Interim Proceedings of International Expert Consultation on “Building the CIARD Framework for Data and Information Sharing”

Beijing

20-23 June 2011
Agriculture across the world faces several very critical challenges that will need global efforts to resolve. These include mitigating and adapting to climate change, effectively using water for agriculture, combating desertification and degradation of fragile soils, managing agricultural biodiversity, and controlling spread of plant and animal diseases and alien/non-native species. Sharing and exchange of the outputs of agricultural research sustains innovation systems that contribute to improved agricultural production and productivity, more effective, efficient and sustainable use of natural and genetic resources, especially for resource poor smallholders and producers all over the world and more equitable and fair trade in agricultural commodities.

The CIARD partners are therefore organizing a series of International Consultations (through electronic and face to face events) to build a framework for action in making outputs of agricultural research truly accessible through coherent management, sharing and exchange of knowledge, information, and data and achieve its wide endorsement and adoption by national actors in ARD.

The International Expert Consultation at Beijing from 20-23 June 2011 sought to stimulate and develop broad-based consideration of AR4D data and is an initial step in a future global activity towards more effective and efficient sharing of Agriculture research-related data and information. It is a step, in an extended process of strengthening operational linkages between different forms of information and data, the owners/providers and users.

The specific objectives of the consultation were:

1. **Take stock of the current collaborative bilateral, multilateral, global coherence frameworks and collaboration in management and sharing of information**

2. **Share experiences of national, regional and global collaboration in managing, sharing and exchange of agricultural research information in the context of new challenges to agriculture;**

3. **Charting of future action, strategies and activities for action to further enable collaboration and partnerships involving fast growing economies in global agricultural research information sharing and exchange.**

The event did not define standards, mechanisms or methods for interoperability.
The aims in practice of the consultation were to: 1. Achieve consensus on the need and required extent of interoperability between different information/data management systems, 2. Discuss practical actions to enhance interoperability. 3. Discuss the implications, opportunities and challenges of issues such as IPR, data system security and governance in sharing, validity and verification of data etc that may emerge.

The Consultation discussed that to make the information more easily accessible as also Interoperable so as to make its effective use in different situations possible and easier, there is a need to work at the level of information objects or data. This requires open data repositories and couple them to concepts of “linked open data” or data objects that can be hyperlinked across common attributes. To develop these data repositories that can be located and used globally there will be a need standards, norms and regulations to govern effective, efficient, transparent and equitable flows and uses. There will also be a need standard descriptors, mutually agreed taxonomies and vocabularies based on common ontologies to describe and organize the storage and access to the data. To reduce costs and time in assembling data to meet the information needs for meeting the most critical challenges to agricultural development, there may be a need to define Core Data Sets that Institutions and National Systems of agricultural research and Innovation universally may contribute and work in the spirit of global shared responsibility, collaboration and partnership. And for this policies and strategies are needed at Institute, Organization and Country level. There will be a need for governance structures, legislation and International treaties to share data and information openly as also protect interests of all parties in information management and use. There is a need to create Trust organizations that will manage the data and metadata that is shared openly at national and global levels. There is also a need to look at investments, financial and in human skills that will be needed to manage the entire information infrastructure in global ARD. And of course for all these ideas to take off, advocacy and promotion and new capacities to advocate and manage open data repositories sustainably and all the issues related to them are needed.

A lot is already being done and there is now no need for all do the same individually and independently. There are simply no resources for it. For example, the concept of open repositories is now well developed and there is constant development of the concept of “linked open data” with basic standards such as XML, RSS, RDF etc already in place. The taxonomies and vocabularies, such as AGROVOC, are being rapidly evolving. We need to look at Core Data Sets though some such as for weather and climate, plant germplasm and spatial data already exist and some for example in agronomy are in the making. The issue is who defines them? We need to look at Trust Organizations. The CIARD.RING led by GFAR is one of them. We need to look at implications of open data access in ARD at organizational and national levels and this can be done through GFAR and FAO. We need to advocate for increased investment in information infrastructure in global ARD and this can be done at GCARD 2012. And much more already done, being done and needs to be done can be mapped once we have a framework.
Participants of the International Expert Consultation
The Infoshare MarketPlace

Other Photos at: http://www.flickr.com/photos/gfar/sets/72157626996718431/
Introduction

Agriculture across the world faces several very critical challenges that will need global efforts to resolve. These include mitigating and adapting to climate change, effectively using water for agriculture, combating desertification and degradation of fragile soils, managing agricultural biodiversity, and controlling spread of plant and animal diseases and alien/non-native species. Sharing and exchange of the outputs of agricultural research sustains innovation systems that contribute to improved agricultural production and productivity, more effective, efficient and sustainable use of natural and genetic resources, especially for resource poor smallholders and producers all over the world and more equitable and fair trade in agricultural commodities.

There are many global, regional and public-private sector services and partnerships that facilitate or provide access to agricultural research data and information. Institutional networks have been established to foster and support public access, such as the Regional Agricultural Information Systems developed by regional organizations.

The conventional pathways for communicating research outputs, through scientific publications (journals etc) and face-to-face events, have been enriched by new digital formats including the newer social media such as wikis, informal blogs and online communities of practices. In addition, the concepts about what constitutes shareable agricultural research information are rapidly changing to include ‘raw’ data, organized datasets in databases, information objects such as photographs, videos and audio recordings, maps, etc. Research data are now increasingly managed using advanced technologies such as high speed internet networks, often remotely through global hosts or “clouds” and processed where the capacities are the most effective and economical. Web-based collaboration allows geographically separated laboratories to work together in real time and share knowledge.

It is generally accepted that the implications of these trends in the communication of agricultural research outputs are profound. Over the last decade a series of international workshops and consultations have been organized by FAO, GFAR and the CGIAR to enhance the contribution to agriculture science by 1

1 Partnerships for public provision of information: genomics data (e.g. Rice Research Genome project, Holstein Genome project, CGIAR SINGER database), bibliographic databases of agricultural literature (e.g. AGRIS, AGRICOLA, CAB Abstracts), and access to full text (e.g. AGORA)
information and communication and associated technologies, and commitments have been made by a wide range of organizations which have lead to major advances. These meetings indicated that the main challenges are in (a) advocating increased investment and targeting it appropriately, (b) generating and managing content that is economically produced and affordable to all involved, (c) rapidly building capacities and bringing organizational change towards more efficient and effective information flows and information use.

These global efforts also led to the launching in 2008 of an international multi-stakeholder initiative on Coherence in Information for Agricultural Research for Development (CIARD), co-sponsored by all the main international organizations, regional forums and National Institutes that had been involved in the previous efforts to meet these challenges. The CIARD vision is “to make public domain agricultural research information and knowledge truly accessible to all”, with the partners share the common objective of working together to collaboratively develop common standards, share knowledge, and contribute to effective and coherent institutional approaches in agricultural science and technology information. A CIARD Manifesto was developed through a series of regional consultations in 2009 together with tools such as a Checklist and model Pathways that need to be adopted by all actors in ARD, and this was endorsed by the GCARD2 in 2010. With more emphasis on the ensuring effective use of ICTs, the main international partners also organized two international consultations in 20093 on addressing emerging challenges and exploiting opportunities through ICTs in support of agricultural research, from which emerged the need for a generic Strategic Framework and Action Plan with a perspective on deliverables.

**Objectives of the International Expert Consultation for Building the CIARD Framework for Data and Information Sharing**

The CIARD partners are therefore organizing a series of International Consultations (through electronic and face to face events) to build a framework for action in making outputs of agricultural research truly accessible through coherent management, sharing and exchange of knowledge, information, and data and achieve its wide endorsement and adoption by national actors in ARD. Detailed agendas for high priority actions will be developed and agreed by experts and policy-makers based on the CIARD Manifesto for the major types of information and data that will incorporate outputs of the various relevant global and regional consultations. Under the broad umbrella of CIARD, the program will chart future strategies for action and specific activities for information sharing and exchange, maximizing the potential value offered by new ICT and in relation, especially to the information resources of fast growing economies that are also emerging major scientific powers through collaboration and partnerships.

Expert opinion is needed to identify the opportunities and challenges, so that national authorities can make well-informed choices on getting the best development value from the integration of agricultural research data.

The International Expert Consultation at Beijing from 20-23 June 2011 sought to stimulate and develop broad-based consideration of AR4D data and is an initial step in a future global activity towards more effective and efficient sharing of Agriculture research-related data and information. It is a step, in an extended process of strengthening operational linkages between different forms of information and data,

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2 Global Conference on Agricultural Research for Development
3 Science Forum, Wageningen, June 2009 and ICT Consultation, Hyderabad, December 2009
the owners/providers and users. The event did not define standards, mechanisms or methods for interoperability. The aims in practice are to: 1. Achieve consensus on the need and required extent of interoperability between different information/data management systems, 2. Discuss practical actions to enhance interoperability. 3. Discuss the implications, opportunities and challenges of issues such as IPR, data system security and governance in sharing, validity and verification of data etc that may emerge.

The specific objectives of the consultation were:

1. **Take stock of the current collaborative bilateral, multilateral, global coherence frameworks and collaboration in management and sharing of information;** Current collaborative bilateral, multilateral and global information management initiatives will be mapped, to specifically include those of fast growing economies countries and international agencies including the private sector activities in agricultural research. These activities would include information of different forms and its access and sharing, e.g.:

   - Information residing in communications between individuals, such as in blogs and community platforms supported by sources such as directories of people and institutions;
   - Formal scientific data collections as published data sets and their associated metadata and quality indicators, peer-reviewed scholarly journals or document repositories;
   - Knowledge ,derivatives such as collections of descriptions of agricultural technologies, learning object repositories, expertise databases, etc.;

2. **Share experiences of national, regional and global collaboration in managing, sharing and exchange of agricultural research information in the context of new challenges to agriculture;** address issues in global collaboration, with a focus on involving fast growing economies further in managing, sharing and exchange of agricultural research information in the context of new challenges to agriculture and the potential offered in collaborative international agricultural research by new ICT.

3. **Charting of future action, strategies and activities for action to further enable collaboration and partnerships involving fast growing economies in global agricultural research information sharing and exchange.**

The outputs from the 2011 program of consultations are being summarized in an issues paper on “Enabling Collaboration in Global Agricultural Research Information Sharing and Exchange” for the consideration of the global ARD community, with suggestions/recommendations for governments for submission to the intergovernmental Technical Consultation in planned in late 2011 or early 2012 in Rome, and following that the GCARD-2012.

**The need for data and information sharing globally**
As a prelude to the consultations, the reasons for data and information sharing for agricultural research (and innovation) for development and for building a framework were considered. This data and information was not only as generated by research but also that used in research.

Data and information sharing for agricultural research for development enable, among many benefits:

- New information and knowledge to be generated
- Localization globally of available information and knowledge and enable it to be used more effectively
- Increase efficiency and effectiveness of research and its outputs and innovation in time, cost, quality and human effort
- Reduce reinvention and repetition of research efforts
- Allow greater inclusiveness and participation in research and innovation
- Bring cross-disciplinary and specialized skills to agricultural research
- Reduce “market failure” or inability to use research outputs effectively and/or efficiently
- Create new research directions and avenues
- Bring greater equity in using agricultural knowledge across and among communities

The need for a framework for data and Information Sharing

The building of a framework is essential as data and information sharing related to agriculture involves the use of complex information and communications technologies (ICTs) including the Internet and cellular telephony in a variety of social, economic and political environments in different countries with very varying infrastructural and technical capacities. Along with the use of ICTs, due to the specificities of agriculture and farming especially if data and information sharing has to contribute to innovation and development to benefit the remote, resource poor farmers and producers of (economically) developing countries, several Institutional barriers including those related to Intellectual Property Rights, equity in availability and access, applicability including validity, relevance, usefulness of information and making its effective use and community participation need to be considered.

Frameworks, which are a plan of action for an objective or set of objectives, makes it easier to work with complex technologies and ties together a bunch of discrete objects/components including those related to Institutional support and community participation into something more useful. A framework such as being discussed in this consultation outlines possible courses of action, many a time concerted over nations, organizations and communities and presents preferred approaches to the sharing and exchange of data and information related to agricultural research for development globally.

The E-Consultations

The Expert Consultation at Beijing was preceded by an electronic consultation organized on the E-Agriculture Platform.
The E-Consultations discussed four questions:

**Question 1: What are we sharing and what needs to be shared?**

**Types of data already shared.**

The types of data already shared by CIARD partners include bibliographical descriptions of research outputs (e.g., AGRIS); information about standards, tools, services, datasets, and events (e.g., the CIARD Ring, AIMS Website, and AgriFeeds); data on plant genetic resources (e.g., SINGER, GENESYS); agricultural science and technology indicators (e.g., ASTI); agricultural factsheets and e-books (e.g., CABI); locally produced research re-packaged for wide dissemination (e.g., GAINS); soil and land-use maps (e.g., INRA Morocco); and remote sensing data (e.g., AREA Yemen).

**Sharing research data**

Sharing other products of research on the Web, including raw datasets and other re-usable results, is seen as essential for enabling innovation on important topics of agricultural research for development and food security such as desertification, managing the spread of pests and diseases, and biodiversity. Such data may include earth observation data and the results of field trials, surveys, or cultivar tests. Potentially breakthrough findings remain hidden within institutes, or even on home computers. While many scientists are in principle willing to share more of their data in the interest of better science, others regard research results as personal or institutional property, especially where there is an emphasis on securing patents. Others fear that their work could be “copied” without credit or that incompletely contextualized data could be misinterpreted. Providing proper documentation for research data requires more effort than busy scientists may be willing to provide. In order to justify the investment, scientists and their institutions need to see potential gains, for example in terms of visibility, reputation, or standing with donors. There is a significant movement in the research community towards making all publicly funded research open and transparent and to enable public access to all research data, though in the area of agricultural research for development, sharing is still quite limited.

**Sharing “hidden” knowledge.**

Communication among scientists increasingly occurs through informal channels such as blogs and community forums, where “tacit” or “hidden” knowledge is made manifest. Other types of information currently “hidden” include planning documents, reviews, meeting minutes, posters, PowerPoint presentations, video clips, preliminary project results and—where academic programs exist—theses and teaching materials. Some institutes already use social media sites such as Flicker and Slideshare to post photographs and slide decks. Hidden knowledge can also be discovered by knowing whom to ask; finding people with specific subject or technical expertise can be supported by databases of experts.
Sharing with the users of research data—farmers.

When asked, one organization of farmers expressed interest in information on pesticides (and biopesticides), seeds, hydroponics, crop recommendations, pest alerts, market prices, irrigation forecasts, and crop trends—not just in Web or print form, but with videos. The organization also requested information on research plans, ongoing projects, and research outputs. Where farmers are invited to view on-farm trials, communication between farmers and researchers can become a two-way channel in which potentially valuable indigenous knowledge is elicited. Communicating with farmers requires outputs to be translated into local languages, simplified, and published in accessible formats—efforts less likely to be undertaken if the results are rejected as “not scientific” when presented for reward and promotion.

Sharing with machines.

Standing between research information and its ultimate beneficiaries are the computer systems which deliver that information. In this sense, “machines” are the front-line consumers with which information is “shared”. Modern Web technologies—protocols and formats such as the Open Archives Initiative Protocol for Metadata Harvesting (OAI-PMH; for sharing metadata records), Linked Open Data (LOD; for integrating information between many sites), Rich Site Summary (RSS; for distributing news items on the Web) and Resource Description Framework (RDF; for describing information in a form that easy to integrate)—do not so much determine how information is delivered to end users as to encapsulate, structure, or link that information in ways that flexibly support its delivery to users downstream. (See “Trending Technologies” below.)

Reusability of information shared.

The potential value of any given information to someone else is not always obvious, so some people recommend erring on the side of sharing “everything”. Intelligent aggregators can sift through well-tagged chunks of information, extracting and re-packaging the information for new audiences or purposes (example: the extensionist who merely needs one photo from a long report) or re-packaged for different target audiences. The counter-argument is that sharing too much risks spreading scarce resources too thin while presenting users with too much information—much of which, in the absence of peer review, will be of dubious quality. Information is needed about what is being shared, preferably ranked for completeness and quality for the benefit both of information consumers and of creators of value-added services.

For discussion at the Expert Consultation in Beijing.

1. For what purposes does ARI need to be shared?

Priorities for sharing should be informed by purposes related to natural resource management, climate change, innovative agricultural practice, sustainable production, equitable access to markets, or the dissemination of research results.
2. What are the social or cultural barriers to sharing, and how might those barriers be overcome?

**Question 2: What are the prospects for interoperability in the future?**

**Interoperability defined.**

Interoperability is a feature of datasets— and of information services that give access to datasets— whereby data can easily be retrieved, processed, re-used, and re-packaged (“operated”) by other systems.

The less pre-coordination required to achieve this, the more “interoperable” the source. Interoperability ensures that distributed data can be exchanged and re-used among partners without needing to centralize data storage or adopt common software. “Mashing up” data from multiple sources can lead to new insights about relationships between factors such as weather, markets, crops, and geographic location. Interoperable data can more easily be pulled together into specialized services, such as crop portals and virtual research environments.

**Interoperability on the (inevitably) diverse Web.**

Interoperability can be achieved within closed systems— in some cases very large closed systems, such as Google and Facebook— by using specialized information formats usable by custom-built software. However, interoperability can also be achieved within the highly heterogeneous environment of the Web on the basis of open and generic “Semantic Web” standards. For social, political, and practical reasons, the concentration of information in big, centralized repositories, using centralized tools, is both unrealistic and counter-productive. Computer applications and data formats will continue to evolve, virtually guaranteeing that any particular system in use today will sooner or later grow obsolete. Where data exchange based on ad-hoc solutions requires pre-coordination between tightly coupled components, exchange based on standard data representations supports sharing among heterogeneous, “loosely coupled” information sources — an approach that copes with diversity not by trying to eliminate it, but by embracing it as inevitable.

**Globally unique names (identifiers) for things.**

Central to the concept of open interoperability described here is the role of URIs as identifiers for “things” (resources). URIs give names to things, making them citable and “linkable.”

Metadata allows applications to see information through different lenses, re-packaging it into different aggregations or incorporating new information, as it becomes available, into “expandable descriptions.”
Interoperability through a common “grammar” for data. Resource Description Framework (RDF) technology is used to publish data in a form is generically “understandable” by applications. Linked Data builds on the power of RDF by using globally unique identifiers (URIs) to establish browsable links between diverse datasets and tag resources with precise search concepts. In Linked Data, the boundary between “data” (“things”) and metadata (“descriptions of things”) is blurred. RDF can be used to publish interoperable metadata or, in principle, any other structured dataset, from earth observation data to financial spreadsheets.

Interoperability through the use of shared vocabularies.

A shared grammar does not, of itself, ensure interoperability. To be fully interoperable, data must be expressed using shared concepts (“vocabularies”)— whether well-known properties such as Dublin Core or topic identifiers from RDF-enabled thesauri such as AGROVOC. To be interoperable with AgriFeeds, for example, an event description must minimally include a title, date, location, and topic. Explicit mappings between vocabularies (“alignments”) such as AGROVOC and the National Agricultural Library Thesaurus establish interoperability between entire concept schemes.

For discussion at the Expert Consultation in Beijing.

3. How can new information and communications technologies (ICTs) be harnessed to provide information to the people who most depend on them?

4. What specific policies and structures— open data repositories and trust organizations with requisite standards and norms— are needed at the global, regional, national, institutional, even individual levels?

Question 3: What are the emerging tools, standards and infrastructures?

A continuum of choices from basic to advanced.

Linked Data is not an all-or-nothing proposition but a continuum starting, at the low end, with simple choices. Tim Berners-Lee summarizes the Linked Data approach as a pathway leading information providers towards progressively higher levels of interoperability (paraphrased here):

* On the Web, open licenses. Make your stuff available on the Web, in whatever format, under open licenses

** Machine-readable data. Make your stuff available as machine readable structured data; a table in Excel is better than just an image of the same.
*** Non-proprietary format. Use plain Comma-Separated-Values format(CSV) in preference to Excel.

****RDF standards. Use URLs (URIs) to identify your things so that people can point to them, and describe them using RDF.
***** Linked RDF. Link your data to other people’s data to provide context and add value.

Existing data exposed as RDF.

One of the simplest starting points is to expose an existing database as Linked Data by using an RDF wrapper that does not require changing the underlying database management software. If the entity model of a database does not map cleanly to RDF, the mapping can focus on data elements of particular utility. The AGRIS Application Profile, for example, was intended to provide a target for such mappings while leaving underlying applications untouched.

RDF generated by Content Management Systems and tools.

New Content Management Systems support the publication of structured data in RDF, such as the mainstream open-source platforms Drupal and Fedora. Drupal can be extended with an OAI-PMH module for harvesting content from providers. AgroTagger, developed by IIT Kanpur, uses natural-language processing to describe the content of a submitted text with AGROVOC concepts. The AGROVOC VocBench provides an online vocabulary editing and workflow tool for maintaining large vocabularies in highly distributed environments and in multiple languages.

Best-practice services.

