

## **A Gateway to Plant Genetic Resources Utilization**

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### **Abstract**

**The world is faced with the need to increase crop productivity, develop varieties that are better adapted to face environmental and biological constraints, and meet the needs of local communities. To meet these challenges farmers and breeders must have access to a wide range of plant genetic resources together with the essential information about the traits they possess that facilitates their utilization. Accurate characterization and evaluation data promote utilization, especially if it is available in an easily usable or standard format. Bioversity International (Bioversity) aims to stimulate the characterization and evaluation of germplasm collections by providing uniform standards for the description and exchange of information on plants. The CGIAR (Consultative Group on International Agricultural Research) centres along with crop research institutes and networks have collaborated with Bioversity in the production of standards or ‘descriptors’. Crop standards are an important tool that permits the international community to find and exchange information in a ‘common’ language. These standards have been adopted by the GCP (Generation Challenge Programme) Ontology Consortium, FAO WIEWS, EURISCO (the European Plant Genetic Resources Catalogue), CGIAR centres and are also being promoted by the Crop Genebank Knowledge Base and GRIN. These data standards constitute the backbone of the GENESYS global portal for access to information on plant genetic resources. GENESYS heralds a new paradigm for access to and use of these resources. GENESYS 1.0 was released in May 2011 following nearly three years of development by Bioversity on behalf of the CGIAR System-wide Genetic Resources Programme (SGRP) and in partnership with the International Treaty on Plant Genetic Resources for Food and Agriculture and the Global Crop Diversity Trust. It brings together the passport data from three of the major genebank information networks – SINGER (the CGIAR System-wide Information Network for Genetic Resources), EURISCO and GRIN, the USDA system which added further value through the inclusion of characterization and evaluation data.**

### **INTRODUCTION**

This paper provides an insight into GENESYS, the gateway to plant genetic resources (PGR) information. It also describes an assessment of the history of descriptor lists, the scientific standards that have been published by Bioversity since 1976. The assessment aims to develop an understanding of how useful they are to a range of users globally, and their value in promoting collaboration and information exchange among

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organizations. It also explores how Bioversity scientific standards contribute to developing databases, networks, ontology and global portals, thus facilitating the access to information on crops to further their utilization.

Plant genetic resources provide the biological basis for food security around the globe, and support the livelihoods of every person in the world. These resources represent the most important raw material for plant breeders and the most essential input for farmers. They are therefore fundamental for sustainable agricultural production. At present, plant genetic resources are not only underutilized but also under conserved. The best way of conserving is through their utilization. More than seven millions of accessions of *ex situ* collections are stored in 1,750 genebanks around the world for both conservation and utilization purposes. The genetic diversity in these resources allows crops to adapt to climate change conditions and to face the constraints caused by biotic and abiotic stresses. Much of the world's crop diversity is currently not readily available to scientists and to farmers who rely on it to safeguard agricultural productivity. Furthermore, biodiversity is being lost and with it our capacity to keep agriculture productive.

The conservation and sustainable use of PGR for food and agriculture is crucial for ensuring global food security; especially now, when the continuous improvement of crops is instrumental for sustained agriculture in response to the many current challenges such as, climate change, increasing human population, hunger and poverty, to name just a few. Associated information about the valuable genetic resources available in our world is crucial since we cannot use those resources if we do not know about their attributes or even where they can be found. Additionally, the associated information about these resources is of limited use, because either necessary documentation is lacking or because data are dispersed across numerous, disconnected genebank information systems. Plant genetic resources without information are almost worthless, like a book without a title; information is the crucial link between conservation and use.

## **A BRIEF HISTORY OF DESCRIPTORS AND THE NEED FOR STANDARDS**

The development of standardized descriptors began in 1976, when it became clear a common language was necessary for exchanging data and information. The establishment of an international system was required to support global efforts in PGR conservation and use for crop networks and genebanks to coordinate and operate effectively. Collaborative work by Bioversity and various other crop research institutes [including other centres within the CGIAR and various national agricultural research organizations (NARs)] has attempted to improve the documentation of plant genetic resources by providing a uniform series of crop descriptors and derived standards. Bioversity descriptors have evolved according to user needs. Bioversity in collaboration with partners has developed the following types of descriptors and derived standards so far:

- crop descriptors,
- the Multi-crop Passport Descriptors,
- descriptors for marker technologies,
- descriptors for farmers' knowledge about plants, and
- key sets of characterization and evaluation standards for utilization.

The adoption of descriptors and derived standards is integral to genetic resources activities, assuring the effective conservation of PGR and their efficient utilization in crop improvement programmes.

