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PERENNIAL TROPICAL FRUIT DEVELOPMENT IN SRI LANKA

PLANT CULTIVAR COLLECTIONS, MOTHER TREE ORCHARDS AND PLANT PROPAGATION

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TABLE OF CONTENTS

LIST OF APPENDICES
ACRONYMS
ACKNOWLEDGEMENTS
EXECUTIVE SUMMARY

1. INTRODUCTION 1

2. SCOPE OF WORK 6

2.1 BACKGROUND 6
2.2 OBJECTIVES 6
2.3 TEAM AND DURATION OF ASSIGNMENT 6
2.4 RESPONSIBILITIES 7
2.5 REVIEW OF SCOPE OF WORK 8

3. METHODOLOGY FOR ESTABLISHING PRIORITIES FOR PERENNIAL TROPICAL FRUIT SPECIES DEVELOPMENT 9

4. IDENTIFICATION AND RELEASE OF NEW SUPERIOR LOCAL VARIETIES 17

5. PLANT CULTIVAR COLLECTIONS, MOTHER TREE ORCHARDS, AND NURSERY SITES 19

5.1 PLANT CULTIVAR COLLECTIONS: VARIETIES TO BE PROPAGATED 20
5.2 PLANT CULTIVAR COLLECTIONS: POLICY ON CULTIVAR RELEASE 20
5.3 GUIDELINES FOR SETTING OUT AND DOCUMENTING PERENNIAL TREE CROP CULTIVAR COLLECTIONS 22
5.4 PLANT CULTIVAR COLLECTIONS: COLLECTION AND INTRODUCTION 24
5.5 PLANT QUARANTINE CONSTRAINTS ON PERENNIAL TROPICAL FRUIT INTRODUCTION 26
5.6 PLANT CULTIVAR COLLECTIONS: GENERAL COMMENTS 27
5.7 MOTHER TREE ORCHARDS: GENERAL COMMENTS 27
5.8 NURSERY SITES: GENERAL COMMENTS 30

6. NOTES AND COMMENTS ON VISITS TO VARIOUS GOVERNMENT FARMS 31

6.1 BIBILE - RESEARCH STATION 31
6.2 KUNDASALE GOVERNMENT FARM 32
6.3 MAHA ILLUPPALLAMA GOVERNMENT FARM 34
6.4 AMBEPUSSA GOVERNMENT FARM 35
6.5 GANNORUWA RESEARCH FARM 37
6.6 HORANA RESEARCH FARM 38

6.7 MAHA ILLUPPALLAMA AGRICULTURE RESEARCH FARM 39

7. NURSERY REGISTRATION AND PLANT CERTIFICATION FOR PERENNIAL FRUIT CROPS 40

7.1 NURSERY REGISTRATION 40
7.2 PLANT CERTIFICATION 41

8. STAFF AND LABOUR AVAILABILITY, TRAINING NEEDS, AND WORK PLAN 42

9. NURSERY MANAGEMENT 45

10. CONCLUSIONS AND RECOMMENDATIONS 45

11. REFERENCES 51

12. PROGRAMME OF VISIT 53

LIST OF APPENDICES

APPENDIX I	Factors Important in Assessing the Potential of Tropical Tree Fruit Species for Australian Horticulture. (Cull, 1984)
APPENDIX II	Assessing Soils, Climate and Water Supply Constraints to Tropical Tree Fruit Production - An Example for Bolovens Plateau and Vientiane Province in Laos. (Chapman, 1992)
APPENDIX III	Altitude Range for Tree Fruit Crops - Recommended Altitude with 12^0 of the Equator. (Anzdec Ltd, 1983)
APPENDIX IV	Potential Perennial Fruit Cultivars for Introduction to Sri Lanka.
APPENDIX V	Perennial Fruit Crop Introductions made by UNDP/FAO Horticulture Development (Fruits) Project - Phase II.
APPENDIX VI	Perennial Fruit Crop Mother Plantations for Scionwood and Rootstock Seeds, Established Under UNDP/FAO (Horticulture) Development (Fruits) Project - Phase II.
APPENDIX VII	Status of Perennial Fruit Crop Introductions into Sri Lanka, as at April, 1988.
APPENDIX VIII	List of Private Horticultural Plant Nurserymen Registered for 1992 by the Seed Certification Service and Plant Protection Division of the Department of Agriculture in Sri Lanka.
APPENDIX IX	Plant and Plant Products of Which the Importation into Sri Lanka is Prohibited.
APPENDIX X	Table Showing Availability of Fruits in Sri Lanka.
APPENDIX XI	References and Texts on Propagation of Perennial Fruit Crops
APPENDIX XII	A Recommended Booklist for Horticultural Production Research and Development, Science and Technology
APPENDIX XIII	A Recommended Book list on Post-harvest Handling of Fruits and Vegetables
APPENDIX XIV	DOA Programme for Establishment of Mother Tree Orchards - June 1992
APPENDIX XV	DOA Programme for Fruit Plant Production for Maha 1992/93.
APPENDIX XVI	Suggested Training Programme on Propagation of Perennial Fruit Crops and Nursery Practices.

ACRONYMS

Add.DD	-	Additional Deputy Director
ARTI	-	Agrarian Research and Training Institute
DAI	-	Development Alternatives Incorporated
DARP	-	Diversified Agriculture Research Project
DOA	-	Department of Agriculture
DDR	-	Deputy Director of Agriculture, Research
DD (S&PM)	-	Deputy Director of Agriculture, Seeds & Planting Material
EDB	-	Export Development Board
GCEC	-	Greater Colombo Economic Commission
GOSL	-	Government of Sri Lanka
IBPGR	-	International Board for Plant Genetic Resources
KVS	-	Agricultural Field Assistants (Krushi Viyaptha Sevaka)
PGRC	-	Plant Genetic Resources Centre
R&D	-	Research and Development
SCS	-	Seed Certification Service
S&PM	-	Seed and Planting Material
USAID	-	United States Agency for International Development

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EXECUTIVE SUMMARY

1.1 Increased production of perennial tropical fruits is a high priority of GOSL for diversification, providing opportunities to earn foreign exchange. At the same time prospects for expansion of domestic consumption are good, as local fruit consumption is currently low but will undoubtedly increase as personal incomes rise.

1.2 The GOSL has policies in place to foster investment and development in horticulture, including perennial fruits. However, for significant exports to occur long-term guaranteed land tenure on large tracts of land is needed, as the only way export volume can be sufficiently increased is via sea transport and economies of scale in the operation.

1.3 Fruits chosen for development should have: 1) long post-harvest life (two weeks to Middle East, South-South East Asia and Japan, and four weeks to Europe), 2) international market acceptance, and 3) a domestic and/or processing market at home to use up the surplus that does not meet export quality.

1.4 Because of current lack of consensus on which fruits should be developed for domestic/processing and export markets, this report presents a suggested list. Section 3 and Appendix I present methodologies for deciding:

- Potential for development of various tropical fruit species and how to arrive at a list of priorities.
- Where fruits can be grown in Sri Lanka and constraints to be considered.
- How to achieve national horticultural development using a framework to examine the issues involved, including exports of fresh fruits.
- Priorities for R&D--some suggestions.

1.5 Major physical constraints to perennial tropical fruit development in Sri Lanka will be land availability and water supply for irrigation, given that large tracts of land will be needed for significant fresh and processed export development.

1.6 There is no strong, effective, cohesive, problem/opportunity/industry oriented group to support the production and post-harvest research and development so desperately needed to respond to the GOSL high priority for perennial tropical fruit development.

A new Horticulture Division, Horticulture Department or possibly a Horticulture Research Institute should be established as a high priority for GOSL. It should embody fruits, vegetables and floriculture, should cover production and post-harvest R&D, and should have responsibility for production of planting material, technology transfer and extension.

1.7 Many perennial tropical fruit cultivar collections previously established by the DOA are in need of urgent care and attention, rationalization, upgrading with new introductions, and replanting in some instances. Internationally acceptable cultivars need to be quickly introduced and incorporated into the collections and at the same time released to the private sector. Guidelines for setting-out and documenting perennial fruit crop cultivar collections are given in Section 5.

Currently, many of the desirable exotic cultivars of tropical fruits are either not in Sri Lanka or are not made freely available to the private sector for development.

1.8 Policy on release of perennial fruit crop cultivars is highly restrictive. The private sector should not be expected to wait 8-12 years for release of a tree crop cultivar. Section 5 addresses this issue in detail and gives guidelines on how to set-up and implement the new policy. Suggested features include:

- Immediate release to private sector and S&PM Division of new cultivar introductions.
- Immediate release of promising local selections to the private sector and S&PM Division with certain conditions.
- Immediate release of promising older local varieties and selections and existing introduced cultivars to the private sector and S&PM Division with certain provisions.

Some of these suggestions link directly to the DOA/DARP review of the Varietal Development and Release Programme, recently completed.

1.9 DOA has identified Horana, Gannoruwa and Maha Iluppallama stations under Research Division and Bibile, Ambepussa, Maha Iluppallama and Kundasale under S&PM Division for upgrading.

Section 5 details staff, resources, equipment, and funding needed for upgrading the plant cultivar collections at the above stations under Research Division and the mother tree orchards and nurseries at the stations under S&PM Division.

1.10 A considerable number of perennial fruit species are listed as prohibited for import into Sri Lanka (Appendix IX). Review of this list is urgently needed, as for many of them pest and disease risk can be managed quite safely. Suggestions on review and risk management are given in Section 5. The recent DARP quarantine review is addressing this issue.

1.11 It is recommended that DOA with DARP support carry out the proposed Training Programme on Propagation of Perennial Tropical Fruit Crops and Nursery Practices (Appendix XVI) as there is a demand from both the private and government sectors for such training. S&PM Division should co-ordinate with DARP to make all necessary arrangements as detailed in a work-plan given in Section 8.

1.12 During the consultancy advice was given on-the-spot on: plant cultivar collections, mother tree orchards, rootstock/seed requirements, propagation, nursery organization and management, and research at various farms and stations visited. Texts have also been recommended on propagation (Appendix XI), production (Appendix XII), and post-harvest management (Appendix XIII).

1.13 It is recommended that plant introductions and mother orchards established under the UNDP/FAO Horticulture (Fruits) Project be carefully maintained by the DOA as these valuable materials must not be lost to Sri Lanka.

1.14 DOA needs to establish closer co-operation with the private sector, including small-scale farmers, nurserymen, large-scale farmers, and estates interested in perennial tropical fruit development. Such co-operation will encourage: 1) better information and cultivar exchange, 2) more relevant R&D programmes, and 3) co-operation in such matters as plant multiplication, production, post-harvest management, processing and export development.

1.15 Progress achieved by DOA in nursery registration and plant certification is commendable. DOA is urged to continue to support these services.

Additionally, DOA should set-up a citrus certified disease free seed and budwood scheme to assist the expanding citrus industry in Sri Lanka.

1.16 The utmost importance of preserving perennial fruit cultivars and selections in the field, and the very high priority that DOA must place on this preservation both now and in the future, cannot be emphasised strongly enough.

1. INTRODUCTION

Recently, production of horticultural crops in Sri Lanka has been given high priority by the Government of Sri Lanka (GOSL) for agricultural diversification and for earning of foreign exchange (Anon, 1992). The Department of Agriculture (DOA) estimates the value of the fruits, vegetables and condiments industry at over Rs.20 billion in 1989/90 (approximately US$ 500 million) or almost half that of all food crops in the country (Mannion, et al, 1992). The nursery, cut-flower and foliage plant industries, may be added to the above to arrive at the total contribution of horticultural industries which is very significant in the economy of Sri Lanka. Customs returns show that fresh and processed fruits and vegetable exports have grown from Rs.29.1 million in 1979 to Rs.585.2 million 1991. Fresh fruit exports were Rs.69.59 million in 1991.

However, horticulture in Sri Lanka has always been accorded a low priority by GOSL and has run a poor second to basic food crops. Research and development is disjointed and inadequately staffed, and is unable to make significant, effective contributions to production and post-harvest R&D in horticultural crops. A strong effective, problem/opportunity, industry focused group within the DOA, or possibly an independent, separate institute or department for fruits, vegetables and floriculture, is desperately required to support production and post-harvest needs of diversification and export development. Weisner (1988) and Mannion, et al 1992, support the need for a Horticulture Research Institute.

Present production, post-harvest handling/storage/management systems in Sri Lanka are outdated and produce low quantity product out-turn with huge post-harvest losses. Fruits may suffer up to 40 percent losses (Mannion, et al, 1992). Furthermore, processors and exporters of fruits complain that they are unable to procure good quality produce in sufficient quantities for their purposes and prices for products are unrealistically high.

Domestically, fruit consumption is said to be very low, although data on this point is conflicting. Food Balance Sheet for 1988 showed fruit consumption at 8.16 kilograms per capita and for 1989, and only 2.59 kilograms per capita in 1990. From Department of Census and Statistics (1987) which puts production of 1,000,000 tonnes of fruit per annum and population at 17 million, consumption would be equal to approx. 58.8 kg fruit per capita. However, if we allow for 40 percent (40%) wastage then consumption would be about 35.2 kg fruit/year. Probably, somewhere between 2.59 and 35 kilograms percapita is the true level of consumption.

ARTI (1992) reports that only about two percent (2%) of household total food expenditure across the urban, rural and estate sectors in Sri Lanka is spent on fruit. Generally fruit prices are high, which again suggest insufficient supplies and a good opportunity to increase production for the domestic home market. In Australia, consumption of fruits is 90-100 kilograms percapita, while for Canada it is around 60, Western Europe 35 and USA about 50 (Schoorl, personnel communication).

·If we assume a consumption target of 40 kilograms percapita, there is a great deal of opportunity for expansion just for domestic consumption alone.

Imports of fruit into Sri Lanka are said to be quite low according to EDB and import substitution is thus only a small opportunity area for development mostly for oranges, apples and grapes.

ARTI (1992) report fruit exports for 1990 as:

	Tonnes
Pineapple	939.60
Banana	2.43
Mango	4.07
Other	907.78
	61,853.88

To foster export opportunities in agro-based industries the GOSL and the Greater Colombo Economic Commission (GCEC), dependent on approval criteria such as foreign equity, scale of operation, and degree of export orientation, are giving attractive incentives to investors. Current packages include up to 15-year tax-free holidays, up to 100 percent foreign ownership, exemptions from exchange and import controls, duty free imports of approved inputs and duty free exports of outputs, free transfer of shares, exemption from income tax for expatriate employees, and exemptions from tax on dividends paid to non-resident shareholders (Anon, 1992 A).

Thus, policy is being set to foster investment and development of industries such as export of fruits. However, guaranteed land tenure of large tracks of land (100 ha or more) is required if long-term perennial fruits are to develop and succeed to supply export markets.

TABLE 1. VALUE OF EXPORTS OF FRESH AND PROCESSED FRUITS AND VEGETABLES, 1979-1991

YEAR	FRUITS, VEGETABLES AND ROOT CROPS		TOTAL
	Fresh Rs. Million	Processed Rs. Million	Rs. Millions
1979	4.7	24.4	29.1
1980	14.1	39.9	54.0
1981	27.9	47.4	75.3
1982	47.0	79.7	126.7
1983	48.4	31.2	79.6
1984	52.2	13.3	65.5
1985	63.1	11.4	74.5
1986	71.1	29.3	100.4
1987	75.1	61.6	136.7
1988	96.0	50.9	146.9
1989	138.2	140.0	278.2
1990	170.0	306.0	476.0
1991	285.5	299.7	585.2

Source: Sri Lanka Customs Return

TABLE 2. VALUE OF FRUIT AND VEGETABLE EXPORTS, 1991

	Product Description	Value Rs. Millions		
PROCESSED				
07.11	Gherkins in brine	188.64		
08.12	Fruits and nuts provisionally preserved by sulphur dioxide gas in brine	00.12		
20.01	Vegetables, fruits, nuts and other edible fruits preserved in or prepared in vinegar	51.24		
20.02	Tomatoes prepared or preserved	00.16		
20.04	Other vegetables prepared or preserved frozen	00.20		
20.05	Other vegetables prepared or preserved and not frozen	00.81		
20.06	Fruits, nuts, peels, other parts preserved in sugar	00.22		
20.07	Jams, fruit jellies, marmalade, fruit and nut puree, whether or not containing sugar	05.56		
20.08	Fruits, nuts and other edible parts of plants otherwise prepared or preserved	05.86	**Subtotal**	**299.65**
FRESH FRUITS				
20.09	Fruit juices: orange, passion, tomato, pineapples	46.84		
08.03	Bananas, plantains, fresh or chilled	01.67		
08.04	Pineapples, avocados, mangoes, mangosteen and guavas fresh or chilled	23.42		
08.05	Citrus fruits fresh or dried	01.43		
08.06	Grapes fresh or dried	00.10		
08.07	Melons, papaws fresh	00.18		
08.08	Apples, pears and quinces fresh	00.38		
08.09	Apricots, cherries, peaches, plums fresh	00.23		
08.10	Other fruits fresh	14.70		
08.11	Fruits and nuts steamed or frozen	00.47		
08.13	Fruits and nut mixtures dried	27.01	**Subtotal**	**69.59**
FRESH VEGETABLES				
07.01	Potatoes fresh or chilled	01.73		
07.02	Tomatoes fresh or chilled	01.34		
07.03	Onions, shallots, garlic fresh or chilled	19.56		
07.04	Cabbages, cauliflowers fresh or chilled	0.33		
07.05	Lettuce and chicory fresh or chilled	1.25		
07.06	Carrots, turnips, beetroot, radishes fresh or chilled	1.09		
07.07	Cucumbers, gherkins fresh or chilled	0.98		
07.08	Leguminous vegetables fresh or chilled	0.25		
07.09	Other vegetables fresh or chilled	155.25		
07.10	Vegetables steamed or frozen	1.62		
07.12	Dried vegetables, sliced, cut, broken or powdered	3.77		
07.13	Dried leguminous, shelled or steamed	5.24		
07.14	Manioc, sweet potatoes and similar high starch roots, tubers fresh or dried	23.5	**Subtotal**	**215.91**
	TOTAL	**585.15**		

Source: Sri Lanka Customs Returns

Fruits that are produced for export should have a domestic home market and/or processing market for surplus produce, which cannot meet export quality standards. Currently, canning and bottling (processing) taxes are high with 15 percent Business Turnover Tax, 5 percent Excise and 1 percent Defence Levy (ARTI, 1992). Again such taxes need to be reduced to foster investment.

Finally, early cash flow from short-term cash crops will be needed in many instances, while producers wait for the 5-7 years for tree crops to come into production.

Mannion, et al, 1992, in the DARP Horticultural Assessment of commodities and programmes in Sri Lanka, identified avocado, banana, lime, mango, passion-fruit and pineapple as having high economic importance, or immediate potential for expansion and having particular production and handling problems that can be addressed with support from DOA. The Export Development Board (EDB) indicates that papaya, mangosteen, sapodilla, purple passion-fruit and muskmelons are also in demand for exports. However, if export of fresh fruits are to develop in a very significant way it must be via sea transport and not by air transport. Transport by sea in Sri Lanka's case is the only economic way to send large quantities of fresh fruit to distant export markets. Air transport is too costly and space is far too restricted. Even for air transport to Maldives the cost is US$ 0.42/kg (Eastern Allied Agencies, pers comm). Thus exportable fresh fruits for distant markets must have post-harvest life-up to one month for Europe and up to two weeks for the Middle East, South-South East Asia and Japan. Such characteristics are of paramount consideration in deciding which fruits to produce for export. Additionally Mannion, et al (1992), among other issues, identified a need to:

- Improve fruit and vegetable cultivars by introductions from overseas, especially those with international acceptance.

- Select new cultivars of fruits from seedlings and clones already in Sri Lanka, through involvement of the Plant Genetic Resource Centre of DOA.

- Multiply rapidly desirable cultivars of selected fruits for private sector production.

With the background given above, this present consultancy and Scope of Work (Section II) were developed by the Diversified Agriculture Research Project (DARP), supported by Development Alternatives Inc (DAI).

2. SCOPE OF WORK

2.1 BACKGROUND

Fruit trees such as mango and avocado are mostly limited to "backyards" where the trees receive no special attention or care. Productivity is low. But more importantly, trees are grown from seed, often voluntary, and therefore lack uniformity. Fruit varies greatly from one tree to another, making collection of a uniform product a difficult and costly exercise. At the same time, the potential markets within Sri Lanka and other countries are rising rapidly.

The Department of Agriculture (DOA) is interested in contributing to the expansion of tropical fruit production. The Research Division has tested several cultivars over the past few years. However, only a few plants of each variety are available for propagation. The next step is to establish budwood gardens of selected tropical fruits, in order to make this valuable material available to farmers on a wider scale. In addition, the DOA should establish or improve 1-3 small nurseries for demonstration and training purposes. These activities should be carried out by the S&PM Division, using land in some of the existing seed farms targeted to remain over the long term with the DOA.

For the most part, multiplication of cultivars and establishment of budwood gardens would be with varieties known to have acceptance in world markets. However, it is also possible to include in this Scope of Work the collection and selection of Sri Lankan germplasm. This activity should be the task of the Plant Genetic Resources Centre (PGRC) of the DOA.

In some cases, research results may not yet be conclusive as to which varieties are most suited to local environments, especially for some of the long-term species. However, it is wise to establish budwood gardens of promising varieties in order to have the material available in the event it is needed.

2.2 OBJECTIVES

- To establish budwood gardens for each cultivar selected for possible multiplication and distribution
- To establish or improve 1-3 nurseries for demonstration and training
- To provide training in plant propagation and grafting, and nursery management

2.3 TEAM AND DURATION OF ASSIGNMENT

- One expatriate and one local consultant would be employed to assist the S&PM Division to carry out this scope of work. The S&PM Division would appoint one primary counterpart who would specialize in operation of tropical fruit nurseries.

- Initial six-week planning mission to prepare work plan, review present status of varieties and nurseries, identify nursery locations and appropriate site for establishment of several budwood gardens.

- Two visits of 2-3 months each to monitor progress, to provide training in nursery management and management of commercial plantings.

- To be completed within 12-14 months.

- Based at S&PM Division/DOA in Peradeniya.

- Field trips as needed to identify materials; to select locations for commercial production, budwood gardens, demonstration nurseries; and to provide technical assistance to selected nurseries and agro-enterprises.

2.4 RESPONSIBILITIES

Before the arrival of the team, the S&PM Division will collect seeds from cultivars suitable as root-stocks. About 2,000 to 3,000 seeds of each type of fruit will be needed. These would be planted in nurseries currently operated by the Seeds and perhaps Research Divisions.

<u>VISIT ONE, 1.5 Months, July-August, 1992</u>

Prepare Work Plan. Working closely with DOA officials and private firms, devise an action plan. Organize the technical assistance and training activities so that both DOA and private sector technicians are both involved. S&PM Division would lead the efforts to establish budwood gardens and demo/training nurseries. The PGRC of the Research Division would lead the efforts to select new local cultivars.

Outline a Strategy to Identify Superior Local Varieties. The Research Division will assign an officer to specialize in each fruit species determined to be of priority for the selection of local cultivars. It is recognized that this is a long-term effort. Locations for maintaining local varieties will be included in the plan.

Determine Varieties to Be Propagated. Identify sources of improved commercial varieties locally or from outside. Determine phytosanitary requirements and prepare documentation if genetic material is to be imported.

Identify Budwood Gardens and Nursery Sites. Sites should be selected on the basis of proximity to potential areas of future commercial production.

Determine Labour Availability and Training Needs. Determine availability of trained labourers and skilled technicians to monitor and care for seedlings after planting. Direct planning of training programme as required, with assistance from DARP staff and DOA officials.

Manage Transplanting. After germination, technicians can line out seedlings in the nursery. Advice will be given in the care of seedlings. Selected private nurserymen will participate in these steps to improve their skills in nursery management and practices.

VISIT TWO, 2-3 Months, October-December 1992

Train in Grafting. When plant stem diameters reach 1.5 cm, at a 20-30 cm height above soil level, grafting can begin. Procurement of grafting knives and other materials must be arranged before this assignment. Private nurserymen would also receive this kind of training.

Identify grafting methods in light of wood available. If supplies permit, terminal (or veneer) grafting can be utilized; if not, budding can be done.

Train in Careful Monitoring of Grafts. Selected nurserymen would participate along with DOA officers in the following training exercises:

- Depending on wind conditions, supervise tying plants in bags loosely, around developing stems, to thin bamboo stakes when buds grow out.

- Manage formative pruning. When grafted plants reach 40 cm, and have not yet branched, formative pruning should be carried out. This consists of cutting out terminal shoot over last whorl of buds. This has the effect of forcing branches out.

VISIT THREE, 1-2 Months, April-May 1993

Plant Budwood Garden. The consultants would work with DOA officers in the establishment of budwood gardens of the various crops at selected sites.

Provide Technical Assistance for the Establishment and Management of Commercial Plantations. In collaboration with DOA, the DARP consultants would assist in determining the correct tree spacing, establish a weed and disease control programme, a pruning schedule as well as assist in setting up a simple farm management record system.

Follow Up on Selection of Local Varieties. In conjunction with the PGRC, the advisors would review the procedures being employed and help evaluate the potential success of the programme.

Prepare a Manual on the Establishment of Commercial Plantings of Mango and Avocados.

2.5 REVIEW OF SCOPE OF WORK

In general the Scope of Work as outlined in Section II is justified and should help to meet the needs of DOA and the private sector in Sri Lanka. However, after inspection of a number of plant cultivar collections, it was felt that there is a need to place more emphasis on this issue than was initially envisaged when the Scope of Work was drawn up. This view point was also supported by DD (Research). This emphasis is justified as in many instances plant cultivar collections are in urgent need of rationalization, redevelopment, rejuvenation and vastly improved maintenance and management, as well as condition with new improved introduced and local cultivars.

Secondly, it became apparent that many mother tree orchards used for scion and rootstock materials were also in poor shape in many instances and in need of care and attention as desired for collection. Here again, the mother orchards need an infusion of improved cultivars to support planned expansion in the tropical fruit sector. Mother orchards established under the UNDP/FAO Horticulture (Fruits) Projects Phase II are in most cases well managed can provide useful materials for the future.

3. METHODOLOGY FOR ESTABLISHING PRIORITIES FOR PERENNIAL TROPICAL FRUIT SPECIES DEVELOPMENT

There is no general consensus on the perennial tropical fruits that should be considered as major or potentially major tropical fruit crops for development in Sri Lanka and thus be evaluated and multiplied. Therefore, the consultants have digressed to address this issue and have included methodologies that can be used to decide:

- The potential of various perennial tropical fruit species for commercial development.
- Where they can be grown in Sri Lanka and constraints to consider.
- How a framework provided can be used to examine and handle issues involved in achieving horticultural potential and growth.
- Priorities for research and development (a brief discussion).

As indicated in the introduction Mannion, et al (1992), identified the following list of fruits as having high economic importance or immediate potential for expansion and having particular production and handling problems that can be addressed with support from DOA viz.

Avocado
Banana
Lime
Mango
Passion-fruit
Pineapple
(Plus Melon as non-perennial)

Rambutan, mangosteen, purple passion-fruit, papaya, durian, sapodilla (EDB - De Zoysa, pers comm) and plantains (Eastern Allied Agencies-pers comm) can be added to this list.

Harmon (1991) in his examination of possible export of fruits from Sri Lanka to Dubai, Baharain and United Arabs Emirates (UAE) identified as best bets the following fruits viz.

Mango
Lime
Cashew
Pineapple
Grapefruit
(Plus Melon as non-perennial)

Weerawardena (1992) in a local survey of Sri Lanka markets identified the following fruits to have high domestic demand viz.

Pineapple
Papaya
Mango

Harmon (1990) in a survey of the Singapore Market for fresh fruits and vegetables from Sri Lanka identified possible markets for:

Lemon
Lime
Grapefruit
Grapes
Mango
Strawberry
(Plus Honey dew and Rock Melon as non-perennials)

Somasiri, et al (1990) in giving crop recommendations for adoption in all Grama Niladhari Divisions of Sri Lanka list Perennials in three groups defined as follows:

Group I Plants are defined as "Crops important for national food security, crops with high profitability and crops with a high potential."

Banana	Coconut	Betel
Pineapple	Rubber	Pepper
Lemonine	Cocoa	Cardamon
Mango	Tea	Murunga
Lime	Coffee	Cinnamon
Grape	Sugarcane	
Orange	Cashew	Floriculture Plants
Palmyrah		
Citrus		
Papaya		

Group II "Crops capable of providing moderate to high returns, crops important for a particular region for some special reason and crops that are in demand locally."

Banana	Passion-fruit	Coconut	Betel
Pineapple	Mangosteen	Rubber	Pepper
Lemonine	Avocado	Cocoa	Cardamon
Mango	Durian	Coffee	Cinnamon
Lime	Breadfruit	Sugarcane	Clove
Orange	Rambutan	Cashew	Nutmeg
Palmyrah			
Citrus			
Papaya			Citronella

Group III "Crops important for local food security and crops that provide relatively low profits." In one region a crop may be considered as a Group I Crop, while in another it may be considered as a Group II or Group III Crop, dependent on agro-ecological, edaphic, environmental and management opportunities or advantages.

