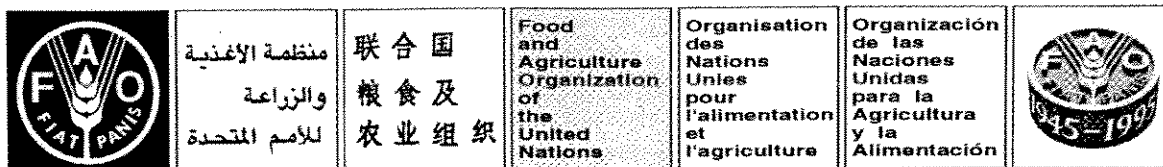


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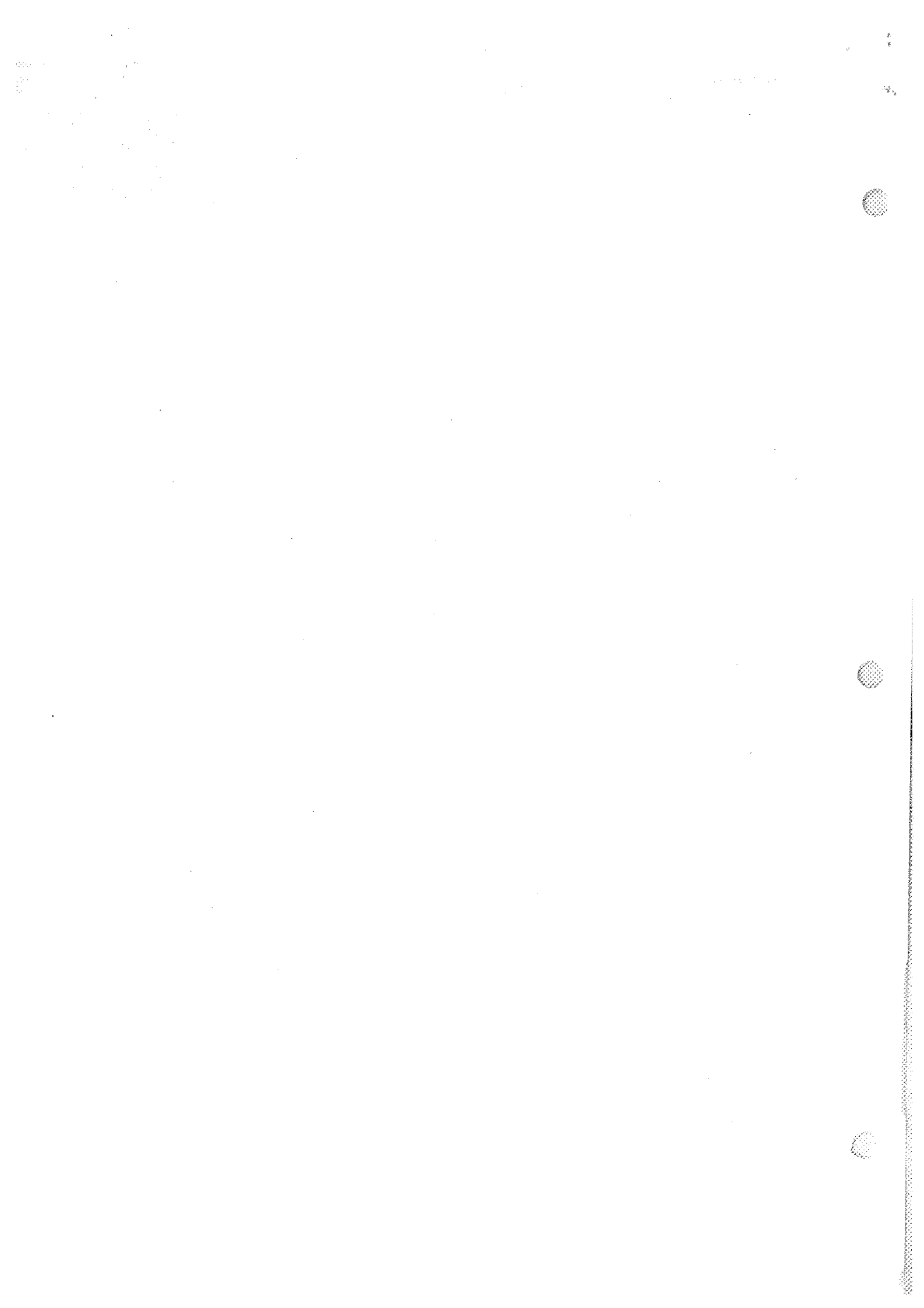
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**A PRELIMINARY ABSTRACT OF A CURRENT STUDY ON *EX SITU*
COLLECTIONS AT BOTANIC GARDENS**
With particular emphasis on plant genetic resources for food and agriculture

