SECTION II

Recommendations of Key Workshops Held Under the BDGR Programme

Twenty-one workshops were held during the period October 1985 to June 1992 in order to: (a) sensitise the decision-makers at both the policy and the operational levels; (b) develop national and regional networks; (c) train scientists involved in research, development and teaching in the relevant technologies (e.g. tissue culture), and technicians in applying appropriate techniques at field level for achieving practical results (e.g. herbarium management, ethnobotany); (d) develop relevant documentation; and (e) identify gaps that may exist in the programme. The titles of the workshops and their nature are given in Table 3, while detailed recommendations of selected workshops are given below.

A. International Workshop on Micro-Propagation and Meristem Culture

An International Workshop on 'Mass Propagation using Tissue Culture and Vegetative Methods' was held in 1986 in Malaysia. The aims and scope and recommendations of the workshop are given below.

Aims

The purpose of this Training Workshop/Symposium was to promote development of capability in micropropagation and meristem culture techniques in the SE Asia and Pacific region. The specific objectives were:

(1) To review the state of the art on techniques for micropropagation and meristem cultivation available to less advanced countries in the Asia-Pacific region.

(2) To evaluate the application of tissue culture techniques for both development and commercial purposes.

(3) To create an interface between micropropagation techniques and:
   (i) Socio-economic needs of countries
   (ii) Plant breeding requirements
   (iii) Agro-ecosystems/Environmental problems
   (iv) Genetic resource conservation
   (v) Genetic engineering.

(4) To develop strategies for upgrading the productivity of plant species used in agricultural and industrial crops, both conventional and under-utilised.

Scope

The scope of the workshop was predominantly concerned with:

(1) Training of scientists in the following aspects of tissue culture technology:

TABLE 3.

	Workshops/Symposia	Year	Place	Remarks C: Development of Concepts O: Operational Development of Projects CO: C plus O
1.	Medicinal and aromatic plants	1985	St Kitts-Nevis West Indies	O
2.	International workshop on micro-propagation and meristem culture	1986	Kuala Lumpur Malaysia	C Recommendations *pp. 47-50*
3.	International workshop on biological diversity and genetic resources of under-exploited plants	1986	London Britain	CO Recommendations *pp. 51-54*
4.	Pharmacognostic authentication and standardisation of crude drugs	1986	Colombo Sri Lanka	CO Recommendations *pp. 55-58*
5.	International workshop on maintenance and evaluation of life support species	1987	New Delhi India	C Recommendations *pp. 59-65*
6.	Regional workshop on conservation biology in SADCC member countries	1987	Lusaka Zambia	CO Recommendations *pp. 66-67*
7.	International workshop on ethnobotany	1988	Christchurch New Zealand	C Recommendations *pp. 73-78*
8.	Regional training workshop on conservation biology for humid tropics	1988	Peradeniya Sri Lanka	CO Recommendations *pp. 79-82*
9.	Regional workshop on tropical forest ecology and management for Pacfic Island nations	1988	Lae Papua New Guinea	CO Recommendations *pp. 83-86*
10.	Training workshop on standardised methodology and guidelines on pharmacognostic and botanical aspects of medicinal plants for uses as drugs in industry	1988	Georgetown Guyana	O

NB: Recommendations of workshops that have a direct impact on training of persons for the building of indigenous capacity, and from which specific training courses, technical documentation and projects have evolved, are given in Section II of this report.

(i) Rapid multiplication of selected mother plant materials

(ii) Plant health, disease elimination and exclusion

(iii) Genetic conservation and international distribution of germplasm

(iv) Somaclonal variation, anther and pollen culture

(v) International transfer and germplasm.

(2) Developing the capabilities of scientists for exploiting clonal *in vitro* techniques

Workshops/Symposia	Year	Place	Remarks C: Development of Concepts O: Operational Development of Projects CO: C plus O
11. Identification of key species for conservation and socio-economic development	1989	Port of Spain Trinidad & Tobago	C Recommendations *pp. 87-92*
12. Workshop on standardised methodology for survey and documentation of locally used plant genetic resources	1989	Ibadan Nigeria	O Recommendations *pp. 96-97*
13. Regional training workshop on conservation biology for SADCC member countries	1989	Lusaka Zambia	O Recommendations *pp. 93-95*
14. Tropical forest ecology and management in Asia-Pacific region	1989	Lae Papua New Guinea	O
15. International workshop on ecological foundation for sustainable agriculture, biological diversity of invertebrates and micro-organisms	1990	London Britain	C Recommendations *pp. 98-101*
16. International workshop on biological diversity: Conserving germplasm in botanic gardens	1990	London Britain	C
17. Workshop on conservation through *in vitro* methods	1990	Kuala Lumpur Malaysia	C Recommendations *pp. 102-106*
18. Workshop on the biodiversity of traditional and under-utilised plants	1991	Malta	C
19. International conference on bioresources diversity, ethnobotany, development and sustainability	1991	Hawkesbury Australia	C
20. Workshop on tropical forest ecology: Methods of research in social sciences; Research on non-timber products in Asia	1992	Bangkok Thailand	CO
21. Planning meeting of CSC BDGR network	1992	London Britain	C

for application in propagation of tree species, and industrial and agricultural crops.

Conclusions and Recommendations

On the basis of discussions the participants concluded and recommended that:

(1) CSC should, in collaboration with the governments concerned in the region, continue to promote research activities in this field where appropriate by

organising national, sub-regional, regional or inter-regional meetings, workshops and seminars by drawing resource persons from industrialised states and developing countries from within the region.

(2) Such meetings be organised at different levels to include officials and scientists both from the government and from private sectors concerned and that such meetings should be organised on request of an individual government or of groups covering activities in this field of research.

(3) CSC and interested industrialised states, in close collaboration with governments of developing countries within the region, should provide necessary technical assistance by arranging special programmes and courses for training in industrialised countries.

(4) CSC promote and widen access to and exchange of information for countries within the region with the aim to promote the use of *in vitro* culture technology in upgrading productivity of plant species which are both conventional and underutilised, e.g. breadfruit, coffee.

(5) CSC promote the development and application of tissue culture cloning techniques on selected plant species of interest in the Asia-Pacific region. Evaluations of the field performance of these species will need to be exchanged to co-ordinate experiences in the large-scale uses of plant tissue culture propagation.

(6) CSC promote and facilitate exchange of relevant expertise for the benefit of the member countries in the region.

(7) A regional network of specialists in this area called 'Asian network for utilising tissue culture cloning techniques' be established.

(8) CSC give annual award(s) to outstanding scientists in recognition of their contributions to this field of work.

(9) The participants, upon their return to their home countries, should report their experiences at the workshop to their national offices, and collaborate closely with them for future activities which may be organised by CSC or by national institutions.

B. International Workshop on Biological Diversity and Genetic Resources of Under-exploited Plants

The above workshop was held in October 1986 in Britain with the following aims and scope:

Aims

(1) To bring together information already available in this field and identify priority areas of planning and action at local, national, regional and international levels.

(2) To discuss and develop action plans for survey, documentation, evaluation, cultivation, utilisation, etc.

(3) To finalise a Commonwealth-wide project proposal on selected species of importance which would support the national economies in the areas of agriculture, forestry and industry.

Scope

The workshop concerned scientists, agriculturists and foresters as well as local rural community representatives. It dealt with under-exploited plant resources, with initial emphasis on the family *Leguminosae* for their:

(1) Identification and evaluation

(2) Development

(3) Harnessing/exploitation

(4) Improvement/manipulation if necessary.

Summary of Recommendations

The following recommendations were arrived at by the participants of the workshop:

(1) General, inter-regional

(i) The project framework on under-exploited plants, initially proposed by New Zealand, was accepted.

(ii) Specific endorsements were given to:

- Training courses on herbarium management, conservation biology, ethnobotany and mass propagation in laboratory and field.
- A computerised database for information on inventories, seed bank and germplasm management.
- Action programmes as contained in the national proposals.

(iii) Preparation of an immediate action programme for development of under-exploited plant resources in the following groups: *Leguminosae*, *Palmae*, root crops, grain crops and tree genetic resources (specific national proposals, if different from the above, to be submitted as national requests).

(iv) A national survey and documentation of potentially valuable plants to be undertaken for all the countries involved.

(v) Publication of a book on the under-exploited plant resources of Commonwealth countries by 1988.

(vi) Publication of a newsletter on biological diversity and genetic resources of under-exploited plants.

(vii) Establishment of computerised databases for these plant resources; information accumulated in these database centres to be exchanged freely within the participating countries.

(viii) International funding agencies (IBPGR, UNEP, FAO, IUCN/COSTED, British Council, UNESCO, SIDA, OAS, IDRC, ODA, ICRAF, World Bank and other organisations) to be approached for co-operation and financial assistance in the implementation of the BDGR programme.

(ix) The establishment of a co-ordinated network with support staff in the programme under the Commonwealth Science Council for monitoring the progress of the programme and for providing help in training aspects.

(x) The Commonwealth Science Council should function as a centre of contact and information dissemination and as a resource base, as well as an agency through which funding may be arranged and channelled.

(xi) A follow-up of this international workshop to be organised by the Commonwealth Science Council, preferably in South-East Asia, towards the latter part of 1988.

(xii) For Africa, it is recommended that a workshop be organised in 1987 on 'conservation methodology' and rational utilisation of African plant genetic resources for the improvement of agriculture, forestry, environment and rural economies. This would be an important follow-up to: (i) the African Ministers' Conference on the Environment (Cairo, December 1985) which decided to establish an African network for the conservation and management of genetic resources and the implementation of 150 pilot villages and 30 pilot arid stock-raising zones for self-sufficiency in food energy, based on local genetic resources and skills; (ii) the SADCC/Nordic countries workshop on the establishment of a plant genetic resources programme for SADCC countries (Lusaka, September 1986); and (iii) this workshop on biological diversity and genetic resources.

(2) Regional Recommendations

(i) West Africa

Countries represented in this group were Nigeria, Ghana and Sierra Leone. They recommended that:

- Joint programme be initiated for the survey and collection of plant material of countries concerned. The genetic resources identified and collected will be kept in the native country but duplicates may be shared by others.
- Evaluation be undertaken of the collected genetic material in the native region or outside, depending on the facilities available.
- National workshops be organised to disseminate gathered information to extension workers and farmers.
- Joint training programmes for farmers in their fields and for extension

workers in appropriate workshops be organised between 1988-1992, for countries of the region.

- All African co-ordinators of the programme to meet to standardise methodology for survey and authentication for this region.

(ii) East Africa and SADCC Countries

Countries represented were Kenya, Malawi, Mauritius, Tanzania and Uganda. They recommended that:

- Commonwealth Science Council invite other countries of East and Southern Africa who were members of the Commonwealth but were not represented at this workshop to join the programme and network.
- National co-ordinators to constitute a task force for the implementation of this programme and other projects emerging from it.
- Regional meeting be held to discuss further the plan of action. Regional co-ordinators should disseminate information on project activities every six months. For this it was suggested that a regional newsletter be published. Malawi offered to act as a regional co-ordinator and it was felt that it would be appropriate to seek funding from international agencies.
- A regional workshop by the end of the second year to be organised by the Commonwealth Science Council.

(iii) Caribbean

Countries represented were Jamaica, St Lucia, Guyana, Trinidad & Tobago, and Canada. They recommended that:

- Botanical inventories of floras of their countries be prepared. Where this information had already been collected it should be updated.
- Extensive ethnobotanical investigations for each country of the region should be undertaken.
- Infrastructure be built for seed storage facilities, arboreta, botanic gardens, tissue culture facilities and cryopreservation facilities.
- Wherever appropriate, germplasm exchange facility be made available for comparative evaluation of genetic diversity.
- The need for establishing herbaria and providing training for taxonomy, conservation biology and ethnobotany be addressed.
- Scholarships be provided for attending such courses, and funding be given for expertise, symposia, workshops, training of curators, technicians and other staff.
- Teachers' training course in conservation biology be developed so that they are equipped to further teach this subject in educational institutions.
- The following plants of high regional importance should be studied, evaluated and developed: Pigeon pea; Breadfruit; *Leucaena*; *Vigna*; Mango; Amaranth.
- Earlier editions of appropriate botanical books be updated, so that a complete botanical inventory of the flora may become available.

