



Agrobiodiversity

1. The questions

The need to conserve the biodiversity of cultivated plants is widely acknowledged. Because they are not yet solved, the questions on the why, what and how to conserve need to be specifically addressed, either by research on natural biodiversity or conventional research on crop genetic resources.

Why conserve? The rationale for agrobiodiversity conservation has too often been limited to the need to conserve resources for plant breeding. Although yet scarcely studied a rising issue is the contribution of agrobiodiversity to the sustainability of agroecosystems, which encompasses biological and social issues.

What and how to conserve? There is an overall consensus about the need to develop the complementarities between *ex situ* conservation (genebanks) and *in situ* conservation (on-farm). However, both the complexity of unsolved issues in the *in situ* conservation of cultivated plants and the historical isolation of *ex situ* conservation have hampered the development of the theoretical and practical approaches to this complementarity.

2. Research fields

Exploring and collecting agrobiodiversity, managing collections and information

The time of projects dedicated to the building of *ex situ* collections is mostly over and a continuous effort is made to maintain the germplasm collections already available (see the description of Biological Resource Centres for crop species). Information management will become increasingly important, as most projects on *in situ* agrobiodiversity generate more information than sample collections.

Analysing the genetic diversity of crop genetic resources

The analysis of the genetic structure and diversity of species complexes has been a major activity of the genetics laboratories in Montpellier. For major crops such as rice, maize or sorghum, these results on the genetic structure of the crop, the rise of genomics, the access to DNA sequences, the progress in statistical analyses and phenotypic characterization, favour the quest for genes of agronomical interest and the understanding of the molecular and physiological basis of adaptation.

Dynamics of crop diversity in relation to environmental and anthropogenic factors

The evolutionary biology of cultivated crops is studied at several levels. Crop domestication processes and their impact on crop diversity are studied for past (e.g. cereals) or on-going (e.g. tuber crops) domestication events.



Crops adaptation to climate change is a major issue both in temperate and tropical countries. The influence of climate change is assessed through diachronic analyses of genetic and phenotypic diversity, and results can be used to detect genes of agronomical interest.

Linking biological and social approaches is a key element of success when addressing the dynamics of diversity in agroecosystems. Research is conducted taking into account the impact of farmers practices and social dynamics on crop diversity. The geographic scale issue is salient. While research is needed to understand in depth processes at the community level, conservation objectives have to consider larger (national, regional) scales, which raise methodological issues. Among these issues, measuring genetic erosion and defining conservation/erosion indicators are important aspects.

Using landraces through participatory breeding approaches

The overall objective of broadening the genetic variability of cultivated plants has been a constant target over years. Pre-breeding approaches are used to develop and manage crop populations with a large genetic variability. Related species are used in neo-domestication programs.

Recently developed, participatory breeding programs have aimed at bringing farmers and breeders together in tropical countries and in France in order to promote the conservation of agrobiodiversity through its use in the development of improved varieties that meet farmers' selection criteria and expectations. These programs are both operational and academic, as numerous methodological issues remain regarding the type of genetic material to be used and produced, the ways to optimize farmer-scientist interactions and how to involve farming communities in the release and diffusion of participatory-improved varieties.

Seed systems: preserving agrobiodiversity and ensuring food security

Traditional seed systems are based on the reproduction of seeds by farmers with the selection, production, and conservation undertaken locally. The change of farmers' access to seeds is central to research questions concerning: i- the stability of agricultural production and genetic diversity; ii- the diffusion of improved varieties and the resilience of a seed system; iii- the knowledge of traditional systems and responses to the management of modern crises. The overall objective is to develop models of agro-biodiversity management focused on seed circulation and to use these models as tools to improve the capacity for discussion among a multidisciplinary scientific corpus. The methodology is based on building a shared vision of farmers access to seeds (formal and informal systems) through the development of models allowing to compare the operating rules of seed systems and to simulate change in diverse socio-economic and environmental contexts, as in Africa and Latin America. The outcomes rely on our capacity to provide tools to share points of view and facilitate the dialogue between diverse actors. Multi-agent modelling is a possible solution because it mediates between disciplines, between disciplines and field actors, and between field actors to simulate possible changes in a system and assess its resilience.

3. Programs and collaborations

The Montpellier scientific community has a long-standing tradition in research on crop genetic resources. The scope of the research has dramatically broadened over the last decade. The research on the nature, conservation and use of agrobiodiversity is conducted through approaches aiming at combining recent advances in biological and social sciences. It has to be acknowledged that the study of the relationship between crop diversity and its management by farmers leads back to ideas brought to the front of the French scene by Portères and Pernès between 1950 and 1980.

In Montpellier, the research benefits from the interaction between the local laboratories in plant genetics and agronomy (Ird, Inra, and Cirad) and in evolutionary biology (Um2, Cnrs). It takes advantage of the local development of genotyping facilities and the existing genetic resources collections, as demonstrated by the participation and leadership in the Generation Challenge Programme (SP1 and SP3) and the set up of “Centers of Biological Resources” at Inra and Cirad.

By initiating projects of participatory plant breeding a few years ago, Cirad brought an operational dimension to the study of agrobiodiversity in Southern countries (FFEM-funded projects in West Africa and Oceania), associating teams of geneticists and breeders with teams interested in natural resources management and interactions between stakeholders.

Overall, the “signature” of the Montpellier scientific community lies in an in-depth approach to the biological and social processes that influence agrobiodiversity. This approach complements and supports international programs more oriented towards the actual implementation of conservation projects (GEF, Biodiversity International) with which Montpellier laboratories collaborate.

4. Training

- Courses and lectures at the MSc and Ph.D. level in French (Um2, Montpellier-SupAgro, Univ. Paris X) and foreign universities (Ecuador, Peru),
- Training of PhD students from France and Southern countries (particularly from Africa, Oceania, South America),
- Organisation of training courses,
- Development of training materials (CP Generation, e-learning UVED).

5. Conclusion and perspectives

Making compatible the conservation of agrobiodiversity and the development in agroecosystems is a huge challenge, especially in centres of crop diversity developing countries. The considerable technological means now accessible to crop geneticists and therefore the information being generated on the diversity and genome of cultivated plants brings about exciting perspectives. The biological component of conservation research will have to be combined with innovative social sciences research, including modelling approaches, in order to develop participatory tools of crop diversity management.

This will have to be developed in connection with research on the role of plant agrobiodiversity, including major cultivated species as well as underutilised crops, and the sustainability of agricultural production in a changing environment.



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