

Knowledge sharing on best practices for managing crop genebanks

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Abstract

The Crop Genebank Knowledge Base (CGKB) is an initiative of the Consultative Group of International Agriculture Research (CGIAR) System-wide Genetic Resources Programme (SGRP). The CGKB was created for sharing knowledge about best practices for managing plant genetic resources (PGR), and making effective decisions about genebank management. Genebank practices from CGIAR Centers and national genebanks were gathered for nine crops (banana, barley, cassava, chickpea, forage grasses and legumes, maize, rice and wheat). This information will help PGR professionals to participate in a global crop conservation effort. An interactive approach with many partners and stakeholders was used to gather published and unpublished information about genebank management. Information on crop-specific best practices was initially collected from crop experts using pre-defined forms. In parallel, a web portal was developed using the open-source content management system (CMS) Joomla!. The CMS allows several editors to maintain pages and update them. Other participatory tools such as wiki pages, a blog, a discussion forum and online forms have been set up to gather future contributions, including information on other crops. The site provides a one-stop platform for information on conservation, characterization, regeneration and safety duplication of each of the nine crops. It also provides information on general (non-crop-specific) genebank management procedures as well as a comprehensive bibliography of online publications, a glossary, links to relevant external websites, video and photo materials, and training modules. Important features for success, challenges and major lessons learned are presented, and options for the way forward are discussed.

Introduction

Crop genetic diversity is used as a major resource by plant breeders and farmers to meet food production challenges for the growing number of poor and hungry people in changing environments. Genebanks were first established over 50 years ago to conserve threatened crop diversity in local land races that were being displaced by new improved varieties and destruction of natural habitats. New technologies and better practices have been introduced for more effective and efficient conservation of plant genetic resources in genebanks; in parallel, information technology has advanced allowing more efficient documentation and sharing of information.

Genebank management guidelines for different crops were scanty and hard to find; most were generic (Engels and Visser 2003; Reed et al 2004; Rao et al 2006) and scattered in the literature. Many procedures were inaccessible in the public domain because they only existed as institutional manuals or guidelines. Earlier approaches focused on identifying rigid standards that curators were expected to follow in all genebanks (FAO/IPGRI 1994). A new approach was required to collate individual crop best practices for germplasm management. The objective of this project is to making them accessible to collection holders, with the desired outcome of conserving the genetic integrity and viability of crop germplasm.

The use of searchable web-based tools to exchange information, experiences, approaches and best practices is replacing traditional indexed publications such as encyclopedias and dictionaries. The development of technical knowledge bases requires quality content, content management systems and web development to address issues of design and usability that meet the needs of the target audiences (December 1996). Conventionally accepted principles of knowledge organization and representation for learning tools are being combined with integrated semantic tools to develop models in concept-based digital learning environments, such as searchable databases, browsers, search engines, wikis, blogs, ontology and visualization (Bergman 2007), and software (Smith et al 2004).

Knowledge bases have been developed for a range of work areas in recent years. Those related to agriculture and development include the Global Knowledge Center on Crop Biotechnology (<http://www.isaaa.org/kc/default.asp>), the Food Security and Agricultural Production Knowledge Forum (<http://www.fao.org/corp/knowledgeforum/en/>), the International Fund for Agricultural Development (IFAD) Rural Poverty Portal (<http://www.ruralpovertyportal.org/web/guest/home>), the Pro-poor Livestock Development Knowledge Base (http://www.cop-ppld.net/cop_knowledge_base/), the World Bank Institute for poverty reduction and development (<http://wbi.worldbank.org/wbi/>), the Cereal Knowledge Bank on rice, maize and wheat (<http://www.knowledgebank.irri.org/>) and the Global Plant Clinic on diseases of tropical crops (http://www.globalplantclinic.org/Html/About_Us.htm). Despite the number of crop-related knowledge bases however, none focus specifically on crop genetic resources.

