level)

  - quality assurance system methodology and implementation

  - sampling and inspection techniques

  - management skills and communication.

- Compilation of standards and specifications to assist marketing. Initiatives already being made in this area must not be allowed to lose impetus. Further technical input is required for some crops to interpret market specifications for producers in a way specific to their marketing chain.

- Identification of critical control points in commodity-specific post-harvest handling systems. Present manuals on post-harvest handling provide information on what the specific requirements of the commodity are for a given market. However they fail to provide the exporter with a system of ensuring that the objectives described are being fulfilled. This aspect should be incorporated by researchers and extension agents providing tech-packs or manuals on post-harvest handling of tropical crops by including QA recommendations and sample documentation.

- Compilation of the type of measuring techniques available and equipment required for measuring quality.

  There is also a research need for improved objective measurements and non-destructive tests for quality parameters such as colour, maturity, juice quality and internal quality.

We have limitations in the human resource/skills base available for implementing successful quality assurance systems. The development of and support to small farmer organizations and joint marketing by co-operatives may help to overcome this constraint.

The new economic era being heralded in the Caribbean is said to hold good opportunities for locally-based core marketing companies with market-led strategies for diversified products (Davies 1991). These companies should work in a vertically integrated fashion with small and medium-scale farmers in crop production and then assume responsibility for processing and marketing. Such companies require technical data from research workers to allow maximum production of non-traditional products which conform to the market requirements. To make optimum use of the technologies available. these companies surely need the support of well-researched and constructed quality assurance systems in achieving their marketing aims.

Bibliography

Anon. 1985. Postharvest technology of horticultural crops. Univ. of California Special Publ, 3311 USA: Univ. of California

Anon. 1990. Quality manual - Food industry. ISO 9002. United Kingdom: Lloyds Register Quality Assurance Ltd.,

Crucefix D. 1991. Quality assessment of horticultural produce received in the UK from member countries of the OECS. United Kingdom: Natural Resources Institute

Davis L H. 1991. Research and technology transfer in Caribbean agricultural development. IICA News July-Sept. 1991 Year VIII No. 45.

Department of Trade and Industry. 1988. Getting to grips with quality. United Kingdom: HM Government.

Didier M. 1991. An examination of fruit quality control in the banana industry – the quality challenge for consistency. DBMC Banana Business. September.

FAO. 1986. Improvement of fresh fruit and vegetable handling - A manual. RAPA, FAO and AFMA, Bangkok

Feigenbaum AV. 1983. Total quality control New York: McGraw Hill

Hallam D and Molina J P. 1988. The United Kingdom market for fresh exotic fruit. ODNRI Bulletin No. 13 United Kingdom: Overseas Development Natural Resources Institute.

Harvey E C. 1987. Maturity indices for quality control and harvest maturity from mangoes – A review. United Kingdom: Commonwealth Science Council

Kramer A and Twiggs B A. 1980. Quality control for the food industry. 3rd edn. Vol. 1. CN, USA: AVI Publ. Co. Inc.

Medlicott A P. 1990. Product specifications and postharvest handling of fruits, vegetables and root crops exported from the Caribbean. Barbados, West Indies: CARICOM Export Development Project.

Peleg K. 1985. Produce, handling, packaging and distribution. CN, USA: AVI Publ. Co. Inc.

Proctor F J. 1985. Postharvest handling of tropical fruit for export. The Courier 92:83-86.

Sealy L. 1984 Quality control and small scale processing. In: Short Course in Food Processing. Unit of Food Technology, The University of the West Indies, Trinidad

Wills R B H, McGlasson W B, Graham D, Lee T H and Hall E G. 1988. Postharvest - An introduction to the physiology and handling of fruit and vegetables United Kingdom: BSP Professional Books.

THE ROLE OF COMMUNICATION IN PRODUCT PROMOTION AND MARKETING OF TROPICAL FRUITS AND ORNAMENTALS

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It is my honour to speak to you on 'The role of communication in product promotion and marketing of tropical fruits and ornamentals'. Before I actually delve into this topic however, I believe a slight digression is needed to put into perspective the Caribbean region *vis-'a-vis* the global environment.

We are all painfully aware of the trauma which the Caribbean economies have been undergoing within the recent past. This trauma however, is a manifestation of a more perverse problem the region faces, i.e. a narrow production base geared primarily to the production of primary products and raw materials. The region has been a traditional producer of primary agricultural products (sugar, cocoa, coffee, citrus, bananas) and mineral resources (petroleum and bauxite). These economies depended on these primary products to provide employment, earn foreign exchange and generally to finance development. However, depressed world market prices, the production of substitutes and the emergence of cheaper alternative suppliers have served to depress demand for these commodities from the region. Presently, these commodities (with the exception of the mineral resources) are sold in markets to which we have some form of preferential access. The need therefore arose to diversify the economies thereby reducing dependence on these primary products. The production of non-traditional exports like steel, urea, methanol, electronics and data processing services filled this need. Also to be included in this list are fresh fruit, vegetables and ornamentals.

The diversification of our production base away from the traditional products into non-traditional products (especially in the area of horticultural products) arose not as a result of any positive action on our part but rather it was a reaction to developments that were taking place elsewhere - South East Asia, South and Central America. The region therefore is not singular in its efforts to develop non-traditional exports. The development of an export industry in non-traditional horticultural products blossomed into a vibrant industry because of our proximity to the major metropolitan cities, direct transportation links, preferential access to metropolitan markets (Lomé, CBI, Caribcan) and also because we were producing these products for domestic consumption and had prior experience in their production. Opportunities therefore arose to export these non-traditional horticultural products which we did not grow commercially but which could be done so profitably.

Within recent years, there has been an increase in the demand for tropical fruits, vegetables and ornamentals in the metropoles. This increased demand has translated itself into opportunities the region can exploit and in the process create employment and earn that much needed foreign exchange. The potential of the non-traditional horticultural market is quite extensive - total world imports of cut flowers, foliage and plants was US$2.5 billion in 1985.

Developing countries/areas supplied an increasing share of total imports, increasing from 13.7 per cent (1981) to 15.4 per cent (1985). The available data do not dissect these figures to give the proportion of Caribbean exports, but the indications are that it is quite small. There are no aggregate trade data on the trade in tropical fruits but sources indicate that it is quite extensive. As an example, for the United Kingdom, imports of tropical fruits for 1986 were £1.3 million (avocados); £9 million (mangoes) and papaya (£842,000).

The handling of perishables from harvest to the consumer presents a series of technical and economic problems. The technical problems include physical changes, pathological and physiological deterioration and control of the physical environment to which the produce is subjected. The economic problems involve the balancing of costs against returns. Therefore, as producers and exporters of fruits and ornamentals, every effort should be made to meet the challenge these problems present if we are to benefit from our comparative advantage and the increasing demand for good quality fresh tropical produce on the international market.

The goal of producers/exporters is to be successful. Success in the export of horticultural products lies not solely in its production, but also in the ability to be competitive in terms of both price and quality - in short, success lies in one's ability to effectively and efficiently promote and market the products. Today, the responsibility is mine to highlight the role of communication in this process.

The word communication denotes the expression of feelings, rapport, liaison, conversation, correspondence, writing. Broadly defined it refers to information. Behavioural theorists view communication in terms of a stimulus/response relationship between sources of communication and individuals or groups that receive them. Communication can also be viewed in terms of its type, i.e. written, verbal and visual.

Many of you present here today would be aware of the term 'marketing mix' and the four elements which comprise it, i.e. price, product, place and promotion. We shall assume for convenience that the first three are constants. It is the fourth element, promotion which concerns us. The word promotion is simply the active furtherance of the sale of merchandise through advertising or publicity. Promotion therefore is any method that communicates to the target market about the other three elements of the marketing mix. It is a persuasive form of communication which depends in part on the message and to a considerable extent on the manner in which the receiver perceives or interprets it. The objective of promotion is to communicate information between a seller and a buyer with a view to changing attitudes and behaviour.

There are three methods of promotion. These are personal selling, mass selling and sales promotion. The first involves direct face to face relationships; the second is designed to communicate with large numbers of customers at the same time - advertising is the main form in this case. The third method complements the first two and includes point of purchase displays, booklets, leaflets and direct mailings.

Promotion is undertaken to communicate information to buyers about the existence of a product (new or existing) and the attributes of the product. Promotion is important because it is what grabs your customer's attention, tells him/her what you have to sell and hopefully convinces him/her that you have the product he/she is looking for. For the promotion effort to be successful, the communication effort must be successful. Effective communication therefore would mean a change in behaviour has taken place or a previous behavioural change has been successfully reinforced, i.e. it leads to adoption. This leads us to the question of marketing.

Marketing

A definition of the concept of marketing would be appropriate. Marketing is many things to many people - but it is felt that marketing is getting rid of a product, i.e. selling it. This narrow view of marketing must be rejected. A more appropriate view of marketing is the performance of business activities which direct the flow of goods and services from producer to consumer or user to satisfy customers and accomplish the company's objectives. It should include decisions about product development, design and packaging, what prices are to be charged, credit and collection policies and where and how the products are to be advertised and sold. Marketing involves selling goods that don't come back to people that do. It can therefore be viewed as the universal set with the other activities as sub-sets which are used to achieve our objectives.

Export marketing as I am sure you are all aware is infinitely more complex than domestic marketing, since it embraces marketing a product in a completely alien environment – an environment in which we have little or no knowledge in so far as consumer preferences, disposable incomes etc. are concerned. Export marketing embraces various types of transactions – language (especially if exporting to a non-English-speaking country), legal, financial, insurance, payment arrangements, documentation. Also of importance are the time element and the degree of risk involved.

As producers and exporters of horticultural products from a developing region, we are faced with the initial disadvantage of inadequate export experience, technical knowledge, training, and finance

At the same time we are exposing ourselves to increased and merciless competition in an alien environment with producers and marketers of greater experience and against whose standards we will be judged. Similarly, we are entering markets which are likely to be culturally and socially different to our own.

What then therefore is the role of communication in all of this? The answer lies in our aforementioned definition of communication – information becomes a crucial competitive asset if we are not to be totally powerless in such an alien environment. Survival for small and medium enterprises like ours in such an arena lies to a great extent in the fulfilment of our information needs. This appropriately represents the old adage that knowledge is power.

The transition from domestic producer for the local market to producer for the export market requires in the short term information on the following:

Country information

- Import trade statistics (to determine market size, growth, apparent consumption and other competitors).
- Trade barriers/trade agreements
- Legal restrictions/import restrictions
- Currency and payment arrangements
- Reliability and regularity of transport
- Political stability

All of these help in arriving at a lucidly defined decision as to the most favourable market in terms of cost effectiveness and ease of penetration.

Product information

- Varieties
- Size
- Shape
- Colour
- Maturity/ripeness
- Taste and texture
- Chemical restrictions

This information is vital, for that which is satisfactory on the local market will not necessarily be acceptable on the international market.

Such information can be sourced through printed/published materials available at a variety of sources including:

- Export organizations
- Central statistical offices
- Chambers of Commerce
- Banks
- Embassies
- FAO
- ITC

Turning our attention now to the role of communication in product promotion and marketing, one must be cognizant of the fact that promotional activity is often divided into two broad categories:

- Above the line promotion – which involves advertising in the press, television or billboards.

- Below the line promotion – any other form of promotion including sponsorship, display material, literature, direct mail and money-off orders.

Due to the need to be cost effective and also to the embarrassingly small promotional budgets export organizations may have access to, 'below the line' promotional activities are used to introduce and promote the product. It is extremely important to know that there is nothing that will damage our reputation more than the use of poorly designed or produced promotional material. It is much better to do a little and do it properly than be over ambitions and fail to meet the required standards.