Banana	Passion-fruit	Coconut	Betel
Pineapple	Mangosteen	Rubber	Pepper
Lemonine	Avocado	Cocoa	Cardamon
Mango	Durian	Coffee	Murunga
Lime	Guava	Cashew	Clove
Orange	Rambutan		
Palmyrah	Jak		
Papaya	Apple		

Pear	Pasture	Castor
Peach	Pan (Sedges)	
Plum	Citronella	
Grapefruit		
Woodapple		
Nelli		

The Research Division of the DOA which is in the process of prioritizing all crops under its jurisdiction include the following perennial fruits in the various priority groups:

Group I	Group II	Group III	Group IV
Banana	Durian	Apple	Guava
Citrus	Grape	Avocado	Woodapple
Mango	Jak		
Papaya	Mangosteen		
Passion-fruit	Pear		
Pineapple	Water Melon (Annual)		
Rambutan			

It is understood that the prioritization for research is still going on in DOA and that the above decisions have been determined from existing research projects with priority based on the number of research thrusts being made into each crop.

Whenever prioritization is done it is based on questions of value or value judgements of people. Unlike questions of fact, questions of value have no single answer and depend on the perspective or viewpoint of individuals. Total agreement is never likely to occur. Hence, the range of lists presented above. Priorities, developed by a small group of well informed people in the industry, and research and development sectors, offer the best priority decisions.

Furthermore, even when R&D priorities are listed there will never be enough staff available to address the problems and opportunities. In such a case it is our experience that should:

i) Address the big--100 percent plus--pay-offs first.

ii) Chase the 5 - 10 percent improvements later.

iii) Let those closest to the industry and the problem select the things to be done first.

iv) Where staff is limited use a crop- not discipline-based approach, making use of good "all rounders" and not highly specialised personnel.

v) Develop a whole system not just parts. Farmers are confronted with whole system for production, marketing, post-harvest management, and administration.

vi) Train researchers to pick winners. Use systems and lateral thinking as well as logical thinking skills.

vii) Employ people who have experience in breeding, physiology and general horticulture for perennial fruit production research.

There are criteria which can be used, in a qualitative way to assess the potential for perennial tropical fruit species. Cull (1984) presents the following factors which are the most important in assessing the potential of a tropical tree crops viz.

Consumer Potential
Product Marketing Characteristics for Fresh/processed Fruit
Environmental Adaptability
Production Potential
Economic Potential
Other Uses

It is not the intent of the authors of this report to explain in detail the numerous criteria in each of the above factors. Refer to Cull (1984) for such information (Appendix I). At this point, it is enough to quote as follows in likely order of priority:

> " Consumer Potential covers those elements that influence the demand by the public for the product, maintain their interest and might eventually establish a continuing viable market outlet. Product Marketing Characteristic evaluates those factors that control the successful transfer of quality produce from the grower to the consumer.
>
> Environmental Adaptability outlines the ability of the crop to perform under various conditions. Production Potential looks at those cultural areas pertinent to the economic field performance of a crop. Economic Potential summarizes the possibilities for success in the market, as well as the limitations on a product's viability."

The above evaluation is based on use as a food crop and not as ornamental or a drug crop. Other uses of some fruit trees may, of course, be of considerable value, eg. use of jak or coconut for wood, or use of different plant parts for medicinal use. The above factors have been applied quite successfully to determining tropical tree fruit potential for development in Australia and may be applied to Sri Lanka or indeed any tropical country.

Once likely contenders are identified as having good economic potential for development, such things as land availability, infrastructure, irrigation, and environment must be examined to see if a crop has a place in Sri Lanka. The crop characteristics and environment will dictate what crop will grow where in any given country. With tropical tree fruits, the first screening criteria to use is mean monthly minimum temperature for the coolest month as this is the most important determinant of tropical tree fruit distribution. (See Appendix II for Soils, Climate and Water Supply Constraints to Tropical Tree Fruit Production - Example for Laos, Chapman, 1992). Appendix III provides suggestions on altitude range for tree fruit crops within 12^0 North or South of the equator and where crops will grow. It also contains data for Indonesia (West Timor) and for Sri Lanka. See notes on use in Appendix III, below the tables.

Assuming that suitable areas and tracts of land can be found to grow the crop (with irrigation if needed), the next step is to examine how horticultural development can be achieved. Schoorl and Chapman (1989) provide a framework for examining and handling the issues involved for domestic or export markets. See Figure 1, in the following page for an example used for Thailand which is directly applicable to any country.

For Sri Lanka, Appendix X provides a table showing time of availability of fruits throughout the year. Such information is essential for defining niche markets (market gaps) at home and abroad, for supply by increased production through new horticultural crop development.

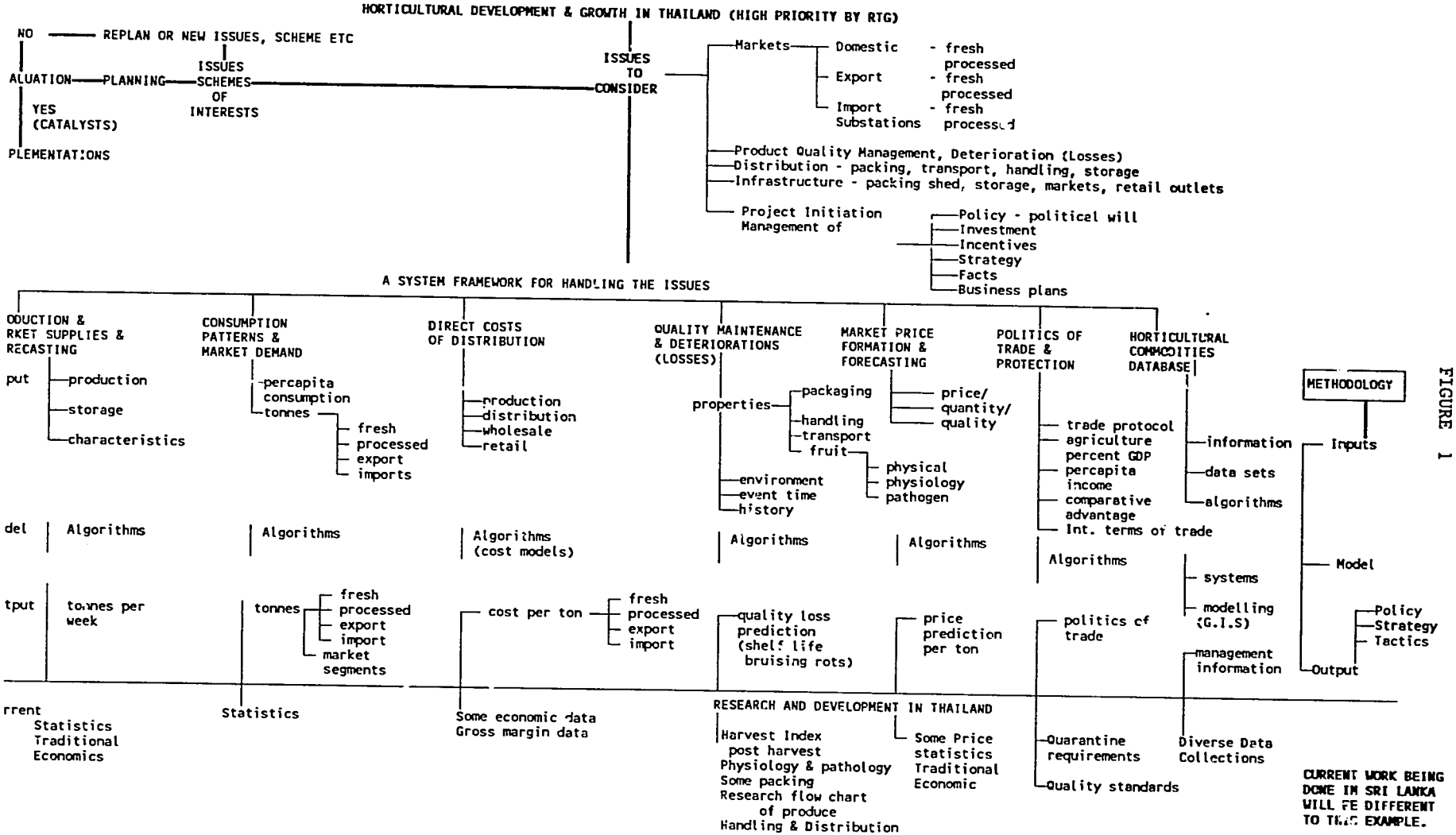
HORTICULTURAL DEVELOPMENT & GROWTH IN THAILAND (HIGH PRIORITY BY RTG)
NO
REPLAN OR NEW ISSUES, SCHEME ETC
ALUATION
PLANNING
ISSUES
SCHEMES
OF
INTERESTS
YES
(CATALYSTS)
PLEMENTATIONS
ISSUES
TO
CONSIDER
Markets
Domestic - fresh processed
Export - fresh processed
Import Substations - fresh processed
Product Quality Management, Deterioration (Losses)
Distribution - packing, transport, handling, storage
Infrastructure - packing shed, storage, markets, retail outlets
Project Initiation Management of
Policy - political will
Investment
Incentives
Strategy
Facts
Business plans
A SYSTEM FRAMEWORK FOR HANDLING THE ISSUES
ODUCTION & RKET SUPPLIES & RECASTING
put
production
storage
characteristics
del
Algorithms
tput
tonnes per week
CONSUMPTION PATTERNS & MARKET DEMAND
percapita consumption
tonnes
fresh
processed
export
imports
Algorithms
tonnes
fresh
processed
export
import
market segments
Statistics
DIRECT COSTS OF DISTRIBUTION
production
distribution
wholesale
retail
Algorithms (cost models)
cost per ton
fresh
processed
export
import
QUALITY MAINTENANCE & DETERIORATIONS (LOSSES)
properties
packaging
handling
transport
fruit
physical
physiology
pathogen
environment
event time
history
Algorithms
quality loss prediction (shelf life bruising rots)
MARKET PRICE FORMATION & FORECASTING
price/
quantity/
quality
Algorithms
price prediction per ton
POLITICS OF TRADE & PROTECTION
trade protocol
agriculture percent GDP
percapita income
comparative advantage
Int. terms of trade
Algorithms
politics of trade
Quarantine requirements
Quality standards
HORTICULTURAL COMMODITIES DATABASE
information
data sets
algorithms
systems
modelling (G.I.S)
management information
Diverse Data Collections
METHODOLOGY
Inputs
Model
Output
Policy
Strategy
Tactics
rrent
Statistics
Traditional
Economics
Statistics
Some economic data
Gross margin data
RESEARCH AND DEVELOPMENT IN THAILAND
Harvest Index post harvest
Physiology & pathology
Some packing
Research flow chart of produce
Handling & Distribution
Some Price statistics
Traditional
Economic
CURRENT WORK BEING DONE IN SRI LANKA WILL BE DIFFERENT TO THIS EXAMPLE.

FIGURE 1

Applying the criteria of Cull (1984) the authors suggest the following fruits for development in Sri Lanka:

TABLE 3. MAJOR AND POTENTIALLY SIGNIFICANT PERENNIAL FRUIT CROPS FOR SRI LANKA

Major	Potentially Significant for Further Development (Near Future)	Less Significant for Development (at Present)
Banana	Avocado	Apple
Pineapple	Breadfruit	Pear
Mango	Woodapple	Peach
Passion-fruit	Strawberry	Plum
Rambutan	Mangosteen	Nectarine
Lime	Tamarind	Custard Apple
Cashew *	Durian	Sugar Apple
Papaya	Carambola	Cherimoyer
Grape	Sour Sop	Star Apple
Grapefruit	Lychee	Marang
Lemonine	Longan	Santol
Lemon	Macadamia	Duku Langsat
Other Citrus	Guava	Chempadak
Palmyrah *	Persimmom	Jujube
Jak	Sapodilla	Salak

* Not handled by DOA.

The list is a guide only and people will argue over the classification, eg. maybe avocado should be a major crop as exports are significant to Maldives and Middle East. However, areas for expansion of high quality cultivars are limited. The major world market will not accept Sri Lankan cultivars of avocado. Also such a list is not static. Fruit may move from one group to another according to opportunities and problems in industry.

In Thailand, Chapman indicates that fruits were further classified in the above list according to use:

- Processing
- Export
- Import substitution
- Domestic use only

These export and import substitution crops may rate higher priority in earning foreign exchange and reducing foreign exchange spent on imports.

In all of this classification and prioritization what really matters is meeting the needs of industry, solving problems and developing opportunities. The Department of Agriculture will not have all the resources and personnel to address the priorities noted. The potentially large gains must be addressed first, with small gain areas to be addressed later. In most instances staff must be flexible--physiologists doing agronomy, pathologists doing post-harvest work, agronomists doing plant improvement. When resources and staff are limited, crop specialization is far more effective in delivering results to industry than discipline specialization with perennial fruits.

A major constraint to production of perennial fruit crops in Sri Lanka is land availability. Most land in the wet zone is currently fully utilized, unless inter-cropping of older coconut plantations (25 years+) is attempted or old plantations are turned over to tree fruit production. Most land currently available for development (Somasiri, S., pers comm) is in Monaragala District (Intermediate Zone), steep scattered degraded hill country (Wet and Intermediate Zone) and the Dry Zone of Sri Lanka. It is only in Monaragala District and the Dry Zone that larger tracts of land may be available for development of nucleus estate fruit plantations and significant export market development enterprise.

Apart from the many other constraints to perennial fruit development such as; markets, soil, climate, policy, post-harvest management, post-harvest life distribution and infrastructure, investment, incentives, quarantine protocols, trade protectionism, technology and trained personnel, transport etc., in Sri Lanka, land availability and water supply/irrigation availability are probably the primary physical constraints to such development and will determine major crops to be produced and expanded.

4. IDENTIFICATION AND RELEASE OF NEW SUPERIOR LOCAL VARIETIES

The identification of new, superior local varieties of perennial tropical fruits in Sri Lanka should be co-ordinated by the Research Division PGRC at Gannoruwa, Peradeniya. The Plant Genetic Resource Centre to effectively attempt such a task, must enlist the assistance of researchers in the Research Division at both CARI and Regional Agriculture Research Centres and Stations, Regional Seed Division Centres and farms and the officers of Provincial Regional Extension Services at district and village level. At the same time Research Division and S&PM Division officers, should make use of their connections to the private sector nurseries, especially when registering and inspecting approved nurseries. Liaison should be also strengthened with the Export Development Board and the Sri Lanka Fruit and Vegetable Processors and Exporters Association, as well as the MARD/ MDS projects to co-ordinate efforts and increase interest in identifying new superior varieties.

As new superior varieties may exist virtually anywhere in the country, fruit competitions and agricultural fairs at village, district or regional levels are particularly good ways to involve general public participation in the search. Prizes and awards should be given as incentive to participate in such competitions. Participants must be willing

to allow collection of vegetative propagation material of the superior or promising lines as a condition to participate. Mass media advertising of competitions of fairs encouraging public participation is highly desirable to promote public awareness country-wide.

The vast majority of cultivars in the major perennial fruit crops of the world have been identified from chance seedlings and bud mutants (sports) with only a small proportion derived from determined breeding programmes. Sri Lanka should be a fertile source of diverse promising varieties because many fruit species have been cultivated from seed in the past and not vegetatively propagated, and this is still the case today with some species.

The task of identifying new, superior local varieties of perennial fruit crops is somewhat different to collecting, describing, characterizing, and documenting (using standard IBPGR Descriptors) and preserving all germplasm of a species or genus, since it involves selection for superior attributes. Thus the skills of an experienced horticulturist or fruit breeder need to be enlisted to make selections.

Such horticulturists and breeders develop selection criteria for crops based on industry needs, problems and opportunities and aim to meet these criteria in their breeding and selection (plant improvement) programmes. Researchers are advised to do the same in Sri Lanka. However, it is realised that this selection of perennial tropical fruit species for new and promising varieties lines will be comparatively new to some. Appendix I lists "Factors Important in Assessing Potential of Tropical Fruit Species for Australian Horticulture," given by Cull (1984). Many of these attributes apply to a desirable, superior variety or cultivar of a given species and thus with intelligent interpretation may be used for this purpose. The criterion value and performance rating is a personal valuation and must be used only as described. Some criteria may be of little importance in Sri Lanka.

In breeding and selection of particular species a breeder or horticulturist will develop a Short List of very important attributes that can be rapidly assessed from hundreds of different fruit lines. Attributes appropriate to the crop can be developed from Appendix I, Guidelines and IBPGR Descriptors, by selecting those appropriate to the crop.

With fruits, quality always reigns supreme and if a fruit selection or variety does not measure-up in terms of quality attributes, it will be rejected immediately as a potential new cultivar. Thus, quality is always the primary screening characteristic. However, if a potential variety has special characteristics of disease/insect tolerance, time of harvest (early, mid, late) tolerance to drought etc. it may still be retained in collections with a view to future breeding.

With fruit selection, it is vital that the horticulturist or breeder is fully aware of industry needs; problems and opportunities, and whether the emphasis is on fresh fruit (domestic and export), processing, or dual purpose. Thus, it is important in individual crops to incorporate these industry requirements into the selection programme. **eg. 1:** With mango for the wet zone, tolerance to anthracnose on the plant and on the fruit itself is essential, if an expensive spray programme is to be avoided. **eg. 2:** Mango for export by sea must have a long post-harvest life in storage. **eg. 3:** Strawberry must have good transport characteristics and bruise-resistance for transport to distant markets. **eg. 4:** Banana must have good bruise resistance and long green life for long distance transport.

It is not the purpose of this report to lay down the guidelines for all of the fruits but to alert those doing the selection of new and promising superior local varieties to carefully develop their selection criteria by consultation, observation, industry requirements and published literature.

Once new, promising, superior varieties are identified they should be incorporated into the plant cultivar collections of Research Division at Gannoruwa, Horana and Maha Iluppallama as appropriate and released to S&PM Division and the Private Sector as described in the following section.

5. PLANT CULTIVAR COLLECTIONS, MOTHER TREE ORCHARDS, AND NURSERY SITES

DOA has many centres and stations under the control of either Research Division or S&PM Division, which contain various cultivar collections and mother tree orchards. In early discussions with DOA, it was agreed that the consultants would address for up-grading, plant cultivar collections at:

Gannoruwa (Wet Zone, Highland)
Maha Iluppallama (Dry Zone)
Horana (Wet Zone, Lowland), and

Mother tree orchards and nursery sites will be at:

Kundasale (Intermediate Zone)
Bibile (Intermediate Zone)
Maha Iluppallama (Dry Zone, Lowland)
Ambepussa (Wet Zone, Lowland), as agreed with S&PM Division.

Bibile will serve the potential expansion areas of the Intermediate Zone (Monaragala District and Uva Province and the Dry Zone from System C up to System P of the Mahaweli).

Maha Iluppallama will service the central and northern Dry Zone regions (System H) which have land available for expansion.

All of the above areas (and others) were visited during the consultancy and at each centre, sites examined and expansion plans and locations discussed.

5.1 PLANT CULTIVAR COLLECTIONS: VARIETIES TO BE PROPAGATED

Plant Cultivar Collections (Field Germplasm Banks) are under the Research Division of DOA, Plant Genetic Resources Centre (PGRC) in liaison with the S&PM Division of DOA. Research Division is responsible for the introduction and screening of new varieties (local and introduced) and the upgrading and maintenance of plant cultivar collections. They are responsible for recommending and listing of cultivars for approval by DOA for release to S&PM Division for mother tree orchards.

We have given a list of potential perennial fruit cultivars for introduction into Sri Lanka (Appendix IV). Some of these cultivars are already in Sri Lanka. However, some of these previous introductions have died, are diseased or identity confused. In other instances (for citrus especially) many were only brought as seed and will not be true to type for some species. Thus Research Division must develop a list of cultivars for re-introduction or new introductions from existing records and field checking, in relation to Appendix IV suggestions. Appendices V, VI and VII contain lists of planting material held by DOA in Sri Lanka and these are the cultivars requiring field checking. DARP has funding set aside for Research Division to make such introductions required.

Good older clones of various cultivars of tree crops are present in old budwood gardens established in the 1970's. Information should be sought on these from S&PM Division and good clones included in the upgraded cultivar collections.

Finally, Research Division should liaise closely with the private sector farms and nurseries, S&PM Division, Plant Quarantine, and the Seed Certification Service to obtain performance and quality information on private sector introduced cultivars, that are promising and should be included in collections. Additionally, plant cultivar collections will hold new, superior, local varieties/selections of perennial tropical fruits.

5.2 PLANT CULTIVAR COLLECTIONS: POLICY ON CULTIVAR RELEASE

Existing policy on perennial fruit crop cultivar release is far too restrictive and in need of very urgent modification by DOA. Under present policy the private sector and even S&PM Division may have to wait 8-12 years for release of budwood of introductions. Currently, the private sector and S&PM Division have to wait until Research Division recommends a cultivar for release. Such policy may be acceptable for annuals, but is totally inappropriate and unacceptable for perennial fruit.

We recommend that DOA urgently develop a system that provides for early release of promising local selections and introduced cultivars. Our suggestions on such a system are as follows and are drawn from similar systems operating in other countries.

(i) We recommend that new introductions of perennial fruit cultivars by DOA be immediately released to the private sector after clearing quarantine and after the first multiplication. (The mechanism for managing this release is described below).

The private sector must also be permitted to import plants, to be held in government plant quarantine or in private plant quarantine facilities conforming o prescribed quarantine requirements.

(ii) We recommend that where local promising fruit selections are found to be performing well in a given ecological zone, these selections/varieties be immediately released to the private sector in that zone.

In addition the selection/variety must be immediately released to Seeds Division for multiplication and sale in that zone.

(iii) For older local varieties and selections and existing introduced cultivars that are showing promise in terms of flowering, fruiting and fruit quality, early in the screening process, it is recommended that:

a) They be immediately released to the private sector, and

b) They be immediately released to S&PM Division for pre-release multiplication ie. establishment in mother tree orchards.

The data on these cultivars should be collected by Research Division from Gannoruwa, Maha Iluppallama, Girandurukotte, Aralaganwila, Walpitia, Horana, Bibile, Monaragala and Angunukolapelessa and the private sector farms and nurseries.

The mechanism for release to the private sector of any planting material of perennial fruit crops can be as follows and modelled along the mechanism used in Queensland, Australia for the past 10 years or more.

When DOA has new introduced cultivars, or indeed new untested local selections for release to the private sector the following simple steps may be adopted.

1) Advertise locally and nationally that DOA has limited amounts of budwood/grafted plants/air layers, etc. of cultivar XYZ for release under the following conditions:

a) All material is given in good faith on an "All Care - No Responsibility" basis.

b) Material will be distributed as follows: 3-5 budsticks per applicant or 1-2 plants as appropriate.

c) Distribution is on a " First in - First served " basis. All names and addresses of applicants will be placed in a special register in order of application and applicants will be given a numbered application receipt. (DOA may at it wishes charge a fee for the plants.)

d) At date of release of the budwood/plants etc. and after distribution of all materials the register is ruled off below the last recipient. At the next release date, those below the ruled off section are next in line for plants.

e) When applicants receive the plants they must sign an Indemnity Form which goes on record with copy to applicant. The Indemnity form states that even though DOA has given the material in good faith, DOA cannot be held responsible for:

   i) Authenticity of the cultivar given,
   ii) Pest and disease status of the cultivar (especially with respect to viruses, mycoplasmas etc. which are hard to detect),
   iii) Yield performance of the cultivar, or
   iv) Fruit quality of the cultivar, etc.

If an applicant does not sign the Indemnity form, the cultivar must not be given.

Such a mechanism ensures rapid release of cultivars of perennial fruits and because such material will be spread far and wide, it offers DOA an opportunity to follow-up in the future, additional performance information from many different environments. This information augments formal trial and screening results of DOA and is a source of valuable adaptive information.

Some of the suggestions above tie in with those of the DOA/DARP review of the Varietal Development and Release Programme recently completed.

5.3 GUIDELINES FOR SETTING OUT AND DOCUMENTING PERENNIAL TREE CROP CULTIVAR COLLECTIONS

There is a need to determine the centres or stations which will hold the collection. DD/R has decided that it should be at Maha Iluppallama, Horana and Peradeniya.

1. Plant a minimum of three (3) plants of each cultivar in the collection block.

2. Spacing	-	Mango	6m x 2m
	-	Avocado	6m x 2m
	-	Rambutan	6m x 2m
	-	Mangosteen	6m x 6m
	-	Other tree crops	6m x 2m
	-	Banana	3m x 3m
	-	Citrus sp.	6m x 3m (lemonine 3m x 2m)

3. Select well drained, deep soil, and a wind protected site. Irrigation facilities must be available at MI -optional at Horana and Gannoruwa, except where Banana is grown. Hand watering facilities must be available for the establishment of trees during the first year at all centres.

4. Group blocks according to species.

5. Draw field plan of the collection block with cultivar names and root stock name shown. Keep this in a master file or in a bound book. Other copies to be made for use in the field (farm) and kept with the Research Officer who will hand it over to his successors. Give each tree in the block a number on the plan.

6. Identify each cultivar in the field with a white peg with the tree number and cultivar name painted in black. The peg should be planted beside and under the canopy. Also attach an aluminium label, embossed with cultivar name and number hung with an aluminium wire, which has to be inspected regularly to avoid it cutting into the stem of the plant. Galvanized metal tags can also be used with the name painted on the tag. The tag is wired or nailed to the tree.

7. Record the following information about each tree of each cultivar in a permanent bound book giving one page for each entry.

   a) Crop name
   b) Block name
   c) Block number
   d) Name of Cultivar
   e) Synonyms
   f) Tree number and a computer reference number
   g) Plant quarantine and/or introduction number
   h) Country of origin
   i) Origin of cultivar being planted
   j) Type of material planted
   k) Root stock name
   l) Comments from Plant Quarantine
   m) Other centres known to hold this same cultivar

5.4 PLANT CULTIVAR COLLECTIONS: COLLECTION AND INTRODUCTION

As indicated earlier, Research Division must first develop a list of cultivars for re-introduction from existing records and field checking in relation to Appendices IV, V, VI and VII and other records.

For each cultivar to be introduced select the countries that are likely to be holding the cultivar and make an introduction from the country which is likely to have the cleanest source of planting material with respect to pests and diseases. Developed countries such as USA and Australia hold large collections of many perennial tropical fruit species. Imports of fruit trees/budwood/seed, etc. from such countries is preferred, because of their stringent post-entry quarantine procedures, clean budwood and seed schemes, generally good nursery hygiene and stringent phytosanitary certificate issue. Next preferentially, choose cultivars that have quality attributes accepted internationally, especially on international export markets.

For each cultivar identified for introduction:

1) Obtain necessary quarantine and phytosanitary requirements, documentation and approval required by Sri Lanka, well in advance of planned introduction. Arrange for suitable rootstock material where needed to be put into quarantine for later grafting, prior to departure for collecting.

2) Follow-up with the country from which plants/material is to be obtained to ascertain likely availability at a given time or the year.

3) Arrange for a competent perennial tropical fruit horticulturist to visit the source country to collect the plant material which must comply with Sri Lankan phytosanitary requirements with respect to dipping treatments, etc.

4) Have the horticulturist purchase or procure the planting material and hand carry the material from the source country to Sri Lanka as accompanied baggage. The planting material should not be sent unaccompanied or by air cargo.

5) Where possible obtain five grafted plants (absolute minimum of three (3) of each cultivar propagated in media other than soil eg. peat, vermiculite, sawdust or other as appropriate.

   For budwood, try to obtain eight to ten budsticks of each cultivar. For seed, again depending on cultivar and use as scion or rootstock try to obtain at least ten seeds of say a mango scion (polyembryonic); one kg of seed of a Citrus rootstock; 100g of say papaya or guava seed or passionfruit seed; five crowns or slips of a pineapple cultivar; three cultures of tissue cultured

banana; 500g of logan seed for rootstocks or mangosteen seed; four kg peach seed (rootstock).

6) Where it is necessary to carry bare-rooted plants, wash off all soil thoroughly, wrap the roots in ample amounts of moist paper and the put roots in a plastic bag with a small amount of free water, and seal at the stem with adhesive masking/carton tape. Foliage should be cut back by 30-40 percent (except durian) and wrapped in many layers of moist and then dry paper on the outside. Place in a box thickly lined with dry paper as insulation against heat and cold. Sturdy, thick stemmed plants survive transport & post-entry quarantine better than small plants.

7) Attach to every plant and every bundle of Budwood an aluminium tag with the cultivar and/or rootstock name and mark clearly each seed packet in the same way by including a tag and writing on the outside of the packet.

8) Tie bundles of budwood together with cord or plastic strips and place budwood in a moistened cloth towel-Chux" dish cloth towels, which are thin and absorbent are ideal. Then place the bundle in a plastic bag and seal. Mark cultivar/rootstock name on outside.