(iv) Asia, Pacific and Mediterranean

Countries represented were: Cyprus, India, Sri Lanka, Australia, Papua New Guinea, New Zealand and Nepal. They recommended that:

- An action group be set up in each country, to act as the focal point for the project and for liaising with the Commonwealth Science Council.
- A regional co-ordinator within the CSC be appointed to assist the programme officer in co-ordinating activities of each country and to keep in contact with the Commonwealth Science Council.
- Extensive survey, documentation and ethnobotanical investigations of the under-exploited genetic resources of the regions be undertaken by each country separately with assistance from international agencies.
- They meet again in about 18 months to review the progress.
- Computerised database facilities be set up for germplasm documentation and training for the region. India offered to develop a regional network.

C. Regional Workshop on Pharmacognostic Authentication and Standardisation of Crude Drug Materials Extracted from Plants of Families *Zingiberaceae* and *Rutaceae*

Aims

The above workshop was held in 1986 in Sri Lanka to discuss the project developed on above theme and to identify agreed guidelines for preparing manuals on:

(a) Phytochemical aspects;

(b) Pharmacognostic aspects; and

(c) Botanical aspects.

Recommendations

The meeting recommended that a manual be produced using the following guidelines.

(1) Guidelines for Pharmaceutical Aspects

The manual to cover the following areas:

(i) General Concepts:

- Identification Profiles
- Recommended TLC systems for crude drugs belonging to *Rutaceae* and *Zingiberaceae*.

(ii) Preparation of Extracts:

- Essential oils
- Flavonoids
- Coumarins
- Alkaloids
- Bitter principles
- Colouring principles.

(iii) Thin layer chromatography (TLC) – TLC 4,5,6,8,10:

- Plates
- Solvents
- Running distance.

(iv) Detection:

- Record colour/daylight, ultraviolet (UV) 254 • 365 nm
- Record fluorescence/quenching, UV 254 x 365 nm
- Spray using following reagents: Record LRF values
  - (a) Essential oils
  - (b) Bitter principles
  - (c) Alkaloids
  - (d) Flavonoids
  - (e) Coumarins
  - (f) Colouring principles.

(v) Select the best three TLC profiles for each drug and check reproducibility by repeating at least three times with different samples.

(vi) Use standard concentration samples of common compounds belonging to the classes of compounds selected and re-run the TLC.

(vii) Same procedure should be repeated with known adulterants and substitutes.

(viii) Use **standard** biochemical screening procedures.

Abbreviations

TLC: Thin Layer Chromatography

Silica gel 60: specific surface area 500 cm/g; pore volume 0.75 cm/g; pore diameter 60A

UV: shorter wavelength ultraviolet light, used to detect substances that quench fluorescence (Silica gel 60F).

(2) Pharmacognostic Aspects

These should cover:

(i) Studies of the effectiveness of the drug on animals should use similar route of administration used by the indigenous people.

(ii) Serial extraction (with increasing polarity solvent) to identify the active fraction.

(iii) Identification of the chemical structure of the active ingredient.

(iv) Determination of methods of standardisation and bioassay of plant extracts (crude/pure) in established system.

(v) Synthesis of the chemical and compare chemical and pharmacological properties.

(vi) Extrapolation of the findings to carrying out detailed clinical trials on crude/pure extract.

(vii) The therapeutic section should contain:

- Reported actions and name of the country that claims the action.
- Reported indications and name of the country where that drug is indicated.
- Preparations and dosages and name of the country where the dosage forms are used.
- Scientific studies should contain:
  - (a) Pharmacological studies of drug in animals
  - (b) Toxicological studies.

(3) Botanical Aspects

The manual should cover:

(i) Name of Plant – Botanical nomenclature

- This will include existing Latin names, synonyms, latest updated names (in that order).

- Local names: State the various local names known in each participating country. (In the final draft these names should be written in alphabetical order of languages.)
- Varieties/races: State whether there are any varieties/races available locally, i.e. in each participating country.
- Brief diagnostic information: Note the diagnostic features of the species. As for the varieties, a brief diagnostic information is sufficient. However, if there are distinct/vast disparities a more detailed description is necessary, as in the species.
- Herbarium reference: Each specimen collected must have a herbarium voucher specimen. Hence the herbarium reference number is stated in this section.

(ii) Photographs and drawings

(a) Colour/black and white photographs

For each species described, each participant is required to provide colour/black and white photographs of the plant as follows:

- Plant in its habitat (if possible whole plant)
- Parts of fresh specimens (e.g. rhizome/roots, flowers, etc.)
- Parts used in drugs (e.g. fruits/roots/rhizome, etc.)

(b) Line diagrams

Each participant should provide a complete line diagram/drawing of the species described (i.e. whole plant, flower, bract, etc.)

(c) If there is a great difference (in morphology) between the varieties and the species concerned, photographs and line diagrams as stated in (a) and (b) above are also required for the varieties described.

(iii) Definition

The definition should emphasise the following:

- Parts used

  Mention the parts used in crude drugs in each participating country.
- Geographical distribution of original plant

  Each participating country will provide information on the geographical distribution of original plant. The final draft will be in the form of a map indicating the total distribution (wherever possible).
- Geographic distribution of commodity

  Similarly, the final draft will be in the form of a map indicating the distribution of commodity with additional information on the commercial aspects, i.e. export and import.

(iv) Voucher specimens

- Each participant must collect and make herbarium specimens as well as provide information on the ethnobotanical uses of the species from the

place of collection. Each participant is also required to preserve flowers, fruits or even rhozomes in FAA as part of the collection procedure.

- Herbarium specimens: each participant is required to make surveyor duplicates of each herbarium specimen. The number of duplicates should be equal to the number of participating countries plus two extras.
- Each duplicate will be sent to all the participating countries; of the two extras, one will be sent to Kew Herbarium and the other to another herbarium in the Asia-Pacific region, for instance China.

(v) Drug sample

Each participant is required to obtain market samples of the crude drug – if possible several samples so that a sample can be sent to all the participating countries.

(vi) Description

- Macroscopic

  Detailed descriptions of the parts used are required both for fresh sample and commercial sample.

- Microscopic

  These are mainly anatomical studies and description is required for cross-section of parts used, e.g. of rhizome/root. Wherever possible, materials in the forms of powder should also be described and analysed. In the description, the main diagnostic characteristics should be emphasised. Diagrams and photographs of cross-sections must be provided for each species studied.

Glossary

Abbreviations

Local names – botanical names and vice versa

Preservation of germplasm of medicinal value

Each participant should be aware that the species concerned should be preserved in their respective countries. Effort should be made to maintain them in a botanical institution, or ideally, in botanical gardens.

D. International Workshop on the Maintenance and Evaluation of Life Support Species

An international workshop was held in 1987 in India on 'Maintenance and Evaluation of Life Support Species in Asia and the Pacific Region'.

Aims

The aims and scope of the workshop were to:

(1) Develop guidelines and methodologies for preparing inventories of life support species under different stress conditions.

(2) Facilitate evaluation of the growth characteristics of these species under a range of environmental conditions for their harnessing in agriculture, forestry, fisheries, etc., especially through small-scale and integrated rural systems.

(3) Develop methodologies for the synthesis of information about life support species, and develop a strategy for evaluating growth characteristics of life support species especially for rural and small-scale use.

Summary Recommendations

The following recommendations emerged from the different working groups of the workshop.

(1) Working Group on Life Support Species for Water Stress

The Group felt that a lot of work was already going on in arid parts of India and other countries. Hence, there should be some collaboration on arid species. Though they are slow growing, they have a lot of potential. The following points emerged during discussion:

(a) Catalogues need to be prepared to list existing work in different countries.

(b) It will be appropriate to have an International Agricultural Research Institute for the second and third order crops, especially life support species.

(c) About half a dozen species in each category should find high priority for research and management. Tentatively, these were identified as:

For arid regions:

(i) Tree species: *Prosopis* species, Eucalyptus (particularly salt tolerant lines), *Casuarina* species, *Quandang* (for fruit)

(ii) Legumes *Indigofera* species

(iii) Annual grasses *Cenchrus*

(iv) Medicinal plants *Citrullus colocynthis*.

For flooded areas:

(i) Lotus (*Nelumbo nucifera*)

(ii) *Ipomoea aquatica*

(iii) *Avicennia* (Mangrove).

(2) Working Group on Life Support Species for Temperature Stress

The following recommendations emerged from this group:

(i) A classification be made for environments with regard to the interacting components of temperature and drought stress. The categories identified were hot dry habitats, cold dry habitats, hot humid habitats and cold humid habitats.

(ii) For each of these habitats, a catalogue of life support species be made, with most immediate attention being directed to those areas where there are critical situations of drought and famine. It was accepted that a good amount of knowledge existed, but systematic cataloguing will indicate gaps of knowledge.

(iii) Immediate action needs to be taken to advance research on species which are already identified to be of life support value. Preliminary lists of species for some of the four habitat characteristics were drawn up on the basis of theknowledge of the working group. It was further suggested that the countries, according to the habitat classes, may draw up their own lists.

(iv) For each of the species identified for immediate action, existing knowledge be compiled under the following headings:

- Basic information – taxonomy, distribution, ecological characteristics
- Products – food, fuel, fibre, soil stabilisation, etc.
- Knowledge of productivity levels
- Research needs including selection and management requirements (ethnocultural/ethnobiological)
- Socio-economic aspects including conservation factors.

(It was indicated that this classification will differ for different countries according to state of knowledge and particular socio-economic factors.)

(v) Efforts need to be made to set up a 'life support species network' between participating countries, providing necessary effective co-ordination, transfer of knowledge and infrastructure to carry forward the recommendations of the workshop. In setting up this network, it was recognised that large countries such as India might choose to set up an internal national network to relate to a single national co-ordinator who would communicate to the international network. Persons involved in the network would be those with specialist involvement on the life support species.

(vi) Participants in the workshop should endeavour to further expand the aims of the workshop through their participation in bilateral programmes on crop production and ecosystems, fellowships, consultancies, exchange of materials and exchange of scientific information.

(vii) As a further development, national co-ordination should be encouraged for the habitat classification, i.e. the countries of particular habitat class should most directly co-operate and share knowledge, exchange materials and undertake joint research programmes.

(viii) It was suggested that momentum for work on life support species could be best obtained by involving post-graduate students, using life support species as subjects for their studies for thesis/dissertation. Participants in the workshop were requested to spread the work on life support species by giving seminars to students and teachers/groups, and discuss with administrators and politicians the importance of life support species.

(ix) The workers on life support species be mindful of the effects of population so that they can ensure that their efforts are directed to best resolve the problems involved with high human and non-productive densities.

(3) Working Group on Life Support Species for Problem Soils

It was recognised that soil related stresses pose a major constraint in achieving adequate productivity levels to support the increasing population. The major soil related stresses can be classified in the following broad categories:

(i) Salt-affected environments

Excess salts limit production and choice of life support species in several countries. The problems are most acute in arid and semi-arid regions where saline ground is the only source of irrigation. The problems are also widespread in coastal regions influenced by the sea. It is foreseen that problems will become more acute with increase in irrigated areas and as the re-use of available water resources becomes increasingly important.

(ii) Acid environments

Acid soils are widespread in the humid tropics. Acidic soil environments affect plant growth adversely, limiting in many cases the choice of species.

(iii) Mineral-stress environments

Deficiencies of essential nutrients and presence of toxic levels of several ionic species result in loss of productivity and associated hazards for several biosystems.