Services highlighted in the e-consultation include VIVO, a search engine which “facilitates interoperability between people” by providing information about scientists, academic departments, courses, grants, and research publications; and eScienceNews, an aggregator for news and blog postings of scientific interest which uses natural-language processing and machine learning to semantically annotate Web contents for enhanced discovery.

Compliance with standards.

“Compliance with standards” frightens managers because it sounds expensive. Ideally, compliance with standards should “just happen” as a by-product of routine workflows and simple tools. Many research institutes lack IT specialists, or if they do have qualified staff, find that they resist exploring new approaches, such as RDF, which lie outside the comfort zone of familiar SQL and XML databases. Once trained, qualified staff often leave for positions that are better paid. To stand a chance of success, an open interoperability strategy must be based on tools that are easy to set up, use, and maintain.

The increasing availability of applications and storage space in The Cloud (Web-based server banks) may mitigate this problem by allowing institutes with less capacity to implement advanced services without increasing local staff or computing power — a prospect to be explored by FAO in an upcoming EU project, AgINFRA. Cloud computing could help trusted organizations such as CIARD.RING better serve a broad community by managing and aggregating the data and metadata of its partners and using the data to develop value-added services.

For discussion in Beijing.

1. What capacities must be developed, and at what levels, to facilitate the creation of exemplary services in compliance with standards?

2. What kinds of technical services can be externalized to servers in the cloud, and what capacities must be developed locally?

**Question 4: What actions should be facilitated by CIARD Task Forces?**

Re-think the role of information managers and of “communicators.”

Addressing the challenges of data and information sharing is not only a question of technology, but of institutions, culture, and processes. The introduction of new technology and processes may imply a more central role for information professionals, possibly in the context of “regional data transformation centers.” In addition, there is a need for “communicators” with the knowledge and skill to “translate” between scientists and practitioners, creating ways to present scientific information in practice-oriented advisory services.

Provide advice and support for information management choices.

There is a clear demand for advice from CIARD on basic choices such as when and how to use open versus proprietary data formats; whether to manage Web sites with Content Management Systems; how to describe specific types of information interoperably; when to use a traditional library system, OAI repository, or custom-build application; how to augment face-to-face meetings with multimedia social reporting; and which “star level” to target in a given situation given costs, difficulty, connectivity, and required level of ICT skill. The role of CIARD could be to describe available options, making the case for open solutions and providing information on specific tools—but with no expectation that partner organizations should all adopt a uniform approach.

Provide capacity development for adopters.

Based on an analysis of capacity gaps, capacity development events could target key people for training both in the technical aspects of data interoperability and in practical methods for migrating data. Mentoring arrangements between institutions at different levels of the “star system” could provide a channel for the transfer of practical knowledge and experience. The CIARD Capacity Development Task
Force could form partnerships with other organizations involved in developing capacity, such as new degree programs in agricultural information and communication management.

Package well-tested and popular tools into a CIARD toolkit or CIARD-hosted Website.

CIARD could package well-tested and popular tools into a toolkit— a “filled shopping bag” with solutions that work “out of the box” to meet the most common requirements. The CIARD Website could point to tools customized for the agricultural 4 research community such as AgriOcean DSpace and AgriDrupal. The Website might also host content on behalf of CIARD partners with less local capacity or facilitate the creation of data repositories at the national or even global level.

Improve CIARD Ring as a global “signpost” and directory for ARD information.

Consistent follow-up with registrants of services on the CIARD Ring could ensure the provision of basic information such as location (for the map), URLs for OAI-PMH providers and RSS feeds, and subject headings. By adding to the current offering of tutorials on OAI-PMH and RSS, the Ring portal could become a one-stop source of practical information on how to implement the CIARD Pathways and improve interoperability.

Work with regional authorities and donors to advocate for targeted funding.

CIARD should develop a blueprint for a global agricultural research infrastructure and use that blueprint to mobilize investments in a strategy for information sharing based on technologies for open interoperability and in capacity building of its champions. The blueprint should demonstrate the strengths of a Linked Data approach by highlighting success stories and showing how shared data has benefitted rural communities.

In conclusion, some brainstorming...

1. Define Core Data Sets for topics such as Plant Breeding or Natural Resources Management.

2. Identify “Trust Organizations” for holding specific types of data (as CGIAR, the Global Trust Fund, and the International Treaty on Genetic Resources for Food and Agriculture do for seeds).

3. Ensure the long-term preservation of Data Repositories. Create something like the Open Access movement to energize people to take action, perhaps in the form of a Global Treaty on Information Sharing.
**Trending technologies**

1994: “World Wide Web” and URIs (Uniform Resource Identifiers)

First proposed in 1989, an Internet-based network of documents linked using globally unique URIs, which took off with the spread of graphic Web browsers in 1994.

2000: “Semantic Web”

As proposed by Tim Berners-Lee, inventor of the Web (of documents), the notion of a web of structured data meaningfully processable by machines. See: http://www.w3.org/standards/semanticweb/.

2001: OAI-PMH (Open Archives Initiative Protocol for Metadata Harvesting)

A computer protocol for aggregating (“harvesting”) metadata records over the Web from multiple repositories. See: http://www.openarchives.org/pmh/.

2004: RDF (Resource Description Framework)

First introduced in 1999, a key Semantic Web standard for data interchange that achieved widespread use after the release of a major revision in 2004. See: http://www.w3.org/RDF/.

2006: RSS (Really Simple Syndication)

First introduced in 1999, a format for disseminating news items (or Rich Site Summaries) which took off with support by major Web browsers after 2005. See: http://en.wikipedia.org/wiki/RSS.

2008: “Linked Data”

First introduced in 2006, the notion of data expressed using RDF and URIs — also known, when published world-readably on the Web, as “Linked Open Data” (LOD). See: http://linkeddata.org/.

**Background Papers for the Consultation**

A Background Paper for the Consultation was prepared by the organizers. This paper along with the background paper for the e-consultation is included in Annexure 1.

**Summary Papers**

The IEC participants were requested to present summary papers regarding their perspectives on data and information sharing based on their and their organizations experiences. Thirty nine summary papers and background documents were prepared and circulated before the International Expert Consultation. These papers are included in the Annexure 2.
Infoshare Marketplace

An Infoshare Marketplace where participants could share their and their organizations experiences in sharing data and information was organized on 20 June 2011. Twenty four organizations shared their experiences at the Marketplace. A list of organizations who shared their experiences is available in Annexure 3.

Sessions of the International Expert Consultation

Inaugural Session

The International Expert Consultation’s inaugural function was chaired by Prof. Gong Xifeng, Deputy Director General of the Department of International Cooperations, Chinese Academy of Agricultural Sciences (CAAS). The Chief Guest was Prof. Liu Xu, Vice President CAAS. In his welcome address, agricultural research is moving toward a globalization process. Joint efforts and effective cooperation among different nations are especially important in the research fields including global climate change, breeding of plant and animal varieties, collection, conservation and utilization of crop germplasm resources, and control of plant and animal pests and diseases of key importance. Information exchange and sharing is the basis for international cooperation. Through effective information exchange and sharing, research duplication and waste of research resources can be reduced or even avoided so that the efficiency of agricultural research can be improved. Through development and utilization of information and data, new knowledge can be created so as to benefit the whole human beings. Through integration of information and data, agricultural scientific knowledge can be effectively protected and stored so that precious knowledge assets can be handed over to our future generations. Therefore, in an era that agricultural research is moving toward globalization, establishment of a global agricultural data and information sharing system is of practical importance, and is also a common wish of agricultural research, extension and education workers of different nations in the world.

Dr. Mark Holderness, Executive Secretary of GFAR, highlighted the need for a global movement to share and exchange data and information related to agriculture and indicated how GFAR pursues advocacy and other activities in the area of Agricultural Knowledge for All through its members and partners. Dr. Stephen Rudgard of FAO laid the stage for further discussions on the topic.

Prof. Gong Xifeng, in his address, reiterated the need for international cooperation in agriculture with information sharing as a major global action needing collaborative action. He thanked all hosts and the CAAS staff for organizing the Expert Consultation.

The Program of the International Consultation and List of Participants is included in Annexure 4.
Launch of CIARD Website in Chinese

Dr. Liu Xu also launched the CIARD website in Chinese. At the launch he stated that the website will have important meaning for Chinese agricultural research and extension workers. Meanwhile, the development of China’s agricultural science and technology and their contribution to its agriculture industry will provide reference for international counterparts. Therefore, we have also provided large amount of data and information to the English version of CIARD website, in wish of sharing the information with our foreign counterparts.

Session: Introduction to the Expert Consultation

Dr. Tom Baker presented the summary of the e-consultations held in April, 2011. The summary is attached as Annexure. His presentation is attached as Annexure 5.1.

Dr. Tom Baker was followed by Dr. Johannes Keizer who highlighted the technical issues and Dr. Ajit Maru who highlighted the institutional issues to be considered in the Expert Consultation.

Dr. Keizer (Presentation as Annexure 5.2) taking cues from the various summary papers indicated the growing need for data, statistics and experimental methods. He indicated there were very few functional repositories of agriculture related data. A lot of material was not on-line. He indicated towards a stage wise approach of Linked Open Data advocated initially by Dr. Tim Berners-Lee who had invented the World Wide Web as a suitable approach to sharing data globally.

Dr. Ajit Maru in his presentation (Annexure 5.3) highlighted the Institutional issues. He proposed the ideal goal as developing globally accessible linked open data and information repositories that are effectively used for Agricultural Innovation and Development. He also stated that in addition to technical and Institutional issues, issues related to community participation and involvement also need to be considered. Information management work flows need to consider not only availability, access and applicability but appropriation by communities and effective use of data and information. He also indicated that Institutional issues were affected by Capital, Capacity, Collaboration, Community, Culture of the organizations and Control/Governance. He summarized the Institutional issues as being from Global and National to Organization Policies, Regulations, Rules, Norms, Standards, Strategic objectives and strategies to achieve the objectives and structures as in the Table below:

<table>
<thead>
<tr>
<th>Level</th>
<th>Policy and Governance Related</th>
<th>Structures Needed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Global</td>
<td>Regulations: Global Data Sharing Treaties and Agreements</td>
<td>Trust Organizations for aggregation and amalgamation of data sets and Treaty/Agreement oversight, Signposts, Governance structures for information flows (IPR etc), International Research Funding by Donors to include data sharing clauses</td>
</tr>
<tr>
<td></td>
<td>Rules: International Rules and Codes such as of ITU, WTO, UN etc</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Norms: Agreed Internet, web, Global Communication Norms</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Standards: Internet related, Linked Data related, Data Repositories, Metadata etc</td>
<td></td>
</tr>
</tbody>
</table>
Interim Proceedings of International Expert Consultation on

“BUILDING THE CIARD FRAMEWORK FOR DATA AND INFORMATION SHARING”

<table>
<thead>
<tr>
<th>International/Regional</th>
<th>Regional, Multilateral and Bilateral Treaties and Agreement</th>
<th>Regional Blocks (eg. EU, ASEAN) Codes</th>
<th>Agreed Regional Norms e.g., data sharing on agricultural development investments</th>
<th>As above with Regional Specifications</th>
<th>As above but with emphasis on Regional Data Repositories, Signposts, Core Data Sets, Regional Funding Regional Capacity Development</th>
</tr>
</thead>
<tbody>
<tr>
<td>National/System</td>
<td>National Legislation and Regulatory Frameworks</td>
<td>National Information and Communication Rules (eg. Open Government, CGIAR, FAO, UN)</td>
<td>National/System level norms such as on genetic/genome related i, ARD spatial, investment information, institutions projects, project outputs experts,</td>
<td>As above with National Specifications and possibly for validation such as ISO standards</td>
<td>National Data Repositories, Regulatory Authority, Signpost National Funding to include data and information sharing clauses and support, National Capacity Development, Coordinating Units</td>
</tr>
<tr>
<td>Organization / Institute</td>
<td>Organization/Institute Policies, Statutes, Regulations</td>
<td>Organizational/Institute policies on Data sharing including for accountability, reward etc/</td>
<td>Institute level norms on data validation, sharing, Intellectual property Rights etc</td>
<td>As above with Organization/Institute level Standards</td>
<td>Infrastructure, Capacity, accountability and Reward Structures, Work Flows embedded for data and information sharing, Research programs and projects to include data and information sharing and support for it, Coordinating Units</td>
</tr>
<tr>
<td>Team/Individual</td>
<td>Ethical and Values Based Commitments</td>
<td>Commitment to adhere to above standards</td>
<td>Research proposal to include support for data and information sharing</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Prof. Meng Xianxue provided the national perspectives to be considered in the framework with China as an example. He stated that China is a large agricultural country. With the rapid growth of the national economy, investments in agricultural research and technology development are on the increase. As a reflection of this increase in this field, research outputs in terms of publications in scientific and technical journals are also growing rapidly. Formal publications authored by Chinese scientists, published in both Chinese journals and international journals are increasing steadily. There are a lot to be shared internationally, especially those publications in Chinese. He illustrated several examples of how data and information in China are shared. At national system level, he proposed the need to consider at least four factors related to the framework. The First is data and information, which are the objects we want to share with others. The framework may describe a list of types of data and information required from each national system. The Second is technologies and standards, which are the ways we share data and information in today’s information environment. All national systems should use similar technologies and standards to enable interoperability. The Third concerns data and information providers. Should we rely on individual scientist, research team, or institute to provide data, information and related service? Or a combination of all of them? The Fourth is investment. Data and information processing, providing service, building infrastructure, developing systems, etc will need investment. The framework may suggest a common strategy for each national system to target necessary investment.
He also stated that policy support and project setting has been important for the development activities in agricultural information sharing in each country. Both international and national supports are needed. Any development and progress in agricultural information sharing needs greatly the financial support for coherent and cooperative activities especially in the situation of different starting points of each country. There must be a financially sustainable mechanism to guarantee the development of the activity. Financial sources can be of various channels such as governments, institutions, foundations and international organizations, etc. He also indicated several CIARD actions necessary for success in promoting data and information sharing including advocacy and capacity building especially training. Prof. Meng’s presentation is available in Annexure 5.4.

**Discussions following the session**

The discussions covered issues of what information should be shared, defining interoperability, sharing with and for whom, what actions would be required and by whom?

The issue of what information should be shared is a vexing issue covered during the e-consultations. In theory all information should be shared as it is difficult to value information. Associated with the question of sharing what information is the issue of revelation of hidden knowledge and of redundancy of information. There are also issues such as sharing with and for specific groups, example farmers and directly with and through machines.

Interoperability was defined during the e-consultations as a feature of datasets— and of information services that give access to datasets— whereby data can easily be retrieved, processed, re-used, and re-packaged (“operated”) by other systems. The level of interoperability is a continuum, for example, as defined by the Sir Tim Berner-Lee’s framework of 1 to 5 stars.

As regards actions, there was advice to embrace diversity and adapt loosely coupled approaches that fit the objectives of the organization/individual providing the shared data. There are a variety of technological options each with specific Institutional needs based on the level of interoperability the organization wishes to offer.

The panel of presenters observed that the fresh approaches to data and information sharing requires rethinking of the role of the information professionals and communicators. CIARD as a movement also now has to offer choices, support and contribute to development of individual and organizational capacities, develop toolkits that support sharing of data and information technologically and through Institutional innovation as also advocate and promote community participation. Partners without appropriate capacities may need support from CIARD partners who have the capacities. There is a need to start looking at Core Data Sets and their generation that are needed acutely for agricultural research and innovation for development, the founding of trust organizations that support data and information sharing equitably and effectively at global, international/regional and national levels.

Dr. Mark Holderness, who chaired the Session along with Dr. Pan Shuchun, observed that CIARD movement will have to now demonstrate how all the new developments in sharing data and information
work rather than providing technical explanations to convince decision makers and managers. He also noted that the new developments needed significant Institutional change and innovation including in reward and accountability systems.

Session 2 and 4

Session 2 and 4 were Group Discussion Sessions that discussed Priority services and Capacities and Next Steps.

The preliminary results from these discussions are summed up as below:

**OVERALL CONSIDERATIONS**

- Most countries/organizations already have policies and practices in place that may need to be adapted, rather than starting afresh.
- It is important to influence policy/strategies towards information sharing and Open Access at all levels – Organizations, Countries, Sub-regions/Regions, and Global.
- There is no ‘ideal’ approach to data/information sharing that covers all situations in terms of phasing and scheduling approaches. Organizations will be in different stages of development in each of the seven action areas, and they will need to take that into account as they plan their approaches. However agencies and organizations may wish to address Actions Areas 1 (Policy, Incentives, and Copyright) and 2 (Advocacy and Evidence) together. At the global and regional level, Action Areas 5-7 (Services, Tools, and Standards) are interlinked.
- The types of information provider and user will need to be carefully defined and/or recognized, especially as the categories are shifting along with the community involved in innovation and market chains and multidirectional flows of content are now evident.
- There is an overwhelming need for concrete evidence on why information/knowledge should be shared and why a CIARD framework is needed.

**ACTION AREA 1: POLICY/STRATEGY DEVELOPMENT**

**Global and regional advocacy initiatives to be undertaken by CIARD partners with mandates to support national programmes**

- Promote adoption of CIARD Manifesto for information sharing – in adapted forms as appropriate to national policies
- Identify/select examples/models of policy/ies on access to public goods (e.g. USDA) and copyright to support national policy discussions
- Develop guidelines on process for developing policies
**National Organizations**

- Work towards the enactment of a national law/policy which mandates open access to agricultural knowledge wherever possible and promotes interoperability
- At the organizational level, develop specific policies and plans for sharing public domain information and data and ensuring quality (pertinence, consistency, reliability, timeliness, etc.) of information, with special attention to channels/formats other than peer review journals, that embeds information sharing activities into organizational processes & “systems”:
  - Seek inputs/advice from national authorities and experts
  - Take into account context of other relevant national policies/laws (e.g. IPR)
  - Develop an action plan (objectives, results) for information sharing with short- to medium-term actions (1-3 years)
- Add regional and global agreements (such as those for trade, etc):
- Promote use of trust organizations (such as CIARD Ring led by GFAR) instead of commercial instances (such as google):
- Develop mechanisms to aggregate info without extra burden for providers and for updating information on global sites such as FAO:

**ACTION AREA 1.A: COPYRIGHT/IPR** *(part of national/organizational policies)*

Global and regional action to be undertaken by CIARD partners with mandates to support national programmes

- Develop or identify generic guidelines on IPR policies

**Actions for national and local organizations**

- Organizations need to develop a well-defined copyright/IPR statement, with due consideration of Creative Commons licenses, and to make them public (i.e. on the Web)
- Organizations should take into account advice from resources such as Sherpa/Romeo for publishers’ copyrights policies

**ACTION AREA 1.B: INCENTIVES & BENEFITS**

Global/regional actions for CIARD partners with mandates to support national programmes

- Develop case studies and examples of types of incentives and benefits currently in use at national level
- Consider development of incentives at global and regional levels for scientists that curate and share information, for example through disciplinary communities of practice and/or thematic knowledge networks/forums

**Actions for national and local organizations** *(part of national/organizational policies - see 1. above)*
• Review of existing knowledge sharing incentives in national research system
• Define incentives/benefits within an organization for scientists to stimulate information sharing through a variety of channels (i.e. not just journals)
  – Introduce ‘fun’ element especially when starting a scheme, so that people will be more willing to invest time
  – Consider concrete incentives such as promotion awards and prizes
  – Recognize data originator and/or authors’, and collaborators’ contributions in corporate outputs/publications

ACTION AREA 2: ADVOCACY / EVIDENCE

Organizations should advocate in the context of their information sharing policy/ies under their mandates and strategic plans (see Action Area 1)

Global and regional advocacy initiatives to be undertaken by CIARD partners with mandates to support national programmes

• Identify pilot advocacy initiatives at national level already using interoperability, and support these as learning processes, onto which new aspects can be built
• Develop a benchmarking system for open access approaches, and
• Develop advocacy toolkit as a collaborative initiative to support national/regional activities, with
  – a universal short focused piece that can be used as “elevator speech”
  – diverse formats of messages/stories including slide sets, short videos etc
  – case study evidence demonstrating value (cost-benefit) of sharing and interoperability, with measures/indicators of networking/uptake/use through CIARD Pathways leading to changed practices with concrete economic/social/environmental results/outcomes
  – facilitate sharing of advocacy experiences at national level across countries through the community platform (see Action Area 3)
• Organize advocacy events for senior decision-makers, taking advantage of existing events where possible (e.g. GCARD and ministerial roundtables/dialogues) to convey key messages and catalyze action as an external player with privileged access
• Advocate with international donors that their funded projects earmark funds for information sharing, preferably in the public domain (i.e. open access)

Actions for national and local organizations (research, academia, information, civil society, associations)
Define advocacy strategy and detailed activity plans, recognizing that every country/province/organization requires a particular approach, with measures for sustained follow-up and which should not be seen to be top-down, with the following components:

- Assess constraints, including both explicit and hidden barriers, affecting information sharing and how to overcome them, and identify needs and opportunities for interoperability and sharing
- Assign advocacy roles and tasks to a group or individuals, if possible with formal recognition
- Define and prioritize advocacy targets (e.g. ministers, senior ministry officials, directors of organizations, administrators, scientists/researchers, information professionals, and donors/funders)
- Define messages in relation to “Benefits of data and information sharing at different levels with tangible outcomes that achieve their organizational/national aims” (with reference to CIARD)
- Develop contributory advocacy “facility” based on the CIARD Advocacy Toolkit, with specific resource materials (e.g. ppts, video & print), and including evidence etc
- Use social media, online forums, such as blogs, Twitter etc. as advocacy tools
- Organize advocacy (sensitization/awareness raising) events & seminars etc, (e.g. “Open Access Week”) for heads of research organizations, taking advantage of existing events where possible
- Recruit senior champions to support advocacy

Adopt a pilot / case study approach to provide evidence for advocacy and attract funding, which may include:

- ‘learn-by-doing’ for technical services;
- sharing of experiences (e.g. co-creation of knowledge at local level)

**ACTION AREA 3: PARTNERSHIPS, COMMUNITY-BUILDING AND PARTICIPATION**

Global actions to be undertaken by CIARD international and regional partners

- Establish/strengthen ‘open’ means of communication (virtual and face-to-face) among interested individuals and participants involved in information sharing (including CIARD) to document, discuss and share developments in Agricultural Information Management
- Emphasizing that CIARD is a learning initiative (not preaching), recognizing that each organization is unique, and every experience of information sharing is valuable, establish a community “platform” that leverages existing facilities (i.e. CIARD, AIMS and e-Agriculture sites):
  - to share experiences and new ideas in promoting information sharing (technologies, incentives, policies, etc.)
  - an observatory and timeline of technologies, standards, tools and concepts that describes advances in Agricultural Information Management
  - success stories (case studies); and
  - good practices e.g. about collaboration”, “convergence” across disciplines and value chains (traceability)
• Create a partnership to enhance information sharing at the global level, supported by the international CIARD partners, with national /regional participants (organizational partners national partners)

<table>
<thead>
<tr>
<th>Expected Outputs</th>
<th>How to achieve outputs</th>
</tr>
</thead>
<tbody>
<tr>
<td>strengthened legal and social framework for information sharing</td>
<td>(a) a declaration - framework - action plan signatories - concerned actors - oversee implementation</td>
</tr>
<tr>
<td>improved communication among all actors in information sharing</td>
<td>link existing efforts and tools for communication to create the necessary channels</td>
</tr>
<tr>
<td>a platform to encourage investments</td>
<td>communicate (make transparent) possible opportunity/ies for funding/proposals</td>
</tr>
<tr>
<td>a framework for projects in common</td>
<td>share project proposals and provide means for contacting partners</td>
</tr>
</tbody>
</table>

Collateral benefits from the Partnership would support other actions e.g. advocacy toolkit, capacity building and training platform (see Action Area 4), and infrastructure and technology tools/tool kit.