Budwood and seed, where possible may be dusted with a powder of Benlate or Captan plus Carbaryl. Dipping roots of trees in Copper Oxychloride solution is suggested, if roots are damaged or cut back for shipment bare-rooted. Other treatments may be done to meet phytosanitary requirements depending on species.

9) If a permit to export plants is required by the source country, this must be obtained, before collection.

All plants and budwood in particular must be hand-carried with accompanied baggage. Do not send unaccompanied or as cargo. Many seeds must also be hand carried, especially the recalcritant ones as viability is lost in a matter of days, especially with some tropical fruits such as mangosteen.

10) Cardboard boxes should be completely sealed with tape around all edges and openings, clearly addressed to the collecting officer, C/o DOA Sri Lanka and the permit to import and phytosanitary certificate attached to the box. Hand carry a copy of all documentation as well. If an export permit is required this also should be attached to the outside of the box and hand carry a copy.

11) All plants and budwood, plus recalcitrant seeds, should be placed in quarantine, potted, budded or set for germination, preferably within 4-5

days of collection. One week is generally too long from collecting to propagating in quarantine in Sri Lanka. Arrange assistance well in advance to do the propagation on return to Sri Lanka, so that most activities can be completed in a day or two.

12) Make sure well in advance that you know the ideal propagating conditions, media, techniques, etc. as speed is all important for success.

13) All plants should carry aluminium tags and plant introduction number in quarantine, with rootstock/scion information and source from where obtained.

14) Plants in quarantine should be re-propagated where the plant is big enough to take budwood from or use approach graft. This helps ensure survival where initial plant numbers are small.

15) After introduction, clearance by Plant Quarantine and release from quarantine, multiplication for release can continue.

5.5 PLANT QUARANTINE CONSTRAINTS ON PERENNIAL TROPICAL FRUIT INTRODUCTION

Based on the existing policy of DOA there are a number of perennial tropical fruit species which appear on the Prohibited Plants and Plant Products Import List for Sri Lanka (Appendix IX contains the Prohibited Perennial Fruit Species of interest, as well as various other species). By DOA definition permits to import Prohibited Plants will be given only to/through appropriate research institutes of Sri Lanka.

Because of this existing policy Sri Lanka is being severely disadvantaged, as reasonable access to desirable, improved international germplasm is very restricted, especially for the Private Sector. For many of the perennial fruit species on the Prohibited Plant Import List (Appendix IX), with possibly the exception of citrus and banana, pest and disease risk can be managed by post entry quarantine, especially where plants are sourced from a third country instead of country of origin. From the discussions with Plant Quarantine officers and the DARP Team that has been Reviewing Plant Quarantine Policies and Regulations, it is noticed that DOA policy and regulation on prohibited plants can be revised. An early step on this regard will be beneficial.

We see a need for private sector import of desirable perennial tropical fruit cultivars, as essential to development of such fruit industries in Sri Lanka for domestic and export markets and for import substitution.

(i) Plant quarantine facilities managed by DOA, and

(ii) Private sector post-entry quarantine facilities managed by private sector, with necessary inspections by Plant Quarantine officers. Such facilities must of course comply with quarantine specifications with respect to security, location, structures, management and inspections.

Assessing and managing the risk will need to be reviewed for each fruit species and urgent review is recommended. Considerable risk reduction can be made by introducing desirable perennial tropical fruit cultivars from USA and Australia, countries that hold substantial collections. Furthermore, these countries hold cultivars which now cannot be obtained from other countries as they are on prohibited export lists. Also USA and Australia have stringent quarantine entry, clean budwood and seed schemes, good nursery hygiene and strict procedures on issue of phytosanitary certification.

Total prohibition encourages illegal, uncontrolled entry of plant materials and that it is better to manage importations than risk severe problems that may result.

The consultants understand that currently plant quarantine faces severe shortfalls in staffing, funding and resources. Both DOA and GOSL should try to overcome these very serious constraints and vigorously support Plant Quarantine in Sri Lanka.

5.6 PLANT CULTIVAR COLLECTIONS: GENERAL COMMENTS

Plant cultivar collections at the various centres and stations visited are generally not well managed at present. They require in many instances considerable rationalization, rejuvenation, replanting and vastly improved management and maintenance if they are to fulfil a useful purpose in future. Collections for a number of species need to be upgraded by re-collection from other parts of Sri Lanka, re-introduction and supplemented with new introduced cultivars. Damaged and diseased plants in particular should be replaced. New plant cultivar blocks should be developed using guidelines provided in Section 5.3. Additionally, funds must be made available by DOA for such items as training, irrigation, field equipment, extra staffing, nurseries and nursery requisites and tools, fertilizers, spray materials, and so on. In the sections to follow the improvements which should be made are detailed by station to station.

5.7 MOTHER TREE ORCHARDS: GENERAL COMMENTS

Mother tree orchards and nursery production in DOA come under the responsibility of S&PM Division of DOA. Sources of improved commercial perennial tropical fruit cultivars within Sri Lanka are contained in Appendices V, VI and VII.

DOA Research Division, S&PM Division and the Seed Certification Service have more detailed records and plans of both plant cultivar collections and mother orchards at

various centres and stations throughout the country, while Plant Quarantine holds plant introduction lists especially those made during Phase I and Phase II of the UNDP/FAO Horticulture Project.

Existing mother tree orchards range from good, especially for those established under Phase II of the above project, to very poor for older orchards (budwood and seed) at some stations. Some of the orchards just need better maintenance and management, while others are old and diseased and need to be replanted. Others still can be rejuvenated by fertilizing, structural pruning, weeding and in some cases provision of irrigation.

S&PM Division of DOA has developed a programme for establishment of mother tree orchards (June 1992) and the English translation of this programme is given as Appendix XIV. Furthermore, the DOA programme for fruit plant production for Maha 1992/93 is presented in Appendix XV. Appendices XIV and XV cover all stations under the control of S&PM Division and not just those of Ambepussa, Maha Iluppallama, Bibile and Kundasale which are the ones to be addressed in this consultancy.

These programmes have been developed in relation to anticipated demand for trees based on current demand and recent requests. Short falls in the Government sector will be met from private sector nurseries, who can in registered nurseries produce plants for Government purposes as well as the private sector. A list for Bibile Horticulture Station does not appear in Appendices XIV and XV. Bibile is under Research Division. S&PM Division finances the nursery programme, however, there is no plan to include the mother tree orchards at Bibile, which are well maintained at present, but will rapidly deteriorate without funding for management and maintenance.

The consultants suggest that for Bibile, with approval from DDR, that the following fruit cultivars be maintained for mother orchard budwood and seed for supporting the Bibile nursery:

Bibile Horticulture Station

Mango Scions

Karutha Colomban
Vellai Colomban
Willard

Mango Rootstocks for Seed

Wal Amba
Kohu Amba

Sweet Orange Scions

Bibile Sweet Orange
Bibile Seedless Orange
Pineapple Sweet
Liyangolla

Budwood and Seed of Local Lime

Monaragala lime
Thimburana lime

Citrus Rootstock Seed

Rough lemon

Lemonine Scions

Lemonine

Guava Scions

Bangkok Giant
Saffeda
Allahabad Safeda
Thai

Rambutan

Malwana

Avocado

Pollock

Minor Crops

Pomegranate etc.

Inspection of this above list and Appendices XIV and XV reveal that very few high quality, introduced cultivars popular in international market are contained in these list of plants for propagation and mother orchards.

In addition to the existing programme for mother orchards, that they be supplemented with:

1) Promising introduced cultivars, local selections that are undergoing screening. These cultivars should be released early by Research to S&PM Division for pre-release multiplication, instead of waiting years for final trial results.

2) Local promising selections, that appear to be performing well in a given ecological zone. These should be immediately released to the private sector and to Seeds Division for multiplication and sale in that zone.

If the above practices are adopted now by DOA, then multiplication can be quickly speeded up to meet the expanding needs of industry for high quality cultivars. To achieve this desired objective S&PM Division and Research Division must co-operate closely to not only identify these high quality cultivars; but to get them into the mother orchards programmes. Mother Tree Orchard constraints are addressed by individual station in later parts of this section and again it is recommended that DOA act to overcome these constraints. The second visit of this consultancy can be used not only for training but for propagation of the above improved and high quality selections, to supplement the existing mother orchards.

5.8 NURSERY SITES: GENERAL COMMENTS

In general, the quality of plants currently being propagated for sale at S&PM Division nurseries were impressive. Quality, efficiency in production, nursery facilities, techniques, structures, staffing varied from nursery to nursery, but even those with many constraints were still producing satisfactory plants for sale, although their plant losses were probably higher.

All stations visited were very interested in the training programme to be run by DARP in conjunction with S&PM Division during the next planned consultancy. Staff were particularly interested in nursery infrastructure, nursery management including plant protection and hygiene, propagation principles and methods for various tropical fruit species and how these may be improved.

6. NOTES AND COMMENTS ON VISITS TO VARIOUS GOVERNMENT FARMS

6.1 BIBILE - RESEARCH STATION

General

This farm was earlier known as the Horticultural Station and is presently under the Research Division operated from Bandarawela. The Seed Division finances nursery programmes. The consultants visited and inspected the farm with Mr.Padmalal ADA (S&PM), and were assisted with information by Mr. Wijesundara Farm Manager and Mr.H.M.S. Heenkenda, RO, Bandarawela. The management should be complimented for the well managed nursery and high quality plants produced.

Nursery

(a) There is sufficient land and best use is being obtained from the three shade netting houses and propagation house. There is land for expansion. Ground nurseries have also been established.

(b) There is no apparent need to increase structures as they are already available.

(c) Irrigation facilities are available. The water supply has to be improved for an enhanced programme and budwood gardens. One possibility is to renovate a storage tank situated at the top of a hillock, which will facilitate gravity irrigation. A high volume pump and supply line are necessary.

(d) Staff - There are no appointed budders, no KVS etc. Only one other officer is available. There is a permanent appointed nurseryman (woman). There is a need for one good officer to assist the Farm Manager who is now solely looking after the nursery.

(e) Labour is available.

(f) There are very few pieces of equipment. Hence twenty five budding knives, twenty five secateurs, six pruning saws and six pruning knives have to be provided, as they will be used for training classes. Sprayers both power driven and hand operated are needed. A polythene sealer is also necessary for a extended programme. Field equipment such as tractor, tractor mounted rotary slasher, and an additional bowser is needed.

Facilities for Training

Facilities are available under Technology Transfer Division/Provincial Director. Arrangements must be made in advance to use such facilities and pay for their use.

Mother Tree Orchards

a) Scion Wood garden

There is no plan by the S&PM Division programme to include mother tree orchards. However the orchards planted earlier are available and these have been very well maintained. Either Seed and Planting Material Division or Research Division should provide finances to maintain these. There are both mango and orange blocks. Identified mother trees should be numbered and labelled. Other plants in the plant collection can also be used.

b) Stock plant gardens of mango, rough lemon and woodapple have been established. These should be maintained properly.

c) Land is available for expansion, but additional irrigation facilities have to be provided. Former orange and lime blocks appear very suitable.

d) Provision of a motor cycle is suggested.

6.2 KUNDASALE GOVERNMENT FARM

General

This farm is under the S&PM Division (S&PM). The farm was visited in the company of Mr. Padmalal ADA (S&PM). Discussions were held and inspections done with Mr. A Kularatne (ADA S&PM) Kundasale, Mr. Liyanage Farm manager and Mrs. Liyanage AFM in charge of nursery.

The nursery is small with very little facilities but it is important because it serves mostly the mid country region. The nursery is fairly well managed and maintained. It is currently producing grafted/ budded plants of avocado, mango, guava, durian, orange, and mandarin and seedings of other crops and lime. The programmes drawn up for this station are given in annexes XIV and XV.

Nursery

a) Land is limiting in the present site. A new site near the office was examined and is suitable.

b) There is only a small temporary thatched structure. There is a need to construct a number of shade netting houses in the existing and/or the proposed nursery sites.

c) Irrigation facilities are minimal, mostly from a domestic well. If the nursery is to be developed further the irrigation facilities have to be provided either from deep wells or pumped from the Mahaweli. An assured water supply is absolutely necessary and funds should be channelled to this immediately as Kundasale has 4 - 7 months which receive less than 100mm of rain per month.

d) The AFM is quite competent and very hard working despite inadequate facilities. There is no budder appointed but there is a capable budder and other helpers. Action must be taken to appoint one or two permanent budders and a nurseryman.

e) Labour is available

f) Very few pieces of equipment are available. Hence early action should be taken to supply about 25 budding knives, 25 secateurs and 6 pruning saws, 6 pruning knives as this station will be used for both training and the establishment and maintenance of mother plants.

This station should be provided with sprayers, preferably at least one power sprayer for use in the mother orchards and others for the nursery.

Facilities for Training

Accommodation for trainees can be arranged. The budder needs to be trained in different methods of grafting as presently his experience is limited to mostly patch budding.

Mother Orchard

a) Present scion wood blocks in both the farm and former Horticultural Research Station are generally old, scattered and need re-development. Trees should be identified, labelled, pruned, manured etc.

b) Stock plant gardens do not exist. These have to be established for the major crops such as mango, avocado and citrus.

c) Prospects for expansion - DD (S&PM) intends to have this station especially for avocado and some other crops. See Appendix XV. The terraced block of land by the Teldeniya road opposite the main office is available for establishment of the new mother tree orchards. Irrigation is necessary.

d) Additional facilities include the availability of a tractor with bowser, rotating slasher and micro/mini spray equipment.

6.3 MAHA ILLUPPALLAMA GOVERNMENT FARM

General

This farm, formerly known as School Farm is administered by DD (S&PM). It was visited in the company of Mr. Padmalal ADA (S&PM). Discussed and visited fields and nursery with Mr. Abeysekere ADA (S&PM). Maha Illuppallama, Mr. Rambukwella Farm Manager and Mrs. Rambukwella AFM who is in charge of the nursery. The nursery is excellent, very well managed and maintained. Plants were healthy. The AFM should be especially complimented for the excellent job done.

The plant production programme drawn up by DD (S&PM) as well as the mother tree orchard programme are in appendices XIV and XV.

The method of propagation adopted in mango is mostly wedge grafting and success rate is very high. Seeds are sown directly in pots and grafting done about four months after sowing, except that additional nuclear seedlings produced are pruned off. This method of establishment appears to be successful and cheaper than the sandbed/pot process. Many plants have been planted in ground nurseries and are potted after grafting/budding, success is relatively high but irrigation requirements and weed control are problems.

Citrus propagation is by "T" budding and quite successful. Grafts and seedlings are healthy and have benefited from correct pest control measures adopted. Seed and Planting Material Division Staff in nurseries should visit this station and study the methods used there.

Nursery

a) Land - Adequate, good and can be expanded.

b) Structures - One shade net house is providing excellent results. More shade net houses should be constructed and the temporary ones replaced. The propagation structure under construction could also be turned into a shade house. This farm could benefit by the provision of a mist propagator.

c) Irrigation facilities are available, but an additional water tank should be constructed as envisaged. The mother orchard programme is to be correctly implemented. There is a need for a 2" or 3" pump together with the piping and spray irrigation equipment.

d) There is one permanent budder appointed and two casual budders. Action should be taken to appoint two more permanent budders. The current casuals to be appointed as permanent budders. This will help to maintain the excellent work being done in the nursery. There is no KVS. It was revealed that it was hard to recruit casual labourers.

e) Very few pieces of equipment are available. Twenty five budding knives, twenty five pruning secateurs, six pruning saws, six pruning knives should be made available as this station will be a site for training. Sprayers, are necessary. Also tractor and slasher and other equipment is necessary and should be provided. Other field equipment for uprooting plants should also be made available. Equipment for sealing polythene bags should also be made available.

Facilities for Training

Excellent facilities are available at the Inservice Training Institute, Maha Illuppallama.

Mother Plant Orchard

a) A mango budwood garden established about 17 years back is badly in need of rejuvenation, and manuring. These are from selected mother trees and should be pruned, manured and used as budwood source. The plans of this block should be in the farm files and should be searched and used.

(b) Stock plant orchards do not exist.

(c) Land is available for expansion. Irrigation facilities must be provided.

(d Additional facilities such as tractor mounted rotary slasher and power sprayers should be provided.

6.4 AMBEPUSSA GOVERNMENT FARM

General

This farm is under S&PM Division. The two consultants were accompanied by Mr. Padmalal Add. DD (Seeds Division). Mr. Palipana Farm Manager and Miss Chitra K.V.S. took part in the discussions.

The programme for the plant production and establishment of mother orchards prepared by DD (S & PM) is in Appendices XIV and XV respectively. DD (S & PM) has decided that this farm be selected for development of the nursery and establishment of budwood garden under the present consultancy.

The nursery, its situation and the quality of plants produced are good given the constraints for operating. The potting mixture used is good. Demand for plants are year round.

Nursery

a) Nursery land is suitable and can be expanded if necessary.

b) Only temporary structures are available. There is a need to construct net houses and propagation beds to supplement existing facilities.

c) Irrigation - A good water supply is available for the nursery. This supply can be expanded for an expanded nursery programme.

d) Staff available - One KVS, one permanent appointed budder, one casual budder, one permanent labourer/budder. There is a need for an Agricultural Instructor at the nursery. At least one more budder and one nurseryman should be appointed.

e) No problems in obtaining labourers.

f) Very little good quality equipment is available. Secateurs, budding knives, pruning saws and pruning knives are required, since this farm is to be used for training purposes at least 25 budding knives and 25 secteures should be made available.

Facilities for training

There are good facilities for training, accommodation etc. The nursery staff needs training for vegetative propagation of Sapodilla and durian.

Mother orchard

a) Existing scion wood orchard contains old mother trees and needs pruning, manuring and pest control for rejuvenation. The following mango varieties are in this orchard.

Peter passand	10 trees	Dampara	10 trees
Betti Amba	10 trees	Vellai Colomban	45 trees
Carabao	4 trees	Karutha Colomban	40 trees
Gira Amba	11 trees	Willard	40 trees
Pol Amba	10 trees		

A few plants each of other crops also exist. The earlier field plans have to be obtained or new field plans drawn up.

b) There are no mango or citrus or Palu or Mee stock plants. These have to be established in the future programme.

c) Prospects for expansion: Sufficient land is available. Irrigation facilities can be provided. However a pump, irrigation unit, hydrants and nozzles have to be obtained. Areas earmarked are an area below existing nursery 3 acres in extent, 4 acres next to the nursery, also about 3 acres near the old mango orchard. This latter block is away from the existing water supply lines.

d) Tractor driven slasher and sprayers are needed.

e) Methods of propagation. The suitable stock and scion materials should be raised to allow continuity in the following methods of propagation until new methods are introduced and people are trained.

Present methods of propagation are as follows:

Mango	- Sand bed/polyethylene bag/Cleft graft
Rambutan	- Sand bed/bag/Patch budding
Guava	- Seedling bagged/Patch budding
Durian	- Seedling in bag/Patch budding
Avocado	- Sand bed/bag/Patch budding
Lemonine	- Cuttings in sand bed, bagged
Mangosteen	- Sand bed/bag, sold as seedlings
Jambu	- Sand bed/bag, sold as seedlings
Biling	- Sown in seedbed/bagged, sold as seedlings
Jak	- Sown in bag/Patch budded

6.5 GANNORUWA RESEARCH FARM

General

This farm is under Research Division management and services in the Intermediate Zone. Inspection of the farm was done with Mr.Diyanesius and Mrs.Wijetunga.

Many of the Tropical Sub Tropical fruit tree species are held at this centre and many species come directly from post entry quarantine release to the farm.

Nursery

The nursery facility is well managed and maintained.

a) For current purposes land is adequate for nursery structures etc. which mainly serve the propagation of plant cultivars for plant cultivar collections and release to Seed Division and the private sector.

b) Screen house (Net house) facilities, propagation structures and Green House structures are generally adequate. Green House Roofing needs replacement.

c) Adequate water is available for the nursery.

d) More staff trained adequately, are required.

e) Labouring staff are generally available.

d) Provision of irrigation to proposed Plant Cultivar Collection blocks is required. Tractor driven slashers and walk behind slashers or a rider mower, would simplify management. Some additional budding knifes,secateurs, priming saws, sharpening stones etc. are needed. Improved mist propagation facilities in polythene enclosed beds would be useful.

Plant Cultivar Collections

Some plant cultivar blocks are well maintained. Others need rationalizing , better maintenance and replanting - use Guide Lines in Section 5 for new blocks. Thought and planing for new cultivar collection blocks are needed for new introductions and promising local selections as well as for PGRC requirements. Land is somewhat limiting and more steeply sloping areas need development. These areas will need micro/mini spray under tree irrigation. Propagation and issue to other stations of introduced cultivars of some crops such as carambola, abiu, avocado, mandarin, lemon, pineapple, annona, lychee, local selections for rambutan are also needed.

6.6 HORANA RESEARCH FARM

General

The Horana Research Farm is under Research Division management and was formerly a Horticulture Station under Horticulture Division. The station services the wet zone low-lying with major crops being mango, rambutan, durian, mangosteen and lemonine with some minor fruits . Discussions and inspection of the station were made with Mr. Aluwihara, F M Horana, Mrs. Dissanayake, R.O., RRC Bombuwela and Mr. H P Ariyaratne R,O, PGRC Gannoruwa. In general the station is well managed both in the field and in the nursery.

Nursery

The nursery area is small but it is well maintained with good screen house and green house facilities.

a) Irrigation water is sufficient for the nursery.

b) Staff is competent in the production of mango, durian, rambutan, lemonine, guava and avocado. They have one trained budder but could use more trained staff in propagation and nursery management.

c) Labour is generally available for field and nursery work.

d) A tractor with tractor drawn, slasher, walk behind slasher, power sprayer, bowser and additional budding knives, secateurs, pruning saws, sharpening stones etc. are needed to simplify management as new cultivar collections are established blocks. A mist bed would also be a useful addition to the nursery.

Plant Cultivar Collections

Plant cultivar collections are generally well maintained for mango, Avacado and guava. The rambutan block is old and needs to be re-developed in a new block. The same is true for the old durian block. The old mangosteen block also need to be re-developed if it is still to act as a seed source for Research or Seed Division. The old mango mother orchards for bud-wood and seed.

Adequate land is available for expansion of plant cultivar collections at Horana Farm. Irrigation is not available for plant cultivar collection blocks and in most years is probably not required. However, hand watering of young trees will be needed to establish trees.

6.7 MAHA ILLUPPALLAMA AGRICULTURE RESEARCH FARM

General

This farm is under Research Division management. Discussions at the farm were held with Dr. Joseph, DDR, and Mr. Piyadasa, RO. Inspection of facilities was made with Mr. Piyadasa.

In general management of especially the older plant cultivar collections was poor. Trees were in poor health, often over grown with weeds and showing past fire damage and or disease lack of labour, funds, staff, irrigation and fencing (against wild boar), tools and equipment, were cited as the major constraints and need urgent attention by DOA. MI is a very important centre for the Dry Zone and major crop include : mango, cashew, woodapple, banana, passion fruit, papaya, grape, lime, lemonine, guava, soursop and jak.

Nursery

Only a small nursery facility was present at this farm, although the adjacent seed farm has a very well managed nursery. It is suggested that either the Research Division

co-opt. the services of the Seed Farm for propagation or fund a completely new nursery facility.

Plenty of land is available for a new nursery. But it should be sited near to a water supply or canal. No trained staff are available for nursery work. Given the importance of Maha Illuppallama to Dry Zone horticulture at least three more Research Officers, in horticulture should be appointed to handle the fruit and vegetable research development programme.

Tractor, trailer, slasher, power sprayer, bowsers, hand-sprayers propagation tools and wild boar proof fences are urgently required at MI.

Plant Cultivar Collections

Poorly maintained as indicated earlier. Imported mango cultivars sensation, Zill, Momi-K, Kensington, Cambodiana, Tommy Atkins, Govea, S-1 and Joy Welch have all flowered and fruited and should be multiplied for release (except Cambodiana).

The old citrus block is dying out and should be redeveloped onto Troyer, Cleopetra or rough lemon stock to try to save the cultivars.

There is an area available for expansion on the road to the Government Seeds Farm at MI and a site near main gate. Irrigation and fencing are key constraints to new areas being developed.

Some selection of local germplasm has begun. A citrus root stock trial, grape variety trial, banana trial and young mango cultivar block are well maintained and should give good results.

7. NURSERY REGISTRATION AND PLANT CERTIFICATION FOR PERENNIAL FRUIT CROPS

7.1 NURSERY REGISTRATION

Private nurseries approved for the production of perennial fruit crops are registered after inspection by the Seed Certification Service (SCS) of DOA. A registration fee of Rs.250/- is payable for registration, which must be renewed yearly. Appendix VIII carries the list of some 108 nurseries registered by Seed Certification Service. The private nurseries that are registered have some advantages. People are more inclined to buy plants from a DOA registered nursery. Additionally, such nurseries may participate in export of fruit plants as well as fruit tree subsidy schemes of Government, where trees are given to farmers or settlers. at reduced prices-trees being drawn from

DOA's own nurseries or registered nurseries. Registered nurseries can also participate in the plant certification scheme run by the Seed Certification Service of DOA; which also operates for DOA nurseries. Registered nurseries can also be referred to by DOA where needs cannot be met from DOA nurseries. Private fruit crop nurseries whether registered or not can grow, for distribution and sale, any fruit cultivars they wish.

DOA S&PM Division plant nurseries can only grow, for distribution and sale, those cultivars recommended, listed and approved by DOA for the various fruit species and regions. These cultivars under the current system have to be recommended by Research Division after field trials. As discussed elsewhere in this report. Such a system is far too restrictive with tree crops and an alternate policy, on cultivar release needs urgent implementation.

7.2 PLANT CERTIFICATION

The Seed Certification Service only began the fruit plant certification programme in 1990 and is receiving assistance from DARP.

Currently SCS with assistance from other DOA divisions is mapping and numbering mother tree plants as budwood sources at various centres and stations of DOA. They are confirming cultivar authenticity from tree and fruit characters. So far this mother plant selection programme has identified and characterised in Government farms the following:

17 Mango cultivars,
9 Rambutan cultivars,
2 Pineapple cultivars, and some avocado cultivars.

In future, this programme will be expanded to other cultivars and species. SCS is now beginning to implement. first in DOA nurseries and later in private nurseries, Plant certification, where grafted/budded (vegetatively propagated) plants are inspected for pest and disease status and general thriftiness and vigour and provided with a Certified Numbered Label, showing cultivar, rootstock etc. Such certification is only given if budwood used for propagation is obtained from mapped/identified/ authenticated/numbered/ mother trees.

Such certification can be expanded to the private sector, firstly via inspection, numbering and authentication of the mother trees for budwood.

DARP is currently providing assistance for DOA in this plant certification process.

We suggest that SCS should consult with other divisions of DOA and the private sector, before suggesting standards such as budding height above ground, pot type, potting mixtures, and so on. SCS needs to be flexible in these issues, in most instances - except

for perhaps citrus, where budding height must be not less than 10 cm above the first lateral root, but 15 cm is referred as a precaution against collar rot.

Again with some species, such as citrus, field propagated plants also must be catered to by certification, as plants may be sold bare-rooted or in containers.

The consultants recommend that where ever possible both scion and rootstock are stated on the certification label. This is important as it will help identify stock/scion incompatibilities and other desirable stock/scion characters of vigour/dwarfism and rootstock disease/pest/drought/salinity/poor drainage and pH tolerance in the field in the various fruit species.

It is further recommended that DOA implement a certified disease free seed and budwood scheme for citrus. Such schemes are in widespread operation in Europe, USA and Australia and are required, if Sri Lanka is to significantly expand production.

PGRC has fine-screen/glasshouses which could be readily adapted to maintenance of completely disease free nucleus mother plants of various important citrus cultivars and rootstocks (3-5 potted plants of each). PGRC has also indicated a willingness to participate in such a programme. Co-operation would need to be established between Research and S&PM Division to regularly index for disease these nucleus mother plants and isolated mother tree orchards from which seed and budwood are taken for propagation of disease-free certified commercial plants for industry.

China, Indonesia, Vietnam and Thailand have during recent years begun to implement such programmes.

The steps being taken by DOA in nursery registration and plant certification should help to significantly improve the quality of plants being sold and ensure that the buyer gets the cultivar he wants in the form of a healthy, vigorous plant. The DOA is urged to continue their good work in nursery registration and plant certification.

8. STAFF AND LABOUR AVAILABILITY, TRAINING NEEDS, AND WORK PLAN

In Section 5.8 of this report, staff and labour availability at the various Research, Seed and Planting Material division centres and stations have been noted. Few centres or stations have an appointed budder on staff, with most having only permanent labourers or casual budders. No station or centre except Bibile had on staff an appointed nurseryman. However, in most instances success achieved with propagation was acceptable.