Recognising the constraints that the major group of environments exert and the need for maintaining/improving the productivity under these adverse environments, the group made the following recommendations:

- Traditional food crops will continue to be grown in large areas under these environments. Study of the genetic variability of these crops and genetic improvement of their adaptation to stress environments should receive high priority.
- Where feasibility of growing food crops is low, the scope of alternate systems having potential for meeting feed, forage and fuel demands is urgently called for.
- Under certain harsh environmental conditions, some biological species, e.g mangroves, have come to play a major role in conservation and maintenance of ecological balance which directly acts as a saver of life support plants. The past decades have witnessed their over-exploitation causing serious concern both to the ecology and the very existence of life support species. *In situ*

conservation and concerted efforts for their rejuvenation and regeneration are urgently needed.

For meeting the above objectives, the following activities were suggested:

- Appropriate agencies, based on resources and facilities, need to be identified for cataloguing, preservation and exchange of germplasm.
- Research efforts to define quantitative relationship between stress parameters and biological responses need to be undertaken at identified selected centres.
- There is need to organise training programmes, both at national and international level, to develop human resources required for identification, evaluation, maintenance and utilisation of germplasm collection.
- There is an urgent need to identify specific genes governing heritable differences in major crops regarding soil-stress tolerance for use in breeding programmes.
- Periodic organisation of symposia/seminars/discussions to exchange information, to review progress and to formulate future strategies would be most desirable.

(4) Working Group on Life Support Species for Emergency Situations

Having discussed and deliberated the life support species for emergencies, the working group considered and adopted the following resolutions:

(i) The country reports on the state of the art presented in this workshop should be prepared by the respective countries on life support species for emergencies. Each country should have a convener or group who can prepare state of the art reports.

(ii) It was recommended that life support species should be able to withstand sudden perturbation due to emergencies. Emergency situations were identified as drought, flood, cyclone and epidemics.

(iii) It was felt that the main areas of work should cover pseudo-cereals, minor millets, minor pulses, minor tubers, multi-use species like bamboos and canes, mangrove species and medicinal plants.

(iv) Since the germplasm of some of the species is under threat due to habitat loss, *in situ* and *ex situ* conservation should be given high priority.

(v) Research and developmental efforts should be made to improve and popularise the selected prioritised species for food, fodder, medicine and energy needs.

(vi) It was considered useful that exchange and dissemination of information is to be undertaken through national conveners or groups. It is appropriate in assessing responsibility of co-ordination to a regional convener.

(vii) The nodal agencies for each country for crop plant germplasm and wild plant germplasm need to be identified. So far as India is concerned, NBPGR is the nodal agency for the conservation of crop plant germplasm and long-

term storage, evaluation and documentation of priority crops. The nodal agencies for each country for wild plant germplasm should be identified as most wild germplasm is threatened due to habitat loss. So far as India is concerned, the nodal agency for the survey and conservation of wild plant species is the Botanical Survey of India under the Department of Environment.

(viii) Education and training is necessary for scientists in the areas of: (i) germplasm collection, evaluation and storage, (ii) taxonomy and evaluation, (iii) ethnobotany, and (iv) conservation methodology. India has the necessary facilities in the above-mentioned areas. For extending the facilities of the training programmes and also for exchanging personnel and experts with member countries, proper funding is required for travel, deputation and training facilities.

(ix) Prioritisation of species was considered essential for effective action. **Multipurpose Bamboos, Canes, Cucurbits, *Artocarpus* species, pulses** (e.g. **rice bean**), a few **minor millets, pseudo-cereals** for hills, **tuber crops** like ***Colocasia***, floating species like ***Trapa bispinosa*** and a few potential medicinal plants depending on regional needs were recommended for emergency requirements. In case of emergency due to perturbation, the agro-cropping pattern based on the multi-species concept should be followed for tiding over emergency situations.

(5) Working Group on New Frontiers of Science and the Life Support Species

The discussion centred around the possible role of biotechnology in the context of life support species. The following recommendations emerged:

(i) *In vitro* preservation of germplasm of life support species needs to be done, for which necessary techniques are to be standardised, wherever required.

(ii) Genomic libraries of important but threatened species need to be established for their future use.

(iii) Genetic variability through *in vitro* cultures need to be created in respect of a few priority crops for future exploitation.

(iv) Newly emerging fields like computerised database generation, agronomic manipulation and conservation methodology should develop training courses especially for the life support species.

(6) Plenary Session

The important general recommendations and resolutions adopted in the Plenary Session were:

(i) Life support species have an important role to play for the betterment of mankind especially under situations of limited natural resources (land, water, nutrients and energy), particularly in view of ever increasing human and livestock population pressures and various stresses. Therefore, life support species must be given due importance as far as scientific and technological inputs are concerned.

(ii) Major thrust be given to studying these plants in more detail so as to generate required information on their origin, distribution, habitats, agro-climatic requirements, various uses and benefits as well as their scientific utilisation to meet ever increasing needs. Inventories of all life support species need to be prepared and made available to all concerned in the region.

(iii) It was recommended that a few important species having economic potential for use as food, forage, fuel, energy, medicine and for industrial purposes for specified stress and emergency situations be selected for detailed studies as per the specific needs of the respective countries.

(iv) Collection, evaluation, documentation and cataloguing of the prioritised life support species need to be taken up systematically so as to ensure their efficient utilisation.

(v) It was emphasised that the germplasm of various life support species, including those which are threatened with extinction, be conserved on top priority basis both through *in situ* and *ex situ* means.

(vi) It was recommended that training of scientists with emphasis on the study of different life support species including their collection, evaluation, utilisation, conservation, taxonomy, ethnobotany, etc., will be most essential as well as rewarding. Necessary facilities in this area are available in India at the National Bureau of Plant Genetic Resources, the National Botanical Research Institute, Lucknow, and the Botanical Survey of India, Calcutta, which can profitably be utilised.

(vii) A suitable funding mechanism at the national, regional and international level through possible support of CSC, FAO, IBPGR, UNEP, UNDP, UNESCO, IUCN, etc., will have to be developed so as to protect the biological life support system.

(viii) Periodic organisation of symposia/seminars/conferences on life support species so as to exchange information, review the progress and to formulate further strategies was emphasised. It was also recommended that a regional co-ordinator be identified to co-ordinate these activities in collaboration with national co-ordinators. It was further suggested that a regional workshop be convened after two years, preferably by the CSC in collaboration with other agencies concerned, so as to review the progress made.

(ix) It was recommended that the post-graduate students be encouraged to work on life support species for their thesis/dissertation work and all the concerned institutions/universities in the region be addressed accordingly.

(x) It was also recommended to bring out films, books, brochures and research journals on life support species for quick dissemination and exchange of information and for generating public awareness.

(xi) Steps need to be taken to establish a 'network of life support species' between participating countries. Countries such as India might consider establishing a national network involving different organisations engaged in life support species. It was also recommended that a national centre of life

support species be established in different countries, especially in India.

(xii) It was also recommended that an 'Information System' for Asia and the Pacific Region be developed for more effective linkages and for the dissemination of knowledge as well as materials.

(xiii) Areas of biotechnology relevant for conserving and utilising these life support species were identified as *in vitro* preservation of germplasm, studies of variation of culture, and these were recommended for use for conservation as well as utilisation of life support species.

(xiv) The role of biosphere reserves in every bio-climatic zone needs to be emphasised to the respective governments. The biosphere reserves need to be established and information on various aspects such as population dynamics, ethnobotany, etc., needs to be generated.

(xv) An inventory of active research scientists working on life support species should be prepared and circulated to all concerned. Similarly, for effective linkages, it will be appropriate if a newsletter on life support species is published and circulated periodically either by CSC or IBPGR.

E. Regional Workshop on Conservation Biology

The Commonwealth Science Council organised a regional workshop to develop a training programme and training materials in conservation biology in 1987 in Lusaka, Zambia.

It was recognised at this workshop that senior scientists and extension workers in agriculture, forestry and wildlife management in developing countries needed training in conservation biology if land-use conflicts were to be minimised, while promoting conservation and sustainability of biological diversity. A general main course framework in conservation biology was developed for senior scientists at this workshop which had the following themes:

(a) Public policy for biological conservation

(b) Inventory of species

(c) Biosystematics

(d) Breeding systems

(e) Life cycles and population dynamics

(f) Physiology and biochemistry

(g) Population maintenance and monitoring

(h) Documentation and data handling.

Details of Course Structure

(a) Public policy criteria for biological conservation

- (i) World Conservation Strategy
- (ii) National Conservation Policy
  - 1) National Conservation Strategies
  - 2) Conservation laws (basis of the legislation)
- (iii) *in situ* and *ex situ* conservation

(b) Inventory of species

- (i) Criteria on choice of conservation area
- (ii) Criteria on choice of species for conservation
- (iii) Biometrical sampling techniques, and statistical data treatment and interpretation
- (iv) Phytogeographical and paleobiographical descriptions

(c) Biosystematics

- (i) Herbarium techniques
- (ii) Intra-specific diversity (e.g. biotypes and ecotypes)
- (iii) Physiological and biochemical variations

(iv) Management implications of ecotypes (i.e. environmental factors)

(d) Breeding Systems

(i) Types of reproductive strategies

(ii) Role of vectors in pollination

(iii) Gene flow and maintenance of genetic diversity

(e) Life Cycles and Population Dynamics

(i) Plant life cycles

(ii) Population dynamics monitoring

(iii) Plant–animal and plant–plant interactions

(iv) Minimum viable populations

(v) Seed viability and dormancy

(f) Physiology and Biochemistry

(i) Chemistry of biological active compounds

(ii) Vulnerability of essential physiological processes that cause mutations

(iii) Aspects of eco-physiology

(iv) Physiological aspects of *ex situ* seed conservation

(g) Population Maintenance and Monitoring

(i) Forms of cropping systems

(ii) Management of populations

(iii) Problems of genetic decay

(iv) Biotechnology techniques in germplasm conservation and propagation

(v) Field trials

(vi) Neighbour relations and species interactions (i.e. experimental designs and competition studies)

(vii) *in situ* aspects of propagule conservation

(h) Documentation and Data Handling

(i) Documentation of available literature

(ii) Selected case studies on genetic resources conservation

(iii) Systems of data collection storage and retrieval.

F. International Diploma Course in Herbarium Techniques, Kew, Britain

The Commonwealth Science Council (CSC) has been involved since 1986 in promoting the techniques and methods for the study, use and conservation of biodiversity and plant genetic resources and has been closely involved with the training in 'Herbarium Development and Management'.

At present a Herbarium Techniques course is held at the Herbarium, Royal Botanic Gardens, Kew, Britain. It is held every year for 8-12 weeks and the following areas are dealt with:

- Taxonomy
- The development, purpose and types of herbaria
- The herbarium building and specimen storage
- Pests and treatments
- Materials
- Label design and production.

The course is divided into two components, (i) formal, and (ii) optional. The formal part constitutes the major component of the course, and is concentrated in the first six weeks with practical assignments and options occurring in the last fortnight.

The formal components include the following lectures and demonstrations:

(a) Herbarium management, routine and materials

(b) Plant collecting, preservation and related subjects

(c) Plant morphology, identification and curation of collections

(d) General interest subjects.

The above areas are covered under the following headings:

1 The development, purpose and types of herbaria
2 The role of taxonomy
3 Arrangement of herbarium collections
4 The herbarium building and specimen storage
5 Pests and treatments
6 Materials
7 Ancillary collections (i) spirit, carpological and wood
8 Ancillary collections (ii) illustrations and photographic records
9 Centralised accessions, recording and dispatch procedures (GSU introduction) related to these accessions
10 Duplicate distribution
11 Loans to other institutions
12 Preparation for mounting
13 Mounting
14 Good and bad practice

15 Special curation (succulents, *Palmae* and *Pandanaceae*)
16 Curation of fungi
17 Plant names
18 Palynology (lecture and tour of laboratory)
19 Incorporation of mounted specimens (laying-in)
20 Essential herbarium literature (including tour of library)
21 Removal of samples from herbarium sheets
22 Arrangement of herbarium collections according to new publications (curation)
23 Label design and production (including demonstration of printing press)
24 Photographic copying of herbarium sheets (including tour of studios)
25 Illustration
26 Plant identification and family recognition
27 Ecology and taxonomy
28 Introduction to computers
29 Collecting and preserving specimens
30 Notes on the collection and preservation of fungi
31 Collecting materials for ancillary disciplines (anatomy, cytology, palynology and phytochemistry)
32 The collection and curation of *pteridophytes*
33 Collecting living material
34 Accessioning living material and phytosanitary regulations
35 Photography and field work
36 Keys – punched-card and computerised
37 Check Lists
38 Collectors, itineraries, maps and gazetteer (including a tour of the map room)
39 Role of botanic gardens for seed banks (lecture and tour)
40 Seed bank
41 Conservation and the herbarium
42 Economic botany (lecture and museum tour).