**ACTION AREA 4: INDIVIDUALS’ SKILLS & COMPETENCIES**

**Actions for Regional, Sub-Regional, and National Levels and Organizations**

• Assess the training needs and design training programmes for better information sharing, linking to policy and organizational context/environment and team building approaches to ensure newly acquired skills can be applied
• Develop training programmes for national information professionals on data/information interoperability etc and other CIARD issues, and use e-learning approaches where appropriate (e.g. webinars which can be recorded)
• Co-ordinate capacity development activities between CIARD partners and others
• Revisit curricula for information management and interoperability, linking to IM faculties in universities if possible and select trainees appropriately, and compile a list of training materials targeted on different 5 star levels (Berners-Lee)
• Support advice and learning platforms for content management in the CIARD community (e.g. AIMS, IMARK, forums) in local languages, and establish linkages among platforms/sources
• Develop Pathways (‘what you need to know & do’) for information sharing processes (e.g. ranging from helping users understand and give the metadata of web content) using participatory approaches with partners, with scenarios e.g. 5 star levels

ACTION AREA 5: SERVICES, TOOLS AND INFRASTRUCTURE

Global actions to be undertaken by CIARD international and regional partners

• Extend the RING into a comprehensive and easy to use registry for agricultural information resources, enhanced by community annotations on quality and provenance of materials (see Action Area 7):
  – improve the user interface of the RING
  – strengthen advocacy for institutions to register services in the RING
  – highlight Open Access information sources
  – consider using the Comprehensive Knowledge Archive Network (CKAN)
• Establish a CIARD service on the web (e.g. a “Tools-Wiki”) as signpost for useful tools for the CIARD community to provide a ‘filled shopping bag’ of alternatives that also includes tools to:
  – enable data and information interoperability,
  – restructure unstructured data e.g. ‘wrappers; auto-indexing, and
  – map local data structures to global ones.
Establish a mechanism for management of the “Tools-Wiki” and assign responsibility/ies.
• Conduct a survey about the need of cloud services for specific business processes within the CIARD community
• Evaluate the possibility of specific cloud services for the CIARD community maintained by single partners, and encourage the establishment of such services if considered valuable and feasible
• Facilitate development of plug-ins and customized versions for mainstream software (e.g. Dspace, Drupal, WordPress, Joomla, E-Prints) to work more efficiently for the CIARD community
• Implement prototypes of information-sharing platforms, (e.g. news, events, bibliographic data, community platforms, document repositories, GIS applications, statistical data):
  – build in capability to handle local language in data/information sharing
  – build in capabilities to mash up data from different sources
• Create an agri-VIVO pilot application as an information sharing platform, as one of the components contributing to Community Building (see Action Area 3), and in relation to this:
  – develop Expert finder service through a multi-lingual ontology
  – implement Authority data services (authors, journals, geographic)
• Enhance the CIARD “community” (see Action Area 3) online collaboration by linking together the ‘best’ of the existing platforms (e.g. CGIAR-KM, AIMS, eGFAR) using tools such as Wikis; mailing lists; alerts (RSS), and an AgriVIVO pilot, as part of the CIARD as a mechanism of discovering and linking of CIARD community members
• Investigate and make recommendations on how to create services that can deliver information on
different devices, including mobiles

National

- Build/strengthen infrastructure platforms to share public research results and data, using organizational servers or cloud services

**ACTION AREA 6: STANDARDS & SYSTEMS ARCHITECTURE**

Global actions to be undertaken by CIARD international and regional partners

- Develop/enhance an international system, such as FAO-AIMS, that signposts existing standards and the areas/tasks to which they apply
- Endorse open standards for protocols, ontologies, vocabularies (e.g. OAI-PMH, SPARQL, SKOS, GeoNetwork etc.) that are used across domains
- Engage the community with the process for setting open standards (*see Action Area 3*)
- For development of standards that are specific to the CIARD community, follow processes as they have been adopted by other communities, like DCMI (Dublin core) and CIARD partners could solicit initiatives to take the lead in an area
- Identify high-priority information types and develop – or re-use – and promote descriptive template (e.g. Passport data for Plant Genetic Resources)
- Develop recommendations for metadata to describe datasets, as well as for formats for packaging and documentation of data (e.g. how observations were made)
- Create a system of mapped vocabularies for the purposes of classifying and organizing information in agriculture, openly available as Linked Open Data, that are developed/maintained by the CIARD members
- Creating an efficient auto/tagging/indexing service (i.e. ‘agrotagger’, ‘OpenCalais’)
- Help to improve automatic translation services for agricultural topics
- Develop recommendations for methodologies for digital preservation, including formats (that guarantee that files can be converted to formats for future software)
- Develop recommendations, written in non-technical style without too much jargon, on how to produce efficient Linked Open Data, with illustrative case studies
- Develop or identify sound guidelines on how to conduct bibliometric analyses

**ACTION AREA 7: QUALITY, CERTIFICATION AND PROVENANCE**

Global actions to be undertaken by CIARD international and regional partners

- Identify roles, responsibilities, and issues for data providers, aggregating services etc to certify quality and provenance of materials (*see first item of Action Area 5*)

Session 3
This session had presentations on status of interoperability standards on RDF (Tom Baker), CIARD-RING (Valeria Pesce), AgINFRA (Johannes Keizer) and DIAS (Seishi Ninomiya). The presentations are available in Annexure 6.

Discussions

Participants queried on how RDF relates to services like Google Scholar? Tom Baker opined that high street services like Google will become better if information generators and providers provide better interoperable sources such as through RDF and if Microsoft, Google, Yahoo etc started collaborating on standards (see http://www.schema.org) including RDF. On the other hand, we in agricultural research information management have to deliver more specialized services than the high street services and may adopt RDF and similar standards.

The issue of standards also brought into limelight what should be the focus as regards standards in agriculture related information management. Many of the technologies and standards are generic and universal and not associated with agriculture example internet standards etc. The query was should the agricultural community know about all of this or rely on the communities that are already working on it? (E.g. for GIS we rely on the GIS community). The experts felt that CIARD will have to play the supporting role in advising the agricultural community and its focus will be on the issues specific to agriculture such as ontologies, vocabularies and specific issues as they emerge.

As regards how “Cloud” computing can help institutions with less capacities the clarification was that organizations that can provide large servers for the “cloud” can make them available for other institutions to publish content without having to maintain the technical infrastructure needed. Technologically the cloud approach has lesser risks that individual organizations providing information through their own server.

There were queries if CIARD could also offer a “Cloud” service and offer an “open” repository. It was explained that CIARD is a voluntary movement and not an Institution or a legal entity. CIARD as an entity should not host actual data. CIARD partners may offer the services for example GFAR hosts CIARD.RING and manages the metadata of the services, not the actual data. It was opined that the costs of hosting basic web services and even substantial data is now very low when they are outsourced.

The participants were also informed that Governments, such as the USA, are now setting up regulatory mechanisms for effective data and information sharing.

On an issue whether data and information sharing services should be developed on the basis of “supply” (providers) side or “demand” (user) side perspectives, the house had mixed opinions. Services that did not consider user needs and satisfied them would not be sustainable but developing new, cutting edge services and innovative ideas may emerge from “supply” side perspectives also.

There was a suggestion, following a query regarding what CIARD can now offer, that an “observatory” for all advances in agricultural information management be developed.

Session 5
In this session brief presentations on examples of sharing research data and information were made on VIVO (John Ferriera), CABI (Zhang Qiao Qiao), AGRIS (Johannes Keizer) GAINS (Joel Sam), CAAS National Agricultural Data Center (Zhou Guolin) and Crop Germplasm resources (CGR) (Fang Wei), NECTEC (Asanee Kawtrakul), FARA (Dady Dembi), IAALD (Barbara Hutchison), INBAR (Andrew Benton) and PROGIS (Walter Mayer).

The presentations are included in Annexure 7.

**Session 6: Agenda for Action and Report**

In this session, Prof. Mei Fangquan presented how China’s agricultural informationalization in rural areas is progressing. He outlined the historical development of providing information to China’s rural development. He stated that China was about 15 years behind the World leaders in rural information services and indicated the critical gaps. He described the various services, the ICT and Institutional structures and examples of how the information services work on the ground. He expected China to rapidly develop information services to rural areas in the very near future. The approach for China is distributed integrating and networking management in the future. The presentation is available as Annexure 8.1.

Dr. Ajit Maru in initiating the Session briefly summed up the current global trends in data and information sharing and indicated that the agricultural sector is increasingly regaining its priority for development. It is within this environment that we should view the CIARD task of developing the framework for information sharing.

The final session can be summed up as below:

To make the information more easily **accessible** as also **Interoperable** so as to make its effective use in different situations possible and easier, there is a need to work at the level of **information objects or data**. This requires **open data repositories** and couple them to concepts of “linked open data” or data objects that can be **hyperlinked** across common attributes. To develop these data repositories that can be located and used globally there will be a need **standards, norms and regulations** to govern effective, efficient, transparent and equitable flows and uses. There will also be a need **standard descriptors**, mutually agreed **taxonomies** and **vocabularies** based on **common ontologies** to describe and organize the storage and access to the data. To reduce costs and time in assembling data to meet the information needs for meeting the most critical challenges to agricultural development, there may be a need to define **Core Data Sets** that Institutions and National Systems of agricultural research and Innovation universally may contribute and work in the spirit of global shared responsibility, collaboration and partnership. And for this **policies and strategies are needed** at Institute, Organization and Country level. There will be a need for **governance** structures, **legislation** and **International treaties** to share data and information openly as also protect interests of all parties in information management and use. There is a need to create **Trust**
organizations that will manage the data and metadata that is shared openly at national and global levels. There is also a need to look at investments, financial and in human skills that will be needed to manage the entire information infrastructure in global ARD. And of course for all these ideas to take off, advocacy and promotion and new capacities to advocate and manage open data repositories sustainably and all the issues related to them are needed.

A lot is already being done and there is now no need for all do the same individually and independently. There are simply no resources for it. For example, the concept of open repositories is now well developed and there is constant development of the concept of “linked open data” with basic standards such as XML, RSS, RDF etc already in place. The taxonomies and vocabularies, such as AGROVOC, are being rapidly evolving. We need to look at Core Data Sets though some such as for weather and climate, plant germplasm and spatial data already exist and some for example in agronomy are in the making. The issue is who defines them? We need to look at Trust Organizations. The CIARD.RING led by GFAR is one of them. We need to look at implications of open data access in ARD at organizational and national levels and this can be done through GFAR and FAO. We need to advocate for increased investment in information infrastructure in global ARD and this can be done at GCARD 2012. And much more already done, being done and need to be done can be mapped once we have a framework.

Dr. Dady Demby made a presentation indicating how CIARD can progress in the context of data and Information sharing (See Annexure 8.2).

Dr. Stephen Rudgard closed the session stating that the CIARD direction is decided by all of us. There is not a lot of money to drive CIARD. The CIARD resources are the people working in it. We need coherence in content but also coherence between the organizations also.

Closing Session

Dr. Stephen Rudgard thanked all the participants for their contribution to the International Expert Consultation. Dr. Ajit Maru thanked Ms. Bi Jieying, Dr. Pan Shuchun, Dr. Meng Xianxue, Dr. Feng Dongxin, Prof. Mei Fangquan, Prof. Gong Xifeng, all the staff and volunteers of CAAS for their constant support and encouragement and those providing various services and for providing excellent facilities for the International Expert Consultation. Prof. Mei Fangquan also thanked all participants and the organizers for the successful consultation. Prof. Gong Xifeng thanked FAO and GFAR for their support to CAAS for hosting the International Expert Consultation.
The 5 stars of open linked data

★ make your stuff available on the web (whatever format) under an open license
★★ make it available as structured data (e.g. excel instead of image scan of a table)
★★★ non-proprietary format (e.g. csv instead of excel)
★★★★ use URIs to identify things, so that people can point at your stuff
★★★★★ link your data using RDF to other people’s data to provide context

By Tim Berners-Lee
Annexure 1
Building the CIARD framework for data and information sharing

Background Note for the e-Consultation April 4 - 15

The international CIARD initiative (http://www.ciard.net) is working to make agricultural research information publicly available and accessible to all. Among its actions are advocating for and promoting open access, improving applicability and enabling effective use of data and information in agricultural research and innovation.

Challenges and opportunities

Knowledge generated from agricultural research should be easily accessible and so easily taken up by agricultural researchers and the agricultural community at large. This issue is always more vital in the face of rapidly shifting challenges such as climate change, trans-boundary pests and diseases, effectively use of water for agriculture, combating desertification and degradation of fragile soils and managing agricultural biodiversity.

Conventional pathways for communicating research outputs, through scientific publications (journals etc) and face to face events, have been enriched by new digital formats including the newer social media such as wikis, informal blogs and online communities of practice. The volume of outputs of agricultural research such as scholarly or informal publications, blogs, discussion forums, institutional directories and very importantly raw data, is rapidly increasing.

Whereas an increasing amount of information becoming available represents an enormous opportunity, a challenge exists in the scattered way in which this information is being made available. The sources of information have become more heterogeneous and so coordination and coherence has become more problematic, making it more difficult to share data and information efficiently within and between scientific communities and more importantly with the wider range of stakeholders involved in agricultural innovation systems.

New approaches have to be adopted to facilitate sharing without resorting to tight coordination and centralization, which, for political and logistical reasons, are not foreseeable in the current spontaneous proliferation of data sets and services in agriculture.

This is where the current trends in information technology and web practices represent a unique opportunity to develop a coherent framework for sharing agricultural information. Approaches like Web 2.0, Linked Data, the OAI-PMH protocol, etc., are all means of improving the interoperability of distributed information and datasets without requiring strict coordination or the omologation of the software and data environment.

The CIARD partners are organizing a series of international consultations (through electronic and face to face events) to build a framework for action in making outputs of agricultural research truly accessible through coherent management, sharing and exchange of knowledge, information, and data. This background note is the basis for a discussion on the e-Agriculture platform from April 4 to 15. The e-consultation will be followed by an expert meeting in Beijing in June 2011 with the same title. These two events will be an exercise in describing the current status and analyzing the needs for tools, standards and infrastructures, leading on to defining future actions.

Background Figures
Scientific publication and data production is growing at a much faster rate than ever before. Figure 1 charts the increase in numbers of articles indexed by MEDLINE from 1950 to 2010. The rate of increase in publication has clearly risen, especially since the year 2000\(^1\), but the production of scientific papers is only the tip of the iceberg.

![MEDLINE-indexed articles published per year](image)

Figure 1. MEDLINE-indexed articles published per year

Behind growing numbers of scholarly publications is a growing amount of scientific data. Furthermore, scholarly papers are no longer the only way in which scientific information is exchanged. Researchers are using more social platforms such as blogs\(^2\) to discuss results before they are published in scholarly journals or after they have been published.

Data on publication rates in agriculture are not readily available, but it is quite clear that the trend will be similar, although perhaps less dramatic, to the other life sciences which are monitored by MEDLINE.

The second graph shows that the steeper increases in publication rates since 2000 is mainly due to the entrance of a few large countries with so-called “emerging economies”.

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\(^1\) [http://altmetrics.org](http://altmetrics.org)  
/manifesto/ Last accessed March 2011

especially China, Brazil and India, into the scientific mainstream. Taking 1990 as a base, Brazil has increased its scientific production by 800% and China by 1200%. The growth of these key new players in the scholarly communication arena has made interoperability a more important global issue, with special regard to the handling of languages other than English.

**Objectives of the e-Consultation**
The CIARD partners aim to provide an opportunity to discuss some specific questions that will provide resource material for the expert consultation that will follows in Beijing. The e-consultation has the following objectives:

- To increase awareness about opportunities and technical options for creating an infrastructure for data interoperability;
- To create a list of discussion points about the current state of the art of sharing and interoperability in the agricultural research context as basis for the discussions of the expert consultation in Beijing;
- To provide suggestions for actions that will enable increased sharing and exchange of data in agricultural research and innovation.

**The Topics**
The e-consultation will consider the following topics/questions over two weeks, focusing on two questions in each week:

1. What are we sharing and what needs to be shared?
2. What are the prospects for interoperability in the future?
3. What are the emerging tools, standards and infrastructures?
4. What actions should now be facilitated by the CIARD Task Forces?
Baseline Material for the Topics of the e-Consultation

1. What are we sharing and what needs to be shared?

The landscape of information and data flows and repositories is multifaceted. Peer reviewed journals and scientific conferences are still the basis of scholarly communication, but science blogs and social community platforms become increasingly important. Research data are now increasingly managed using advanced technologies and sharing of raw data has become an important issue. This topic thread will address and discuss details about the types of information that need to be shared in our domain, e.g.:

- Information residing in communications between individuals, such as in blogs and community platforms supported by sources such as directories of people and institutions;
- Formal scientific data collections as published data sets and their associated metadata and quality indicators, peer-reviewed scholarly journals or document repositories;
- Knowledge ‘derivatives’ such as collections of descriptions of agricultural technologies, learning object repositories, expertise databases, etc.;
- And surely more....

Figure 3. Schema of data repositories and flows in agricultural research and extension. Data flows exist between distributed repositories of the same type, and also between repositories of different types.
There are several interesting examples of successful data exchange between distributed datasets, and some of them in the area of agricultural research and innovation. There are also ambitious attempts that still have to live up to expectations. A common characteristic of most examples is that they are based on specific ad-hoc solutions more than on a general principle or architecture, thus requiring coordination between “tightly coupled” components and limiting the possibilities of re-using the datasets anywhere and of replicating the experiment.

In some areas there are global platforms for sharing and interoperability. Some of these address the need to access scholarly publications, mostly those organized by the publishers, and others address the interfacing of open archives. With regard to standards and services in support of interoperability, there are several very successful initiatives, each dealing with different data domains. Among document repositories, the most successful initiative is surely the Open Archives Initiative (OAI) Protocol for Metadata Harvesting used by a global network of open archives. The strength of this movement is changing the face of scholarly publishing. Geospatial and remote sensing data have strong communities that have developed a number of wildly successful standards such as OGC that have in turn spurred important open source projects such as GeoServer. Finally, in relation to statistics from surveys, censuses and time-series, there has been considerable global cooperation among international organizations leading to initiatives such as SDMX and DDI, embraced by the World Bank, IMF, UNSD, OECD and others.

Singer System\(^3\), GeoNetwork\(^4\), and GeneOntology Consortium\(^5\) are examples of successful initiatives to create mechanisms for data exchange within scientific communities. The SDMX\(^6\) initiative aims to create a global exchange standard for statistical data.