Each centre/station visited indicated interest in participating in a training programme on propagation of perennial fruit crops, as did representatives of the private sector (the Sri Lanka Fruit and Vegetable Producers, Processors and Exporters Association). DOA centres and stations all indicated a requirement for more and better trained staff in propagation and nursery practices, to meet increasing demands for good quality plants.

WORK PLAN

The consultants propose that during the next visit, training courses be conducted at the Seed Division stations of:

Bibile (Intermediate Zone) - Horticulture Station
Kundasale (Intermediate Zone) - Seed Farm
Maha Iluppallama (Dry Zone) - Seed Farm
Ambepussa (Wet Zone) - Seed Farm

Both the DOA Research Division, PGRC, S&PM Division and Seed Certification Service and Plant Quarantine will be asked to nominate people for training.

In addition S&PM Division will be asked to contact all registered nurserymen in their files (Appendix VIII) who are producing fruit trees for sale. Such contacts should be made during the first week of October 1992 to seek an indication of interest in participating in the Training Programme to commence on 18th January, 1993. Consultants should arrive approximately 10-14 days before to write, prepare and co-ordinate hand out notes and practical issues.

S&PM Division should, with assistance from DARP, co-ordinate the requests for nominations and indications of interest from both the Government and private sectors and make all necessary arrangements for the training programmes. Each training course will last for three days, with a four day break between. It is suggested that DARP prepare certificates to be issued to those who participate for the full three day period.

The suggested training programme on propagation of perennial fruit crops and nursery practices is contained in Appendix XIV and this programme should be circulated by S&PM Division to both the Government and private sectors when canvassing interest in participation.

It is further suggested that DARP purchase the following propagation tools:

14	Pruning saws - as procured by DARP previously
3	Pairs multigrip pliers
50	Budding knives - high quality, folding, straight blade
50	Pairs secateurs - high quality, shearing action

5000	Aluminium label tags and ties
1	Roll Polythene (10 kg) 12" wide x 300 gauge
7	Rolls of twist tie wire
15	Carborundum sharpening oil stones large (for knives)
15	Small carborundum sharpening stones (for secateurs)
7	Polythene heat sealers

The tools are required for the training courses, and afterwards will be distributed to the four (4) S&PM Division stations and the three (3) Research Division stations participating in this consultancy.

S&PM Division should follow-up in September 1992 with Technology Transfer Division (In- Service Training Centres) to book the places for training as follows:

Kundasale	-	18, 19 and 20 January 1993.
Bibile	-	25, 26 and 27 January 1993.
Maha Iluppallama	-	1,2 and 3 February 1993.
Ambepussa	-	8,9,10 February 1993.

Above venues can be switched, if need be, to fit in with other training activities.

S&PM Division should also follow-up with the above centres to ensure they have sufficient rootstock and scion materials on hand to allow the Training Courses to proceed smoothly. It is further suggested that each course should contain not more than 30 trainees, ideally 20-25.

It is recommended that the Consultancy Period for the two consultants should be as follows:

4-17 Jan. 1993 -	Preparation of notes/hand outs and ensuring all equipment is on hand and satisfactory and arrangements are complete.
18 Jan - 27 Feb 1993	Conduct Training Courses as outlined above.
18 Jan - 10 Feb 1993	Tidying up issues arising from training; provide advice on follow-up training and management of grafted plants for mother orchards; check mother orchard sites and nurseries; check progress being made with cultivar collections, plant certification, plant collection, importing etc.; report writing.

9. NURSERY MANAGEMENT

During our visits to various nurseries in the course of the consultancy on-the-spot advice was given by both consultants on various aspects of: propagation, nursery organization and management, mother tree management, planning, renovation and maintenance of plant cultivar collections and research being conducted.

Appendix XI provides a list of references and texts on Propagation of Perennial Fruit Crops, which nurserymen both in the private and Government sectors may find very useful. Some of these texts are held by DARP for distribution to Research Division and S&PM Division.

We have also given useful references and texts on Horticultural Production Research and Development (Appendix XII) and Post Harvest Handling and Management of Fruits and Vegetables (Appendix III). Again a few of these texts are held by DARP for distribution.

The DOA, Research and S&PM Division should attempt to procure many of the key publications in the above Appendices, for use by their staff who requested from us such information.

Specific reference literature should be given to the relevant farms/research stations and a copy should also be held in the DOA Central Library in Peradeniya.

10. CONCLUSIONS AND RECOMMENDATIONS

10.1 Increased production of perennial tropical fruits in Sri Lanka is a high priority of GOSL for agricultural diversification and earning of foreign exchange, and is also justified by high prices and local shortages of fruit and low levels of domestic fruit consumption compared with other countries. Because of this situation and because a fruit export industry will create a surplus of fruit, the consultants recommend increased production of fruits for which there is a domestic market or processing demand at home, as well as an export market opportunity.

10.2 While policy is already in place to foster investment and development of perennial fruits for export, long term guaranteed land tenured leases for larger tracts of land (100 Ha to 1000 Ha or more) are essential. Significant exports of fruit can only be developed where economies of scale can be employed. It is recommended that GOSL address this issue on an estate basis (nucleus + out-growers) if substantial fruit export industries are to become a reality.

10.3 Taxes on processing (bottling and canning) are high at present and need review by GOSL if the large investments needed to process fruits and other commodities are to be encouraged to further expansion and exports.

10.4 Very significant development of fresh perennial tropical fruits for export can only occur with fruits that have a long post-harvest life (two weeks to Middle East South-South East Asia, Japan and four weeks to Europe) so that large volumes can be transported economically by sea to larger world markets. Air transport is too expensive and the volume far too small to warrant large scale industry development. Currently, Sri Lanka does not have many of the desirable fruit cultivars suitable for international markets, or they are not freely available to the private sector.

10.5 Currently, considerable confusion exists on deciding priorities regarding major fruits, potentially significant fruits for further development in the near future, and less significant fruits. The consultants present a suggested list in Table 3, Section 3 and recommend that in future DOA employ the methodologies outlined in Section 3, ie. methodologies for deciding:

- The potential of perennial tropical fruit species in Sri Lanka,
- Where they can be grown in Sri Lanka and constraints to consider,
- How the framework provided can be used to examine and handle issues involved in achieving national horticultural development and growth,
- Priorities for R&D.

10.6 From discussions with various agencies and people, but in particular Dr. Somasiri, of the Land Use and Water Management Research Centre DOA, and examination of extensive land use climatic and agro ecological data, it is our conclusion that the major physical constraints to production of tropical fruits in Sri Lanka are:

- Land availability - mostly Dry one and Intermediate zone (Monaragala District) are the areas available for development of perennial fruits, unless degraded highlands and existing estates are converted or intercropped.
- Water supply and availability of irrigation.

10.7 The establishment of a strong, effective, cohesive problem/opportunity industry orientated group within the DOA or possibly separate a horticulture institute or department should be a very high priority of GOSL. Such an institute should embody fruits, vegetables and floriculture production and post-harvest research and development and have responsibility for production of planting materials, technology transfer and extension. (Weisner 1988 and Mannion et al 1992 support this viewpoint.)

The dispersed and inadequate staff, and demoralized horticulture people now in DOA are unable to make the very significant effective contributions to horticulture production and post-harvest research needed to lead and foster horticulture development in Sri Lanka. Many of the existing problems found during this consultancy emanate from the absence of a strong horticultural R&D body in Sri Lanka that has a determined focus, strategy, and leadership.

10.8 Perennial tropical fruit cultivar collections established previously and now under Research Division need good care and maintenance, and in many instances, complete rationalization and upgrading with new introductions. Already some valuable materials have been lost through neglect, disease etc.

These Plant Cultivar Collections should be upgraded by Research Division in close collaboration with S&PM Division and PGRC. All plants in the field must be checked against existing lists, names, numbers and field plans. Missing cultivars should be replaced from other known sources in Sri Lanka. Missing exotic cultivars should be re-introduced. Appendix IV contains a list of desirable cultivars for introduction, to replace losses and to upgrade the quality of fruits with good cultivars that have acceptance on international markets.

10.9 It is recommended that plant cultivar collections (field germplasm banks) should also include new, superior, local varieties and selections of fruits collected and characterised by PGRC in collaboration with Research Division. A strategy for identification of such varieties and selections is given in Section 4 of this report.

10.10 Guidelines for setting out and documenting perennial fruit crop cultivar collections are given in Section 5 and should be adopted as a DOA standard.

10.11 Existing policy on release of perennial fruit crop cultivars is highly restrictive to development and in need of very urgent review by DOA. Currently, the private sector and even S&PM Division may conceivably have to wait 8-12 years or more to receive budwood or grafted trees of introduced or local cultivars, after Research Division recommends a cultivar for release. Such policy may be appropriate for annuals like rice, grain legumes, vegetables etc, but is totally inappropriate and unacceptable for perennial fruits of any kind. Under existing policy the private sector may have to wait up to 15 years or more to produce the first crop of fruit from a new approved cultivar.

New introductions of perennial fruit cultivars should be released immediately to the private sector on a "First-in First-served" basis, (after clearing quarantine and after first multiplication) fully described in Section 5 of this report. Release is conditional on an Indemnity Form being signed by the private sector customer. This indemnifies DOA against any legal action emanating from cultivar authenticity, pest and disease status, poor cultivar performance, quality etc. Such an "all care no responsibility" approach gets material out to the private sector quickly and thus provides DOA with

the opportunity of accumulating much more information on the cultivar across a number of environments and thus augmenting trial results.

A further recommendation is that local promising fruit selections found to be performing in a given ecological zone, be released immediately to the private sector in that zone, and at the same time to S&PM Division for multiplication and sale in that zone.

With older local varieties and selections and existing introduced cultivars, that show promise in terms of quality and performance in trials, it is recommended that they be immediately released to the private sector and given to S&PM Division for establishing mother plants for pre-release multiplication.

10.12 It is recommended that both DOA and DARP note the staff, resources, equipment and funding needs of the Research Division stations of Horana, Gannoruwa and Maha Iluppallama and attempt to meet existing short-falls and overcome constraints to development and maintenance of plant cultivar collections.

10.13 A considerable number of perennial tropical fruit species are listed as prohibited plants for import into Sri Lanka (Appendix IX). With many of these plants, perhaps with the exception of possibly citrus and banana, the pest and disease risk can be managed, especially where plants are drawn from a developed country. Depending on risk, the species, and source country, permission to import many of the species need not be restricted to a government department or institution. Private imports should be permitted in many instances.

Sri Lanka is being severely disadvantaged in accessing improved germplasm available internationally for perennial fruit species. Thus urgent review by DOA of these prohibited plants is recommended and sensible risk management employed, as suggested by the recent DARP Quarantine Review Consultancy. (See Section 5 for more details).

10.14 It has been agreed with DOA that mother tree orchards and nursery sites will be at:

- Kundasale,
- Bibile,
- Maha Iluppallama and
- Ambepussa

These sites will have mother tree orchards for budwood and rootstocks (seed). Current plans with varieties and numbers for planting these mother tree orchards are outlined in Appendices XIV and XV, based on expected demand for trees at various stations. To this list should be added: mother trees from future imports; local selections performing well in the zone of a particular station; and local varieties and selection plus existing introduced cultivars showing promise in screening trials of Research Division.

10.15 It is recommended that both DOA and DARP note that the staff, resources, funding and equipment needs of S&PM Division stations (Section 5) and attempt to meet these needs as promptly as possible.

10.16 It is further recommended that DARP in conjunction with DOA carry out a proposed training programme on propagation of perennial tropical fruit crops and nursery practices (Appendix XVI). A demand for such training has been indicated by the private and government sectors. The workplan is for S&PM Division to co-ordinate with DARP and make all the necessary arrangements for the training programme, as detailed in Section 8. The programme is to be run during the period 4th January to 27th February 1993 in four courses for both the private sector nurseries and DOA.

It is recommended that S&PM Division begin preparation during first week of October 1992. It is also recommended that DARP purchase the tools for the training programmes between September and December 1992 (Section 8).

10.17 Advice on plant cultivar collections, mother tree orchards, rootstock/seed requirements, propagation nursery organization and management and research was given during visits to research stations and seed farms.

The consultants recommend that the selected references and texts given in Appendix XI, Appendix XII and Appendix XIII and texts photocopied during the consultancy be procured and distributed to regional staff and a copy retained in the central library, Peradeniya.

10.18 The progress achieved to date in registration of nurseries for production of perennial fruit plants and the plant certification scheme undertaken by SCS is impressive. The DOA is urged to continue to support these activities. Additionally, it is recommended that for citrus species DOA setup a Certified Disease Free Seed and Budwood Scheme. Such a scheme is essential if Sri Lanka is to significantly expand production of citrus.

10.19 It is recommended that plant introductions and mother orchards under the UNDP/FAO Horticulture (Fruits) Project, should be carefully maintained by Research Division. Furthermore, Research Division should co-operate and collaborate with S&PM Division in the use of these materials for propagation and release both now and in the future. These valuable materials must not be lost to Sri Lanka.

10.20 It is recommended that, where possible, the Seed Certification and Plant Quarantine in its liaison with the private sector, should obtain performance and quality information on cultivars imported by the private sector and make this available to Research Division.

It is further suggested that the private sector be advised that DOA is prepared to undertake commercial multiplication of selected materials by conventional vegetative

propagation or by tissue culture with certain crops. Such an arrangement to be on a "Fee-for-Service" basis.

10.21 Budwood gardens were established in some of the government farms in the 1970's, using the best cultivars and clones available at that time. It is suggested that Seeds Division should obtain information on these trees and together with Research Division rejuvenate and retrieve the best of this material for new collections and mother orchards.

10.22 Finally the consultants recommend that DOA, both now and in the future, give the very highest priority on the preservation of perennial fruit cultivars in field collections and orchards, on government farms in Sri Lanka. Firm policy should be in place to ensure that continuity in preservation never fails.

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12. PROGRAMME OF VISIT

17/19 July 1992	Depart Buderim/Arrive Brisbane Depart Brisbane/Arrive Bangkok Depart Bangkok/Arrive Sri Lanka (KR CHAPMAN)
20 July 1992	Briefing with Dr. Pattie, Chief of Party/DARP Briefing with Dr. M Sikurajapathy - DD(S&PM) - DOA, Mr. Padmalal - Ad.DD(S&PM) Review of relevant reports of DARP, MARD etc. and arrange programme of visits.
21 July 1992	Visit Kundasale Station (S&PM Division Farm) for farm and nursery inspection and discussions with Mr. A Kularatne ADA(S&PM) Mr. Liyanage FM(S&PM) Mrs. Liyanage - Nurseries
22 July 1992	Briefing and discussions with Dr. S L Amarasiri, DD(Research) Dr. M Sikurajapathy DD(S&PM) Dr. Pattie, DARP Arranging programme of visit and visit Land Use Division, Dr. S Somasiri - Head of Division
23 July 1992	Discussions with Mrs. I S Padmasiri CARI, on research programmes and plant collections, collect climatic data and land use data from Land Use Division
24 July 1992	Visit to CARI Gannoruwa, Horticulture Research Farm to inspect nurseries and plant cultivar collections with Mr. Diyanesious Ms. Bandaranaike Ms. Wijetunga
25 July 1992	DARP Office - Data collection, report reading.
26 July 1992	Free day
27 July 1992	A.M. - Visit to Walpita Research Station for inspection of nursery, mother orchard, cultivar collection and research trials with: Mr. Kannagasa - FM, Walpita Mr. Somadasa - RRC Makandura

	P.M. - Visit Makandura Regional Agriculture Research Centre and inspection of trials, nursery etc and discussion with: Dr. Samaratunga - DDR/RRC
28 July 1992	DARP Office - Discussions with Dr. Pattie, Mr. Padmalal Ad.DD (S&PM) and collection of data from DOA, DARP and Land Use Division
29 July 1992	DARP Office - outlining of report
30 July 1992	Visit to Horana Research Station for inspection nursery, cultivar collection blocks and old mother tree orchards - discussions with : Mr. Aluwihara - FM, Horana Ms. Dissanayake - RO, RRC Bombuwela Mr. H P Ariyaratne - PGRC, Gannoruwa R.O. Germplasm Exploration & Collection
31 July 1992	A.M. Visit to Girandurukotte Agriculture Research Station to inspect plant cultivar collections with: Mr. Lecamwasam, DDR - RRC Aralaganwila Mr. A S P Weerasinghe - RO, Girandurukotte P.M. Visit to MARD office system B and MARD nursery System B - Mahaweli. Discussion with Dr. G W Selleck & Mr. Nayeem of MARD. Visit to MARD nursery and plant collection area and grape trials.
1 August 1992	DARP Office, report outlining compiling notes on field visits.
2 August 1992	Free day
3 August 1992	A.M. Discussions with: Dr. J Fernando, DD(SC&PQ) Dr. Weerasena, Ad.DD(SC&PQ) on Plant Quarantine policy and regulations on introduction of fruit tree cultivars P.M. Visit to Maha Iluppallama Regional Agriculture Research Centre Discussion with: Dr. Joseph DD/R, RRC MI, Mr. Piaydasa, RO MI and inspection of plant cultivar collections.
4 August 1992	A.M. Visit S&PM Division Government Farm at MI and for discussions and inspection of nursery and mother tree orchards with: Mr. Padmalal Ad.DD(S&PM) Mr. Abeysekera ad.DD(S&PM) MI Mr. Rambukwella F.M. Govt. Farm MI

	Mrs. Rambukwella A.F.M. Govt. Farm MI
	P.M. Visit to remainder of research division plant cultivar collections and research trials at MI with Mr. Piyadasa R.O. M.I.
5 August 1992	Visit to Ambepussa Government Farm to inspect mother tree orchards and nursery and have discussions with Mr. Palipana - Farm Manager Ambepussa, Miss. Chitra - KVS Ambepussa.
6 August 1992	Visit Colombo for discussions with: Mr. M A U de Zoysa - Deputy Director, Export Development Board Mr/ S Gnanaskandan Executive Director of Eastern Allied Agencies & Secretary of Sri Lanka Fruit and Vegetable Producers, Processors and Exporters Association, and Mr. S Amarasinghe, Manager, Marketing Division, Mahaweli Authority, Mr. Liyanage, Agronomist Mahaweli Economic Authority
7 August 1992	Visit to Bibile Horticulture Station for inspection of nurseries, mother orchards and plant cultivar collections with: Mr. Wijesundara, F.M. Horticulture Station, Bibile Mr. Heenkenda, R.O. RRC Bandarawela
8 August 1992	DARP Office, compiling notes on field visits, collating information for appendices - Discussions with Dr. R L de Silva Team Leader of Plant Quarantine Review Team
9 August 1992	Free day
10 August 1992	Visit to Plant Genetic Resources Centre at Gannoruwa for inspection and discussions with: Mr. C R Hindagala, R.O. Germplasm multiplication and conservation Dr. H H Mendis, R.O. Invitro conservation & Biotechnology Visit to Seed Certification Service, Gannoruwa. For discussion with: Mr. G. de Silva - ADA (SCS)
11 August 1992	Report compilation and discussions with Mr. N. Santacroce of DARP Review Team on Plant Quarantine.
12 August 1992	Report compilation, typing and further discussions with Mr. N Santacroce regarding Plant Quarantine Review.
13 August 1992	Report compilation and typing

14 August 1992	Report compilation and typing
15 August 1992	Report compilation and typing (K R Chapman)
16 August 1992	
17 August 1992	Report compilation and typing (K R Chapman)
19 August 1992	Debriefing with Dept. of Agriculture: Dr. Preston S Pattie - Chief of Party/DARP Dr. S L Amarasiri - DD(Research), DOA Dr. P Ganeshan - Head, PGRC Mr. Lambert Dissanayake - Co-ordinator Hort. Crops. CARI Mr. B.A.S.S. Padmalal - Add.DD(S&PM), DOA Mr. G de Silva - Add.DD(SCS)
20 August 1992	Visit Colombo for discussion with: FAO Representatives regarding horticulture programme in Sri Lanka. and debriefing with USAID and Dr. Pattie/DARP
21 August 1992	Depart Colombo Arrive Bangkok - K R Chapman
22 August 1992	Depart Bangkok - K R Chapman
23 August 1993	Arrive Brisbane Depart Brisbane Arrive Buderim (Home Base) - K R Chapman

APPENDIX I

* FACTORS IMPORTANT IN ASSESSING THE POTENTIAL OF TROPICAL TREE FRUIT SPECIES FOR AUSTRALIAN HORTICULTURE

by B.W. CULL

This chapter discusses those factors which might be considered most important in an assessment of the potential of a tropical tree crop.

They are considered. in their likely order of priority under five main headings. Consumer Potential covers those elements that influence the demand by the public for the product. maintain their interest and might eventually establish a continuing viable market outlet. Product Marketing Characteristics evaluates those factors that control the successful transfer of quality produce from the grower to the consumer. Environmental Adaptability outlines the ability of the crop to perform under Australian conditions. Production Potential looks at those cultural areas pertinent to the economic field performance of a crop. Economic Potential summarizes the possibilities for success in the Australian market. as well as the limitations on a product's viability.

A tabulated list is also provided of the numerous. but by no means interdependent. criteria relating to each of these divisions. The criteria are allocated values to give some indication of their comparative importance. The evaluation preferably should be used as a basis for discussion. and not as a definitive analysis.

One column has been left clear for the reader to make his own evaluation of a particular crop's performance in relation to each criterion. It is not suggested however that crops should be judged by their 'tally'. There are too many varying and indefinite factors involved for such a simple analysis. However. this system of rating might be useful as a 'shorthand' summary of your evaluation. or as a reminder.

The evaluation of the crops is based on their use as food crops and not as ornamentals or drug crops. Alternative uses may be considered of additional value.

Consumer potential

Products can be sold by vigorous advertising at a cost: others sell themselves by developing a strong want in the purchaser. The latter is the better course but the maintenance of this want depends on several factors.

Quality

Quality. the all embracing term. must be such to firstly capture the want. However. quality must be consistent to maintain the want. Quality can vary throughout the year. as in pineapples. Poor quality at one period acts to deflate the market even when quality is high. Quality varies between localities and cultivars as is the present situation with papaws. Bad experiences are reflected in a general reaction and resistance to purchase the entire crop. Some discerning buyers select specific growers from whom to buy. However. this is not the basis of broad market development.

Quality can be broken into two aspects. The first relates to all those characteristics which enable the fruit to remain edible. pleasing to the eye. and saleable at the retail outlet. Such factors as disease susceptibility. ease of bruising. physiological breakdown. and dehydration. all mitigate against quality.

* EXTRACT FROM :

Cull, B.W.(1984) - In " Tropical Tree Fruits for Australia " Ed. by P.E. Page, Dept. Primary Industries Brisbane, Australia. pp. 10-19.

The second aspect is related to the joy of eating. The major factors here in order of priority are an acceptable sugar-acid ratio, acceptable flavour and pleasant texture. Major factors affecting acceptance are the presence of off-flavours, bitterness and astringency.

Buyer confidence

The maintenance of sales depends on uniform quality. Some products have acceptable eating quality in the majority of fruit produced (banana) while other fruit can be assessed in the main by appearance (Delicious apple). Variations in another group cannot be assessed by eye and must be tasted to assess quality (pineapple). Where quality control is easily achieved, buyer confidence can be maintained, assuring sales.

Market development

A short or interrupted supply is costly in market stimulation and has to compete with a drift to other products. The success of market development and its maintenance therefore depends greatly on an even supply of significant quantities of good quality fruit over an extended period.

Competition with other fruits

Competition with other products either prevents the development or limits the potential of market size. In Australia the February-March-April period is glutted with a wide range of temperate and subtropical fruit. The late winter-spring period is starved for fruit. On the export sphere the ability to place an accepted fruit commodity on the market in a gap in traditional supplies could assure an outlet. Such gaps have by far the greatest opportunity for success.

On the export market the introduction of new crops outside a region's normal cultural and dietary experience requires massive development and promotional inputs. Such input is not likely to be available for these new, comparatively small scale, tropical fruit crops.

Place in dietary chain

The potential value of a fruit crop depends greatly on its place in the dietary chain. Commercial fruits can be described as staple foods (apples, bananas); speciality foods (passionfruit, cherries); and novelty foods (jackfruit). The avocado as a savoury, entree and salad component has, as the price falls, the potential of becoming a staple food and hence an expanding market outlet. The passionfruit as a flavouring item could never achieve this.

Ease of consumption

The ease of consumption also affects adaptability of the product. Fruit can be eaten directly out of hand, out of hand with the aid of a utensil only, and prepared or cooked prior to eating. The size of the market and ease of sale tends to decrease in order of these divisions. Exceptions may occur but presently no major selling fruit line is sold only for cooking in Australia. Speciality and novelty fruits must meet the convenience requirements that rip-top canned drinks and wrapped confectionery do.

Ability to promote

A particular characteristic of a fruit may provide an outlet and means of promotion. The avocado as an entree or savoury is a good example, while kiwifruit as a decoration on deserts is another. Food value or health gimmick are possibly of initial value but such factors do not prevail unless the food has a characteristic which gives joy to eating.

Ability to sell on particular markets

Certain crops, and in fact cultivars within crops, and manner of presentation must be aligned with certain markets.

The Australian market yet unaware of many of the crops can in fact be educated to a taste. There is, however, a preference for sweetness with an acid balance rather than acid sweet. Bland favours are not relished. However, self-appointed connoisseurs of a crop tend to prefer a much stronger flavour than the general public will accept.

The export market requires fruit which suit their taste and texture requirements as well as their local cultural and religious needs. Launching a new crop or even cultivars unknown to the area, from Australia, could be very difficult and costly.

The future in export markets possibly lies in those crops to which the countries are already accustomed. Here the out-of-season market would be exploited. Under these circumstances, varieties, style of fruit, and degrees of maturity must suit their traditional requirements. The ability to obtain and grow suitable cultivars with the quality characteristics they require and place them on the market as required are the factors to be considered in establishing this outlet.

Processed product market

It appears that the major factor limiting the sale of processed products is the previous acceptance of the fresh fruit. Without a knowledge and appreciation of the fresh fruit there could be initial resistance to the processed product. Where the crop has attributes making it suitable for processing, the use of dual purposes or individual fresh fruit and processing lines, are needed to establish simultaneous markets.

Product marketing characteristics

Marketing could be defined as the steps which follow harvest — preparing, holding and transporting the product to reach the point of sale.

Here we must look at two individual streams, fresh fruit and processed fruit. There is, however, an overlapping in needs for both outlets.

FRESH FRUIT

Fruit life

The life of fresh fruit depends on the maturity (edible stage) status of the fruit at harvest. Fruit can be either immature at harvest and ripen with time, while others must reach full maturity before harvest. The former type has considerable advantages.

The life of the fruit following harvest (transit and shelf) must be sufficient for it to reach the consumer and then remain usable for several days. Preference would be given to fruit which are in an edible state at the market and maintain this characteristic for an extended period (apple) rather than those which have only an acute peak of acceptability (banana).

Fruit life may be extended by either cool storage or controlled atmosphere techniques. Such manipulation can mean the success or otherwise of a crop, although the cost is significant (kiwifruit).

Fruit storage

The ability to store fruit enhances its usefulness for fresh and processing outlets by facilitating the development and control of transport techniques and general holding and redistribution. The process of reaching distant markets and retail points can capture sales. Storage also allows a controlled and extended supply to the market place which will maintain the market. Similarly the processor can control the rate of flow or fruit through the plant, thus reducing the capacity needs in equipment and staff.

Cool storage presently dominates most aproaches to crop storage. Controlled Atmosphere (C.A.) techniques appear more involved and the possibility of having detailed information on undeveloped crops is unlikely.

Packaging

The case, type and cost of packaging relates to the shape and susceptibility to damage of the product. Those having uniform and preferably rounded shape fit automated sizing, transfer and packaging. Fruit with a capacity to support a package (orange) obviously is cheaper to carton.

Transport

Fruit value to weight ratio controls the costs of packaging and transport, and becomes more significant the further away markets are, and the more perishable the product. The more perishable the product the faster and more costly the mode of transport needed. The costs of transport increase abruptly as the need for controlled temperature and atmosphere storage becomes necessary.

Trade barriers

Trade barriers associated with quarantine exist both interstate and overseas. The susceptibility of fruit limits their value. Disinfestation and treatment techniques are available for some crops. Such techniques are costly and also impede the process of crop assemblage and forwarding. The ability to assess this area depends on the availability of past research and development input.

PROCESSED FRUIT

Type of supply

The development of a processing industry in the main cannot grow from the chance excess production or discards of a fresh fruit industry. As crop production becomes large this rule changes in part. However, guaranteed supply over an extended period, within limits, is a must. A further rider is that some fresh fruit varieties do not meet the needs of a processor and special cultivars are required.

Type of processing

Suitability of a crop to either drying, freezing or canning alters its value in the development of processing. Small freezing and drying plants, provided they can get the continuity of supply from one or more crops, can be viable. Canning of goods in remote areas has the major problem of shifting tinplate in two directions. In addition, the general canned fruit market is somewhat depressed. The production of juices is usually a simple and low capital cost process. However, the market is presently limited and highly competitive.

