USING DIVERSITY

ENHANCING AND MAINTAINING GENETIC RESOURCES ON-FARM

Proceedings of a workshop
held on 19-21 June 1995
New Delhi, India

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and
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International Development Research Centre

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A ROLE FOR ICRISAT IN ENHANCING AND MAINTAINING GENETIC RESOURCES ON-FARM

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ABSTRACT

CGIAR centers have made a major global contribution to ex situ conservation of crop genetic resources. Some centers have also made detailed socio-anthropological studies of mandate crops in traditional farming systems and, more recently, farmer participatory research is becoming part of crop improvement programs. Centers can expand these studies to develop strategies for on-farm conservation in close collaboration with national agricultural research and extension systems, NGOs and farmers. A specific role for ICRISAT is firmly based on its locations in centers of crop diversity and traditional agriculture; its complement of experienced crop scientists and extensive databases; its capacity to analyze genetic, environmental, and genotype x environment interactions as determinants of crop productivity; its close relationships with national programs; and its growing involvement in farmer participatory research. The expertise and experience of ICRISAT and other CGIAR centers can make a major contribution to the dynamic conservation, enhancement and utilization of agrobiodiversity on-farm for the benefits of farmers and global food production.

INTRODUCTION

The immense genetic diversity of traditional varieties of crops is the most directly useful and economically valuable part of global biodiversity. Traditional varieties - or landraces - are used by subsistence farmers as a key component of their survival strategies. Such farmers account for about 60% of agricultural land use and provide approximately 15-20% of the world's crop production. In addition, landraces were and, in some cases, still are the basic raw materials used by plant breeders in the production of modern varieties, which provide the remainder of the world's crop production, on which most of us depend for food.

During the last 20 years, ICRISAT and other centers of the Consultative Group for International Agricultural Research (CGIAR) have made a major contribution to the *ex situ* conservation of crop genetic resources, particularly for wheat, rice, maize, barley, sorghum, pearl millet, potato, cassava, common bean, groundnut, chickpea, pigeonpea, lentil and other crops by establishing genebanks in which hundreds of thousands of germplasm samples have been assembled for both active use in breeding programs and for long term storage. Assembling germplasm samples is only a small part of the CGIAR crop conservation effort. Centers have made substantial efforts to characterize samples for many different parameters including: reaction to diseases and pests; physiological characteristics; and grain quality, for example, starch, protein and oil content. During this process, crop scientists have developed methodologies for evaluation of important characteristics and a good understanding of the crop-specific diversity, its geographical distribution, and potential for adaptation. In recent years, more attention has been paid to documenting information on indigenous knowledge at the time of collection. Thus collections held by the CGIAR are not just seed collections but valuable sources of genetic information required for effectively utilizing available crop resources.

In highly variable environments which are often marginal for crop growth, subsistence-oriented farming systems predominate over both space and time. Such systems are particularly common in the semi-arid tropics which is ICRISAT's mandate region. Many of the principal crops grown in such environments are not globally important staple crops but 'poor peoples' crops, for example lentil, chickpea, pigeonpea, pearl millet, minor millets. These include many of ICRISAT's mandate crops. These farming systems are undergoing profound changes due to increased population pressure, economic and environmental changes. Recognizing farmers' untiring enthusiasm to improve their lot, if possible through improving their genetic stocks, and in view of these profound changes in farming conditions, the utilization of genetic diversity on-farm is of particular importance for both crop evolution and crop improvement. This paper will define a role for ICRISAT in this process and suggest necessary areas of research to enhance and maintain genetic resources on-farm.

A ROLE FOR ICRISAT

A role for ICRISAT in enhancing and maintaining genetic resources on-farm is firmly based on the following facts:

- its locations in centers of crop diversity and traditional agriculture;
- its maintenance of global *ex situ* collections;
- its recent re-focus on eco-regions, to allow a more intensive targeting on specific production systems;
- its close working relationships with national programs;
- its complement of crop scientists with detailed familiarity with specific crops and regions over many years;
- its specimen databases and in-house technical ability to determine the history of the movement of landraces;
- its capacity to evaluate genetic variation and genotype x environment interactions which are major factors determining the effectiveness and direction of selection processes on-farm;
- its experienced economics group with linkages to national policy makers; and
- its considerable experience with on-farm research and growing involvement in farmer participatory research, presently in breeding and watershed management and with an excellent and relevant model for farmer involvement in integrated pest management (IPM) research evolving.