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I. INTRODUCTION

1. Resolution 3 of the final document of the Nairobi Conference for the Approval of an Agreed Text for the Convention on Biological Diversity (May 1992) recognizes the need to seek solutions to outstanding matters concerning plant genetic resources within the framework of the Global System for the Conservation and Sustainable Use of Plant Genetic Resources for Food and Agriculture, and makes special mention of the accessions to *ex situ* collections not acquired in accordance with the Convention. The great majority of collections at present existing at botanic gardens were acquired prior to the entry into force of the Convention, and therefore fall into this category.
2. The present document provides a preliminary summary of the study commissioned by the Secretariat for Plant Genetic Resources pursuant to Resolution 3 of the Nairobi Conference.
3. The documentation that includes the present report makes use of the following sources:
a) successive editions of the Directory of Botanic Gardens, published by IABG and BGCI; b) the catalogues, guidebooks and other publications existing on many botanic gardens; c) the papers published in the **Threatened Plant Newsletter** and the **BGCI Newsletter** on the species and collections in botanic gardens; d) other papers scattered among various books and journals; e) the survey and personal visit by the author to over a hundred botanic gardens in America, Asia and Europe. The information acquired has provided the groundwork for the conclusions and results submitted in the present preliminary report.

II. THE BOTANIC GARDENS

Background

4. Botanic gardens are institutions that combine scientific research and conservation work with educational and cultural tasks by interactively disseminating messages and knowledge in local societies and communities while managing and conserving a manifold heritage, ranging from the documentary (libraries, herbaria, museological collections), to the genetic (cultured germplasm collections, seed banks, tissue banks), and even to the historical, the ethnological and the artistic. The synergy of these multiple objectives gives rise to a unique potential for the conservation of plant genetic resources, not only those of wild origin but also those relevant to agriculture and the food requirements of a population.
5. Some botanic gardens have existed for as long as 450 years. Many botanic gardens not only cultivate plant species in an orderly and visually pleasing or charming fashion; they also maintain monographic collections, develop propagation techniques for endangered species, conserve plant germplasm in a seed bank form, develop conservation and multiplication techniques and do research work on folk practices, cultivation systems, taxonomic nature, phytochemical components, the phylogenetic origin or ecological needs of the species in question. Botanic gardens keep tens of thousands of hectares under cultivation. Their over half a million square metres of environmentally conditioned greenhouses house some 50 000 plant species. No fewer than 150 botanic gardens have germplasm banks in seed form, and 35 of these have laboratories and in vitro culture chambers.

Geographical distribution of botanic gardens

6. Most of the nearly 1500 botanic gardens existing around the world and distributed across 187 countries make up an international network that maintains a high degree of cooperation and interaction.¹ The gardens are unevenly distributed, with 61 percent of the total located in Europe, the countries of the former USSR and the United States. As a whole, they conserve or cultivate approximately half of all the higher plants known on our planet.

III. GERMPLASM COLLECTIONS AT BOTANIC GARDENS

Background

7. According to the study under way at present, approximately 47 percent of botanic gardens - i.e. 698 - have "plant germplasm collections". In the remaining 792 plant biodiversity is high - in many cases there are well over 10 000 taxons under cultivation - but without reaching the level of germplasm collections.² The 698 can be divided into three groups:

- i) In 410 of them, the collections serve an exclusively ornamental purpose, or are made up of endangered wild species, originating from the country where the botanic garden is located. The latter can be of some agricultural interest since in many cases they include species phylogenetically close to those under cultivation (they are part of the same genetic stock).
- ii) A further 169 gardens also maintain collections of medicinal plants or plants with a timber potential (suitable for lumbering, paper or cork making) of significant importance.
- iii) Lastly, another 119, in addition to the collections mentioned in points i) and ii), maintain germplasm collections of specific food or agricultural interest, made up of species and varieties from their wild population cultivated or exploited for their food, fibre or oil content value, or for other industrial applications. Some are made up of species of ethnobotanical interest or agricultural promise.

Location of collections

8. Twenty-five percent of the 698 botanic gardens with germplasm collections are located in European Union (EU) countries, and these are the ones with most know-how and the best equipment. It can be estimated that 40 percent of the collections are in these gardens and in these countries. Together with the other European countries and the United States, they probably account for 75 percent of all collections maintained in the botanic gardens all over the world.