Processing plant siting

In newer crops one can see a limited opening for such processing plants. Continuity of supply is possibly the major limiting factor. Alternatives are, to find a range of crops to give the supply, or transport the product to a processor with an already established throughput. The former requires the simultaneous establishment of the range of suitable crops at a limited distance from the plant. The possibility of this happening is remote. With established fruit processing plants being presently centred no further north than close to Brisbane, a processing crop established in far flung areas could require characteristics in the fruit which would enable it to be economically transported over a long distance. Another alternative is to have some simple processing step carried out on the grower's property.

Environmental adaptability

We accept that environment encompasses both soil and climate and that within what is classed as a tropical environment both factors range widely due to the original geology and present land relief. Adaptability refers to the crop's ability to exploit a wide range of these situations. Exploiting would mean consistently producing commercial crops and not merely surviving. Advantage can then be made of significant land areas for production and the variations in the related cropping times to exploit markets.

Location of production areas is often governed by the historical location of man and the services which serve him and his horticultural activities. The wider the adaptability the greater the chance of a crop being exploited. Where limited genetic diversity restricts fruit harvesting periods to weeks (mango and lychee) fresh market development through extended supply can only be achieved by having production areas in differing environments or by costly storage systems.

The criteria which are listed are considered those most suitable to define the adaptability of a horticultural tree crop. They also type the crop sufficiently so that its location can be defined with respect to the environment.

Consideration is given to temperature, water, wind, soil, land use and cultural practice, and environmental adaptability.

Production potential

Production performance is related to crop size and regularity of such cropping, year by year. This is further coloured by the ease or ability to bring commercial areas to this status within an economical time scale. Performance can be jeopardized by the susceptibility of the crop to pests and diseases and weather conditions. A further controlling factor of performance is the ease of harvesting.

Bearing capacity

The ability to bring sizeable plantings into production quickly spells potential financial success for any crop. Ease and cost of producing trees and their early development are important. The size of the early crop and the ultimate crop all govern its potential success. The actual production life of the tree has a bearing on return to investment. Life can be measured as either when the plant is replaced or when the plant has to be rejuvenated or skeletonized to bring it back to a controllable unit.

Tree and crop management

The ease and cost of manipulating the size, structure and shape of a tree is important with respect to the structural stability of the tree and the economics of cultural procedures and harvesting. The ability to control yield limitations or manipulate trees to yield more in a given time to improve the ease of harvesting are factors in favour of a crop. Factors which may be manipulated are tree growth and vigour, flowering and fruit set. This ability does not totally negate the defect as there can be considerable cost involved.

Usually in evaluating crops, the ability to assess these manipulators depends greatly on the accrued technical background which is related to previous input.

Crop loss

The incidence of pests and disease and also environmental damage in a specific region will have the ultimate control of crop loss. This is difficult to measure before plantings are made. What can be evaluated is the potential susceptibility of the crop to likely problems.

Ease of harvesting

This is a function of the cost-benefit relationships of time spent accumulating a certain value of product. This is usually controlled in part by the size of the fruit unit, its resistance to damage, the ease of finding it in the tree and its dislodgement, and the height of the fruit above ground level. These factors are magnified dramatically by the number of times you have to return to one tree to complete the harvest cycle.

Crops may be divided into: those that ripen only after removal from the tree (avocado); those which mature and will hang, retaining their quality (orange); those which mature fairly evenly on a tree but must be harvested immediately (peach); and those which require to be harvested immediately when mature but which on a given tree, mature over a period of time (custard apple). The first one obviously has great benefits both in the harvesting and marketing spheres. The second, like the first, also assists management and allows time for solving problems arising in the harvesting, marketing and processing chain. The third type is subject to acute loss by misfortune due to environmental and marketing factors at fruit maturity. The fourth tends to spread the risks in this area. However, the cost of repeated harvesting tends to limit the value of the crop.

Economic potential

The future and continued success of any crop depends on the financial return for investment in labour and capital. In addition certain economic factors control the type of person, related to his access to capital, entering the potential industry.

Likely grower return

Selling infers returns to growers which will allow continued marketing. Likely returns per kilogram of fruit may in the long term be equated against similar products in the dietary chain today (lychee may be compared with cherries). Many of the overhead and cultural costs of production are similar for tree crops. Harvesting, packaging and marketing costs can vary significantly. Where the latter costs are equated to be similar, then potential weight of marketable fruit should give a fair estimate for comparison of the likely financial viability of a new crop.

Capital investment

The capital investment required depends on two major factors. The first is the net return per unit area. Where the returns are high (avocado) the actual initial investment in tree crops need not be high. Where the returns are lower the scale of investment needs to be far greater to cover larger areas (macadamia).

The second controlling factor is the years to break even between costs and returns. The longer the period the greater the initial capital input. Large capital usually involves investors of some degree who are more likely to place their money in industries with a performance record than in potential new crops. Therefore new crops with a lower initial capital input are more likely to make a start than those requiring intensive capital investment.

Integration with established crop

If a crop can be generally coupled with an established industry or in fact progressively replace it, then capital invested in machinery, packing and storage facilities do not require duplication. This would also apply to cultural and management procedures making the adoption of the crop by established growers far easier.

Other uses

The tropical tree fruit crops have additional roles in many cases. Such roles may act as additional income to the production of fruit or as separate activities. Drug production, industrial chemical products, timber, the sale of ornamental cultivars and suitability for non-commercial backyard production are worth noting.

Evaluation of the potential of tropical tree crops

Using the understanding described in the section on factors important in assessing the potential of fruit species, the relevant criteria have been laid out in a structural fashion for easy use.

Against each criterion a nominated criterion value has been given. This value indicates the relevant importance, in my opinion, of each criterion. These values can be the subject of debate and possible change. The values are based on the following verbal value judgements.

Vital	Highly desirable	Desirable	Useful	Inconsequential
10	8	6	4	2

The use of this list of criteria in evaluating a crop may be considered in two ways. The criteria could be used as a check list and by working systematically through them, most important factors related to the potential of a crop are reviewed. The strengths, weaknesses and areas of lack of knowledge are revealed. Research and development areas should follow from this assessment.

Those wishing to evaluate marginally may use the following rating system to record the performance of a given crop against each criterion. It is suggested that by using the rating you are forced to make an active decision about each criterion and in recording it you have the opportunity to review the situation at a later date. It is not recommended that candidate crops be compared by a numerical accumulation scheme. The suggested performance ratings are:

High	Medium	Low	Nil
10	5	2	0

These are a guide and ratings may be allocated between 0 and 10.

Consumer potential	Criterion value	Performance rating
Quality		
Ability to maintain good quality throughout production period	10	
Ability of all cultivars used to maintain a good and similar quality standard	10	
Acceptability of visual quality characteristics at the market place	10	
Acceptability of the sugar-acid ratio of fruit	10	
Acceptability of unique flavour of fruit	10	
Acceptability of texture of fruit flesh	8	
Buyer confidence		
The relationship between visual characteristics and eating quality	10	
The relationship between texture (softness) and eating quality	6	
Market development		
Ability to maintain a supply of significant quantity of good quality fruit on the market (high: 4 months; low: 6 weeks)	10	
Competition with other fruit		
Ability to place fruit on the Australian market in autumn-early winter	6	
Ability to place fruit on the Australian market in late winter-spring	10	
Ability to place fruit in a gap in traditional supply overseas	10	

Place in dietary chain	
Characteristics of fruit are such that they fulfil a significant role in the dietary chain. High = staple food; Med. = speciality; Low = novelty	8
Ease of consumption	
Ability to be consumed easily	8
Ability to promote	
Ability to promote on some specific use characteristic	8
Ability to promote on some food value	6
Ability sell on particular markets	
Possible degree of acceptance by a wide range of the Australian public or ethnic group	10
Ability to grow cultivars which are now marketed overseas for that market	8
The availability of known markets with gaps or opportunities which do not require extensive development	8
Ability to sell at an acceptable price	8
Ability to replace imports	10
Processed product market	
Ability to exploit the fresh fruit market simultaneously	10
Ability to be marketed and used without competition from a similar product from another established crop	8
Product Marketing Characteristics	
FRESH FRUIT	
Fruit life	
The extent of fruit life after harvest without cooling — high: >14 days; low: < 7 days	8
The extent of fruit life after harvest with cooling — high: > 60 days; low: < 14 days	8
Span over which fruit becomes edible following harvest — high: for whole period low: < 3 days	6
Fruit Storage	
The ability to extend fruit life by cooling	8
The ability to extend fruit life by C.A. storage	6
The ability to hold ripe fruit in a household refrigerator	8
Packaging	
Ability of fruit to withstand mechanical damage	8
Ability of fruit to easily fit automated sizing and packaging equipment	6
Ability of fruit to support the package	4
Transport	
Value by weight ratio (strawberry — high; bananas — low)	6
Ability of product to be marketed without sophisticated packaging	6
Ability of product to be marketed without storage requirements	8
Proximity to market	4
Trade barriers	
Ability of fruit to resist attack of Queensland fruit fly and other fruit flies	8
Ability of product to be marketed without pesticide treatment for rots and infestation	8
Ability of fruit to withstand without damage ethylene dibromide fumigation or gamma irradiation	10
PROCESSED FRUIT	
Type of supply	
The potential for processing is such to stimulate separate production for processing	8
The ability to use fresh fruit varieties for processing	8

	Criterion value	Performance rating
Type of processing		
Ability of the product to be frozen	8	
Ability of the product to be dried	6	
Ability of the product to be canned	4	
Ability of product to be juiced	6	
Processing plant siting		
Ability of the crop to supply a processor continuously with commercial quantities for more than 4 consecutive months	10	
Ability of product to be transported in bulk 500 km	8	
Ability of product to be stored and transported in a dried form	6	
Ability of product to be simply processed for storage and then transport on the property	6	
Environmental adaptability		
Temperature		
Crop suited to:		
Tropical climate only	6	
Tropical and subtropical	8	
Subtropical	8	
Subtropical and semi-temperate	8	
Temperature stress:		
Ability to withstand 3 consecutive days at 38°C	6	
Ability to perform with extensive periods 32°C	8	
Ability to perform with extended minimum screen temperature of 0°C to 10°C	8	
Ability to survive minimum screen temperature of −4°C to 0.0°C	4	
Water		
Rainfall pattern adaption of crop:		
Suited to heavy wet summer — moist winter pattern	8	
Suited to heavy wet summer — dry winter pattern	8	
Suited to moist summer — dry winter pattern	6	
Suited to dry summer — moist winter pattern	4	
Poor water quality adaption:		
Ability to use irrigation waters 150 to 300 ppm chloride	8	
Ability to use irrigation waters 300 ppm chloride	8	
Response to humidity:		
Ability to withstand high humidity at:		
flowering	8	
carrying crop	8	
Ability to withstand low humidity at:		
flowering	8	
carrying crop	8	
Wind		
Response to wind extremes:		
Ability to perform in prevailing winds 15 knots:		
during vegetative growth	6	
during flowering	6	
Ability to withstand dry, warm to hot winds:		
during flowering	8	
at carrying crop	8	
Ability to withstand structural damage in cyclonic and storm winds	8	
Soil		
Adaptability to soil types:		
Range of adaptability to internal drainage	8	
Range of adaptability to soil pH	4	
Range of adaptability to soil fertility	4	
Land use and cultural practice		
Resistance to erosion risk	8	
Ability to use wide variations in topography	6	
Ability to use wide variation in orchard surface	6	

	Criterion value	Performance rating
Environmental adaptability		
Range of genetic environmental adaptability exhibited by cultivars	8	
Production potential		
Bearing capacity		
Ease and efficiency of multiplication of clonal material	6	
Years to commercial harvesting (5 years: high; 10 years: low)	8	
Ability to bear crops of an economic size	10	
Reliability of annual cropping	10	
Length of commercial economic harvesting life (20 years: high; 10 years: low)	8	
Tree and crop management		
Ease of cultural management	8	
Ability to control tree vigour	6	
Ability of plant to flower sufficiently and consistently	10	
Ability of plant to carry set fruit through to harvest	10	
Extent of reported technical knowledge on crop performance	6	
Crop loss		
Degree of resistance to known important insect pests	8	
Degree of resistance to known important diseases	8	
Degree of resistance to environmental stress during growing period	8	
Degree of resistance to environmental stress during cropping period	8	
Ease of harvest		
Ability to remove fruit on one tree at one harvest	8	
Ability to hold fruit on tree after reaching an acceptable market stage (3 weeks: high; 1 week: low)	8	
Ease of harvest of fruit from ground in mature tree	6	
Ability to harvest fruit from external surface of tree	6	
Predisposition to mechanical harvesting of crop	8	
Resistance of fruit to mechanical damage	8	
Economic potential		
Likely grower return		
Likely financial return based on comparison with another crop — nominate crop	10	
Capital investment		
Ability to establish a viable production unit on low investment in land (2 ha high; 6 ha med.; 20 ha low)	6	
Ability to establish a viable production unit on common standard farm machinery	6	
Ability to establish a viable production unit without large investment in harvesting, processing and storage equipment	8	
Ability to reach break even point between costs and returns early (5 years: high; 8 years: med.; 10 years: low)	8	
Integration with established crop		
Ability to integrate with an established crop industry in Australia — nominate crop	8	
Other uses		
Nominate uses		
Ornamental		
Chemical		
Drug		
Timber		
Backyard		

APPENDIX II

ASSESSING SOILS, CLIMATE AND WATER SUPPLY CONSTRAINTS TO TROPICAL TREE FRUIT PRODUCTION

AN EXAMPLE FOR BOLOVENS PLATEAU AND VIENTIANE PROVINCE IN LAOS (CHAPMAN, 1992)

6.3.1 Soils:

The Bolovens Plateau, which topographically, geographically and geologically may be likened to the Atherton Tableland in Queensland, has no major soil constraints to the development of tropical tree fruits. The deep red-brown loam to clay loam Basaltic soils have no major chemical or physical constraints to fruit production. The Terra Rossa soils likewise are good for fruit production, but in general have poorer water holding capacity, higher aluminium levels, lower calcium and tend to tie up phosphate (Docurieux 1991). However, the latter constitute only a small area of the plateau.

Approximately 40,272 Ha of land available for agriculture were identified by Anon (1990 b) on the Bolovens Plateau. Thus land availability is not a constraint.

In the North of Vientiane province around Vang Viang and Kasi, the Nham Son river bank limestone, alluvial silty loams are ideal for fruit and vegetable production and close to a good water supply. Development of 1000 Ha by the Lao Kaset Samphann Sericulture Co. Ltd., just north of Vang Viang on the Nham Son river has already started. Mulberry for silk production, Durian and some Lychee have already been planted. Planting of mango and citrus are planned for the future. The area will be too warm for good Lychee cultivars and would be better suited to longan and rambutan. Labour employed are Hmong and Yao people from the near by village — they are paid 300,000 Kip (US 430)/family/year for farm work.

The slash/burn hillsides between Hin Heup Station and Vang Viang on Variable Depth Ferrasol Loam to Clay Loam soils, should only be planted with more Drought Resistant hardy fruits such as Jambu, Tamarind and Mango, Guava, Pineapple, Bamboo Shoot, Jujube, Jak, subsistence managed Banana and some Citrus species, unless Irrigation is available. Rainfed Cashew should only be planted on deep soils (2 M or more in depth), and on the more gently sloping terrain.

If irrigation is available other crops such as rambutan, durian, sugar apple, pummelo, papaya can be successfully cultivated, provided the deeper soils (1 - 2 M) are chosen. Some areas only have 0.4 - 0.7 M of topsoil. These areas should not be planted to tree crops.

Currently the fertile silty/sandy loams along the Mekong River appear to be very under utilized for fruit trees and vegetables. These deep rich soils with ready access to water for irrigation, could easily supply much of fruit and vegetable needs of the towns along the Mekong and Vientiane city, e.g., 400 Ha of these fertile soils, with irrigation and well maintained could easily supply Vientiane city with 30 Kg of fruit/person/year. Again a further 1500 Ha could easily supply all of the vegetable requirements (50 Kg/person/year) for Vientiane, with the exception of some cool climate vegetables. The latter would be supplied from the highlands.

These fertile soils along the river are to some extent used for vegetable and fruit, while some are used for rice and field crops. In general such soils would produce much greater returns per hectare from fruit and vegetable, when all inputs (including irrigation pumping costs are included), than from rice or other field crops.

Most tropical fruits, except the cooler requirement fruit such as; Avocado, Lychee, Strawberry, Persimmon, Peach, Pear, High-quality Oranges and Mandarins, Custard Apple, Kiwi Fruit, Apple, Bramble fruits, Macadamia and other temperate nuts, can be grown on the river bank alluviums up to probably 500-900 m. Generally, nutrient supply is not considered as a constraint in soils used for fruits and vegetables. The higher value of product more than adequately compensates for fertilizer inputs. Soil physical condition is far more important than chemical fertility for Horticulture Crops.

In summary, adequate areas of good soils are available in Lao-PDR for fruit and vegetable production both for domestic markets and for export. Thus soils provide no major constraints to such development.

6.3.2 Climate:

In matching plants to land the climatic factors of most importance are Light, Temperature, Rainfall, Evaporation and Water Deficit, Water Logging and Relative Humidity.

For LIGHT it is usual to consider Day Length and Solar Radiation (Hackett, 1988). For tropical fruit, all of the important cultivated species are day-neutral with respect to flowering and thus daylength is of little interest and in most cases is not a constraint.

For most fruit crops to be grown up to 1200 m in the Bolovens or Vientiane, it is unlikely that solar radiation would be limiting, except in areas with extended periods of rain and heavy cloud. As a guide Monteith (1977) suggested that C3 plants (most fruits) require a minimum solar radiation level of 25 megajoules per sq. m. per day.

TEMPERATURE, is clearly the most important determinant of tropical tree fruit distribution.

Hackett (1988) has used various notional relationships to describe threshold temperatures and marginally suitable temperatures for brief and extended cold and cold damage and rates of development. For most tropical fruits these relationships are far from developed and for the present my preference is to use the simple approach of Watson and Moncur (1985), for determining where fruit will grow.

Watson and Moncur(1985) proposed, *Guideline Criteria for Determining Survival, Commercial and Best Mean Minimum July Temperatures for Various Tropical Fruit in Australia (Southern Hemisphere)- Table 1.*

Table 1 Guideline Criteria for Determining Survival, Commercial and Best Mean Minimum July Temperatures for Various Tropical Fruits in Australia (Southern Hemisphere).

Extracted from a paper by B.J. Watson and M. Moncur (1985), Wet Tropics Regional Publication, Queensland, Australia, pp. 3.

The mean minimum monthly temperature data presented below when applied to the coolest month (January), in various areas of Laos will indicate areas where various tropical fruits may grow commercially.

		Mean Min-imum Temperature (°C) for Coolest Month		
Common Name	**Botanical Name**	**Survival**	**Commercial**	**Best**
Abiu	*Pouteria caimito*	8-10	10 plus	12-18
Acerola	*Malpighia glabra*	6-8	8 plus	14 plus
Akee	*Blighia sapida*	10-12	12 plus	16 plus
Ambarella	*Spondias cytherea*	10-12	12 plus	14 plus
Babaco	*Carica hybrid*	?	6-12 ?	6-10 ?
Banana	*Musa spp.*	6-8	8 plus	16 plus
Bell fruit	*Syzygium aqueum*	8-10	10 plus	16 plus
Black persimmon	*Diospyros digyna*	6-8	8-18	6-14
Blueberry (L.Chill)	*Vaccinium spp.*	0-2 ?	1-12 ?	6?-10?
Bread fruit/Bread nut	*Artocarpus altilis*	14-16	16 plus	16 plus
Caimito	*Chrysoplyllum cainito*	8-12	12 plus	16 plus
Canistel	*Pouteria campechiana*	6-8	8 plus	14 plus
Carambola	*Averrhoa carambola*	6-8	8 plus	14 plus
Casimiroa	*Casimiroa edulis*	2-4 ?	4-14 ?	4-12 ?
Chempedak	*Artocarpus polyphema*	12-14	14 plus	16 plus

		Mean Minimum Temperature (°C) for Coolest Month		
Common Name	**Botanical Name**	**Survival**	**Commercial**	**Best**
Cherimoya	*Annona cherimola*	4-6?	5-12?	6-10?
Cocoa	*Theobroma cacao*	12-16	16 plus	18 plus
Coconut	*Cocos nucifera*	8-10	10 plus	18 plus
Custard apple	*Annona hybrid*	4-6?	6 plus ?	10-14 ?
Durian	*Durio zibenthus*	14--16	16 plus	18 plus
Duku	*Lansium domesticum*	12-14	14 plus	18 plus
Guava	*Psidium guajava*	4-8	8 plus	14 plus
Jaboticaba	*Myrciaria cauliflora*	6-8 ?	8-18	10-15
Jack fruit	*Artocarpus heterophyllus*	6-10	10 plus	14 plus
Kiwifruit	*Actinidia chinensis*	?	?	?
Langsat	*Lansium domesticum*	12-14	14 plus	18 plus
Longan +	*Euphoria Longana*	4-8	8-18	8-14
Loquat	*Eriobotrya japonica*	2-4	4-14	6-12
Lychee +	*Litchi chinensis*	4-8	8-18	8-14
Mabolo	*Diospyros discolor*	8-14	14 plus	16 plus
Malay Apple	*Syzygium malaccense*	8-14	14 plus	16 plus
Mamey Sapote	*Pouteria sapota*	6-8	8 plus	14 plus
Mammea	*Mammea americana*	10-12	12 plus	16 plus
Mamoncillo	*Melicoccus bijugatus*	10-16	16 plus	18 plus
Mango	*Mangifera indica*	6-8	8 plus	12 plus
Mangosteen	*Garcinia mangostana*	10-14	14 plus	16 plus
Marang	*Artocarpus odoratis-simus*	12-16	16 plus	18 plus
Matisia	*Matisia cordata*	12-16	16 plus	18 plus
Miracle fruit	*Synsepalum dulcificum*	8-12	12 plus	14 plus
Mulberry	*Morus nigra*	2-4?	2-18 ?	4-12 ?
Nectarine (L.C.)+	*Prunus persica*	2-4 ?	4-12 ?	4-10 ?
Nutmeg	*Myristica fragrans*	10-14	14 plus	16 plus
Papaw	*Carica papaya*	6-8	8 plus	14 plus
Peach (L.C.)+	*Prunus persica*	2-4 ?	4-12 ?	4-10 ?
Pepper	*Piper nigrum*	12-14	14 plus	16 plus
Persimmon	*Diospyros kaki*	0-2 ?	8-12 ?	8-12 ?
Pitaya	*Hylocereus quatemalensis*	12-14	14 plus	16 plus

		Mean Min-imum Temperature (°C) for Coolest Month		
Common Name	Botanical Name	Survival	Commercial	Best
Pineapple	*Ananas comosus*	6-8	8 plus	10 plus
Pulasan	*Nephelium mutabile*	14-18	16 plus	18 plus
Pummelo*	*Citrus grandis*	4-8	8 plus	14 plus
Rambutan	*Nephelium lappaceum*	8-12	14 plus	18 plus
Rollinia	*Rollinia deliciosa*	8-10	12 plus	14 plus
Rose apple	*Syzygium jambos*	8-12	12 plus	16 plus
Salak	*Salacca edulis*	12-14	14 plus	18 plus
Santol	*Sandoricum koetjape*	10-14	14 plus	16 plus
Sapodilla (Chico)	*Manilkara zapota*	6-10	10 plus	14 plus
Soursop	*Annona muricata*	6-10	10 plus	16 plus
Tamarind	*Tamarindus indica*	6-10	12 plus	14 plus
Taun (Daws)	*Pometia pinnata*	8-12	14 plus	16 plus
Uvilla	*Pourouma cecropiaefolia*	8-12	14 plus	16 plus
Vanilla	*Vanilla planifolia*	8-12	14 plus	16 plus
Wampi	*Clausena Lansium*	2-6	8-14	8-10
Wax jambu	*Syzygium samarangense*	8-10	10 plus	14 plus
Woolmi	*Antidesma dallachyanum*	8-10	12 plus	14 plus
Macadamia +	*Macadamia spp.*	4-6 ?	8-12 ?	8-10 ?
Palm oil	*Elaeis guineensis*	10-16 ?	16 plus	18 plus
Aloe Vera	*Aloe barbadensis*	?	8 Plus	14 plus ?
Cashew	*Anacardium occidentale*	8-10	12 plus	16 plus
Lime (W.I.)	*Citrus aurantifolia*	8-10	12 plus	16 plus

N.B. + Varietal reaction to "chill" temperature variable
* Quality downgraded if grown in cool conditions

The above technique is a method for sieving out environments where tropical fruits may be grown. However, with some fruits, e.g. Durian, Mangosteen and Rambutan, we know that a high humidity environment is necessary for success, even if the temperate range is satisfactory.

Similar limitations may apply to other fruits, and over time we hope to gather such information, so that the minimum temperature approach can be further refined.

Watson and Moncur (1985) have taken the Mean Minimum Temperature (Degrees Celsius) for the coolest month (July- S.Hemisphere or January N.Hemisphere). Based on knowledge of the

plants, they describe temperatures for: Survival, Commercial and Best Production. This approach provides a broad " Rule of Thumb " guide for distribution and testing of various fruit species.

Temperature is clearly one climate parameter over which we have little or no control and we must select suitable areas with near ideal temperatures for production.

If there are no good temperature data available it is possible to take temperature data from a near-by Centre and allow for elevation changes. In the tropics temperatures may drop by 0.5°C/100m increase in altitude (Burke, quoted by Hackett 1988 for Papua New Guinea) or 0.6°C/100m as suggested by Ducourieux (1991) for the Bolovens Plateau in Laos. Thus estimates for the Bolovens rising up in 100M internals fron Pakse, for January Mean Minimum Temperatures (°Celsius) are as follows, using 0.6°C Drop/100m:

Table 2 Estimated Mean monthly Minimum temperature for coolest month on Bolovens Plateau.

	Elevation (metres)	Mean Minimum Temperature January (°C)	
PAKSE	101 m	17.6	(Pakse - 15 Deg 09 Min - N Latitude) — from FAO Data
	200 m	17.0	
	300 m	16.4	
20 Km.Station	400 m	15.8	
	500 m	15.2	
	600 m	14.6	
	700 m	14.0	
	800 m	13.4	
Ban Itou (35Km)	900 m	12.8	
	1000 m	12.2	
	1100 m	11.6	
Pakxong	1200 m	11.0	

Example: By reference to Table 1 and Table 2 we can see that for Rambutan and Mangosteen commercial production should cease at about 700 m, while Durian production should cease at about 400 m, but mango can be produced up to 1000 m, based on temperature estimates for the areas above Pakse.

However, as mentioned previously in some instances we may have to take into account other factors, e.g. Durian, Rambutan and Mangosteen prefer high humidity conditions; Mango grows better if little or no rain fails during flowering as rain encouragers Anthracnose fungal damage to flowers and often results in poor set. Avocado needs relatively cool temperatures 15-20°C at flowering time etc. Also rainfall at Pakxong, which may average 3987 mm per annum is far too high for good quality fruit production of some species, unless the fruit mature in the dry season.

For Lowchill Stone Fruits Sharpe's model (Figure 1), seems to be very much more useful in predicting useful sites than other complex temperature models (George, Pers Comm.). The model is based on the accumulation of Chilling Units according to the Mean Monthly Temperature for the coolest month, (January in N. Hemisphere Lao-PDR).

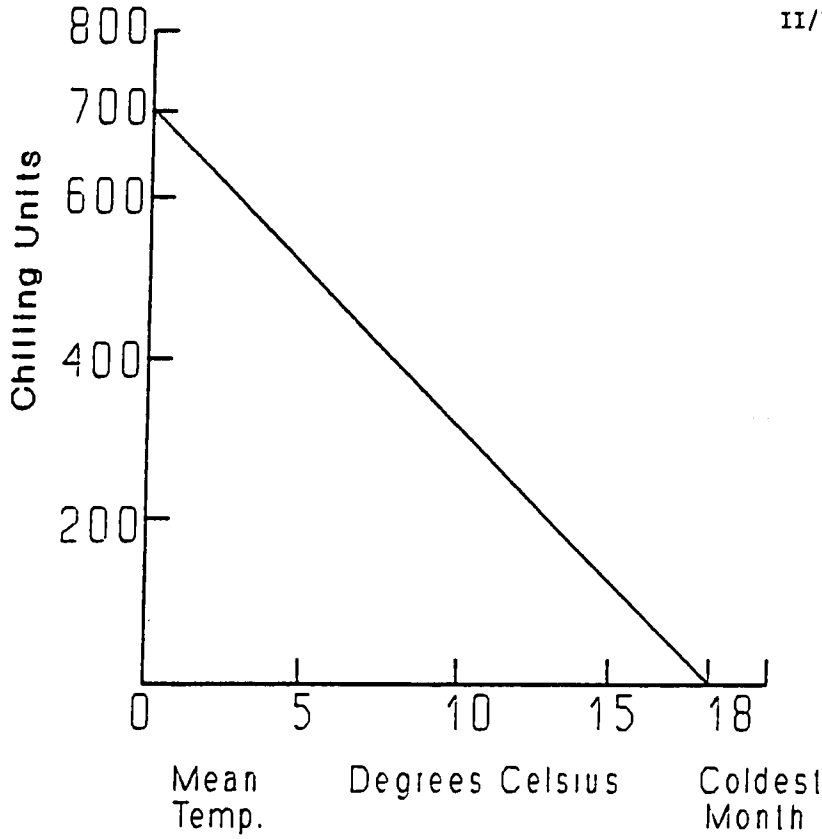

Figure 1 Sharpe's Chilling Units (George, A.P., Pers. Comm)

The relationship between chilling units and temperature is linear. At a mean monthly temperature of 18°C no Chilling Units accumulate. At 0°C, 700 chilling units accumulate. Most stone fruits of the low chill-Peach and nectarine group need at least 200 Chill Unit or more to produce satisfactorily.

