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COMMISSION ON GENETIC RESOURCES FOR FOOD AND AGRICULTURE

WORKING GROUP ON PLANT GENETIC RESOURCES FOR FOOD AND AGRICULTURE

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TOWARDS THE SUSTAINABLE USE OF PLANT GENETIC RESOURCES FOR FOOD AND AGRICULTURE (PGRFA): STRENGTHENING PLANT BREEDING

Table of Contents

	Paragraphs
1. INTRODUCTION	1 - 5
2. PLANT BREEDING AND CHARACTERIZATION OF PGRFA	6 - 8
3. BASE-BROADENING EFFORTS	9 - 10
4. UNDER-UTILIZED CROPS AND SPECIES	11 - 12
5. CHALLENGES FOR THE IMPROVED UTILIZATION OF PGRFA IN DEVELOPING COUNTRIES	13 - 16
6. IMPROVING SUSTAINABLE UTILIZATION OF PGRFA BY ASSESSING AND STRENGTHENING PLANT BREEDING CAPACITY	17 - 21
7. GUIDANCE BEING SOUGHT FROM THE WG ON PGRFA	22

1. INTRODUCTION

1. The International Treaty on Plant Genetic Resources for Food and Agriculture acknowledges that plant genetic resources for food and agriculture (PGRFA) are indispensable for both traditional and modern approaches to crop improvement. Article 1 highlights the sustainable use of plant genetic resources as one of the Treaty's three main objectives. The utilization of plant genetic resources is crucial for food security and our ability to adapt to changing environmental conditions and social needs. Article 6 of the International Treaty on PGRFA foresees that Contracting Parties will promote sustainable use of PGRFA. Article 14 of the International Treaty also recognizes the importance of the *Global Plan of Action*¹, which was adopted in the Leipzig Declaration in 1996. The plan is a strategic framework for the implementation of the International Treaty and it recognizes the need for continued efforts at national and international levels to use plant diversity for increased food production and the promotion of sustainable agriculture systems. The Plan emphasizes the importance of capacity building, technology transfer, information exchange and benefit sharing for the effective implementation of the International Treaty.

2. A principal aim of the Global Plan of Action is to promote the sustainable use of PGRFA. The Plan outlines a set of activities for achieving this objective, which are to be carried out in harmony with associated activities for in situ and ex situ conservation, and institution and capacity building. Within the framework of the Global Plan of Action, activities for the "Utilization of PGRFA" include: expanding the characterization, evaluation, and the number of core collections to facilitate use (Activity 9); increasing genetic enhancement and base-broadening efforts (Activity 10); promoting sustainable agriculture through diversification of crop production and broader diversity in crops (Activity 11); and promoting development of underutilized crops and species (Activity 12). The Global Plan of Action provides a framework for strengthening the synergies between conservation and utilization in plant breeding for development. In addition, Activity 10 stresses that support is required for national systems, regional networks, International Agricultural Research Centres, non-governmental organizations, universities and other relevant organizations to carry out "pre-breeding" and genetic enhancement activities.

3. At its Ninth Session in 2002, the Commission on Genetic Resources for Food and Agriculture emphasized "the importance of promoting the sustainable use of plant genetic resources for food and agriculture, through germplasm characterization, evaluation and enhancement, plant breeding (including participatory plant breeding), and seed production and distribution; and its contribution to food security"². The Commission agreed that its Working Group (WG) should look at issues related to PGRFA use and strengthen germplasm conservation, plant breeding capacity and seed systems.

4. While previous discussion on PGRFA accurately emphasized the crucial aspect of conservation, it should be noted that the actual benefits of plant genetic resources can only materialize when they are utilized through traditional or modern plant breeding processes. Governments may now wish to focus more attention on the utilization of PGRFA and its potential to contribute to the development of countries and regions. Countries require adequate human and economic resources and technical capacity to fully realize and utilize the benefits of conservation.

¹ The Global Plan of Action for the Conservation and Sustainable Utilization of Plant Genetic Resources for Food and Agriculture; FAO, 1996.

² CGRFA-9/Rep. 2003.