The Crop Genebank Knowledge Base (CGKB) was developed to fill this gap. It provides dynamic, up-to-date information on peer-reviewed best practices for germplasm management of a number of major crops and genebank procedures (registration to distribution), protocols, guidelines, manuals, publications, training materials and other aspects of genebank management to support more efficient and effective conservation. The website is a balance of technical and practical genebank knowledge channeled through information (IT) technologies that facilitate knowledge sharing. The website uses the most current, appropriate web tools, web-communication platforms and interactive multimedia. The primary objectives of the CGKB are to:

- Provide user-friendly online access to procedures, standards and practices for managing clonally propagated and seed crops held in genebanks;

- Compile and adapt best practices in a learning platform;
- Provide links to other related information and training resources;
- Provide a mechanism to update and develop new best practices for the management of a range of crops – this platform will allow for improvement of best practices in the future as well as provide a baseline for monitoring change;
- Strengthen capacity of genebank curators and technicians to manage genebanks, including new staff; and
- Ensure the quality of genetic resources distributed from genebanks.

Approach in developing the Crop Genebank Knowledge Base website

CGKB was an initiative of the Consultative Group of International Agriculture Research (CGIAR) System-wide Genetic Resources Programme (SGRP). It was developed as part of a three-year project on collective action for crop genetic resources, focusing on the nine crops conserved and managed in the genebanks of international agricultural research centres (IARCs).

Partnerships

A participatory approach involving crop experts from IARCs and national genebanks worldwide was implemented to collate and develop crop-specific best practices and associated information concerning genebank management. This information was compiled by training and communication experts, project collaborators and selected users, who co-developed the best practices and undertook technical and editorial reviews.

Website structure

Four major themes (crops, procedures, management strategies and learning resources) were chosen to encompass the core content of the website. The names, content and layout for these menus were fine-tuned during website development and adjusted as necessary to incorporate useful and practical features observed in similar websites. Sub-menus were identified for each main menu, harmonizing general genebank procedures with those for seeds and clonally propagated crops.

The structure was designed to have a simple and logical flow of content, with no more than three clicks to reach any page (Web Transitions 2003). Navigation options were established, linking related pages across the site. Relevant content was repeated (links to visual aids for specific procedures, tables, files or references) where appropriate to facilitate access to information. From the beginning, the CGKB website structure and layout were developed with the involvement of genebank experts; design and navigation features were fine-tuned based on feedback from user questionnaires. The training component of the website was validated through its successful use in a genebank training course co-organized by Bioversity International and the Rural Development Administration in Suwon, Republic of Korea (7-18 September 2009).

Tools

The CGKB was developed using an open-source (General Public License) content management system (CMS), Joomla! (<http://www.joomla.org/>), which does not require expensive licenses and can be used

by different contributors. CMS software keeps track of every file (text, photos, videos and documents) on a site, thus making the overall management easy to oversee. A major advantage of using a CMS is that it allows different editors in multiple locations to manage content.

A separate platform linked to the CGKB was built using the wiki software Wikispaces (<http://www.wikispaces.com/>) to provide a space where contributors can post, edit and discuss possible content for the CGKB. A discussion forum and online form were set to gather contributions. The CGKB was enriched with multimedia products to illustrate content such as images, flipbooks, video clips and photo database (<http://www.flickr.com/photos/croptgenebank/collections/>) using Flickr (<http://www.flickr.com/>). Website traffic is monitored and recorded using Google analytics (<http://www.google.com/analytics/>). A blog was established using WordPress to facilitate informal communication among collaborators and users, and provide current information about work and activities.

Content

Practical information on best practices for managing PGR was primarily provided by experts from IARC genebanks and partners using pre-designed templates. Information was edited and uploaded into the website. Information gaps were captured by the editors from literature reviews and appropriate websites. Experts regularly reviewed material uploaded onto the web portal and provided feedback, thereby ensuring that the information was correct, precise and up to date. A peer review was also carried out at the end of the project by external genetic resources experts.

A list of references was compiled for each web page with hyperlinks to the full text where available in the public domain, for additional information. Key contributors were listed for each webpage and a focal point was identified to keep each page regularly updated and to respond to queries. Copyright issues for the various types of information (text, links, visual aids, references) displayed on the website follow the policies of each collaborating institution.

Results

Features of the CGKB

Results of this work are publicly available on <http://croptgenebank.sgrp.cgiar.org> and are summarized below:

Home

The Home section (Fig. 1) provides general information about the website, how it was created, how it is expected to be updated and its main features. It includes the copyright policies of collaborating institutes and an editor login. It also provides information about contributors and sources of information. This page incorporates interactive communication features such as a forum and a blog, inviting users to interact and collaborate, register comments, pose queries or upload their own best practices. They can also find the latest news from RSS feeds on genebank management and related topics. Wikis provide users with work spaces to update existing practices or develop new ones in a collaborative way. These tools contribute to dynamic learning, participation in networks and help to strengthen links with other organizations and individuals; according to Horton et al (2003), this is becoming increasingly important in managing modern organizations.

