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PLANT TISSUE CULTURE IN SRI LANKA

A Report on the Industry

by

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for the

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5B Department of Agriculture : Royal Botanical Gardens

6 Department of Export Agriculture

7 Rubber Research Institute

8 Coconut Research Institute

9 Ceylon Institute of Scientific and Industrial Research

10 A Faculty of Agriculture : Department of Crop Science

10 B Faculty of Agriculture : Department of Agricultural Biology

11 CTC Foliage Limited

12 Speciman Application for a permit to import plants/plant parts/plant products to Sri Lanka and Guidelines.

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SRI LANKA

24 February 1991

Mr Robert C Flick,
Chief-of-Party,
ACDI/CSFD Project,
3 McLeod Road,
Colombo 4.

Dear Mr. Flick,

Plant Tissue Culture in Sri Lanka - A Report On The Industry

I am pleased to present the final report on a study of tissue culture facilities and practices in Sri Lanka and the potential for introducing new and improved varieties of planting materials, in accordance with our agreement of December 30, 1990.

I have made every endeavour to conform to the terms of reference prescribed by you in the draft terms of reference dated December 18, 1990 and amplified in my proposal to you dated December 27, 1990.

Following submission of the draft technical report and our discussion on the 13th instant I have incorporated the suggestions in your letter of February 13, 1991 and specifically expanded on the recommendations included in Chapter 5.

I strongly recommend that the CSFD Project should work on two parllel lines of development for the supply of planting material. For the project to take off the ground as early as possible, locally available elite planting material from certified sources will be screened, multipled by conventional vegetative propagation methods at the nucleus farm and distributed to the small farms. Simultaneously, a tissue culture programme will commence using local (and possibly imported) high quality material, plants raised to field planting stage in the CSFD nurseries and screened in small scale experimental plots of the project nucleus farm as well as some commercial small farms. These plots would serve as screening points for possible genetic mutations and also serve as demonstration plots or fertiliser trial plots. Successful TC multiplication without mutants (or at least a reasonably low percentage) will thus enable the building up of a high yielding stock for conventional multiplication practice subsequently and project follow through.

I appreciate the confidence you have placed in me and wish to assure you of my continued interest in the furtherance of the ACDI/CSFD Project.

Yours sincerely,

Reginald S John, B.Sc.Agric.(Ceylon); Ph.D.(Aberdeen)

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Thanks are also due to the many officers of the CISIR, Coconut Research Institute, Sugarcane Research Institute, Department of Agriculture and Department of Export Agriculture and also lecturers of the Faculty of Agriculture, University of Peradeniya, for granting personal interviews at which matters relating to plant tissue culture and future prospects for the industry were discussed.

We wish to record our thanks to Dr. Jinasiri Fernando, Additional Deputy Director Research and Mr. R.S.Y.de Silva, Chief Plant Quarantine Officer, both of the Department of Agriculture, for information on plant material imports and plant quarantine procedure.

A special word of thanks is due to Mr. S.B.Rajakaruna, Head of the Research Division, CTC Foliage Ltd., for the discussions we had on the activities of CTC Foliage, commercial TC production and lines for development.

PRINCIPAL ABBREVIATIONS

ACDI	Agricultural Cooperative Development International
CARI	Central Agricultural Research Institute
CISIR	Ceylon Institute for Scientific and Industrial Research
CRI	Coconut Research Institute
CSFD	Commercial Small Farm Development
CTC	Ceylon Tobacco Company
CTC/FL	CTC Foliage Ltd.
DA	Department of Agriculture
DEA	Department of Export Agriculture
EAC	Export Agriculture Crops
EDB	Export Development Board
EIED	Employment, Investment & Enterprise Development
F & V	Fruit & Vegetable
HD	Horticultural Division
HRD	Horticultural Research Division
MADR	Ministry of Agricultural Development & Research
MASL	Mahaweli Authority of Sri Lanka
MPI	Ministry of Plantation Industries
RBG	Royal Botanical Gardens
RRI	Rubber Research Institute
TC	Tissue Culture
VP	Vegetative Propagation (conventional)

CHAPTER ONE

INTRODUCTION AND BACKGROUND

INTRODUCTION

1.1 Sri Lanka has witnessed during the last decade a shift in emphasis towards increasing production in the export oriented agricultural sub-sectors other than the tea, rubber and coconut plantation sub-sector. This is evident from the availability of state land on lease for commercial agriculture, crop diversification programmes, the granting of subsidies/credit, development of Export Promotion Villages and the establishment by entrepreneurs of medium scale commercial farms - many of them on the "nucleus farm peripheral outgrower" concept.

1.2 The potential exists for small farmer participation through linkage with large commercial farms and/or exporters. However, since most small farmers lack access to credit facilities, a knowledge of advanced agronomic practices and material inputs, production levels are low with little marketable surplus.

1.3 Recognising the scope for increasing small farmer incomes through commercial agriculture and thereby contributing to an increase in production of non-traditional agricultural exports, Agricultural Cooperative Development International (ACDI) is to commence a Commercial Small Farm Development (CSDF) Project which would *inter alia* provide training, make available agricultural inputs and provide extension and marketing services.

1.4 Since one component of the CSFD Project is to make available elite planting material, plant tissue culture (TC) techniques may provide a ready means for rapid multiplication of selected parent stock. This study has threfore been undertaken in

order to document the status of TC in Sri Lanka with respect to facilities, practices and potential and also determine the prospects for commercial production of TC plants.

General Background

1.5 Sri Lanka has made significant progress since the early 1980s in diversifying and increasing production in the export oriented agricultural sub-sectors excluding the traditional tea, rubber and coconut sub-sector. The crop categories include the 'Export Agriculture Crops' (EACs) formerly referred to as minor export crops (cocoa, coffee and spices), fruit and vegetable (F & V) and exotic foliage and flowering plants.

1.6 State efforts in this direction include inter alia:

.1 the leasing of uneconomic lands under plantation crops (tea and rubber) for crop diversification and promoting inter-cultivation under coconut or rubber;

.2 the leasing of land to entrepreneurs in System B, C, and H of the Mahaweli Project and Uda Walawe Special Area by the Employment, Investment & Enterprise Development Division (EIED) of the Mahaweli Authority of Sri Lanka (MASL) for commercial agriculture;

.3 the establishment of Export Promotion Villages under sponsorship by the Export Development Board (EDB);

.4 the provision of subsidies and credit facilities under the ADB assisted Perennial Crop Development Project (PERCRODEP) for the cultivation of EACs and fruit in the Matale, Kandy, Kegalle, Badulla and Moneragala Districts.

1.7 Performance analysis relating to exports for the period 1979 - 1989 shows that the export of F & V in terms of volume and value increased most significantly in comparison to EACs and foliage

and flowering plants. Data presented in Annexe 1 shows an almost ten fold increase in exports of fresh and processed F & V from Rs. 29.1 Mn. in 1979 to Rs. 278.2 Mn. in 1989. In comparing fresh and processed produce the former showed a 27 - fold increase reaching about Rs. 138 Mn. in 1989 while processed material recorded a 6-fold increase to Rs. 140 Mn.

Market Potential

1.8 The export of F & V which has been the subject of many seminars and studies, notably those of SRD Groups for the EIED of MASL (Refs. 1 to 6), clearly indicates scope for expansion especially to the Middle East, selected W. European markets, Japan, Singapore and Hong Kong. However, in order to reach these markets some major constraints in production must be addressed, e.g. the non-availability of elite planting material in sufficient quantities to produce export grade products and the high cost of production compared to other South and S.E.Asian exporting countries.

1.9 The fresh F & V varieties in demand has been well documented (Ref. 7 & 8) and an indicative export value distribution in 1989 of these are given in Annexe 2. The item "vegetable other" accounting for nearly 95% of exports comprises a mix of low country vegetable mainly cucurbits, leafy vegetables, green chillies, capsicum peppers, beans with some 'exotics' like cabbage, cauliflower, leeks, kohlrabi etc. The category "fruit other" comprising mainly mango, mangosteen, papaya, and rambuttan accounts for about 58% and pineapple about 38% of total fruit export.

1.10 The untapped potential for exports of banana, papaya, mango, avocado and under-exploited market for pineapple (fresh and processed) is mainly attributed to the non-availability of adequate quantities of the desired variety of export grades and also the relatively high costs which in turn can be traced to the cultivation of genetically non-uniform material under poor cultural practices.

Small Farmer Participation

1.11 With the exception of a few commercial enterprises operating on the "nucleus farm - peripheral outgrower" concept, most exporters of F & V depend on the produce from smallholdings and home gardens brought in by collectors or agents (middlemen). The majority of small farmers, especially in the low and mid-country are not commercially oriented for an export market and thus a highly heterogenous volume is collected for futher selection and grading to cater to a fastidious export market. The concommittant result of low level on - farm technology, post harvest losses and operating marketing mechanics inevitably results in low prices to farmers and high prices paid by exporters and processors for export quality commodities.

1.12 The field extension services and supplies of plant material provided by Department of Export Agriculture (DEA) for EACs as well as and services (extension, agricultural inputs and credit facilities) to outgrowers/contract growers by entrepreneurs operating nucleus farms (foliage and F & V cultivation) are largely lacking in the broader sphere of other new export crops like F & V. Thus, there is much scope for small farmer development through technology transfer, supply and marketing organizations in order that this group could make a significant impact on efforts to increase non-traditional agricultural exports.

CSFD Project

1.13 With this backdrop and being mindful of state policy favouring 'small producer partnership in big investor enterprises', ACDI is to embark on a CSFD project with the primary objective of improving incomes of small farmers and increasing Sri Lanka's non-traditional farm exports through technology transfer, input supply and marketing activity. The strategy envisaged is based on the establishment of nucleus demonstration farms and nurseries, initially in the coconut triangle and thereafter expanded to include the mid-and up-country, which would eventually be farmer owned businesses serving as activity centres for field extension, supply and marketing services.