Below the line promotion involves:

- **In-store promotions** – involves descriptive literature, display cards, demonstrations and samplings. This type of promotion provides excellent exposure to the product as well as the place of origin. For example, in the United States and Canada, supermarket chains have begun including in their merchandising operation a separate area for the display of ornamentals with the relevant information about the product and its area of origin. In Canadian supermarkets, in order to provide exposure to the passion fruit, the supermarkets provide advice on the use of the fruit in the preparation of juices and ice creams to the consuming public.

- **Editorials** – editorials in trade publications are always on the look-out for stories and new products or entrants to the market. As an example of this in the June/July 1991 issue of *Casual Living*, the wood furniture industry of Trinidad & Tobago was featured. This editorial featured teak (called the diamond lumber) and its use in the Scarlet Ibis collection of furniture.

- **Direct mail** – a cost effective method of reaching a well-defined audience. There are two keys to successful direct mailing:

  - Write to the correct people – address to individuals not to titles e.g. 'Buyer'.

  - It should be specially designed for the job and should have a reply facility included whereby you can update your records and encourage others in the prospect company who have an interest in your product to identify themselves.

- **Trade fairs** – for consumer products, the fair can be directed toward trade or to trade and the consumer combined. Such fairs are a useful way of gauging consumer reaction and of local producers identifying possible distributors/ agents, e.g. the recent participation under the auspices of the Export Development Corporation at the Anuga Trade Fair; the appointment of Mr Abbas as the distributor/agent of products entering Sweden from Trinidad.

Others include brochures and samples.

All of the aforementioned promotional methods exemplify the role of communication in the promotion and marketing of tropical products in terms of visual, written and verbal communication forms.

There is widely held belief that the major obstacle to the further increase in sales of tropical horticultural products is the lack of consumer awareness about the products. The only way to overcome such a constraint is through the provision of information, i.e. to communicate to the consumers of the metropoles the product and its attributes.

I have in this presentation outlined the role of communication in product promotion and marketing of tropical fruits and ornamentals. I have also outlined the different mechanisms available to exporters to communicate the relevant information to consumers. I have also deliberately emphasized the low-cost 'below the line' promotion methods, because for developing countries, they are invariably the only affordable methods. It cannot be over-emphasized however, that whatever type of promotional effort is undertaken, it must serve its primary objective of communication in a deliberate attempt to change one's behaviour or reinforce a previous behavioural change, i.e. it must lead to adoption.

OPPORTUNITIES FOR ALTERNATIVE CULTIVARS OF EXISTING (TRADITIONAL) AND NON-TRADITIONAL FRUITS FOR EXPORT

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Some of the opportunities for export development of traditional and non-traditional fruits from the Caribbean are discussed. Basic import statistics are provided for the USA market and general trends are given for the UK. Assessments are made of selected fruits which offer potential for continued or increased growth. Factors such as competition, supply periods and quality requirements are given. The advantages and disadvantages of present cultivars for selected crops are discussed together with their requirements for development. General constraints to the development of exotic fruit exports from the region are discussed together with research, technology transfer and collaboration requirements.

There are several ways in which this paper can be presented depending on how the words 'opportunities for alternative cultivars' are interpreted. Several of the non-traditional crop varieties produced in the Caribbean are already 'alternative' to the majority of importers and consumers. In these cases, 'alternative' to the producer and grower would be changing varieties to those which are commonly produced and exported from other exporting regions. This paper will attempt to cover both of these areas.

Present Caribbean fresh fruit exports

Exports from the Caribbean are commonly divided into two groups:

Traditional fruits: banana, plantain, coconut, citrus

Non-traditional fruits: mango avocado, melon, limes, papaw, guava, passion fruit, breadfruit, soursop, carambola, sapodilla, cashew, golden apple, pickling mango.

Almost all of these fruits are currently exported to extra-regional markets; regional trade also occurs in some, such as banana, plantain, citrus and melon. Regional trade occurs in pineapple but this is not regularly exported extra-regionally.

Extra-regional markets

The main export markets are the USA, Europe and Canada. A brief outline will be given of the markets for selected products. Detailed information can be obtained from various sources such as the USDA Vegetable Specialities – Situation and Outlook, FATUS, APHIS, Natural Resources Institute, UK, and the International Trade Centre (ITC), Geneva. Table 1 gives import figures into the USA of four separate products with the contribution of the Caribbean.

Mango imports to the USA are currently restricted to countries with fruit fly-free status or with approval for hot water treatment. Both St Vincent and Grenada currently have fruit fly-free status. No such quarantine restrictions apply to Europe and Canada. Data in Table 2 give imports into the USA for the first 6 months of 1991. It should be noted that the Haitian Francis mango is categorized in 'others'.

Data are not available for most individual tropical fruits as the statistics categorize a whole range of products under the single heading of 'tropical produce'.

Table 1 USA Imports: October 1989 – September 1990

Product	'000 tonnes	$1,000
Banana & plantain	3,236	925,532
Leeward & Windward Islands	0.2	52
Melon	426	118,100
Jamaica	0.008	4
Haiti	0.24	102
Dominican Republic	10.7	1,884
Leewards & Windwards	0.04	37
Mango	59	57,566
Haiti	7.7	5,137
Dominican Republic	0.04	40
Leewards & Windwards	0.02	11
Pineapple	116	47,909
Dominican Republic	40	7,721

Source: Foreign Agricultural Trade of the US

Table 2 USA mango imports: January 1991–July 1991

	Tonnes	$1,000
Mexico	63,712	47,549
Other	14,469	8,017
TOTAL	78,181	55,556

Source: Horticultural Products Review, October 1991
Varieties: Tommy Atkins, Haden, Francis

Table 3 gives an indication of the level of imports of tropical produce and chilli peppers from 1986 to 1989 and shows the substantial increase in volume which has occurred.

Table 4 gives a breakdown of four crops for 1987. Data on individual non-traditional tropical fruit crops are difficult to find but general trends indicate that the level of imports is following that of tropical produce and may be increasing at faster rates.

Table 3 USA imports of 'tropical produce' and chilli peppers: 1986–1989

Year	Tropical produce	Chilli peppers
1986	7,250	31,168
1987	7,098	35,399
1988	61,926	40,086
1989	72,846	40,177

Source: Agricultural Marketing Service, USDA
Tropical produce = batatas, breadfruit, calabaza, chayote, dasheen, ginger root, malanga, tamarind, yams and yucca.

Table 4 USA imports in 1987 of tropical vegetables from Latin America and the Caribbean

Product	Tonnes
Dasheen	19,091
Yam	12,727
Chayote	6,818
Cassava	6,364

Source: APHIS, USDA

The consumption of fresh fruit in general in the UK is considered to be static while the apparent trend in consumption in exotic fruit is increasing (Hallam and Molina 1988). The UK market for exotic tropical fruit was divided into three groups by Henderson (1989). These are given below; those marked by an * were given as showing high market growth prospects.

'Large': Banana, avocado*, pineapple

'Medium': Mango*, papaw*, coconut, lime, plantain, lychee

'Small': Christophene, carambola, breadfruit, guava, mangosteen, custard apple, passion fruit, rambutan, soursop, ortanique, ugli fruit

Those which are expected to increase will do so due to increased consumption by the indigenous populations rather than by increases from the ethnic populations.

As with most import markets, the relatively high prices of the exotic produce restricts the demand and growth. Reductions in price will lead to proportionate increase in demand. Product quality was stated by the trade as being the most important factor determining exotic sales (Hallam and Molina 1988).

Market preferences

Market preferences are dependent on the marketing outlet and the products which are being exported. Preferences are usually found only with those crops which are considered main stream or popular, where the large producer, the consumer or the importer is placing emphasis on certain characteristics. This is true for avocado, banana, pineapple and mango, which are limited to a few selected varieties. The selection of varieties of temperate fruit such as apple and pear is very wide; similarly so with citrus. The lesser known or less consumed tropical fruit can be placed at either an advantage or disadvantage. For example, importers of rambutan buy on the basis of the external appearance and size but it is unlikely that many importers know that there is considerable variation between varieties on the internal flavour.

Supermarket trade in mangoes and avocados will prefer the usual Florida varieties while the outlet for the Caribbean mango is presently towards the ethnic populations. It is possible this will gradually change as consumers become more aware that there are various types of mango which offer similar or improved flavour characteristics. This will require promotional activities. A similar point can be made with bananas where alternative types of banana could be provided to the consumer. This would not be limited only to the ethnic markets but would cross into the indigenous populations via the supermarket trade.

Quality parameters

Where a crop or variety is already established in the market by large exporting countries, specifications and quality standards usually follow those set by the market. If virtually all the avocados are sold in 4 or 5kg single layer cartons in counts of eight to twelve, there will be limited or no advantage in sending larger cartons, nor smaller or larger fruit. Small exporters have little option but to follow the market specifications and requirements.

Rating potential for less traditional fruit crops from the Caribbean

A paper presented by Marte (1988) in Jamaica, assessed the potential and constraints of less traditional fruit enterprises from the Caribbean. The assessments were based on a range of parameters including adaptability, production requirements, costs, land availability, market accessibility, demand (present and future) and competition (present and future).

The rating potential was given in the following groups with No. 1 showing the most potential:

1. Mango, breadfruit and carambola
2. Cashew, papaw, passion fruit, guava, soursop, West Indian cherry, lychee and mangosteen
3. Avocado, limes, sugar apple, tamarind, rambutan, pulasan and longan.

Full information on the criteria used, agricultural and land requirements and the economic assessments can be found in Marte (1988). Since this date, advances have been made with papaw, passion fruit and carambola.

Attempts to develop or diversify fruit exports will have more chance of succeeding if a market-led approach is used together with promotional activities to develop the demand and educate the consumers, particularly outside the ethnic populations. The main fruit crops which show potential based on the market-led approach are given below together with requirements for development.

Banana

Alternative types of banana such as the lady finger, red banana, apple banana and saba all offer potential export development to all extra-regional markets. Several of these are already grown in the Caribbean, mostly in isolated areas and would require expansion. Basic information on the physiology and handling requirements is available from production areas in the Far East.

There is obviously considerable room for expansion of exports of the standard banana. This however, is tied up not only with production, handling and quality factors, but with political decisions with Lomé IV, the unification of the European market and the presence of tariff and quotas on dollar fruit.

Plantain

Exports of the French plantain to Europe could be significantly increased if technical problems could be overcome with the sea shipment systems and the presence of ship-ripes. The problem is mainly caused by the inadequate control of fruit maturity at harvest. This could be overcome by tagging fruit at emergence and harvesting after a specific number of weeks, depending on the storage requirement. This system is currently being used both for bananas and plantain in Central America. Development of 'horn' plantain production (the major plantain on the international market) would require careful consideration due to the high quality competition from Central America.

Mango

Exports of mango increased from 55,300 tonnes in 1983 to 99,500 in 1987 (from Mexico, Thailand, Brazil, India, Philippines, Venezuela, Pakistan and Kenya) (Yourassowsky 1989). Exports of mango will continue to increase, as can be seen by the substantial investments in plantings in Central and South America. All of these are with the Florida type mango. There would be no advantage for the small islands to plant these varieties as it is unlikely they would be competitive on the open market. Development of the varieties already grown in the Caribbean would be more suitable but this will require considerable effort in improving the current systems of production and procurement. Trees would have to be pruned, fertilized and pre-harvest disease control measures implemented. As plantings are not localized in one area, surveys would have to be carried out to identify the production volumes, varieties and time of harvesting. Agreements would have to be made between the grower and the exporter at the end of one export season so that all producers use similar cultural practices and final quality and disease susceptibility at least bear some resemblance. If not, exports will continue as at present with only limited volumes and variable quality.

