Harnessing ICTs in managing Southern African genebanks

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Abstract

The Southern African Development Community (SADC) has a centre for coordination of collection, preservation, management of plant genetic resources in the region, based in Lusaka, Zambia. The SADC Documentation and Information System (SDIS) is used at the SADC Plant Genetic Resources Centre (SPGRC) and in the National Plant Genetic Resource Centres (NPGRcs) of each of the 15 SADC Member States. The SPGRC network has adopted international standards of plant genetic resources conservation and documents its information in a standard computerized format on SDIS which effectively facilitates decision making and taking action in genebank activities such as: registration, inventory of genebank collections, collecting priorities, regeneration and multiplication time, production of catalogues, distribution and exchange of germplasm. The system integrates information from the time germplasm material is collected from the field by *in-situ* personnel, it undergoes sorting, cleaning, drying by the *ex-situ* conservationists until when it is weighed, treated and packed in bottles for long-term preservation in freezers under -20^0 Celsius. All what is conserved short-term by the National Plant Genetic Resource Centres (NPGRCs) in each of the SADC Member State is duplicated to SPGRC for long-term conservation, part of which is again apportioned for safety duplicate at the Global Seed Vault in Svalbard, Norway. The SDIS captures data from both NPGRCs and SPGRC to integrate in into one regional database. To enhance 'real-time' updating and to improve communications between stakeholders, SPGRC is working towards connecting all NPGRCs to the Internet to be followed by the launch of a web-based SDIS that is currently under development. This paper elaborates on salient achievements and future plans of using ICTs in the management of plant genetic resources in the SADC region.

Introduction

The Southern African Development Community (SADC) countries have pooled their resources and established the SADC Plant Genetic Resources Centre (SPGRC) in Lusaka, Zambia where base collection for long-term storage are maintained and plant genetic resources activities for the region are co-ordinated from; whereas, the National Plant Genetic Resources Centres (NPGRCs) in each of the 15 Member States (namely Angola, Botswana, Democratic Republic of Congo - DRC, Lesotho, Malawi, Mauritius, Mozambique, Namibia, Seychelles, South Africa, Swaziland, Tanzania, Zambia and Zimbabwe) maintain active collections for short-term storage for immediate use in crop improvement.

The SPGRC objectives are to conserve and guarantee safe preservation of crop and wild plant genetic resources; document the plant genetic resources of the region to ensure their efficient and sustainable use and provide a forum for exchange of scientific, cultural, traditional and indigenous knowledge and experiences; to train personnel and co-ordinate plant genetic resources activities in the region.

The SPGRC has therefore a mission to mobilize, conserve and make available, plant genetic resources using appropriate technologies and standards, thereby contributing to sustainable development, environment and food security for the well being of people of the region. This is done in collaboration with NPGRCs, NGOs, local authorities in respective countries, farmers, interested conservationists and other stakeholders.

This paper briefly describes how ICTs are being applied in managing genebanks in the SADC region with particular emphasis on the SPGRC Documentation & Information System (SDIS) that helps genebank managers in decision making and taking action in genebank activities.

Benefits of Conservation

While farmers have maintained germplasm from time immemorial and they are the major depositors of materials held in the national genebanks and at SPGRC, they do benefit from the collections in that, if they ever loose their materials, they can always get it from the genebank. Crop restorations and

enhancements are done in case of crop losses due to floods, change in farming systems, relocation of homesteads to pave way for other development activities like dam building, road extensions, *etc*. The *ex-situ* materials are used for crop improvement and plant breeding trials for increased agricultural production.
The information system is meant to help managers in the identification of target areas for subsequent collections and conservation; provides information for evaluation of collected crop landraces thus facilitating them to identify methods and strategies to be used for maintaining plant genetic resources. It also provides information on development of databases for on-farm plant genetic resources management; landrace restoration and enhancement; as well as monitoring of on-farm conservation. Crop passport data and germplasm MIS (including location, viability, availability) is embedded inside SDIS.