5. This document responds to the Commission's request that the implementation of the Global Plan of Action strengthen plant breeding capacities. It considers a series of issues related to plant breeding. Next, it outlines practical steps to establish and eventually address crop breeding priorities, especially in developing countries. Finally, the WG is asked to provide guidance on a FAO survey, which has been developed to characterize national capacity in sustainable use of PGRFA and related activities. The survey results will be presented to the CGRFA.

2. PLANT BREEDING AND CHARACTERIZATION OF PGRFA

6. Considering that plant breeding uses PGRFA as "building block," the collection, characterization, and evaluation of plant germplasm are essential steps in an efficient breeding programme. This potentially includes germplasm from primary, secondary and tertiary gene pools, which may be introduced into a breeding programme at any stage. Many plant breeding programmes, especially those in developing countries, have made limited use of the PGRFA available in gene banks around the world; FAO needs to work with partners to help stimulate countries to fully utilize these gene pools.

7. In order to exploit the full potential of PGR conservation, emphasis must be placed on the "germplasm enhancement" or "pre-breeding" phase of plant breeding. Nearly all plant breeders need to broaden the base of their breeding material when starting a new cycle of variety development. By beginning with a wide range of crop diversity, they are able to capture new desirable traits from wide crop diversity and work these into material adapted to diverse ecological conditions and economic needs. "Pre-breeders" are often responsible for providing basic germplasm to a large number of other plant breeders who, in turn, use it to create new cultivars. Therefore, this phase of the plant breeding cycle is of particular importance in providing effective utilization. In the majority of developing countries, "pre-breeding" programmes and biotechnology are located within universities, while applied plant breeding is generally within the Ministry of Agriculture. By working together on integrated national breeding activities, universities and government ministries can create efficient programmes that make a tangible impact. Funding allocations to university staff to increase their ability to work with applied plant breeders is often an effective policy implementation tool to enhance coordination.

8. There are a range of opportunities for improving the utilization of plant genetic resources, including recent technical developments, that can help streamline many aspects of plant breeding. One principal technical constraint to plant breeding is that selection is mostly done based on physical attributes (phenotype), which are influenced by the environment and are not necessarily a good guide to the actual heritable genetic constitution (genotype). Biotechnological methods can help overcome this constraint by allowing direct selection of genotype through molecular tools and technologies, including marker-assisted selection and genetic engineering. The biotechnology based tools are useful for measuring biodiversity; and for breeding crops adapted to harsh environments with abiotic stresses, such as drought and salinity; and for developing crops resistant to biotic stresses like diseases and pests. Biotechnology has also shown the potential to broaden the useful gene pool to include genes from related or non-related organisms. Advances in genomics and "quantitative trait loci" related techniques assist in targeting the genes of interest and allowing for selections to be based on genotype, thereby making selection more direct and more efficient.

3. BASE-BROADENING EFFORTS

9. Both the International Treaty and the Global Plan of Action give specific attention to base-broadening. Most modern crop varieties are based on narrow genetic variation and were developed when conventional breeding programmes relied on a narrow range of parents. Improved utilization needs to address this. It is now clear that broadening the genetic base of crop varieties, especially highly bred species such as maize and soybean, is a means of reducing genetic vulnerability to stresses, thereby increasing the use and the benefits of conserved PGRFA.

10. Base-broadening is an expensive, long term endeavour. Therefore, optimized gains and enhanced efficiencies can be achieved through partnerships and networks. In Latin America, for example, the Germplasm Enhancement of Maize project (GEM) is a private/public collaboration that builds on the Latin American Maize Project (LAMP). In this initiative, the private sector industry contributes proprietary inbred lines in crosses with the best LAMP accessions provided by public scientific organizations. All partners may benefit. Results indicate that maize exotic germplasm has contributed significantly to disease and insect resistance and expanded “value-added” traits. Exploiting genetic diversity through partnerships for base-broadening could well be a strategically important element for stimulating effective utilization of PGRFA and a beneficial factor in addressing national plant breeding objectives.