There are more examples, but these advanced systems cannot have a strong impact on the average (smaller, less capacitated) agricultural information systems, because overall there are no easy mechanisms and tools for information systems developers to access, collect and mash up data from distributed sources. An infrastructure of standards, web services and tools needs to be created.

2. What are the prospects for interoperability\(^7\) in the future?

“Interoperability” is a feature both of data sets and of information services that gives access to data sets. When a data set or a service is interoperable it means that data coming from it can be easily “operated” also by other systems. The easier it is for other systems to retrieve, process, re-use and re-package data from a source, and the less coordination and tweaking of tools is required to achieve this, the more interoperable that source is.

Interoperability ensures that distributed data can be exchanged and re-used by and between partners without the need to centralize data or standardise software.

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Some examples of scenarios where data sets need to be interoperable:

- transfer data from one repository to another;
- harmonize different data and metadata sets;
- aggregate different data and metadata sets;
- virtual research environments;
- creating documents from distributed data sets;
- reasoning on distributed datasets;
- creating new information services using distributed data sets.

There are current examples of how an interesting degree of internal interoperability is achieved through centralized systems. Facebook and Google are the largest examples of centralized systems that allow easy sharing of data and a very good level of inter-operation within their own services. This is due to the use of uniform environments (software and database schemas) that can easily make physically distributed information repositories interoperable, but only within the limits of that environment. What is interesting is that centralized services like Google, Facebook and all social networks are adopting interoperable technologies in order to expose part of their data to other applications, because the huge range of social platforms is distributed and has to meet the needs of users in terms of easier access to information across different platforms.

Since there are social, political and practical reasons why centralization of repositories or omologation of software and working tools will not happen, a higher degree of standardization and generalization (“abstraction”) is needed to make data sets interoperable across systems.

The alternative to centralization of data or omologation of working environments is the development of a set of standards, protocols and tools that make distributed data sets interoperable and sharing possible among heterogeneous and un-coordinated systems (“loose coupling”).

This has been addressed by the W3C with the concept of the “semantic web”. The semantic web heralds the goal of global interoperability of data on the WWW. The concept was proposed more than 10 years ago. Since then the W3C has developed a range of standards to achieve this goal, specifically semantic description languages (RDF, OWL), which should get data out of isolated database silos and structure text that was born unstructured. Interoperability is achieved when machines understand the meaning of distributed data and therefore are able to process them in the correct way.
3. What are the emerging tools, standards and infrastructures?

The new paradigm for interoperability on the web and for building the basic layer for a semantic web is the concept of **Linked Open Data** (LOD).

Instead of pursuing ad hoc solutions for the exchange of specific data sets, the concept of linked open data establishes the possibility to express structured data in a way that it can be linked to other data sets that are following the same principle. Examples of an extensive use of “linked open data” technologies are the NYT or the BBC news service. Some governments too are pressing heavily to publish administrative information as LOD.

![Figure 4. The Linking Open Data cloud diagram](image)

The technology of LOD is based on W3C standards such as the “Resource Description Framework” (RDF), which facilitates the exchange of structured information regardless of the specific structure in which they are expressed at the source level. Any database can easily be expressed using the RDF, but also structured textual information from content management systems can be expressed in RDF. The presentation of data in RDF makes them understandable and processable by machines, which are able to mash up data from different sites. There are now mainstream open source data management tools like Drupal or Fedora commons which already include RDF as the way to present data.

Within the area of agricultural research for development an infrastructure to facilitate the production of linked open data is needed. The four key elements to make this possible are:

- a registry of services and data sets (CIARD RING, http://www.ring.ciard.net);
- common vocabularies to facilitate automatic data linking (thesauri, authority files, value vocabularies);
- technology (content management systems, RDF wrappers for legacy systems);
- training and capacity development.

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8[Linked Data - Connect Distributed Data across the Web](http://linkeddata.org/) Last accessed March 2011
8[Resource Description Framework](http://www.w3.org/RDF/) Last accessed March 2011
4. What actions should now be facilitated by the CIARD Task Forces?
There are immediate actions and strategic interventions.

Immediate actions:

- Registering services at the CIARD RING: the CIARD RING is a platform on which information systems and data sets can be registered and technical details about them can be provided together with instructions on how to use these sources, making their “interfaces” (parameters, formats etc.) transparent for others.
- Extensively using shared vocabularies and frameworks: well known common vocabularies are already available for the description of data. Generic vocabularies like “Dublin Core” or “FOAF” and specific vocabularies like AGROVOC and the Library of Congress Subject Headings are accessible openly on the web. The use of concepts from those common vocabularies will enormously facilitate the future production of linked data. Statistical data finds a coalition of international partners in the SDMX initiative. GIS standards such as OGC continue to lead the pack in sheer production quantity of interoperable data points.
- Creating document repositories using existing data exchange protocols such as OAI-PMH.
- Documenting and reporting successful examples of interoperability.

Strategic interventions:

- A blueprint is needed for a global infrastructure for data exchange in agricultural research for development. This blueprint should be also the basis for mobilizing financial resources.
- Ad hoc working groups could be established for specific areas.
- A series of events could be organized for advocacy and capacity development.

Participation in the e-Consultation

Contributions can be posted on the e-Agriculture Community platform at http://www.e-agriculture.org/ by registered members of the community. Contributions should ideally be provided in English, although French and Spanish will also be accepted and will be summarized in English. At the end of each week a summary of discussion of each question will be produced and distributed for additional inputs and comments. The final report of the consultation will acknowledge all contributors, and will be published electronically on the Community’s platform. The report will serve as a background document for the expert consultation in Beijing to be held in June 2011.
If you are interested to contribute to this e-consultation, please register on the e-Agriculture portal and look out for announcements on the site. Please feel free to contact us at info@e-agriculture.org should you need any additional information or assistance in registering.

Looking forward to your active participation,

*Johannes Keizer (FAO)*
*Ajit Maru (GFAR)*
*Valeria Pesce (GFAR)*
*Stephen Rudgard (FAO)*
Acronyms

- BBC - British Broadcasting Corporation
- CIARD - Coherence in Information for Agricultural Research for Development
- CIARD RING - CIARD Routemap to Information Nodes and Gateways
- DDI - Dynamic Data Integration
- FOAF - Friend of a Friend
- GIS - Geographic Information System
- IMF - International Monetary Fund
- LOD - Linked Open Data
- MEDLINE - Medical Literature Analysis and Retrieval System Online
- NYT - New York Times
- OAI - Open Archives Initiative
- OECD - Organisation for Economic Co-operation and Development
- OGC - Open Geospatial Consortium
- OAI-PMH - Open Archives Initiative Protocol for Metadata Harvesting
- OWL - Web Ontology Language
- RDF - Resource Description Framework
- SDMX - Statistical Data and Metadata Exchange
- UNSD - United Nations Statistics Division
- W3C - World Wide Web Consortium
- WWW - World Wide Web
“Building the CIARD Framework for Data and Information Sharing”:
Summary Paper of the International Expert e-Consultation

About CIARD and the 2011 International Expert Consultation. This discussion paper presents preliminary results from an International Expert Electronic Consultation on developing a CIARD Framework for Data and Information Sharing held online from 4 to 15 April 2011 by Coherence in Information for Agricultural Research for Development (CIARD). CIARD is a movement by major actors and stakeholders in Agricultural Research for Development (ARD) devoted to making Agricultural Research Information (ARI) publicly available and accessible to all by helping member organizations disseminate their knowledge more effectively, especially to innovators addressing key challenges of agricultural development and food security.¹ A workshop from 20 to 23 June 2011 in Beijing will continue the consultation and chart next-step actions.²

Question 1: What are we sharing and what needs to be shared?

Types of data already shared. Types of data already shared by CIARD partners include bibliographical descriptions of research outputs (e.g., AGRIS); information about standards, tools, services, datasets, and events (e.g., the CIARD Ring, AIMS Website, and AgriFeeds); data on plant genetic resources (e.g., SINGER, GENESYS); agricultural science and technology indicators (e.g., ASTI); agricultural factsheets and e-books (e.g., CABi); locally produced research re-packaged for wide dissemination (e.g., GAINS); soil and land-use maps (e.g., INRA Morocco); and remote sensing data (e.g., AREA Yemen).

Sharing research data. Sharing other products of research on the Web, including raw datasets and other re-usable results, is seen as essential for enabling innovation on important topics of agricultural research for development and food security such as desertification, managing the spread of pests and diseases, and biodiversity. Such data may include earth observation data and the results of field trials, surveys, or cultivar tests. Potentially breakthrough findings remain hidden within institutes, or even on home computers. While many scientists are in principle willing to share more of their data in the interest of better science, others regard research results as personal or institutional property, especially where there is an emphasis on securing patents. Others fear that their work could be “copied” without credit or that incompletely contextualized data could be misinterpreted. Providing proper documentation for research data requires more effort than busy scientists may be willing to provide. In order to justify the investment, scientists and their institutions need to see potential gains, for example in terms of visibility, reputation, or standing with donors. There is a significant movement in the research community towards making all publicly funded research open and transparent and to enable public access to all research data, though in the area of agricultural research for development, sharing is still quite limited.

Sharing “hidden” knowledge. Communication among scientists increasingly occurs through informal channels such as blogs and community forums, where “tacit” or “hidden” knowledge is made manifest. Other types of information currently “hidden” include planning documents, reviews, meeting minutes, posters, Powerpoint presentations, video clips, preliminary project results and — where academic programs exist — theses and teaching materials. Some institutes already use social media sites such as Flickr and Slideshare to post photographs and slide decks. Hidden knowledge can also be discovered by knowing whom to ask; finding people with specific subject or technical expertise can be supported by databases of experts.

Sharing with the users of research data — farmers. When asked, one organization of farmers expressed interest in information on pesticides (and biopesticides), seeds, hydroponics, crop recommendations, pest alerts, market prices, irrigation forecasts, and crop trends — not just in Web or print form, but with videos. The organization also requested information on research plans, ongoing projects, and research outputs. Where farmers are invited to view on-farm trials, communication between farmers and researchers can become a two-way channel in which potentially valuable

¹http://www.ciard.net
²http://www.ciard.net/events/international-expert-consultation-building-ciard-framework-data-sharing
indigenous knowledge is elicited. Communicating with farmers requires outputs to be translated into local languages, simplified, and published in accessible formats — efforts less likely to be undertaken if the results are rejected as “not scientific” when presented for reward and promotion.

Sharing with machines. Standing between research information and its ultimate beneficiaries are the computer systems which deliver that information. In this sense, “machines” are the front-line consumers with which information is “shared”. Modern Web technologies — protocols and formats such as the Open Archives Initiative Protocol for Metadata Harvesting (OAI-PMH; for sharing metadata records), Linked Open Data (LOD; for integrating information between many sites), Rich Site Summary (RSS; for distributing news items on the Web) and Resource Description Framework (RDF; for describing information in a form that easy to integrate) — do not so much determine how information is delivered to end users as to encapsulate, structure, or link that information in ways that flexibly support its delivery to users downstream. (See “Trending Technologies” below.)

Reusability of information shared. The potential value of any given information to someone else is not always obvious, so some people recommend erring on the side of sharing “everything”. Intelligent aggregators can sift through well-tagged chunks of information, extracting and re-packaging the information for new audiences or purposes (example: the extensionist who merely needs one photo from a long report) or re-packaged for different target audiences. The counter-argument is that sharing too much risks spreading scarce resources too thin while presenting users with too much information — much of which, in the absence of peer review, will be of dubious quality. Information is needed about what is being shared, preferably ranked for completeness and quality for the benefit both of information consumers and of creators of value-added services.

For discussion in Beijing. For what purposes does ARI need to be shared? Priorities for sharing should be informed by purposes related to natural resource management, climate change, innovative agricultural practice, sustainable production, equitable access to markets, or the dissemination of research results. What are the social or cultural barriers to sharing, and how might those barriers be overcome?

Question 2: What are the prospects for interoperability in the future?

Interoperability defined. Interoperability is a feature of datasets — and of information services that give access to datasets — whereby data can easily be retrieved, processed, re-used, and re-packaged (“operated”) by other systems. The less pre-coordination required to achieve this, the more “interoperable” the source. Interoperability ensures that distributed data can be exchanged and re-used among partners without needing to centralize data storage or adopt common software. “Mashing up” data from multiple sources can lead to new insights about relationships between factors such as weather, markets, crops, and geographic location. Interoperable data can more easily be pulled together into specialized services, such as crop portals and virtual research environments.

Interoperability on the (inevitably) diverse Web. Interoperability can be achieved within closed systems — in some cases very large closed systems, such as Google and Facebook — by using specialized information formats usable by custom-built software. However, interoperability can also be achieved within the highly heterogeneous environment of the Web on the basis of open and generic “Semantic Web” standards. For social, political, and practical reasons, the concentration of information in big, centralized repositories, using centralized tools, is both unrealistic and counter-productive. Computer applications and data formats will continue to evolve, virtually guaranteeing that any particular system in use today will sooner or later grow obsolete. Where data exchange based on ad-hoc solutions requires pre-coordination between tightly coupled components, exchange based on standard data representations supports sharing among heterogeneous, “loosely coupled” information sources — an approach that copes with diversity not by trying to eliminate it, but by embracing it as inevitable.

Globally unique names (identifiers) for things. Central to the concept of open interoperability described here is the role of URIs as identifiers for “things” (resources). URIs give names to things, making them citable and “linkable.” Metadata allows applications to see information through different lenses, re-packaging it into different aggregations
or incorporating new information, as it becomes available, into “expandable descriptions.”

**Interoperability through a common “grammar” for data.** Resource Description Framework (RDF) technology is used to publish data in a form is generically “understandable” by applications. Linked Data builds on the power of RDF by using globally unique identifiers (URIs) to establish browsable links between diverse datasets and tag resources with precise search concepts. In Linked Data, the boundary between “data” (“things”) and metadata (“descriptions of things”) is blurred. RDF can be used to publish interoperable metadata or, in principle, any other structured dataset, from earth observation data to financial spreadsheets.

**Interoperability through the use of shared vocabularies.** A shared grammar does not, of itself, ensure interoperability. To be fully interoperable, data must be expressed using shared concepts (“vocabularies”) — whether well-known properties such as Dublin Core or topic identifiers from RDF-enabled thesauri such as AGROVOC. To be interoperable with AgriFeeds, for example, an event description must minimally include a title, date, location, and topic. Explicit mappings between vocabularies (“alignments”) such as AGROVOC and the National Agricultural Library Thesaurus establish interoperability between entire concept schemes.

For discussion in Beijing. How can new information and communications technologies (ICTs) be harnessed to provide information to the people who most depend on them? What specific policies and structures — open data repositories and trust organizations with requisite standards and norms — are needed at the global, regional, national, institutional, even individual levels?

**Question 3: What are the emerging tools, standards and infrastructures?**

**A continuum of choices from basic to advanced.** Linked Data is not an all-or-nothing proposition but a continuum starting, at the low end, with simple choices. Tim Berners-Lee summarizes the Linked Data approach as a pathway leading information providers towards progressively higher levels of interoperability (paraphrased here):

| **On the Web, open licenses.** Make your stuff available on the Web, in whatever format, under open licenses. |
| **Machine-readable data.** Make your stuff available as machine-readable structured data; a table in Excel is better than just an image of the same. |
| **Non-proprietary format.** Use plain Comma-Separated-Values format (CSV) in preference to Excel. |
| **RDF standards.** Use URLs (URIs) to identify your things so that people can point to them, and describe them using RDF. |
| **Linked RDF.** Link your data to other peoples data to provide context and add value. |

**Existing data exposed as RDF.** One of the simplest starting points is to expose an existing database as Linked Data by using an RDF wrapper that does not require changing the underlying database management software. If the entity model of a database does not map cleanly to RDF, the mapping can focus on data elements of particular utility. The AGRIS Application Profile, for example, was intended to provide a target for such mappings while leaving underlying applications untouched.

**RDF generated by Content Management Systems and tools.** New Content Management Systems support the publication of structured data in RDF, such as the mainstream open-source platforms Drupal and Fedora. Drupal can be extended with an OAI-PMH module for harvesting content from providers. AgroTagger, developed by IIT Kampur, uses natural-language processing to describe the content of a submitted text with AGROVOC concepts. The AGROVOC VocBench provides an online vocabulary editing and workflow tool for maintaining large vocabularies in highly distributed environments and in multiple languages.
**Best-practice services.** Services highlighted in the e-consultation include VIVO, a search engine which “facilitates interoperability between people” by providing information about scientists, academic departments, courses, grants, and research publications; and eScienceNews, an aggregator for news and blog postings of scientific interest which uses natural-language processing and machine learning to semantically annotate Web contents for enhanced discovery.

**Compliance with standards.** “Compliance with standards” frightens managers because it sounds expensive. Ideally, compliance with standards should “just happen” as a by-product of routine workflows and simple tools. Many research institutes lack IT specialists, or if they do have qualified staff, find that they resist exploring new approaches, such as RDF, which lie outside the comfort zone of familiar SQL and XML databases. Once trained, qualified staff often leave for positions that are better paid. To stand a chance of success, an open interoperability strategy must be based on tools that are easy to set up, use, and maintain.

**New prospects for Cloud Computing.** The increasing availability of applications and storage space in The Cloud (Web-based server banks) may mitigate this problem by allowing institutes with less capacity to implement advanced services without increasing local staff or computing power — a prospect to be explored by FAO in an upcoming EU project, AgINFRA. Cloud computing could help trusted organizations such as CIARD.RING better serve a broad community by managing and aggregating the data and metadata of its partners and using the data to develop value-added services.

**For discussion in Beijing.** What capacities must be developed, and at what levels, to facilitate the creation of exemplary services in compliance with standards? What kinds of technical services can be externalized to servers in the cloud, and what capacities must be developed locally?

**Question 4: What actions should be facilitated by CIARD Task Forces?**

**Re-think the role of information managers and of “communicators.”** Addressing the challenges of data and information sharing is not only a question of technology, but of institutions, culture, and processes. The introduction of new technology and processes may imply a more central role for information professionals, possibly in the context of “regional data transformation centers.” In addition, there is a need for “communicators” with the knowledge and skill to “translate” between scientists and practitioners, creating ways to present scientific information in practice-oriented advisory services.

**Provide advice and support for information management choices.** There is a clear demand for advice from CIARD on basic choices such as when and how to use open versus proprietary data formats; whether to manage Web sites with Content Management Systems; how to describe specific types of information interoperably; when to use a traditional library system, OAI repository, or custom-build application; how to augment face-to-face meetings with multimedia social reporting; and which “star level” to target in a given situation given costs, difficulty, connectivity, and required level of ICT skill. The role of CIARD could be to describe available options, making the case for open solutions and providing information on specific tools — but with no expectation that partner organizations should all adopt a uniform approach.

**Provide capacity development for adopters.** Based on an analysis of capacity gaps, capacity development events could target key people for training both in the technical aspects of data interoperability and in practical methods for migrating data. Mentoring arrangements between institutions at different levels of the “star system” could provide a channel for the transfer of practical knowledge and experience. The CIARD Capacity Development Task Force could form partnerships with other organizations involved in developing capacity, such as new degree programs in agricultural information and communication management.

**Package well-tested and popular tools into a CIARD toolkit or CIARD-hosted Website.** CIARD could package well-tested and popular tools into a toolkit — a “filled shopping bag” with solutions that work “out of the box” to meet the most common requirements. The CIARD Website could point to tools customized for the agricultural
research community such as AgriOcean DSpace and AgriDrupal. The Website might also host content on behalf of CIARD partners with less local capacity or facilitate the creation of data repositories at the national or even global level.

**Improve CIARD Ring as a global “signpost” and directory for ARD information.** Consistent follow-up with registrants of services on the CIARD Ring could ensure the provision of basic information such as location (for the map), URLs for OAI-PMH providers and RSS feeds, and subject headings. By adding to the current offering of tutorials on OAI-PMH and RSS, the Ring portal could become a one-stop source of practical information on how to implement the CIARD Pathways and improve interoperability.

**Work with regional authorities and donors to advocate for targeted funding.** CIARD should develop a blueprint for a global agricultural research infrastructure and use that blueprint to mobilize investments in a strategy for information sharing based on technologies for open interoperability and in capacity building of its champions. The blueprint should demonstrate the strengths of a Linked Data approach by highlighting success stories and showing how shared data has benefitted rural communities.

**In conclusion, some brainstorming...** Define Core Data Sets for topics such as Plant Breeding or Natural Resources Management. Identify “Trust Organizations” for holding specific types of data (as CGIAR, the Global Trust Fund, and the International Treaty on Genetic Resources for Food and Agriculture do for seeds). Ensure the long-term preservation of Data Repositories. Create something like the Open Access movement to energize people to take action, perhaps in the form of a Global Treaty on Information Sharing.