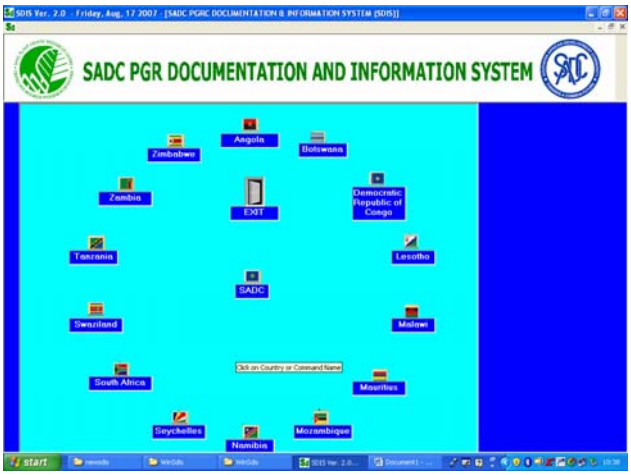
SPGRC Documentation and Information System (SDIS)

Background

The standardisation of genebank information for the SADC Plant Genetic Resources Network has been made possible through the development of the SPGRC Documentation and Information System (SDIS) at SPGRC and installed at all the NPGRCs. The system was developed as a source of information to assist the SPGRC together with its network of NPGRCs in planning and operating the network's genebank activities.
A computerized information system for the documentation of accessions that are stored both at SPGRC and the NPGRCs records information facilitates decision making and taking action in genebank activities such as: registration, inventory of genebank collections, collecting priorities, regeneration and multiplication time, production of catalogues, distribution and exchange of germplasm, and detecting duplicates. This has resulted in standardization and user participation in systems development at regional level.

System Development Milestones

The SPGRC (http://www.spgrc.org.zm), in collaboration with the NordGen (http://www.ngb.se) started designing this system in 1994 and since then, the system has undergone a series of morphological and functional improvements and updating. The SDIS, which was initially developed in dBase and upgraded to windows in 2003, is a system made up of several databases some of which can be linked together to facilitate data entry and retrieval. All the databases in SDIS are relational. A relationship therefore is accomplished by matching an attribute appearing in more than one table. Once a selection is made from the main menu, information related to the sub-menu appears below and the user can proceed to view, add, query, edit and print what is contained in the database. The application allows the viewing of data on accessions from all NPGRCs, but restricts the adding and editing of this data to the genebank.



To date, the SDIS is window-based and is still being improved so as to optimize usability by stakeholders. Additional modules, crop descriptors and species are continuously added to it. Currently, the system is being developed for transformation into a web-based that will allow 'real-time' accessibility and updating. This will complement efforts that are underway to improve access to the Internet for all constituent NPGRCs.

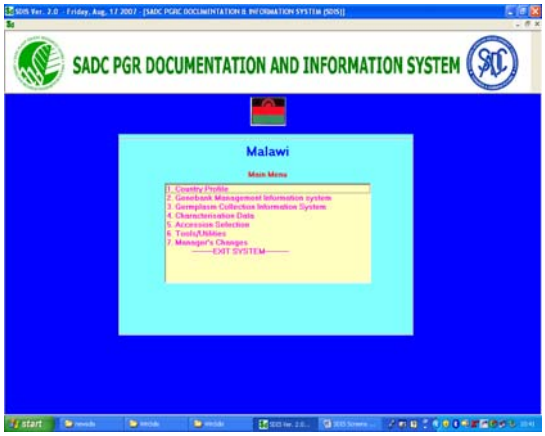
Objectives and Use of the System

The SDIS is used at SPGRC and NPGRcs of each of the 15 SADC Member States to assist in planning and operating the network's genebank activities.
This documentation system has adopted international standards of plant genetic resources conservation and documents its information in a standard computerized format that facilitates decision making and taking action in genebank activities.

Technology Description

Data Structure

The structure of the SDIS follows that of the SPGRC as a core unit within a system of autonomous NPGRCs. Hence SDIS is not a centralized system accessible on a website, but a 'federation' of users of a common system. The entry of data on accessions in active collections is the responsibility of each country. All other countries have access to these data, but may only edit their own. Data are transferred to SPGRC by e-mail, ftp and physically, on CDs; and the SPGRC is responsible for distributing updated versions to all countries (except the originator to avoid overwriting their data). SPGRC keeps the base collection updated in SDIS and develops the SDIS system.
The data structure for each accession is divided into window modules:



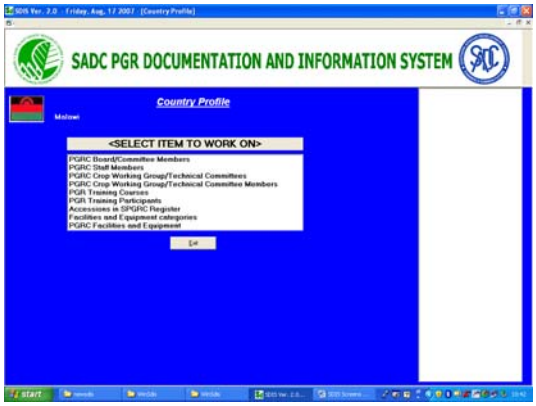
- Accession registration module;
- Active collection module for NPGRCs;
- Germplasm collection module;
- Characterization module;
- Distribution module – most recently developed; and
- Evaluation module: under development.

In order to visualize data for several accessions at a time or to print anything from SDIS, data must be exported to Excel or similar functions in Windows.

Fig 2: Database main menu

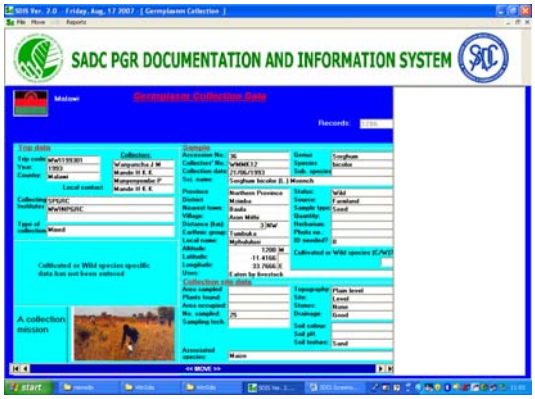
System Requirements

System requirements are features that must be included in an information system in order for the system to be acceptable to the end users who are, in this case, NPGRCs and staff at SPGRC. The requirements have been classified into five categories as follows:
Outputs: As and when required, the system can produce information on the following:



Country profile – Plant genetic resources community data
Genebank management information system – Accession registration data, batch reference handling, base/active collection data, germination test data and germplasm distribution.
Germplasm collecting information system – Collection trip and site data, collection data, cultivated species and wild species.

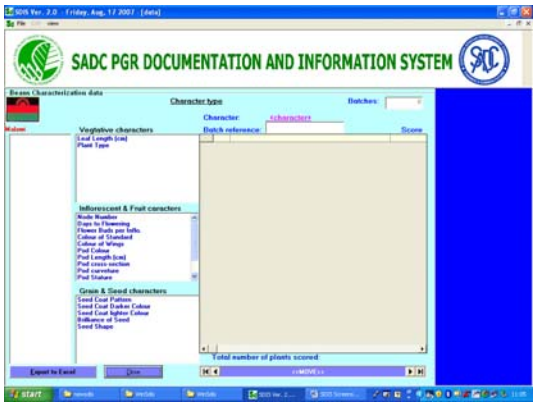
Fig 3: Country profile window



Characterization data – Process and print data on sorghum, finger millet, cow pea, pearl, millet, maize, common beans, groundnuts and bambara nuts.
Accession selection – Locate accessions, which meet given or specified criteria.
Species list management – Print/ view selected or all species.
Distribution – what species, when and what amounts supplied to who, balances.

Fig 4: Germplasm collection output data

Inputs



Country profile – Plant genetic resources community data;
Collection trip data;
Characterisation data - vegetative characteristics, inflorescence and fruit characteristics, seed characteristics.
Genebank storage data – physical location in the genebank.

Processes

Records are accessible through the accession number;
Available collection data;
Specific sample selection based on characteristics.

Timings

Data is captured as it is received and daily backups are done.

Controls

Data on country profile, accession registration, collection trip data and characterization data can be edited, but with certain restrictions put in place. Each NPGRC can only edit its own data.