### **Crop Descriptors**

There are currently available descriptors for more than 100 crops, which provide unambiguous guidelines for the documentation of accessions held in germplasm collections. They are international standards for which Bioversity takes responsibility. Each new or revised standard is prepared in consultation with various groups, including international experts on specific crops, genebank documentation staff and members of Bioversity's thematic and regional groups. The aims of this extensive consultation are to play an honest broker role, to ensure a transparent production process and maintain a standard format in the face of a wide variety of potentially conflicting opinions. This in turn ensures that the final result has the broad support of the majority of intended users.

Each crop descriptor list represents an important tool for global data exchange by providing an internationally agreed format and universally understood language for PGR information, particularly with regards to characterization and evaluation data. The descriptor lists constitute the basis for a standardized documentation system and the adoption of these tools (and in some cases, a conversion method to Bioversity's format) has helped to establish an efficient and reliable instrument for information and data exchange, storage and retrieval, facilitating the optimal utilization of germplasm.

The crop descriptors published by Bioversity, thus far, represent 3.5 million accessions held in genebanks worldwide and cover 90% of the crops listed in Annex I of the Treaty. They also cover 95% of the CGIAR mandate crops.

Descriptors contribute to increased knowledge among users and facilitate research activities, not only on mandate crops, but also on crops receiving limited attention from the research community, which are often those crops most accessible to the poor. Of Bioversity's crop descriptor lists, 35% deal with Neglected and Underutilized Crops.

### **FAO/Bioversity List of Multi-Crop Passport descriptors [V.2]**

With the integration of national collections into multi-crop collections, it became evident that common descriptors needed to be more consistent across crops. As a result, Bioversity and the Food and Agriculture Organization of the United Nations (FAO), with substantial contributions from European countries and CGIAR centres, published the List of Multi-crop Passport Descriptors (MCPD) in 2001 as a subset of passport information contained in the crop descriptors.

The FAO/Bioversity Multi-Crop Passport Descriptors (MCPD V.2) is the result of a thorough revision of the original publication released by FAO/IPGRI in 2001, which has been widely used as the international standard to facilitate germplasm passport information exchange. In this improved version the 2001 list of descriptors has been expanded to accommodate emerging documentation needs, derived *inter alia* from the entry into force of the Treaty and its Multilateral System for access and benefit-sharing, and from technological changes such as the broader use of GPS tools. The descriptors and allowed values of the first version form a subset of those in this revision.

These descriptors are compatible with Bioversity's crop descriptor lists, with the descriptors used by WIEWS (the FAO World Information and Early Warning System on PGR), and with the GENESYS global portal.

This passport standard has had an immense impact, especially in Europe where the European Plant Genetic Resources Search Catalogue (EURISCO, available at <http://eurisco.ecpgr.org/>), which contains passport information on European *ex situ* collections, was developed based on the MCPD standard. EURISCO contains germplasm information from 40 countries, representing more than 1.0 million accessions in Europe. Additionally, the MCPD standard is being used as the basis for the development of several Central Crop Databases belonging to the European Cooperative Programme for Plant Genetic Resources (ECPGR).

Further, the FAO-WIEWS Directory of Germplasm Collections includes passport data fields following this standard and nearly all CGIAR Centres follow, when possible, the format and content proposed in the MCPD, making it easier to both retrieve and exchange data.

Outside the CGIAR system, other scientific initiatives are also utilizing or promoting the MCPD standard, among them the Generation Challenge Program, FAO, USDA-ARS, FAO/IPGRI Genebank Standards, and others.

### **Descriptors for Marker Technologies**

With increased molecular and biochemical characterization of PGR, the need arose to also define common standards for documenting information about genetic markers. In order to address this issue, ‘Descriptors for Genetic Marker Technologies’ were published to complement classical agro-botanical analysis (De Vicente *et al.* 2004). This descriptor list includes a minimum set of standards for documenting information about genetic markers and is targeted at researchers who use such technologies, aiming to facilitate the documentation and exchange of standardized genetic marker data by providing descriptions of content and coding schemes to assist in computerized data exchange.

### **Descriptors for Farmers’ Knowledge about Plants**

In an attempt to integrate traditional knowledge with scientific research Bioversity, in 2009, developed a standard for sharing data describing farmers’ knowledge about plants, including cultural, social and socio-economic characteristics important for farmers. This standard has been developed in order to establish a *lingua franca* to capture and share information amongst farmers and scientists and to integrate biology and traditional knowledge.