Practical Sessions are dealt with either in the form of a one-to-one instruction session with staff members, or are organised in a 'workshop' format. A 'work sheet' is provided to help guide the students through most of the one-to-one sessions where Kew in-house procedures must be strictly followed. Two unaided practical assignments for assessment are also included (see note below).

List of Practical Sessions

- General Services Unit (GSU) – practical work relating to accessioning, recording and dispatch procedures
- Preparation for mounting

- Mounting one-to-one with a staff member (from the mounting team)
- Laying-in plants with the help of a staff member (work sheet provided)
- Collecting
- Pressing, and preparation of data labels
- Preparation for mounting, and mounting
- Vegetative morphology
- Floral morphology, dissecting fresh material
- Floral morphology, dissecting and preserving dried material
- Curation (i.e. the use of a revision to update specimen names)
- Keys – practice with dichotomous and multi-access keys.

Family recognition

1 Family sort of East African specimens

2 Family sort for Malesian specimens

3 *Compositae* workshop

4 *Graminae* workshop

5 *Rubiaceae* workshop

6 *Leguminosae* workshop

7 Ferns and fern allies.

Options

This aspect of the course aims to provide the students with an introduction to a supplementary skill which would be of benefit both to the individual and to his/her home institution. The students are offered a choice of five options from which they are asked to indicate their first and second preferences.

List of options

Option 1 – Additional curation

Option 2 – Practical plant identification

Option 3 – Check-list compilation

Option 4 – Illustration

Option 5 – An introduction to library management.

Option Choice

The course offers a choice of options designed to give the student the opportunity to acquire additional skills and techniques relevant to herbaria and taxonomy.

Option 1 – Additional herbarium curation

This course gives the opportunity to help rearrange the collections in

accordance with a newly published work and extract loans as requested by other institutions.

Option 2 – Practical plant identification

Plant identification is a skill frequently required of herbarium technicians. Specimens from certain geographical areas and families can be selected to give students practical experience in identification.

Option 3 – Check list compilation

This option is suitable for trainees with some previous experience of herbarium routines and plant identification. If you select this option please state title and parameters of your intended check list.

Option 4 – Illustration

Local or specialised herbaria often do not have the services of a professional illustrator. Students will be encouraged to develop their skill in drawing plants, maps and diagrams.

Option 5 – An introduction to library management

In local or specialised herbaria, the duties of a herbarium technician often include routine library maintenance. This option introduces the student to acquisition, cataloguing and storage (with special reference to tropical conditions).

Changes since 1990

The 'fern and fern allies' workshop has been introduced as a new topic and the amount of time devoted to 'ecology and taxonomy' reduced. Otherwise, the syllabus remains unchanged.

Projects

These are additional to the course and only available to those students who are granted twelve-week subsistence by their sponsor. The students are provided with facilities and given help and guidance as necessary. The projects are not assessed by Kew staff.

Both projects and options should reflect the personal needs of the candidate and the needs of their home institution, and must be chosen with the approval of the candidates' Head of Department or Director. As far as possible, the subject of the project is chosen with the approval of the students' Head of Department or Director.

Project choice for students granted 12 weeks of work

The additional four weeks are not formally considered part of the course, but students are encouraged to spend this time working on a project of their own choice. Kew offers facilities and expert guidance but not full supervision.

The project may be relevant to herbarium techniques or ancillary topics (check lists

production being particularly suitable). Appropriately experienced students may select a taxonomically based subject, but if they are not acquainted with the basic principles this is not recommended. Students can either carry on a project they have already started or chosen what they can complete while at Kew or continue in their home institution.

Four such courses have been held at Kew since 1987.

G. International Workshop on Ethnobotany

An international workshop on ethnobotany was organised in 1988 in New Zealand to develop a training programme in ethnobotany. The workshop provided a forum for interaction between scientists and lay people and gave a clear indication of the ease with which lay people could relate their knowledge and concerns to scientists, and showed how easily scientists can communicate their findings to people not directly engaged in scientific work. The workshop made a number of recommendations which are given below.

Summary of Recommendations

Recommendation 1

Addressed to: Organisers of regional and international workshops

If a similar workshop (Hui) on Ethnobotany is held elsewhere it is important that the resources and knowledge of local people be used. Protocol of the country where the workshop is to be held in should be observed.

Local people need to be regarded as key experts for their region and their requirements to follow particular procedures have to be accommodated. The process used should respect the rights and the culture of the people of the country where such a workshop is held.

Recommendation 2

Addressed to: All workshop delegates

Delegates who return to areas where traditional knowledge and utilisation of plant resources continue, should impress upon other members of their communities the importance of maintaining their existing knowledge and practices in order to preserve, and to preserve on an **as and where basis** as far as possible, those plants that are considered to have high cultural, traditional and economic values. The introduction of new crops, regarded as more economic both by the people who undertake their cultivation as well as the distributors and the people who purchase them from both the indigenous people and the outside world, has frequently led to the unintentional extinction of plants whose existence many had taken for granted.

Recommendation 3

Addressed to: All participants and organisations represented at the workshop

Grave concern was expressed about the continuing and accelerated loss of plant species and genetic diversity and indicated the need to consider a framework for making recommendations. The distinction between global, regional and local aspects and concerns about the depletion of species was emphasised, indicating recommendations should be framed at these levels. A distinction needed to be made between recommendations being directed to the Commonwealth Science Council and those directed

internally to the New Zealand government for its action. Concern about the loss of species is worldwide and cannot be resolved by piecemeal, nation by nation, action, but only through international effort based on fundamental principles of equity and co-operation. There is a continuing and urgent need to recognise the interconnectivity of physical ecological conditions, economic use and social values and to integrate these elements. The New Zealand government should take positive steps to implement IUCN's World Conservation Strategy and a similar strategy by New Zealand, instead of paying lip-service to them. Action is required for implementation of policies. It should be recognised that there are limits to the development of resources and that there is an urgent need to instigate programmes which will lead to the sustainable use of all resources including botanical ones. It was recommended that New Zealand should adopt the findings of the United Nations World Commission on Environment and Development reported in 1987. Implicit in recognising these findings is a need by the New Zealand government to recognise the inherent conflict between market-oriented policies and their implementation through user-pay requirements, which give undue emphasis to economic issues to the detriment of social needs and the integrity of the physical environment.

It was felt that the self-interest and unbridled greed that market-oriented philosophies breed are anathema to a caring world. The occasional meaningless splitting up of government departments, creation of state-owned enterprises with their own narrow central concerns and the introduction of user-pay policies are examples of actions which may work against the integration and co-operative approaches which are necessary to further research and development of our botanical heritage. A call was therefore made for the Ethnobotany Workshop to reject market-oriented and user-pay policies and to inform governments of this rejection.

Recommendation 4

Addressed to: (a) Department of Scientific and Industrial Research (DSIR), New Zealand, (b) Commonwealth Science Council (CSC)

It was said that science should flourish for the benefit of all people and not for the profit of a few as was frequently propounded. Science must be accountable to the people, and they must establish research priorities by means of a thorough and constant consultation.

Training in social responsibility for all DSIR and other government scientists was recommended.

Recommendation 5

Addressed to: CSC and DSIR with regard to its involvement in the CSC Biological Diversity and Genetic Resources Programme

This recommendation was received as two submissions stated together because of their similarity.

(a) To develop cultural exchange of plant uses among the 15 islands of the Cook Islands by holding two conferences, one in the northern group and one in the southern group of islands. The objective of the conferences would be to bring together the knowledge of plants related to such properties as medicinal, romantic, music, dance, legend, food and technology.

(b) To prepare a list of all plants used in medicine, technology and nutrition in the Cook Islands.

Recommendation 6

Addressed to: CSC and DSIR

That CSC or DSIR should help to promote further studies on the traditional uses of Fijian plants and specifically support a programme on Kava and Yaqona and then cultural use by the Fijian people.

Recommendation 7

Addressed to: CSC

That CSC assist in undertaking a scientific study of the plants traditionally used in the Solomon Islands.

Specifically, a request was made to construct a Hoava Dictionary of Plants and Animals. The Hoava language is one of the bush languages in Western Solomons. The 400 people who speak this language have a considerable knowledge of the plants and animals of the land they occupy and this needs to be recorded.

Objectives of the proposed study would be:

(a) To preserve the Hoava language

(b) To record the local names of plants and animals from the few old people who know these names

(c) To record the important uses of these plants and animals for food, fibre and medicine and record the means by which these were grown or harvested.

Recommendation 8

Addressed to: DSIR and CSC

This was presented on behalf of Niuean people resident in New Zealand.

It was requested that *Pandanus* be cultivated in New Zealand for weaving and medicinal purposes especially for use by Niuean people resident in New Zealand.

In making this request it was noted that 30,000 Niuean people are resident in New Zealand and only 2,000 in Niue.

Recommendation 9

Addressed to: (a) DSIR, (b) Director, National Museum of New Zealand, (c) Department of Education

It was felt that the following activities were pertinent to the CSC programme on Biological Diversity and Genetic Resources:

(a) Development of operational policies which incorporate cultural elements, such as traditional use of land and plants. Such policies should also include employment of more Pacific Island staff.

(b) Establishment of additional scholarships to train Pacific Island curators.

(c) Determination of approvals entry criteria, selection procedures and the course content for such training. It should reflect an understanding and knowledge of the Pacific region cultures.

(d) Research be conducted to establish the maximum growing requirements of various Pandanus species commonly used in the Pacific. Results of this should be fed back to women's organisations as well as to government departments concerned.

(e) That an illustrated record be published of medicinal plants found in the Pacific. This is to include photographs of plants, local and scientific names, plus descriptions of uses.

(f) That the findings of research into the traditional uses of plants, particularly for medicinal purposes, be publicised widely using the cultural network as well as the normal scientific channels so that:

  (i) the value of the work done by traditional healers is given appropriate recognition

  (ii) traditional healers are encouraged and promoted in their work

  (iii) access to such practices are facilitated more readily.

(g) That researchers be encouraged to actively promote and encourage the work of individuals such as taulasea or fofo who have been identified for valuable and effective healing practices.

(h) That school science courses should include a study of the traditional uses of plants for food, clothing, housing, medicine, etc., in the Pacific.

Recommendation 10

Addressed to: (a) CSC, (b) CSIRO Australia, (c) Educational Departments

(a) In Australia the CSIRO and botanists should work alongside aboriginal people in recording details of traditional plants and designing courses for young aboriginals to allow them to pursue careers requiring this knowledge. This will enable development of new schemes for employment.

(b) That findings of research into the traditional use of plants for medicinal purposes

be publicised widely using the cultural network as well as the normal scientific procedure of publishing data.

Recommendation 11

Addressed to: CSC

Four recommendations, given below, were presented by the Aotearoa Moananui a Kiwa Weavers, which is a New Zealand national organisation of Maori and Pacific people concerned with the traditional uses of plants for weaving, craft and cultural purposes.

Submission 1 – A hui (workshop) be held near a National Park to allow people to see and discuss the forest plants in their natural habitat. In organising this steps should be taken to include local people and elders of that area, including elders connected to that area who may have moved away. This would require a considerable amount of planning and discussion with the local people.