Crops

The Crop section is the heart of the website and is particularly important for genebank managers because it provides crop-specific information, references and options on recommended procedures. This section describes best practices for germplasm management in genebanks for specific crops. Information is

currently available for banana, barley, cassava, chickpea, forage grasses and legumes, maize, rice and wheat, together with additional information on regeneration guidelines for other major crops – the output of a related project sponsored under the Global Crop Diversity Trust.

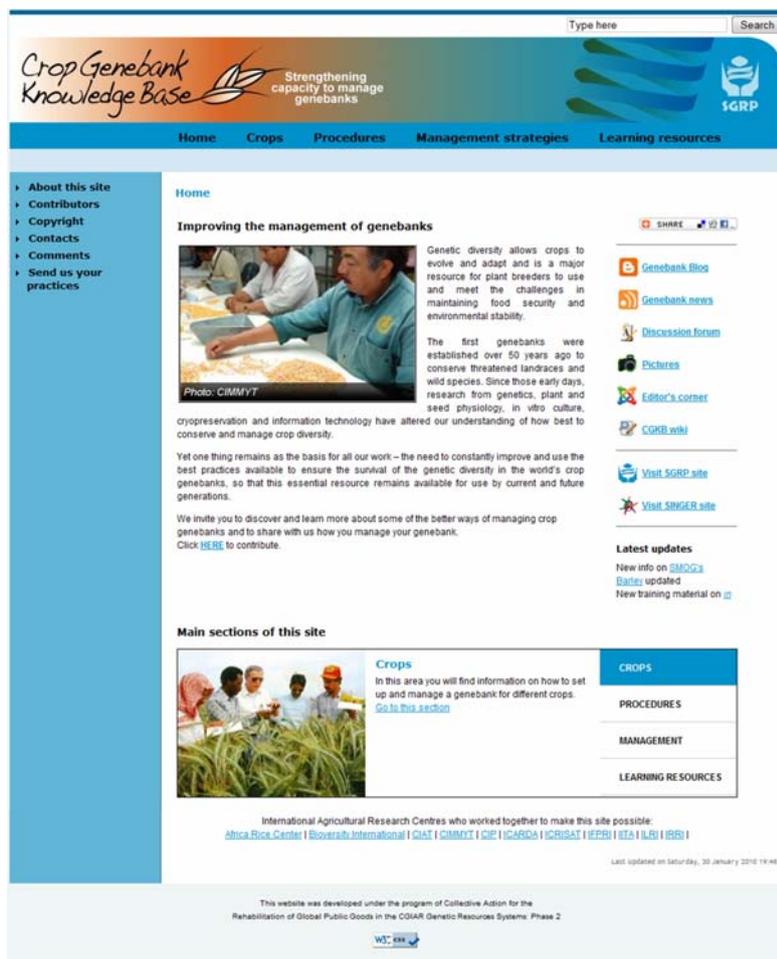


Fig. 1. Home page of the Crop Genebank Knowledge Base, showing menus and links

Each crop section starts with a general introduction about its importance and origin, available types and utilization, and information on how the best practices were compiled. Users can then access the detailed pages about conservation, characterization, regeneration, and safety duplication. These pages have a similar structure within crops, making it easy to find and add information for new crops. Small-format variations were needed for clonal and seed crops, related to the conservation methods used.

Procedures

This section provides the reader information about general (not-crop specific) genebank procedures in an interactive manner. It describes all procedures from registration to distribution, which were mainly derived from the *Handbooks for Genebanks* published by Bioversity International (Rao *et al* 2006; Reed *et al* 2004, Engels and Visser 2003). Each menu describes a procedure and explains why, when and how it should be followed. It also discusses the relative advantages and disadvantages of different kinds of genebanks (seed banks, field banks, *in vitro* banks, cryobanks, vegetative banks and DNA banks) under the conservation subsection. A compilation of genebank equipment, supplies and main suppliers is also provided. This section was specially designed to help newcomers' to access information and learn about genebank-management procedures. The procedures found here can be used by lecturers as handouts for training workshops or courses on genebank management or *ex situ* conservation.