At 1200 m above Pakse, (Mean Min January Temp. = 23°C), the Mean Min.Temp. at Paloxong is estimated to be approx. 17.3°C, giving 30 Chilling Units. This is not adequate chilling for good Low-Chill, high-quality peach and nectarine production.

For multiple cropping of apple and peach, (Edwards, Sinclair and Chapman, 1988) have described maximum and minimum temperature limits throughout the year which help select areas as being suitable for this system, based on successful cultivation areas. Essentially for Apple Mean Monthly Maximum Temperatures for all months should range from 23 to 32°C and Mean Monthly Minimums from 10-20°C. For Peach, the values are Max. 20-25°C, Min. 10-17°C. Again, very high rainfall areas should be avoided as fruit quality declines and pests and diseases become more serious.

Using the above "Rule of Thumb" methods, areas can be broadly selected for testing a whole range of fruit crops.

6.3.3 Water Supply

Water Supply (Rainfall, Evaporation and Water Deficit) are topics that can be treated as a group. Hackett (1988) treats this topic in some detail. I will outline just the major points:

1. **Excessive Rainfall** may cause problems with flowering, pests and disease, fruit quality at maturity and water-logging. May tree fruits require a period of dry and/or cold to stop growth and allow flower initiation to occur.

   If these conditions are not met, trees may fail to flower completely or adequately.

   Water Logging is especially important in trees such as Avocado, Citrus, Lychee, Peach, Cashew, Pineapple, etc., where longer term water logging causes death by anaerobic soil conditions or pre-disposes plants to disease. If soils are well drained waterlogging should be rare.

2. **Water Deficits** can be calculated by many methods taking into account rainfall, evaporation and soil water Storage, (See Hackett, 1988).

   Weekly Data are required to produce accurate calculations, Monthly data often indicate that demand for water is much less than it really is.

   For tree fruits, where under-tree irrigation is often used, (as this method is the most efficient in applying water), the formula below can be used to calculate **Water Requirement** and **Irrigation Demand** (Chapman and Turner, 1990) and using various factors modified for sprinkler or flood irrigation.

Chapman and Turner (1990), give a detailed treatment of water requirements of plants., peak irrigation requirements and long term irrigation requirements. The latter is of chief consideration here and may be calculated as follows:

Long Term Irrigation Requirement (I_L)=$F_2F_3F_1(0.8\ E_{USPAN}$ -Rainfall)
(mm/year)

where

- E_{USPAN} is monthly (or better still) weekly average evaporation from a US Class A Evaporation Pan.
- 0.8 is the factor relating evaporation from a free water surface to a US Class A pan.
- F_1 is a crop factor (use only if known - if not known assign a value of 1.0)
- F_2 is a factor, to allow for deep percolation losses by various types of irrigation systems, (for clay loams and loams F_2 = 1.0 e.g., for Bolovens and N. Vientiane Province).
- F_3 is a factor for evaporative loss of water applied; for localised (drip, trickle and mini-micro jet irrigation) F_3 = 1.0 and for spray irrigation F_3 = 1.25.
- Rainfall is actual monthly rainfall (for 30 years if available) or better again weekly rainfall. Use averages where actual data are not available.

For the example below (I_L) simplifies to:
$I_L = (0.8\ E_{USPAN} - R) \times A$
where A = Area of land irigated, e.g Ha

The sum of I_L's for each month are added to provide a yearly Long Term Irrigation Requirement.
For assessing storage requirements and annual water allocations I_L values used with probability data to determine these values.

With horticultural crops, values of product are higher and net returns per Ha are much greater than for all field crops and cereals, thus the reliability of the storage or allocation has to be very much better. A 1 in 10 year failure is usually acceptable for horticulture crops, while for field crops and cereals designs usually plan for a 1 in 4 failure or shortfall in supply.

For Pakse the following calculations have been made on a monthly basis as these are the only data available.

PAKSE (example) :

Month	**Pan** Evap(mm)(E) (Penman Method)	**Rainfall(R)** mm	**0.8 E_{USPan}** mm	**(0.8 E_{USPan})-R** mm	**Water Requirement** Mega litres/ha $\frac{(0.8E-R \times 10{,}000)}{1 \times 10^6}$
Jan.	163	1	130.4	129.4	1.294
Feb.	194	12	155.2	143.3	1.432
Mar.	260	12	208	196.0	1.96
Apr.	235	83	188	103.0	1.03
May.	181	230	-	-	-
June	148	314	-	-	-
July	133	505	-	-	-
Aug.	122	450	-	-	-
Sep.	111	404	-	-	-
Oct.	135	103	108	5.0	.005
Nov.	145	17	116	99	.99
Dec.	153	4	122.4	118.4	1.18
				TOTAL (ML)	7.801

The Water requirement calculated above of 7.801 Megalitres is: if the whole area of (one) 1/ha is watered on the surface, e.g. for vegetables with flood or spray irrigation. For trees using under-tree Microjet or Minispray irrigation the Water Requirements are approx half of the above calculation, as canopies of trees rarely cover more than 50% of the land area in commercial orchards and irrigation efficiency is between 95-100% However, what the above calculation tells us is that irrigation for fruit trees is essential, for approx 6 months at Pakse.

It is true to say that in this calculation we have neglected soil water storage and included light falls of rain which may be ineffectual. However, once the effective root zone is wet (say 1.5 M for many trees) any excess is lost to deep drainage and run off. *A Water Balance approach using Soil Water Storage, may reduce the above values somewhat, but irrigation is still a must for tree crops to be successfully grown at Pakse.*

Thus Water Deficit is a significant limitation to fruit production at Pakse and even at Paksong where rainfall if higher and evaporation lower. *Water deficits will occur in at least 4 months each year at Paksong and irrigation is essential for good commercial production.*

For Tropical fruit production, water limitation is the largest constraint to tropical fruit production in Laos. The same comments will apply to N. Vientiane Province where generally evaporation exceeds rainfall for 6-7 months of the year.

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In general the drop-off in mean maximum and minimum temperature adiabatic lapse rate with altitude in the tropics is between 0.5 and 0.7°C per 100m. Data for Sri Lanka suggest it is nearer to 0.7°C per 100m. Henry Nix (Pers. comm) suggests that in valleys or on plateaus between higher mountains, minimum temperatures may be up to 5°C colder than expected by lapse rate predictions, because of cold air drainage from higher mountains and trapping of this air on the valley or plateau floor.

For more details about crops and their tolerance of various environments and edaphic factors such as minimum temperature (survival, growth) maximum temperature, drought tolerance, frost tolerance, drainage tolerance, pH tolerance and so on. See:
HACKETT,C. AND CAROLANE,J. (1982) EDITORS. "EDIBLE HORTICULTURAL CROPS". ACADEMIC PRESS, SYDNEY, N.YORK AND LONDON pp. 673

APPENDIX IV

POTENTIAL PERENNIAL FRUIT CULTIVARS FOR INTRODUCTION TO SRI LANKA
(SUGGEST MINIMUM OF FIVE PLANTS OF EACH)

APPLE

65-39 (Florida)
82-20 (Florida)
Centenaria (Brazil)
Marquesa (Brazil)
Galicia (Brazil)
Soberana (Brazil)
Aqua Nueva II(Mexico)
Einshemer
Anna
Dorset Golden
Red Delicious
Rome Beauty
Granny Smith
Manalagi (Indonesia)
Indonesia Rootstock
Chinese Crab Apple(Rootstock)
MM 106 (Rootstock)
Merton 778 (Rootstock)

ASIAN PEAR

Pineapple
Baldwin
Spadona
Pyrus calleryana

AVOCADO

Hass
Wurtz
Sharwil
Pinkerton
Reed
Shephard
Rootstock (Velvick)

BANANA

Lady Finger
Mons Mari
Williams Hybrid
TV8
Ducasse

BREADFRUIT

Khancon Sumpalow
Khao Niew
Khao Chao

CARAMBOLA

Fwang Tung
B6
B4
Penang
Bangkok

CITRUS ROOTSTOCKS(Seed)
(1 kg of each)

Cleopatra Mandarin
Trifoliata
Troyer Citrange
Volkermariana
Swingle Citrumello
Rangpur Lime

CUSTARD APPLE

African Pride
Palethorpe
Hillary White

DURIAN

Chanee
Mon Tong
Gan Yeow
Kradom Tong
Gob Pical
God Mataow

GRAPE
Vitis vinifera

Seedless:

White
Perlette
Fresno 32-145
Fresno G4-74
Sultana Moscata
Fresno 58-93
Emeral Seedless
Fresno 32-68

Red
* Flame Seedless
CG4320

Black
Russian Seedless
MS-23-7
Black Monukka

Seeded :

Early White
Pearl de Csaba
M R Selection (A)
M R Selection (B)
Early Muscat
* White Muscat = Early Muscat (?)

Early Red
M.F. Selection

Mid Season White
* Early Muscat
Irsay Oliver

Mid Season Red

* Cardinal E5V14 - Clone good in warm climates; budburst to flowering is short and it has good resistance to downy and powdery mildew.

* Most important cultivars for Introduction

Mid-Late Season White

Dizmar
Waltham Cross - Bolgar Clone
Walthahm Cross - Tresco
Clone
* White Malaga
The need to trim and thin out Waltham Cross bunches is a problem, but the Tresco clone seems less susceptible to these "hen and chicken" problems.

Mid-Late Season Black

Djandal Kara - V. good
crunchy grape
Fresno 27-31 - Maybe good for export
Carolina Black Rose - Disease Resistant - Stems
brown quickly
* Muscat Hamburg - Disease susceptibility will be major disadvantage in wet areas.

Late Season White

Waltham Cross
Burgran
Calmeric

Late Season Black

Purple Cornician
Black Malaga
Black Rose
* Ribier
Balbiti

Very Late Season White

* Ohanez
M G Selection
Tandanya

Very Late Season Red

* Red Emperor

Vitis labrusca

* Schuyler
* Improved Isabella

Rootstocks' for Grape

3306
Dog Ridge
Schwarzamann
Ramsey

Grapefruit

Marsh Seedless

Guava

Indian Pink
Seedless Thai Guava
Kom Toon Khao
GA11-56 Selections
Common Pink Selections
Beaumont
Alahabad Safeda

Jak

Fah Talom
Large Seed
Small Seed
Hew No. 1
Jampa
Ta Buay

Jambu Air

Bogor
Chompoo Pa

Jujube

Rien Tong
Bombay
Calcutta
Guay Thong
Dok Phiset

Langsat/Duku

Langsat
Longkhong
Duku

Lemons

Villa Franca
Lisbon
Meyer

Limes

Tahiti Lime
West Indian Lime

Logan

Chompoo
Kohala
Daw
Dang
Haew
Biew Kiew

LOQUAT

Try for Japanese and Taiwanese Sweet Cultivars. Plus Cartagena, Bessel Brown and Champagne.

LYCHEE

Tai So
Kwai May (Pink)
Salathiel
No Mai Chee
Wai Chee
Haak Ip
Chacrapat
Kaimarna

MACADAMIA

A 16
660
344
Renown
741
800
246
A4
Plus H_2 & renown - Rootstocks

MANDARIN

Ellendale
Murcott
Imperial
Kinnow
Glen Retreat
Emperor
Som Kheow Wan (Thailand)
Hickson

MANDARIN

Minneola (Tangelo)

MANGO (MANGGA)

Sweet Cultivars

Palmer
Shoganan
Nam Klang Wan
Kensington Pride
Irwin
Nam Dok Mai
Okrong
Early Gold
Florigon
Ngar Charn
Carabao
Haden
Sensation
R2E2

Starchy Cultivars (Green Mango)

Keow Savoey
Pimsen Mun

MANGOSTEEN

Seed or seedlings from good plants in Indonesia & Thailand

ORANGE

Washington Navel
Pineapple
Joppa
Valencia

PAPAYA

Introduce a range of ripe fruit rot resistant dioecious lines from Queensland and small red hermaphrodite lines from Bali and Thailand (Kaeg Dum), Plus Taiwan & Florida lines; that are resistant to ring spot mosaic.

PASSIONFRUIT

Lacey
E-23
Purple Golden, plus open pollinated seed of hybrids

Flavicarpa (Yellow/Golden) for Lowlands

Seeds of self pollinated selections from Seychelles, W. Samoa and Hawaii - available in Australia - including rootstock selections for disease tolerance.

PEACH (low chill)

Mayglo
Flordaprince
Flordagold
Flordabelle
Flordastar
New Flordabelle
plus New CVs held in Florida & Australia

Rootstocks

Okinawa and low chill peaches from coastal Queensland, Australia. (As seed or plants) Very important to use these for low chill stone fruit.

NECTARINES

Cultivars (Low chill)

Sundowner
Sunlite
6-3
9-12 N
Plus other new CVS

Rootstocks

As above for Peach.

PLUM (low chill)

8-1
Gulf Ruby
Gulf Gold

PEAR (P.communis) low chill

Flordahome
Hood

PERSIMMON

Cultivars

Izu
Fuyu Hana
Ichikikei Jiro
Suruga
Fuyu

Pollinator

Gailey

Rootstocks

Use D. kaki seedlings as rootstocks.

PINEAPPLE

Smooth Cayenne

Queensland Cayenne Clone 8
Queensland Cayenne Clone 10
Queensland Cayenne Clone 13
Queensland Cayeene Clone 30
Champaka F-180
53-116
Battavia

Rough Leaf Types

McGregor
Ripley
Victoria (Mauritius)
Phuket (Probaby Mauritius)

PUMELLO

Range of selections from Australia & Thailand
Including Thong Dee, Tubtim

RAMBUTAN

Rongrien
Jit Lee
R134
R168
R156
Chompoo

SAPODILLA

Makok Lek
Makok Yai
Khai Harn
Prolific
Ksra Suay
Far Chee
Mar For

SOURSOP(Annona muricata)

Whitman's Fibreless

TAMARIND

Sweet	Sour
Jae Home	Kradarn
Sri Chompoo	Khee Maen
Nai Yad	Sating Phra
Red	
Sri Tong	

APPENDIX V

PERENIAL FRUIT CROP INTRODUCTIONS MADE BY UNDP/FAO HORTICULTURE DEVELOPMENT (FRUITS) PROJECT - PHASE II

A. MAJOR PLANT MATERIAL INTRODUCTIONS

a) Avocado varieties	Number of budded/ grafted plants	Country
Booth 8	5	Florida, the United States
Brooks Late	5	Florida, the United States
Lula	5	Florida, the United States
Tower 2	5	Florida, the United States
Peterson	4	Florida, the United States
Simmonds	4	Florida, the United States
Booth 7	4	Florida, the United States
Monroe	4	Florida, the United States
Choquette	4	Florida, the United States
Pinkerton	11	Florida, the United States; Australia
Edranol	6	Australia
Sharwil	6	Australia
Reed	6	Australia
Sheppard	6	Australia
Fuerte	11	Australia; Cyprus
Hass	11	Australia; Cyprus
Waldin	5	Cyprus
b) Orange variety		
Valencia	2	Australia
c) Mandarin varieties		
Kinnow	2	Florida, the United States
King	2	Florida, the United States
Murcott	2	Florida, the United States
Oneca	2	Florida, the United States
Imperial	2	Australia
Hickson	2	Australia
d) Grapefruit variety		
Marsh seedless	4	Florida, the United States; Australia

e) Lemon variety

Lisbon	5 (budwood sticks)	Cyprus

f) Litchi varieties

Sweet Cliff	2	Florida, the United States
Tait Tso	2	Australia
Wai-Chee	2	Australia

g) Mango varieties

Lippens	1	Florida, the United States
Saigon	2	Florida, the United States
Ott	3	Florida, the United States
Palmer	10	Florida, the United States
Harumanis	10 (budwood sticks)	Malaysia
Siam	5 (budwood sticks)	Malaysia

h) Pineapple varieties

Smooth Cayenne	6 (crown)	Australia
Masmerah	1 (crown)	Malaysia
Sarawak	1 (crown)	

B. MULTIPLICATION AND EVALUATION OF PHASE I AND PHASE II INTRODUCTIONS

a) Mango varieties

Anwar Ratual	Cambodiana	Carabao
Carrie	Davis Haden	Duschri
Glenia	Goweia	Gulab Khas
Haden	Irwin	Joe Welch
Kensington	Kent	Keitt
Langra	Malvana	Mapulchu
Momi-K	Mulgoba	Nam Dok Mai
Neelum	Panchaaladhara	Pope Summer
Samarbehisht Chousa	Selection VCGA/M/I	Sensation
Suvanarekha	S-1	Tommy Atkins
Zill		

b) Avocado variety

AS-1

C. PLANTINGS AT VARIETY COLLECTION AND EVALUATION CENTRES

a) Avocado varieties

At Gannoruwa four grafted plants from each of the nine varieties:

AS-1	Booth 7	Booth 8
Choquette	Lula	Monroe
Peterson	Simmonds	Tower 2

At Rahangala, four grafted plants from each of the varieties:

AS-1	Edranol	Fuerte
Hass	Nabal	Pinkerton
Reed	Sharwil	Sheppard

b) Mango varieties

At Horana, five grafted plants from each of the 13 varieties:

Carabao	Glenia*	Haden
Joe Welch	Keitt	Kensington
Mulgoba	Pope Summer	Samarbehisht Chousa
Sensation	S-1	Tommy Atkins

At Bible, five grafted plants from each of the 24 varieties:

Carabao A-16	Davis Haden	Dusehri
Glenia*	Gulab Khas	Haden
Joe Welch	Keitt	Kensington
Langra	Malvana(W/MAL/1)	Mapulehu
Mulgoba	Nam Dok Mai	Neelum
Panchakaladhara	Pope Summer	Samarbehisht Chousa
KG/14/2		
Selection VCGA/M/1	Sensation	Suvarnarekha
S-1	Tommy Atkins	Zill

At Maha Illuppallama, five grafted plants from each of the 14 varieties:

Carabao	Gulab Khas	Haden
Joe Welch	Keitt	Kensington
Langra	Mulgoba	Neelum
Pope Summer	Sensation	S-1
Tommy Atkins	Zill	

* Possibly the Cultivar Glenn.

APPENDIX VI

PERENNIAL FRUIT CROP

MOTHER PLANTATIONS OF SCIONWOOD AND ROOTSTOCK SEEDS
Established under UNDP/FAO Horticulture (Fruit) Development Project Phase II

Thirteen mother plantations were established during the project for the production of scionwood and rootstock seeds:

- An avocado mother plantation, one acre, at the Gannoruwa Horticultural Farm to be used as rootstock source. A local selection was used and some of the seedlings were budded with the variety Waldin.

- An avocado (variety Pollock) mother plantation, one acre, at the Horana Horticultural Farm, to be used as scionwood source for the propagation of nursery stock.

- An avocado (variety Pollock) mother plantation, one acre, at the Walpita Horticultural Farm, to be used as scionwood source.

- A mango (varieties Karutha Colomban, Vellai Colomban and Willard) mother plantation, ten acres, at the Bible Horticultural Farm, to be used as scionwood source.

- A mango (varieties Karutha Colomban, Vellai Colomban and Willard) mother plantation, ten acres, at the bible Horticultural Farm, to be used as scionwood source.

- A mango (varieties Wal Amba and Kohu Amba) mother plantation, one acre, at the Horana Horticultural Farm, to be used as rootstock source.

- A mango (variety Wal Amba) mother plantation, one acre, at the Walpita Horticultural Farm, to be used as rootstock source.

- A mango (variety Wal Amba) mother plantation, one acre, at the Ulpothagama Horticultural farm, to be used as rootstock source.

- A mango (variety Wal Amba) mother plantation, two acres, at the Weerapana Horticultural Farm, to be used as rootstock source.

- An orange mother plantation (variety Bibile Sweet), three acres, at the Bibile Horticultural Farm, to be used as scionwood source.

- A rough lemon mother plantation, one acre, at the Bibile Horticultural farm, to be used as rootstock source.

- A rough lemon mother plantation, one acre, at the Walpita Horticultural farm, to be used as rootstock source.

APPENDIX VII

STATUS OF PERENNIAL FRUITCROP INTRODUCTIONS INTO SRI LANKA AS AT APRIL 1988 (PHASE I & II FAO/UNDP HROTICULTURAL PROJECT)

Key

Gan	:	Gannoruwa CARI
Gan (H)	:	Gannoruwa Horticultural Station
Kil	:	Kilinochi RRC
Tin	:	Tinnevelly ARS
MI	:	Maha Illuppallama RRC
Mak	:	Makandura RRC & Walpita ARS
Van	:	Vanathavillu ARS
Kal	:	Kalpitiya ARS
Rah	:	Rahangalla ARS
Bib	:	Bibile ARS
Mon	:	Monaragala ARS
Gir	:	Girandurukotte ARS & Aralaganwila RRC
Ang	:	Angunukolapelessa RRC
Sita	:	Sita Eliya ARS

ORANGE

Ac. No.	Variety	Stations
2, 427	Kozan	Rah; Bib
35	Hamlin	Bib; MI; Kal
36	Frost Naval	Bib; Mon; MI; Mak; Kil; Gan; Kal Gir; Van
39	Jaffa	Bib; Kil; Kal; Van
40, 435	Blood Red	Bib; Kil; Gan; Van
42	Washington Navel	Bib; MI; Gir; Kil; Kal; Ang
43	Hinkley	Gir
44, 249, 429	Pineapple	Bib; MI; Kil; Kal
282	Valencia Frost	Van
* 627	Valencia	Gan(H); in pot

* Grafted Plants of citrus - other citrus brought as seed

MANDARIN

65, 444	Willow Leaf	Kil; MI; Van; Kal; Mon; Bib
66	Wilkin	MI
67	Shamel	Rah; Bib
68	Ponkan	MI; Van; Mak; Kal; Rah; Bib; Gir Ang
75	Honey Mandarin	Kil; MI; Mak; Van; Kal; Bib; Gir
76, 443	Feutrells Early	Kil; MI; Mak; Van; Kal; Rah; Mon; Bib; Gir; Ang
77,257, 445	Kinnow	Kil; MI; Mak; Van; Kal; Bib
78	Kinnow N	MI; Van; Kal; Bib
259	King	Van; Kal; Rah; Bib
266	Fair Child	Van; Rah
268	Fremont	Van; Kal; Rah; Mon; Bib; Ang
274	Avana	Van; Kal; Rah; Mon
80, 278	Seminole	Van; Rah; Gan; MI; Bib
279	Tardmo di Cicalli	Van; Kal; Rah; Mon; Bib
283	Lee	Van;Rah
* 607	Kinnow	Gan(H); in pots
* 608	King	Gan(H); in pots
* 609	Murcott	Gan(H); in pots
* 610	Oneca	Gan(H); in pots
* 629	Imperial	Gan(H)
* 630	Hickson	Gan(H)
	Tangerine Mandarin	Rah

LEMON

37	Cascade Eureka N	Mak; Rak; Gir
45	Mayor Lemon	MI
46, 441	Clavers Lisbon	Gan; MI
47, 439	Frost Eureka	MI; Mak; Kal; Bib; Gir; Van
50	Allen Eureka	Rah; Bib; Gir
269	Femminello	Kal; Rah; Mon
* 589	Eureka	Gan(H) in pots

* Grafted Plants of citrus - other citrus brought as seed

TANGERINE		
25	USDF's Dancy	MI; Ang
26	Fremont	Mak; Rah
280	Robinson	Van; Kal; Rah; Mon
GRAPEFRUIT		
55	O.P. Davis Seedling	Gan
56	Red Blush	Kil; MI; Van; Kal; Bib
57	Frost Marsh	Gan; Mak; Kal; Mon; Bib; Gir; Ang
73, 426	Reed	Gan; Mak; Rah
74	Marsh Grapefruit	Kil; MI; Mak; Van; Kal; Bib; Gir; Ang; Gan(H) in pot
272	Marsh Frost	Rah
276	Marsh Brown	Van; Rah; Mon; Bib
* 606	Marsh seedless	Gan(H) in pots
KUMQUAT		
69	Meiwa	MI; Bib
CITRUS ROOTSTOCKS		
7	Jullundri Khatti	Van
8, 329, 473	Seville kimb	Van; Kal; Rah; Bib
10	Sylhet lime	Kal; Bib
11	Mokri	Van
12	Khatta Tane Jabba	Van
13	Mithi	Bib; Gir
14, 321, 455	Sour Orange	Van; Gir; Mak; Kal; Rah; Mon; Ang
15	Narangi shandra	Mak; Kal; Rah; Bib; Gir
16, 465	Citrus histrix	Van
17, 468	Kharna Khatta	Gir
18, 458	Atoni	Mak; Van; Rah; Gir

* Grafted Plants of citrus - other citrus brought as seed

92

CITRUS ROOTSTOCKS contd..

Ac. No.	Varity	Stations
19	Jamberi Lyallpur	Kal· Rah; Mon; Bib; Gir; Ang
20, 460	Jamberi Ceylone	Rah; Gir; Ang
21	Trifoliate	Mak; Rah; Gir; Ang; Gan
22, 462	Jatti Khatti	Mak; Rah; Gir
23	Macropetra	Rah
24,323, 454	Gadadehi	Van; Kal; Mon
27, 459	Brazilia Sour Orange	Rah
28, 451	Citrumelo 1452	Gan; Kil; MI: Van; Kal; Mak; Bib; Gan
29, 453	Citrumelo 4475	Mak; Kal; Van; Rah; Mon; Bib; Gir; Ang
30, 319, 467	Volkamariana	Van; Kal; Mon; Ang
31, 317, 472	Keen sour orange	Gan; Van; Kal; Mon
32, 322	Taiwanica	Gan; Kil; MI; Mak; Van; Kal; Bib; Gir; Mon; Ang
33, 318, 463	Red Rough Lemon	Kil; MI; Kal; Bib; Mak; Van; Kal; Mon; Rah; Ang
34, 450	Troyer citrange	MI
63	Pomelo	Kal; MI; Mak; Van; Kal; Rah; Bib; Gir; Ang
64	Shaddok webber	Gan; Mak; Van; Gir
248	Aber's narrow leaf	Van; Kal; Rah; Bib
251	Willow leaf sour orange	Mon; Bib
252	Narrow leaf 77148	Mon
263, 452	Sacaton	Van; Kal; Rah; Mon; Bib; Ang
264	Melangolo	Van; Kal; Rah; Mon; Bib; Ang
267, 457	Rubidox	Rah
273	Troyer	Van
275	Inglisn Large	Van; Rah; Bib
277	Citrangor 42681	Rah; Mon
448	Carrizo citrange	Mon; Bib

* Grafted Plants of citrus - other citrus brought as seed

LIME

61	Kaghzi lime	Rah; Mon; Bib; Gir

CITRUS - NOT CLASSIFIED

Ac No.	Variety	Stations
3	Akay Scari	Rah
247	Fasistrimedin FACH 7826	Van; Kal; Rah; Bib
250	Etrog citron	Bib
261	Istrix	Van; Kal; Rah
265	Swatow	Van; Kal; Rah; Mon
271	Continella	Van

TANGELO

79	Pearl	Gan; Kil; MI; Mak; Van; Kal; Rah; Mon; Bib; Gir; Ang
81	Orlando	Gan; Kil; MI; Mak; Van; Kal; Bib
82	Minneola	MI; Van; Kal; Bib

MANGO

103, 306, 406	Sensation	Mak; Gan; Mi
104, 232, 310, 391	Tommy Atkins	MI; Gan; Mak
105	Malgoba	Gan; MI; Mak
106, 224, 305	Zill	Gan; MI; Mak; Van
107, 223	Carrie	Gan; Mak
108	S-1	Gan; MI; Mak
109, 303, 388, 536	Keitt	MI; Gan; Mak
110	Cambodiana	MI
111, 231, 304, 389	Kent	Gan; MI; Mak
112, 233	Haden	MI; Mak
113, 217, 512	Irwin	Mak; MI
175, 420	Gouveia	MI
177, 228, 311	Kensington	MI; Van
210, 313	Springfels	MI
212	Edward	Gan
218	OK Rong	Gan

(MANGO contd....)

