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BROADENING THE GENETIC BASE OF CROPS: STATEMENT DEVELOPED BY THE PARTICIPANTS IN A PREPARATORY FAO/IPGRI WORKSHOP ON BROADENING THE GENETIC BASES OF CROP PRODUCTION

FAO, Rome, Italy, 17-20 September 1997

Activity 10 of the *Global Plan of Action for the Conservation and Sustainable Use of Plant Genetic Resources* calls for increasing genetic enhancement and base-broadening efforts, and a focus on the most pressing problems identified in fifteen crops of international and regional significance.

Since the Leipzig Conference, FAO, and the International Plant genetic Resources Institute (IPGRI), have taken steps to promote base-broadening, consistent with other relevant activities of the *Global Plan of Action*, particularly activity 11: *Promoting sustainable agriculture through diversification of crop production and broader diversity in crops*, as noted in documents CGRFA-8/99/3, para. 27, and CGRFA-8/99/10.1, para. 15 In this context, a preparatory workshop was convened in September 1997, which brought together experts from universities, and national and international research institutes. A statement developed by participants of the workshop, which may be of interest to the Commission, is provided for information, in this document.

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Plant breeding and the production of new cultivars is widely regarded as underpinning agriculture and the development of society. Yet crop failures and risks associated with genetic uniformity on large cultivated areas, yield stagnation (below potentially attainable levels), and persistent failures to achieve sustainable production increases in important local ecologies are widespread problems. What is frequently not recognised is that continuing success requires a long term and sustainable commitment to the effective utilization of plant genetic resources by enhancing and expanding the genetic base from which future cultivars will be generated.

This is *not* a question of more collecting, storage and evaluation—we have more than 6 million accessions in the world's genebanks. Nor is it enough to introduce selectively a few genes. Indeed, the future needs for an enhanced base cannot be predicted and the particular needs of farming systems should not be prejudged.

Because of this, and of the short term interests of many involved in current national and international breeding programmes, there is a clear need for an international commitment by FAO and others to take a lead in championing base broadening of the world's food and fibre crops. This commitment should take many forms: initiating specific crop programmes; promoting awareness; and supporting and linking local, national and regional activities. It should be aimed at ensuring that farmers and breeders have increased access to useable diversity.

This commitment should be a essential component of an ecologically sound approach to agricultural production based on the more effective use of genetic diversity, employing, as appropriate, decentralized plant breeding driven by the specific needs of farmers and consumers. Strengthening the participation of farmers communities is vital to achieving these goals.

Full Statement

It is widely accepted that future crop productivity increases can only be achieved sustainably through an increased use of plant genetic resources, through plant breeding at all levels. Yet, despite the great amount of diversity assembled in collections, and available in situ in the world at large, lack of diversity/variation within the pools of genetic resources available to breeders and to farmers limits progress, and for some crops, results in yield plateaux, inability to overcome biotic and abiotic constraints, or even crop failure. For specific crops, historical factors such as domestication and crop movements have meant that both globally and locally only a fraction of the potential genepool for some crops has been tapped for agricultural production. For many specific agro-environments there is a extremely limited pool of adapted germplasm available to farmers and breeders, comparative to what could be made available to them.

A major problem hindering the utilization of plant genetic resources is that of getting genetic diversity into a form that can be more easily used by breeders and farmers. Much available germplasm in the primary, secondary and tertiary genepools of crops is not in a form which is of immediate and direct utility to either breeders or farmers in particular regions or locations. There is currently a lack of a clear strategy for the increased utilization of exotic or undated plant genetic resources based on ecological principles.

There is a need for large-scale base-broadening of the genetic base of important crops. Thus would involve the development of several locally-adapted pools of genetic resources, from a diverse, and previously undated material. In a sense such programmes might re-trace crop evolution or even domestication. One approach is to establish composite plant populations by crossing a number of genetically different accessions with a view to maximising the genetic diversity, and then allowing sub-populations to progressively adapt to local conditions in a range of different locations where a need for novel germplasm or new variability is identified. While the techniques required are cheap and technically rather easy, long term programmes,—of the order of a decade, though this depends on the crop concerned—are required to generate tangible results / usable material. This approach is fundamentally different from the introgression of selected characteristics from diverse genepools into usable populations, and is complementary to it. Priority crops would be selected on the basis of assessments of needs at the global regional, national and local levels; of the extent of genetic diversity potentially available, and on feasibility.

The adapted pools of crop genetic resources, developed through Base Broadening programmes should feed into both formal plant breeding systems and into informal systems of farmers' crop improvement and genetic resource management. As appropriate, emphasis should be given to the latter, including through strengthening of links between the conservation and utilization of genetic resources, including on-farm; decentralisation of plant breeding programmes; further support to participatory plant breeding; and, where appropriate, of support for farmer management of dynamic genetic resource populations.

Since specific adaptation to such difficult environments can be only be achieved through direct selection in the target environment, decentralized approaches to plant breeding, with effective farmer participation is particularly important in marginal areas

Initially work should build upon the experience of some 40 ongoing cases of participatory plant breeding, involving NARS, NGOs, farmers or peoples organizations and the international agricultural research system, and upon the methods and experience in farmer research and education pioneered through the Farmer Filed Schools and similar approaches. In turn this will require institutional support and capacity building at the national and community levels.