Submission 2 – A hui (workshop) be held in which attention is focused on one or two plants or flowers. In this hui, each Pacific Island and/or Maori group, would be responsible for a day, or half a day, discussing plants from their island or region. It may be possible to focus on one plant common to all islands, e.g. coconut, by examining all known users, traditions, folklore, music, songs and chants.

Submission 3 – The CSC should examine ways to find support and/or funding to provide assistance to talented lay-persons wanting to learn certain scientific disciplines that will enable them to co-operate effectively in increasing the knowledge of traditional uses of plants.

Submission 4 – A future hui of this type should also involve 'hands-on' experience with plants and plant materials. It should take into account the changing use of plants from traditional to modern and involve their use for artistic purposes.

Recommendation 12

Addressed to: Commission for Sesquicentennial Celebrations in 1990

Some of the funds allocated for the sesquicentennial celebrations be used for establishing a national botanical garden as a place where native plants would be maintained. All people who love plants, from whatever background they come, can go to this garden and understand how to use and maintain these plants using existing methods.

It was also suggested that DSIR might take up this recommendation and convene a working group to foster the development of a National Botanic Garden of this type.

It was also suggested that delegates go back to their communities and organisations and contact the Commission for the Sesquicentennial Celebrations of the Department of Internal Affairs in support of setting up a National Botanic Garden.

This recommendation has been implemented.

Recommendation 13

Addressed to: (a) DSIR, (b) Plant Varieties Registrar

It was recommended that all DSIR experimentation relating to native plants be stopped, and that there be no further registrations of native plant varieties under the Plant Variety Rights Act, at least until after DSIR has completed a thorough consultation with the Tangate, concerning their wishes about the use of native plants.

Recommendation 14

Addressed to: DSIR

At an early date, preferably within the next six months, all the information emerging from the Ethnobotany Workshop be made available to all sectors of the Maori community so that they can use it for discussions in the next workshop. If given the opportunity to consider and discuss the subjects to be covered in that workshop the Maori people would be able to either endorse the recommendations made at that workshop or make new submissions for consideration and adoption.

Recommendation 15

Addressed to: DSIR

It was said that DSIR should look to the Treaty of Waitangi and its responsibility under the Treaty in the framing of these guidelines.

Recommendation 16

Addressed to: DSIR

The present DSIR Maori Steering Committee be dissolved and the Maori people be asked to nominate their own steering committee through the runanga structure in their traditional manner.

Guidelines be developed for scientists working in the area of ethnobotany, conservation and sustainable use of the local plant resources to enable them to interact effectively with the indigenous population having knowledge about the indigenous plant resources.

H. Regional Workshop on Conservation Biology for Humid Tropics

This workshop was held in Sri Lanka in 1988 to develop a specific curriculum for a training course in conservation biology for the humid tropics to supplement the main course developed at the Zambia workshop in 1987 (see E).

It was agreed that a regional manual should be developed, as a supplement to the general manual prepared after the 1987 workshop. It should have the following five modules:

(a) Biological diversity and conservation

(b) Target habitats and species

(c) Life cycles, population dynamics and breeding systems

(d) Population variability, maintenance and use

(e) Data handling and documentation curriculum and references.

All these modules except (c) above have been prepared.

Details of each of the five modules are given below:

(1) Module 1

(a) Biological Diversity and Conservation

(i) Concepts and definitions

(ii) Case Study – Restricted distribution of threatened endemics (IUCN Red Data Book Categories) in wet zone of Sri Lanka

(b) Introduction to Conservation Strategies and Biological Conservation treaties and laws

(i) World Conservation Strategy

(ii) Regional and National Conservation Scenarios and Strategies

Exercise: Case Studies

(i) Conservation Plan for the Sinharaja Forest prepared under WWF/IUCN Project 3307 by the Ministry of Lands and Land Development, Forest Department of Sri Lanka, and WWF/IUCN, Gland, Switzerland (1986)

(ii) Management Plan for coastal zone conservation in Sri Lanka prepared by the Department of Coast Conservation, Colombo (1987)

(c) Distribution of Biological Diversity – Regional and National perspectives, e.g. Ecosystems – vegetation types of Sri Lanka. Crop Plants and their wild relatives – Rice, Rubber, Cinnamon, Oil Palm, Spices and Yams

Exercise: Visits to different Natural Vegetation sites and Agricultural, Plantation and Forestry Research Stations

(d) Existing and potential threats to Conservation of Regional Biodiversity

Case Studies: Sinharaja, Mahaweli Scheme – Sri Lanka

Exercise: Field visit to Mahaweli Development Area

(e) Synchronising Development with Conservation

Case Study: Natural Parks & Wild Life Sanctuaries in Mahaweli Development Area – Sri Lanka

Exercise: Field Visit to Mahaweli Development Area (to be combined with work area module 4)

Exercise Details for Module 1:

No. 1 ..... 3 Hours
No. 2 ..... 3 Hours
No. 3 ..... 3 Hours
No. 4 ..... 3 Hours

Field visits (in combination with module 2) to study Natural Vegetation Types

Field visit to Mahaweli Development Area.

(2) Module 2

(a) Target Habitats and Species for *in situ* conservation

(i) Choice of critical areas – Forest Reserves, Wild Life Parks, Man and Biosphere (MAB) Reserves – examples from the region to be used

(ii) Procedure for declaration of a protected area

(b) *Ex situ* Conservation sites, Establishment and Management

(i) Field/*Vivo* Sites

- Botanic Gardens
- Home Gardens
- Urban Parks
- Field Gene Banks

(ii) *Vitro* Sites

- Seed Gene Banks
- Cryo Preservation
- Tissue Culture

(c) Target Species and Centres of Diversity (criteria for selection)

Collection of information on:

- Traditional **rice** varieties
- Wild relatives of **rice**, fruits, spices
- Under-exploited plants (***Chenopodium, Caryota***)
- Endangered Species (***Dioscorea***)

(d) Economic Analysis of Conserving a Plant Species *ex situ* vs *in situ*

Course work: 3 days

Exercise details: Field visits combined with module 1.

(3) Module 3

(i) Life Cycles, Population Dynamics and Breeding Systems

(a) Plant life cycles
(b) Population dynamics monitoring
(c) Plant–animal and plant–plant interactions
(d) Minimum viable populations
(e) Seed viability and dormancy
(f) Types of reproductive strategies
(g) Role of vectors in pollination
(h) Gene flow and maintenance of genetic diversity
(i) Eco-physiology and biochemistry, medicinal plants, spices
(j) Biological control

Course work: 3 days of course work

Exercise details: Field visits combined with module 1.

(4) Curriculum for Module 4

Population variability, maintenance and use

(a) Exploration and collection

(i) Basic population genetics
(ii) Inter and intra population variability
(iii) Sampling theory for **oil palm, yam, rice** and **calamus**

(b) Maintenance and evaluation

(i) Theory lecture on evaluation and maintenance
(ii) Experimental designs (field trials)
(iii) Descriptors list for **oil palm, yam, rice** and **calamus**

(c) Utilisation

(i) Theory lecture on utilisation
(ii) Utilisation of **oil palm, yam, rice** and **calamus** will be illustrated as course studies

The oil palm, yam, rice and calamus will be used as case studies. The studies will consist of field visits to habitats; demonstrations of field collection and recording techniques; and procedures for carrying out field trials for evaluation and some practical exercises on these. The oil palm study will concentrate on analysis of sample data in the laboratory, while field sites will be for yam, rice and calamus.

Course work: 2 days of Lectures

Exercises: Field visits combined with Module 1.

(5) Module 5

Documentation and information management system for plant genetic resources

(1) Sri Lanka National Gene Banks information system based on dBase III software should be used

(2) A system based on an appropriate 4 GL software, e.g. 'Oracle', will be developed by Palm Oil Research Institute of Malaysia for demonstration

(3) Database set up by the International Board for Plant Genetic Resources (IBPGR) should be used.

I. Workshop on Tropical Forest Ecology

The above workshop was held in Lae, Papua New Guinea, in 1988, to prepare a Tropical Forest Action Plan for integrated research, education and training in many aspects of tropical forest management in the Pacific Island region, with emphasis on both traditional and commercial utilisation of fruits, their conservation and regeneration.

Major problems of inventory, land tenure, unwise exploitation and lack of biological or sociological understanding were identified and discussed in many differing contexts throughout the region. Project proposals incorporating research and training among all levels of forest policy makers, managers, users and occupiers were shaped into an Action Plan for Tropical Rainforest Ecology and Management, within the region.

Objectives of the workshop were:

(1) To review advances in tropical forest research, especially current concepts of the regeneration dynamics of tropical rainforest ecosystems.

(2) To discuss current forestry and land resource management of systems, in particular to review their success in terms of resource use, conservation and maintenance of both wood and non-wood values.

(3) To carry out seminars and training exercises to inform student participants and forest resource managers of recent ecological principles and scientific methods.

(4) To promote the need for an ecosystem approach to land resource management, training and research, including development of an action plan to implement such an approach.

(5) To foster personal interactions among land resource managers, social and economic planners and forest scientists.

Specifically, the workshop comprised three phases:

(i) A five-day training course in Data Collection and Processing in Tropical Rainforests, principally for local and regional participants as foresters and land resource managers.

(ii) A three-day seminar on Tropical Forest Ecology and Management, using scientific resource persons and senior forest managers to address perspectives of natural and plantation forest silviculture, forest inventory and planning, ecosystem processes and environment protection, social and cultural evaluation of traditional forest management practices, and socio-economic aspects of commercial forest exploitation, in the region.

(iii) Two-day meeting to discuss collaborative and multi-disciplinary research and training opportunities in the Pacific Island region, concluding with the draft Tropical Forest Action Plan, as appended.

Recommendation: The workshop concluded with the preparation of the draft Tropical

Forest Action Plan which gave specific action in seven areas that need to be taken for sustainable utilisation of the forests in the region. These are given below:

1. Planting/restoration/rehabilitation/redevelopment

   Steps need to be taken for:

   (a) Experimental restoration of degraded ecosystems, including logged-over forest, heavily and badly degraded forest and grassland.

   (b) Experimental introduction of valuable species among replicated sites within the region, e.g. *Terminalia kaernbachii*. Introduction of multiple use species.

   (c) Studying cultural impacts of restoration.

   (d) Comparative studies on sustainable utilisation of forests within the region.

   (e) Implementation of a forest tree plantation programme to provide sustainable supply of wood to reduce pressure on natural tropical forests.

   (f) Implementation of social forestry techniques for production of food, and harvest of wood and other forest products, e.g. rattan, fruits, mushrooms, etc., in a sustainable manner.

   (g) Integrating traditional agroforestry techniques with modern logging practices.

2. Protected areas/environmental protection and environmental services

   The following tasks are required to be undertaken:

   (a) Investigation and development of potential genetic resources for better utilisation for human well-being.

   (b) Development of a comprehensive system of parks and protected areas in the region for conserving representative tropical forest ecosystems for their potential economic, social and cultural value to mankind.

   (c) Development of workable systems to assign values to tropical forests for all purposes.

   (d) Introduction and use of conservation biology as a discipline for managers, scientists and technicians concerned with managing this sustainable utilisation of forests.

   (e) Study of positive and negative impact of tourism on tropical forests.

3. Social and cultural interactions with forests (including legislation and economic valuation)

   Steps should be taken to:

   (a) Encourage the implementation of procedures to promote public participation in decisions affecting the future of tropical rainforests in the region.

(b) Develop guidelines for appropriate legislative and institutional mechanisms to enable full participation of people in the management of the resources.

(c) Study traditional land tenure and use rules and see their influence on the long-term management of the total forest resource.

(d) Develop appropriate means of conserving cultural diversity as well as biological diversity.

4. Natural Forest Management

Steps need to be taken to:

(a) Carry out a comprehensive resource inventory inclusive of both wood and non-wood components.

(b) Classify the resources in respect to social, cultural and biological aspects.

(c) Study biological processes in the ecosystems.