1.14 Within the ambit of the main CSFD project objectives is a component to make available high quality, disease free planting material of crop varieties in demand and which would ensure uniformity of product and therefore command high prices. In view of the fact that some of the crops are not propagated by seed but by vetgetative propagation (VP) methods e.g. pineapple, banana, strawberry, vanilla etc.) or that some may need to be propageted by methods other than seed (e.g. papaya) and also that large quantities are required for high planting density crops, the application of plant tissue culture (TC) techniques may be a means of meeting these requirements in the shortest time.

1.15 The objectives of this study are inter alia to document the status quo of TC in Sri Lanka with respect to facilities, practices and potential with a view to exploring the possibilities of commercial production of planting material of candidate crops of the CSFD project. In undertaking this study, the methodology adopted was based on information retrieval from published sources, a survey of institutions with TC facilities through mailed questionnaire (see Annexe 3) and personal interviews with persons engaged in TC work.

CHAPTER

TWO

PLANT TISSUE CULTURE

General

2.1 Conventional plant propagation techniques in agriculture uses seed material or vegetative plant parts such as stem cuttings or slips, ratoons or suckers and underground tubers, rhizomes, corms and bulbs. The introduction of TC techniques for mass propagation of planting material during the last two decades has provided a fast and dependable method of VP whereby a large quantity of uniform plantlets could be produced in a short time throughout the year from desirable parent stock.

2.2 Basically TC is the cultivation or growth in vitro of live plant parts, tissues or cells (technically referred to as explant) in an artificial nutrient medium under sterile conditions, inducing differentiation and multiplication into many plantlets which are then conditioned for planting in the open. The procedural pathways may vary with species, explant and media but in general for clonal multiplication, the shortest possible protocol is desirable. With some species propagated under devious paths and being subject to "drastic" treatment in order to induce differentiation and multiplication, genetic mutations may occur resulting in non-uniformity of material for commerce. This characteristic is however used to advantage in some breeding programmes.

2.3 Some of the advantages of TC are briefly:

- Tree or plant requirement especially of high density orchards being high, the cost of planting material

obtained by conventional VP techniques could be a limiting factor and this cost could be increased further as some planting cycles last 3 to 10 years. TC has the potential to produce high quality trees relatively inexpensively and also throughout the year.

- Uniformity of material is achieved to a greater extent compared to conventional VP material obtained from diverse sources.

- There is an elimination of stock-scion interaction of bud-grafted plants.

- Indexing of plants during mass propagation by TC gives material free of known latent viruses.

- Mutation breeding using chemical mutagens incorporated in the culture media enables the development of new cultivars or lines.

Development Stages in TC Propagation

2.4 The concepts of 'developmental stages' described by Murashige (Ref.9) broadly sets out the steps involved in TC propagation. The stages are:

Stage 1 : Explanting or the establishment of live and growing plant material in *in vitro* culture.

Stage 2 : Multiplication of the propagule culture.

Stage 3 : Establishment of rooted plants and hardening them off to survive planting into soil.

Stage 4 : Planting into soil and special treatment required for initiating rapid growth and development.

2.5 In stage 1 the choice of explant is a critical factor and is determined chiefly by the ease with which it could be proliferated into plantlets with the least degree of mutation. Material generally used includes meristem from shoot apex usually 0.1 to 1.0 mm (meristem culture), long softwood shoot tips 2 to 5 cm long, axillary buds, etiolated shoots from root cuttings (eg. raspberry), leaf tissue, and as a final source, tissue from seedlings or immature embryo. The latter sources have the disadvantage that genetic make up and performance of adult progeny is uncertain (eg. numtmeg, coconut).

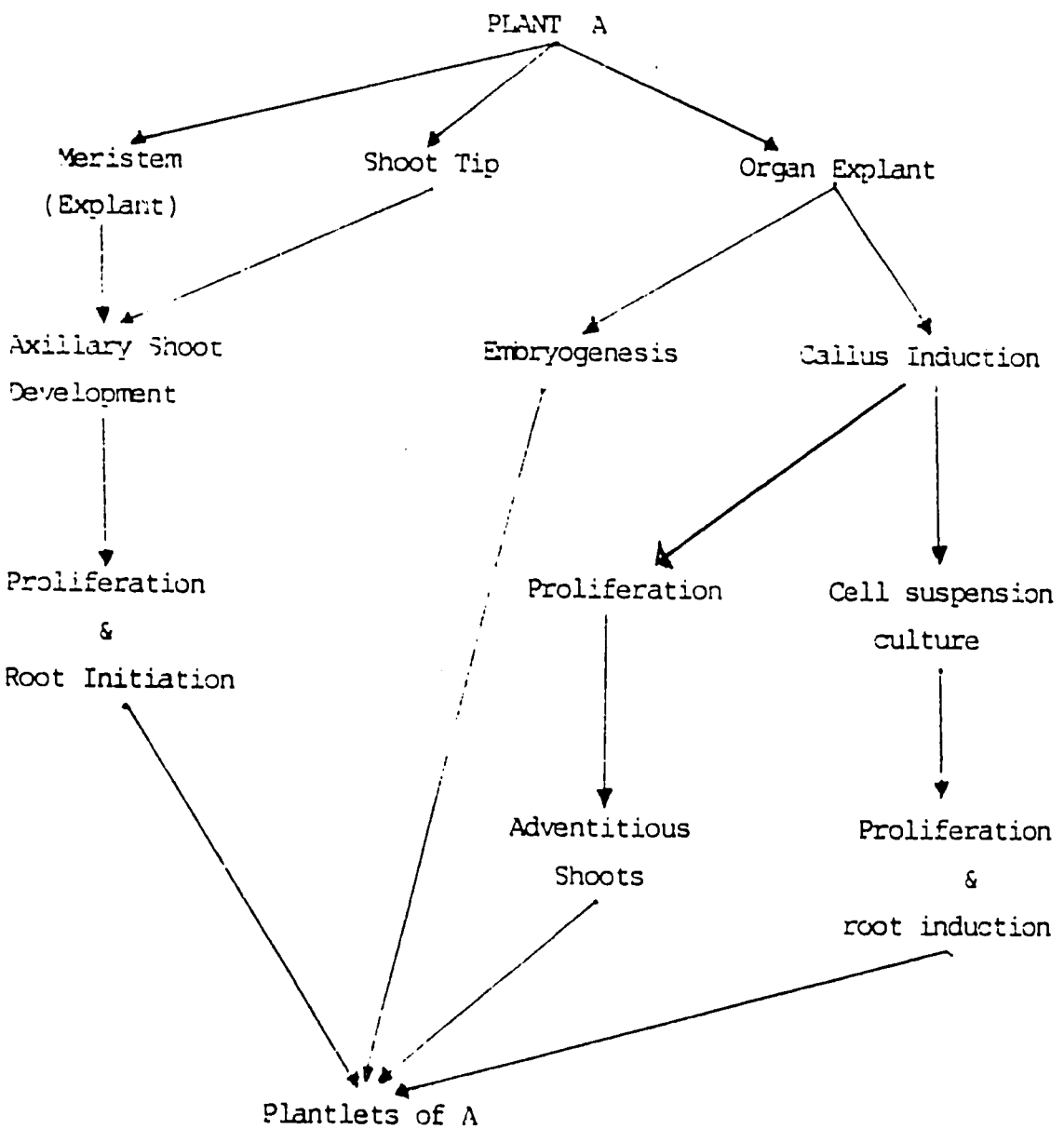
2.6 Areas of concern in stage 1 include: the need for attaining cultures free of contamination (generally difficult in underground plant parts as in banana and ginger TC) and the choice of culture medium (generally specific for some species or explant and composed of nutrients as inorganic salts and organic compounds such as sugars, amino acids etc., other organic factors like Vitamins and also growth hormones).

2.7 Stage 2 is important because proliferation rate is the major economic criterion for successful commercial TC and the primary objective is therefore to obtain the maximum number of useful propagule units in each sub-culture incubation. A common technique of propagule multiplication is through axillary and adventitious bud development (see para 2.10) but this pathway nets the lowest multiplication rate. Somatic embryogenesis (para 2.10) has great multiplication potential but this pathway could, in the case of some species, give rise to mutations with undesireable plant characters. Further, it is at this stage that the use of appropriate growth regulators like cytokinins and auxins is critical in that they have a major control of organogenesis or development of plant organs and thereafter production of uniform propagules.

2.8 The major objectives during stage 3 are to condition and develop the propagules from stage 2 in order to survive stress when transfering to soil. It is at this stage that root initiation is induced, plants are hardened and plant size increased.

2.9 Stage 4 involves the acclimatization of TC plantlets in soil grown in culture cabinets and under white fluorescent light prior to tranference to a greenhouse. Greenhouse plants are further conditioned thereafter and brought up to field planting stage. Plant mortality is a critical factor at this stage for commercial application of TC.

2.10 Within the broad outline of developmental stages are pathways of protocol which depends largely on crop species, explant used and the degree of multiplication desired. These pathways are schematically summarised as follows:



2.11 Ilustrative schematic outlines of some pathways of propagation such as via the formation of an initial undifferentiated mass of cells (Callus) are presented in Fig. 1 (path A & B). Commercial TC propagation (eg. strawberries) from meristem tips is schematically shown in Fig. 2. The process of explanting upto rooting is depicted as stage 1 inset "meristem culture". Batch samples are rooted and indexed (stage 2 a) for latent viruses for batch certification while parallel proliferation (2 b) continues. The rooted plants are hardened under greenhouse conditions (stage 4) prior to field planting. This stage is of utmost importance as mortality rates in the field is a critical factor especially for TC raised plants. It is important to note that in all these procedures the sub-culturing stage for mass propagation or multiplication could theoretically go on indefinitely but as far as possible is avoided after 3 or 4 sub culturings not only to avoid loss of vigour but also reduce the likelihood of inducing mutations which would result in genetically non-uniform plantlets.