Already there is a recognized need for large-scale broadening of the genetic base of some important crops. The world's governments have explicitly recognized this in both the FAO Global Plan of Action and the CBD's decision on agricultural biological diversity. However, they have also recognized that this is a classic 'public good' problem where individual incentives to individual nations, breeders, companies and farming communities to enhance and adapt germplasm for strategic long term needs are insufficient to mobilise action on this problem.

Thus long term cooperative approaches among different countries and institutions are needed in this area, most likely led by the public sector. Indeed for many staple crops of poor people where there is little financial incentives for the private sector, the public sector has a clear responsibility. Such activities must be founded on scientific, ecological, principles, and be developed with the full and meaningful involvement of actors at all levels, local communities, national programmes and institutions, and international organizations. The facilitation and coordination of such long term cooperative programmes an area where FAO, IPGRI and the other centres of the CGIAR have an important role, indeed a responsibility, to play.

Specific recommendations.

FAO should launch a "Base Broadening Initiative" in close collaboration with IPGRI, other CGIAR centres, the NARS, existing crops networks, and other relevant institutions, in order to:

(a) facilitate the establishment of international networks of partners (institutions, individuals) to promote base broadening projects/programmes, on a crop by crop basis (where possible existing crop network structures would be used);

(b) carry out reviews of the state of diversity within the cultivated genepools of crops of importance to global and national food security, and develop indicators and criteria to identify crops in possible need of genetic base broadening both globally and nationally;

(c) for identified crops facilitate the development of long term projects and programmes on genetic base broadening through multi-partner approaches;

(d) in collaboration with educational institutions promote training in approaches to base broadening and population genetics, especially for developing country scientists and students;

(e) recognise, strengthen and build upon on-going management of genetic resources by communities, and take steps to increase the diversity of genetic material available to farmers and rural communities (for example, by promoting stronger linkages between formal plant genetic resource conservation institutions, genetic enhancement and plant breeding programmes with farmers, and employing, as appropriate, existing mechanisms such as the Farmer Field Schools developed through the FAO IPM programmes;

(f) promote awareness on the need for and modalities of genetic base broadening, at policy and technical levels, through appropriate meetings, publications and the internet.

High priority should be given to these areas by FAO, and the international agricultural research system. They should form a central part of the programme of work of FAO's Division on Plant Production and Protection. In particular, support for these activities should be developed within the joint FAO/IPGRI programme to facilitate implementation of the Global Plan of Action, and in collaborative efforts to implement the CBD's decision on agricultural biological diversity. FAO should actively seek the necessary financial resources for such work, including from extra budgetary sources.

Technical note on base-broadening

Large scale genetic base broadening programmes could help to increase the flow of genetic resources from genebanks to farmers fields to meet future needs. Base broadening is based upon the establishment of composite plant populations by crossing a number of genetically different accessions in order to maximise the importance of genetic and geographic origins. It is then proposed to split these populations into the different locations where a need for novel germplasm or new variability is identified, and to let each sub-population progressively adapt to local conditions. Genetic base broadening would therefore involve the evolutionary development over time of different locally-adapted pools of genetic resources from an initially genetically diverse pool of unadapted exotic germplasm

The genetic base broadening approach proposed is different from the periodic introgression of a few selected genes or gene complexes from exotic germplasm into elite germplasm, to meet specific needs. The genetic base broadening approach is instead based upon the construction of <u>genetically</u>

diverse dynamic plant populations, which through sequential cycles of genetic recombination and selection will be used to develop locally adapted germplasm pools. The base broadening approach is not based upon gene by gene (or character by character) considerations as is the case for introgression based approaches. However both are complementary approaches to crop improvement.

In the genetic base broadening approach both natural selection and light artificial selection *in situ* would be used to develop such locally adapted germplasm pools. Initially, for the first few years natural selection and high recombination rates will be preferred to any conscious selection by breeders or farmers. However in the post environmental adaptation period the populations could then be distributed to breeders and interested farmers, and subjected to selection by the breeders and farmers, according to their needs. The more participating breeders, farmers and hence locations the more diversity will be both maintained and enhanced.

The parental materials for the composite crosses can be undated (exotic) or a mixture of adapted and undated germplasm, depending on the objectives and time horizons of the particular base broadening programme. For instance, the most long term programmes might require the re-domestication or major reconstruction of the cultivated genepool of a particular crop species, albeit in a more rapid manner than previously. In other instances, the enhancement of locally adapted germplasm over the short term may be the objective. In all instances, the plant breeding techniques required are relatively cheap and technically rather easy, however long term programmes,—of the order of a decade, though this depends on the crop concerned—are required to generate tangible results / usable material.

It will be necessary to develop sets of indicators and criteria which would allow an assessment of which crops may require genetic base broadening, and to what extent such base broadening may be required for specific environments or end-users. Such indicators of the extent of a need for base broadening might include information on the following:

- yield plateaux and yield stability
- persistent crop failures
- increasing frequency of searches for genes from non-cultivated genepool
- genetic bottlenecks and founder events.
- relative genetic diversity in cultivated and wild progenitor genepools.
- crop movements between regions
- lack of novel adapted material

Priority crops for base broadening could therefore be selected on the basis of such types of criteria applied to assess needs at the global regional, national and local levels; of the extent of genetic diversity potentially available, and on the practical feasibility.