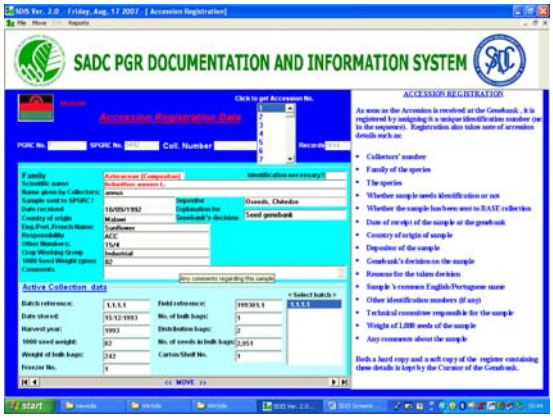


Fig 6: Accession data display

System Developments

SDIS Linkage with GIS

Although a database is an information system that provides information about the state of a real world system, it falls short of some geographical or spatial analysis. This shortfall has provided a need to integrate SDIS with Geographic Information System (GIS) also as a way of further enhancing the usefulness of SDIS. Two main advantages are:

- Through spatial queries, it is possible to identify where species occur so that when collection missions are planned, collectors know where to go; and

- Provides additional analytical information to that observed by the collectors in a given area that will enable identification of gap filling.

Part of the information collected in the field is that related to the physical location of the site of collection. This is represented in decimal degrees (latitude and longitude). When such kind of data is available, it makes it possible to conduct spatial analysis on the data. Since SDIS was designed using relational databases, linking these databases in GIS makes it possible to cartographically display different combinations of data.

Value-Addition to Collections

Management of genetic resources being a complex and multi-faceted process involves a number of distinct stages, which are nevertheless linked and interrelated. These different stages generate various types of data, including information on the identity (passport data) and characteristics of germplasm (characterization and evaluation data), which are crucial for the effectiveness of the conservation process as a whole. To make full use of the generated data and information it is better that the data is analyzed and packaged into usable format. In a proper format, data can be used not only to assist conservation efforts, but to "add value" to plant genetic resources for food and agriculture There are also several tools available that genebank managers can use in order to add value to their data. Such tools include Numerical Taxonomy System (NTSYSpc), R-Statistics, DIVA GIS just to mention a few. Scientists are encouraged to make use of the tools so that the conserved materials are accorded corresponding economic value for the good of the region and the world, at large.

The SPGRC organizes workshops so that NPGRC officers are acquainted with analytical tools thus enhancing availability of useful information associated with the conserved germplasm which in turn adds value to the conserved germplasm.

Increased usage of the available information through training of regional experts on data analysis, interpretation and increased use of materials for breeding, conservation, re-introduction, multiplication, is eminent in order to justify the collections and their conservation. In order to increase usage, SPGRC has deliberate efforts for supporting local seed systems and linking with seed production, recognizing and incorporating medicinal plants and traditional knowledge in her systems, as well as mainstreaming HIV/AIDS.

System Adoption

As earlier mentioned, the SDIS is developed at SPGRC (with inputs from NPGRCs), installed and used in all the 15 SADC Member State NPGRCs. Training of NPGRCs is frequently done focusing on new developments of the system.

Technical backstopping from SPGRC is at the disposal of NPGRCs. This is done through physical visits to NPGRCs as well as online troubleshooting, supplemented by email communications, *etc*.

Communication Facilities: Telephone, Fax, E-mail and Internet

A modern radio-telephone system is installed and has effectively improved communication within SPGRC, between SPGRC and NPGRCs and the outside world. SPGRC is connected to the Internet and has a local area network using a Novell platform installed. Currently, all of the NPGRCs are connected to the Internet enhancing their equal play in the network of information exchange and sharing.

Publicity materials depicting activities at SPGRC including annual reports and other publications are produced as part of information dissemination; whereas, SPGRC web page is accessible at http://www.spgrc.org.zm where SPGRC discussion forum is also hosted.

Complementarity with Related On-Going Initiatives

As a regional organization, SPGRC is not working in isolation and therefore has a focus on all other developments in ICTs that are taking place in the region. It is particularly interested on the mushrooming Internet connectivity initiatives such as:

EASSy (Eastern African Submarine Cable System)

Considered as a milestone in the development of information infrastructure in the Eastern Africa, EASSy is an initiative to connect countries of the region *via* a high bandwidth fibre optic cable system to the rest of the world.
EASSy that runs from Mtunzini in South Africa to Port Sudan in Sudan, will link to the global submarine cable network through other regional undersea systems including SAT3, SAFE, SEA-ME-WE 3 and SEA-ME-WE 4. It will provide the last link to completely encircle Africa by high capacity optic fibre telecommunications networks.

Fig 7: EASSy cable map

SAT-2

SAT-2 is a 9,500 Km submarine communication cable linking Melkbosstrand, South Africa, to El Medano, Tenerife Island, Spain and Funchal, Madeira Islands, Portugal. Operating at 560 Mbit/s, it contains 82 repeaters.