(d) Develop appropriate management systems for timber production by:

(i) applying improved logging techniques to minimise adverse environmental impacts

(ii) studying growth and yield

(iii) developing appropriate silvicultural systems

(iv) studying natural regeneration techniques

(v) enrichment planting techniques (nursery practices, rate of arrival, spacing, costs, etc.)

(e) Promote the understanding of ecological processes and their limits to ensure natural forest management systems are both economically and ecologically sustainable.

(f) Maintain representative samples of reserves and protected areas within managed forest areas for carrying out studies to understand integrated resource forest management systems and the associated social systems.

(g) Study the impact of various types of land uses in relation to productivity of soil and nutrient, water resources, wildlife habitat and people.

5. Co-operation for Education and Training among countries in the region

Action should be taken to:

(a) Develop appropriate training courses for all levels of forestry and forest resource management.

(b) Identify and promote collaborative research.

(c) Organise seminars and workshops for decision makers, planners, resource managers and resource owners/users.

6. Development of University of Technology (UNITECH) at Lae as an information centre for the Pacific nations and as a centre for the development of tropical forestry education

   (a) To collaborate with (University of Papua New Guinea) UPNG, Bulolo College and PNG Forestry Department.

   (b) To develop library resources.

   (c) To initiate a three-monthly circulation of 'contents' of journals and to provide a copying service for requests of articles for research and development.

   (d) To establish a research school for Tropical Rainforest Studies.

7. Establishment of a centre for Tropical Rainforest Studies in the Pacific Island nations

   Action was required to:

   (a) Identify and direct resources into the centre.

   (b) Promote the study of rainforests as a comprehensive resource leading to a broad concept for the management of the rainforest ecosystems.

   (c) Affiliate appropriate research persons with the centre.

J. International Workshop on Identification of Key Species for Conservation and Socio-Economic Development

An international workshop was held in 1989 in Trinidad & Tobago on 'Identification of Key Species for Conservation and Socio-economic Development' jointly with IUCN. In view of the importance of the concept of key species relevant details pertaining to the above workshop are given below.

Background

Keystone Species

In most ecosystems, certain species exert a controlling influence out of proportion to their density as biomass over the overall diversity and long-term stability of their ecological communities. Identifying those critical species is one major objective of the IUCN Conservation Science Programme for the next triennium.

Unfortunately, keystone species are difficult to identify: they are not usually the most abundant, nor the most striking or glamorous, members of the community. Further, they do not belong to a particular ecological type: in a given ecosystem, the keystone species might include top carnivores, decomposers, herbivores, pollinators or some of the plants. Up to now, except for a few celebrated experiments, keystone species have been discovered accidentally, following their removal – via harvesting, or replacement by an introduced species – from the habitat.

The workshop was organised to examine how to undertake a systematic analysis of all such cases, to decipher the underlying mechanisms at play so that it would allow us to predict, within reliable limits, the potential keystone species in the major biomes and habitats. A likely spin-off of this effort is to develop a co-ordinated research programme, based on controlled experimental perturbation, to verify such predictions in an integrated programme worldwide.

Life Support Species

Many species display distinct adaptations to environmental extremes, as they are able to grow and reproduce under such conditions as drought and desertification, flood, water pollution, soil toxicity and high salinity. Among such species a number can provide sources of food, materials and energy to human, livestock and other animals, and so are of considerable potential benefit to man. Those species are referred to as life support species. As such, they naturally include keystone species since these hold the key to the integrity of landscapes which include both the diversity of living biota and the human communities.

The potential value of life support species is only now beginning to be appreciated, and has yet to receive the proper attention of agroforesters, aquaculturalists, and more generally from ecological and environmental scientists. For example, of a global total of some 80,000 edible terrestrial plants, only about 150 species have ever been cultivated on a large scale, and over 90% of the world's food is produced from less than 20 species.

In CSC's regional workshop on 'Maintenance and Evaluation of Life Support Species' in 1987 it was highlighted that there are no integrated inventories and studies available worldwide to allow for the use of life-support species. It was observed that there was, therefore, an urgent need to develop a strategy for action to collect information, and focus research priorities on key species that are most critical as:

(a) keystone species to maintain the ecological integrity of ecosystems; and

(b) life support species to ensure human survival under environmental stress (e.g. drought, water pollution, soil pollution, etc.)

In spite of their far-reaching potential, key species as a whole have never been systematically studied. Three key areas of study are:

(i) identification and monitoring

(ii) preparation of inventories

(iii) application in native environment and the potential for introduction to new environments to promote national socio-economic goals.

To prepare the necessary groundwork, a workshop was organised jointly by IUCN and CSC in which 20 leading international experts on the subject were invited from the respective networks of both organisations (Commission on Ecology and Species Survival Commission for IUCN, Network on Biodiversity and Genetic Resources for CSC).

Workshop objective

The workshop objective was to examine and develop guidelines and methodologies as follows:

(a) to develop systematic analysis of key species which play a controlling influence on biotic communities (including human) especially in terms of stability, resistance and resilience through their important linkages.

(b) to identify and develop priority action on those species which present life-support value to rural people (especially in tropical environments).

(c) to develop the application of information for use in the identification mechanisms and processes underlying occurrence, maintenance and survival of these key species by initiating co-ordinating research on (1) theoretical/predictive approaches, (2) experimental approaches and (3) socio-economic approaches.

(d) to develop specific research programmes for terrestrial (forests, agro-ecosystems, etc.) and aquatic environments with emphasis on problems of (1) drought, (2) emergency, (3) flooding, (4) toxicity of soil, (5) water and soil pollution, etc.

Several observations for preparing an Action Plan for the identification of key species were made. These are given below:

(1) Along with the degradation of ecosystems worldwide, thousands of species, and even more genetic variants, are being lost. The main causes of this destruction are rapid

growth in human population, unsustainable levels of resource consumption by the relatively affluent, and the impact of the increasing numbers of people struggling to survive.

(2) Some of the species (or species groups) under threat possess special economic or cultural significance, and are essential for the survival of the ecosystems and landscapes in which they occur. They are therefore regarded as 'key' species.

(3) Conservation and integrated development strategies are needed to halt the biological impoverishment of the planet. Unless human numbers are stabilised and consumption levels are brought into balance with environmental capacities, any conservation strategies will be ineffective.

(4) Conservation efforts to save species and maintain ecosystems have expanded in recent years. Historically, these efforts have tended to focus on the rare and the beautiful species. Today, there is increasing concern for species having particular ecological, economic and cultural significance. Although conservation priorities are recognised for species of obvious economic importance, such as rice, eucalyptus, cows or catfish, many other species of key ecological and socio-economic importance will be lost unless action is taken urgently, within the next five years.

(5) The objectives of the workshop were considered in the following three ways:

(a) to begin to identify such species

(b) to define the most urgent research priorities

(c) to identify priorities for conservation/development action.

(6) A small, but unknown fraction of the world's total of several million species has a disproportionately important role in the ecological processes that maintain the totality of life on this planet. It is important to relate human life and biological diversity to the sustainable ecological and social systems of the Earth. The species that do this are called 'ecological key species' (or 'amplifier species').

(7) Similarly, another unknown fraction of the world's species, used by people for food or for their culture, makes a disproportionate contribution to people's social and economic well-being. Such species are called 'socio-economic key species' (or 'service species').

(8) Both ecological and socio-economic key species are 'Life Support Species'. Conservation of these key species will result in the conservation of many other species and assists in the survival of human communities.

(9) Ecological key species and species groups are key with respect to certain major natural processes, particularly:

(a) organic production

(b) nutrient accumulation

(c) habitat structuring

(d) colonisation

(e) herbivory

(f) pollination

(g) seed dispersal
(h) decomposition
(i) predation
(j) defence against parasites and predators.

(10) Socio-economic key species and species groups are key with respect to certain categories of use, particularly:

(a) commodities (important economic products such as food, animal feed, fibre and medicines)

(b) genetic resources (source of new domesticates and of improvements to established domesticates, and of potential value in biotechnology)

(c) cultural value (significant contribution to the spiritual, emotional, and/or psychological lives of people)

(d) environmental management (use by people to modify, stabilise or rehabilitate environments).

(11) Certain species and species groups are key both ecologically and socio-economically (and some ecological and socio-economic key species are important in more than one of the categories listed in (9) and (10) above).

(12) Key species and species groups are usually specific to particular ecological, cultural and economic circumstances. In other words, there are few, if any, universally key species. Likewise, one cannot anticipate which species, or which genetic variants, might become significant in the future. In other words, species not considered important today may become key tomorrow.

(13) Although we know a large number of socio-economic species, knowledge of key species among them is highly fragmented and often limited to their immediate users. We know much less about ecological key species and can identify only a few. Improving our knowledge of key species is essential; the starting point is in their recognition.

(14) Because of the rapid loss of species and reduction of genetic variability, direct conservation action is needed now, not next year or sometime in the future. At the same time, international research co-ordination to identify key species is called for. The sooner the results of research can guide action, the better it will be for the sustainability of human life on this planet.

Recommendations

The workshop recommended that:

- A strategy for conservation and sustainable use of key species and species groups should include the following six points:

(a) Management and protection of those areas where key species and species groups occur should ensure their long-term survival, at the same time recognising the needs and rights of the local human population.

(b) Conservation plans to identify and maintain migratory key species should be developed.

(c) In human-modified ecosystems, the contribution of agriculture, silviculture and aquaculture to the maintenance and genetic improvement of socio-economic key species should be encouraged.

(d) In degraded land, restoration through the use of key species and species groups, particularly nutrient accumulators and colonisers, should be promoted.

(e) The most efficient and best adapted species (and genetic variants of such species and other species) should be identified.

(f) Native species and genetic variants of native species should be investigated and tested before using exotic species.

Particular attention should be paid to three groups of key species:

(i) species that serve as both ecological and socio-economic key species

(ii) threatened ecological and socio-economic key species

(iii) key species with known, yet unfulfilled, socio-economic potential.

- Governments should promote the identification of both ecological and socio-economic key species, and assess their ecological and socio-economic contribution, within their own countries.
- Governments should support those local socio-economic systems that are actually or potentially compatible with the maintenance of key species, and explore with the local people involved ways of supporting such systems sustainably.
- Governments should determine which key species are adequately maintained in the protected area system of their country, and should as a matter of priority make adequate provision for the conservation of those species that are not adequately protected.
- Governments should ensure that the germplasm of key species is properly collected, conserved and made available including, where appropriate, through captive breeding programmes.
- Regardless of their socio-economic importance, species should not be translocated to new biogeographic provinces (whether marine or continental) without stringent evaluation of the likely ecological consequences.
- The relevant international agencies should promote the international co-ordination of research programmes and information systems concerning key species.
- National and international NGOs should consider and advocate the most effective way to promote the conservation of key species.
- NGOs should promote the information gathering process on, and the conservation of, key species at the local community level, with particular emphasis on the perceptions and practices of indigenous peoples, recognising especially the contribution that women make in this process.
- A major research effort is required to identify ecological key species in natural and

semi-natural ecosystems. A much better understanding of how key species influence the diversity and structure of major ecosystems is needed.

- Research should be carried out on ways of using native key species, exploiting their fullest genetic variability, for socio-economic development activities such as in silviculture, cyclical agriculture, aquaculture and land rehabilitation.
- The range of genetic diversity in key species be assessed for its potential use and conserved in perpetuity, incorporating modern developments in biotechnology as appropriate.
- Research on the ecological implications of global change must be closely integrated with research on key species and their conservation in a changing environment.

K. Regional Workshop on Conservation Biology

The above workshop was held in 1989 in Lusaka, Zambia. At this workshop, the draft edition of the general training manual on Conservation Biology was reviewed. Also, two additional curricula for regional training courses and training manuals on conservation biology for the SADCC Africa region targeted for senior scientists and field extension workers were prepared. Details of these are given below.

