Biodiversity conservation is key

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Biodiversity or biological diversity is the variety of life on earth; it includes all living forms, animal, plant, or microbial. It is accessible at three levels: ecosystems, species within the ecosystem, and genes within the species. Today, 65 million years after the fifth and largest notable extinction of species (that wiped away the dinosaurs), alarming reports state an unprecedented rate of biodiversity loss—maybe the sixth extinction (Eldregde 1999).

The loss of spectacular trees in the rainforests or of polar bears at the North Pole is well-publicized and of great concern. However, equally worrying but so much less acknowledged is the loss of agricultural biodiversity. Agrobiodiversity refers to the part of biodiversity that feeds and nurtures people—whether derived from the genetic resources of plants, animals, fish, or forests. The diversity of these genetic resources is the foundation for sustainable agriculture and global food security. It enables plants to adapt to new pests and diseases as well as to climatic and environmental changes.

Germplasm data management using a microcomputer (data logger), IITA genebank. Photo by Olusegun Adebayo, IITA.

There are two complementary methods to conserve plant genetic resources: *ex situ* (in an artificial environment) and *in situ* (in a natural environment). Both approaches have pros and cons. *In situ* conservation allows further evolution of germplasm in natural conditions, but *ex situ* conservation allows ready access to clean germplasm.

Since its establishment in 1967, IITA has devoted considerable resources to *ex situ* conservation. In 1975, the Genetic Resources Unit was created to collect, conserve, and study food legumes, roots and tubers, and their wild relatives. Today, IITA's Genetic Resources Center (GRC) maintains over 28,000 accessions of six main staple crop collections: black-eyed pea (cowpea), maize, soybean, cassava, yam, and banana. The biggest collection is of cowpea, with over 15,000 accessions collected or acquired in or from 89 countries, mainly in Africa. This biodiversity is very valuable for further genetic improvement and food security. It is maintained in trust for the international community and is available to all.

Any new sample entering the genebank is given a "passport" and a unique accession number. The passport holds important information related to the background of the accession. Such data, and in particular the georeference, i.e., the exact location where the sample was collected, provide valuable information. Indeed, when searching for drought tolerance traits, breeders may want to give priority to samples collected in dry areas. The analysis of georeferences of accessions also shows any potential ecogeographical gaps in the collection. Finally, the genetic erosion of a crop can be assessed during recollecting missions based on vernacular names and georeferences of already collected accessions. Unfortunately, for most collections, passport data are far from complete; the country of origin may be known, but the georeferences are missing. This lack of information is partly because the importance of passport data was underestimated in the past.

A collection of biodiversity is traditionally measured at the accession level using phenotypic characterization and evaluation descriptors. The former category generally refers to highly heritable, easily seen, measured, and expressed descriptors. The second includes descriptors that are more sensitive to the environment, such as yield or pest and disease resistance. Among the 52 international descriptors used to describe cowpea diversity, some quantitative traits show a high rate of diversity. Cowpea pod length varies from as little as 5.6 cm up to 49.9 cm, depending on the accession.

Vegetative trait diversity can be equally spectacular. Depending on the accession, the number of days required to harvest the first mature pod varies from 49 to 129 days after planting. In the context of global climate change and the shortening of the rainy season, such a descriptor is of high interest to the breeding community. Although it is important to capture diversity for today's breeding interests, it is equally important to capture "neutral" diversity. Something that has no direct use for improvement today may become valuable in the future.

Since the 1980s, the development of molecular tools has had a substantial impact on biodiversity characterization. This fast-evolving tool provides increasingly efficient, precise, and cost-effective methods of managing collections. Where the combination of

Diversity of crop genetic resources in the IITA genebank. Photo by IITA.

passport and phenotypic descriptors fails to identify duplicates, molecular methods provide a new tool for discriminating and identifying. It is also used to detect the potential loss of genetic integrity, whether associated to conservation or regeneration. IITA is presently fingerprinting the international collections of yam and cassava.