South Africa Far East (SAFE Cable System)

The cable system is a 13,104 Km optical fibre submarine communications cable linking Melkbosstrand, South Africa to Penang, Malaysia with an initial capacity of 10 Gigabits per second, which is upgradeable to 130 Gigabits per second. It provides high-speed digital links between Europe, West and Southern Africa and the Far East

The Future for SPGRC Networking

A reliable and accurate plant genetic resources for food and agriculture data exchange network through development of expertise and infrastructure at the regional and national levels is inevitable and that is why support on access to the electronic communication infrastructure by genebanks is top on the SADC network agenda.
Basically, the envisaged web-based system operation will be such that the NPGRC system updates its database into the central database, at SPGRC at around 24:00 hours daily. After updates from all countries have been received, the central database in turn, will update every country with a fully updated database (excluding respective country's database) at around 03:00 hours or so, every night.
Education and training in data management and electronic communications is advocated at the genebank level, with emphasis on data management and analysis, connectivity, and data exchange.

Other Supporting Technologies

Biotechnology Laboratory

There are limitations in terms of complementary conservation facilities and capacities to enable the conservation of a broader range of germplasm such as species that are vegetatively propagated and those whose seed may not survive the adopted conditions of storage. While SPGRC has no facilities for molecular characterization, plans are underway to establish a biotechnology laboratory specifically for *in vitro* propagation of vegetative plant genetic resources and for molecular characterization of accessions.
The senior technical staffs at the SADC Centre are expected to be up-to-date with the rapidly evolving biotechnology approaches and methods in dealing with PGRs in order to maintain a credible technical network coordinating and leadership function.

Irrigation Facilities at SPGRC

The mandate of SPGRC covers a wide range of utilized plant species and their wild relatives. Many of these may not be successfully propagated during the rainy season and therefore entirely depend on irrigation. Irrigation is also essential to supplement rain-fed crops during prolonged drought in some years. A capacity to irrigate 4 hectares of land used for germplasm seed multiplication, regeneration and characterization has been developed using the overhead sprinkler system; whereas, 4ha more have been opened up for the same purpose.

Challenges and Way Forward

The SDIS is faced with a number of challenges and is working to address them. These include the integration of SDIS with GIS, addition of crop descriptors, and development of a web-based documentation system, going hand-in-hand with facilitating NPGRCs' reliable access to the Internet. Others include capacity building for data analysis, and need for increased data and information usage by stakeholders.

These are holistically being tackled through a number of capacity building efforts that include training on-site and at workshops in a number of areas of conservation as well as ICTs. While efforts are underway to connect NPGRCs to the Internet, a web-based SDIS is also under development at SPGRC. While crop descriptors, necessary for characterization are continuously being added to the SDIS, at the same time capacity is being built on the side of GIS so that its integration with SDIS is easily and professionally done.

References

BANGWE, L., A. BJORNSTAD and B. LUNDGREN (2006). In-Depth Review of the joint SADC/Nordic programme: SADC Plant Genetic Resources Centre and the network of NPGRCs, Lusaka, Zambia.

EASSy (2006). East Africa Submarine Cable System: Closing the Last Link <http://www.eassy.org/> Accessed 21 November 2009.

KAPANGE, B. (2007). Conserving the Plant Genetic Resources of Southern Africa. *Magazine on Low External Input and Sustainable Agriculture – LEISA* (Netherlands), Issue of June 2007/Volume 23 No. 2. Online at http://www.leisa.info/index.php

KAPANGE, B. (2007). Using ICTs for Managing Genebanks: the Case of SADC Plant Genetic Resources Centre. Paper presented at the World Information Technology Forum (WITFOR) 2007 held in Addis Ababa, Ethiopia. Online at http://www.witfor2007.org/commission/agriculture/speakers

SADC Plant Genetic Resources Centre (2007). Annual Report. Lusaka, Zambia.

SAT-2 (2009). <http://en.wikipedia.org/wiki/SAT-2_(cable_system)> Accessed on 22 November 2009.

SPGRC (2003). SPGRC Documentation and Information System (SDIS). SADC Plant Genetic Resources Centre, Lusaka, Zambia.

SPGRC (2007). Training report: Data analysis (using NTSYSpc) for scientists. SADC Plant Genetic Resources Centre, Lusaka, Zambia.