The opportunity exists for developing mango exports from the Caribbean for such varieties such as Julie, Graham, Ceylon and Peach. With promotion and development of outlets, these varieties can find a market outside of the West Indian population despite initial resistance due to preference for the Florida type. The success of the Francis mango in the USA is a good example as it does not show the expected external colour and shape characteristics.

The fruit fly-free status given by the USA to St Vincent and Grenada is an excellent opportunity to develop exports as virtually all others have to treat fruit with prolonged hot-water treatments and incur substantial initial investment costs.

The technology for mango exports is readily available; if volumes are to increase significantly, sea-shipment is a requisite for competitive reasons. Most major exporting countries have a shipping requirement of 20 to 30 days, so harvesting is carried out with fruit of various maturities, which subsequently do not develop uniform or good quality.

Papaw

Exports of papaw increased from 30,700 tonnes in 1983 to 63,600 in 1988 (from Malaysia, Thailand, Mexico, Brazil, Costa Rica and the USA) (Yourassowsky 1989). Brazil accounts for between 80 and 90 per cent of the UK market (Hassan and Molina 1988). Some countries are still increasing and plantings continue to expand in Central and South America. There is still room for additional volumes of papaw exports and this would be suitable for the Caribbean. The technology for the production and export is available for the Solo-type papaw (both yellow and red flesh). To be carried out successfully and competitively, significant investments are required to develop this crop.

Fruit fly-free status for papaw exports to the USA was given to the Bahamas who are now exporting significant volumes on a regular basis.

Breadfruit

Exports of breadfruit still show room for development to all extra-regional markets. At present, the fruit has to be shipped by air and careful control is required of the timing between harvesting and delivery to the importer. The main limitations for the region are in the wide dispersion of production areas (no breadfruit plantations) and in the size of the trees which creates difficulty with harvesting. Both of these would need to be addressed if volumes are to increase significantly.

Annona species

Soursop, cherimoya, sugar apple, custard apple: imports into the UK of the Annona species are around 60 tonnes a year of which one-third is cherimoya and the remainder soursop. In the UK, Spain and Israel supply the majority of the cherimoya; Kenya and India supply the soursop (Fruit Trades Journal, 2 September1988). Development of the market could be achieved with these crops by increasing the post-harvest life and consumer awareness.

Carambola

Little information is available on the export volumes and demands for carambola although it is believed that 350–400 tonnes are imported into the UK, 90 per cent of which comes from Malaysia (Fresh Produce Journal, 3 May 1991). It is likely however, that sufficient demand exists for increased trade of the preferred varieties. This is probably dependent on promotional activities both at retail and trade levels and a drive for quality and productivity by the producers.

Passiflora

Passion fruit: two species – the purple and the yellow. The purple is more popular as fresh fruit as the yellow is more acidic and is used more in processing. Europe is believed to be the major market for fresh passion fruit, although no direct data are available. It is estimated that imports increased from 300 tonnes in 1982 to 1,000 tonnes in 1988. France accounted for almost 70 per cent of the imports into Western Europe. It is not anticipated that volumes will increase above this level (Yaurassowsky 1989). On the UK market, fresh purple passion fruit is unlikely to become a rapid growth area but has the potential for limited expansion (Fruit Trades Journal, 6 May 1988). The level of development may depend on consumer education on how to use the fruit. Processed passion fruit juice has shown considerable price fluctuations due to irregular supplies (both under and over), and stable pricing has not been achieved. Supplies from the main export countries - Brazil, Peru, Colombia, Venezuela, Sri Lanka and Ecuador - have reached levels which currently exceed world demand.

Granadilla and banana passion fruit: have begun to appear on the UK market though have yet to gain widespread acceptance. These are supplied mainly by Colombia from February to June.

Sapodilla

Sapodilla shows some promise for the future although probably only as a line in speciality retail outlets. It is consumed mainly by ethnic populations and has yet to cross over into the indigenous consumers (Fruit Trades Journal, 12 August 1988). Growth in availability may occur, but its general use is unlikely to increase.

Avocado

Avocado is already one of the most established exotics in the markets with sales increasing over the last 20 years. Its prospects continue to be good due to promotion, the many uses of the fruit and a good shipping capacity. The conclusions given by Marte (1988) appear correct in that there would be little advantage for the Caribbean islands to initiate production of the most popular varieties due to the level of present competition. Development of the production and exports of the West Indian varieties should be continued as an alternative to those generally marketed.

Guava

Two types of guava are currently produced - the white and the pink (the latter mainly in South Africa). Exports have fluctuated over the last few years with 1,950 tonnes being exported in 1983 and 1,480 tonnes in 1988 (from Brazil, Thailand, Taiwan and Venezuela) (Yourassowsky 1989). Prospects for fresh trade are considered limited but a good future exists for processed products (juices, pulps and canned guava) (Fresh Produce Journal, 14 April 1989).

Asian fruits

Lychee and rambutan: 90 per cent of the fresh lychee on the UK market is supplied by South Africa. Prospects for both fruit are are considered good, particularly for the fresh lychees, which are beginning to become preferred over the canned product. The short selling season, the handling and quality problems which occur with these fruits, may limit significant increases in volume.

Mangosteen: could have a promising future if present trends continue and improvements are made in the consistency of supply. The UK market is presently supplied by Brazil, Indonesia, Malaysia, Philippines and Thailand.

Organic fruits

Retail sales of organic produce in California increased from US$174 million in 1980 to US$1.25 billion in 1989 (Morgan et al. 1990). Further expansion of the industry is believed to be related to quality, availability of supply, the price premium consumers are willing to pay and the entry into high volume retail outlets. Organic price premiums can range from 25 to 35 per cent above the equivalent non-organic item. Without reductions in the price premium and improved supply, it is unlikely that volumes will continue to grow at previous rates.

Organic fruit production in some of the Caribbean islands may be feasible as many of the trees are simply left to produce and harvests are made from whatever is available. The problem will come with certification of these production areas.

Fruit processing

To support fresh fruit exports, a processing industry or systems to utilize non-export quality fruit appears essential. Producers generally have reservations with investing money, time and land in export crops if only 50 to 70 per cent of the crop will meet export quality specifications. In Central America, bananas which do not meet export specifications are processed into purees and exported in bulk containers. Similarly, pulps and concentrates from West Indian cherry, passion fruit and soursop also deserve consideration. On a smaller scale, green or ripe banana and plantain can be fried as chips or 'tostones' for snacks or meals. Dried natural or sugar fruit slices is a continually expanding market, particularly for the tropical fruits. Frozen sliced bananas and plantain both have market opportunities in the USA and Europe.

Constraints

The main limitation to the development of tropical fruit sales is generally considered to be the lack of consumer awareness. However, interest will continue to grow in these products if the prices can be reduced by improved production organization, quality, packaging, marketing and the development of sea-freight shipment combined with co-ordinated promotional activities.

Cultivar constraints

Several varieties of the non-traditional products already grown in the Caribbean are not the main varieties which are in supply in the importing markets. This is particularly apparent with mango, avocado and plantain. This is not necessarily a constraint if the products are marketed as alternative varieties and are supplied consistently and with good quality.

System constraints

Production areas are rarely mono-culture resulting in logistics problems for collection and preparation of products for export. This also gives problems with maintaining uniform standards and quality control, not only from country to country but also within one island.

Spot purchase at the farm gate is the normal method for exports of the majority of non-traditional fruit crops. This system of procurement will always limit the volume of export due to logistical problems in collecting produce from a whole range of farmers. Quality control and handling practices will vary considerably and be difficult to control without good procurement management. Projections for export volumes cannot be accurately predicted which will cause problems with projections cash flow, stock requirements, freight space and importer confidence in the ability to supply.

Cultivar improvement requirements

It is important to select the most promising cultivars and establish adaptation trials. These same trials can be used to develop initial costs of production and yield figures and together with market price trends can be used to develop preliminary business plans for new exports. Who carries out and finances these trials is a decision which has to be made in the region.

Support from effective applied field research is a critical element in any export crop development and diversification programme. This normally takes the form of an experimental farm research programme; an on-farm research extension programme; and an adequate technology transfer system.

References

Hallam D and Molina J P. 1988. The United Kingdom market for fresh exotic fruit. ODNRI Bulletin No 13. United Kingdom: Overseas Development and Natural Resources Institute

Henderson D W. 1989. The UK market for exotic tropical fruit. In: Aspects of Applied Biology 20. Tropical fruit — technical aspects of marketing. pp. 3-12.

Marte R. 1988. Assessment of less-traditional fruit enterprises for the Caribbean: potential and constraints. A paper presented at the workshop on Alternative Agricultural Enterprises for the Caribbean and Pacific Basins. Jamaica, 18-20 August 1988.

Morgan J, Barbour B and Greene C. 1990. Expanding the organic produce niche: Issues and obstacles. In: Vegetables and specialities, situation and outlook year-book, November. 1990. pp. 55-60.

Yourassowsky K. 1989. Tropical fruits, fresh/processed. A survey of world trends in mangoes, guavas, papayas and passion fruits. England: FN Research and Marketing.

DISCUSSION SESSION VII

N Munroe (Department of Agriculture, Bahamas):
What type of information is obtained by retaining portion of the shipment?

A Malins (CARDI, Dominica):
Keeping the produce in a condition, simulating shipping conditions allows the producer to determine the state of his product on arrival. The findings can be used for resolving queries concerning the condition of the produce when the buyer says that produce arrived with poor quality.

S New (TROPRO, Barbados):
One of the problems with breadfruit export is in predicting its condition on arrival. Therefore we attempted to keep fruit under conditions similar to those during transport to the final destination. At least this gives one confidence in settling any queries regarding the quality of the fruit.

Common problems are stage of maturity, dehydration etc., but an equally important problem is that the correct net weight is not packed so there is variability in the net weight of consignments.

P Francis (Productive Farmers' Union, Grenada):
We have had a shipment of tamarind which was short by 20-30kg - so we included extra cartons to make up the weight and to reduce cost of transport.

Are the videos shown earlier available for education/training programmes ?

A Malins:
Where there is need to make up the size of consignments as in this case it may be to the benefit of the supplier as the buyer may regard this as a show of good faith on the part of the supplier.

Videos can be made available - from Colin Bully of ADUC, Dominica.

J Foley (Waitrose Ltd, UK):
Where there is need to add extra boxes this should be done, clearly stating the reason. Grading rings are important - they are needed to ensure that the standard is maintained in packing boxes.

A Malins:
Where we are dealing with wholesale markets we need to know whether the customer wants mixed boxes or graded produce. However graded produce in one box is more acceptable. Where mixed sizes are required it may be better to pack in separate boxes and the varying sizes marked.

E Reid (WINBAN, St Lucia):
Our exported fruits are not identified as Caribbean fruits. The market has expanded with general benefits to all. Towards 1993 with more competition we may have to identify fruit in order to compete more effectively using proper branding, labelling

With regard to quality control: where one has identified irregularities on the part of growers there should be some sort of penalty for the error.

A Malins:
Goods which are not returned can be assumed to be of the right quality etc. To enter a market (e.g. flowers) where suppliers of one country cannot fill a container, it may be more cost-effective to combine with other suppliers. As confidence is gained then it may be possible to market produce separately.

Marketing and communication must be on a one-to-one relationship with the client so that problems with the product can be dealt with on a personal basis, e.g. a telephone call.