### Trending technologies

**1994: “World Wide Web” and URIs (Uniform Resource Identifiers)**
*First proposed in 1989, an Internet-based network of documents linked using globally unique URIs, which took off with the spread of graphic Web browsers in 1994.*

**2000: “Semantic Web”**
*As proposed by Tim Berners-Lee, inventor of the Web (of documents), the notion of a web of structured data meaningfully processable by machines. See: [http://www.w3.org/standards/semanticweb/](http://www.w3.org/standards/semanticweb/).*

**2001: OAI-PMH (Open Archives Initiative Protocol for Metadata Harvesting)**
*A computer protocol for aggregating (“harvesting”) metadata records over the Web from multiple repositories. See: [http://www.openarchives.org/pmh/](http://www.openarchives.org/pmh/).*

**2004: RDF (Resource Description Framework)**
*First introduced in 1999, a key Semantic Web standard for data interchange that achieved widespread use after the release of a major revision in 2004. See: [http://www.w3.org/RDF/](http://www.w3.org/RDF/).*

**2006: RSS (Really Simple Syndication)**

**2008: “Linked Data”**
*First introduced in 2006, the notion of data expressed using RDF and URIs — also known, when published world-readable on the Web, as “Linked Open Data” (LOD). See: [http://linkeddata.org](http://linkeddata.org/).*

*Prepared by Tom Baker, June 2011*
International Expert Consultation on “Building the CIARD Framework for Data and Information Sharing”

Introduction

CIARD is working to make agricultural research information publicly available and accessible to all. Among its actions are advocating for and promoting open access, improving applicability and enabling effective use of data and information in agricultural research and innovation.

Challenges and opportunities for data and information sharing

Knowledge generated from agricultural research should be easily accessible and so easily taken up by agricultural researchers and the agricultural community at large. This issue is always more vital in the face of rapidly shifting challenges such as climate change, trans-boundary pests and diseases, effectively use of water for agriculture, combating desertification and degradation of fragile soils and managing agricultural biodiversity.

Conventional pathways for communicating research outputs, through scientific publications (journals etc) and face to face events, have been enriched by new digital formats including the newer social media such as wikis, informal blogs and online communities of practice. The volume of outputs of agricultural research such as scholarly or informal publications, blogs, discussion forums, institutional directories and very importantly raw data, is rapidly increasing.

Whereas an increasing amount of information becoming available represents an enormous opportunity, a challenge exists in the scattered way in which this information is being made available. The sources of information have become more heterogeneous and so coordination and coherence has become more problematic, making it more difficult to share data and information efficiently within and between scientific communities and more importantly with the wider range of stakeholders involved in agricultural innovation systems.

New approaches have to be adopted to facilitate sharing without resorting to tight coordination and centralization, which, for political and logistical reasons, are not foreseeable in the current spontaneous proliferation of data sets and services in agriculture.

This is where the current trends in information technology and web practices represent a unique opportunity to develop a coherent framework for sharing agricultural information. Approaches like Web 2.0, Linked Data, the OAI-PMH protocol, etc., are all means of improving the interoperability of distributed information and datasets without requiring strict coordination or the omologation of the software and data environment.
**Background Figures**

Scientific publication and data production is growing at a much faster rate than ever before. Figure 1 charts the increase in numbers of articles indexed by MEDLINE from 1950 to 2010. The rate of increase in publication has clearly risen, especially since the year 2000, but the production of scientific papers is only the tip of the iceberg.

Behind growing numbers of scholarly publications is a growing amount of scientific data. Furthermore, scholarly papers are no longer the only way in which scientific information is exchanged.

**Figure 1. MEDLINE-indexed articles published per year**

Researchers are using more social platforms such as blogs\(^{11}\) to discuss results before they are published in scholarly journals or after they have been published.

Data on publication rates in agriculture are not readily available, but it is quite clear that the trend will be similar, although perhaps less dramatic, to the other life sciences which are monitored by MEDLINE.

The second graph shows that the steeper increases in publication rates since 2000 is mainly due to the entrance of a few large countries with so-called “emerging economies especially China, Brazil and India, into the scientific mainstream. Taking 1990 as a base, Brazil has increased its scientific production by 800% and China by 1200%.

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\(^{11}\) See as an example ScienceBlogs [http://scienceblogs.com/](http://scienceblogs.com/) Last accessed March 2011
The growth of these key new players in the scholarly communication arena has made interoperability a more important global issue, with special regard to the handling of languages other than English.

The CIARD partners are organizing a series of international consultations (through electronic and face to face events) to build a framework for action in making outputs of agricultural research truly accessible through coherent management, sharing and exchange of knowledge, information, and data. This background note is the basis for a discussion on the e-Agriculture platform from April 4 to 15 and which will be followed by an expert consultation in Beijing on 20-23 June 2011 with the same title. These two events together is an exercise in describing the current status and analyzing the needs for tools, standards and infrastructures, leading on to defining future actions.

**Building the CIARD Framework for Data and Information Sharing**

Over the last decade a series of international workshops and consultations have been organised by FAO, GFAR and the CGIAR to enhance the contribution to agriculture science by information and communication and associated technologies, and commitments have been made by a wide range of organizations which have lead to major advances. These meetings indicated that the main challenges are in:

- Advocating increased investment and targeting it appropriately,
- Generating and managing content that is economically produced and affordable to all involved,
- Rapidly building capacities and bringing organizational change towards more efficient and effective information flows and its use.

These global efforts also led to the launching in 2008 of an international multi-stakeholder initiative on Coherence in Information for Agricultural Research for Development (CIARD), co-sponsored by all the main international organizations and regional forums that had been involved in the previous efforts to meet these
challenges. The CIARD vision is “to make public domain agricultural research information and knowledge truly accessible to all”, with the partners share the common objective of working together to collaboratively develop common standards, share knowledge, and contribute to effective and coherent institutional approaches in agricultural science and technology information. A CIARD Manifesto was developed through a series of regional consultations in 2009 involving 150 people from 70 countries, together with tools such as a Checklist and model Pathways that need to be adopted by all actors in ARD, and this was endorsed by the GCARD\textsuperscript{12} in 2010.

The realization of the CIARD vision across all domains of data, information and knowledge, will contribute significantly to meeting the challenges of agricultural development and food security, but it is clear that more advocacy and relevant capacity is required to ensure adoption of these common and coherent approaches at national level by key institutional actors in innovation systems. A global series of consultations is proposed for follow up of principles established in the GCARD Roadmap and reports that will provide the basis for reporting on progress at the GCARD-2012.

**Objectives of the International Expert Consultation**

The CIARD partners are organizing a series of International Consultations (through electronic and face to face events) to build a framework for action in making outputs of agricultural research truly accessible through coherent management, sharing and exchange of knowledge, information, and data and achieve its wide endorsement and adoption by national actors in ARD. Detailed agendas for high priority actions will be developed and agreed by experts and policy-makers based on the CIARD Manifesto for the major types of information and data that will incorporate outputs of the various relevant global and regional consultations. Under the broad umbrella of CIARD, the programme will chart future strategies for action and specific activities for information sharing and exchange, maximising the potential value offered by new ICT and in relation to the information resources of fast growing economies who are also emerging major scientific powers through collaboration and partnerships.

Expert opinion is needed to identify the opportunities and challenges, so that national authorities can make well-informed choices on getting the best development value from the integration of agricultural research data. This International Expert Consultation at Beijing seeks to stimulate and develop broad-based consideration of AR4D data and is an initial step in a future global activity towards more effective and efficient sharing of Agriculture research-related data and information. It is a step, in an extended process of strengthening operational linkages between different forms of information and data and the owners/providers. The event will not define standards, mechanisms or methods for interoperability. The aims in practice are to: 1. Achieve consensus on the need and required extent of interoperability between different information/data management systems, 2. Discuss practical actions to enhance interoperability. 3. Discuss the implications,

\textsuperscript{12} Global Conference on Agricultural Research for Development
opportunities and challenges of issues such as IPR, data system security and governance in sharing, validity and verification of data etc that may emerge.

The specific objectives of the consultation are:

1. **Take stock of the current collaborative bilateral, multilateral, global coherence frameworks and collaboration in management and sharing of information**

Current collaborative bilateral, multilateral and global information management initiatives will be mapped, to specifically include those of fast growing economies countries and international agencies including the private sector activities in agricultural research. These activities would include information of different forms and its access and sharing, e.g.:

- Information residing in communications between individuals, such as in blogs and community platforms supported by sources such as directories of people and institutions;
- Formal scientific data collections as published data sets and their associated metadata and quality indicators, peer-reviewed scholarly journals or document repositories;
- Knowledge "derivatives such as collections of descriptions of agricultural technologies, learning object repositories, expertise databases, etc.;

2. **Share experiences of national, regional and global collaboration in managing, sharing and exchange of agricultural research information in the context of new challenges to agriculture**; address issues in global collaboration, with a focus on involving fast growing economies further in managing, sharing and exchange of agricultural research information in the context of new challenges to agriculture and the potential offered in collaborative international agricultural research by new ICT.

3. **Charting of future action, strategies and activities for action to further enable collaboration and partnerships involving fast growing economies in global agricultural research information sharing and exchange**.

The outputs from the 2011 programme of consultations will be summarized in an issues paper on “Enabling Collaboration in Global Agricultural Research Information Sharing and Exchange” for the consideration of the global ARD community, with suggestions/recommendations for governments for submission to the intergovernmental Technical Consultation in planned in late 2011 or early 2012 in Rome, and following that the GCARD-2012.
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In developing a framework for data and information sharing for agricultural research for development (ARD), the first question we need to ask is to why we need a framework, and prior to it, why do we need to share data and information for agricultural research for development? The answer lies in the fact that current and emerging challenges in agricultural development are global in their scope. Every community and country needs increased agricultural productivity from their farms, and just returns for their farmers and producers. They need to reduce hunger and malnutrition, alleviate extreme poverty and use natural resources such as land and water and energy more efficiently and sustainably. Climate change affects their agriculture now and will affect more in the future and they need to adapt their agriculture rapidly to it as also contribute, as responsible world citizens, to mitigating and reducing climate change and its effects. Desertification, trans-boundary diseases, loss of agro-biodiversity and equitable participating in global agricultural markets are also universal problems. And all need research and innovation to be solved.

Data and information sharing for agricultural research for development enable, among many benefits:

- New information and knowledge to be generated
- Localize globally available information and knowledge and enable it to be used more effectively
- Increase efficiency and effectiveness of research and its outputs and innovation in time, cost, quality and human effort
- Reduce reinvention and repetition of research efforts
- Allow greater inclusiveness and participation in research and innovation
- Bring cross-disciplinary and specialized skills to agricultural research
• Reduce “market failure” or inability to use research outputs effectively and/or efficiently
• Create new research directions and avenues
• Bring greater equity in using agricultural knowledge across and among communities

The second question that needs to be asked is what do we do to improve data and information sharing in ARD? The answer, in part, lies in the potential of new information and communications technologies (ICTs). These ICTs have enabled new avenues to generating, processing, sharing and exchanging data and information. The processing power of computing devices has increased dramatically, doubling almost every two years while their size and energy consumption has reduced enabling more mobile use. Similarly, connectivity of these devices has increased not only in speed but in spread and is becoming ubiquitous facilitating further mobility in the use of these devices even in remote, rural areas. “Cloud” computing is enabling huge amounts of data to be stored, accessed and used remotely. “Crowd” computing enables communities to collectively generate, process and use information, many a times through mobile devices, to solve a community’s problems. The Web 2.0 technologies allow an interactive web and in the near future a “semantic” web, which provides information as a human mind understands “information” and further down in the near future, a “symbiotic” web, where the web symbiotically or through mutual benefits provides information to all who are dependent on it rather than only to those who can afford it.

To move faster in harnessing the potential of new ICTs in ARD, and it is important here, that information (and knowledge) is available and accessible to those who are dependent on it and that they can use information effectively, we need to start looking at the information related to agriculture available in the public domain and making it more accessible. And why the focus on the public domain? Because, a majority of information generators, assemblers, amalgamators and disseminators of agricultural information for development are from the public sector and funded through public funds. They are obliged to put their information in the public domain transparently.

To make the information more easily accessible as also interoperable so as to make its effective use in different situations possible and easier, we need to work at the level of information objects or data. And therefore we need to create open data repositories and couple them to concepts of “linked open data” or data objects that can be hyperlinked across common attributes. Of course, to develop these data repositories that can be located and used globally we will need standards, norms and regulations to govern effective, efficient, transparent
and equitable flows and uses. We will need **standard descriptors**, mutually agreed **taxonomies** and **vocabularies** based on **common ontologies** to describe and organize the storage and access to the data. To reduce costs and time in assembling data to meet the information needs for meeting the most critical challenges to agricultural development, we may need to define **Core Data Sets** that Institutions and National Systems of agricultural research and Innovation universally may contribute and work in the spirit of global shared responsibility, collaboration and partnership. And for this we will need **policies** and **strategies** at Institute, Organization and Country level. We will need **governance** structures, **legislation** and **International treaties** to share data and information openly as also protect interests of all parties in information management and use. We may need to create **Trust organizations** that will manage the data and metadata that is shared openly at national and global levels. We will need to look at **investments**, financial and in human skills that will be needed to manage the entire information infrastructure in global ARD. And of course for all these ideas to take off, we will need **advocacy** and **promotion** and new **capacities** to advocate and manage open data repositories sustainably and all the issues related to them.

The third question that we should ask is, how do we do all that is needed to be done for data and information sharing for ARD? In my opinion, we need to start, through inclusive dialogue, by creating a framework for data and information sharing for ARD for all involved to follow and contribute to systematically. A lot is already being done and we need not all do the same individually and independently. We simply do not have the resources for it. For example, the concept of open repositories is now well developed and there is constant development of the concept of “linked open data” with basic standards such as XML, RSS, RDF etc already in place. The taxonomies and vocabularies, such as AGROVOC, are being rapidly evolving. We need to look at Core Data Sets though some such as for weather and climate, plant germplasm and spatial data already exist and some for example in agronomy are in the making. The issue is who defines them? We need to look at Trust Organizations. The CIARD.RING led by GFAR is one of them. We need to look at implications of open data access in ARD at organizational and national levels and this can be done through GFAR and FAO. We need to advocate for increased investment in information infrastructure in global ARD and this can be done at GCARD 2012. And much more already done, being done and need to be done can be mapped once we have a framework.

_________________________________________

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Building the CIARD Framework for Data and Information Sharing:  
A perspective from a CIARD RING developer

John Fereira
Cornell University

When asked to prepare a summary paper and presentation for this workshop I reviewed the suggested content for the paper and found myself wondering how I might prepare a presentation which met the criteria for suggested content for a paper.

The suggested content for the first section of the paper recommends that I should offer observations of how institutions in my country manage and share information and data related to Agricultural Research. Given that I live in the United States and work at Cornell University I felt that observations of how my University and other US institutions manage/share Agricultural Research Information would just not be relevant in the context of what this workshop is trying to achieve.

So, for my paper I would like to take off my Cornell University and United States representative hat, and put on the hat as a collaborative programmer on the CIARD Ring web site and member of the CIARD Content Management Task Force. Specifically, I will attempt to make my observations on how institutions which have registered in the RING have described their services.

With that in mind let us look at the items for the suggested observations for section one:

1. the importance and role of organizational and/or national policies and strategies in your country in fostering sharing of scientific information/data;

I think that we all understand the importance of sharing scientific information and data. While many of the organizations in the CIARD RING have shared information about their services, the RING does not fully facilitate a sharing of organizational policies beyond a yes or no flag indicating if there is an open access mandate and a field for keywords which describe the licensing model. The RING could likely foster sharing of information/data better if it provided a text area for detailed policies that could be used as a model for other organizations.

2. mechanisms, channels, obstacles and constraints for sharing and exchange of research information/data within your country and with the outside world;
This is another area where the CIARD RING could be used to communicate obstacles and contrainst that have been encountered, and more importantly, how an organization might have been able to overcome those obstacles. For example, many organizations are located in regions of the world where Internet connectivity is marginal. Strategies for sharing information/data when there are technical infrastructure barriers could benefit those with similar obstacles.

3. **concrete examples of interoperability between types of digital information/data and the outcomes and benefits derived.**

During my presentation I will briefly show a couple of examples of interoperability between a few institutions registered in the RING.

4. **priority areas, current and potential, where interoperability between types of digital information/data will really enhance sharing of agricultural research outputs.**

This is pretty much outside my area of expertise so I’ll leave discussions of this item to those with a better understanding of the domain.

Now let us look at a few specific services as described in the RING to get an understanding of the scope of these services and some metrics on how the RING currently supports Agricultural Research management and sharing.

1. **information/data type(s) (e.g. documents, maps, statistics, images, genome data etc);**

The CIARD RING provides a wealth of information about services. Each service can be described in terms of the services type, type of documents, geographic scope, technologies and standards used, and can include instructions and examples on how services can interoperate.

2. **subject areas**

Services described in the RING contain a thematic coverage section using fixed list of top level domain terms, KOS terms consumed from a vocabulary from an external AIMS site, as well as a free text vocabulary for describing the subject areas represented by a service.
3. amount of digital information/data content in the system/repository;

The CIARD RING provides fields for describing various metrics related to a service, including the number of items in an institutional repository as well as the percentage of resources which are related to agriculture.

4. "ownership" of the information/data content, and who has access to it;

The metadata available for each service in the RING includes specific information about who can access information, and who can contribute information to the service.

5. any information management standards, database architectures, models etc that have been used.

The RING has a set of specific fields for a information service which will identify metadata standards used, vocabularies that have been used (such as AGROVOC, format/notation (such as XML, JSON), and protocols/architecture such (OAI-PMH, SOAP) that are used for both input and output. Services can also be described in terms of some of the other technologies dependencies such as the identification of a Content Management System or Institutional Repository in use.

I hope that my paper and presentation can provide some context for what the existing CIARD web sites can provided in terms of describing organizations and the services that they provide. The RING already has a significant amount of information as a registry for organizations and services and I am hoping that discussions we are having will help me continue to build and enhance the CIARD Framework for data and information sharing.

___________________________________________________

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French research is conducting in 85 universities & in research institutes. The main research institutes are:

- CNRS (National Center for Scientific Research – the largest French institute). CNRS is also the largest fundamental research organization in Europe. CNRS’s annual budget represents a quarter of French public spending on civilian research.
- INRA (French National Institute for Agricultural research – second largest institute in France). INRA is ranked 2nd in the world and 1st in Europe for publications in the agricultural sciences, and plant and animal sciences, INRA carries out mission-oriented research for high-quality and healthy foods, competitive and sustainable agriculture and a preserved and valorized environment.
- CIRAD, CEMAGREF, IRD, IFREMER in the field of agriculture, environment, aquaculture and food.

Most of them signed the Berlin Declaration on Open Access. If all universities don’t have an institutional open archive yet, all the research institutes in French uses one at least or set up their own one.

HAL (Hyper Article On Line) was developed in 2001 by the CNRS. It became the national platform in 2006 when all universities & research institutes signed a convention in order to provide HAL with their scientific papers.
In Feb. 2011, HAL has more than 160 000 full text scientific papers.
This convention is an important political decision in France but it remains several technical and open access institutional political issues. Actually, it is possible to harvest HAL but HAL never wanted to harvest and expects from the other repositories to use its webservice to export metadata and full-text. In 2006, it was not possible for all institutions to adapt their existing repositories to connect to HAL via its webservice. But the main issue is the difference between HAL guidelines and open access policies for some research institutes. For INRA, papers should remain in the institutional repository and could be removed under author’s wish - it is an intellectual property issue.

Since 2010, INRA has an ambitious open access policy based on an internal mandatory policy for researchers and a dissemination plan towards partners.
VOA3R, Organic Lingua are two European projects in the field of open access and agriculture. Agris is the FAO repository. “Eau France” and “Portail de l’environnement” are two French portals in the INRA research area.

It seems more relevant for me, as responsible of the INRA open access policy to disseminate and share INRA production with partners & portals in the INRA research area than within our country. Research is international.
This dissemination plan will be efficient in 2012 with the new version of ProdInra, the INRA open archive. The objective is to increase the visibility of INRA at the international level. It is really important to get more funds for research and it helps to highlight INRA expertise and INRA experts.

Making this infrastructure efficient is not easy because of technical issues: protocols chosen by the service providers & portals are sometimes different (OAI, FTP, specific webservice...) and also the required format (AGRIS, DC, DC+LOM, HAL, REPEC...)

This infrastructure is the first step of a more ambitious one. INRA has a wish to collect datasets produced by the researchers and to identify more productions than papers produced. INRA is interested in tracking researchers’ activities like being a reviewer in a journal, activity to setup a training course at university, organizing international congress...

These information and datasets are different than the papers. A new, internal, infrastructure has to be designed. It would include the knowledge division applications: ontologies management, scientific knowledge & expert systems. It has been decided to build it upon “linked data”. Different triple stores will have to interconnect to add more value and allow more outputs from this infrastructure.
Overview of some digital data in French repositories

Overview of French digital repositories or portals¹

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Overview of data or information available (public access)

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<td>National open archive or portals</td>
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<tr>
<td>Scientific Portals</td>
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Kind of data/information available on these French repositories

- Example of the grey literature in 2009

The part of the grey literature among the repository's content is:

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<td>Thematic Open Archives</td>
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- Case of scientific pictures

¹ Source: http://archivesic.ccsd.cnrs.fr/docs/00/49/73/89/PDF/DUAO_Partie1.pdf
HAL has provided a specific repository (MEDIHAL) for archiving scientific pictures in France, since 2010. It now offers up to 7541.