Equipment and Infrastructure

2.12 All culture media, instruments and culture vessels (glass 25 ml. Erlenmeyer flasks, test-tubes, screw cap bottles or petri-dishes) are sterilized in an autoclave under steam pressure (103 x 10 Pa) at 120 C for 15 mins or by dry heat in an oven at 150 C for 2 to 3 hours. Explant is thoroughly disinfected by washing plant parts in soap and water and alcohol and after separation, using a disinfectant such as sodium hypochlorite.

2.13 Since all operations must be carried out under aseptic conditions in order to reduce external contamination the culture room for inoculation and sub-culturing is equipped with laminar air flow cabinets. The growth room is provided with shelving for culture containers and adequate lighting arrangement. Temperature control in this room (air conditioned) is of importance while air turbulence must be avoided to prevent contamination.

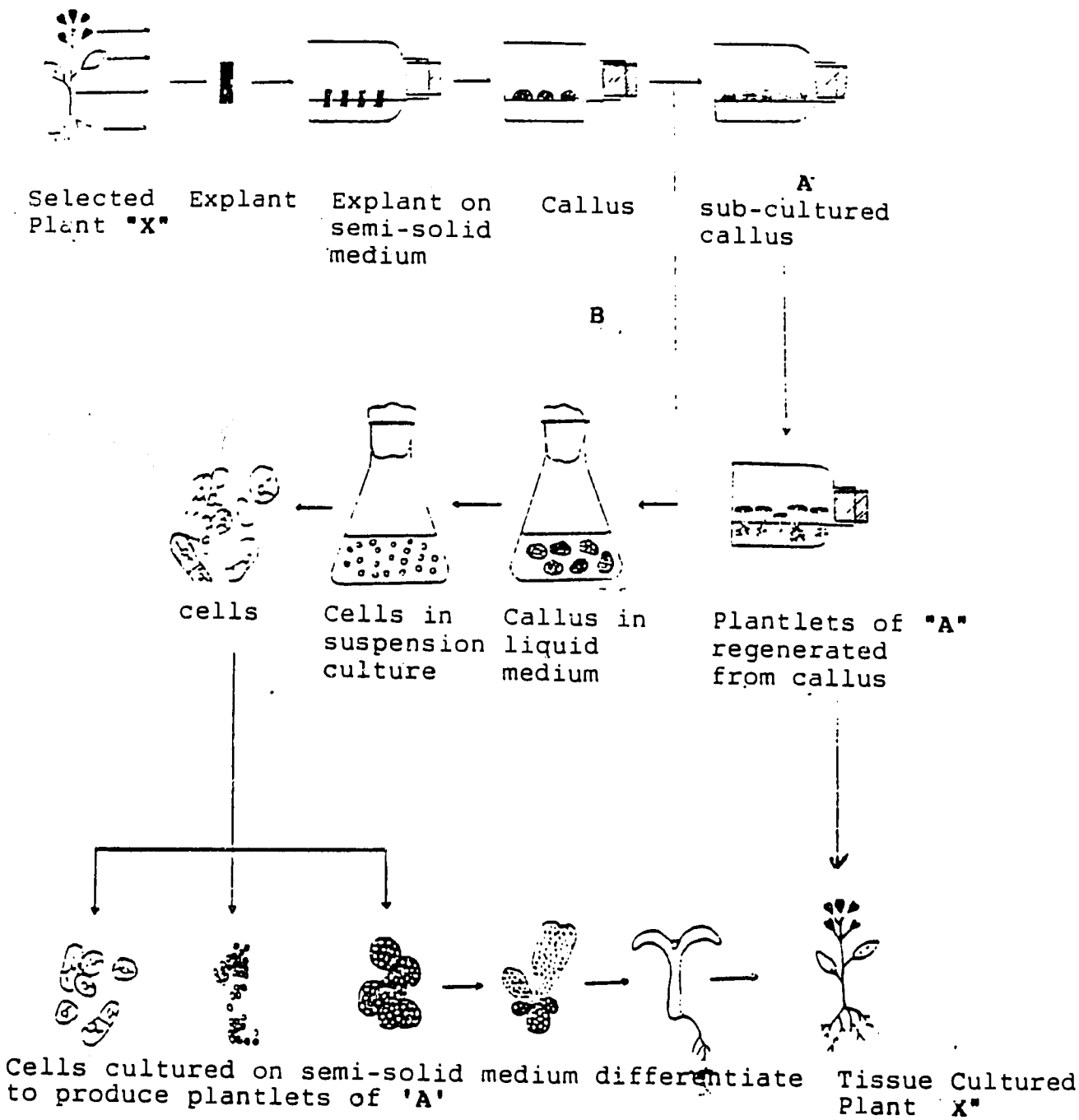


Fig. 1 : Schematic outline of vegetative propagation by tissue culture via Callus **(A)** and Cell suspension **(B)** cultures.

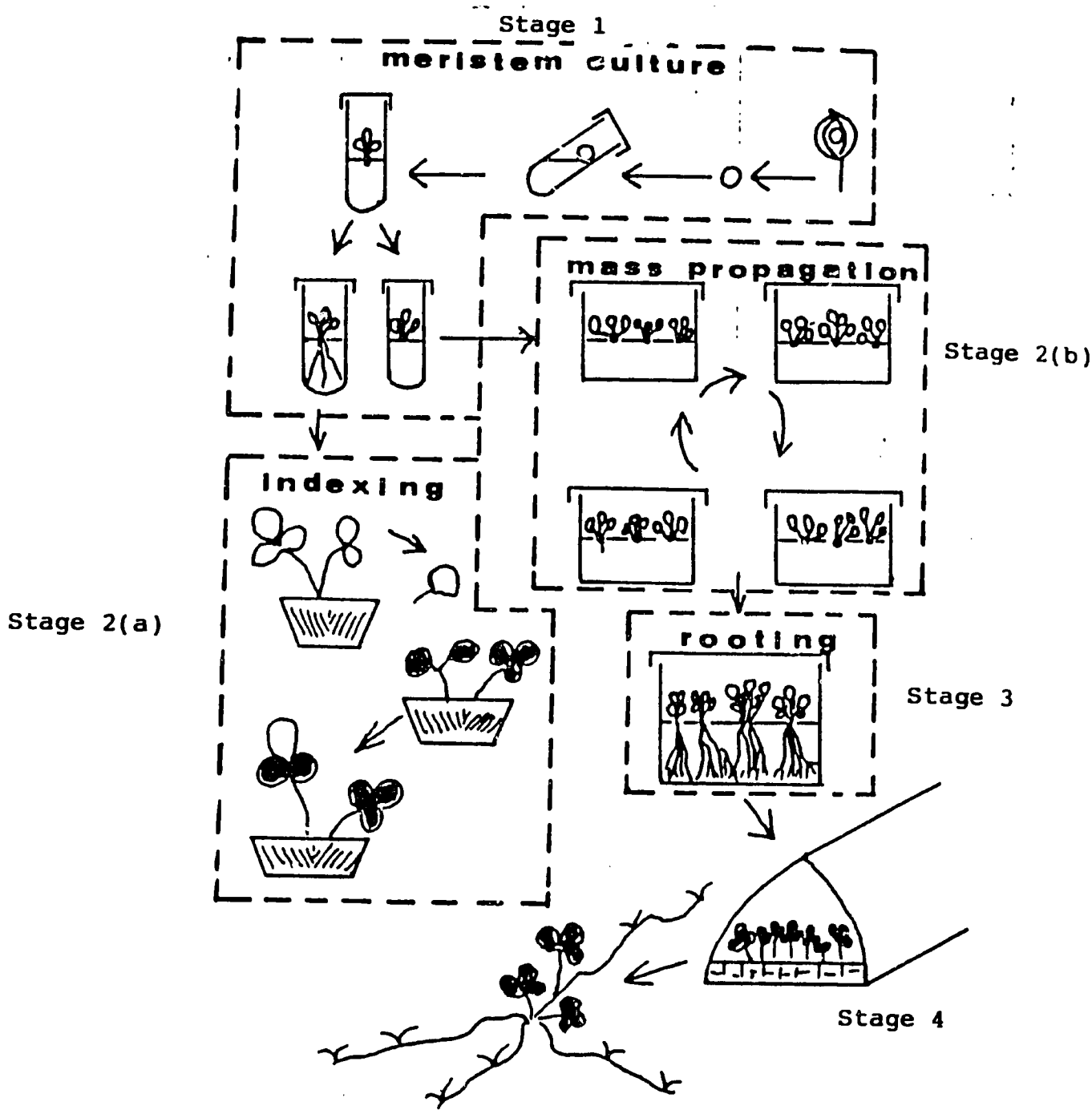


Figure 2. Schematic outline of Stages involved in large-scale TC propagation: eg. strawberries from meristem-tips.

Stage 1 : Explanting. Stage 2(a) indexing for disease. Stage 2(b) : Propagule multiplication. Stage 3 : Root initiation and hardening for transfer to soil. Stage 4 : Acclimatization of plantlets in soil.

2.14 Subsequent to transfer of plantlets into sterilized soil/sand mixture they may be conditioned in another growth room under fluorescent light and thereafter transferred to a greenhouse for further hardening. Some plant species eg. pineapple, banana may be transferred to nursery beds in the open to raise them to a stage where they could withstand the rigour of field planting and thus reduce casualty rates.

Industrial Production

2.15 The commercial production of TC plants has made rapid headway since the mid 1970s especially in developed countries and presently large numbers of crop plants like strawberries, rootstocks for apples, peaches, plums, cherries, orchids, foliage plants etc. are produced *in vitro* to cater to the needs of commercial agriculture.