Regarding delinquent producers: If there is proper quality control etc., there will be less need for complaints.

B Clarke (CARDI, St Lucia):
The Caribbean now wants to move away from traditional exports but use the same established markets rather than try to develop new product lines. How do you react ?

What new markets are available to the Caribbean? Are they accessible through communications, transportation, competitive styles etc. Then we could look at products which are adaptable to these markets, i.e. look at the best opportunities for success not at the more difficult markets.

For example, passion fruit is a new product which can be sold to the United Kingdom but there are other growers worldwide who will also compete. Therefore identify niches and opportunities that are there – attempt to minimize the threats or risks in penetrating the markets.

L Daisley (CARDI, Dominica):
What are your views oo present economic trends in export marketing?

B Buckley (EDC, Trinidad & Tobago): The media tends to exaggerate or dwell on recession in United Kingdom and America. In Ireland, where there is supposed to be a recession, there are areas where there is no recession, e.g. in the tourist industry where fruit etc. are in demand.

In Trinidad in 1989, 25,000 new tyres were sold, i.e. 5,000 cars registered. In 1990 it seems that 10,000 cars were sold but that is not necessarily because of a boom – cars were bought because banks made loans available and there was a rumour that car prices would increase and so people reacted to that. In other areas of the economy the market is depressed.

Therefore information is important. Having secured a market, there is a continued need to update, review and validate the information to ensure continuity.

L Daisley:
I do not think it is media hype as conditions change with the economic situation. Look at the difference in prices to banana farmers as the British pound fluctuated.

L Andrews (CARDI, St Lucia):
With respect to the opinion that Julie does not have a blush and being described as almost a green type mango: my experience from looking at some of the boxes of Julie that are being exported is that 80 per cent of the fruit in a box will have a blush. The problem is that no one takes the time to orient the fruit so that the blush shows. The blush develops on Julie where the sunlight hits it. Whether it is at the front or the side, wherever the sunlight hits it you get a little red blush developing on most of the fruit. So Julie does have a blush – it's just that we need to present it correctly.

Peach is an excellent mango and for me it even competes with Julie.

A Medlicott (Fundacion Hondurena de Ivestigacion Agricola, Honduras):
Virtually all mangoes can have a blush. You will have to prune the tree to make sure most of the Julie fruit is on the outside. If you continue to prune the tree and the sunlight gets in all of your fruit will show a red blush.

L Andrews:
The problem I found with Peach is that it is a lot more susceptible to anthracnose than Julie is so it means that if you are going to plant it you have to be more serious about the zone that you select.

I would not exclude all of the Florida mangoes because there are some of them that I think have potential for the late season production. Keitt is one of them that I think we should consider if we want to extend our production season even if it is just for the local or the regional market. Similarly Madam Francis from Haiti. Apart from the fact that they were given the heat treatment for fruit fly, the reason that Francis is there is that it is also an early type so it gets into Florida around March when there is no other Florida type mango available.

I agree that papaw is one of the few crops which has the capacity to replace banana because of its ability to produce continuously all-year-round. I suspect that the market for fresh papaw will remain high. The challenge for us here is to deal with the major diseases like bunchy top and Erwinia. In terms of handling and post-harvest care etc., we have a good model from the banana industry.

R Marte (IICA, Trinidad & Tobago)
There is only one thing that I disagree with you about and that is when you were mentioning the minor crops you included golden apple. Don't you think that we have the capacity to develop the crop to such an extent that it could be exported in large quantities? A lot will depend on

what we consider large. I consider what Grenada is doing is already large. Grenada exported 400,000lb of golden apples last year, and this year one company out of the three which are exporting has reached that target so the whole country is expecting to reach over a million pounds by the end of the season!

A. Medlicott:
You are talking about a lot of tons but not a lot of money. The price for exported fruit from Grenada worked out at about 35 cents a pound. Based on a million pounds that would mean $350,000 – not a lot of money really.

R Marte
The market for golden apple is growing. At the moment the market is mainly ethnic I believe. That's how papaw started as well. That's how avocado started. I do believe that for the small islands like the ones that we are working with, there is potential for that particular fruit.

S New (TROPRO, Barbados):
I am not so sure that any of us know what is really happening to this all this golden apple. A million pounds is about 500 tons and maybe a lot of that is being processed in one form or another by the people that buy it. Maybe that is where the possible development is for golden apple. Not in the long term as a fresh fruit but maybe as a value added fruit.

R Marte
As a matter of fact that is what I understand too. If I remember correctly, they are shipping to two major firms and one of them required ripe fruit. The other one may be green, I am not sure. Maybe Mr Paul Francis can give us some information on this.

P Francis (Productive Farmers' Uniou, Grenada):
With respect to golden apples, we export them mainly green. It's only in the last 2 weeks that one buyer in New York was asking for some ripe ones. We sent him five boxes in the first shipment and the second shipment was increased to 25. We don't know if they are processing them but we are trying to find that out.

R Marte
At the moment IICA is involved together with the Ministry of Agriculture and CARDI in a clonal selection programme in Grenada. If the market continues to grow it will require fruit of good uniformity. Now we are providing for that in the selection programmes.

P Francis:
We have discovered that the golden apples in the higher rainfall region are much cleaner – there is less anthracnose. This I find is a bit strange.

I Kosto (CARDI, St Lucia):
If the golden apple is to be used for processing, it doesn't make sense to ship it as whole golden apples. It is better to ship it as mashed golden apple or pulp or in any other semi-processed state because then the volume will be much less since 50 per cent is seed. Also, as semi-processed (or completely processed as juice or pulp), there will be no rejects, so the value per ton that we ship would be much higher because we are not shipping waste.

E Harvey (Casse Consultants, Barbados):
If you are looking to see whether they are processing by judging from the state of ripeness of the fruit they are importing, that may not necessarily be appropriate with golden apples because you can use the green fruit to make juice as well as ripe fruit. The green fruit makes a lovely cloudy juice – hard green fruit. You might get a better yield with a ripened fruit but that may not be a good criterion.

S New:
With respect to mango, isn't it true that there is more than one Julie? It seems to me that when you get Julie from different places, they don't all look the same.

F McDonald (CARDI, Dominica):
They may be different clones – some tend to have a kind of purplish cheek rather than a red cheek.

S Parasram (CARDI, Trinidad & Tobago):
Going through Barbados and seeing the golden apples which they have there I get the impression that nothing seems to be wrong with those trees. There is so much fruit on the tree at any one time as compared to Trinidad and I assume

Grenada. I was just wondering whether anybody has looked at it. Is it a clonal difference, varietal difference, or is it a climatic problem?

A Malins (CARDI, Dominica):
Can you generalize about the relative shelf-lives of Horn and French plantain? Is there any difference ?

A Medlicott:
This depends on stage of harvesting. Plantains are harvested based on appearance. French has to be left longer –100–110 days to obtain a shelf-life of 3 weeks.

B Clarke (CARDI, St Lucia):
Are the experiences in Honduras recorded for others? What inputs do the public and private sectors make for the development of new products in Honduras?

A Medlicott:
Research and development are not led by the government . The main thrust is due to the private industry.

The Institute works with four crops determined by the industry. The aim is to provide information for exporters.

However, if there is a niche for completely new crops such as strawberries or asparagus, the government takes the initiative.

- stronger linkage of the industry with tourism through use of flowers, picture postcards, posters as souvenirs, development of recreational park areas, tours through simulated production areas, exploitation of cruise ship visits, publication of articles on growers and their products in in-flight magazines on major international airlines, development of a mail-order service, production of a directory of exporters and their products.

- stronger linkage of the industry with fashion and handicraft industries.

- Greater use of embassies and commercial attachés in importing countries in following up complaints about disreputable importers, and in facilitating import procedures for floricultural products imported from the region.

DISCUSSION

R Marte (IICA, Trinidad & Tobago):
There is danger from movement of germplasm within the region and also from outside. Recommendations to regularize and control this aspect have already been made to Ministries of Agriculture but follow-up action has not been taken. There are serious deficiencies in the quarantine sector.

Market potential and market information for new crops needs to be thoroughly researched before taking decisions on promotion.

G Muller (CARDI, Trinidad & Tobago):
Guidelines for movement of germplasm have already been circulated to CARDI.

R Marte
IICA also has these guidelines but the Ministries of Agriculture have to take an active role.

B Clarke (CARDI, St Lucia):
What proposals are we forwarding to deal with the problems associated with quarantine – germplasm movement etc?

F McDonald (CARDI, Dominica):
Phytosanitary requirements are the responsibility of the Ministry of Agriculture. The Standing Committee of the Ministers Responsible for Agriculture in the Caribbean need to have this issue on the agenda for their next meeting. Except for Jamaica, the quarantine services are poor – no infrastructure; virology tests are unavailable. There is a need to screen new varieties desirable for introduction. In the Ministry of Agriculture one person makes decisions without further consultation with superiors therefore the system needs re-evaluation.

F Proctor (NRI, UK):
How are proposals dealt with? There is commonality between the working groups and the CARDI Strategic Review. How will CARDI/CTA handle the recommendations made here? Should this group advise CARDI/CTA on how to handle the recommendations?

G Muller:
Ministries of Agriculture have mechanisms for dealing with recommendations. CARDI will submit the issues to Ministries of Agriculture asking Ministers to endorse and implement them. Plant quarantine needs to be improved and monitored. Issues have to be brought to the attention of the Standing Committee of the Ministers Responsible for Agriculture.

A Malins (CARDI, Dominica):
It is necessary to identify a body to take action on these issues otherwise they become recommendations in files. Find the groups which should be targeted. People do not always read repots, therefore we should make a personal presentation at ministerial level to get these issues across.

D McAllister (MBM Federal Export Ltd., Trinidad & Tobago):
Be as brief as possible in making presentations. If possible, make it in point by point form sand ummarized.

TECHNICAL SESSION VIII

PANEL DISCUSSIONS

REPORTS FROM WORKING GROUPS

Chairman: Tiberman Narain, *CTA, The Netherlands*

Rapporteurs: Don Walmsley, *CARDI, Trinidad & Tobago*
Glenner Robinson, *Ministry of Agriculture, Jamaica*
Wendy Lee Yuen, APASTT, *Trinidad & Tobago*

PANEL DISCUSSIONS

I. Opportunities and Markets for Flowers and Ornamentals in the UK, Canada, Europe and USA

Chairman: Dolph McAllister
Federal Export Ltd.
Trinidad & Tobago

Introductory remarks from Panel Members

Steven New – TROPRO, Barbados

Let me say in advance that I am no flower expert but I did volunteer to come on this panel. In view of my limited experience I think selling flowers should be sismilar to selling any fresh produce. My experience is limited really to a few years ago when I was working with CATCO, we did get into the business of selling tropical blooms into the UK and to North America and more recently through the TROPRO project. I have also now become involved yet again in trying to market various tropical blooms and foliage in North America and we are actually doing that at the moment through TROPRO.

Over the years I have seen what great difficulty we have had in selling sweet potato. It always seems to me that if we can't get a sweet potato of good quality into the market, what chance do we have with orchids or ginger lilies? I've often wondered as well why it is that cut flowers get so much publicity and seem to generate so much interest in the region. There seems to be a kind of agri-social hierarchy here in the Caribbean at the moment. If you look at the social hierarchy, eddoe growers tend to be fairly non-influential, but the cut flower growers tend to be very influential people usually related to somebody or other and with quite a lot of disposable income – those with income to invest in the business. So I do feel at times that we tend perhaps to lose focus. Barton Clarke's point is very well taken. Before we set priorities to some of these things, we'd better be sure that it's really worth spending much time on ornamentals in the first place from a policy point of view.