4. UNDER-UTILIZED CROPS AND SPECIES

11. For many developing countries, underutilized crops are essential for food security, but a large proportion of the resources available to plant breeders are invested in very few crops. However, not all underutilized crops are “minor;” millet and cassava (both included in the multilateral system of the International Treaty) are grown over enormous areas, but generally for subsistence needs and local markets. Other crops, such as teff (*Eragrostis tef* Zucc.), have enormous region-specific importance, but are not produced over large areas. Within the context of improving utilization of PGRFA, governments may wish to direct some resources to breeding programmes for underutilized crops.

12. Under these circumstances, diverse partnerships, as described in Article 6.2c of the International Treaty, could be particularly beneficial. Some underutilized-crops are not sufficiently domesticated and still have undesirable traits. Tremendous progress in their improvement could be made through simple “mass-selection” procedures, including the involvement of farmers. There has been limited support for breeding of neglected crops and this situation may need to be strategically addressed at regional as well as national levels in any priorities established for improved utilization of PGRFA.

5. CHALLENGES FOR THE IMPROVED UTILIZATION OF PGRFA IN DEVELOPING COUNTRIES

13. Major breeding programmes are often directed at crops grown in favourable environments, or environments that can be manipulated through external resource supply (i.e. irrigation, fertilizers and pesticides) to obviate the effects of a sub-optimal environment. However, agriculture in developing countries often takes place in marginal, fragile environments. Crops being grown in such conditions are frequently neglected by national breeding programmes and nearly always neglected by the private sector. Although there are relatively few plant breeding programmes addressing crop enhancement for stressed environments of developing countries, such programmes would likely pay dividends in terms of improving the livelihoods of local populations. Crop improvement networks to facilitate cooperative research and development on neglected crops are generally poorly funded, particularly in developing countries. Nearly all crop networks for developing countries are currently under-funded.

14. Conventional plant breeding, especially in developing countries, has not always been fully integrated into the social fabric of the communities it serves. Plant breeding has largely taken place inside research stations, with the resulting varieties transferred to farmers through extension services. Farmer participation in the selection and breeding processes has often been minimal. Given that farmers have traditionally practised elements of crop improvement, involving farmers from the outset in a plant breeding programmes will not only increase their relevance, but also reduce costs. Farmer-participatory plant breeding as adjuncts to conventional efforts has shown its advantages in several crop improvement programmes, such as ICARDA’s. Greater awareness of the merit of such partnerships is needed in improved utilization strategies.

15. While the livelihoods of the poorest communities of many developing countries are dependent on agriculture, the options for adapting agriculture are limited in the face of such challenges. A well managed and adequately financed National Agriculture Research System (NARS) in developing countries is often essential to formulate and carry out national plant breeding programmes. Without strong NARS, it may not be possible to harness technological advances for the benefit of national agricultural production and ultimately to improve the livelihoods of resource-poor farmers. However, investments in agricultural research and development are generally in decline. Public sector plant breeding has been particularly affected, and nowhere more so than in developing countries. Strategic planning and the implementation of breeding activities to help overcome production constraints merits greater importance. During such strategic planning, careful assessment of the opportunities to integrate plant biotechnology into breeding programmes to enhance screening efficiencies needs consideration, as well as linking university-level biotechnology research to applied crop improvement in national programmes.

16. Many of the geographical areas where agricultural research is in most need of support, and where plant breeding is becoming increasingly difficult to carry out, are those which are rich in the plant genetic resources that could provide valuable germplasm for crop development. Funds are limited. The needs of resource-poor farmers in sub-optimal environments often receive little attention. The costs associated with plant breeding have risen while government funding for science has dropped. Public plant breeding has often given way to private interests for a few commercially important crops. By necessity, privately funded plant breeding is driven by profit motives. Consequently, it rarely addresses important issues in regions and for crops that are not economically attractive, even if advantages can be obtained through economies of scale. Lack of funds for public plant breeding is a particularly acute problem in the developing world, where the need for public plant breeding is greatest. The status of public and private plant breeding capacity in developing countries must be understood to enable strategic investment. Public/private partnerships can be most effective when both players have adequate capacity and compelling incentives.