The genetic resources of one given crop are classified in three gene pools based on their respective compatibility/ incompatibility to produce viable and fertile progeny (Harlan and de Wet 1971). Gene pool I includes the crop species itself and its wild progenitor. Gene pools II and III include other species that are related to yet different from the crop species of interest (Gepts 2006). Gene pool I is generally well represented in *ex situ* collections but gene pools II and III have often been neglected, although they represent a valuable reservoir of untapped genes as they evolved independently of human preferences.

Africa is a center of diversity for two of the crops maintained at IITA: cowpea (*Vigna unguiculata*) and yam (*Dioscorea* spp.) (Padulosi 1993, Orkwor et al 1998). IITA has devoted considerable resources for conserving the wild relatives of *Vigna*. However, efforts are still needed to further collect more wild relatives and cultivated cowpea. Although generally African biodiversity remains rich, various threats exist. Climate change attracts most attention in this matter but agriculture intensification should not be overlooked. The paradox is that research in agriculture requires diversity to build on existing traits but is one of the main threats to that vital biodiversity.

IITA is planning a collecting mission for cowpea in 2010 in regions of Nigeria where collecting had not been done and will focus on two species*: V. unguiculata* var. *spontanea* (gene pool I) and *V. unguiculata* subsp. *baoulensis* (gene pool II). Remi Pasquet, a taxonomist expert for cowpea from the International Centre of Insect Physiology and Ecology (*icipe*), will lead the expedition.

Over the last 30 years, there has been a profound change in the legal landscape with regard to ownership of biodiversity in general and crop genetic resources in particular (Gepts 2006). In the past, biodiversity was considered a common heritage of humanity, but in 1992, the Convention on Biological Diversity (CBD) assigned sovereignty over biodiversity to national governments. CBD is the first legally binding framework for the conservation of biodiversity that recognizes the "knowledge, innovations, and practices of indigenous and local communities and encourages the equitable sharing of benefits arising for the utilization of such knowledge, practices, innovation, and knowledge" (Shand 1997).

More recently, the International Treaty on Plant Genetic Resource for Food and Agriculture reconsidered the question of sovereignty over plant genetic resources. It promotes the exchange of germplasm for 64 crops in a multilateral agreement (multilateral system, MLS). Within this frame, the conservation of plant genetic resources, i.e., the future of food security, relies on shared initiatives and responsibility and the construction of a global system. Within this system, each stakeholder has a role based on comparative advantage—whether it is access to germplasm, technology, human resources, or capacity development.

The opening of the Svalbard seed vault in Norway, in 2008 is one of the building blocks of the global system. Such an initiative caught the attention of the media and, consequently, directed the attention of the world on the erosion of plant diversity. It is somehow reassuring to know that part (even a little) of plant diversity is now kept in a place that is naturally clean, cool (energy efficient),

Researcher checks tissue culture-grown cassava. Photo by Jeffrey Oliver, IITA.

isolated (as the North Pole), and protected (by polar bears). However, not all plant diversity can be conserved in Svalbard. In fact, many species producing so-called recalcitrant seeds as well as those clonally propagated cannot be maintained at low temperatures for various physiological reasons. These problematic species, which in IITA's collections include yam, cassava, and banana/plantain, are generally banked in the field or *in vitro* slow-growth conditions. The latter approach is preferred as it protects germplasm from field biotic and abiotic risks and allows easy access to distribution of clean material.

The ultimate *in vitro* conservation approach is cryopreservation (conservation at very low temperatures, generally at −196 °C). At such a temperature, all biochemical and biological processes are stopped. Thus, plant tissue can, in theory, be stored forever. IITA has recently developed such a process for cassava (Dumet et al. accepted).

Whatever the *ex situ* conservation approach, it will never be preferable to *in situ* conservation. However, whenever biodiversity preservation poses a threat to human livelihoods, comfort, or convenience, the politically expedient choice is usually to "liquidate" the natural capital (Ehrlich and Pringle 2008). It seems unlikely that more natural space will be available to ensure the safety of biodiversity in the future… This is not impossible, however, if the schools are involved in teaching the value of biodiversity to the younger generations.

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