2.16 Explants used in commercial production are those which have proven successful. Techniques used have also been perfected through research for high proliferation rates and with a low percentage of variants. These include:

- Strawberry : meristem with 2 - 4 leaf primordia or multiple shoots.
- Pineapple : axillary buds from ratoons
- Banana : apical meristem from sword suckers and "eyes" from underground rhizomes.
- Papaya : via callus from petiole and shoot apex.
- Passion Fruit : meristem and seedling culture
- Orchids : meristem and seedling culture
- Anthurium : leaf cutting and embryo culture via callus.
- Brazil nut : embryo culture

2.17 The lead time required for a TC plant from the mass propagation (or sub-culturing stages 2 (b) and 3) as shown in Fig. 2 varies, depending on species and survival capacity under field planting. Generally plants are ready for hardening under greenhouse conditions in about 6 to 8 months. An additional period of 3 to 4 months is required before they are ready for field planting.

2.18 Although an industrial in vitro culture laboratory has facilities needed for research, the investment required to develop a new process to the point of commercial production is considerable. Research findings are published in extenso in scientific publications but it is imperative that there should be close collaboration between the industrial laboratory and research institues.

CHAPTER THREE

TC IN SRI LANKA

Background

3.1 The beginnings of plant TC in Sri Lanka could be traced back to the early 1970s following the return of researchers trained in this relatively new field. Research was mainly confined to developing TC plant propagation techniques for crops specific to the crop research institutes. Much headway was not made until the early 1980s as facilities were meagre and applied TC for plant propagation of many crops was in its infancy.

3.2 In the early 1980s most crop specific research institutes, the Central Agricultural Research Institute (CARI) of the Department of Agriculture (DA), the Department of Export Agriculture and the Faculty of Agriculture of the University of Peradeniya were equipped with TC facilities provided largely by donor funds and extensive research was undertaken. It was about this period that the first commercial tissue culture organization by the Ceylon Tobacco Company (CTC) was established, initially for mass propagation of orchid plants and thereafter other crops.

TC Study Group (TCSG)

3.3 In 1984, on a recommendation by the Ministry of Plantation Industries (MPI) the TCSG was formed with the objectives of providing a forum for discussions and exchange of scientific information on TC and also foster the participation of eminent scientists from abroad in TC work in Sri Lanka and thus benefit from their expertise.

3.4 The TCSG as at 1988 had a membership of over 35 scientists from 14 institutions under 6 Ministries together with private sector participants (see Annexe 4). Membership is voluntary and group meetings are on an unofficial basis. Notable scientists who had worked in research institutes in Sri Lanka and were closely associated with the TCSG include Dr. (Ms.) F.A.Hammerschlag of the USDA, Dr. M. Krishnamurthi, Director of Sugarcane Research Institute, Fiji and Prof. R.E. Litz of the University of Florida. The TCSG which has been non functional since 1989 may be re-activated in the near future.

TC Status

3.5 In order to document the TC facilities, past and on going operations and also future development plans, a mailed questionnaire (Annexe 3) was sent to all institutionS and organizations of the TCSG. This was followed up by personal interviews with a number of persons engaged in TC work. Supplemental information relating to the local availability of selected planting material of candidate crops of the CSFD Project and prospects of importation vis-a-vis quarantine regulations, was obtained through discussion with the relevant authorities of DA and also CTC. The output of the survey and other information is presented in the form of a summary below and an accompanying institution/organization status profile annexed.

Department of Agriculture

3.6 The DA which comes under the purview of the Ministry of Agricultural Development and Research (MADR) has three divisions engaged in TC viz :

- Division of Horticultural Research, CARI
- Division of Genetic Resources and Gene Bank.
- Botanical Gardens.

Of these divisions the Genetic Resources Division is largely involved in mutagenic studies and gene pool conservation while the other two are engaged in research and/or commercial plant production via TC.

3.7 The Horticultural Research Division (HRD) of the DA was provided TC facilities under Phase 1 of the FAO/UNDP horticultural project. Notable achievements include the development of the following upto commercial scale production.

.1 Pineapple : Mauritius variety has been successfully propageted in vitro through the use of axillary buds from crown and ratoon suckers (Ref.10). Plants observed were in various stages of development, including those being hardened in pots in the greenhouse and which were about 20 - 25 cm. height. Some plants are being tested in the field at the horticultural farm at Makandura and also CARI Gannoruwa. It takes approximately 8 months to produce plants upto the 15 leaf stage and a further 4 months for field planting.

.2 Strawberry : The cultivar Kendall has been successfully propagated via meristem culture and reported (Ref. 11).

.3 Banana : about 10 varieties have been propagated through apical meristem culture of suckers and around 100 plants are being screened under field conditions. It is unlikely that many mutations would occur as proliferation rate is relatively low. Estimates of the latter are that around 400 - 500 plantlets could be obtained from a meristem, the time needed for field planting stage being about one year.

.4 Ginger : The Chinese variety being in demand during the recent past was mass propagated successfully via rhizome buds or "eyes". Publication of research findings are pending.

3.8 On going research at the HRD of DA includes:

.1 Papaya : Successful culture of plants obtained from petiole of young plants about 6 weeks old. The disadvantage in this method is that the performance of the seedling (genetic make up) is not known.

.2 Passion fruit : In a study for viral elimination, plants were successfully propagated from callus through meristem explants. No viral symptoms were thus far observed.

.3 Mango, Citrus and Rambuttan : In vitro studies for propagation are in progress.

3.9 The HRD has attempted the multiplication of Smooth Cayenne pineapple from explant obtained from one plant of those reported to have been imported by the Horticultural Division but this has not been successful. Attempts to trace the imported plant failed. However the HRD expressed its willingness to undertake research pending approval of the trained OIC who is presently abroad, but not commercial production. The status profile of the HRD is presented in Annexe 5A.

3.10 The Royal Botanical Gardens (RBG) with its TC facilities has been mainly engaged in production of new orchid varieties and also commercial orchid production through meristem and seed culture. Its scope of activities has been expanded to include the following on-going research :

.1 Research into mass propagation methods for palms, Aglaonema (foliage) and Nadun (timber).

.2 Mutagenic studies of foliage plants especially 'Sanit Paulia' and Begonia.

3.11 The RBG research achievements of the past are reflected in its on-going commercial operations such as the mass propagation of orchids (Dendrobium, Vanda, Cattleya etc.) from meristem and seed culture sold at approximately Rs. 2/- per plant; anthurium plants through leaf cuttings and embryo culture at about Rs. 5/- per plant; Begonia, through leaf cuttings at Rs. 4/- per plant, and Brazilnut (Bertholetia excelsa) through embryo culture at Rs. 25/- per plant.

3.12 The status profile of the RBG is presented in Annexe 5.B and willingness has been expressed to undertake TC short term research as well as commercial propagation of crop plants.

Department of Export Agriculture

3.13 The DEA comes under the Ministry of Agricultural Development & Research and is responsible for the Export Agricultural Crops cocoa, coffee and spices, cardamom, cloves, citronella, nutmeg, pepper, vanilla and papaya for papain production. The status quo with respect to planting material of these crops is that at present there is no shortage of plants of coffee and cocoa. Pepper plant requirements too could be met via the rapid multiplication VP technique developed by DEA. Shortage of pepper planting material arise when nurseries do not follow the recommend practices.

3.14 On going research includes :

.1 Nutmeg : TC has been successful with explant from seedling meristem but since genetic make up is uncertain progeny could be male or female. Young tissue from grafts of known parentage is being tested.

.2 Clove : difficulties have been encountered due to the eugenol content and research is in progress.

.3 Vanilla : meristem culture has been tested out recently.

Published research includes that for nutmeg and allspice (See Ref. 12).

3.15 The DEA has expressed its willingness to undertake short term research and/or commercial production provided funds are made available. The status profile is presented in Annexe 6.

Rubber Research Institute

3.16 The RRI comes under the purview of the Ministry of Plantation Industries (MPI). Research commenced in the early 1970s and is confined to TC propagation of rubber (Hevea brasiliensis). The status profile of the RRI is given in Annexe 7.

Coconut Research Institute

3.17 The CRI under the MPI has until recently concentrated on research only into TC techniques for propagating coconut. Although plants were developed using immature coconut embryo, performance of progeny is still uncertain because the method is not cloning from explant of an adult parent. Further, these plants have not been field tested. Presently, in addition to coconut, research is being done on micro grafting of cashew and mangosteen and mass propagation of Giant bamboo and anthurium. The CRI status profile is given in Annexe 8.

Ceylon Institute of Scientific and Industrial Research (CISIR).

3.18 CISIR under Ministry of Industries and Scientific Affairs had undertaken a project for mass propagation of papaya under USAID grant which was completed in November 1990. The propagation technique was successful via apical meristem and axillary bud explants through organogenesis pathway. The latter plants were successfully field planted and fruits observed for morphological characteristics (Ref. 13, 14, 15).

3.19 The status profile of CISIR is presented in Annexe 9 and indications are that TC work will be concentrated on production of industrial metabolites through cell culture rather than agricultural aspects such as mass propagation.

University Faculty of Agriculture

3.20 The Faculty of agriculture of the University of Peradeniya conducts TC research in two departments viz. Dept of Crop Science (see status profile Annexe 10A) and the Dept. of Agricultural Biology (see Annexe 10B).

3.21 At the Dept. of Crop Science (DCS) the following on going research is reported:

.1 Anthurium - Four varieties are being studied for perfecting propagation techniques via leaf explant. the approximate time interval for production is 9.5 months;

.2 Banana - Propagation is big using buds or 'eyes' from underground suckers as explant and via axillary shoot production; contamination is reported to be low but plants have yet to be brought to the field planting stage.

.3 Ebony and 'Nadun' - timber species are being tissue cultured in the research stage.