Act No.	Variety	Stations
219	Mapulehu	Gan
220	Vandyke	Gan; MI
221	Glenia	Gan
225	Carabao I	Gan; MI
226	Carabao II	Gan
230,515	Fascell	MI;Bib; Gan
234,522	Nam Dok Mai	Van; Bib; Gan
296, 396	Langra	MI
298, 395	Dusehri	MI
299, 399	Anwar Ratual	MI
300	Samar Bahisti	MI; Mak; Van
302, 390, 517	Early Gold	Gir
307, 402, 422	Momo K	Gan; MI
308, 403, 421	Pope Summer	Gan; MI; Mak
309, 524	Joe Welch	MI; Van; Gan
314, 393	Sindhri	Gan
392	Sammar Bahisti Chousa	Gan; Mak
401	Swarna Rekha	Gan
404	Alfonso	Gan
405	Neelum	Gan
513	Ann	Bib;Gir
514	Wilson special	Bib; Gir
520	Zillate	Van; Bib; Gir
523	Kay-L	Bib
* 600	Lippen	Gan(H) in pots
* 601	Saigon	Gan (H) in pots
* 602	Ott	Gan (H) in pots
603	Palmer	Gan(H) in pots
641	Harumanis	Gan(H) in pots
642	Siam	Gan(H) in pots

* Grafted Plants

PEACH AND NECTARINES

541	Okinawa	Rah
544	Nectarine 6-8	Rah

GUAVA

83	Guava (Lahore delight)	Gan;Kil;MI;Van;Rah;Gir
89,284,424	Beamont	Gan;Kil;Rah
134	Psidium Friedricks thelianum	Gan
206,571	Processing 11-56 R5T2 11-56 T3G	Gan;Rah;Ang;Mak;Van;Bib;Gir
208, 574	Processing 11-56 T7G	Gan; Rah; Ang; Mak; Van; Bib;Gir
285	Waiakea 11-26	Gan; Kil; Rah
286	Hongkong Pink	Gan;Kil; Rah
287	Ruby supreme hybridII	Gan;Kil;Rah
316	Guava	Gan;Rah
325	Large white Thai Guava	Gan;Rah
382	Australian variety (Thai)	Gan; Rah
569	GA 11-56 R5T1	Gan;Mak;Van;Bib; Gir
572	GA 11-56 R1T1	Gan;Mak;Van;Bib;Gir
573	GA 11-56 CSIRO	Gan;Mak;Van;Bib;Gir
636	Beaumont	Gan(H) in pots
637	Hawaiian GA/11-56 T3	Gan(H) in pots

OTHER CROPS

(a) GENERAL

128	Antidesma dallachyanum	Gan
129	Guararibea cordata	Gan
130	Inocarpus edulis	Gan
131	Artocarpus hypargyraeus	Gan
132	Eugenia lyschanthiana	Gan
138	Palaguium phylippense	Gan
143	Bunchosida hookeriyana	Gan
144	Pouteria campechiana	Gan

	cv. clemens	
146	Rubus cv. Brazos	Gan
148	Syzygium samarangeuse	Gan

OTHER CROPS contd..

Act No.	Variety	Stations
151	Eugenia dombexi	Gan
155	Fieus pschdopalma	Gan
156	Bunchosida argentea	Gan
157	Bactris gasipaes	Gan
159	Antidesma bunins	Gan
	cv. Kampong	
160	Eugenia aggregata	Gan
161	Synepalam dulcificum	Gan
162	Myrciaria cauliflora	Gan
192	Hillawi Date	Gan;Kil;Van;Kal;Bib;MI
193	Khadrawi Date	Gan;Kil;Van;Kal;Bib;MI
194	Jaman	Gan;Kil;MI;Mak;Van;Rah;Bib;Gir
315	Ziziphus	MI;Van;Mak;Gir;Gan
374	Sweet Bread	Gan
407	Ziziphus Imram (1)	MI
409	Ziziphus Sel. 12 (3)	MI
411	Ziziphus Karal Local (5)	MI
501, 566	Rollina mucosa	Rah;Gir
509	Amazon tree grape	Rah
530,639	Abiu	Gan;Gan(H) in pots
556	White Sapota	Rah;Bib
611	Pomegranate Giant White	Gan(H) in pot

(b) LONGAN

101	Euphoria longan	Gan
	cv. Kohala	
527	Chompoo	Gan

Act No.	Variety	Stations
	(c) LOQUAT	
115	Tanaka	Gan
116	Christmas	Gan
117	Magi	Gan
118	Fletcher	Gan
120	Akko	Gan
	(d) SAPODILLA	
None		
	(e) MAMMEA SAPOTA	
None		
	(f) CARAMBOLA	
123	F Wang Tung	Gan
124	Maha	Gan
125	Arkin	Gan
380	Carambola	Rah;Gan;Mak
	(g) PERSIMMON	
616	Diospyros digyna	Gan (H) in pots
	M 26009	
	(h) MACADAMIA	
290,416	Macadamia 344	Rah;Gan
292	Macadamia 800	Rah;Gan
293, 417	Macadamia 660	Rah;Gan
294	Macadamia 778	Rah;Gan
534	Macadamia 508	Gan (H) in pots (Australia)
645	Macadamia	Gan (H) in pots (Australia)

(i) ANNONA sp.

344,349,532,631	Atemoya Pinks mamoth	Gan; Rah; Gan(H) in pots
345,348,497,531,632	Atemoya African Pride	Gan;Rah;Gan(H) in pots
633	Atemoya Palethrope Pride	Gan (H) in pots

(j) GRAPES

127,613	Julio Sanches	Gan (H) in pot
350	Muscat Hamburg	Van
351	Isabella	Rah

(k) PAPAW

Act No.	Variety	Stations
84,183	Higgins	Tin;MI
85	Wilder	Tin;MI
185,352	Sunrise	MI;Van
201,557	Solo Hawaii	Gan (other research stations for muliplication)
326	Red Thai Papaw	Gan
354,640	Waimanalo	Seed farms at Hingurakgoda and Polonnaruwa
480	Col	MI; Van
481	Co2	MI;Van
482	Co3	MI;Van
483	Co4	MI;Van
484	Oa x 01	MI
485	PGB x 83M2	MI
486	Mason Gold x 83M2	MI
487	OA x M2	MI
488	314 x 01	MI
489	Thai Red	MI

(i) LITCHI

96	Mauritus	Gan
97, 553	Hak Ip	Gan
98	Bengal	Gan
418,545,625	Tai Jso	Gan;Rah;Gan(H) in pot
419	Kwai May	Rah
604	Sweet Cliff	Gan (H) in pot
626	Wai Chee	Gan (H) in pots

(m) AVOCADO

* 586	Hass	Gan (H);Rah
* 328,619	Sharwil	Gan(H);Rah
* 331,620	Reed	Gan(H);Rah
* 333,587,622	Fuerte	Gan (H); Rah
334	Duke 6	Gan
* 588	Waldin	Gan(H)
* 590	Booth 8	Gan(H)
* 591	Brooks Late	Gan(H)
* 592	Lula	Gan (H)
* 593, 621	Pinkerton	Gan(H)
* 594	Tower II	Gan (H)
* 595	Peterson	Gan (H)
* 596	Simmonds	Gan (H)
* 597	Booth 7	Gan (H)
* 598	Monroe	Gan (H)
* 593, 599	Choquette	Gan (H)
* 613	Edranol	Gan (H); Rah
* 623	Sheppard	Gan (G)

(n) PINEAPPLE

179	UNK Hy 1	Gan;Mak
180,638	Smooth Cayenne	Gan;Mak;Gan (H)
181	UNK Hy 2	Gan; Mak

336	Clone 8	Gan;Mak
337	Clone 10	Gan;Mak
338	Clone 13	Gan;Mak
339	Clone 30	Gan;Mak
340	Mc Gregor	Gan;Mak
341	Alex	Gan;Mak
342	Queen	Gan;Mak
343	Riply Queen	Gan;Mak
642	Masmera H	Gan (H)
644	Sarawak	Gan (H)

(o) DURIAN

361	D-16	Gan

(p) RAMBUTAN

Act No.	Variety	Stations
366	R-168 Che Embong	Gan (Era)

(q) BANANA

525	William Hybrid	Gan; Gan(H); Mak

(r) STRAWBERRY

584	CRBS (Cruz)	Rah; Sita
585	SARBS (Senga Sengara)	Rah;Sita

* Grafted Plants

APPENDIX III

ALTITUDE RANGE FOR TREE FRUIT CROPS RECOMMENDED ALTITUDE WITHIN 12° OF THE EQUATOR

CROPS	* ALTITUDE RANGE IN WHICH CROPS WILL GROW (METRES)	UPPER LIMIT OBSERVED IN N.T.T. INDONESIA (METRES)	UPPER LIMIT OBSERVED SRI LANKA (METRES)	HARVEST SEASON SRI LANKA
Avocado	0 - 1,500	1,300	1,500	May-Aug; Dec-Jan
Pineapples	0 - 800	1,000	900	May-Jun; Feb
Carambola	0 - 500	-	1,400	Jan-Apr; May-Aug
Passionfruit (P. edulis)	100 plus	1,500	1,400	Sep-Nov
Bullocks Heart (Annona reticulata)	0 - 1,000	1,000	1,400	Jun-Sep
Pomegranate	0 - 1,000	1,000	500	Yr. round
Jambu air (S. aqueum)	0 - 1,000	1,100	1,400	May-Jan
Guava	0 - 1,000	1,200	1,400	Yr. round
Jambu bol (S. malaccensis)	0 - 1,000	1,100	-	-
Pummelo	0 - 600	1,100	500	May-Sep
Orange (C. sinensis)	0 - 1,000	1,200	1,500	Feb-Mar
Mandarin (C. reticulata)	0 - 1,000	1,000	1,500	Jun-Aug
Mandarin (Siam)	0 - 700			-
Durian	0 - 800	650	1,000	Jun-Aug
Ambarella	0 - 700	1,050	500	Aug-Nov
Persimmon	1,000 plus	-	1,500	-
Longan	300 - 900	1,100	200	Jul-Aug
Lychee	800 - 1,200	-	-	-
Mango	0 - 500	1,050	1,500	Jan-Feb; Jun-Jul
Mangosteen	0 - 800	350	1,000	Aug-Sep
Mulberry	1,000 plus	1,200	-	-
Jack fruit	0 - 1,000	1,200	1,400	Nov-Jan; Jun
Papaya	0 - 1,000	1,150	2,000	Yr. round
Banana	0 -1,000	1,200	2,000	Yr. round
Rambutan	0 - 600	650	900	Jul-Aug
Salak	0 - 500	600	-	-
Sugar Apple (A. quamosa)	0 - 800	1,050	900	Apr-Jun
Sapodilla	0 - 900(*)	-	900	Yr. round
Tamarillo	1,000 plus	1,400	-	-
Chempedak	0 - 1,000	600	-	-
Soursop	0 - 1,000	1,050	900	Mar-Sep
Apple	600 - 1,200	1,100	1,800	Jul-Aug; Dec-Jan
Loquat	800 plus(*)	1,200	1,500	Dec-Jan
Lime	0 - 600(*)	-	1,400	Feb-Sep
Coconut	0 - 1,000(*)	-	800	Yr. round
Cocoa	0 - 800(*)	-	-	-
Custard Apple	300 - 1200(*)	-	1,000	Jun-Jul
Duku/Langsat	0 - 800(*)	0 - 600	-	Aug-Sep
Nectarine (low chill)	800 plus(*)	1,200 plus	1,000 plus	Jul-Aug
Peach (low chill)	800 plus(*)	1,200 plus	1,000 plus	Jul-Aug

CROPS	* ALTITUDE RANGE IN WHICH CROPS WILL GROW (METRES)	UPPER LIMIT OBSERVED IN N.T.T. INDONESIA (METRES)	UPPER LIMIT OBSERVED SRI LANKA (METRES)	HARVEST SEASON SRI LANKA
Tamarind	0 - 800(*)	0 - 800	1,000	Feb-Mar
Macadamia	600 - 1200(*)	800 - 1,200	600	-
Cashew	0 - 800(*)	-	-	Apr-Jun
Oil Palm	0 - 800(*)	-	1,000	Yr. round
Nutmeg	0 - 800(*)	-	1,000 plus	-
Plum (low chill)	800 plus (*)	-	1,400	Jul-Aug
Grape	1,500(*)	0 - 100M	500	Apr-May; Aug-Sep
Passionfruit (Flavicarpa)	300(*)	0 - 500	200	Apr-May; Sep
Grapefruit	0 - 1,000(*)	-	200	Mar-Jun
Pear (European)	600 - 1200(*)	-	1,000 plus	Jul-Aug
Pear (Asian)	1,400(*)	-	1,500 plus	Jul-Aug

(*) - Based on observation in S-S.E Asian Region by Chapman one of the authors.

SOURCE : ANZDEC LTD. (1983) - AN INVESTIGATION INTO PRODUCTION AND MARKETING OF TROPICAL AND SUB-TROPICAL FRUITS IN NUSA TENGARA TIMUR. FINAL REP. UNDP/ IBRD AND REPUBLIC OF INDONESIA - PLUS ADDED INFORMATION BY PINTO (AUTHOR) FOR SRI LANKA & CHAPMAN (AUTHOR).

* Altitude range (Metres) is the range in which the crops as designated will grow. The range is not necessarily the best for commercial production of the crop and other factors are of importance in determining the best location eg. humidity, soil type, topography, wind, water supply, sunshine hours, rainfall etc.

For example good quality Guatemalan or Mexican cultivars of Avocado will not generally grow successfully, unless cool season temperatures of 10°C are experienced to stop growth and promote flowering. Also at flowering temperatures above 10°C at night and 20 - 30°C during the day promote good fruit set. Such conditions are not likely to be found at sea level within 12°C of the equator, but are more likely to be found above about 800 metres.

For Macadamia, maximum temperatures should usually not exceed 30 - 32°C for extended periods and wind-break protection is essential.

For mango, absence of rain at flowering reduces anthracnose on flowers and promotes fruit set with most cultivars. Equally well some mango cultivars prefer mild to cooler environments eg. Kensington, while others demand warmer environments eg. Nam Dok Mai and Carabao.
For pineapple where day maximum temperatures exceed 30-32°C flower induction may be difficult. In Sri Lanka areas around 600 - 700 m will be more suited to commercial pineapple production, where good flowering control is essential for continuity of fruit supply for processing.

For Durian, Rambutan and Mangosteen higher rainfall, higher humidity areas are required at altitudes shown. Thus altitude limitations are only a 'Rule of Thumb' guide that need, some intelligent interpretation, when specific crops are considered for commercial production.

APPENDIX VIII

LIST OF PRIVATE HORTICULTURAL PLANT NURSERYMEN REGISTERED FOR 1992 BY THE SEED CERTIFICATION SERVICE AND PLANT PROTECTION DIVISION OF THE DEPARTMENT OF AGRICULTURE IN SRI LANKA

REGISTRATION NO.	NAME AND ADDRESS
	PROVINCE : WESTERN
	COLOMBO DISTRICT
SCS\CMB\01	D.C. Wijethunge, Wijaya Plant Nursery, Poregedara Padukka.
SCS\CMB\02	A.A.K. erera, No. 18 Polwatta, Pannipitiya
SCS\CMB\04	A.S.M. Rodrigo, " Kanthi " Hokandara South, Hokandara
SCS\CMB\06	J.P.I. Piyadasa Imperial Watte, Kottawa Pannipitiya
SCS\CMB\07	G.D. Samarapala Mahavila Meeriyagolla Padukke
SCS\CMB\08	Nandani de Silva 65 Samanala 1st Lane Hindu Vidyala Mavatha Borupana Road Ratmalana

GAMPAHA DISTRICT

SCS\GQ\01	L.H.J. Jayasekara Agurubitchchiya Walgammulla
SCS\GQ\02	R.M.C.S. Ratnayaka Keenagahawatta Pingamuwa Kirindiwela
SCS\GQ\04	W.A. Somaratne Dhambutuwa Debahera
SCS\GQ\05	H.W. Karunaratne Thusara Eakambrawatte Gaspe, Baduragoda
SCS\GQ\09	N.S.A.D. Nanayakkara Palaturu Kade Baduragoda
SCS\GQ\10	P.S. Jayamaha Agrifeila Plant Nursery Galhitiyawa Ganemulla
SCS\GQ\11	P.B.S. Rathnasekere 'Rathnasiri' 286, Makola Road, Kiribathgoda Kelaniya
SCS\GQ\13	W.P. Siriratne 573/3 Nadungamuwa (W.P.)
SCS\GQ\14	W.A. Siripala 'Jayani' 210, Ihalagama, Gampaha
SCS\GQ\15	Hemalatha Seneviratne

105

1/80 Bonegala
Udathuththiripitiya

KALUTARA DISTRICT

SCS\KT\01	D.L. Vales Perera Adishtana Plant Nursery Aramanagolla, Horana
SCS\KT\02	D.J. Atukorala 41, Sithumina Malamulla West Panadura
SCS\KT\03	S. Siybalagoda Uthuru Uduwa Plkotuwa Kuda Uduwa, Horana
SCS\KT\04	D. Vinee Jayasinghe 'Vijitha Plant Nursery Ballnathuduwa Bandaragama
SCS\KT\05	S. Abeysinghe Korosduuwa watte (Polthawana asala) Piriyena Road, Pothupitiya Wadduwa
SCS\KT\06	G.A. Fernando 4th Mile Post Bombuwela Kalutara
SCS\KT\07	Chandra Sooriarachchi 'Sooriyamadura' Kotalawela, Bandragama

PROVINCE : SOUTHERN

GALLE DISTRICT

SCS\GL\03	R. Fubudukumara Deviya gahawela Karandeniya
SCS\GL\04	A.A. David Wattehena nursery Wattehena Banwelduwa Talgampola

MATARA DISTRICT

SCS\MH\1	D.M. Gamage 'Srinivasa' Sri Sumanatissa Mawatha Dakunu Navimana

HAMBANTOTA DISTRICT

SCS\HB\02	G.G.D. Samaranayake Amitha, Bowalana, Ruhunu Ridigama Ambalantota
SCS\HB\03	M.R. Casim & Company P O Box 1 Rathupasgodella Hambantota
SCS\HB\04	E. Gomas Near 212, Yahagela Bandagiriya Weligatta

PROVINCE : SABARAGAMUWA

KEGALLE DISTRICT

SCS\KE\01	H.D.M. Devasinghe Uthuvana Uthuvankande Mawanella
SCS\KE\02	S.M. Ranmenike Udagaladeniya Rambukkana
SCS\KE\04	S.M.T. Bandara 'Shanthi' Udagaldeniya Rambukkana
SCS\KE\05	H.A. Boyagoda 6, Kalugalla Mawatha Rambukkana
SCS\KE\06	K. Mahindadasa Kalwana Nursery Kalwana Aranayake
SCS\KE\07	W.D.S. Wickremesinghe 631/1 Sri Sunanda Mawatha Uthuwankande Mawanella

RATNAPURA DISTRICT

SCS\RN\1	B.R. Ranjith Siyambalapitiya Vandala Watte Plant Nursery Ruwanwella
SCS\RN\2	S.M.S. Dayaratne Kiramanakandura Bulpe, Balangoda Imbulpe

SCS\RN\3	U.G. Ubayasekere Buluwela Ranwela Godakewela

PROVINCE : CENTRAL

KANDY DISTRICT

SCS\KY\01	J.J. Jayalath C/o Post Office Barawardannoya
SCS\KY\02	S.A. Herath 99B, Fairland Gorakadeniya Road Peradeniya
SCS\KY\04	Nimal B Wegodapola Ranawana walawwa Kiribathkumbura
SCS\KY\05	K.M. Premadasa 584, Wathuwela Katugastota
SCS\KY\06	J.S.M. Jayasooriya 'Sooriyawasa' Danturai
SCS\KY\07	Agroconsultant Compnay Pvt. 56/42 2nd Rajasinghe Mawatha Kandy

MATALE DISTRICT

SCS\MT\01	R.G. Tikirimemike Rathninda Illukkumbura via Matale

SCS\MT\02	P.G. Bandaramenike Mahalakotuwa Ellagala Illukkumbura via Matale
SCS\MT\03	U.P.G. Kusumawathi Dambagahamula Galewela
SCS\MT\04	W.M. Mutubanda 1, School Lane Akuramboda via Matale
SCS\MT\05	H.M. Piyaratne Greenland Plant Nursery 29/7, 7th Mile Post Devahuwa

PROVINCE : UVA

BADULLA DISTRCIT

SCS\BD\01	W.G.S.K. Warawatte 'Gaminivasa' Keselwatte Megahakiula Badulla
SCS\BD\02	R.M. Siyathu 44, Dodamwagawa Uraniya, Badulla
SCS\BD\03	P.H. Gunapala de Silva 7, Jayabima Demodera Badulla
SCS\BD\04	W.M. Sunil Weerasekere Galendaru gaspathana S/Kabillewela

	Bandarwela
SCS\BD\05	D.M. Samarapala 'Sisila' Taldena Badulla
SCS\BD\06	R.M. Ranbanda 'Lilani' Imbulgoda Badulla
SCS\BD\07	H.L. Kulatunge Moragaswatte Koslanda
SCS\BD\08	D.M. Ariyadasa Kahataruppa Badulla
SCS\BD\09	Irangani Hapuhinna Rajagiri Badulla Road Annalawa Haliela
	MONERAGALA DISTRICT
SCS\MJ\01	B.A. Jayaratne Plant Nursery 10th Mile Post Madagama Moneragala
SCS\MJ\02	M.T. Ekanayake Wijaya Plant Nursery Siriwijayapura Moneragala
SCS\MJ\03	N.M. Goonawathi 'Ariyawila' Dutugemunu mawatha Moneragala

SCS\MJ\04	B. Siriwardena Maligathenna Badalkumbura Moneragala
SCS\MJ\05	S.M. Heenkumarihami Maligatenne Badalkumbura Moneragala
SCS\MJ\06	T.B. Meekotuwa Meeyann Oya mola Daliwa Road Dambagalla Moneragala
SCS\MJ\07	K.M. Ratnaweera Egodawatte Galabedda Moneragala
SCS\MJ\08	K.M. Ratnayake Egodawatte Galabedda MOneragala
SCS\MJ\09	G.A. Piyadasa Elapotha Galabedda Moneragala
SCS\MJ\10	H.R.M. Wijekoone Beraliyapola Galabedda Moneragala
SCS\MJ\11	Suba M. Herath Kolongolla Moneragala
SCS\MJ\12	M.M.P. Weerasekere Arawa Alimulla Okkampitiya

SCS\MJ\13	H.M. Wijeratne Herath Galabedda Moneragala
SCS\MJ\15	H.M. Kolitha Dharmasiri 'Ratna' Nursery Kabelleketiya Bibile
SCS\MJ\16	H.M. Janaki Kumari 20/3 Wegama Sawatsara Niwasa 3rd Mile Post Wegama Bibile

PROVINCE : NORTH CENTRAL

ANURADHAPURA DISTRICT

SCS\AD\01	D.G. Gunaratne Tharanga Plant Nursery Ghanakulama Anuradhapura
SCS\AD\03	G.B. Sugathapala 500, C Yaya Padaviparakramapura
SCS\AD\04	D.T.K. Koranelis 'Ruksara' 1 Padaviya
SCS\AD\05	D.M.P.B. Wijeratne Konaragama Manneruwa Negampha
SCS\AD\06	P.W. Goonatunge Yaya 2 Saliya Asokapura
SCS\AD\07	N.L. Sajith Jayawardena 'Jayanivasa'

Puttalam Road
Nochchiyagama

POLONNARUWA DISTRICT

SCS\PR\01

B.R. Anton Mendis
Deepthi Rajarata Plant
Nursery
Polonnaruwa Road
Jayanthipura

SCS\PR\02

I.M. Ubayawardena
Ubaya Plant Nursery
Palugasdamana
Polonnaruwa

PROVINCE : NORTH WESTERN

KURUNEGALA DISTRICT

SCS\KG\01

N.M. Kirimudiyanse
Sanasuma
Pathiniwatte
Lokaheetiya
Kurunegala

SCS/KG/02

P.L. Wijesingha Gorakagahakotuwawattha
Dambaliyagoda
Bamunakotuwa
Kurunegala

SCS/KG/03

P.S. Mahinda Patmasiri
3rd Lane
Udawalapola
Kurunegala

SCS/KG/04

B.M. Wijerathnabanda
Kandewaththa Plant Nursery
Galabodagama
Uhumiya
Kurunegala

SCS/KG/05	C.P. Thenakoon Kobiygane Kobiygane West
SCS/KG/06	H.M. Jayaratna Boraluwa Plant Nursery Kumbukgatte
SCS/KG/07	W.M. Herathbanda Weesingha Pahalapeddawa Paluwattha Mahanukalanyaya Kurunegala
SCS/KG/08	W.M. Aubadahami Sawashakthi Plant Nursery Unagolla Heelogala
SCS/KG/09	A.M. Sunil Jayantha Amarasooriya Jayadisena Plant Nursery Usgala, Siyambalangamuwa Rd. Megalewa.
SCS/KG/10	S.B.M.O.K. Jayasundara Disna Plant Nuesery Kudagalgamuwa Kurunegala
SCS/KG/12	T.S.N. Jayakody Deera Plant Nursery 161 Mahi - Ella Kurunegala
SCS/KG/13	S.M. Ariyapala Heangamuwa Kobiygane
SCS/KG/15	D.N.K. Dissanayaka Disapaya Kulipitiya Road Polgahawela

PROVINCE : NORTH EAST

PUTTLALM DISTRICT

SCS/PX/01	I.P.B. Ukkubanda Track 7, Dangaswewa Saliyawea Junction Rajangana.
SCS/PX/02	R.L. Thilakapala 117, Wilpatha, Chilaw
SCS/PX/03	K.J.A. Gunasingha Kshemaboomy Plant Nursery Mahakoonwewa Thabbowa Puttlam
SCS/PX/04	H.P.D Chandrwansa Suwashakthi Plant Nuesery Dummaladeniya Wennappuwa
SCS/PX/05	W.M.N. Priyantha Wijenayaka Kadiruppuwa Galmuruwa
SCS/PX/06	J.E. Wijepala "Sathuta" Nursery Haldanduwawa Dankotuwa
SCS/PX/07	A.M.A.P. Adikari Susana Mawatha Kudawewa
SCS/PX/08	628 A c/o Grama Niladhari Pallivasalthurai Puttalam

AMPARAI DISTRICT

SCS/APR/02	G.G. Nandasena 10/159 Veharagama Central Camp Amparai
SCS/APR/03	G.L.W. Dayananda Sub Post Office Kolamanthalawa Amparai
SCS/APR/04	A.G. Sirisena 22 C Nilali Plant Nursery Chadayanthalawa Amparai
SCS\APR\05	Y.M.G. Abeysinghe 8, Gamunupura Amparai
SCS\APR\06	M.A. Rani Pushpalatha 70/10 Veheragama Central Camp
SCS\APR\07	G.M. Sisira Jayatiss 'Sisira'Nursery C 26, Chadayanthalawa Amparai

BATTICALO DISTRICT

SCS\BC\01	Velayudam Thangadurai Thirikkudai Palugamam

APPENDIX IX

* **PLANT AND PLANT PRODUCTS OF WHICH THE IMPORTATION INTO SRI LANKA IS PROHIBITED.**

	Description Scientific Name	Common Name	From localities/ Countries
(A)			
01.	Any plant or plant material with soil		All
02.	Plants, Planting materials, plant products and seeds		Tropical America
03.	All aquatic plants		All
04.	Plants, planting materials and plant products of forest trees		All
(B)	**All plants and planting materials (including seeds) of the following:**		
05.	Alocasia (Schott.) G. Don	Taro	All
06.	Anacardium L.	Cashew	All
07.	Arachis L.	Ground nut	All
08.	Arotcarpus J.R & G. Forst	Breadfruit Jak	All
09.	Camellia L. (= Thea L.)	Tea	All
10.	Carica L.	Papaya	Angola, Cameroon, Egypt, Ivory Coast, Hawai, South Africa, Tanzania, Zaire, India, Sudan, West Indies and USA.
11.	Citrus L.	Lime, Lemon Orange, Citron, Grapefruit etc.	All
12.	Cocos L.	Coconut	All

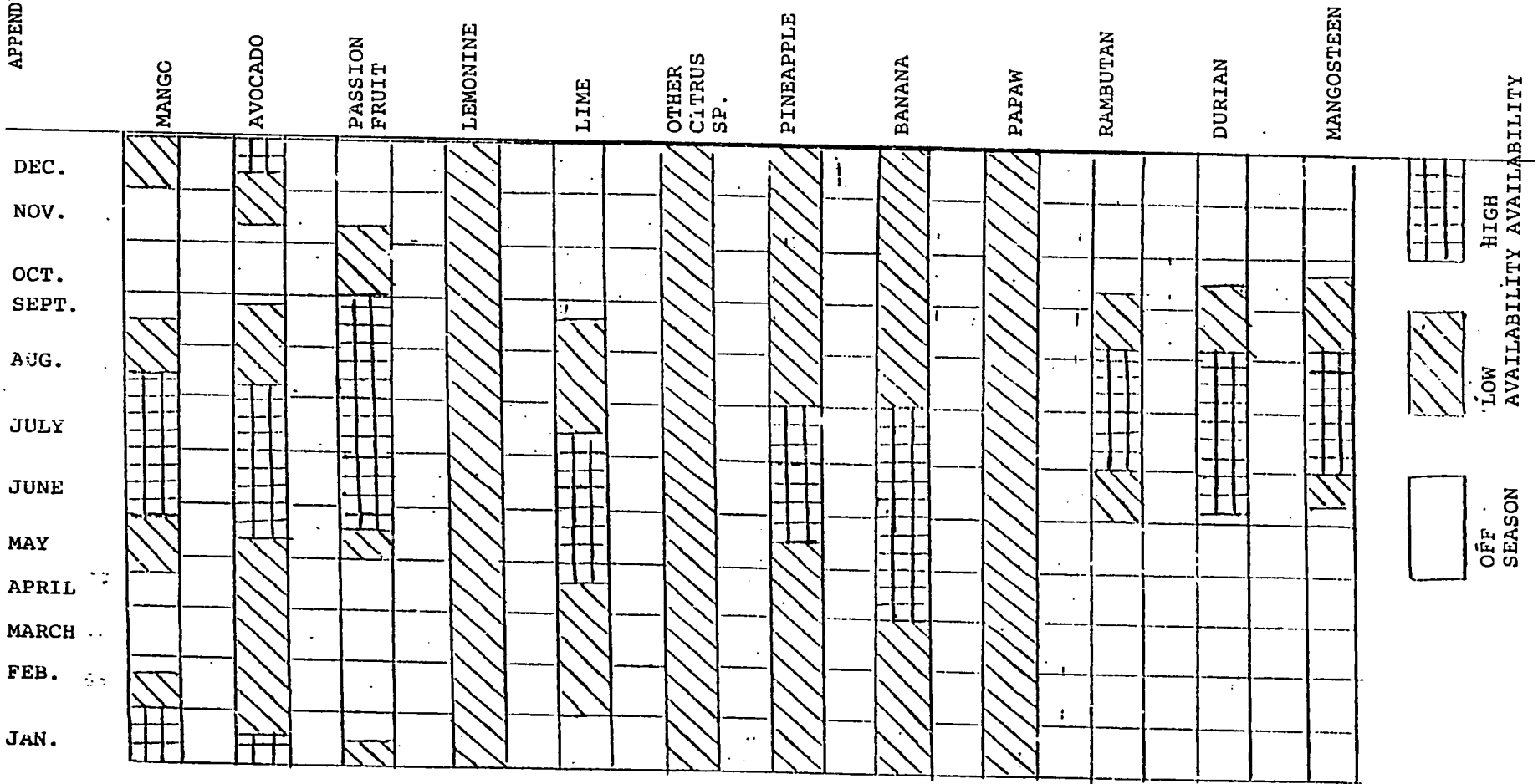
* Extract from DOA revised policy on import of seeds and planning materials to Sri Lanka (Annex 2).