Focus on ProdInra

- Number of data

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- Number of data per type of document (public access)

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<td><strong>Total</strong></td>
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ProdInra is a strategic information system for INRA as it aims at providing bibliometric studies for management boards. The new version is under development and will use standards like: DC, LOM, MODS, Agris, RDFa with very used protocols (OAI, SOAP, FTP).

We are thinking of enlarging connections with ontologies, internal knowledge systems as well as integrating datasets & researchers’ activities to create an INRA scientific information system.

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Moroccan Situation
Agriculture sector has a substantial role in the macroeconomic balance of the country. It plays an important social role as 80% of the 14 millions rural populations depend on revenues from the agricultural sector. Agriculture contributes by 19% of the GNP, with 15% from agriculture and 4% from agro-industry. For these reasons, scientific and technical information in general and agricultural information in particular were a major concern for Moroccan government since early 70’s. An institutional body called the National Documentation Centre www.cnd.hcp.ma was mandated by law to collect, process and manage information (conventional and non conventional) using information technology. CND offered online access to scientific and technical information resources through European information providers (questel/orbit www.orbit.com and Ovid www.ovid.com). In early 90’s, a national agricultural information system was set as basis for information sharing between NARS institutions. In early 2000, a Moroccan institute for Scientific and technical information IMIST www.imist.ma was founded under the supervision of the National research council www.cnr.ma. IMIST is serving the Moroccan research community among universities and research centres via the government-driven ‘Maroc Wide Area Network’ (MARWAN) www.marwan.ac.ma. IMIST is hosting national databases on thesis and researchers besides offering access to a wide range of online resources of scientific and technical literature through a portal the Maghreb Virtual Science Library www.mvslmorocco.ma. In 2008, the Government launches the Moroccan Green plan 2010-2010 with 10 billions dollars budget. This plan is based on projects and actions plans for each region. In accordance to this plan, the Ministry of agriculture is taking a series of actions related to NARS restructuring and extension that will impact information resources access and sharing among stakeholders.

Exchange of research information/data is done through different communication channels. At individual level, the large use of internet services (mail and group discussions) made communication between the research communities easier, to prepare joint papers, presentations or posters for conferences, workshops and agricultural fairs. Some researchers are using the European Website CORDIS http://cordis.europa.eu/ to interact with their European partners. In addition, some researchers are maintaining their own websites where research information is published. At institutional level, exchange of information is done through information systems of national and international levels. Most agricultural institutions have their own websites. Some are providing access to information resources (references publications with full text access to journal papers, GIS based system on soil fertility and land suitability, genetic resources and more recently genome data). This shows that successful systems are those which are backed by decision makers, based on voluntary contribution of national institutions, provided with incentives to stakeholders (capacity building, logistics with sets of tools and standards) and support for projects maintenance. On the other hand, information systems with limited resources and no incentives have
little chance to sustain. Some examples of major constraints are related to lack of existing strategy for coordinating information content generation and use, lack of awareness of decision makers, lack of funding for supporting projects maintenance and viability, and lack of standards use making it difficult data exchange and sharing.

Though the concept of interoperability can not be considered in the Moroccan situation since we are far from adopting new trends in interoperability, however, some examples showed that existing information resources was used to feed information systems on soil fertility and genetic resources in Morocco. In the first example, data on land suitability maps were integrated to the soil fertility information system. This information system was also enriched with existing data on water resources, climate forecast and desertification. In the second example, data from an existing database of Moroccan species gene bank was used to feed Moroccan data on the Global Plan of Action (GPA) on Plant Genetic Resources for Food and Agriculture (PGRFA). Data obtained from the first database was exported to the PGRFA database. This has lead to save time, avoid duplication of work and contribute to the PGRFA database input.

Sharing of agricultural research outputs will be more enhanced by raising awareness of decision makers within NARS for registering services at the CIARD RING; indentifying application tools for web based content generation and management of agricultural research that are commonly used and available at IARCs and supporting regional foras to implement those tools within NARS; targeting potential information producers made of researchers by providing support for capacity building on existing tools for information generation; making an inventory of successful information systems of agricultural research within national, regional and international levels that can be used as a model by other NARS and be subject to collaboration and linking those resources to the CIARD ring; documenting and reporting successful examples of interoperability; advocating for the use of shared vocabularies and frameworks at NARS level; supporting the use of non commercial interoperability tools (LOD) and finally agreeing on a blueprint for a global infrastructure for data exchange in agricultural research for development.
Case Studies:
1. Soil Fertility Map
2. Land Suitability maps
3. The World information sharing mechanism on the implementation of the global plan of action (GPA) for plant genetic resources for food and agriculture
4. Grape genome analysis: SSR identification and related Primer design
5. Web application tool for Potato genome analysis and SSR identification
Soil fertility map in Morocco

URL: http://196.200.149.150/pmapper/map.phtml

Map of Moroccan soil project is conducted under agreement between the Ministry of agriculture, OCP group and NARS institutions (INRA, IAVHII, ENAMeknes) for a 5 years period (2010-2014) with the objective to develop a national map of soil fertility: Potassium, Phosphorus and Organic Matter, in addition to other classic soils attributes. This map will guide the rational use of fertilizer for better fertilization of cultures, to improve sustainable agricultural production in Morocco. It will also enable the development of regional averages of fertilizer formulas for the main crops that will allow the vast majority of farmers who do soil test analysis, to use more suited fertilizers formulas to their region conditions. First maps concern regions of Gharb-Chrarda, Rabat-Salé-Zemmour-Zaer Chaouia-Ouardigha and Meknes Tafilalet. 8000 soil tests were conducted besides a training program on Geographic Information Systems and GPS to the benefit of researchers and techninian involved in the project.

Information Data:
Documents, thematic maps, and statistics.

Subject scope:
Soil (soil depth, texture, soil horizon, soil fertility (phosphorus and potassium, organic matters), crop forecasting,, land suitability for major crops (Triticum, barley, oats, olive, sunflower, Maize), topographic data, , administrative data (cities, villages, road network), dams network, rivers, water resources (surface and underground), climatology forecast and desertification

Amount of digital data: 753 Mb

Ownership:
The Map soil fertility project is coordinated by INRA with partnership of NARS (IAVHII, ENAMeknes). Data will be hosted at INRA and will be publicly used.
http://196.200.149.150/pmapper/map.phtml

Used tools and Standards:
Mapserver version 5.2.6 for map engine
PHP V.5.2.6 for PHP script interpreter
Cartoweb for framework and navigation
Postgresql 8.4 as a DBMS
PostGIS for spatial data management
Phppgadmin 4.2.2 for DBMS administration
Land Suitability maps:

Land use and management is based on land suitability maps that combine ecologic, technologic, economic and social data. In order to optimise use of land resources within Morocco. A collaborative project coordinated by INRA was initiated in 1999.

the project is targeting useful agricultural areas (SAU) which count for 6 millions of hectares by 2010.

Information Data:
Maps, documents

Subject scope:
Soil data, Climate and crop data

Ownership:
Coordinated by INRA with partnership of Directorates of Agriculture and Development Agricultural Agencies (ORMVAs).

Amount of digital information:
300 Mo

This data is accessible on the Net through the Map of moroccan soil fertility website.
http://196.200.149.150/pmapper/map.phtml

Tools;
Fortran for data interpolation
Surfer for output maps
ArcGis tools for map production and database management on soil, climate and crop
GIS tools are only used to generate thematic Maps on land suitability combining soil and climate data.

Information management standards:
Tools and models based on international standards
FAO Ecocrop and LGP “Lead Growth period” Model
The World information sharing mechanism on the implementation of the global plan of action (GPA) for plant genetic resources for food and agriculture: [http://www.pgrfa.org/gpa/mar/welcome.html](http://www.pgrfa.org/gpa/mar/welcome.html)

A network of public and private institutions which conserve and/or use plant genetic resources with an objective to share information related to plant genetic resources and, in particular, to the implementation of the Global Plan of Action (GPA) on Plant Genetic Resources for Food and Agriculture (PGRFA)

**Information type:**
Resources genetic data (crop species), documents

**Subject scope:**
Plan genetic resources management (In Situ Conservation and Development and Ex Situ Conservation)

**Amount of digital information:** 68 Mo

**Ownership:**
Coordinated by INRA with partnership of major NARS (Hasan II of Agronomic Institute, Enameknes, National institute of forestry, and other Ministry of agriculture Directorates)


**Tools**
Use of open source programs
Java Servlet and Javaserver pages
McKoi V94 as DBMS
XSL (Extensible Stylesheet language) as XML interpreter
Tomcat 4.1.24 as webserver

**Grape genome analysis**
SSR identification and related Primer design

A tool for searching for SSR or Short Sequence Repeat (SSR) in the entire genome of grape (Vitis vinifera), and design of SSR markers for identifying genes or screening for disease such as mildew and fan leaf vidrus. Grape genome consists of 190 contigs, and 2,745,612 SSR. Of Microsatellites grape genome
**Information data types:**
Genome data

**Subject Scope:**
Biotechnology, genetics and breeding

**Amount of digital data:**
85 Mo

**Ownership:**
INRA . system is being accessed locally by INRA researchers (biotechnologist).

**Tools:**
NCBI (National Center for biotechnology information www.ncbi.nlm.nih.gov) database
MISA (Microsatellite) algorithm for SSR identification
programming SSR research
Use of Primer3 for Primer PCR identification
Perl program for scripts
Activeperl interpreter for Perl script running
PHP language for web bioseq design
Mysql as DBMs
Apache as web server
Web application tool for Potato genome analysis and SSR identification

A tool for searching for SSR in the coding and non-coding areas of potato, *Solanum tuberosum L.* genome and Sequence tagged microsatellite STMS markers applications in genetic and breeding.

**Information data types:**
Genome data

**Subject Scope:**
Biotechnology, genetics and breeding of Potato

**Amount of digital data:**
380 Mo

**Ownership:**
INRA system is being accessed locally by INRA researchers (biotechnologist).

**Tools:**
NCBI (National Center for biotechnology information www.ncbi.nlm.nih.gov) database
MISA (Microsatellite) algorithm for satellite identification
Promoter prediction tools (SoftBerry (TSSP)).
Use of Primer3 for Primer PCR identification
Perl program for scripts
Activeperl interpreter for Perl script running
PHP language for web SoSuTA design
Mysql as DBMs
Apache as web server

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CAAS information sharing and Perspectives for the framework development of high-efficient agricultural inforshare system

Pan Shuchun  
All of CAAS

1. Current status of CAAS information sharing

The Chinese Academy of Agricultural Sciences (CAAS) has a strategic task of serving nation-wide agricultural and rural development and empowering farmers with science and technology. CAAS has about 10,000 staff members and 39 research institutes located across 17 provinces, municipalities and the autonomous regions with its own institute’s library or reading room. CAAS institutes produces research outcomes both in published and informally published materials including raw research data and materials and published papers in official publications. Formally published ones like databases, government publications, technical reports, conference papers and so on have been completely collected by libraries at both institutional and national levels. CAAS has been producing a bibliographic/abstracts database of “Chinese Agricultural Sci-tech Documents Database (CASDD)” since 1980s. It has now reached over 600,000 records and about 50,000 records are added annually. The data selected from the literature of more than 1000 titles of Chinese agricultural journals, proceedings and other materials which provides a comprehensive Chinese agricultural document to users. The recent years records are available at the CIARD RING from June 2011.

However, informally published documents or information covering research reports, research development reports, research project reports research datasets etc. are difficult to collect and integrate. Those research findings usually keep in the hands of researchers or research labs. Even within each institute, such research findings are hardly cummulated in its own institute library. And most of the institutes are showing scattered model in storage of their research findings. Also, different levels of facilities and equipments, non-standard knowledge/information organization, and lack of the long term digital preservation development plan for those research findings, as well as different documents processing methods in each research institute make the inforshare rather difficult.

There are surveys and researches undertaken to try to find ways for CAAS research information and data sharing, such as ARIS inforshare plan and other research projects by the CAAS library, however, the implementation of the respected infor share has been realized at some low level. Only consortium acquisition of published materials has been organized. The main reasons for the weekness of sharing among CAAS institutes due to
the lack of special project support and understanding of the importance of inforshare within CAAS.

In order to change such fragmented "information island " and integrate information in various formats, we have done some researches on building an integrated information repository system within CAAS to integrate all information resources in a knowledge base, according to disciplines. The Agricultural science data sharing platform(ASDSP) by the Agricultural Information Institute(AII), CAAS has been a good example. The building of institutional repositories and special database constructions in key fields of agriculture have been undertaking in recent years.

2. Perspectives of the framework development of information sharing

The Overall planning, internal and external project supporting, standardization and coordinated management of agricultural research findings are critical to realize access, sharing, monitoring and reuse of the agricultural research information among institutes. The continued and stable financial assistance and a sustainable developing mechanism for inforshare of the CIARD community are important. An effective and efficient information sharing needs a general planning, scientific management at all levels, cooperation with clear responsibility of each institute and etc. are necessary in realizing an ideal information resource sharing globally. Some key factors in the framework development should be considered are as the follows:

(1) Enhancing unified planning and decentralized organization
The international information sharing platform requires a strong organization and leadership. On a voluntary basis, CIARD head quarters should take the lead in planning and organizing to lead information systems of all levels to work together under the guidance of a common goal and practical policies and regulations. There should be also an effective mechanisms to encourage and attract regional, national and local agricultural research information systems to participate CIARD activities and make their contributions. The decentralized coordination and organization is particularly needed to extend the impacts of CIARD activities.

(2) Promoting financial and project support
International information sharing system needs multi-channel financial support for its constant development, including support from international consortia and foundations, national government support, international organizations as well as support from enterprises. Information system itself also may provides information products and services to increase replenishment. Only when excellent and efficient services have been provided through constant research and improvement, and the information system becomes a reliable scientific supporting system to users, it may gain more ambitious prospects in development in the future.

(3) Stimulating Standardization throughout the whole process of information management and services
Standardization is a prerequisite for sharing of information resources. Standardized handling, processing and disseminating of information resources are guarantee for a barrier-free access of information sharing. Implementation of the standards depends on the full understanding and
conscious implementation of information institutions. However, no matter what standard to be used, we should enable the professionals clear and master its principles, requirements and specific methods for service descriptions and classification to facilitate the accuracy, availability and sharing of the standards in implementation. This also requires relevant personnel training and guidance particularly for harmonization and adjustment of descriptive data of information resources in different formats or using different standards.

(4) Building a high-efficient information sharing mechanism
International, regional, national levels infoSHARE system should be build with high efficiency in information services. A suitable information sharing operational mechanism at each level should be established to ensure the sustainable development of the system. At the regional and national levels, there should be mainly the operational and implementation of the coherent activities according to the overall plan of the international system. The mobilization and organization of registration of agricultural resources at national and local information resource systems will play the role of nodes to promote information sharing, and gradually increase and improve the agricultural and rural Information resources crawling, processing, repository building and utilization of the infoSHARE system to improve the efficient use of information resources.

(5) Ensuring efficient use of advanced ICTs
Whether the system is friendly in use relates the development of the system. Practically, it should (1) support any type of content storage, including published books, papers, journals, administrative records; articles, preprints, working papers, technical reports, minutes of meetings, all kinds of electronic documents; data sets, computer programs; visual model, simulation models and other Model; multimedia publications; bibliographic data; images, audio files, video files, digital library collections, a variety of learning objects and HTML web pages etc. (2) with more complete functionality. Registration of digital resources, its description, index, preservation, retrieval, interoperability etc. should be able to complete basic metadata exchange function. (3) comply with relevant standards. Mainly information resource metadata standards, identifier standards, and a series of different levels of technology interface standards. (4) supports OAI-PMH, METS agreement and RSS on institutional repositories in harvesting of metadata resources, aggregating knowledge contents, storing searched results and shared services and support OAI-PMH-based metadata interoperability.

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CIRAD’s contribution to scientific dissemination at institutional, national and international level

Marie-Claude DEBOIN, CIRAD

CIRAD is a French research centre working with developing countries to tackle international agriculture and development issues. Under its mandate, CIRAD acquires and supplies scientific information to its researchers and their peers involved in joint research projects. Keen to ensure the high quality of its research activities and outputs, CIRAD has been making special efforts in: 1) providing its researchers with scientific databases, journals and books (budget 550,000 euros in 2010) through the national Couperin consortium (www.couperin.org/); 2) training its researchers and partners in scientific writing and publishing papers (3,400 publications in 2010) and giving them advice on “Authorship”, “How to correctly write their CIRAD affiliation when publishing”, “Author addenda”; 3) storing researchers’ outputs (grey literature and publications) in the Agritrop database; 4) undertaking bibliographic and bibliometric analyses to support CIRAD’s research strategy and provide the French government with indicators.

In order to disseminate its research results to its partners, CIRAD provides free access to Agritrop on its website (http://agritrop.cirad.fr/) and through the Montpellier Languedoc-Roussillon Open Library access portal (http://www.bomlr.info/). Moreover, CIRAD publications can be searched and displayed by authors, teams, themes, countries, and partners on the CIRAD website (http://publications.cirad.fr/).

For several years, CIRAD, which signed the Berlin Declaration on Open Access to Scientific Knowledge in 2006, has been involved in targeted actions to promote Open Access by: 1) participating in the French repository Hal (http://hal.cirad.fr/), which provides access to a large number of scientific or technical documents; 2) helping its researchers identify Open Access Journals to publish in, or negotiate with publishers the copyrights attached to a paper. To that end, CIRAD guidelines are available on publishing in an Open Access journal, or negotiating an agreement with a commercial book publisher.

CIRAD is now improving its information system to place its research results at a higher national and international level. In 2012, Agritrop will offer: 1) new online processes such as self-archiving by CIRAD authors in Agritrop and Hal, author rights agreements to allow CIRAD, which has private status, to disseminate publications written by its own researchers; 2) new types of documents and new data about peer-review journals, impact factors, funding agency names and grant numbers. These new data will be added to Agrovoc keywords (FAO), Agris/Caris themes (FAO), and CIRAD priority lines of research; 3) international standards for metadata, to export CIRAD publications. Agritrop will be indexed.
by search engines such as Google and Google Scholar, and OAI harvesters. Agritrop will be compliant with the CIRAD maps catalogue and the new CIRAD images database, with other institutional databases such as ProdInra (INRA), and with national repositories such as Hal, and with European projects such as OpenAire (http://www.openaire.eu/ - ERC and EC-FP7). CIRAD would be ready to provide access to its publications through EFARD and the CIARD ring (http://ring.ciard.net/) for knowledge sharing in the area of agricultural research for development. For other types of information (statistics, data tables, experimental methods and materials), there is a growing need being expressed by CIRAD research teams and projects for storage and access to scientific data on dedicated platforms managed at institutional, national or international level.

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Co-learning and co-creation within knowledge exchange platform

Myra Wopereis-Pura and Dady Demby
Forum for Agricultural Research in Africa

Mr. Jean – Jacques Andrianaivo is a farmer leader in Madagascar. He leads a group of farmers from 20 families within 5 villages. His farmer’s group used to worry on how they could sell on time and at good price the vegetables they harvest on a weekly basis. With the use of mobile phone and SMS, they are able to identify buyers, assure quality of their produce and increase income up to 500-2000 USD per week for their vegetables. He realized the benefit of ICT tools in improving his farming and agribusiness. He recently created his own erails website, where he published the various processes their farming community conduct within the growing season. They know their challenges, and that it can be solved if they can get access to timely information and right services from research, agribusiness and extension services.

This is just one story on the growing awareness of the importance of information and knowledge in increasing agriculture productivity in Africa. The African Ministers of Agriculture, Science and Technology realize the necessity to strengthen the community knowledge base and call on all African governments to increase their investments in tools and approaches that can facilitate dissemination and exchange of information and knowledge (April 2011). The report on agribusiness for Africa’s prosperity (2010) showed the case that emerging Africa’s economic leaders are ahead because they invested in research and evidence-based decision making. Few of these countries include South Africa, Tunisia, Egypt and Mauritius. Although most of the African countries still need more solid indices or hard data that can provide reliable trend analysis and other data on technology, knowledge and innovation systems. Some countries have notable number of research publications such Nigeria, South Africa, Egypt, Kenya and Tunisia.

Africa is also noted for the record speed it has absorbed the use of mobile phones. It has spread not just within cities but also at the country side. It is increasingly used for market access by farmers. One of the reasons for this success is the poor telephone infrastructure in Africa. It usually takes several months or years before a telephone landline can be installed if at all possible. Once installed the cost is also unaffordable. Telecentres have grown like
mushrooms in the countryside due to the mobile phone business. Farmers are realizing the potential of information in improving their livelihoods. They are now seeking information not just for prices of farm products but on valuable advice to improve their productivity.

With these trends, are the agriculture research, education and advisory services ready to respond? Unfortunately, most of these institutions have their continuing challenge of infrastructure and resources especially internet access. Their culture of knowledge sharing is also limited. Scientists are still limited in their ability to publish either in scientific journal or through informal communication channels such as internet.