.4 Citrus - different citrus spp. are being micrografted on woodapple stocks and is in the experimental stage.

4.22 The DCS has perfected in vitro techniques for foliage varieties, diascorea yam, orchids and strawberry and is prepared to undertake sponsored research and also small scale commercial production.

4.23 The Dept. of Agricultural Biology has limited TC facilities and presently is undertaking research (by post graduate degree students) in propagation methods for Nadun (Ref. 16) and bamboo.

CTC Foliage Ltd (CTC/FL)

3.24 CTC Foliage is a wholly owned subsidiary of Ceylon Tobacco Co. Ltd. (CTC/FL). The TC lab was established initially for mass production of orchid plants and then diversified into other crops. The company has undertaken the raising of in vitro plants for foreign organisations including 'Dane Feldt' of Denmark (Strawberry), 'Dwyford' of U.K. (foliage) and 'Sunki' of Australia (foliage). In addition to its foliage project and TC laboratory at Kalagedihena, other agricultural projects include plantation of fruit for juices in System C of the Mahaweli and a potato project at Ambewela (N'Eliya).

3.25 The status profile of CTC/FL is given in Annexe 11 and on going development work and noteworthy achievements are presented below.

.1 Pineapple :

Large numbers of TC propagated plants of the Mauritius variety have been obtained using meristem of ratoons and not crowns or slips. Good multiplication and rooting was achieved in culture and the hardening process appears to also have been successful. The time taken from ex-agar to 20 -25 leaves was about 5 - 6 months. The tested and hardened plants are presently in the field trial stage and initial fruit set is expected shortly. Results in terms of yield and quality should be completed in several months. Nursery techniques are to be developed further and costing carried out for potted TC hardened plants in nurseries raised for subsequent field planting. Current estimated cost of a plant ex-lab is Rs. 2.00 but this could increase 50 - 100 % due to mortality and the costs associated with nursery and field hardening required to produce plants ready for selling to farmers.

.2 Banana :

The TC technique has been perfected and field trials show that fruiting is comparable to conventional plants. The explant is apical meristem of selected sword suckers. Commerical production is possible and cost about Rs. 3.50 per plant ex lab .

.3 Strawberry :

The TC technique via meristem culture has been perfected and good performance observed on certain selected varieties. Commercial scale production is undertaken and cost about Rs. 3.00 per plant.

.4 Passion Fruit :

The CTC/FL pioneered the TC production of passion fruit via seedling explant. The company has a suitable variety, 'Madugoda', which is being cultivated in System C. Research is in progress for better multiplication in order to go in for commercial production of planting material.

.5 Grapes :

The TC system has been perfected for both good multiplication and also rooting. Field trials are in progress.

.6 Other :

The technology for micro-propagation of potato for seed production and development of new product lines of foliage plants especially Dracaena types are other achievements.

3.26 The company's production plans on commercial scale for 1991 are approximately 100,000 pineapple, 10,000 banana and 20,000 strawberry plants. The CTC/FL has indicated the possibility of expanding facilities to cater to any firm orders although their stated commercial capacity is somewhere close to 6 million plants.

Other Institutions

3.27 Discussion with the Sugarcane Research Institute officials reveal that the TC facilities are at present solely for the production of new clones via callus as part of their breeding programme.

3.28 The Research Division of the Department of Forestry conducted research into TC production of some bamboo and other timber species but work has temporarily been suspended.

3.29 None of the research insititutions were in a position to provide even indicative costs of production of TC plants. The only organizations presently undertaking commercial production are the CTC/FL and the Royal Botanic Gardens of the Department of Agriculture. Both have quoted selling prices but most of these are for ex-lab plants and costing has to be included for further hardening under greenhouse and field nurseries before the planting material is ready for sale to farmers.

CHAPTER FOUR

POTENTIAL, CONSTRAINTS, TIME AND COST FACTORS

4.1 In the light of the CSFD Project and its key component of ensuring a supply of high quality planting material in the shortest possible time the status quo of TC in Sri Lanka, its potential and constraints are viewed from the following aspects:

- Quarantine Regulations ;
- Availability of planting material in Sri Lanka in terms of quantity, desirable quality including uniformity, in the immediate short term;
- The time factor to produce the required quantities and evaluating performance by TC (local and imported material) vis - a - vis the duration of the CSFD Project :
- The cost factor.

These are examined briefly with cross-comparison of advantages and disadvantages and where relevant, with reference to examples.

Plant Quarantine Regulations

4.2 The DA of the MADR is responsible through the Director/Chief Plant Quarantine Officer for the import and control of plants/plant materials and plant products. A specimen application for such importations and guidelines are presented in Annexe 12.

4.3 In general, there are few restrictions on import of seed and in recent years newer varieties grown by MASL an other areas have been imported provided the supplier forwards an International Seed Testing Certificate that gives source and health status. The import of grafting material, cuttings and plants is however severely restricted for phytosanitary reasons, although very small amounts for research purposes have and/or could be brought in under very special circumstances.

4.4 Of significance to the CSFD Project is that most tissue cultured products are permitted provided they arrive as in vitro plants in sealed vessels containing clear growth media and certified that the source has been indexed for specific viruses.

4.5 Consequent to an application to DA being processed after an exchange of technical information between despatching country and Sri Lanka and possible clearance, the next major aspect would be the availability of facilities for post-quarantine operations and control such as checks at points of entry, routine inspection and screening etc. Such facilities are available at Research Institutes, the RBG, the CTC and the Plant Quarantine Division of the CARI, the latter being restricted by space and staff as it serves the country in general. The CSFD should take cognisance of this respect in arranging for any post-quarantine operations if large amounts of material are to be handled.

Locally Available Planting Material

4.6 Considering the undesirability of large-scale import of planting material per se (specially of fruit species) the FAO/UNDP Reconnaissance Mission Report on Sri Lanka Planting Material Project in 1982 recommended that at that time the immediate course of action would be to make a selection of best material locally for distribution pending the development and testing of newer varieties. The report further suggested that "where commercial interests are prepared to take the risk, direct imports of large quantities of material of improved but locally not available varieties would be justified, provided all phytosanitary precautiouns are taken".

4.7 As a major constraint, at least at the initial stages of the CSFD project, would be the availability of the nucleus stock of planting material with respect to selection etc. information gathered by and available with the Consultant is documented here for possible lines of future action. The crops considered are the fruit crops more suitable for the coconut triangle and excluding the EAC crops and vegetable crops which could be raised from imported seed.

.1 Pineapple

There are two varieties viz : Kew and Mauritius, the former being larger is preferred by canneries but the latter appears to be more popular and is extensively cultivated for the fresh fruit market although the latter too is purchased by fruit processors to meet the shortfall in Kew. The Smooth Cayenne variety reported to have been imported by the DA a few years back could not be traced at the HRD or the HD. The TC work at the HRD and the CTC are on the Mauritius variety.

Possible areas of sourcing selected ratoons for TC or other VP methods are the DA farms at Makandura and Walpita, and selected commercial holdings in the Pannala or Kirindiwela area.

.2 Banana

The popular varieties in areas of limited rainfall and which have been described as "Specialty Bananas" (see Ref.1) are the local 'Ambul' and 'Kolikuttu'. These varieties are known to have a large number of sub-species of cultivars and a high investment, long duration programme or screening may be required to obtain the desired strains for an export market.

TC work has been done on many varieties at the HRD of the DA and which are being tested at the DA farms. Testing upto the fruiting stage of TC plants has been done at the CTC.

A possible sourcing point of selected sword suckers where 14 varieties were tested is the Killinochchi Regional Research Centre (if operative) of the DA or other DA farms. Another possible line of importation is FHIA in Honduras in order to obtain meristem cultured plants.

.3 Papaya

Imported varieties at different times like Solo Hawaii, Co - 1 and possibly Coorg Honey Dew cannot be easily traced as the purity of seeds cannot be easily maintained as the

plants are freely cross-pollinated. Nevertheless the DA has indicated (Personal Communication) that these could be imported and thereafter TC work followed up by the HRD of the DA on lines worked by CISIR. Possible places of sourcing are the Tamil Nadu Agricultural University, India or the Indian Institute of Horticultural Research.

.4 Passion Fruit

The success of the local selection by CTC and named 'Madugoda' could be followed up in TC work as this selection has performed extremely well giving about 11,000 Kg/ha fruit under normal conditions and upto 20,000 Kg/ha under irrigation.

.5 Other fruits

It is reported by the HD/DA (Personal Communication) that at its farms there are at present 47 varieties of mango and 18 of avocado which are being tested but are presently not for release.

Cost and Time Factor

4.8 The cost and time factors to produce TC plants depends on species, explant used, TC pathways followed to produce an economical number without a high percentage of genetic mutants etc. from explanting to the ex-lab stage and thereafter for acclimatisation under greenhouse and/or field nurseries prior to being ready for field planting. The data reported for some crops in Ch.3 under the respective institute/organization appear to be somewhat empirical and in some instances information on the cost for acclimatisation/field planting stage have as yet to be worked out. Nevertheless this data is used below in evaluating the pros and contras of TC material as against conventional VP methods bearing in mind the need for field testing for mutations prior any issues to CSFD Project beneficiaries.

.1 Pineapple

The conventional VP material used and time for bearing (months) is crowns (about 24), slips (18-20), suckers (16-18) and ratoons (12 - 14). Prices vary but is generally about Rs. 2/- with ratoons which are in demand and generally in short supply reportedly fetching Rs. 3/- at present.

In the case of TC material the reported time from explanting to the 20 to 25 leaf stage (HRD and CTC) is between 6 to 8 months and costed by CTC at an ex-lab price of Rs. 2/-. However to this has to be added the cost of acclimatisation in pots under greenhouse and perhaps hardening in field nurseries in order to withstand the rigours of direct field planting. The additional period could be an 2 to 3 months, with expected bearing in about 16 months. While the advantage in the TC material is that a large number of plants could be made available at approximately the cost of a ratoon, the risk element of having genetic mutants remains, unless these are further tested and these sources used for VP progeny.