Having said all that, what is really interesting about ornamentals is that they fully illustrate more than anything else the kind of things that I think are necessary to be successful in selling fresh produce. Most of us here are not the growers or the sellers and my view is that most of the fresh produce trade is a very fragmented industry and success really depends upon individuals doing very well in their own operations. Government, CARDI, TROPRO etc. can all do something over the top of all this with these very delicate, difficult, expensive, tropical products like flowers and fruits. Surely we can try and get more market information and we can try and predict things and we can try and become more businesslike. But at the end of the day it boils down to individual operators doing their job well. John Foley knows more about price than I do probably but it has also been my experience that with things like fruits and ornamentals, price is not usually the problem if you actually do the job properly.

I was under the impression I was here to comment on the UK market in flowers. A couple of years ago when I was with CATCO, we did (for our own use) a short survey of the UK market for flowers, for the blooms, that people were asking us to sell. All we did really was go out and talk to about 25 to 30 buyers of tropical exotics (These results are available). The reason we did it was that we found the transaction cost of dealing with all these small shipments of cut flowers just wasn't worthwhile. Shipping 20 or 30 boxes, no matter how high the value of the product, the overhead was too great, so we thought the only way we could ship flowers and foliage was to lock it into a bigger shipment; that might be mango, breadfruit, papaw at that time. So most of the shipments as far as we were concerned at least were going into the UK market. In fact that's where most of the wide-bodied aircraft go in this region. So realistically if you are going to be in the business of setting up a product and you're not going by sea, you need a wide-bodied aircraft. Therefore you're really looking at the UK market most of the time because there aren't that many wide-bodied aircrafts with that capacity to North America. So we wanted to sell in the UK although we knew that the UK market tends to be not as good as other markets for cut flowers, but for the above reason it was more economical for us to do that. When we tried to sell to Covent Garden we didn't do very well for a variety of reasons so then we hit upon the bright idea of trying to contact these 25 or 30 high class retailers to see if we could somehow organize selling some expensive tropical blooms to them on a weekly basis and contract some and distribute them. Just to find out a bit more about the customers really.

They said four things to us in relation to the UK market. I think they've all been said already here. Every single one said that they didn't usually get good enough continuity in quality with tropical blooms from the Caribbean (this will also apply to fruit generally). I'm sure that's been said many times this week. So they wanted better continuity in quality.

In relation to flowers specifically, almost everybody said that the people didn't know the product including some who didn't know what a ginger lily was and they didn't feel that they could do very much in terms of taking bigger volumes without some significant promotion. Related to that they almost all said as well that they got too many in a box. This is a very simple thing, not a very philosophical point. But, with most products, the shipping at the moment is a problem and this applies to fruit as well – quite often we do have too much in the box. One of the first things we need to look at in terms of shipping is to put less in the box. The big problem is of course when you ship the product by air and the relative cost of packaging and shipping. Packaging becomes a significant cost factor if you make the box smaller because then you're to freight cardboard or whatever and then the economics become more difficult to deal with. But certainly in the case of flowers (I also notice its the case with ginger and other fruits) these days people in the UK generally want less per box.After all, most people confirmed what we also thought was the problem. If you can really do a great job, price isn't normally the most important factor.

John Foley – Waitrose Ltd., UK

I would just like to make some very general comments. These do not apply just to the Caribbean – they probably apply to every part of the world. The first is: don't try to run before you can walk. Get the basics right first. Look for your windows of opportunity and explore them in the short term. You have to understand your strengths and your weaknesses and it takes time to create the sophisticated markets which I showed to you yesterday. Those markets are there for you in time but your most valuable asset is your reputation and I would recommend that you guard that closely and don't let it be ruined by a substantive product coming on to the world market under any sort of branding or any sort of recommendation unless you are sure of the quality of the product.

Anthony Pantaleon – EDC, Trinidad & Tobago

In Trinidad & Tobago we have specifically targeted the fresh fruit and vegetable sector together with the floricultural sector as areas of export opportunity and we have been involved in a comprehensive programme over the last 5 years in fresh fruits and vegetables and more recently we have developed a programme for the floricultural sector.

Luis Bonilla - JACC, Dominican Republic

I am no flower or ornamentals specialist – mostly I've been dealing with fruits. However, there are some experiences in my country concerning ornamentals that I would like to comment on.

The ornamental flower industry visualized exporting and the first project started with something like five sub-projects all at the same time. Most of them were on geraniumsbut some were on roses. They set up most of their facilities on the site of the project to handle the production for export but they found that the internal demand for ornamentals was so high that they got better prices in the country for their produce than when they exported it.

GENERAL DISCUSSION

Question:
What are the fresh fruits that are being exported from Trinidad now and to what markets?

A Pantaleon (Export Development Corporation. Trinidad & Tobago):
The export of fresh fruit from Trinidad & Tobago is miniscule. What has happened over the last 5 years is that the emphasis has been on the export of vegetable products, some traditional, some non-traditional. In the cut flower sector.exports have just begun to increase. From 1988 we saw an increase in export activity from almost a zero base. So as far as fresh fruit is concerned, there has been very little activity. I do know of a number of organizations and companies who are looking at that particular market again but in the area of fresh fruit, there is very little export activity in Trinidad & Tobago. The activity has been in the vegetable sector and the sector has performed very well. There is significant room for improvement but we are satisfied at the present time with the level of exports in the vegetable sector.

S New (TROPRO, Barbados):
I would just like to make a general point on fruit. It is absolutely crucial to find your personal comparative advantage as well as national comparative advantage Being very tropical is the first one that we have. It's the same with flying flowers. The very big tropical blooms are, if anything, what we have a comparative advantage for. I did an interesting exercise with a World Bank team recently visiting all the islands and one of the things that came up was the relative markets of fruits other than bananas. As you know, there is a lot of emphasis on diversification now and if you add together the total current market demand of all the fruits that are mentioned around the region in terms of potential (those that we can grow; those that we know about),the potential revenues from those are less than 2 per cent of the current potential revenue from bananas in global terms. That's one side of the story so if you are a policy maker you really have to think whether you should be putting your research and development activities into making sure you keep your banana market or whether you do really want to get into golden apple.

However that is totally different from an individual who, if he produces the best golden apple on the market, will probably take most of the market because no one else is doing it very well. He will make an extremely good living if he is the best supplier of golden apple to the market. What often confuses us at these meetings results from not defining what we are talking about – whether we are talking as policy makers or individuals making some money out of fresh produce.

L Bonilla (JACC, Dominican Republic):
In the Dominican Republic, we are exporting boxes of papaw, mostly Sunrise and mostly to the United States. Last year we exported 49,000 tonnes of pineapple and we will export about 30–40,000 boxes of avocado. This is mainly to the United States market (except for the pineapple which is going to Europe) because we have the Dole Company, Chiquita Banana and United Brands. There is some kind of argument as to how much treatment we could afford to give to the fruit to cope with the quality the buyers (not the consumers but the supermarkets or the importers) will ask for because the price for us is somewhat inelastic. They are willing to pay better prices for better produce but only up to a

point. So we have to be very careful about how much we put into the product to improve the quality. It depennds on how much increase in the price we will get for that.

J Foley (Waitrose Ltd, UK):
I would like to make a comment about a product that is new to a market – it's all to do with perception. In the UK, the first passion fruits to arrive on the market were purple so one's perception is that all passion fruit should be purple. If you try to introduce a pink passion fruit or a yellow passion fruit, you actually have a marketing job to do. Likewise, if the first mangoes that arrive are red blush mangoes, then you come along with Julie, you have got a marketing job to do to tell them that the correct colour for this particular mango is green. That's all additional marketing cost. Now it may well be that you should be looking at some of the products that we don't currently see on the UK market and they may be very small niche products initially – star apple is one that springs to mind. The only star apple that I have seen has come from Jamaica so therefore people's perception of what should be a good star apple would be a Jamaican star apple. I would just like to leave that thought with you that if there are new products there which the market is not used to, you've actually dominated it in the first instance.

K Craig (CARDI, Trinidad & Tobago):
Our friend from the Dominican Republic brought up the issue of domestic demand which is something that we haven't talked about. I suspect because of the orientation. I think it's an issue that needs to be addressed if we are into production for export and may I say quickly that within CARICOM that domestic demand is still only a maximum of five million people. That is still not a measure of effective demand which would probably be half of that. That is domestic demand and then of course there is the tourist industry There will be some opportunities because by and large we are not talking of specialized production, or specialized large-scale production for export. We are really talking of exporting quantities of produce that are currently being produced. So to the extent that money can be made in such a way it doesn't matter whether it is sold locally or sold overseas. We need to look at that.

Just to bring things a little closer home, there is every evidence to suggest that Barbados (of course not from a political point of view but for economic reasons), should perhaps be importing most, if not all, the vegetables. That is one example.

A second example is that while the OECS is currently looking at what fruit crops to produce for export extra-regionally, Barbados is currently importing between 1,500 and 1,800 tonnes of citrus (oranges specifically) per year and those oranges are being sourced from extra-regionally mostly – Florida, Cuba – with some from Jamaica. When we look at the proximity of Barbados to the OECS, that is a problem but this is the reality at the moment. In some cases, as our friend says, heaven is at home and I think this is something that we need to continue focusing on. Export opportunities aren't necessarily always in the US or in the UK. They could be a lot closer.

Comment:
I just wanted to pursue something that Steve New had mentioned about the size of the market for fruit. I feel that we need to look at it in the context of the land size that we have and our production capacity. Two per cent of the world market for banana, I dare say, will exceed our production capacity for any one of the commodities that we are talking about. In St Lucia right now I think the area in banana is something in the region of 16,000 acres. I don't think we're going to do away with all of that and whatever area we are going to replace with fruit crops is now to be sub-divided – some of it for mango, some for pineapple and some of the other diversification crops. So I suspect the volume we are talking about putting on to the world market is going to be small in relation to the other fruit crops.

The other thing is that I feel our marketing strategy has to be niche market, and also quality, and despite whatever is going on in the market if you come on the market with good quality, I feel that you are going to find a place.

S New
The point I was making was one in terms of resource allocation. That is in role terms as far as CARICOM was concerned. In this case, the Windward Islands and Jamaica. The question is how do you allocate your scarce resources in agricultural research and development given the fact that for the alternative crops to banana the potential market is probably at the moment only a few per cent of the potential market for bananas so there will always be more constraints to developing that. The point I was making was therefore: at that level how do we decide how to allocate resources. Those are the kinds of things that you need to look at.

I did follow up by saying that I still believe there are crops, specific food crops, for which we do have comparative advantage and for someone like me who has been involved in the export of fruits in this region for a few years now, it is very frustrating to see that we haven't managed to totally tie up (through improvements in quality for example) those crops where we do have market share. Breadfruit is one of course. The Windward Islands have probably 95 per cent of the UK breadfruit market and yet we've seen no improvement in quality over the past decade - if anything it is probably getting a bit worse. It was interesting for me to be in the market last year with a group of exporters who saw some boxes of breadfruit from Mauritius. Now Mauritius is a speck in middle of the Indian Ocean and it costs a great deal of money to ship breadfruit from Mauritius. All they'd really done is shrink-wrap single breadfruits and put them in a nice looking box; nothing tremendously revolutionary. They thought it was fantastic that Mauritius should send such good breadfruit into the market place. All that Mauritius did was take a few breadfruit and do the job properly. It was nothing spectacular really and one thing we have to do is to take a good look at ourselves. Okay we have breadfruit, we have Julie mango, which is an excellent mango and we've all heard the argument about red mangoes. People really don't just eat red apples. The Granny Smith apple is becoming a favourite. People are buying Granny Smith apples which are green because they perceive them as being juicier and fresher than Golden Delicious which often may not be so delicious because they are grown for other reasons. Equally therefore I don't see any insurmountable problem with selling people Julie mangoes as long as we put in the marketing effort that John Foley has mentioned. So what we have to do is find those specific crops for which we do have comparative advantage and really try and concentrate on those and even if the market is very small, let's at least be the best at it!