Details of Course Contents Developed for a Regional Training Manual in Conservation Biology

Manual Aimed for Trainers of Field Extension Workers

The course will consist of a common 'stem' course which can be followed by optional specialist sections (e.g. genetic conservation, wildlife conservation or forest conservation).

Principles of Resource Conservation

a) Definition of natural resources (e.g. renewable, non-renewable, land, water, biological)

(b) Use of natural resources (uses in agriculture, forestry, fisheries)

(c) Objectives in resource use (short-term and long-term returns).

Socio-economic Implications of Conservation

(a) Definition of development (economic and ecological)

(b) Human population growth patterns and resource carrying capacity

(c) Environmental impact assessments and their role in conservation

(d) International trade in biological resources and its implications on conservation.

Ecological Principles of Resource Management

(a) Energy flow

(b) Nutrient cycling

(c) Biotic interactions (competition, production, etc.)

(d) Community dynamics (succession, etc.)

(e) Population and species dynamics

(f) Biological diversity.

Quantifying Resources

(a) Land inventories and allocation

(b) Inventories of biological resources (communities and species)

(c) Changing patterns of resource use (changing patterns of land, energy, etc.)

Uses of Land

(a) Agriculture (environmental, economic and social constraints)

(b) Forestry (systems of forest production, constraints to production)

(c) Water capture (water catchments, rocks and reservoirs)

(d) Fisheries (types of fisheries and their management)

(e) Game management

(f) Range management

(g) National reserves.

Interactive Land Uses

(a) Agriculture and forestry

(b) Agriculture, forestry and wildlife

(c) Agriculture, forestry and water capture.

Uses of Biological Resources

(a) Plant resources in agriculture (crop and grassland species)

(b) Animal resources in agriculture

(c) Plant resources in forestry

(d) Plant and animal resources in fisheries

(e) Wildlife management

(f) Range management

(g) Soil as a living resource.

Conservation of Biological Diversity

(a) Current and future values of biological diversity

(b) Objectives in conserving biological diversity

(c) Types of conservation *(in situ* and *ex situ)*

(d) Levels of diversity and casual factors.

Methods of Genetic Conservation

(a) Sampling of *ex situ* conservation

(b) Sampling for *in situ* conservation

(c) Preserving seed material; preserving vegetation material (e.g. tissue culture)

(d) Multiplication of material

(e) Evaluation of material

(f) Documentation.

Guidelines for Preparation of Papers

The main guidelines are covered in the syllabus of the Regional Training Manual.

(a) Purpose of Manual

The global core training manual for conservation biology has adequately covered the theory and principles of conservation biology. It is most useful for training scientists and trainers. There is need to supplement it with practical regional and local examples that are essential in training extension workers and land users. For which a supplementary manual, i.e. regional training manual for Southern Africa, is therefore necessary as a basis for strengthening training in conservation biology in the region especially for trainers of field extension workers.

This manual is targeted at resource managers in the region with a minimum qualification of at least a diploma in biological sciences and/or agricultural sciences. The main objective of the manual is to provide guidance to trainees in the conservation of biological resources, including fields such as agriculture, forestry, wildlife, range management, soil conservation and genetic resources. In order to meet this objective, papers prepared for the manual should emphasise the practical aspects of conservation biology with a minimum of theory. The papers should draw upon local conservation examples and practices. This will greatly enhance its relevance as a practical training manual.

(b) Length of Papers

Papers should be written in simple English with a maximum of 15 typed pages at double spacing.

(c) Content

Each paper should attempt to answer the following questions with the aid of as many examples as possible:

(i) What is conservation?

(ii) Why do local people conserve a particular resource?

(iii) What are the existing uses of the resource?

(iv) How do the local people manage the resource?

(v) Is the management objective aimed at short-term or long-term benefits?

(vi) How can the management strategy be improved in order to achieve optimum use and long-term sustainable utilisation of the resource?

(vii) What are the linkages between the particular resource utilisation pattern and the uses of other biological resources?

(viii) How can the proposed management strategy assist in the conservation of biodiversity and/or genetic resources?

L. A Training Workshop on Standardised Methodologies for Survey and Documentation of Locally Used Plant Genetic Resources in Africa

This workshop was held in May 1989, in Ibadan, Nigeria. The workshop's aim was to identify training needs and develop project proposals for the survey and documentation of locally used plant genetic resources. The following recommendations were made:

(1) A survey of all African countries be conducted on the existence of gene banks or institutions working on under-exploited plant species and the status of the existing collections.

(2) Survey of the availability of existing gene banks that can preserve the germplasm of under-exploited crops.

(3) Research or survey be made on the most efficient method of propagating the materials for multiplication and maintenance.

(4) It was pointed out during the workshop that it is possible to preserve seeds of some species for long periods (up to 50 years or more) in a very economical way. This is to dry seeds to a very low moisture content of 4% (for orthodox seeds), then seal the seeds in airtight containers and store at a temperature of 20°C, which can be achieved by the ordinary wall or split-type office airconditioners. National programmes of the developing countries should explore this method of conserving national germplasm.

(5) Survey and research on seed and *in vitro* conservation standards or methods.

(6) To formulate strategy of establishing national *in situ* conservation programmes.

(7) It is essential that any available material be documented for at least the passport data. The characterisation and evaluation data should be documented when available.

(8) The simplest way of documenting the passport information is by recording the information in a log book or cards if a computer facility is not available.

(9) It is essential to use a computer facility to document large volumes of germplasm data. Minicomputers as well as many types of software suitable for data documentation and retrieval are now available on the market and are not too expensive to acquire. National programmes with limited resources are encouraged to use minicomputers for germplasm documentation.

(10) It is useful to establish an international standardisation documentation system including software packages for worldwide exchange of information. Institutions such as IBPGR may be requested to co-ordinate this activity.

(11) It is recognised that some African countries lack qualified and experienced personnel in both conservation and documentation. Accordingly, it is suggested that development of trained manpower is important.

Training Needs

The great potential for the utilisation of under-exploited plants has been recognised. They can be used to extend productive agriculture into areas that are now unsuitable for cultivation. Improvement of plant species adapted intrinsically to fragile ecosystems, e.g. arid areas, for

better performance will solve some of the inherent problems of such countries and areas. The limited resources of poor nations can be used to build a simple agricultural base with the under-exploited plants rather than embracing technological agriculture.

There has been a concerted effort to collect, conserve and utilise the genetic resources of major crops. This effort in Africa has been the responsibility of the International Agriculture Research Center (IARC). The International Institute of Tropical Agriculture (IITA), Ibadan, Nigeria, the International Crop Research Institute for the Semi-Arid Tropics (ICRISAT), with headquarters in Andhra Pradesh, India, and regional centres in Malawi and Zimbabwe, etc., are also involved in this effort. However, there is urgent need to collect and conserve the genetics resources of the under-utilised plants.

The need for surveys and collection programmes is becoming critical as the genetic resources of these plants face imminent genetic erosion. This is due to several factors including natural disasters, overgrazing, destruction of natural habitats and competing demands for land as a result of population growth and development.

One of the major constraints to the effective conservation and utilisation of plant genetic resources in Africa is the shortage of trained manpower at the different levels of involvement in plant genetic resources conservation. There is therefore urgent need for a centre in Africa for short-, medium- and long-term training of personnel geared towards individual country needs.

M. International Workshop on the Biodiversity of Micro-organisms and Invertebrates, and Its Role in Sustainable Agriculture

An international workshop on 'The Biodiversity of Micro-organisms and Invertebrates, and its Role in Sustainable Agriculture' was organised in 1990 in Britain, jointly with CAB International. The workshop reviewed the status of biodiversity among invertebrates and micro-organisms, assessed how agricultural and other changes are affecting it now and may affect it in the future and made recommendations about what action needs to be taken by scientists and governments to improve knowledge and determine future action.

Recommendations

There is a well-recognised need to maintain a stable base for agricultural production, which is increasingly jeopardised by the worldwide changes in land use, population growth and its demands on the environment and the threat of climatic change. The range of diversity contained among the fauna and flora, and certain special habitats, are at particular risk.

Much attention has been focused on the loss of biodiversity among vertebrates and higher plants, where changes in habitat produce easily observed losses in the diversity of species present. Actual losses in numbers of species are likely to be much greater among the less readily observed invertebrates and micro-organisms living in the soil and within the forest canopy. These organisms, while less ornamental, play an exceedingly important role in maintaining and promoting soil fertility by recycling the nutrients contained in decaying organic matter, by fixing nitrogen from the air and by detoxifying pesticides and other waste products. They are also an essential source of many valuable products, such as antibiotics and other pharmaceuticals, and have an important role in most biotechnological and bio-industrial processes.

The workshop reviewed the importance of biodiversity among invertebrates and micro-organisms, what is involved, why it is useful and how it can be preserved and better used. The following summarises the main findings (which should be of interest to scientists and policy makers alike):

(1) The needs of human populations for food, fuel and fibre have historically been supported, directly or indirectly, by genetic diversity among the micro-organisms and invertebrates. These organisms perform functions which prime and fuel the metabolism of soils, plants and animals. The development of sustainable agro-ecosystems and the enhancement of agricultural productivity will depend increasingly on the maintenance of such diversity for:

   (i) The improvement of soil structure and fertility, through the decomposition of organic material added to the soil, and the detoxification of pesticides and other pollutants

   (ii) The provision of biological controls for insect pests and diseases of plants and animals

   (iii) Processing and enhancing the nutritional value of foods

   (iv) Maximising the potential for novel products for use in the pharmaceutical and other industries.

(2) We need to increase our knowledge of the nature, extent, functions and potential usefulness of the genetic resources to be found in micro-organisms and invertebrates and how to protect different ecosystems as reservoirs of such biodiversity.

(3) To do this will require that:

(i) Existing genetic potential in invertebrates and micro-organisms is conserved by the preservation of natural and man-made systems and sites, and where there are difficulties in recovering micro-organisms from the environment, by maintaining culture collections of organisms of current potential value*

(ii) Research is undertaken on the measurement of the diversity of organisms, and of the gene contained, and to identify the ecological interactions and the role played by different organisms in agricultural and natural systems. This is particularly pertinent for pest management and, for example, in the role of fossil organisms involved in the restoration of degraded lands, the decomposition of carbon compounds and the evolution of carbon dioxide and other greenhouse gases. The likely effects of climatic change on the activities and conservation of invertebrates and micro-organisms, their migration and the development of new associations are, as yet, almost wholly undeciphered. While their involvement in the release of carbon dioxide and other greenhouse gases is well established, much remains to be learnt of the factors controlling the quantities and rates of release, and of the organisms involved.

(4) Knowledge of the functional role of many micro-organisms and invertebrates in agricultural and other ecosystems is inadequate. Limited understanding of their role in ensuring the continued stability of ecosystems requires that much more research be conducted to obtain the information which will enable the importance of biodiversity to be assessed and managed so as to promote the sustainability of agricultural production.

(5) The promotion of biodiversity alone will not eliminate the need for improvements in production and husbandry measures. It will, however, contribute to the development of diverse systems able to sustain a low level of production on marginal lands, while making more sustainable the robust, high production systems of more fertile areas, and minimising the need for external inputs.

(6) Habitat disturbance, pollution and climate change all cause changes in the biological population, particularly in ecologically sensitive areas. Invertebrates and micro-organisms need to be monitored to follow the effects of these changes. They can be used as indicators of the stress applied to the environment.

(7) Current capabilities for the recognition, characterisation and study of micro-organisms and invertebrates are insufficient to meet current needs. The need to support effective conservation and utilisation of biodiversity requires development of skills in biosystematics and related disciplines worldwide.

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* The Workshop noted the work of IUCN (the World Conservation Union) and the World Federation for Culture Collections (WFCC) on these topics, and stressed the need to consider micro-organisms and invertebrates more fully in the selection of reserves.

The shortage of biosystematists can be accommodated in the short term only by the fullest collaboration between centres of expertise. This may best be done through the establishment of a formal Network of Biosystematic Centres. This will involve the strengthening of existing centres of activity, and the development of new centres through training, infrastructure building and information transfer.