For the past 6 years, the Forum for Agricultural Research in Africa, have been establishing a Pan-African platform that can catalyze and facilitate knowledge exchange for agriculture innovations. Based on the demands of their stakeholders, they’ve a platform was created called the Regional Agricultural Information and learning systems (RAILS). It had 3 main objectives namely; advocate for increased investment in information and learning systems by African governments, strengthen the capacity of Africa’s institutions for knowledge exchange, facilitate learning among national and international partners.

**Approach and methodologies**

To achieve such ambitious objectives, RAILS is not re-inventing the wheel, rather it builds on existing systems, partnerships and institutions. It operates on the concept of co-learning and co-creation at all levels and for all processes undertaken. The basic concept is to empower the people and institutions as the main reason for creating systems and tools. Engagement and initiatives are based on the actual needs of countries stated by national focal points. The RAILS pan-African platform is built and maintained by the national partners. Coordinated plans and actions are critical to achieve results.

In each of the 34 countries involved, national learning teams were established. They have guidelines on how to integrate learning in the process of establishment, planning and operation. The right people and institutions are to be involved. Priority activities are identified with specific timeframe and well defined expected results. Online discussion groups are established at continental and national level. The continental online platform serves as an information exchange gateway to share among the learning teams across the continent their challenges and opportunities related to knowledge management. National online platforms are more focused on operational issues such as project management or simply content management of national portals. Face to face meetings became essential as members get more acquainted with the systems and ownership is achieved.
An information gateway was co-created among the members called eRAILS (www.erails.net). The objective was to facilitate access to consolidated agriculture information not just from research but other agriculture service providers such as farmer’s group, extension, civil society and agribusiness. The eRAILS was developed using a participatory approach. National and subregional partners were engaged in the process of creation using an open source systems. Partners were involved in the conceptualization, testing, maintenance and continuous monitoring. The simplest system was necessary to accommodate the challenges Africa has in internet connectivity and content management. Features and tools are decided based on demands of users and national administrators. Regular assessment is conducted with national administrators and users whenever training is conducted. Each training on use of the eRAILS are prepared through meticulous selection of participants having the skills and potential to share their knowledge after the training. Training is based on actual information available brought by the participants to the training centres.

Despite the huge allocation of investments to build national infrastructure for internet access, the establishment was limited due to availability of the right equipment at the local level and ease of donor’s procurement procedure. National partners were provided with desktop computers, netbooks, printers and internet connectivity.

**Moving forward**

Despite the enthusiasm of African leaders to a real African ownership, there are major challenges faced in establishing the RAILS platform, namely, i) finding the right people with the basic skills and resources (mainly time) given the right mandate, ii) limited knowledge of group dynamics and culture of knowledge sharing, and iii) poor infrastructure and organized information that can be easily shared and iv) lack of supporting institutional and national policies to promote knowledge sharing not least information sharing.

The RAILS national learning teams are established in 80% of the target countries. Leadership and membership is based on endorsement from the national research systems which can sometimes delay the process. Current membership goes beyond research to involve extension, farmer’s groups and agribusiness. Activities and dynamism of teams depends on the ability of national focal to lead and understand group dynamics. It is observed that leaders with the knowledge management background are faster in engaging different stakeholders and implementation of activities. The potential of the RAILS platform is immediately identified as an added value to ensure research relevance to development agenda. While leaders, with more scientific background hesitate on the kind of information to be published and the categories of members to be engaged. They insist on information quality control and strict process of account management and uploading information.
The online group discussions are useful in motivating national teams, especially when progress of one country is shared within the platform. Small steps are encouraged especially in the area of content management. Opening an eRAILS account is easy, but publishing interesting information or articles becomes a challenge. Small news on how one country is progressing keeps the other motivated to innovate. A period of lax quality control was needed to encourage members to develop their skills and instincts to publish online.

Despite the co-creation of eRAILS by RAILS members, its added value was hard to be understood. National partners found it difficult to distinguish the purpose of having the institutional websites against the eRAILS sites or accounts. It was later appreciated that eRAILS serves as a faster way of communicating agriculture innovations by individuals or local communities. The Madagascar innovativeness in the use of eRAILS resulted to farmers being trained to open and maintain an account. Through his eRAILS account, Mr. Andrianaivo is able to communicate outside his country. He is considered as a model farmer-leader within the broader FARA network. He is currently identified as a lead speaker in the upcoming international conference on advisory services. His network has expanded beyond his village and country.

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Communicating Agricultural Science and Technology Indicators: Lessons Learned

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Abstract

This paper discusses the strategy of the Agricultural Science and Technology Indicators (ASTI) initiative toward communicating agricultural S&T information and trends at global, regional, and national levels. To understand the contribution of agricultural S&T to agricultural growth, quantitative information is fundamental. Indicators derived from such information allow the performance, inputs, and outcomes of agricultural S&T systems to be measured, monitored, and benchmarked. These indicators assist S&T stakeholders in formulating policy, setting priorities, and undertaking strategic planning, monitoring, and evaluation. One of the few sources of information on agricultural S&T statistics in low and middle income countries is the Agricultural Science and Technology Indicators (ASTI) initiative. Since 2001, ASTI has been active in compiling, analyzing, and publicizing data on institutional developments, investments, and capacity trends in agricultural S&T in low- and middle income countries worldwide. ASTI is generally recognized as the most authoritative source of information on the structure, financing, and capacity of agricultural S&T worldwide, and its outputs have been widely cited in international agricultural research policy documents. Based on lessons learned since the inception of the ASTI initiative, a number of approaches have been developed to enhance the dissemination and usage of ASTI outputs, including the formation of strong partnerships, the tailoring of information to different stakeholders, and the creation of an interactive data tool on the ASTI website.

Résumé

Cet article discute de la stratégie des Indicateurs relatifs aux Sciences et Technologies Agricoles (ASTI) pour communiquer l'information agricole scientifique et techniques (S&T) ainsi que des tendances au niveau mondial, régional et national. Pour comprendre la contribution des S&T agricoles à la croissance agricole, les informations quantitatives sont fondamentales. Les indicateurs dérivés d'une telle information permettent l'exécution, les entrées et les résultats des informations S & T agricoles destinées à être mesurées, surveillées et évaluées. Ces indicateurs aident les intervenants en S&T à
formuler des politiques, établir des priorités et entreprendre la planification stratégique, le suivi et l'évaluation. L'ASTI est une des rares sources d'information en statistiques S & T sur les produits agricoles dans les pays à revenus faibles et intermédiaires. Depuis 2001, l'ASTI a été actif dans la collecte, l'analyse et la publication des données sur l'évolution institutionnelle, les investissements et l'évolution des capacités en S & T agricoles, dans le monde entier, pour les pays à revenus faibles ou intermédiaires. L'ASTI est généralement reconnu comme la source d'information qui fait autorité sur les structures, les financements et les capacités des S & T agricoles dans le monde entier ; ses résultats ont été largement cités dans les documents internationaux de politique de recherche agronomique. Sur la base des leçons apprises depuis le début de l'initiative ASTI, un certain nombre d'approches ont été développées pour améliorer la diffusion et l'utilisation des données de l'ASTI ; elles comprennent la formation de partenariats solides, l'adaptation de l'information aux différentes parties prenantes et la création d'instruments de données interactifs sur le site Internet de l'ASTI.

Resumen

Este artículo trata la estrategia de la iniciativa Indicadores de Ciencia y Tecnología Agrícola (ASTI, su sigla en inglés) para comunicar información y tendencias de ciencia y tecnología (C&T) agrícola a nivel mundial, regional y nacional. La información cuantitativa es fundamental para comprender la contribución de la C&T agrícola al crecimiento agrícola. Los indicadores derivados de tal información permiten medir, hacer seguimiento y comparar con la competencia el desempeño, los insumos y los productos de los sistemas de C&T agrícola. Estos indicadores ayudan a los interesados directos en C&T a formular políticas, establecer prioridades y abordar la planificación, el seguimiento y la evaluación de manera estratégica. La iniciativa ASTI es una de las pocas fuentes de información sobre estadísticas de C&T agrícola en países de bajos y medianos ingresos. Desde el año 2001, la ASTI ha sido activa en compilar, analizar y divulgar datos sobre desarrollos institucionales, inversiones y tendencias de capacidad en C&T agrícola en los países de bajos y medianos ingresos a nivel mundial. La ASTI es reconocida, en general, como la fuente de información más fehaciente sobre estructura, financiamiento y capacidad de C&T agrícola en todo el mundo, y sus resultados han sido ampliamente citados en documentos de políticas de investigación agrícola internacional. Con base en las lecciones aprendidas desde el inicio de la iniciativa ASTI, se han desarrollado varios enfoques para mejorar la difusión y el uso de los productos de ASTI, incluyendo la formación de alianzas sólidas, la adaptación de información a diferentes interesados directos y la creación de una herramienta interactiva de datos en el sitio Web de ASTI.
Introduction

One of the few sources of information on agricultural science and technology (S&T) statistics in low- and middle-income countries is the Agricultural Science and Technology Indicators (ASTI) initiative. Since 2001, ASTI, facilitated by the International Food Policy Research Institute (IFPRI) has been active in compiling, analyzing, and publicizing data on institutional developments, investments, and capacity trends in agricultural S&T in low- and middle income countries worldwide. ASTI has published sets of country briefs and regional synthesis reports that have been widely and frequently cited in both national and international agricultural research policy documents. ASTI outputs describe trends (progress of human and financial capacity in agricultural research over time) and comparative information (performance of a country or region compared to others). The initiative entails a large amount of original and on-going survey work focused on developing countries, but also maintains access to relevant data for developed countries. In addition to providing statistics, ASTI is also a comprehensive source of qualitative information relating to the history of national agricultural R&D systems, changes in institutional setups, and constraints faced by agencies and researchers in undertaking agricultural R&D. Data collection, analysis, and dissemination are conducted through a network of national, regional, and international agricultural R&D agencies.

Based on lessons learned since the inception of the ASTI initiative, a number of approaches have been developed to enhance the dissemination and usage of ASTI outputs, including the formation of strong partnerships, the tailoring of information to different stakeholders, and the creation of an interactive data tool on the ASTI website. This paper will discuss ASTI’s strategy toward communicating agricultural S&T information and trends at global, regional, and national levels.

ASTI Data in the Context of Agricultural S&T Policy

In recent years, there has been increased emphasis on the critical role of S&T in promoting economic growth, food security and poverty alleviation in the developing world, particularly in the field of agriculture. Well-funded and staffed agricultural research systems and new and better-targeted technologies are important prerequisites for successful innovations in agriculture. Unfortunately, investments in agricultural research and development (R&D) in many developing countries have stagnated over time, despite the fact that numerous studies have repeatedly linked agricultural productivity improvements with increased investments in agricultural R&D. Moreover, agricultural R&D systems in many countries have become increasingly complex with new organizational structures to manage and allocate public funding, increased participation of the higher-education and private sectors, and diversification in funding sources. Finally, there has been an increasing diversity in the structure, investment trends, and functioning of agricultural R&D systems across countries and regions (Pardey et al., 2006).

Data on the size, scope and institutional changes of agricultural research agencies informs understanding of the contribution of agricultural S&T in promoting agricultural growth. Indicators based on such quantitative information assist in measuring, monitoring, and benchmarking the performance, inputs, and outcomes
of agricultural S&T systems (Spielman and Birner, 2008). Institutional capacity and methods of collecting national S&T indicators have been developed by industrialized countries in the past few decades, mostly as a result of the advocacy efforts by the Organisation for Economic Co-operation and Development (OECD) and the United Nations Educational, Scientific and Cultural Organization (UNESCO). However, national S&T indicators, agriculturally related indicators in particular, are still scarce in developing countries, except for some Latin American and Asian countries that have developed their own national S&T indicator capacity and databases. South Africa is the only country in Sub-Saharan Africa that produces national S&T indicators, although the New Partnership for Africa’s Development (NEPAD) has recently initiated the African Science, Technology and Innovation Indicators Initiative (ASTII) program aimed to build capacity to develop African S&T indicators. Although these national S&T indicators include the agricultural sector, no suitable provisions are available to extract a full set of agricultural S&T indicators that encompass all activities in the agricultural sector.

ASTI fulfils a unique role in providing the information needed for understanding the current status and direction of national agricultural research systems in developing countries. In a framework of policy change, these types of information provide a foundation for developing policy options (Traxler, 2008). However, data and statistics need to be developed as part of a system that ensures accessibility of the information as well as the capacity to collect and use the data. In the policy cycle, policy analysis takes that information a step further by advancing understanding of and weighing of policy options. Data and policy analysis can provide the basis for advocacy of these policy options (see also Tijssen and Hollanders, 2006; NEPAD, 2007). At this stage, communication is most important to strengthen the links between networks of policy researchers and policymakers. Data, statistics, and analysis can also inform the policy implementation and monitoring and evaluation stages of the policy change cycle by providing a baseline with which to measure performance. The final outcomes and evaluation of the policy change then inform the next round of priority-setting, which can influence the development of future data collection and policy analysis.

Communicating ASTI

ASTI information is provided at the global, regional, and national levels, meaning that it can be applied to a wide range of agricultural policy issues and is used by a diverse set of stakeholders. Communication of such information can therefore be a challenge. After almost a decade of operation, a number of insights have been gained into how to communicate ASTI information more clearly and reach a wider audience. In the following sections, we review the main components of ASTI’s communication strategy and experiences in implementing communication activities.

What to communicate?
The ASTI datasets and reports feature a wide range of indicators and time-series data across countries, regions, and at the global level, including:

- Levels and trends in agricultural research investments
- Levels and trends in agricultural research capacity
- Developments in the institutional arrangements surrounding agricultural research
- Agricultural R&D funding levels and donors
- Degree levels of agricultural research capacity
- Proportion and degree levels of women participating in agricultural research
- Proportion of research capacity allocated to crop, livestock, and other agricultural areas

**Target Groups**
ASTI has a large set of stakeholders at the national, regional, and international level including:
- National agricultural research agencies and policymakers in developing countries
- Regional and sub-regional agricultural research organizations such as the Asia Pacific Association of Agricultural Research Institutions (APAARI), the Association for Strengthening Agricultural Research in Eastern and Central Africa (ASARECA), West and Central African Council for Agricultural Research and Development (CORAF/WECARD), the Forum for Agricultural Research in Africa (FARA), and the Forum for the Americas on Agricultural Research and Technology Development (FORAGRO)
- Multilateral organizations such as the World Bank, InterAmerican Development Bank, the African Development Bank, the Asia Development Bank, OECD, UNESCO, Food and Agriculture Organization, and other UN organizations
- Donor organizations involved in funding agricultural R&D in developing countries
- International agricultural research consortiums and forums such as the Consultative Group on International Agricultural Research (CGIAR), including its 15 International Agricultural Research Centers, and the Global Forum on Agricultural Research (GFAR)

Since its inception, ASTI’s audience has not changed significantly. Some users draw on only a portion of ASTI’s outputs (e.g. specific gender data or R&D spending totals for a specific country or region), while others use the indicators more intensively to analyze the institutional structure, funding, or impact of agricultural R&D in a particular country or region. Generally, ASTI information has been more likely used by its international and regional audience. When cited or used for analysis, ASTI data has usually been presented at the aggregated global and regional levels. The initiative’s primary methods of disseminating data and information through its website and publications have been more likely to reach these types of stakeholders. In comparison, ASTI has been less successful reaching national level stakeholders. One of the biggest communication challenges for the initiative has been in trying to enhance the relevance of its information for national policymakers and R&D managers.

**Vehicles and Channels of Communication**
Each group of stakeholders has different needs and the use of ASTI information might differ widely from one stakeholder group to the next. Because of this diversity of stakeholder groups, a clear approach as to how to reach each group needed to be defined. For certain stakeholders, the traditional ASTI outputs, which have included country briefs/fact sheets, regional reports, presentations, and other publications, would suffice. Other stakeholders, however, might require custom-made publications and presentations and special events that would focus on issues most relevant to them. In Table 1, we present these audiences and vehicles that have been identified to reach them.

Table 1: ASTI Audiences and Vehicles of Communication

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<tr>
<th>Audience</th>
<th>Vehicle(s)</th>
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<tbody>
<tr>
<td><strong>National</strong></td>
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| National policymakers and advisors | • Concise publications for quick outreach  
• High-level events for visibility  
• Interviews and mentions in local media  
• Newsletter announcements |
| Policy stakeholders and researchers at national research agencies, universities, NGOs, and producer organizations | • Publications with national focus including training documents and manuals targeted to local needs and issues, in local language if possible  
• Workshops, training events  
• Website: Datasets, tools, online instructions, contact information |
| General public | • Local media interviews, press releases |
| **Regional** | |
| Regional and sub-regional agricultural research organizations (e.g., APAARI, ASARECA, CORAF, FARA, FORAGRO) | • Publications with regional or sub-regional relevance  
• Events with collaborators and other stakeholders for visibility  
• Website: Success stories, access to research and to researchers’ bios, etc.  
• Newsletter announcements |
Table 1: ASTI Audiences and Vehicles of Communication (cont’d)

**Global**

<table>
<thead>
<tr>
<th>Audience</th>
<th>Vehicles of Communication</th>
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| International policymakers, advisors, and donors to agricultural S&T | • Publications: Concise publications for quick outreach, research reports of results  
• High-level events for visibility  
• Website: Success stories, publications available online, access to researchers and program managers (bios, publication lists, etc.)  
• Interviews and mentions in local media  
• Newsletter announcements |
| Universities, NGOs, and multilateral and bilateral organizations | • Publications  
• Website: Interactive data tool to allow for easy access to data  
• Events, workshops with collaborators and other stakeholders for visibility  
• Publicize research, reports, success stories, events on various web platforms  
• Newsletter announcements |
| UNESCO Institute for Statistics, OECD, and other S&T indicator developers | • Engagement in S&T indicator methodology and data collection procedures |
| General public | • Publications: Summaries of reports  
• Website and other web platforms: Publicize research, reports, success stories, events  
• International media: interviews, editorials, press releases |

We will focus on three of the major vehicles for communication of ASTI data and analyses: publications, datasets, and website. These three elements have been in place since the beginning of the ASTI project. However, over time, they have been modified to more effectively reach the target groups.

**Publications**

Publications have always been a primary means of transmitting analyses of agricultural S&T indicators. A typical ASTI publication is the country brief, which provides those stakeholders interested in a particular country with an overview of trends of national agricultural research agencies over time. Other reports present regional and global analyses of agricultural R&D investments. For the second round of ASTI surveys, rather than repeating the information found in the original brief, the new briefs were shortened and focused more on trends occurring since the last survey. Although the longer in-depth reports are of interest to researchers, the more concise, to-the-point briefs have been found to be most useful for policy stakeholders who are concerned with having the most recent data available. The most recently designed briefs will have hyperlinks to more data analysis available on the website, to make additional information easier to find. These briefs and factsheets are then followed by reports with more
in-depth analyses of the trends underlying key ASTI data, at the global and regional levels, and also at the national levels for select countries.

Datasets
Datasets are usually most relevant to researchers conducting analyses on global, regional, or comparative country trends. The ASTI datasets include data on numbers of agricultural scientists and total investments in agricultural research by the government, higher education, and nonprofit sectors of developing countries; yearly short-term data on numbers of scientists by degree status and gender, support staff numbers, funding sources, categories of spending, and research focus by agricultural subsector and by crop and livestock item. The choice of data to include within the dataset, the way it is presented, and its accessibility are all factors that affect the usefulness of the data to stakeholders.

When ASTI first began and web technology was more limited, data was simply presented on the website as a table. Next, an interface was developed that allowed users to download the specific data they needed in a spreadsheet format. Last year, an interactive data tool was launched that allows the data to be presented in different ways based on user-selected indicators and formats. The tool presents mapping and graph features that offer greater capabilities for analysis by users. The full datasets are, of course, still available to download as spreadsheets. Additional datasets will be made available through hyperlinks in the country fact sheets.

Website
The ASTI website currently provides access to ASTI datasets and other outputs. Based on survey feedback by users, it was recently redesigned and expanded to make it more user friendly and readily accessible to all stakeholders. The interactive website allows users to

- Map, view, and compare agricultural S&T data from over 60 low and middle income countries
- Download and export national, regional, and global investment and capacity time series datasets
- Access the ASTI Website Directory, which provides links to a large and growing number of agricultural R&D agencies worldwide
- Develop country web pages that provide links to all relevant ASTI publications, datasets, and other ASTI information; the country pages will also provide links to non-ASTI datasets and relevant information on agricultural and food R&D for the specific country
- Download national, regional, and global ASTI publications

Given that internet connectivity is still difficult in many developing countries, improving the use of ASTI outputs at the national level requires additional efforts at outreach. Raising awareness of the initiative through national forums and media, and building capacity to use agricultural S&T indicators, whether for research, advocacy, or policymaking, are all key components of establishing a national presence. ASTI has always developed national partnerships in the collection of its data, usually working with the country’s main government agricultural research agency. However, dissemination of the information collected usually does not spread far beyond that agency.
Next Steps for the Communication Agenda

ASTI’s communication activities have evolved with these lessons learned in mind:

- It cannot be assumed that data is used simply because it is available. Data providers must take the next step of communicating the data to stakeholders.
- Communication should not be one-way only. Encouraging feedback and input from stakeholders improves the quality and use of the data.
- Working with national and regional partners is essential in data collection and dissemination. These partnerships help to improve the quality of the data provided and build capacity for both supply and demand of the data.
- Data should be tailored and presented in various formats and venues to target different stakeholders.
- Resources and time must be allocated to developing and thinking through data communication activities from the very beginning. Communication should not be an afterthought.