9. Nevertheless, if the nature of the collections is analysed, it will be noted that the botanic gardens of the most highly developed countries - namely, those in the European Union, the United States and Japan - devote most of their attention to group i) collections (some 60 percent), followed by group ii) (30 percent), and, trailing rather far behind, group iii) (10 percent). Most of group

¹ Cooperation and interaction take place through:

The International Association of Botanic Gardens (IABG) which regularly holds international congresses and promotes association and cooperation at lower levels.

The various supranational or national associations of botanic gardens, e.g. the European-Mediterranean, Asian, Latin American and Caribbean, North American (AABG), Ibero-Macaronesic (AIBMB), Japanese and French associations. These associations maintain a high level of cooperation among their members through meetings and exchange of experience of all kinds.

Botanic Gardens Conservation International, an organization that coordinates the activities of nearly 250 botanic gardens engaged in conservation programmes. BGCI publishes a newsletter and a steady stream of papers and handbooks on conservation techniques, international cooperation and education. It also organizes meetings, workshops and, every three years, an international congress.

A mechanism whereby plant germplasm is interchanged free of charge by the editing, distribution and offer of *Index Semina*; this has been going on for over 300 years, and it is estimated that between one and two million accessions take place each year.

² "Germoplasm collections" are defined here as those made up by a number of individuals or by a volume of propagules in the accession sufficient to guarantee the taxon's minimum genetic variability.

iii) collections - i.e. the collections of specific interest for food and agriculture - are kept in other botanic gardens such as those in Asia (e.g. India and China) and Central America (e.g. Mexico).

Nature of collections

10. The group i) collections, when made up of ornamental, in many cases cultivated, varieties, tend to be comprised of the following families: *Araceae*, *Bromeliaceae*, *Commelinaceae*, *Cycadaceae*, *Cactaceae*, *Ericaceae*, *Fabaceae*, *Geraniaceae*, *Moraceae*, *Musaceae*, *Myrtaceae*, *Orchidaceae*, *Rosaceae*, and *Salicaceae*, or of species belonging to such genera as: *Agave*, *Aloe*, *Ananas*, *Anthurium*, *Araucaria*, *Bambusa*, *Begonia*, *Camellia*, *Eucalyptus*, *Ficus*, *Grevillea*, *Hibiscus*, *Hydrangea*, *Ilex*, *Iris*, *Magnolia*, *Malus*, *Morus*, *Opuntia*, *Picea*, *Phoenix*, *Phylodendron*, *Pinus*, *Platanus*, *Populus*, *Prunus*, *Rhododendron*, *Robinia*, *Rosa*, *Salix* and *Syringa*.

11. Those in group ii) (medicinal and timber plants) are mostly made up of species in the following families: *Apiaceae*, *Arecaceae*, *Asteraceae* (*Anthemideae*), *Betulaceae*, *Chenopodiaceae*, *Cycadaceae*, *Cupressaceae*, *Ericaceae*, *Fabaceae*, *Moraceae*, *Myrtaceae*, *Pinaceae*, *Rosaceae* and *Salicaceae*, or of species belonging to such genera as: *Abies*, *Acacia*, *Acer*, *Aloe*, *Araucaria*, *Artemisia*, *Betula*, *Castanea*, *Cinchona*, *Cinnamomum*, *Cupressus*, *Eucalyptus*, *Fagus*, *Ficus*, *Gentiana*, *Grevillea*, *Ilex*, *Mentha*, *Michelia*, *Morus*, *Nicotiana*, *Notofagus*, *Papaver*, *Picea*, *Pinus*, *Platanus*, *Populus*, *Pseudotsuga*, *Quercus*, *Robinia*, *Salix*, *Sorbus*, *Taxus*, *Thymus*, *Tilia* and *Zingiber*.

12. Those in group iii) (of food and agricultural interest) are mostly made up of species in the following families: *Annonaceae*, *Apiaceae*, *Araceae*, *Brassicaceae*, *Chenopodiaceae*, *Cactaceae*, *Fabaceae*, *Musaceae*, *Oleaceae*, *Poaceae*, *Rosaceae* and *Rutaceae*, or of such species as: *Actinidia*, *Agave*, *Allium*, *Ananas*, *Annona*, *Atriplex*, *Bambusa*, *Castanea*, *Cichorium*, *Cinnamomum*, *Citrus*, *Coffea*, *Corylus*, *Crocus*, *Crataegus*, *Dioscorea*, *Diospyros*, *Eugenia*, *Ficus*, *Fragaria*, *Glycyrrhiza*, *Gossypium*, *Hevea*, *Hordeum*, *Juglans*, *Lycopersicum*, *Malus*, *Mangifera*, *Morus*, *Opuntia*, *Passiflora*, *Phaseolus*, *Persea*, *Prunus*, *Psidium*, *Pyrus*, *Ribes*, *Rubus*, *Simmondsia*, *Solanum*, *Theobroma*, *Triticum* and *Vitis*.