.2 Banana

Sword suckers are recommended in conventional VP and come into bearing in about one year. Present prices for quality 'Ambul' and 'Kilikuttu' is between Rs. 11/- and 14/-.

Estimates by the HRD indicate that via meristem culture it would take approximately 9 months from explanting to planting in pots for acclimatisation and thereafter a further 3 months for being ready for field planting. the cost of plant ex-lab (CTC) is Rs. 3/50 to which has to be added the cost of potting and hardening in nurseries which would still be generally less than the current prices paid for sword suckers. However, the disadvantage of meristem culture is that each meristem produces around 500 plantlets and the percentage of mutants would still have to be tested.

CHAPTER

FIVE

CONCLUSIONS AND RECOMMENDATIONS

Evaluation

5.1 The outputs of this study were basically evaluated with respect to the following:

- the research and commercial aspects of TC in Sri Lanka;
- the status with respect to the availability of elite planting material;
- the prospects for TC techniques in meeting the needs for planting material.

The results of this evaluation were viewed not only in relation to the immediate requirements of the CSFD Project but also with respect to the national long-term needs for adequate supplies of high quality planting material.

Tissue Culture

5.2 The overall picture that emerges is that research on TC in Sri Lanka is very broad based, with much scope for technology transfer and expanding commercial TC application. The main features are summarised below.

.1 Sri Lanka has adequate trained personnel, most of them with post-graduate experience in TC work, at all research units and also in the commercial sector.

.2 Most research institutions have facilities for research per se. Although some have expressed their willingness to undertake some commercial production they are unable to do so for lack of funds.

.3 The re appears to be some overlapping areas of research but this is inevitable, when academic organizations covering a wide range of crops or institutes with common interests are involved.

.4 While the commercial sector (CTC Ltd.) has taken its own research findings into commercial production, a closer collaboration between the research (state) sector and the commercial sector would certainly prove beneficial in technology transfer.

.5 Development of a successful TC technique has quite often not proceeded beyond the ex-lab stage and in many instances follow up field testing of economically important crop species (banana, pineapple, papaya) has not been systematically undertaken to evaluate progeny performance in relation to parent.

.6 The only state sector unit undertaking commercial scale production in the Royal Botanical Gardens of the Department of Agriculture. There is much scope for expanding the activity of this TC unit in producing small and medium quantitites of high value crops such as specific orchid and foliage varieties, vanilla etc.

.7 The performance of the CTC is commendable especially with regard to the development of TC in banana and pineapple which has been taken up to the field evaluation stage and also the programme of selection and efforts in the multiplication of high yielding passion fruit.

Planting Material

5.3 In the Export Agriculture Crops sector the planting material requirements of cocoa and coffee are reported to be adequate while that of pepper could be met by the rapid multiplication (VP) techniques developed by the Department of Export Agriculture. With

respect to nutmeg and clove the on-going research efforts by DEA is commendable in that these being perennial crops with a long gestation period, the certainty in obtaining female high yielding plants by TC cloning will effect high cost saving in capital investment.

5.4 In the horticulture (Fruit) sector the problem of the availability of adequate supplies of selected high quality planting material appears to be acute. This is especially so with respect to pineapple and banana which are high planting density fruit crops. The dearth in supplies of planting material of these crops has on the one hand resulted in a cost escalation of high quality material while on the other the use of unselected heterogenous material negates the efforts towards increased production and export promotion.

5.5 Some of the salient features that have emerged from this study with respect to fruit crops which are adapted to a wide range of agro-ecological zones in Sri Lanka, more so in the coconut triangle and which are high potential "new" export crops are summarised below.

.1 Tissue culture techniques appear to offer a viable and cost effective alternative for producing commercial quantities of elite planting material.

.2 Techniques have been perfected for TC of the Mauritius variety of pineapple and several varieties of banana. However the immediate need is a programme of <u>field evaluation</u> of the performance of TC progeny in relation to parent characteristics in order to determine the extent (if any) of genetic mutations that could occur before plants are released to farmers.

.3 Passion fruit has been successfully multiplied by TC techniques using seedling explant by the CTC and meristerm culture by the Horticulture Research Division of the Department of Agriculture. The latter pathway is advantageous and therefore a programme by CTC for commercial multiplication and screening by this method prior to release to farmers in justifiable.

.4 The TC technique developed for propagating papaya by the CISIR should be taken beyond the lab stage and plants subject to field trials. Successful cloning without a high percentage of genetic mutants will prove beneficial in propagaating any imported varieties such as Solo Hawaii, CO - 2 and Coorg Honey Dew.

.5 An important aspect that has to be covered is the post-lab operations of transfering lab ("fluorescent tube") hardened plants to be conditioned in the greenhouse or field nurseries prior to being made available to farmers at a stage when they are ready for field planting. This would essentially entail an evaluation of mortality rates and the cost component.

Specific Recommendations

5.6 The time frame required for production of TC plants upto the ex-lab stage is about 6 to 8 months, hardening upto field planting a further 3 to 4 months and following field planting production commences after about one year in the case of banana and around 1.5 years for pineapple. In view of the uncertainties about the performance of TC plants under Sri Lankan conditions any issues of such plants by ACDI after field testing could commence around 2.0 to 2.5 years for local TC plants from the ex-planting stage and about 1.5 to 2.0 years for any imported ex-lab stage plants but excluding the quarantine test period of the latter.

5.7 In view of the proposed time schedule of three years for the CSFD project and that during this span it is unlikely that TC plants could be made available to farmers until the latter stages of the project it is recommended that two lines of operation be commenced with regard to the plant material input supply component of the project viz:

.1 the supply of screened and selected locally available planting material from certified plantations and special VP multiplication nurseries of the CSFD Project.

.2 The raising of TC plants from local selected material and *in vitro* imported TC plants in quarantined nurseries of the Department of Agriculture, CTC and possbily the CSFD Project.

While the outputs of 5.7.1 will enable the project to take off the ground almost immediately the results of performance from 5.7.2 will be available before the completion of the project for further development.

5.8 Local selections of plant material could be sourced from the Department of Agriculture farms, especially those at Walpita, Makandura, Bandaragama, Horana and Kilinochchi and also from selected commercial farms which would be certified as being disease free and of desireable standards by the Horticultural and Farms Divisions of the D.A. The farms of the CTC would serve as a source for passion fruit and other material in view of the tested plants available.

5.9 It is further recommended that the ACDI acts as liaison between the Department of Agriculture in obtaining the services of the Horticultural Research Division, Royal Botanical Gardens and plant quarantine Division on the one hand and the CTC on the other for arrangements with respect to the possible importation of limited amounts of TC plant maerial, multiplication and screening. Thereafter, this material could be multiplied by VP at the CSFD and DA farms nurseries for release.

5.10 Possible sources locally and abroad with respect to crops suitable for the coconut triangle viz: pineapple, banana, papaya and passion fruit are indicated in paras 4.7.1, 4.7.2, 4.7.3 and 4.7.4 respectively.

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ANNEXE I

Value of Exports of Fruits and Vegetables : Sri Lanka 1979 - 1989

Year	Fruits, Vegetables & RootCrops (Rs.Mn)		TOTAL
	Fresh	Processed	Rs. Mn.
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

Source : Sri Lanka Customs Returns

Exports of Fresh Fruit & Vegetables : Sri Lanka 1989

BIN	Product	Middle East	Maldive Is.	Other	Total Value (Rs. Mn.)
	Vegetable				
07.01 A	Potato	0.002	1.074	-	1.076
07.01 B	Tomato	0.080	0.007	-	0.087
07.01 C	Onion, Shaliot, Garlic	0.243	0.100	0.237	0.580
07.01 D	Vegetable Other	57.015	32.840	9.535	99.390
07.02	Vegetable	0.020	0.007	0.011	0.038
07.06	Root Crops	2.508	-	1.912	4.440
	Total (Rs. Mn.)	59.888	34.028	11.695	105.611
	(%)	(56.7)	(32.2)	(11.1)	(100.0)
	Fruits				
08.01	Banana	-	0.005	0.016	0.021
08.01 E	Pineapple	10.106	1.619	0.475	12.200
08.01 F	Avocado, Guava	0.049	0.046	0.078	0.173
08.02 C	Lemon, Lime	0.300	0.402	0.011	0.713
08.02 E	Citrus F/O	0.083	0.132	0.011	0.226
08.09	Fruit Other	0.095	7.315	2.360	18.770
	(Ginger)	0.031	0.066	0.344	0.441
	Total (Rs. Mn.)	19.664	9.585	3.295	32.544
	(%)	(60.4)	(29.5)	(10.1)	(100.0)
	TOTAL Rs. Mn.	79.552	43.613	14.990	138.155
	(Fruit & Vege.) (%)	(57.6	(31.6)	(108)	(100)

Source : Sri Lanka Customs Returns (Fruit & Vegetables) 1989.

ANNEXE 2

37

Plant Tissue Culture Survey Questionnaire

A. GENERAL

1. Name of Institution/Organisation : .....
   .....

2. Address : ..... T'Phone : .....
   ..... Telex : .....
   ..... Fax : .....

3. Name/Designation of Head of Institution : .....
   .....

4. Address of Laboratories : .....
   .....
   T'Phone : ..... Telex : ..... Fax : .....

5. Division responsible for TC : .....

6. Name, Head of Division : .....

B. FACILITIES

7. Name/s, Designation and Professional background of personnel directly responsible for TC :
   1.
   2.
   3.

8. Staff : Graduate (No.) .....
   Technical (No.) .....
   Other (No.) .....

9. Equipment : (e.g. Autoclaves, inoculation chambers, shakers, culture cabinets etc. State number/capacity where appropriate. Please use extra sheets for additional information).