6. IMPROVING SUSTAINABLE UTILIZATION OF PGRFA BY ASSESSING AND STRENGTHENING PLANT BREEDING CAPACITY

17. In most developing countries, the responsibility for agricultural production, crop improvement and research rests with NARS. In addition, a few developing countries are also incorporating advances in science and technology into plant breeding. However, in many countries there is currently no precise information on the exact situation of NARS with respect to plant breeding capacity or the use of new tools, including biotechnologies. There are not always clear strategies to improve utilization of a wide range of PGRFA. Declining investment in agricultural research and development has led to disarray in many instances. Developing countries require an information base to make long-term plans and secure long-term financial investments in order to seek donor partnerships.

18. In order to lay a sound basis for national and international policies and programmes to improve sustainable utilization of PGRFA and to provide the Commission on PGRFA with more specific information, FAO will compile information on plant breeding capacities of NARS and analyse the trends in resource allocation and outputs. To provide a critical analysis, an expert consultation with stakeholders will be convened during 2004, in order to further understanding and to agree on priority activities. This process will assist NARS in determining national strengths and weaknesses with regard to their plant breeding activities. Opportunities and constraints in using PGRFA will be identified, which can eventually assist government in policy formulation. A better knowledge of the state of plant breeding will help focus national resource allocation to strengthen targeted areas of PGRFA use, including relative allocations to conventional and biotechnology-based plant breeding approaches, and provide an agreed basis for technical

assistance, technology transfer, and capacity building, which the Governing Body of the Treaty may wish to support.

19. Information will be gathered through surveys of the public and private sectors in representative countries. This activity will be carried out in partnership with a range of organizations, including the CGIAR centres, in particular IPGRI, and national research organizations. Maximum use will be made of currently available information. It is anticipated that the information gathered will be integrated into the World Information and Early Warning System. It will be an integral part of FAO's second report on the State of the World's Plant Genetic Resources and will increase the focus on PGRFA utilization efforts. It is also envisioned to be used when updating the Global Plan of Action at a later stage.

20. It is proposed that the information gathered will become part of the global information system on PGRFA to support national and international efforts in improving PGRFA utilization (as foreseen in article 17 of the International Treaty). The information database will be kept current so that it can serve as the basis for regional and international cooperation to improve sustainable utilization. The accumulation of data will allow continuous monitoring of the state of particular plant breeding programme, crop specific or region, and in terms of public/private partnership. In addition, it will assist in developing and highlighting indicators to assess global use of PGRFA and draw attention to important issues for their sustainable use.

21. Effective partnerships will be essential to exploit the benefits of PGRFA utilization. The International Agriculture Research Centres are well positioned to play a number of important roles in national and international efforts to improve utilization on crops for which they have activities, and the International Treaty recognizes their importance. In the context of improving utilization they can help NARS in planning crop improvement, relevant capacity building, base-broadening, and the introduction of a wider range of materials from international collections. They can also facilitate public/private joint ventures.

7. GUIDANCE BEING SOUGHT FROM THE WG ON PGRFA

22. The WG is invited to express its views and make suggestions regarding the way forward in strengthening the sustainable use of PGRFA. The WG may also wish to:

- a) Provide guidance on and suggest priorities for FAO's survey study on plant breeding capacity, so that the results may be of maximum value to the World Information and Early Warning System and the second report on the State of the World's PGRFA. When decided by the Commission, these results will also be useful to update the Global Plan of Action. Areas which the WG may wish to comment include:
 - i) Support for core breeding activities for neglected crops and sub-optimal environments;
 - ii) Investments in base-broadening activities;
 - iii) The promotion of farmers' and stakeholders' participation in plant breeding activities;
 - iv) Ways of bridging the gap between conventional plant breeding and applied biotechnologies;
 - v) Ways to facilitate capacity building, transfer of technology and public/private partnership;
 - vi) Ways in which national plant breeding programmes can be assisted in the identification of areas for strategic resource allocation and enhanced partnerships for plant breeding.

- b) Encourage countries to participate in the survey study, so that initial results may be reported to the Commission at the Tenth Regular Session.
- c) Recommend a consultation with stakeholders/partners in order to further enhance the paper for consideration at the next session of the CGRFA.