Somebody commented on golden apple. Off the top of my head I would suggest that the situation with golden apple is similar to mango. Right now almost all of our mangoes are sold to West Indians living overseas. Very few of our mangoes ever get beyond the Spittlefield Market buyer or Brixton Market etc. at the retail level in the UK. Most of those people also buy golden apples if they are around so it's not really surprising to me that golden apples should quickly catch up on mangoes. The problem for us is getting from that fairly indiscriminating loyal group of buyers into the much bigger mango market which we are not really reaching at the moment until we start doing things more excellently at the small level. I endorse fully what John Foley said "do not try to run before you can walk". Even with these crops, we know all about them supposedly, but we still are not actually consolidating the market we've got and trying to push them on.

H Avey (Kairi Blooms, Trinidad & Tobago)
I'd like to agree with what you are saying and I'd like to share my personal experience with cut flowers for instance and anthuriums. We went into this market that was already established in Miami. We had to compete with Hawaii and Jamaica and the approach taken was of looking at the product and seeing what was required. What we found was that the varieties they had there were all Hawaiian. We introduced the Dutch varieties there and surprisingly that made an impact. The point is that the variety was there. We had to also look at the packaging. The Dutch variety is a different type of anthurium and as a result of that we had to change the packing.

The important point here is that we went to the market, saw what was required and then decided how we can compete. One of the things that we for instance have done, or were able to introduce, was to change the quantity of blooms per box. Where, traditionally, the Hawaiian's variety can start at about 30 large blooms, you find with that with the Dutch variety you can only start with 18. However what we found is that packing 18 in a box is a more marketable item because when you go to a flower shop, they would much rather pay for 18 blooms than 25. It's just like you're selling biscuits or anything. You have a certain amount to spend so this what you're going to buy. So that from that stand-point we have a competitive edge. One of the things we have to look at obviously is the freight but now that we have introduced the new packing system, we find competition for a future place because the Jamaicans are now packing like that and I presume the Hawaiians may eventually. The important thing is that if you have a niche or if you introduce something like that, you have to maintain it and you have to maintain the quality. We must never lose sight of that. It is very tempting to see a bloom and there is only one speck to put it in. I think it is better not to. If one does keep up the standards I think that gradually you will get the name being requested and that confidence will build. So the point I want to leave with you all is the question of looking for excellence. Do not settle for seconds or: "well they wouldn't see this". If you are not satisfied with it, don't sell it!

K Craig

Mr Chairman, I think that this is relevant for the entire group. I wonder if John Foley and Steve New could perhaps respond to this. This whole issue of ethnicity and the demand for products not only in the UK but in the market overseas. Seeing that so much has been said about golden apples, let us think about golden apples because I think we can draw reference from that. How long is this whole thing about ethnicity likely to last. In other words we know that the West Indian population back there are in their thirties, forties, fifties, what have you. Their grandchildren now are not perhaps too interested in the yams and the eddoes and so on coming from this end. Yes we continue to go each year but we West Indians who are going now are not the same West Indians who went in the 1950s and 60s because I think generally the whole diet here has also changed so there isn't such a strong relationship with some of these things as our grandparents or great grandparents had. Where does this fall into the picture, not only as it relates to golden apples but the other commodities?

J. Foley:

I think that there are perhaps a lot of other factors which actually have to be taken into account – social factors that have to be taken into account, not purely of an ethnic nature. In the UK today a very large proportion of the female population goes out to work. If they go out to work, they are looking for convenience. If you have a product, be it ethnic in nature or not, that takes a lot of preparation, then it's going to struggle to find its way into that market whereas if it is in a semi-prepared form or it is ready to cook, then it is going to find much greater acceptability on that market.

I mentioned yesterday that I sold 300 items. Now a great percentage of those was not indigenous items initially so obviously all these items can become established over a period of time but it has got to relate to the ease of preparation, the flavour, the taste. All these other attributes are very important. Obviously there are the economics involved. The share of the total trade in the United Kingdom is moving in the direction of the supermarket so we are gradually getting a bigger portion of what might previously have been described as the ethnic trade coming to us, so I think it will be something progressive. It is happening at this moment in time but I don't think you can say that in one or two years from now it's going to be integrated because life isn't like that at all. It will be a gradual evolution.

S. New:

If I understand your question, you were asking whether ethnic minorities of West Indian heritage living overseas will continue to buy these ethnic vegetables over the long term. I don't think the statistics show any marked drop off in the purchase of those amongst ethnic communities at the moment although one would imagine that over time certainly it would become a less important a factor. I'm a cross-over product in the sense that I am British and have now lived 6–7 years in the Caribbean and eat all local products. My view is that it probably will drop off. In the same way I don't go around trying to buy European products in Barbados any more, West Indians eat less and less West Indian products overseas. What I think we should be doing is looking for those products that we know about, that we previously sold to those West Indians and/or ethnic communities and promote those. And, although we won't retain our market share there, somehow push them into the greater market. Some obviously you can and some obviously you can't and maybe you have to get advice from people like John about the ones you can and the ones you can't. Things such as yam are probably quite difficult to sell to someone who has no historical association with yam. On the other hand probably West Indian pumpkin has potential given the fact that it is a nice orange vegetable. There aren't many orange vegetables available in the winter. It's very cheap to produce. Maybe the West Indian pumpkin could be sold like the vegetables across the board to everybody. I'm sure that Julie mango would sell but I have great doubts about getting people to chew golden apples. Golden apples are not an easy thing to sell into an unfamiliar market.

Then there are some borderline ones like plantain since people will know banana pretty well and to me fried plantain with eggs on a morning is great. It's just that people are not eating so many fried products but there is a lot you can do with a plantain which is not an unfamiliar product but people really don't know how to prepare it. So what I am saying, to answer your question is: yes, I think the demand will drop but on the other hand it can be expanded with the right effort.

II POST-HARVEST MANAGEMENT FOR PROCESSING

Chairman: Tiberman Narain
CTA, The Netherlands

Introductory remarks from Panel Members

L. Sammy – CARIRI, Trinidad &Tobago

There was an early idea that products which were not up to standard for the fresh fruit export market should be used for processing. This is wrong because fruits that are not ready for the market in their fresh state due to poor quality, are not ready for processing either. If we start with poor material, the end-product will also be poor. Quality refers to features that are visible (e.g., colour, size, shape, texture) as well as those which are not (e.g. nutritional value, microbial content).

Factors which determine quality for processing are:

- selection of cultivar
- growing conditions
- pre- and post-harvest handling.

Post-harvest handling for best product:

- length of time after harvest and before processing should be as short as possible
- some fruits have to be held for ripening before processing, e.g. tomato
- sometimes raw material needs to be stored, especially when there is a shortage.

Problems:

- quality of raw materials
- transportation
- storage conditions
- improper packaging (which causes desiccation)
- raw materials are seasonal and come from many sources – local, regional (e.g. soursop and pineapples from other islands) and extra-regional (e.g. white potatoes for fries)
- processors have limited access to storage facilities
- processing is largely labour-intensive.

Often the plant is not run at full capacity because fruits are out of season but gets busy when they are in. Products are acquired on an 'as-need' basis as no storage facilities are available due to financial constraints and lack of awareness.

There needs to be greater effort in some areas, especially in sensitizing processors to (i) management of facilities and (ii) crops which have potential, e.g. mango, pineapple, hot peppers, passion fruit, watermelon and pumpkin.

R Harnarine – Chase Foods, Trinidad & Tobago:

My company will be setting up subsidiary plants on islands where fruits for processing are obtained. Trinidad has limited sources. Some fruits are not widely produced here because they are long-term crops. Farmers prefer short-term crops which give quick returns. The main problem is seasonality.

Pineapple
Pineapple is the major import commodity – 40,000lb per week from Guyana. This is an opportunity for CARICOM trade as the boats take produce from Trinidad back to Guyana and this trip takes only one day.

However, there is much spoilage – up to 50 per cent. The pineapples often come loose.

They tried packing them in cardboard boxes but they squashed each other. Then they tried sacks which also failed. Refrigerated containers were also tried but these were too heavy. The fruits looked good on the outside but were spoilt on the inside. Hence a 10-15 per cent loss.

Papaw
There were two contract farmers who supplied papaws - 2000lb per week for cocktails, syrup and nectar. These will be exported soon with the first container load is going to Barbados next week.

Mango
The mango preferred is Graham which is fleshy. The stringy ones are avoided. Julies do not do well in salads. Grahams are imported from Grenada in wooden crates - 4ft x 2ft x 2ft - 80-100 lb per crate. This is a short journey so fruits are of good quality when they arrive.

Soursop
Soursops are imported from Grenada in the green form. They are put in fruit cocktails and the juice used as nectar. This product was taken to a trade fair in Europe and people (especially those from the press) were very impressed and interested. Articles were written about it; however there is very little literature available on the crop.

Banana
Bananas are grown in Trinidad. A special variety for fruit cocktails is needed.

There are three brands of locally processed fruit cocktails - Sunpic, Happi and Geddes Grant.

Fruit cocktail potential in the Caribbean has increased but there is not much potential in the UK because there is much competition from other countries (USA, New Zealand). We are now looking to the Canadian market.

Fruits which are partially damaged are used for juices, jams, jellies and nectars. This is growing. The Caribbean could be major producers of exotic tropical fruit juices for the European market. There is a need to improve packaging. Sweden has a potential demand for juices of sorrel, mango, pineapple and soursop.

Sorrel is new but has too short a season (December–January), It needs to be semi-processed to be held for the rest of the year.

We are working with Diamond Diary in St Vincent and CARDI on passion fruit and mango - we hope to provide pulp and concentrate.

Patrick Padmore – Co-operative Citrus Growers Association, Trinidad & Tobago

We have been doing processing since 1932. After a peak (over 1one million crates) there was a decline in the late 1960s on citrus farms. Now we get about 200,000 crates but efforts are being made at rehabilitation and new plantings. Since 1977, concentrate from Belize and Costa Rica was imported for processing.

The company has done guava pulping but raw material availability has been low. This company can take all fruits in Trinidad presently and process them within 3 months. We are presently laying down a concentrate plant to deal with the increased amount of concentrate. Only 2–3 persons have enough to warrant large-scale production but this is still enough to justify the equipment being laid down. It has a storage capacity for 4,000 crates of passion fruit/grapefruit.

We have 425 farmers who should provide us with fresh citrus at a guaranteed price. However, we have not been receiving fruits. Farmers prefer to sell on the fresh market first. The processor stands to lose in this case as farmers are not reliable.

Someone has to go out and communicate with farmers and tell them to upgrade their fruit quality. When the price is set before, they bring low quality, damaged fruits. We may have to adopt a penalty system for sub-standard fruit.

We are prepared to process other people's produce if it is of the right quality and quantity.

GENERAL DISCUSSION

S Parasram:
The citrus growers organization helps to guarantee farmers that their fruits will be bought. Is that the way to go for other fruits?

P Padmore:
The company can advertise for passion fruit, say, but if the growers got together in an association their organization could request CGA to process for them.