8. Staff : Graduate (No.) .....
Technical (No.) .....
Other (No.) .....

9. Equipment : (e.g. Autoclaves, inoculation chambers, shakers, culture cabinets etc. State number/capacity where appropriate. Please use extra sheets for additional information).

10. Greenhouse and Field Nursery facilities : (Pleae indicate availability and an indication of approx. area)

C. OPERATIONS

11. On-Going : (Give a brief description of non-classified information of crops/varieties presently worked with, whether at the research stage to perfect techniques; if in the plant production stage approximate time to raise plants for field planting; volumes produced per given period and indicative costs of production per given no. Please use extra sheets for additional information)

12. Past Performance : (Please indicate noteworthy achievements with respect to specific crops and varieties and references to published papers or unclassified information which could be made available i.e. mimeographed reports etc.)

13. Is your Institute willing to undertake :

(i) Commercial production of TC planting material? Yes/No

(ii) Short term research studies (sponsored by ACDI) to perfect techniques for the production of TC planting material of specific crops? Yes/No

14. Commercial Production of TC Plant Material :

(If Yes to 13 (i) please indicate for each crop/variety including those in para 3 of the project brief, the current volumes/performance of production or anassessment of the capability of such production and potential for further expansion. Also, inrespect of each crop/variety, give indicative costs/prices for production of plants upto field planting stage).

15. Any other information, suggestions or proposals.

TISSUE CULTURE STUDY GROUP

Organizations Represented as at December 1988

1. MINISTRY OF AGRICULTURAL DEVELOPMENT AND RESEARCH

   1.1 CENTRAL AGRICULTURAL RESEARCH INSTITUTE
   Gannoruwa, Peradeniya

   1.2 PLANT GENETIC RESOURCES CENTRE
   Gannoruwa, Peradeniya

   1.3 AGRICULTURE RESEARCH STATION
   Pallakelle, Kundasale

   1.4 NATIONAL HERBARIUM
   P.O.Box 15, Peradeniya

   1.5 DEPARTMENT OF MINOR EXPORT CROPS
   No. 1095 Peradeniya Road, Peradeniya
   and
   Minor Export Crops Research Station, Matale

   1.6 SUGAR CANE RESEARCH INSTITUTE
   No. 10/1, Laxapana Mawatha, Jayanthipura, Battaramulla.

2. MINISTRY OF HIGHER EDUCATION

   2.1 UNIVERSITY OF PERADENIYA
   Postgraduate Institute of Agriculture,
   Old Galaha Road, Peradeniya

   Faculty of Agriculture, University Park,
   Peradeniya

   Department of Botany, University Park,
   Peradeniya

2.2 UNIVERSITY OF SRI JAYEWARDENEPURA
Department of Chemistry
University of Sri Jayawardenapura, Gangodawila
Nugegoda

3. MINISTRY OF INDUSTRIES AND SCIENTIFIC AFFAIRS

3.1 CEYLON INSTITUTE OF SCIENTIFIC AND
INDUSTRIAL RESEARCH, P.O.BOX 787,
363, BAUDDHALOKA MAWATA, cOLOMBO 7.

4. MINISTRY OF LANDS AND LAND DEVELOPMENT

4.1 FOREST DEPARTMENT
5, Kew, Road, Colombo 2.

5. MINISTRY OF PLANTATION INDUSTRIES

5.1 COCONUT RESEARCH INSTITUTE
Bandirippuwa Estate, Lunuwila

5.2 JANATHA ESTATES DEVELOPMENT BOARD

5.3 NATIONAL INSTITUTE OF PLANTATION MANAGEMENT
Rathuwila Estate, M.D.H.Jayewardene Mawatha,
Authurugiriya

5.4 RUBBER RESEARCH INSTITUTE
Dartonfield, Agalawatte

5.5 SRI LANKA TEA BOARD
574, Galle Road, Colmbo 3.
and
TEA RESEARCH INSTITUTE,
Talawakelle.

6. Ministry of

6.1 INSTITUTE OF FUNDAMENTAL STUDIES
Hantane Road,
Kandy.

7. PRIVATE SECTOR

7.1 CEYLON TOBACCO COMPANY
CTC SERVICES LTD.,
29, Horton Place,
Colombo 7.

TC STATUS : INSTITUTE / ORGANIZATION PROFILE

A : GENERAL

Name of Institution	:	Department of Agriculture
Address	:	25, Old Galana Road, Peradeniya.
Telephone	:	(08) 88331 to 5
Telex/Fax	:	-
Head of Instituion	:	Dr. S.P.R.Weerasinghe, Director
Laboratories	:	
Address	:	Tissue Culture Unit, Royal Botanical Gardens, Peradeniya.
Telephone	:	(08) 88088
Head of Division	:	Mr. D.B.Sumithraaratchi B.Sc( ) M.Sc.(Kew)

B. FACILITIES

Persons responsible for TC: Mr. D.C.Ranamukhaarachchi B.Sc. Agri.
Ms. S.A.Krishnarajah B.Sc. Botany (Madras)
Mr. W.M.Abeyratne B.Sc. Botany

Staff	:	Graduate 03 Technical 01 Other 03
Equipment	:	Autoclave (01), flow chamber (02), shakers (04), culture cabinets (10) ovens (2) incubators (02) and other basic eequipment for research and medium scale commercial production of about 5000 plants per month.
Greenhouse/Nursery	:	03 Greenhouse of 400 Sq.m. and field nurseries of 550 Sq.m.

C. OPERATIONS

On - Going	:	TC of palms, aglaonema and nadun for mass propagation at research stage. Mutagenic studies of foliage plants (Saint Panlia, Begonia etc.)
Past Performance	:	Techniques and commercial production on going for orchids, anthurium, Begonia and Brazilnut.
Commercial Production/	:	Mass propagation of orchids, vanila and foliage plants also research of TC techniques for other commercial crops.

TC STATUS : INSTITUTE / ORGANIZATION PROFILE

A : GENERAL

Name of Institution	:	Department of Agriculture
Address	:	25, Old Galaha Road, Peradeniya.
Telephone	:	(08) 88331 to 5
Telex/Fax	:	-
Head of Instituion	:	Dr. S.P.R.Weerasinghe, Director
Laboratories	:	Horticultural Research Division
Address	:	Central Agricultural Research Institute, Gannoruwa.
Telephone	:	(08) 88011 to 3
Head of Division	:	Ms. Indrani Padmasiri B.Sc. Agri (Peradeniya) M.Sc. (Bath.)

B. FACILITIES

Persons responsible for TC: Horticultural Research Division
Dr. (Ms.) Kumudu Fernando B.Sc. (Peradeniya) M.Sc. (Calif.) Ph.D. (Bath)
Research Officer
Ms. Asoka Wickremasinghe B.Sc. Agri.
Experimental Officer
Ms. P. Abeysekera
Research Assistant

Staff	:	Graduate 02 Technical 01 Other 01
Equipment	:	Autoclave (01) Orbital shaker (01) inoculation chamber (01), lab oven and other basic equipment for research.
Greenhouse/Nursery	:	Greenhousee facilities mainly for screening plants approx. 100 sq.ft., farm nurseries available.

C. OPERATIONS

On - Going	:	Papaya - plants regenerated from callus obtained from petiole sections of 6 wk.old.plants. Mango,Rambuttan and Citrus - in progress Passion fruit - meristem culture successful for viral elimination.
Past Performance	:	Techniques for banana, pineapple, strawberry and ginger have been perfected up to commercial scale. See Ref. 10 and 11.
Commercial production/ Research	:	Not mass propagation due to limited facilities and research only on arrival of Head of Division.

TC STATUS : INSTITUTE / ORGANIZATION PROFILE

A : GENERAL

Name of Institution	:	Department of Export Agriculture
Address	:	1095 Kandy Road, Peradeniya.
Telephone	:	(08) 88651 and (08) 88364
Telex/Fax	:	-
Head of Instituion	:	Dr. S.Kathirgamathaiyah, Director
Laboratories	:	
Address	:	Export Agriculture Research Laboratories, Matale.
Telephone	:	(066) 2391 and (066) 2822
Head of Division	:	Ms. D.B.R.Swarnathilaka

B. FACILITIES

Persons responsible for TC	:	Mr. Y.M.H.B.Yapabandara B.Sc.Agri M.Phd. Ms. D.B.S.Swarnathilaka B.Sc. Botany
Staff	:	Graduate 02 Technical 01 Other 01
Equipment	:	Autoclave (02), Laminar flow cabinet (02), shaker (01) media dispenser (01) and other basic equipment for research.
Greenhouse/Nursery	:	Facilities not sufficient for expanded production, only limited research

C. OPERATIONS

On-Going	:	Vanila and Nutmeg at Research stage, Cardamom technique has been developed but plants are being tested under field conditions.
Past Performance	:	In-Vitro propagation of Nutmeg and clove funded by USAID/SCI 5399; tip culture of nutmeg; in-vitro propagation of vanila and cardamom pending publication. See. Ref. 12.
Commercial Production/	:	Can be undertaken with assistance for expansion; also short term research for EACs.

TC STATUS : INSTITUTE / ORGANIZATION PROFILE

A : GENERAL

Name of Institution	:	Rubber Research Institute
Address	:	Dartonfield, Agalawatte
Telephone	:	(034) 71426
Telex/Fax	:	-
Head of Instituion	:	Dr. L.M.K. Tillakaratne
Laboratories		
Address	:	As above
Telephone	:	
Head of Division	:	Dr. (Ms.) A.C.I. Samaranayake Plant Science Department.