Repetition in collections

13. A certain amount of repetition is observed in the collections, as well as a degree of regional specialization. Thus, most fruit tree collections belong to the genera *Malus*, *Pyrus*, *Prunus* and *Sorbus*. United States gardens have numerous collections of *Citrus* and those in the countries of the former USSR have numerous collections of *Vitis*, *Fragaria*, *Malus*, *Pyrus*, *Juglans*, *Ribes* and *Citrus*. Those in Asian countries tend to have collections of *Musaceae*, *Bambusa*, *Mangifera* and *Zingiber*. Even so, there is a lack of collections for numerous genera and species of great agricultural importance which no one seems to care about.

14. Geographically correlated repetition is likewise present in timber and medicinal plant collections. This repetition becomes obsessive in the case of ornamental collections. Thus United States gardens show a manifest interest for genera like *Rhododendron*, *Camellia*, *Ilex* and *Magnolia*. Europeans prefer plants in the Cactus, Orchid and Bromelia families (*Tillandsia* most of all). Nevertheless, certain genera are lacking in spite of their importance as ornamental plants; such is the case with *Dianthus*, *Ginkgo*, *Viola*, *Chrysanthemum*, *Jasminum* and *Pelargonium*.

Size of collections

15. In nearly all botanic gardens there is no information concerning the size of the collections. Very few countries have centralized collections. At any rate, it seems that the number of accessions per taxon is in the range of 1 to 5 in the case of cultivated collections, and rarely reaches 10. The number of individuals per accession is also low in nearly all cases and, generally speaking, not

representative of the existing genetic variability. Collections maintained by botanic gardens in seed bank form seem to be kept in a stricter order, both as to number of accessions and volume. The lack of concrete data is a generalized phenomenon.

Conservation regime

16. Eighty percent of botanic gardens maintain their *ex situ* collections by outdoor or greenhouse cultivation. The remaining 20 percent is made up of the 150 botanic gardens that own and handle seed banks using medium- to long-term conservation techniques. A tiny portion is represented by *in vitro* or cryo-conserved collections; although 35 gardens own *in vitro* culture units; this technique is used in very few cases for conservation, handling actual tissue or propagule banks. Some bulbous plants or plants in the Orchid and Bromelia families are kept strictly *in vitro*. The recourse to cryo-conservation techniques is exceptional.

Origin and type of germplasm

17. Even though many botanic gardens (40 percent) do not keep an actual register of the collections of plants they cultivate, 60 percent of those that maintain a collection have some system of registration, and in 25 percent of those it is computerized.

18. Nevertheless, the available data allow us to estimate that in over half the accessions to the botanic gardens' germplasm collections, the geographical origin of the germplasm cannot be established on a locality level, and, in many cases, not even on a country level.

19. The relative percentages of wild or grown germplasm conserved vary according to its taxonomic nature. Generally speaking, the collections of autochthonous species of plants of medicinal or ethnobotanic interest (such as those utilized for crafts or as dyes), come from wild stock. Virtually the opposite situation prevails in the case of ornamental plants. For agricultural collections, the situation varies, although a significant number of gardens are working with local varieties. Others are partly or fully recognized as ethnobotanic gardens inasmuch as they maintain collections of locally exploited species and are specially equipped for this.

Ownership of collections

20. No clear recognition exists of the legal status of the collections from the point of view of ownership, and a proper legal survey would be advisable on this point. If the decision to carry it out is taken, however, a break-down of data should be carried out on the basis of administrative category:

Categories	%
State and Regional Administration	37.5
Local (Municipal) Administration	9.0
Municipality-University Consortium	1.0
Universities and Research Institutes	31.0
Private Bodies	11.0
Others (or no data available)	10.0

Availability and interchange

21. By and large, botanic gardens have for over 300 years kept up a traditional free exchange system based on Index Semina editing, requests and dispatch. This system seems to ensure great accessibility to all applicants; however, as regards the germplasm conserved in botanic gardens, its has a good many drawbacks which have recently been analysed by a number of authors, who have revealed lack of seriousness in requests, waste of germplasm and an obvious bias in the requesting gardens and countries vis-à-vis the donor centres. In nearly every case the final destination and utilization of the material sent remain unknown. A tendency is now appearing to bring a degree of rationality into the system by coordinating supply among countries and restricting the shipping of rare or endangered germplasm, except where its proper use is guaranteed.

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