RESEARCH NEEDS

There has been remarkably little technical research specifically directed at on-farm conservation of agrobiodiversity, despite the paramount value of such resources in feeding people. There is an urgent need for clear objectives which will identify necessary areas of research to both enhance farmers' existing ability to manage crop genetic resources and to meet the future needs of farmers through *in situ* and *ex situ* germplasm enhancement. We suggest the following areas of research:

Identification of benchmark sites

The development of guidelines for selecting geographical areas is urgent. Ecological conditions; cropping system complexity; varieties used; communal tradition of varietal maintenance and experimentation; and sociocultural factors need to be considered. Priority attention should be given to cropping systems rich in species and varietal diversity. Another priority would be systems with a history of dynamic traditional management. Marginal conditions, where diversity many be low, but adaptations to extremes of constraints prevalent, will also need attention.

Varietal and genetic characterization

There have been efforts by botanists and crop geneticists to classify sub-specific variation within crops, however, a simple and precise technique for measuring the overall genetic diversity of a crop is not yet available. Without such techniques, the taxonomy and nomenclature of traditional varieties cannot be established, except at a very local level, using the farmers' own folk-classification. Such local classifications, although usable locally and meriting much further study, cannot be transferred to other regions. This lack of broadly usable methodology for describing intra- and inter-population variation of a crop species is a serious constraint facing efforts to understand and enhance on-farm conservation and management of genetic resources. The formal system can help here with basic descriptor methods coupled with isozyme and molecular techniques (e.g., genetic finger printing) to complement key farmers' input.

Varietal demography

Little is known about varietal demography - the movement of varieties into and out of cropping systems. This information is vital to understand the dynamic nature of on-farm germplasm management. There is a need to know the source of new varieties and how the farm complement of variability changes over time. A minimum time span of at least ten years is recommended. It is of considerable importance to study the reasons for loss of variability; whether accidental and random, through natural selection pressures, or through deliberate rejection by farmers.

Complementarity between on-farm and ex situ conservation

Farmers are proven experts at evaluating and managing variation: their bottleneck is in obtaining sufficient diversity to evaluate. In contrast, the formal *ex situ* system has in store enormous resources of plant diversity, but faces a bottleneck to adequately evaluate samples for a wide range of conditions. We need to combine the varietal management ability of farmers with the resources of samples in genebanks. There is opportunity for *ex situ* stores to return germplasm to farmers when farming communities have lost varieties through war or drought (e.g., recent efforts in Rwanda through the Seeds of Hope initiative). As an absolute right, farm communities should have easy and continued access to germplasm collected from the community and now held *ex situ*. In addition, genetic resources threatened on-farm should be collected and stored *ex situ*. Productive interaction will depend on a greatly enhanced documentation capability - an obvious role for formal genebanks. If the intention is to transfer local knowledge and germplasm to other areas, then the ability and willingness of farmers to act as trainers will be important.

Enhancing farmer management

There is a wide range of possibilities for enhancing the traditional management of varieties. Farmer participatory breeding has an important role to play in some environments. The opportunities for interaction and complementarity between formal breeding work on-station and farmers' expertise need to be fully explored. Research is also needed on the transfer of appropriate technology between farming systems known to manage great diversity. Research support is needed for traditional seed production, with an emphasis on the role of the farmer and natural selection pressures (e.g., insect pests, diseases, storage conditions, soil fertility factors etc.).

Strong emphasis should be placed on the impact of pests and diseases on farmers strategies to manage and enhance their agrobiodiversity. At all levels of management on-farm - characterization, selection, enhancement, storage - pests and diseases may have profound effects on the variability within and between varieties. The intensity of natural selection for characters such as pest and disease resistance in diverse ecosystems may be considerably lower than in less diverse systems. The diversity of traditional farming systems may therefore allow survival of inferior components of the crop population and may reduce the selection intensity for the evolution of disease resistance. In addition, farmers are unable to select for characters which are cryptic, as resistance to diseases and pests occurring at low incidence, or for resistances occurring at low frequencies in the population. It is here that formal research can identify and promote useful variation. Once genetic sources for characters of value have been identified by formal evaluation, they can be multiplied and fed back into the cropping systems. Attempts should be made to enhance the farmers' abilities to recognize, promote and utilize genetic diversity for future evolution.

CONCLUSION

We have defined a role for ICRISAT in increasing the quantity and improving the quality of the genetic resources being maintained by farmers through a research agenda which would underpin the efforts of other key players including national agricultural research and extension systems, non-governmental organizations (NGOs) and farmers. The expertise and experience of CGIAR centers can make a major contribution to the development of methodology for the dynamic conservation, enhancement and utilization of agrobiodiversity on-farm for the benefits of farmers and global food production.

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