Management strategies

This section covers genebank best practices on management issues such as risk and quality management using the following menus: genetic identity, quality management, safety duplication strategies, safe movement of germplasm, policies, risk management, inventory system, decision-support tool and performance indicators. This section is particularly useful for those looking for user-friendly support tools related to cost decisions and risk assessment, or broader guidance on genebank management strategies.

Learning resources

The Learning resources space provides a comprehensive electronic library relevant to teaching and learning about genebanks. This section aims to build capacity of genebank curators and technicians. Its content differs from other sections of the CGKB: it is primarily a repository of publications and other learning resources on genebanks. The learning resources section adds considerable value to the CGKB. For the first time, it gives teachers and learners access to a one-stop genebank management library comprising training modules, handbooks and manuals, most of which are available in pdf or html formats. It also provides an extensive bibliography on genebanks and genetic resources for the CGKB website. The learning resources section provides access to a collection of audio/visual learning resources including videos and slide shows, workshop presentations, and a photo database that is built within a social networking medium (Flickr). Finally, the section includes an extensive glossary and acronym list, and a list of useful links to websites with information about genebanks or genebank management.

Challenges in CGKB development

The process of developing the CGKB as a multi-partner, multi-crop, multi-location and multi-disciplinary project was complex. There were many lessons learned that can benefit others.

Partnerships

The large number of collaborators from various disciplines provided a broad range of expertise and rich content. However, the interdependent steps needed to write, upload and review the content resulted in high transaction costs and delays in completing the project in the required timeframe. Contributions varied greatly in terms of following the proposed template, depth of information, details of references and visual aids. Face-to-face meetings, workshops, surveys, questionnaires and personal genebank visits by the project coordinator were extremely helpful to create awareness about the CGKB project and prompt contributions, as well as to collect visual materials to enrich the site.

Collaboration with remote partners and team members

Discussing the site design by email with people across the globe was often difficult and complicated. It took some time for the editing group to reach a common language. Communication through Skype and telephone during critical discussions of structure and design was helpful. Face-to-face meetings with important collaborators possible helped to resolve difficult decisions.

Tools and Training

The editors had to learn to use the IT tools (Joomla!) to edit and change web pages. Useful training tutorials were developed to facilitate distance learning for current and future editors and collaborators. Editorial rights were maintained within a restricted group of the CGKB team. Most collaborators were unfamiliar with web tools like wikis, blogs or Google shared documents, and these were not used as extensively and effectively as anticipated. Wikispaces were used for a few activities to generate discussion on best practices; however they did not contribute to the majority of information gathered and were only effective with one group of contributors who had a specific, timed objective. In the near future, a facilitated wikispace discussion will be organized to update best practices on plant-collecting procedures that were originally published 15 years ago.

Content

Templates (tables in Word listing fields to be filled) were initially prepared to collect information in a structured manner, similar to the website layout. These were useful but needed adjustment when information was uploaded. It was also challenging to convert text-based information into a meaningful and logical digital structure for access on the Internet. Reviewing the uniformity and layout of each web page was extremely time consuming and difficult until all pages were finalized.

Future opportunities

One major challenge for the CGKB was to develop a product that remains up to date, flexible and useful over time, particularly as regular updating is critical to provide updated knowledge on best practices and risk-management procedures. The CGKB was developed by a community of practice that should remain active for many years to come. Mechanisms to fund minimal maintenance of the site were established with SGRP, assuring the basic support and updating in the future. This website provides a platform to include new crops or translations into other languages, and information on new and emerging technologies.

This platform is already being used as a training tool for genebanks, such as in courses co-organized by Bioversity and ICARDA in Amman, Qatar and Aleppo in early 2010. Whether used for self-learning or formal training, the features found on the CGKB will contribute to narrowing knowledge gaps, help to create communities of genebank practitioners and strengthen their capacity to be effective custodians of the world's crop diversity for food and agriculture in the future.

Conclusions

This paper describes the process of developing a one-stop platform about best practices on crop genebank management and procedures. Synergies were created by many experts who gathered and transformed scattered information into knowledge that will improve the efficiency of conserving seeds and vegetative plant materials, making them available for future generations.

The CGKB is now a valuable interactive platform that can be extensively used and expanded in new directions. Current crops and genebank information will be regularly updated. The crop focal points and their networks now have the responsibility of linking and encourage peers to provide feedback and improve this useful tool. Channels of communication and collaboration have been established and will be easy to use. This is an invitation for the genebank community to participate and provide feedback and new information on genebank issues and other crops.

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