S Parasram:
Would it be possible to work out a system between farmers and processors similar to that at West Indian Tobacco?

R Harnarine:
This can be worked out but one needs to be careful that there is a market for the produce and it is well known so that a glut does not result.

The farmers need to be faithful and understand what processing is about. They should pick at the right time and ensure a regular supply.

Advertising can lead to over-production. Where markets have to be created for exotic fruit we need to move with care.

L Bonilla:
Problems which processors face include: scanty production, scattered trees, many varieties. Thus the product is uncertain and hence cannot compete in the market place – there is no control over the quality of produce. Farmers are willing to produce short-term crops for processing or fresh fruit but it is more difficult for long-term crops. One needs commitment that loans are available at low rates and that the farmer is not left stranded with fruits. There is a need for a long-term, medium-term and short-term programmes so that one can compete in the export market.

Adopting one variety would ensure uniformity in the processing plant

Question:
Is it possible that subsidising farmers in Trinidad could be cheaper than importing fruit? There would be savings from reduced losses during transportation?

R Harnarine:
Processors' problems are not unique to the Caribbean. It is cheaper to buy pineapples from Guyana than locally because it is a new crop here and it will take some time before farmers start getting returns. Pineapple is a native of South America therefore it grows very well in Guyana. There are plans to set up a processing plant in Guyana.

W. Lee Yuen (APASTT, Trinidad & Tobago):
I agree with Mr Harnaraine. I am impressed with the banana success story – standardization of production techniques etc. directed towards the processors' requirements. Can this be adopted for other fruits? How does the Citrus Growers Association direct farmers?

P Padmore:
The price is set in agreement with the citrus farmers and reviewed every 2 years. The problem is that the fresh fruit market is fetching good prices and farmers do not want to keep their obligation to processors. Praedial larceny is a serious problem.

L. Andrews:
What about mangoes varieties from Grenada? Are guavas selected from wild types? Are large table-type guavas suitable, acid enough?

R Harnaraine:
Sensation and Graham stay firm for a long time. Guavas have potential for processing. There are good ones from Brazil and Santo Domingo. The main problem is the fruit fly with guava grown in Trinidad – therefore they cannot be used in fruit cocktails. Not too many farmers grow selected varieties. Wild types are found in Moruga.

P. Padmore:
Guavas were processed in the1970s for the Ministry. The Centeno selection was used However grove management was poor and by Year 3 of the operation, on an enterprise growing 75 per cent of the fruit for the project, the fruits had become infested. The best opportunity is with the Centeno variety as a puree.

A Donelan (CARDI, St Vincent):
With regard to passion fruit processing in St. Vincent: There are few growers and the crop is labour-intensive. Growers prefer the fresh market where they can get $0.80 per lb as opposed to $0.45 for processing. What is the potential?

P Padmore:
There is little potential for passion fruit in Trinidad as yields are too low. There needs to be more information on the crop.

R. Harnarine:
We are looking into fruit concentrates for export which has the potential to be profitable. We need to be careful about citrus and passion fruit as they are doing well in Brazil, Columbia and Ecuador. Brazil leads in passsion fruit etc. - it is exported in tankers to Europe. Some is even impoted into the Caribbean!

REPORTS OF WORKING GROUPS

GROUP I: POST-HARVEST MANAGEMENT OF TROPICAL FRUIT

Presenter: Noel Munroe
Department of Agriculture
Bahamas

The team addressed the wider issues to enable the exploitation of market opportunities. The discussion was not restricted to considerations specifically or exclusively relevant to CARDI's role, nor confined to the CARDI Strategic Review.

The issues raised are catagorized under the following headings: Research and Development, Communication and Technology Transfer, and Removal of Constraints. These are not given in order of priority nor do they identify implementing institutions/involved bodies.

A number of the issues also occur in the CARDI Strategic Review which, where applicable, include action plans.

Research and development

Central mechanism

- Establish a central mechanism for co-ordination of post-harvest research to facilitate prioritization, co-ordinate resource allocation and optimize on resource utilization.

- Strengthen the mechanisms for defining priorities to fully incorporate market and client driven requirements.

- Ensure that the private sector including growers, traders, industry representatives and policy makers are represented within the central control mechanism.

Monitoring and information systems

- Develop a strategy to determine research needs for technologically orientated production and marketing on a national and regional basis taking into account the status of international study/technology.

- Establish an independent (including industry representation) progress monitoring system that would ensure outputs meet user/client demands/needs. This should include options to reallocate resources as necessary.

- Establish a system of regular listing of, and access to, all current relevant projects in the region.

- Ensure a balance is established between long-term strategic research and short-term trouble shooting/problem solving, within the overall research plan.

Communication and technology transfer

Information flows were considered to be a high priority issue.

- Increase the level of awareness of, and information from, relevant international research and commercial activities to enable exploitation by the Caribbean region.

- Collate and document past regional research, specifically material not readily available in the published form (e.g. internal reports).

- Increase the access to (e.g. CARDI modems) and use of comprehensive literature searches including manual searches of earlier published

Caribbean and international work. The allocation of resources to this activity was considered cost beneficial.

- Monitor the efficiency of literature searches including the extent of client satisfaction.

- Ensure that effective mechanisms are established for the free flow of information (literature, market intelligence, constraints) between all user groups (researchers, farmers, traders, extension workers, policy makers).

- Facilitate the ease of access of information by providing videos, 'easy-read', 'user-friendly' materials, to all clients.

- Consider the value of establishing a dedicated extension service including increased specialization within the service.

- Establish/strengthen networks to improve information exchange between participants in the production/market chain (e.g. post-harvest working group in Dominica; quarterly planning meeting, Guyana).

Removal of constraints

Policy framework

- Establish a short, medium and long-term policy framework for export development for priority crops at regional, sub-regional and national levels: this should include mechanisms for annual reappraisal and be responsive to a market-driven approach. The importance of political support to the implementation of programmes within the policy framework was emphasized by the Working Group.

- Undertake financial, economic and risk appraisal for the establishment and maintenance of export industries taking into account the highly competitive and dynamic nature of the market place. This appraisal should determine the balance of short and long-term cropping as a possible mechanism to finance early establishment of infrastructure.

- Determine the relative roles of larger scale producers, grower groups and independent small growers within the future production/marketing framework. It was recommended that the focus for priority support, including target funding, should be given to technology orientated growers (large) and/or grower groups. The grower groups should demonstrate commitment to the market requirements including volume and quality.

- Determine credit/loan requirements and establish financial support mechanisms to enable necessary investment in production, infrastructure and marketing to be undertaken.

- Improve the quality of data on the accessible production of export fruits.

Operational and management considerations

- Identify and characterize the key client groups to determine priority post-harvest interventions.

- Improve the perception of ownership/responsibility of members of grower groups in the collective goals/objectives of the group.

- Grower groups should be encouraged to develop business plans.

- Establish effective product procurement and preparation procedures including the establishment of infrastructure to enable the appropriate operations to be undertaken.

- Define management responsibilities within the production/marketing cycle and develop robust management systems.

- Determine minimum quality standards and develop quality control procedures with regard to current international market requirements.

- Sensitize farmers and produce handlers to export demands, including appreciation of a market-driven approach to production/marketing.
- Strengthen the mechanisms for effective information exchange between key players in production, trade, extension, research and policy.

GROUP II: PRODUCTION AND MARKETING OF FRUIT

Presenter: Lennox Andrews
CARDI, St Lucia

The approach used in conducting the discussion was to sub-divide the crops into two groups (based on knowledge, establishment, trade) as follows:

Major: mango, avocado, papaw, breadfruit, pineapple

Minor: sapodilla, carambola, soursop, pommecythere

The constraints to production and marketing of these commodities were discussed and the approaches to solving the problems were categorized as either Research and Development (R&D) or Technology Adaptation and Transfer (TAT). Where validation work is done it should include feasability. Only priority constraints were entertained. Some recommendations were general and applied to both groups.

Constraints to production

Production system

The current system consists of scattered trees which does not allow for easy management. This issue was pursued only in relation to procurement.

Variety

This was discussed only in relation to mango, papaw and avocado.

Mango
We are satisfied that there are varieties for regional and extra-regional trade. However we felt that further evaluation was required for some varieties that had potential as alternative local varieties, e.g. Ceylon, and others with potential as late or early bearers, e.g. Madam Francis, Keitt. (R & D)

Papaw
Currently available seed-lines would be lost if continued controlled crosses and selection did not occur. (TAT)

Avocado
Sufficient varieties exist within the region for year-round production. Introduction and validation are required (R & D/TAT)

Pests and diseases

Mango: Anthracnose and fruit fly (R & D)

Avocado: Phytopthora (R & D/TAT)

Papaw: Erwinia? (R&D)

Post-production constraints

These include harvesting, procurement, handling, packaging, transport and quality assurance.

- The production system is made up of many small farmers in scattered holdings which poses a problem for procurement. The recommended approach is to deal with farmers as groups, e.g. producers' co-operatives. This facilitates forecasting, allows for benefiting from procurement discounts etc.

- A general recommendation for all the crops was the development of protocols for quality assurance. This involves both R & D and TAT. and includes the determination of range acceptability of maturity indices, especially for some crops, e.g. avocado, sapodilla.

- Another general recommendation was for an engineering component (R & D/TAT) to work on:

- Harvesting - modification of harvesting tools and methods
- Packaging - design changes required
- Transportation - design modifications for vessels used in the inter-island trade
- Handling - sourcing, modification and management of fruit treatment equipment.

Marketing

The issues discussed were market intelligence, promotion and legislation.

Market intelligence

It was agreed that there were already mechanisms in place that would deal with this problem both at the OECS and the CARICOM level. The recommendation was that final delivery of the service needed to be accelerated.

Promotion

The group thought that there was need for more promotion of tropical fruit for:

- general awareness, e.g. what is a mango? – it can be green but also mature.
- consumer education for both local and export market in terms of nutritional value and use.

Legislation

There is need to access information on changing legislation and spread this knowledge to potential users – producers, exporters, processors. We refer here to issues such as EPA regulations, FDA regulations, e.g. pesticide tolerance levels, water quality regulations, use of waxed boxes etc.

Minor fruits

These were of lower priority and would therefore involve less attention by institutions.

The areas of concern were:

- Market information on the true potential of these crops (R & D)
- Information on the production system (R & D/TAT).
- Some specific pests and diseases, e.g. anthracnose in golden apple.(R&D)
- The packaging and post-harvest handling of these crops (R & D/TAT). A general recommendation is that we must have a functional system for dealing with post-harvest issues. The reason is that changes in the market will call for revision of market strategies which inevitably involve some change in the chain from harvest to consumer use, e.g. earlier maturity harvest, new packaging etc.

Co-ordination of research and institutional interaction

After brief examination of research systems in the region – NARs, CARIRI, TADF – and regional institutions (CARDI, UWI, IICA), the consensus of opinion was that there was duplication of effort (e.g. post-harvest work on breadfruit within UWI) and that it was necessary to institute a system to assist in managing and co-ordinating the efforts of various institutions. It is suggested that national networks be set up (Dominica for example has a functional post-harvest group). These national groups should include all relevant actors, especially the private sector. Members thought that there could have been greater private sector participation (e.g. ORD, DEXIA) in this meeting, and where applicable on boards of organizations.

Co-ordination should be managed through one of the regional institutions. Both CARDI and IICA were mentioned – CARDI because it has offices in all of the countries and IICA because it already has involvement in networking. One outstanding preliminary bit of work to be conducted is a review of the post-harvest work done in the region.

Closing comments

- Women play a prominent and extensive role in the application of post-harvest technology and this fact will be useful in seeking funding for further progress in this area.