(8) The benefits to the human race of retaining a wealth and diversity of biological resources should be more clearly recognised. There is particular need to promote an understanding of the potential of invertebrates and micro-organisms for advancing human welfare. It is known that improved management of land and other resources, through the imaginative use of biodiversity, can increase the efficiency of agricultural production and so improve social and economic welfare. Soil organisms have provided a wealth of valuable products such as antibiotics, and much remains to be learnt of the value of the products which may be obtained from the vast biological resources of the natural world.

(9) Education and training must reflect the need to increase awareness of the significance of biodiversity in agriculture and the environment, including the problems of protecting ecologically vulnerable areas. This may be achieved by regional and national policies for primary and secondary education. The media and local natural history and conservation societies also have an important role in complementing and augmenting such policies, and may help to stimulate their initiation.

(10) Information systems are essential for recording, interpreting and making available the accumulated knowledge on biodiversity. The specific needs include:

(i) Research on the most appropriate ways of recording, collecting and interpreting data and for disseminating information through participatory networks

(ii) Standardising methodologies for the collection and recording of information

(iii) Co-ordinating and implementing the acquisition of information

(iv) Co-ordinating and implementing the dissemination and networking of information.

The standards being developed by the International Union of Biological Sciences (IUBS) through its Taxonomic Databases Working Group may be particularly valuable in relation to the needs.

(11) Biodiversity covers immense and complex issues in which many agencies and institutions are active worldwide. There exists a need for an international mechanism to co-ordinate, analyse and disseminate the relevant information. This will include:

(a) The standardisation of scientific and information methodologies

(b) The processing of information on the significant hazards to the protection of biodiversity

(c) The monitoring of worldwide activity relevant to biodiversity and its application

(d) Promoting protocols for the control of the release of exotic unfamiliar organisms

(e) Recommending courses of action to ensure the protection of indigenous property rights and assurance of fairness for those whose survival, social and economic welfare depend on the conservation and prudent employment of natural resources

(f) Ensuring that resources are directed to enable developing countries to implement an optimum course for the sustainable utilisation of their natural resources.

(12) It is hoped that these findings will be considered for inclusion in the Agenda of the United Nations Conference on Environment and Development in 1992, and other appropriate initiatives.

N. Workshop on Conservation through *In Vitro* Methods

The above workshop was held in May 1990 in Kuala Lumpur, Malaysia.

Aims and Scope of the Workshop

(1) Plan and formulate strategies for the conservation of biodiversity and plant genetic resources in the Asia-Pacific region through *in vitro* methods.

(2) Review and standardise protocols for genetic conservation through tissue culture techniques and molecular biology, and to facilitate germplasm exchange.

(3) Develop course material for future training and manpower in conservation of genetic resources through tissue culture and molecular biology.

Observations and Recommendations

The workshop observations and recommendations are grouped into the following categories:

(a) Plant species priorities

(b) Characterisation of genetic diversity and diagnostics

(c) *In vitro* technology

(d) Storage of germplasm

(e) Human resources development and training.

Plant Species Priorities

(1) Gaps in application of technology and future prospects

In some crop and tree species the techniques for conservation are available, but not in others. The technology needs to be transferred to countries where the technique is just being developed. It was felt that the technique of disease elimination and indexing is available in some centres but the technology should be made available to developing countries. It is also necessary to do some characterisation and testing of the generated plants.

(2) Prioritisation of plant species

The plant species were classified into three groups. The first group consists of plants with endangered field gene banks (arboreta, botanic gardens and others). These include taro, sweet potato, yam, banana, sugarcane, mango, durian, timber species, rattan, bamboo, *pandanus*, industrial and medicinal plants. The second group consists of plants located in endangered natural populations due to shifting cultivation, deforestation and over-exploitation. Timber species, fruit trees, medicinal plants and wild relatives of cultivated plants fall into this group. The third group consists of unidentified potential species.

It was agreed that *in vitro* technology should be explored for those plants which cannot be conserved by conventional means.

(3) Centres of excellence

The three research institutions in Malaysia, RRIM, PORIM and FRIM, were identified as centres of excellence for rubber, oil palm and forestry. MARDI is noted for research in other crops. In the Philippines, IRRI is well known for research on rice, UPLB for tissue culture in general, PRCRC for root crops and sugarcane and the Philippines Coconut Authority for coconut. In India, CIMAP is known for medicinal plants, National Botanic Research Institute, Lucknow, for economic plants and NCL, Pune, for tree and plantation crops.

(4) Linkages with on-going programmes in the region

It is necessary to survey the existing activities in the region and to explore the possibility of promoting linkages among different agencies and countries where the relevant technologies are available.

Characterisation of Genetic Diversity and Diagnostics

Diagnostics deals with disease and past resistance whilst characterisation normally refers to general terms of characterisation of genetic diversity.

Currently, characterisation techniques are morphological (e.g. qualitative characters), physiological (e.g. isozymes, storage proteins), cytological (e.g. chromosome count, cDNA banding) and molecular (e.g. RFLPs). Techniques for diagnostics are nearly the same as that for characterisation except for some others like ELISA. Nearly all of these are well established, except for RFLPs which have been worked out in certain crops such as cereals (rice, wheat, barley and corn), vegetables (tomatoes and lettuce) and several field crops (sugar beet, soybean and potatoes). Some attempts to use RFLPs have also been made in tropical plantation species such as rubber and palm oil.

Most of the advances in the development of the above techniques were made in the developed countries or in the various international agricultural research centres. There is, therefore, a need to establish a linkage between researchers in the developing countries and their peers located in these institutions. It is also recognised that there should be a regular exchange of information among scientists using the above techniques, e.g. through a newsletter, which may give very useful hints and thereby save a lot of time and money. Regular scientific meetings and/or short courses at the regional or national levels should be organised from time to time.

In Vitro Technology

(1) Recommendations

(i) The community at large should be educated on the importance of conserving germplasm. It was realised that the scope of this recommendation may not be within the purview of this conference. However, it was felt that in order to ensure that germplasm is recognised as being important, basic educational programmes should be established not only in this region but throughout the world.

(ii) *In vitro* conservation should not be separated from other conventional methods of conservation, most of which are already in existence. *In vitro* technology does have a place in conservation but it must be incorporated into an overall strategy in which other conventional methods are being used.

(iii) Basic *in vitro* studies need to be undertaken of the plant systems that need to be conserved, in order to maximise the success of conservation.

(2) Uses of In Vitro Technology

Uses of *in vitro* technology were discussed under three headings: culture and regeneration, utility in terms of propagation and somatic exchange, and *in vitro* collection.

(i) Culture and Regeneration

- Routine techniques

  In terms of culture and regeneration, there are a series of routine methods that can be used. There was no universal method to regenerate plant systems in all species. In South-East Asia much progress has been made in the culture and regeneration of crop, forest and herbaceous plants, and a high level of expertise has been developed in this area. In order to preserve genetic fidelity, rigorous screening of the plants needs to be undertaken. This will ensure that abnormalities are minimised. *In vitro* approaches may give rise to variation but it will still allow a significant proportion of the germplasm to be preserved.

- Successes

  Several examples of successes in the regeneration of plantlets were cited for cassava, sweet potato and banana.

- New emerging techniques

  A technique which is not widely used in South-East Asia is electro-enhancement of tissues. This could be used to further stimulate regeneration of species which show limited regeneration in culture.

- Information dissemination

  Each country needs some form of organisation to collect and disseminate information on the progress made on *in vitro* studies, particularly on the techniques used for germplasm storage. Above all, a network should be established in each country so that information could be disseminated rapidly between workers. There are commercial implications of this but this has to be dealt with at the commercial organisation level. Sufficient technical workers are active in this area who could transfer information, meet on a regular basis, discuss and disseminate information and solve problems jointly.

(ii) Utility

It was felt that micropropagation was well established for many species except the tree species. Tissue culture work should not be separated from aspects of collection/evaluation/utilisation and conservation.

Research into *in vitro* technology should be part of an overall scheme and brought into the implementation strategy of the programme. It was recognised that germplasm exchange needs to be related to long-term breeding programmes.

(iii) *In Vitro* Collection

It was recommended that simplified facilities be made available for the collection of important germplasm, particularly in relation to recalcitrant seeds and bulky plant materials. Workers should be trained to put these materials into culture in the field.

Training

As far as training for *in vitro* technology is concerned, it was considered that the basics are already in place in most countries and therefore, there is no need to have any comprehensive training programmes on tissue culture *per se*; but there is a need to update tissue culturists with more sophisticated applications in the area of genetic manipulation.

Storage of Germplasm

Genetic conservation is a long-term process and this applies to conventional as well as *in vitro* storage techniques. Therefore, a long-term commitment on the part of policy-makers and researchers is essential. Once established, the programmes must be sustained in terms of resources and ancillary support particularly in information and technology transfer. Further, it is recognised that conservation can only be assured by the use of complementary techniques, and that use of any single technique was unsatisfactory as it put the conserved material at risk.

There is a need for collection and dissemination of research information. This information needs to be collated at the national, regional and international levels. It is also recommended that a specialised computerised database, taking information at these various levels, and from other existing databases and information networks, would be the preferred mechanism on a long-term basis. A mechanism should also be created to link curators, technologists and end-users in a particular region with a support network of experts from the international scientific community. This mechanism would include advisory visits and scientific meetings. These is a need to develop specialised training in *in vitro* storage technology. Courses should be based regionally to ensure wide access and would lead to the establishment of training activities at a local level.

Human Resources Development and Training

Training should be carried out in four broad areas, namely: collection, gene bank management, *in vitro* techniques and characterisation, and evaluation and documentation.

(1) Collection

Region-specific methodology for exploration and collection are emphasised as problems of collection in the tropical areas are quite unique. Courses should be conducted

by experts who are working in this region and familiar with the taxonomy of the plants and also with the various difficulties encountered in collecting live material. Institutions which can offer such training are as follows: Bogor Botanic Gardens (Indonesia), FRIM (Malaysia), Kew Gardens (Britain) and the National Bureau of Plant Genetic Resources (India).

(2) Gene Bank Management

Personnel at the pilot *in vitro* gene banks established with the collaboration of IBPGR, such as that in CIP (Peru) and CIAT (Columbia), could provide expertise for training.

(3) *In Vitro* Techniques

There are several established centres for such training, e.g. National Chemical Laboratory (Pune), National Botanical Research Institute (Lucknow), Central Institute for Medicinal and Aromatic Plants (Lucknow), Institute of Biotechnology (Los Banos) and MARDI (Malaysia). In addition to the available sources of funding such as FAO, JICA, ICRO, IDRC, IBPGR, AIDAB and GTZ, user countries should tap their own resources, as conservation of biodiversity and plant genetic resources are crucial for sustainable development in these countries.

(4) Characterisation, Evaluation and Documentation

A major lacuna exists in these areas. It needs to be filled up expeditiously. As details of evaluation and documentation have been already developed by IBPGR, model training courses suitable to the region may be designed by utilising the expertise available.

Disease detection and quarantine measures for virus indexing of tissue culture-derived clonal material are important. A training programme may be organised to impart the necessary skills by ASEAN PLANTI, Malaysia. The National Botanical Research Institute, Lucknow, may also be approached to provide training facilities.

For developing competence in using modern methods of documentation, a training programme in the use of computers and preparation of databases and retrieval of information is also recommended.

(5) Modality of the Training Programme

To ensure quality, the intake in each training programme must be restricted to 10-12 trainees. The centres of training should be well-equipped and staffed.

With regard to modern technologies for evaluation of germplasm, it is suggested that special training be organised for RFLP mapping and other techniques essential for ensuring the genetic stability and proper identification of the *in vitro* genetic materials. This course can be organised locally with help from experts from the international scientific community.

Conclusion

Experience from the two international workshops co-organised by the CSC has shown that there is a tremendous scope for the introduction and development of *in vitro* methods to conserve and sustainably utilise plant genetic resources.