The standard provides a format for the gathering, storage, retrieval and exchange of farmers’ traditional knowledge of plants. It aims to capture key characteristics, uses and values of cultivated and wild plants, as described by farmers and those living in farming communities.

This standard focusing on farmers’ knowledge is a first attempt to combine a documentation system historically used in controlled environments (genebanks, breeding institutes) with an approach that involves people and their conventional knowledge ‘in the field’. It is anticipated that this descriptor list, which is the result of reviewing many years of fieldwork conducted by scientists and field practitioners, will become an important tool for linking biology and traditional knowledge in order to sustain and conserve agricultural biodiversity (Bioversity and The Christensen Fund, 2009).

### **Key Access and Utilization Descriptors for Crop Genetic Resources**

Bioversity has developed common information standards to describe critical characteristics of genetic resources important for crop improvement, to promote effective communication among the PGR community. These minimum lists consist of an initial set of characterization and evaluation descriptors to help facilitate the utilization of crops.

This strategic set of descriptors, together with passport data, constitute the basis for the global accession level information portal GENESYS. It facilitates access to and utilization of germplasm accessions held in genebanks and does not preclude the addition of further descriptors, should data subsequently become available.

Biotic and abiotic stresses included in the lists were chosen because of their cosmopolitan nature, wide geographical occurrence and significant economic impact. The high number of scientists (500), countries (87), and organizations (190) contributing to the development of these key sets, conferred them the 'internationally accepted status'.

These descriptors form the basis for the information portal developed by Bioversity and its partners to facilitate access and use of plant samples (accessions) held in genebanks.

## **A GATEWAY TO ACCESS PLANT GENETIC RESOURCES UTILIZATION – RATIONALE**

Many genebanks have some form of electronic documentation or information system which was developed according to their specific needs. Consequently, few linkages exist between systems, many are not available online and most are at different stages of development. The large amount of unlinked, largely offline, information systems prevent breeders and other users from effectively searching for and identifying desired traits across genebank samples and restrict their use. There are still gaps, overlaps, and inefficiencies in activities related to information systems of genebanks and national programmes. This lack of compatibility in documentation has seriously hampered data exchange between and among genebank collections making it difficult to identify duplications among them. Consequently, it was evident that a necessary step in the evolution of a fully rational global conservation system for the world's crops was needed.

GENESYS is an online information system that can link genebanks worldwide, is a global portal of information on germplasm accessions (see Fig. 1). GENESYS brings together the passport data for one third of the world's accessions and adds further value through the inclusion of characterization, evaluation and environmental data together with geographic visualization of spatial data.

GENESYS allows breeders and other users to create custom queries on information gathered by various genebanks across all available data and then request samples simply and efficiently; this is an initial step towards enhancing their ability to address and confront the many challenges facing agriculture.

Users can intuitively build custom queries across all these data types to identify the material they require for their research programs. They can also lodge a request for samples of selected accessions online or download the data they choose for offline analysis. Information is the ultimate vehicle by which plant genetic resources can be accessed and used for the benefit of mankind – GENESYS is already the gateway to more information than any other system provides to access and use valuable plant genetic resources.

A global gateway to access PGR information and facilitate their use contributes to the overall effectiveness of global efforts. Bioversity, together with its partners, is contributing to this initiative to facilitate data exchange on agricultural biodiversity, increase sustainable agricultural production, improve livelihoods to meet the challenges presented by

human population growth, food insecurity, climate change and water scarcity. The global portal – GENESYS - contains accession-level passport, characterization, evaluation and environmental data, thereby offering a new paradigm for more effective and effective utilization of biodiversity worldwide; one ingredient for sustainable agricultural production.

The development of crop descriptors and derived standards is one avenue through which Bioversity seeks to achieve its mission, as the value of conserved PGR is dependent upon the type and quality of information available to promote PGR use.



Fig. 1. A gateway to plant genetic resources utilization

## CONCLUSION

A universal system to catalogue and manage the information on plant genetic resources and its exchange has long been recognized as a precursor to developing an accessible data system in order to facilitate the sustainable and effective management and utilization of genetic resources. Bioversity, in collaboration with other institutions, has developed internationally accepted standards to define variables related to the

characterization, management and evaluation of plant genetic resources. They are uniform and unambiguous guidelines for the description and exchange of information on germplasm.

The benefits and contributions resulting from the development of Bioversity's standards, can be summarized as follows: contributes to development of databases, increased uniformity in documentation, facilitates data exchange, increases ability to work collaboratively and therefore the creation of networks which have enabled the establishment of the global portal, GENESYS, to further facilitate the access to and use of PGR.

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