- Some other areas were mentioned but not developed in discussion, e.g. infrastructural facilities, except at farm level as with banana.

GROUP III PRODUCTION AND MARKETING OF ORNAMENTALS

Presenter: Ena Harvey
Casse Consultants Ltd
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In 1990, CARDI prepared a strategic plan of research, development and technology transfer for the improved handling of fruit, vegetables and root crops in order to meet the anticipated future requirements of the Caribbean region in this sector.

The Terms of Reference were to:

(i) collate information on the present resources allocated to this sector in the region including manpower, infrastructure and funding sources.

(ii) assess the capability of current programmes and their potential to service future national and regional needs.

(iii) determine future requirements in post-harvest research, development and technology transfer for fruit, vegetables and root crops in the region.

(iv) develop a strategic plan in collaboration with professional staff of CARDI, to support this sector taking into account national and regional requirements and inter-institutional linkages including international centres outside of the region.

(v) prepare specific proposals with outline costings for the strengthening of CARDI's activities in this sector.

Ornamentals were not included in the terms of reference, but it was noted that they warranted attention. The workshop group therefore attempted, within the limited time available, to address the above Terms of Reference. The regional ornamental industry was examined with respect to:

- Constraints with respect to:
    - Production
    - Harvesting
    - Post-harvest handling and packaging
    - Marketing
- Information, training and research needs
- Research strategy

Constraints

Production

- Unavailability and/or inaccessibility of suitable land (due to difficult terrain as in the case of the mountainous Windward islands; land tenure problems in Trinidad).
- Limited water supply (particularly in Barbados) and low quality water (in terms of microbial and chemical quality) in Trinidad.
- Unavailability and high cost of shade house inputs, including:
    - Good quality saran
    - Coconut fibre
- Difficulties in sourcing propagating material in terms of accessing reliable suppliers and working within plant quarantine restrictions with respect to import of material from certain sources.
- Lack of foreign exchange to purchase inputs that are sourced outside of the region (and even sometimes within the region itself).
- High cost of entry to the industry, particularly in the case of anthuriums and orchids.

- Inadequate control over local purchases of planting material among growers, resulting in spread of bacterial infections.

- Actual size of plantlets used is a limiting factor to the financial viability of the operations.

- Inadequate skills in crop agronomy, agricultural engineering and management.

- Insensitivity of financial institutions to the nature of the industry with respect to grace periods needed on payment of interest on loans, need for working capital to finance cultural operations, and cognizance of the impact of the industry on employment and potential for foreign exchange generation.

Harvesting

- Lack of skills at production and supervisory levels.

- Unavailability of labour to the industry because of competition from tourism sectors, particularly with respect to perception of job and remuneration levels.

Handling/packaging/shipping

- Terrain of producing areas makes in-field handling and transport difficult, particularly for heavy, large blooms of heliconia and ginger species.

- Quality of local packaging materials is inadequate with respect to finish, flexibility of design (particularly for varying sizes of heliconia) and cost.

- Lack of training in the handling of perishables in general, and floriculture crops in particular, at the level of the personnel at ports.

- Existing infrastructure, policies and attitudes inthe public sector act to deter and frustrate, rather than facilitate the trade. This is especially so with respect to assistance from agricultural extension and plant quarantine inspection during plant growth, the preparation of documentation for export shipment and clearing of shipments at the airport by customs and plant quarantine personnel.

- Inadequate freight services in terms of capacity, availability and frequency.

Marketing

- Inadequate volumes of exportable blooms.

- Difficult access to reliable market information, particularly with respect to current prices by variety and market, colour and size preferences, market niches, market access, trends, credit worthiness of importers.

  Lack of skills and available assistance with market development and promotion (development of brand, logo design, promotional material).

- High cost of promotion.

- Damage to product and loss of shipments due to activities of drug interdiction authorities in USA.

- Inadequate facilities at airports for holding of produce awaiting loading.

Information, training and research needs

Information

- Manuals on production technology for anthurium, heliconia, orchid, gingers and foliage.

- Information brochures on investment profiles for anthurium, orchid, heliconia and ginger.

- Information on sources of propagating material.

- Information on sources (regional and extra-regional) and costs of structural materials and inputs for anthurium and orchid production.

Training

- Production technology (agronomy, production management) for specific crop types.

- Agricultural engineering (land development engineering, especially for establishment of enterprises in hilly terrain; irrigation and drainage; design and layout of production and handling facilities, environmental engineering).

Research

- Establishment of a regional gene bank (active collection) of floricultural material.

- Production of protocols for tissue culture studies.

- Manipulation of flowering cycles of flower species in order to capitalize on specific market niches.

- Investigations on types of different planting media (coconut fibre, gravel and other locally available materials) for anthurium and orchid production.

- Investigations on adaptability of imported cultivars to local environmental conditions.

- Establishment of a standard quality control programme for critical analyses during production, including micro-climate analysis; light intensity and ventilation; soil, foliar and water analysis, including micronutrients.

- Estimation of the level of quantifiable risk involved with *Pseudomonas* or other infections.

- Examination of social and economic factors affecting the supply of skills and attitudes to the industry.

Strategies for meeting information, training and research needs

Information

- Strengthening of inter-institutional linkages for the generation, capture and dissemination of information.

Training

- Short-term attachment of farm workers and supervisory personnel to well-established and reputable floriculture companies inthe region, as well as in Latin America, Hawaii and Holland.

- Introduction of greater specialization and more practical and quantitative content into degree programmes offered at university level.

Research

- Training of extension specialists for the industry funded by development banks and/or growers'/exporters' associations.

- Execution of research projects through collaborative efforts of growers and researchers, and the use of students.

Support to the industry

- Establishment of a one-stop service (particularly in Trinidad) for the completion of documentation for export shipments.

- Streamlining of airport checks by locating plant quarantine and customs services in the same area.

- Provision of more positions for inspection personnel inthe ministries of agriculture and trade so as to provide a more regular and flexible service for inspection of growing operations and for inspection of export shipments.

- Financing and sponsorship of promotion for the industry on local, regional and extra-regional markets through the following types of activities:

A Whitwell (NRI, UK):
We need discrete measures to be taken rather than tackling the entire problem all at once.

B Clarke:
To what extent have we determined that we are on the right track? Have we done the correct thinking? Should we pursue processing rather than primary production, given that fresh produce is supposed to get a better price than primary processed foods? Plant quarantine and direction of the macro-economic environment are governed by politics. To what extent have we given goverments the costs and benefits of implementing our recommendations? How do we advise both farmers and politicians on gains to be derived?

A Malins:
Agro-processing is not naturally exclusive with fresh produce production for export. We are here to facilitate business rather than to direct it.

G Muller:
Barton Clarke's issues have not been addressed fully. CARDI is concerned with socio-economic analysis.

K Craig (CARDI, Trinidad & Tobago):
CARDI is researching more than 100 crops. They don't have all the answers but they are narrowing the range. Research must be done within the framework of human and financial resources. Research is presently too diverse. It must be led by the market and what is possible in our context. There are no answers now but we are moving in the right direction. The issue of farming and exporting must be seen as a business. Export is not suitable for everyone. Bananas are a successful export crop. We need to use opportunities in niche markets. We need to tie in activities with resources and limitations of land, transport etc. Many farm management problems are marketing issues. Marketing problems are usually policy oriented therefore they are not easy to solve at the micro level.

D McAllister:
We need to put infrastructure in place in keeping with the marketing thrust - then we will get the benefits.

S Parasram (CARDI, Trinidad & Tobago):
What is the problem with coconut fibre in flower production?

E Harvey: (Casse Consultants Ltd, Barbados):
Coconut husk is expensive (TT$500 per truck load) and 20 truck loads are needed per acre. The grower also has to pay someone to shred, husk and pack it into the beds.

G Simon (Ministry of Food Production, Trinidad & Tobago):
Additionally, there has been a decline in the coconut industry, hence decreased availability of husk. It is now necessary to seek an alternative planting medium.

S Parasram:
Could whole nuts be used??

E Harvey:
There could be problems with pests Also there is doubt about the economics of this.

G Simon:
Coconut husk breaks down rapidly and has to be replaced on a regular basis. However, it also provides the plant with nutrients, so when seeking an alternative, that factor also has to be considered.

Question:
How about using nutmeg shell from Grenada, where there is an abundance?

E Harvey:
This needs research as resins present may have an effect on plantlets.

T Narain (CTA, The Netherlands):
Mauritius uses bagasse as an alternative.

S Parasram:
Can CEPAT type courses provide the training needed?

E Harvey:
A basic degree in crop production is needed as well as practical experience on farms.

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ANNEX II ACRONYMS AND ABBREVIATIONS

ACTCO	Agricultural Commodity Trading Company (Barbados)
ADCU	Agricultural Diversification Unit (OECS)
AESP	Agricultural Export Services Project (Jamaica)
ANTEG	Association of Non-Traditional Exporters of Guyana
APASTT	Association of Professional Agricultural Scientists of Trinidad & Tobago
APHIS	Animal and Plant Health Information System
ARCDP	Agricultural Rehabilitation and Crop Diversifiation Project (Grenada)
AVT	Agriculture Venture Trust (USAID; Barbados)
BDDC	British Development Division for the Caribbean
BMC	Barbados Marketing Corporation
CABI	Commonwealth Agricultural Bureaux – International (UK)
CAGRIS	Caribbean Agricultural Information System
CARDI	Caribbean Agricultural Research and Development Institute
CARIBCAN	Canadian Programmes for Commonwealth Caribbean Trade Investment and Industrial Co-operation
CARICOM	Caribbean Community
CARIRI	Caribbean Industial Research Institute (Trinidad & Tobago)
CARIS	Current Agricultural Research Information System
CATCO	Caribbean Agricultural Trading Company
CATIE	Centro Agronomica Tropical de Investigaciones y Ensenanza
CATIS	Caribbean Agricultural Technology Information System
CBI	Caribbean Basin Initiative
CDB	Caribbean Development Bank
CEDP	CARICOM Export Development Project
CEPAT	Continuing Education Programme in Agriculural Technology (UWI)
CFC	Caribbean Food Corporation
CGIAR	Consultative Group on International Agricultural Research

ITC	International Trade Centre (Switzerland)
JACC	Junta Agroempresarial de Consultoria (Dominican Republic)
JADF	Jamaican Agricultural Development Foundation
JAMPRO	Jamaica Investment Promotions
JARP	Jamaica Agricultural Research Programme
MNIB	Marketing and National Importing Board (Grenada)
NARI	National Agricultural Research Institute (Guyana)
NGMC	New Guyana Marketing Corporation
NGO	Non-Government Organization
NIHERST	National Institute for Higher Education, Research, Science and Technology (Trinidad & Tobago)
NRI	Natural Resources Institute (UK)
ODA	Overseas Development Administration (UK)
OECS	Organization of Eastern Caribbean States
ORD	Organization for Rural Development (St Vincent)
PFU	Productive Farmers' Union (Grenada)
PPMA	Produce Packaging and Marketing Association (UK)
RADA	Rural Agricultural Development Authority (Jamaica)
SCMA	Standing Comittee of Ministers Reponsible for Agriculture (CARICOM)
SLBGA	St Lucia Banana Growers Association
SVBGA	St Vincent Banana Growers Association
TADF	
TROPRO	West Indies Tropical Produce Support Project
UNDP	United Nations Development Programme
UNIDO	United Nations Industrial Development Organization
USAID	United States Agency for International Development
USDA	United States Department of Agriculture
UWI	The University of The West Indies
WINBAN	Windward Islands Banana Association

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