13.	Coffea L.	Coffee	All
14.	Colocasia Schott.	Taro, Dasheen, Eddoes, Cocoyam	All
15.	Dioscorea L.	Yam	All
16.	Elaeis Jcq.	Oil palm	All
17.	Eugenia L. (=Syzygium Gaertn.)	Clove & others	All
18.	Glycine max (L.) Merr.	Soybean	All
19.	Gossypium L.	Cotton	Western Hemisphere
20.	Family Gramineae Juss.		All
21.	Helianthus L.	Sunflower	All
22.	Hevea Aubl.	Rubber Para rubber	All
23.	Homeria Vent.	Cape tulips	All
24.	Ipomoea L.	Sweet potato & others	All
25.	Manihot Mill.	Cassava, tapioca	All
26.	Family Myrtaceae Juss.	Eucalyptus, Guava, Clove etc.	All
27.	Nocotiana L.	Tobacco and others	All
28.	Oryza L.	Rice (paddy)	All
29.	Family Palmae Juss.	All palms	All
30.	Parthenium hysterophorus L.	Congress weed White top	All
31.	Rubus L.	Blackberry	All
32.	Saccharum L.	Sugarcane	All
33.	Spartina Schreb.	Rye grass	All

34.	Striga Lour.	Witchweed and others	All
35.	Syzygium Gaertn. (=Eugenia L.)	Clove & others	All
36.	Theobroma L.	Cacao	All
37.	Vigna sinensis Endl. (=Vigna unguiculata L.)	Cowpea & others	All
38.	Family Vitaceae Juss. (= Family Vitidacae Juss.)	Grapes & others	All
39.	Xanthosoma Schott.	Dasheen	All
(C)	**Vegetative planting materials of the following :**		
40.	Ananas Mill.	Pineapple	All
41.	Frangraria L.	Strawberry	All
42.	Mangifera L.	Mango	All
43.	Family Musacea Juss.	Abaca, banana Plantain etc.	All
44.	Piper nigrum L.	Pepper,	
45.	Family Rosaceae Juss.	Apples, Pears etc.	All

NB.

Seeds of Annona spp. are permitted if certified to be free of Cercospora spp, Elsinoe annonae,
Aecidum annonae & Phakopsora cherimoniae.



APPENDIX X

TABLE SHOWING TIME OF AVAILABILITY OF FRUITS IN SRI LANKA.

(Prepared by Mr. H.M.S. Heenkenda - Research Officer)

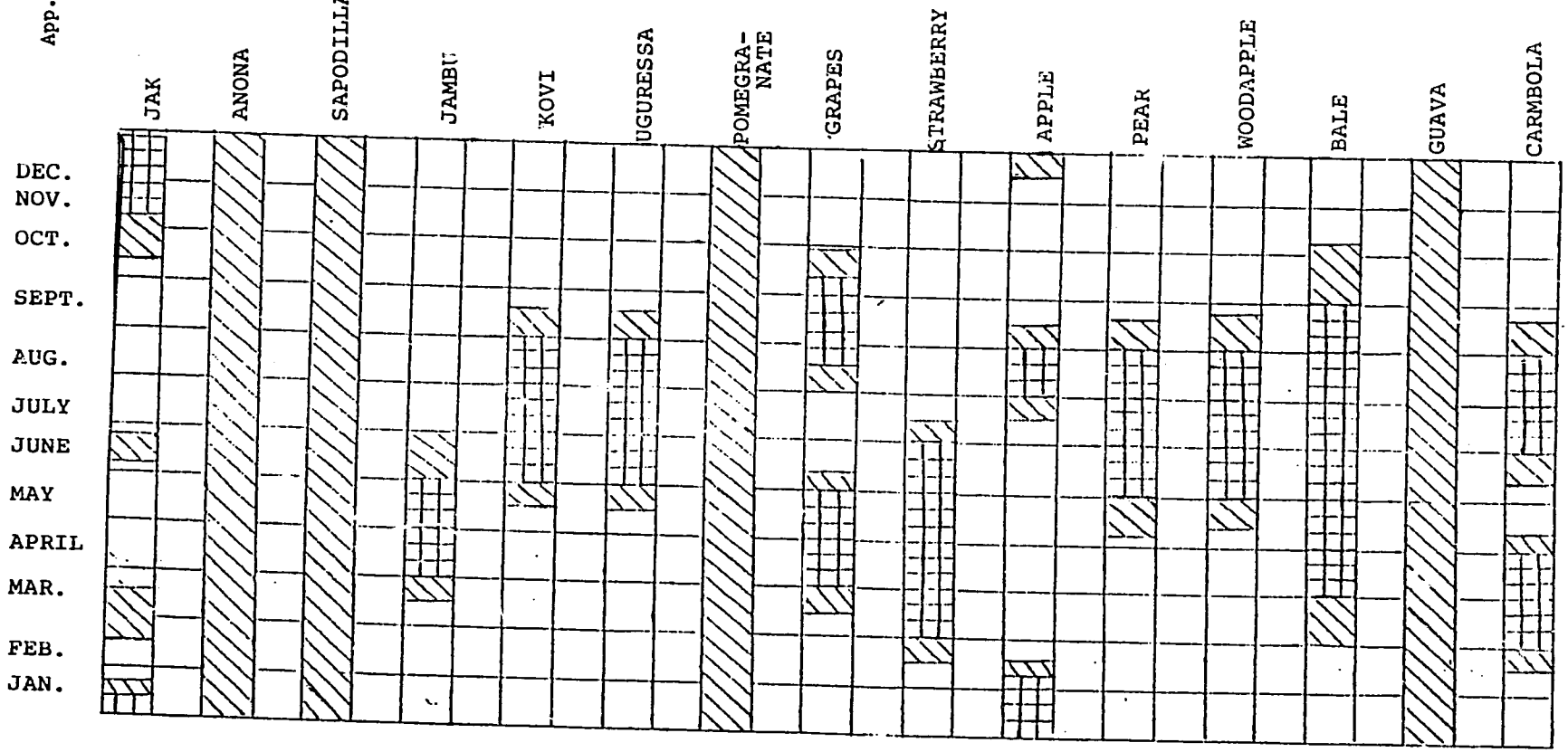


TABLE SHOWING TIME OF AVAILABILITY OF FRUITS IN SRI LANKA (Cont.)

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127

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APPENDIX XIV

DOA PROGRAMME FOR ESTABLISHMENT OF MOTHER TREE ORCHARDS JUNE 1992 (ENGLISH TRANSLATION)

My No. Go/4/1/1/
Office of DD Seeds and Planting Material
Dept. of Agriculture Peradeniya

23.06.92

A.D.A.A (Seeds and Planting Materials)
Farm Managers

Establishment of Mother Tree Orchards

It has been decided to establish mother tree orchards in the farms that have nurseries so as to produce high quality fruit plants.

Annexed is a list of trees to be establishes at each station based on the discussion ADA (Plant Material) Head Quarters had with you.

It is important to grow plants of the fruit crops decided upon which have been propagated from selected mother trees. Accordingly I am taking action to produce the plants from places where mother plants are available and I intend to make there available to you in October 1992.

You are instructed to start the basic work of land preparation in your farm for establishment of the mother tree orchards.

signed DDA (S&P)

AMBEPUSSA FARM

Budded Mango	Vellai Colomban	05
	Neelum	05
	Underground	05
	Peter passand	05
	Dampara	05
	Betti Amba	05
	Gira Amba	05
Orange	Bibile Sweet	10
Mandarin	Local	10
Rambutan	Malayan Red	05
	Malayan Yellow	05
	Malvana	10
Guava	Bankok Giant	10
	Safeeda	10
	Allahabad	10
Avocado	Pollock	05
Sapodilla		05
Durian		04
Mangosteen		06
Uguressa		02
Lovi		02
Jak	Father long	03
	Maharagama	03

KUNDASALE FARM

Budded Mango	Vellai Colomban	10
	Karutha Colomban	10
	Willard	05
	Peter Passand	05
	Dampara	05
Orange	Bilile Sweet	20
Mandarin	Local	10
	King	10
	Kinnow	10
	Clementine	10
Durian		10
Mangosteen		10
Ambarella		02
Pomegranate		10
Grapes		10
Lemonime		20
Sapodilla		05
Chinese Guava		10
Jak	Father long 10	
	Maharagama 10	

ALUTHARAMA FARM

Budded Mango	Karutha Colomban	20
	Vellai Colomban	10
	Willard	20
Orange	Bibile Sweet	20
	Seedless	20
	Liyangolla	20
Mandarin	Local	10
	King 10	

134

	Kinnow	10
	Clementine	10
Lime	Tahitti	20
	Local	20
Guava	Bangkok Giant	20
	Safeeda	20
	Allahabad	20
Pomegranate		20
Lemonime		40
Grapes		10

PELWEHERA FARM

Budded Mango	Karutha Colomban	30
	Vallai Colomban	10
	Willard	20
	Ambalavi	05
	Neelam	05
Orange	Bibile sweet	40
	Seedless	10
	Liyangolla	10
Mandarin	Local	10
	King	10
	Kinnow	10
	Clementine	10
Lime	Tahitti	50
	Local	50
Pomegranate		50
Lemonime		100
Jak	Father long	10

MAHA ILUPPALLAMA FARM

Budded Mango	Kartha Colomban	20
	Vellai Colomban	20
	Willard	20
	Ambalavi	10
Orange	Bibile Sweet	20
	Seedless	20
	Liyangolla	20
Mandarin	Local	10
	Clementine	10
Lime	Tahitti	20
	Local	20
Guava	Bankok Giant	10
	Safeeda	10
	Allahabad	10
Papaw		40
Pome granate		10
Lemomime		40
Grapes		20

BATA ATA FARM

Budded Mango	Kartha Colomban	50
	Vellai Colomban	20
	Willard	30
	Neelam	10

Orange	Bible Sweet	80
	Seedless	10
	Liyangolla	10
Mandarin	Local	20
	King	10
	Kinnow	10
Lime	Tahitti	20
	Local	50
Guava	Bankok Giant	10
	Safeeda	10
	Allahabad	10
Pomegranate		50
Lemonime		40

APPENDIX XV.

DOA PROGRAM FOR FRUIT PLANT PRODUCTION FOR MAHA 1992/93 (English Translation)

English Tanslation

My No.GO/4/1/1
Office of DDA
Seeds & Planting Materials
Dept. of Agriculture
Peradeniya.
04.10.1991

ADA (Seeds & Planting Materials)
Farm Manager
.....

Program for Fruit Plant Production for Maha 1992/93

The program giving the number of fruit plants to be produced in each farm for Maha 1992/93 as given in my letter of even number dated 12.06.91 is ammended and these amendments are given below.

These plants should be ready for issue in September - October 1992.

The stations from which budwood necessary to produce grafted plants, cuttings to produce rooted cutting, fruits to obtain seeds to produce seedlings have been denoted against each varreity so that action could be taken to obtain planting materials from the relevant institutions to enable higher quality planting materials to be issued.

Your should ini tiate the basic steps now itself to achieve the production targets allocated to your farm and if you are facing any problems or difficulties take action to inform me within a week.

Initiate early action to obtain budwood, cuttings and fruits for seed from the oraganizations mentioned. Action will be taken to notify the places from which the materials have to be collected in instances where it is not mentioned in the annexed list.

Please note that all plants produced in the units under you should be healthy, disease-free plants and should conform to the standards set out by the Seed Certification Service.

Sgd.

DOA (Seeds & Planting Materials)

Copies -
1. Secretary, Ministry of Agriculture Development and Research
2. Secretary, Ministry of Agriculture Production and Marketing
3. Director of Agricultre
4. D.D.A (Research)
5. D.D.A (Horticulture)
6. D.D.A (Seeds Certification Services)
7. Addl. D.D.A (Seeds & Planting Materials)

137

Agricultural Station Ambepussa

Crop	Variety/Cultivar	No. of Plants to be produced	Place from which budwood seed and cutting to be obtained
Mango (buded plants)	Vellai Colomban	5000	Horticulture Station, Walpita
	Peterpassand	1000	CARI, Gannoruwa
	Dampara	1000	Horticulture Station, Horana
	Nam Dok Mai	250	Horticulture Station, Walpita
	Betti	100	CARI, Gannoruwa
	Gira	100	CARI, Gannoruwa
Orange (budded)	Bible Sweet	1000	Horticulture Station, Walpita
Orange (seedlings)	Bible Sweet	1000	Horticulture Station, Ulpothagama
Lime (budded)		500	----
Lime (seedlings)		1000	----
Guava (budded)	Bangkok Giant	500	Horticulture Station, Ulpothagama
	Safeeda	250	Horticulture Station, Ulpothagama
	Allahabad	250	Horticulture Station, Ulpothagama
Avocado (budded)	Pollock	1500	Horticulture Station, Ulpothagama
Rambutan (budded)	Malayan Red	6000	Research Station, Eraminigolla
	Malayan Yellow	2000	
	Malwana	3000	Research Station, Eraminigolla
Jak (budded)	Father Long	250	Horticulture Station, Walpita
	Maharagama	250	Race Course Nursery, Peradeniya
Sapodilla (budded)		500	Horticulture Station, Horana
Durian (budded)		500	Horticulture Station, Horana
Jak (seedlings)	Father Long	500	Research Nursery, Peradeniya
	Maharagama	500	Research Nursery, Peradeniya
Sapodilla (seedlings)		500	Horticulture Farm, Gannoruwa
Guava (seedlings)	Safeeda	500	Horticulture Station, Walpita
	Allahabad	500	Horticulture Station, Walpita
Mangosteen		500	Horticulture Station, Horana
Durian (seedlings)		500	Horticulture Station, Horana
Uguressa		500	Horticulture Station, Horana
Lovi		500	Horticulture Station, Walpita
Passion-fruit		2000	--------
Billing		250	Horticulture Station, Walpita
Jambu		500	Horticulture Station, Walpita
Kathurumurunga		3000	---------
Papaw		250	---------
Lemonime (rooted cuttings)		8000	Horticulture Station, Walpita/ Research Station, Makandura
Tahitti Lime		1000	--------
Banana suckers	Ambul	2000	--------
Mangosteen (seedlings)		500	Horticulture Station, Gannoruwa
Durian (seedlings)		500	CARI, Gannoruwa
Kathurumurunga		2000	-------
Lemonime		500	Horticulture Station, Ulpothagama
Gotukola		2000	---------
Banana	Ambul	2000	---------
	Kolikuttu	1000	---------
Pomegranate(seedlings)		500	---------

Government Farm Rahangala

Crop	Variety/Cultivar	No. of Plants to be produced	Place from which budwood seed and cutting to be obtained
Orange (budded)	Bibile Sweet	1000	Horticulrue Station, Bibile/ Research Station, Rahangala
Mandarin (budded)	Clementine	1000	Research Station/Rahangala
Avocado (budded)	Rahangala variety	1000	Research Station/Rahangala
Pears (budded)	Japanese variety 1 Japanese variety 2 Japanese variety 3	500 250 250	Research Station/Rahangala Research Station/Rahangala Research Station/Rahangala
Passion-fruit	Rahangala	1000	Research Station/Rahangala
Peach (budded)		100	Research Station/Rahangala
Nectarine (budded)		100	Research Station/Rahangala
Apple (budded)	Rome Beauty Anna	100 100	Research Station/Rahangala Research Station/Rahangala
Amberalla (seedlings)		250	Research Station/Rahangala
Orange (seedlings)	Bibile Sweet	500	Research Station/Rahangala
Grapes (rooted cuttings)	Cardinal	1000	Research Station/Rahangala
Strawberry	Kendal	2000	Research Station/Rahangala
Lime (budded)	Tahitti	1000	Research Station/Rahangala
Guava (budded)	Safeeda Allahabad	250 250	Research Station/Rahangala Research Station/Rahangala

Government Farm, Pelwehera

Crop	Variety/Cultivar	No. of Plants to be produced	Place from which budwood seed and cutting to be obtained
Mango (budded)	Karutha Colomban Vellai Colomban Willard Ambalavi Neelum Underground	6000 1000 1000 500 500 1000	RRC, Maha Illuppallama RRC, Maha Illuppallama Government Farm, Pelwehera Government Farm, Pelwehera Horticulture Station, Walpita Horticulture Station, Cannoruwa
Orange (budded)	Bibile Sweet	1000	Horticulture Station, Ulpothagama
Mandarin	King	500	-----
Lime (budded) (larger)	Tahitti Tahitti	1000 200	----- ———
Guava (budded)	Allabahad	250	Government Farm, Kundasale
Orange (seedlings)	Bibile Sweet	5000	Horticulture Station, Ulpothagama
Lime (seedlings)		4000	Horticulture Station, Ulpothagama
Pomegranate (seedlings)		250	-----
Kathurumurunga (seedlings)		500	-----
Lemonium (rooted cuttings)		2000	RRC, Makandura

Maha Iluppallama Farm

Crop	Variety/Cultivar	No. of Plants to be produced	Place from which budwood seed and cutting to be obtained
Mango (budded)	Kartha Colomban	5000	RRC, Maha Illuppalama
	Vellai Colomban	2000	RRC, Maha Illuppalama
	Willard	5000	Agriculture Station, Maha Illuppallama
	Alphonso	1000	Race Course Nursery, Peradeniya
	Chembalan	500	Horticulture Station, Gannoruwa
Orange (budded)	Bibile Sweet	1000	Horticulture Station, Ulpathagama
Orange (budded)	Seedless	500	Horticulture Station, Bibile
Mandarin (budded)	King	500	RRC, Maha Illuppallama
	kinnow	100	RRC, Maha Illuppallama
Guava (budded)	Bangkok Giant	250	ARS, Girandurukotte
Guava (seedlings)	Safeeda	250	Government Farm, Kundasale
Kathurumurunga		500	-
Grapes (rooted cuttings)		1000	RRC, Maha Illuppallama
Pomegranate (rooted cuttings)		500	-
Pomegranate (seedlings)		500	-
Gotukola bush		2000	-
Banana	Ambul	1000	-
	Kolikuttu	1000	-
Lemonime (rooted cuttings)		2000	RRC, Makandura
Orange (seedlings)	Bibile Sweet	5000	Horticulture Station, Bibile
Lime (seedlings)		3000	-

140

Government Farm Hingurakgoda

Crop	Variety/Cultivar	No. of Plants to be produced	Place from which budwood seed and cutting to be obtained
Mango (budded)	Karutha Colomban	2000	Government Farm, Hingurakgoda
	Vellai Colomban	2000	Government Farm, Hingurakgoda
	Willard	500	Government Farm, Hingurakgoda
Orange (budded)	Bibile Sweet	1000	Horticulture Station, Bibile
Pomegranate (seedlings)		500	-
Pomegranate (rooted cuttings)		500	-
Banana	Ambul	1000	-
	Kolikuttu	1000	-

141

Galgamuwa Farm

Crop	Variety/Cultivar	No. of Plants to be produced	Place from which budwood seed and cutting to be obtained
Mango (budded)	Karutha Colomban	3000	RRC, Maha Illuppallama
	Vellai Colomban	5000	RRC, Maha Illuppallama
	Willard	1000	RRC, Maha Illuppallama
Guava (budded)	Bangkok Giant	500	-
	Allahabad	250	Horticulture Station, Walpita
	Sajeeda	500	Horticulture Station, Walpita
Orange (seedlings)	Bibile Sweet	5000	Horticulture Station, Ulpothagama
Lime (seedlings)		5000	Horticulture Station, Ulpothagama
Pomegranate (seedlings)		500	-

142

Alutharama Farm

Crop	Variety/Cultivar	No. of Plants to be produced	Place from which budwood seed and cutting to be obtained
Mango (budded)	Karutha Colomban	5000	Agriculture Station, Alutharama
	Vellai Colomban	3000	Agriculture Station, Alutharama
	Willard	4000	Agriculture Station, Alutharama
	Ambalavi	1000	Agriculture Station, Alutharama
	Underground	500	Horticulture Station, Gannoruwa
	Chembatan	250	Horticulture Station, Gannoruwa
Orange (budded)	Bibile Sweet	1000	Horticulture Station, Ulpothagama/Bibile
	Seedless	500	Horticulture Station, Bibile
	Liyangolla	500	Horticulture Station, Bibile
Mandarin (seedlings)	King	250	Horticulture Station, Bibile
	Kinnow	250	Horticulture Station, Bibile
	Bibile selection	250	Horticulture Station, Bibile
Lime (budded)	Tahitti	1000	Horticulture Station, Ulpothagama
Guava (budded)	Bangkok Giant	500	ARS, Girandurukotte
	Safeeda	500	Horticulture Station, Gannoruwa
Orange (seedlings)	Bibile Sweet	5000	Horticulture Station, Ulpothagama/Bibile
Lime (seedlings)		8000	Horticulture Station, Ulpothagama
Mandarin (seedlings)		2000	Horticulture Station, Ulpothagama/Bibile
Pomegranate (seedlings)		500	-
Lemonime (rooted cuttings)		1000	-
Banana	Ambul	2000	-
	Kolikuttu	2000	-
Jak (seedlings)	Maharagama	500	Race Course Nursery, Peradeniya
	Father Long	500	Race Course Nursery, Peradeniya
Kathurumurunga		500	-

143

Bataata Farm

Crop	Variety/Cultivar	No. of Plants to be produced	Place from which budwood seed and cutting to be obtained
Mango (budded)	Karutha Colomban	10000	-
	Vellai Colomban	5000	-
	Willard	3000	-
	Neelam	500	Horticulture Station, Walpita
	Alphonso	1000	Horticulture Station, Bibile
	Dampara	500	Horticulture Station, Gannoruwa
	Chembatan	250	Horticulture Station, Gannoruwa
Orange (budded)	Bibile Sweet	1000	Horticulture Station, Bibile
	Seedless	500	Horticulture Station, Bibile
	Liyangolla	250	Horticulture Station, Bibile
Mandarin (budded)	King	500	Horticulture Station, Bibile
Guava (budded)	Safeeda	500	Horticulture Station, Gannoruwa
Lime (budded)	Tahitti	1000	Horticulture Station, Bibile
Orange (seedlings)	Bibile Sweet	5000	Horticulture Station, Bibile (J.E.D.B
Lime (seedlings)		5000	Horticulture Station, Bibile
Pomegranate (seedlings)		250	-
Pomegranate (layers or rooted cuttings)		500	-
Lemonime (rooted cuttings)		1000	Horticulture Station, Bibile
Banana	Ambul	2000	-
	Kolikuttu	1000	-

Government Farm Middeniya

Crop	Variety/Cultivar	No. of Plants to be produced	Place from which budwood seed and cutting to be obtained
Mango (budded)	Karutha Colomban	10000	-
	Vellai Colomban	2000	-
	Willard	2000	-
Orange (budded)	Bibile Sweet	500	Horticulture Station, Bibile
	Seedless	500	Horticulture Station, Bibile
Mandarin (budded)	King	500	Horticulture station, Bibile
Lime (budded)	Tahitti	1000	Horticulture Station, Bibile
Orange (seedlings)	Bibile Sweet	5000	J.E.D.B., Bibile
Lime (seedlings)		5000	-
Banana	Ambul	2000	-
	Kolikuttu	1000	-

145

APPENDIX XVI

SUGGESTED TRAINING PROGRAM ON PROPAGATION OF PERENNIAL FRUIT CROPS AND NURSERY PRACTICES

A. NURSERY INFRASTRUCTURE

THEORY

I. Greenhouses
II. Types of shade cloth and their characteristics
III. Heating and misting systems for hot bed propagation of plants
IV. Automatic watering systems

B. NURSERY HYGIENE

THEORY & PRACTICAL

I. Factors
Propagation media
Plant source material
Personnel
Containers
Work area
Growing surfaces
Water
Growing on
Maintenance
Reuse of propagating mixtures
Weed control
Disposal of waste materials
Attention to potting on

II. Summary of approved hygiene practices and apparatus needed

C. NURSERY CROP PROTECTION

THEORY

I. Diseases in nurseries
II. Disease symptoms
III. Pests in nurseries
IV. Control of pests and diseases
V. Safety precautions for users

D. NURSERY MANAGEMENT

THEORY & PRACTICAL

I. A dozen things you should know about plants
II. Production system for nursery management
III. Identification system for recording nursery plant production and labelling of stock
IV. Potting mix ingredients

140

V. Physical properties of potting mixtures
VI. Chemical properties of potting medias
VII. Plant containers
VIII. Water management in nurseries and gardens
IX. An introduction to plant nutrition
X. Fertilizer use in nurseries
XI. Weed control in nurseries in Australia

E. PRINCIPALS IN PROPAGATION

THEORY & PRACTICAL

I. Scion selection and treatment
II. Seedling rootstock production
III. Propagation by grafting and budding
IV. Air layering
V. Propagation by cuttings

F. PROCEDURES FOR SUCCESSFUL IMPORTATION OF FRUIT AND NUT TREES

THEORY & PRACTICAL

Importation guidelines
Potting mixtures
Potting and watering
Defoliation and cutting back
Environmental control
Fertilizing
Plant protection
Rootstock and scion import
Propagation
Preparation of plant material in country of origin

G. PROPAGATION METHODS FOR TROPICAL FRUITS AND NUTS

THEORY & PRACTICAL

Important factors
Main grafting techniques
The crops - methods

H. PROPAGATION METHODS FOR SUBTROPICAL/TROPICAL FRUITS

THEORY & PRACTICAL

Avocado)
Citrus) Major emphasis
Mango)
Rambutan)

147

Durian)Emphasis where possible in the course)(Ambepussa)
Guava)

Hand-outs to be given on the above crops and others not included in the list above.

I. TOP-WORKING, INARCHING AND TREE PLANTING

THEORY & PRACTICAL

Top-working
Inarching
Planting and establishment of fruit and nut trees