B. FACILITIES

Persons ressponsible for TC	:	Ms. P.Seneviratne B.Sc. Hons. (presently reading for Ph.D)
Staff	:	Graduate 01 Technical 01 Other 01
Equipment	:	Autoclaves (02), Laminar flow cabinets (02), growth cabinets (04) growth rooms (01).
Greenhouse/Nursery	:	Partially constracted greenhouse and field nurseries available.

C. OPERATIONS

On - Going	:	Only on Rubber (Hevea).Success rate of Plantlets from seedling shoot tip is only 40% when transferred to soil; proliferation from clonal shoot tip explants is slow.
Past Performance	:	Reported publications are mainly on micropropagation of Hevea via seedling shoot tip.
Commercial Production/ Research	:	Unable to undertake/willing to undertake research on intercrops.

TC STATUS : INSTITUTE / ORGANIZATION PROFILE

A : GENERAL

Name of Institution	:	Coconut Research Institute
Address	:	Bandirippuwa Estate, Lunuwila
Telephone	:	(030) 3795, (031) 5300
Telex/Fax	:	-
Head of Instituion	:	Dr. R. Mahindapala, Director
Laboratories		
Address	:	As above
Telephone	:	
Head of Division	:	Ms. S.M.Karunaratne (TC Division)

B. FACILITIES

Persons ressponsible for TC	:	Ms. S.M.Karunaratne B.Sc., M.Sc. (Qld), Head of Division Mr. L.K. Weerakoon B.Sc. Research Asst.
Staff	:	Graduate 02 Technical 02 Other 02
Equipment	:	Autoclaves (03), inoculation chambers (02) shakers (02) and other basic equipment for research.
Greenhouse/Nursery	:	Greenhouse 190 Sq.ft. and field nurseries

C. OPERATIONS

On - Going	:	Coconut - propagation via leaf explant and drought tolerance testing in progress. Cashew and mangosteen - micrografting being tested. Giant tamboo and anthurium - propagation method being tested.
Past Performance	:	Most work has been on coconut and propagation via immature embryo has been successful. An in vitro method for screening germplasm for drought tolerance has been developed.
Commercial Production/ Research	:	

TC STATUS : INSTITUTE / ORGANIZATION PROFILE

A : GENERAL

Name of Institution	:	Ceylon Institute of Scientific and Industrial Research
Address	:	363, Bauddhaloka Mawatha, Colombo 7
Telephone	:	693807
Telex/Fax	:	-
Head of Instituion Laboratories	:	Dr. P.M.Jayatissa, Director
Address	:	As above
Telephone	:	693807 - Ext. 311
Head of Division	:	Dr. P.M.Jayatissa, Head Industrial Microbiology

B. FACILITIES

Persons ressponsible for TC	:	Ms. N.Y.Jayasekera, B.Sc.,Agri.
Staff	:	Graduate 01 Technical - Other 01
Equipment	:	Autoclaves (01), inoculation chambers (01) shakers culture racks (04) and other basic equipment for research.
Greenhouse/Nursery	:	Not available.

C. OPERATIONS

On - Going	:	TC work on mass propagation has been suspended.
Past Performance	:	Papaya: propagated via apical meristem and axillary bud explants. Plants were field tested and observed. (see Ref. 13,14 & 15)
Commercial Production/ Research	:	Only limited research, yes.

TC STATUS : INSTITUTE / ORGANIZATION PROFILE

A : GENERAL

Name of Institution	:	Faculty of Agriculture, University of Peradeniya.
Address	:	Old Galaha Road, Peradeniya
Telephone	:	(08) 8 8041
Telex/Fax	:	-
Head of Instituion	:	Prof. H.P.M. Gunasena
Laboratories		
Address	:	Dept. of Crop Science, Faculty of Agriculture, Peradeniya.
Telephone	:	(08) 38375
Head of Division	:	Dr. K.P.Premaratne

B. FACILITIES

Persons ressponsible for TC:		Ms. Sriyani Peiris B.Sc. Agri, M.Sc. Agri, (Reading for Ph.D.) Lecturer Dr. Colin Peiris B.Sc. Agri M.Sc. (Penn) Ph.D. (Penn) Senior Lecture Horticulture.
Staff	:	Graduate 02 Technical 01 Other 01
Equipment	:	Autoclaves (01), inoculation chambers (02) shakers (01) Culture cabinet (01) and other basic equipment for research capacity 3000 - 5000 plants at a time.
Greenhouse/Nursery	:	Greenhouse (02) and nurseries at Dodangolla

C. OPERATIONS

On - Going	:	TC propagation of: Anthurium - using leaf explant 9 1/2 months for planting. Research stage. Banana - 'eyes' or bud explant using 2 var. (research stage) Ebony and Nadun - research stage. Citrus - micrografting on wood apple (research stage)
Past Performance	:	Techniques perfected for several foliage plants, diascorea yam; orchids and strawberry.
Commercial Production/ Research	:	Yes small scale production and research

TC STATUS : INSTITUTE / ORGANIZATION PROFILE

A : GENERAL

Name of Institution	:	Faculty of Agriculture, University of Peradeniya.
Address	:	Old Galaha Road, Peradeniya
Telephone	:	(08) 8 8041
Telex/Fax	:	-
Head of Instituion	:	Prof. H.P.M. Gunasena
Laboratories		
Address	:	Dept. of Agricultural Biology, Faculty of Agriculture, Peradeniya.
Telephone	:	(08) 88354
Head of Division	:	Dr. H.N.P.Wijegunasekera

B. FACILITIES

Persons ressponsible for TC:		Dr. (Ms.) Deppthi Bandara B.Sc. Agri, M.Sc. (Penn) Ph.D. (Penn) Senior Lecturer
Staff	:	Graduate 01 Technical 02 Other -
Equipment	:	Autoclaves (01), inoculation chambers (01) plus basic equipment for research.
Greenhouse/Nursery	:	Utilizes green house facilities of the Dept. of Agri Biology

C. OPERATIONS

On - Going	:	Research on Nadun (Timber Sp.) propagation from multiple shoot tips and also Bamboo - both being post - projects
Past Performance	:	(See Ref. 16)
Commercial Production/ Research	:	Willing to undertake research

TC STATUS : INSTITUTE / ORGANIZATION PROFILE

A : GENERAL

Name of Institution	:	CTC Foliage Ltd. (Subsidiary of Ceylon Tobacco Co. Ltd.)
Address	:	29, Horton Place, Colombo 7.
Telephone	:	697230/697299/697521
Telex/Fax	:	Telex : 22131 CTCE CE Fax : 697200
Head of Instituion	:	Mr. N.G.R.Karunaratne, Managing Director, CTC Services Ltd.
Laboratories	:	Ceylon Tobacco Co. Ltd.
Address	:	Kandy Road, Kalagedihena.
Telephone	:	0335 342 Celltel 444981
Head of Division	:	Commercial : Mr. H.I.Musheen Research : Mr. S.B.Rajakaruna

B. FACILITIES

Persons ressponsible for TC:		Dr. (Ms.) S. Senanayake B.Sc., M.Phil, Ph.D. Research & Development Manager Ms. S. de Silva B.Sc. Econ, M.B.A. Manager, S
Staff	:	Graduate 03 Technical 02 Other 02 Lab.Asst.
Equipment	:	Autoclaves (03), Shakers (02), Laminar flows (12) growth room 1.2 Mn full capacity and other lab facilities for commercial TC.
Greenhouse/Nursery	:	Propagation (weaning) space 20,000 plants per time (48,000 per year)

C. OPERATIONS

On - Going	:	Pineapple - Successful TC plants are being now tested in the field. Grapes - Successful TC plants of most varieties are on field trials. Passion Fruit - TC system is in the process of being perfectd for multiplication.
Past Performance	:	Banana - System has been perfected and can go into commercial production. Strawberry - TC system perfected and could undertake large scale production.

achievements include:

- Development of TC technology for micropropagation of potato for seed production.
- Developed new product lines for foliage plants, particularly Dracaena.
- Pioneered TC production of Passion fruit.

Commercial Production/ Research	:	Yes
		Pineapple - Approx. 100,000 to 1991 - could be expanded about Rs. 2/- per plant ex-lab.
		Banana - Approx. 10,000 for 1991 about Rs. 3.50 per plant ex-lab.
		Strawberry - Approx. 20,000 for 1991 about Rs. 3.50 per plant ex-lab.

ANNEXE II

Speciman Application for a Permit to Import Plants/Plant Materials/ Plant Products into Sri Lanka

1. Name and address of applicant :

2. Purpose of importation of the plants :

3. Name and address of person, firm organization from whom plants are to be obtained :

4. Scientific name and quantity of each plant species or varieties to be imported :

5. Means of importation : Air freight/Sea freight/Air mail/Sea mail/Accompanied baggage:

6. Port of entry and approximate date(s) of entry into Sri Lanka :

7. Country of origin of plants/mother plants :

8. Type of phytosanitary coverage, other treatments and certification on the consignment :

9. Facilities available for post - entry quarantine screening at the premises of the importer :

10. Location/address of place of propagation of the material :

GUIDELINES

1. Address application to Chief Plant Quarantine Officer, P.O.Box 11, CARI, Peradeniya.

2. The applicant must be aware of the list of prohibited plants given in the Plant Protection Ordinance and should not apply for such material.

3. Most tissue cultured products are permitted provided they arrive as in vitro plants in sealed vessels containing clear growth media.

4. Certain plants are not permitted but their seeds are allowed provided the supplier can forward an International Seed Testing Certificate that gives their source and the health status. Plants or seedlings or all palms are not allowed.

5. Importers should give the botanical name of the plant i.e. the scientific names in Latin, that gives the exact description of the plant species. It has two components:

   i) Generic name and
   ii) Specific name.

The name of a 'Horticultural sport', 'Variety', 'Hybrid' or 'Cultivar' if known, may be written within single/double quotation mark/s after the species name.