The ASTI initiative has sought to increase the usage of its datasets for analytical purposes at the national, regional, and international levels. In addition, increasing the role of its materials in advocacy and priority setting activities by others requires a different mode of interaction than the initiative has used in the past. Going forward, it has identified these next steps for its communication agenda:

- Develop regional, sub-regional links/partnerships to enable a decentralized data collection system with a stronger ownership by national and regional partners. This decentralized system could be initiated in close partnerships with FARA, APAARI and other regional organizations, and CGIAR centers. These partnerships are also critical to support dialogue on agricultural S&T policy.
- Develop capacity building activities through the establishment and maintenance of a clear set of standards and definitions that will be shared with national and regional partners in order to improve the usage and understanding of ASTI data.
- Improve visibility and usage of the ASTI outputs by expanding the available datasets on the ASTI website, targeting publications and events for different stakeholders, and presenting research agenda and results at upcoming international and regional conferences.
- Sponsor more in-depth studies of agricultural S&T indicators that analyze the underlying trends and issues related to agricultural research capacity and investments.
- Establish internal analytical capacity to improve the use, understanding, and expansion of ASTI data collection and address S&T policy questions critical to the development of effective national agricultural research systems.

Conclusion
To be useful as input for the development of policy options and priority setting, data and data analyses must be actively communicated to the policy holders. Data collection and dissemination should also be informed by the needs of the policy stakeholders. With an increasing gap in agricultural S&T capacity and investment in developing countries, the need for more attention to agricultural S&T policy is clear. The ASTI initiative has recognized that its function as a data source requires a greater focus on communication to reach those audiences that are informing and setting agricultural S&T policy. As a result, ASTI has expanded its communication activities in a number of ways in an effort to improve its policy relevance.
References

**Article**


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In an ideal world all data would be produced using open formats and would be linked directly to other related data on the web. This would give the possibility for service providers to set up information systems by mixing and matching data from different distributed repositories. A scenario like this is no science fiction. Methodologies, Standards and Technology exist to achieve a big part of this. Nevertheless most data (of all kindes) resides in database and repository silos and all efforts to create one stop access to distributed data lack functionalities, robustness or sustainability.

The reasons for this are twice:

a) Institutional inertia and the unwillingness to invest in making data sharable and interoperable not understanding the immediate value of this for the contributing institution

b) The lack of explicit standards, written down methodologies, robust tools and a pragmatic approach to achieve interoperability. In areas (like GIS) where these problems have been resolved, remarkable successes have been achieved

The AIMS team at FAO has concentrated it’s efforts for years on providing some semantic standards to facilitate cooperation and data exchange. These semantic standards have gotten their place in the community, but we did not achieve what we wanted to achieve. We now think that we have to work on all elements of an infrastructure that enables data sharing within our community. We will work in the next years on all levels of the 5 star program outlined by Tim Berners Lee and cited during the e-Consultation. Getting to the “5 star” situation is not an effortless job. I am convinced that there will be very few “5 star” data providers for quite some. We have to work for “5 star” services taking this into account. The landscape will stay heterogeneous for many years. We need to create elements for an architecture framework that will make it easier to create these “5 star” services.

Awareness and Capacity: a clear commitment to open access for data and publications from all partners is necessary. Managers, researchers and information managers must understand that sharing will enhance our capacity to create knowledge for agricultural development.

They also must understand the instruments that have been created by international standard bodies to achieve this.

A global exchange platform – the RING: We need a one stop access to existing services from the community. The RING, which is now a registry has to become a route-map from which data streams can be taken automatically and rechanneled into new services and into which all community members channel their data streams.
**Tools and services for data processing and storing:** We cannot be software agnostic. Some tools are good for making data interoperable some less. But not all partners in CIARD have the same requirements and possibilities. We need a suite of tools and services to process and store data. We need tools that can be installed and used on institutional levels. We need services on community/national/regional/global levels that can be used by institutions to process and store their data.

**Common reference vocabularies.** Data will not be interoperable without declared semantics and common metadata and value vocabularies. In our subject area we have more than 5 precious thesauri, many glossaries and other vocabularies. They need not only to be mapped and linked. They need to be made available easily for the community to use them for the mark up of their data. This process needs to be automated and to be integrated in all tools that we are using. Open Calais is giving a taste of what is needed.

**Wrappers to mobilize data out of silos:** Most data repositories will stay in their proprietary structure and format for a long time. This is not a bad thing. Many of these systems have been created to optimize data processing. The data only needs a stream out to mix match with other systems. Such transformation is possible. In this way we can produce “triple stores” of RDF data that interlink distributed information sources and make them accessible from aggregations sides or specialized services. Registration at the RING should trigger the process of creating the wrapper.

**Cloud Storage:** It would be good to have some places on the net where there is sustainable and affordable storage for services within the CIARD community. It would be waste of effort to replicate some types of infrastructures 1000s of times. In a globalized and interlinked world infrastructures can be limited to what is technically and institutionally necessary

**Interfaces to distributed triple stores:** data not only need to be produced, but also consumed. For the consumption of data you need interfaces through which these data can be channeled into applications. The CIARD partners should produce a library of such interfaces with inbuilt data selectors. queries, rankings and rendering mechanisms, documented and accessible on the RING

This is a program, which can be implemented gradually. We are offering already now the vocabulary server with AGROVOC as a core. We can make AGRIS a pilot service that exploits all the elements that we want to produce for an interoperability infrastructure. We are happy that we succeeded in getting some funding from the European commission through the agInfra project for this enterprise.

We think that this picture can be presented in a convincing way to other donors. But basis for this is a community of practice that close collaborate on common goals.
Crop Germplasm Resources (CGR) Information

Sharing in China

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Crop Germplasm Resources (CGR), the foundation of food and crop improvement, are most valuable resources for China. Now, there are more than 180 kinds of crops, over 450,000 accessions of CGR kept safely in National Crop Genebank (NGB) and other genebanks distributed all over China. Those CGR information has been managed and shared in Chinese Crop Germplasm Resources Information System (CGRIS) run by Institute of Crop Science (ICS), CAAS.

As the base of CGRIS, a national CGR data collaboration network was set up which involved 2,600 scientists and technical personnel from over 400 agricultural institutes. The data network consists of a national information center (in ICS), 20 sub-centers, 50 first class data source institutes and 400 second class data source institutes. The CGR databases of CGRIS have been established under a series of unified descriptors and data standards, 200 GB data in total.

The databases (sub-system) include:
1. Passport data
2. Characterization and evaluation
3. Images
4. Distribution and utilization
5. Germplasm introduction
6. Germplasm exchange
7. Regeneration
8. Viability monitoring
9. Genebanks management
10. Atlas and GIS

Most of the CGR data can be shared in CGRIS on the internet. The CGRIS website (http://www.cgris.net) is public and available to anyone, anywhere on the internet. Users can easily use the web query tools to search the database for the germplasm they want. All data in CGRIS are free of charge. The unified information systems with the same interface and data architecture were developed which have been deployed in different institutes, so the data can be easily transferred and exchanged among the systems and eventually gathered in the central databases of CGRIS.
The barriers in CGR information sharing and exchange:
1. Language. The data in the database are almost just in Chinese even the descriptors and standards.
2. Standards. Some international standards, such as IPGRI’s and GRIN’s, were considered when our standards have been made, but there are still many differences.
3. Policies. The national CGR policies strictly limit the CGR exchange and exportation, because about 81% CGR in China are indigenous. But in data sharing and exchange, there’s no very explicit policy to follow. To avoid the policy and legal risk, it should be very careful to carry out the data sharing and exchange.

Here’re some CGR data case study descriptions:
1. The CGR passport data, a catalog of all CGR with basic information.
   Data type: Relational data
   Subject scope: CGR preservation, crop diversity, new varieties breeding
   Amount: 0.2GB
   Ownership: ICS, CAAS, free access to all
   Technical info: Follow the CGR descriptors and standards, sql sever/excel/dbf
2. The CGR characterization and evaluation data, a very specific description of observation about every CGR.
   Data type: Relational data
   Subject scope: CGR preservation, crop diversity, new varieties breeding
   Amount: 2GB
   Ownership: ICS, CAAS, free access to all
   Technical info: Follow the CGR descriptors and standards, sql sever/excel/dbf
3. The CGR images data, images representing the diversity of CGR
   Data type: Image
   Subject scope: CGR preservation, crop diversity
   Amount: 180GB
   Ownership: ICS, CAAS, free access to all
   Technical info: jpg format in file system.

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Comments for the framework development of Agricultural information sharing

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More people has realized that the necessity to Build the CIARD Framework for Data and Information Sharing. With the ICT and network development, information generation and disseminate become rapidly and globally. In order to accelerate agricultural development, more agricultural information need to be accessible and sharable.

As a member of China Academic Library and Information System(CALIS), what we have done is on the way to information sharing among China higher educational institutes. CALIS has national and provincial level of information centers throughout the country. There are four national information centers, The National Agricultural information Center(AIC)is one of them and is located in China Agricultural university Library. AIC now has the member of over 35 agricultural academic libraries. In the past, each library has their own collections and serve mainly to their own clients. Now we begin to integrate every library’s collection together to form an agricultural union catalogue, the others like dissertation database, agricultural professional information databases as well as agricultural rare book database and so on. All these integrated information can be searched through AIC homepage. AIC also provides interlibrary loan and document delivery to all agricultural university clients to make full use of the information. What AIC integrated information is also the part of CALIS and for non-agricultural university clients, too. CALIS provides academic information to academic users and runs well under the Ministry of Education.

My comments for Building the CIARD Framework for Data and Information Sharing is firstly to be clear of our objects: to share agricultural information or data; to solve agricultural problem worldwide; to expand knowledge exchange and generation; to improve agricultural information utilization quickly and efficiently; to promote agricultural research results; to increase of agricultural productivity and to effectively use of information for agricultural marketing.

Secondly we need to understand who will benefit from the program. There
are not only university faculty, student and researchers like CALIS, but also agricultural researchers, government leaders, business people and farmers as well, the clients are real diversified. There are also different contributors, like international organizations, universities, research institutions and individuals from different countries with different information resources, it is important to set up an organizational framework according to countries, regions or institutions and understand how many members registered for this program.

Thirdly, There are a lot of information or data already accessible, like bibliographic information in every institutions, we may integrate them easily according to what we need. Agriculture is very much on the climate and geography, different country may has their own featured agricultural products, farming system, local agricultural statistics, traditional or modern farming techniques for saving some problems, to share all of information above must rely on the country who can provide them. So we need to understand who will be responsible for providing certain information.

Fourthly, we need to concern about ICT environment, not all of the countries are equal in development for the basic information infrastructure, especially in the countrside of developing countries, but in some area mobile devices are even popular used.

Fifthly, some national or international standards, policies and action plan may be drawn up for information resource sharing.

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Data Information Sharing in Ministry of Agriculture and Rural Development – Vietnam

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I. Introduction

In recent years Information sharing’s Ministry of Agriculture and Rural Development has been directed to make a more drastic way, many decisions on implementation were issued as Decision 132/QD-VP 25 February 2008 provisions on the functions of the Standing Office and Decision dated 2 February 2008, the decision 1640/QD-BNN-VP promulgate regulations on implementation of information sharing tasks of the Ministry of Agriculture and Rural development, network officials in charge part time in information sharing units. This decision as a basis for "internal legal" to perform the task to advise the Ministry leadership and leaders of the organization and management unit implemented information sharing program. Application of information technology in state management of the Ministry of Agriculture and Rural Development has recently developed a positive step. The use of information technology and communications to enhance the capacity of executive management, communications more efficiently.

II. Objective

Promote IT application in the activities of the Ministry of Agriculture and Rural Development, in association with the process of administrative reform to improve effectiveness and efficiency of state management on agriculture and rural development.

III. Results

Information sharing has contributed to pushing up the application of IT development to serve the direction, management and administration of the Ministry to increase operational efficiency, reduce paperwork, reduce processing time jobs, contributing to the public, transparency of the activities targeted toward e-government.

1. The activities were developed on information technology

IT applications in this very diverse, many of which application service management software as the management go and come document, archives, research management, office management (eOffice), management of plant and
animal varieties, ... Besides that there are many applications for research, production, such as software for professional work in the field of irrigation, forestry, fisheries, agriculture industry

Implementing Electronic Government at the Ministry of Agriculture and Rural Development has programs to increase awareness of e-government as Direction number 58, Project number 30, Project number 112 and 95

Minister issued Directive No. 1913/CT-BNN-KHCN on 8 January 2006 on the implementation plan for the development of e-government at the Ministry until 2010. Over time has made a step raise awareness about the role of information technology, Internet, E-mail, computer networks and information, the computerization of state management, direction and administration, e-government, e-commerce, building the information society and knowledge economy ...

2. Activities to direct organize and manage information technology

Steering Committee for Information Technology of the Ministry of Agriculture and Rural Development was established in Decision No. 357 NN-TCCB / QD Decision dated 28 March 1996. And Vice Minister is head of steering committee.

Strategic application of information technology for state management of MARD period 2001 - 2010 is a step by step strategy to implement e-government at the Ministry of Agriculture and Rural Development.

Project number 112 is building some projects on the application of information technology for the field of animal health, irrigation and some other areas.

Information systems via electronic mail, to build a system of information technology staff of the unit-oriented training of the assistant heads of the units to help organizations develop information technology applications in management and direction.

The information technology projects with content such as building websites, build databases and integrate data center and application networking services through ... are practical activities to for administrative reform.

Have built the database on the market prices of agricultural and forest products, agriculture, providing farmers through the activities of state agencies, Farmers, agricultural extension stations commune and district levels

3. Application of information technology in the operation, management, information and public services.

Many IT applications are implemented to serve the research and serve people and businesses. Notably information systems and agricultural markets, this system collects and updates the market price of water daily in 20 provinces and 100 districts. Most sites of research institutes, extension unit has published several varieties introduced, new breeding animal and new farming methods as well as the recommendations for agricultural production.
System of internal information network has been operating effectively serve the administration of the Ministry.

Software management and operation of programs for document management, closely monitor the handling of the documents assigned to each unit, allowing the inspection and direction of the urge to be in time units contribute to minimizing missed work.

Software to manage telephone directory has updated all of the numbers of units of the Ministry.

Software to manage all the guests out into the ministry, the software managing meeting rooms and conference registration process of the unit at the Ministry.

Software briefing weekly, monthly and periodic reports, as leadership tools for assigning and tracking the results of the processing unit after the meeting the week of the month.

The Administration unit manages the site www.omard.gov.vn since May 2000 has been providing information for administrative and executive direction for the whole sector.

Home address information is www.agroviet.gov.vn AgroViet was founded on June 11/2001 provides trade promotion information in market prices for trade promotion program of the Ministry, the activities of Information Center (now the Centre for Information and Statistics) and a number of agencies within the Ministry.

Many units of the Ministry also has its own website as the Department of International Cooperation, Science and Technology, Department of Forest, Forestry Department, Department of Crop Production, Animal Husbandry Department, Department of Agro-Forestry Product Processing and Salt Industry, Irrigation Science Institute, Forest Inventory and Planning Institute, Institute of Animal Husbandry ... Many sites are registered at the server's Office, the Centre for Information and Statistics...

Research Institutes, universities and technical schools and vocational training ... site built units to introduce the operation of the unit, the industry and exchange information with partners at home and abroad.

Deployment of public services online is one of the targets of the Ministry of Agriculture and Rural Development as well as other units of the Ministry. The Ministry has now deployed the service of level 2 and level 3 in Department of Farming and the Quality Control Department of Agriculture and Forestry Products and salt.

Some units were initially deployed over the network services efficiently: Information on the documents by the receiving and distribution, and statistical analysis of market information, registration system, granting permit...

TV conference system online system operating on high-speed fiber optic cable. The system can connect to the bridges in 63 provinces nationwide with the cooperation of the military corporation Viettel Telecom.
4. Training and development of human resources information technology

The number of staff training to improve the IT Department of rising, but mostly training comes from the source operation of the projects and programs. IT training plans are unclear, often associated with other activities. Funding for training is very limited, content training is monotonous.

Number of staff responsible for IT in each unit is limited, there are units, have no units and are mainly part-time, building the IT development plans of the units is poor. Qualified staff specializing in IT units are few, should not meet the development needs of the unit.

Since 2001 the Ministry established the Faculty of Information Technology at the University of Water Resources, recruit 60-70 students each year to train IT engineers specialized service Resources and Agriculture and Rural Development.

The training class for leaders and experts on information technology office basic level and advanced are held each year. Already more than 1200 participants attend this training.

Employment Standards Administration officials are required to take courses for Information Technology and a number of public servants, other employees should also implement Information Technology have created the class of servants young relative degree of computerization copies.

5. Information Network

Wide area network (LAN and WAN) of the establishment in 1996, now has about 300 workstations.

Have installed a virtual private network (VPN) connecting 38 Department of Agriculture and Rural Development with the Ministry.

Included generation Internet, electronic library system used for network service (750 account) and (200 account).

The transmission network has reached 10 Mbps 384 Kbps leased line, there are 4 ADSL line.

Have CP Net connection and regular activities.

6. International cooperation

The project cooperation have contributed to the development of information technology for the sector as equipped computers, building LANs, website ... Some projects to build information systems management, monitoring ... information technology platform. Special project to support administrative reform component has its own application of information technology to support administrative reform.

IV. Conclusion
1. Advantage:

Has been raising awareness about information technology and improve the level of information technology leaders, officials and public servants at all levels.

Create the infrastructure for information technology is relatively: fiber optic network, VPN, server systems equipped with computers, databases, software for managing administrative and professional...

Initial results of the application are the computerization of state administration.

Initial build a staff of information technology management at the grassroots level, working regulations promulgated interim basis of the IT system.

2. Disadvantage:

The system has been set yet fully stable.

Infrastructure, qualifications of staff is lower than required, particularly at local

The effect of the other projects have drawbacks, not the mechanisms and policies to attract talented people to develop information technology and sustainable enough.

Lack of information technology development to meet the requirements of rural areas.

V. Information technology applications in 2011-2015

Additional Information technology equipment, such as computer servers, storage devices, proceeds to digitize the entire document of its administrative documents.

Making reports and exchange information over the network, limiting the exchange of paper documents. 2015: 80-90% of documents are exchanged over the network.

Upgrade database management administrative procedures in ministries, the addition of new data.

A standard electronic form, put forms online, the mechanism of publicizing information.

Upgrade the websites of the Ministry.

Plan to replace existing software with proprietary software

Develop plans to apply digital signatures to electronic

Construction of the troubleshooting process safety information.

Incorporate the implementation plan for administrative reform plan to apply information technology in the operation of the ministry really work to promote administrative reform and effective.

Perform consistently in all agencies attached to the Ministry of norms and standards on information technology application in the country.
Enhancing skills in applying information technology for staff and public servants. Fostering professional training for officials and public servants in charge of information technology at all levels.

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Advanced Research of sharing of basic feed composition data based on China Feed-DataBase Information Center (CFIC)

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1. Missions of CFIC

China Feed database Information Center (CFIC) was established in 1989, and its upper department is the bureau of animal husbandry of ministry of agriculture of the people’s republic of China. CFIC is running and being managed in Institute of Animal Science (IAS), Chinese Academy of agricultural Sciences (CAAS). The main missions are following:

- to be in charge of routine data collection and network maintenance of CFDB (China Feed-DataBase);
- to constitute and/or perfect related data description criterions for serving as the construction of CFDB;
- to edit and modify home feedstuff’s composition and nutritive values according to the above designed criterions by paper and electrical methods;
- to do some data mining and to establish some equations to predict other nutrients from those known feed compositions;
- to gather those new-arisen feed samples and to assay their nutrient data into CFDB;
- to derive nutrient data of special feedstuff entities from a number of feedstuff sample data in terms of feed material quality grades;
- to issue “Tables of Feed Composition and Nutritive Values in China” once a year;
- to develop some intelligent application products such as different typical ration formulation system for different livestock and poultry;
- to translate some international issued feedstuff composition tables into Chinese and to transfer those special units into international units such as changing pound into kg, Mcal into MJ etc.

2. Objectives of CFIC

Firstly, CFDB has being supplied all-round basic feed and nutrition data sharing for home vast feed industry and animal husbandry to develop all kinds of new feed commodities; Secondly, CFIC has been organizing feedstuff nutritive value assessment for making good use of all kinds of different feedstuff resources and alleviating feedstuff supply pressure and reducing pollution from nutrient emission into environment in order to give basic data support to obtain good quality and safety animal products.
3. Origin of running funds
   - Non-profit projects from the Ministry of Science & Thchnology of China.
   - Condition platform construction projects from the Ministry of Science & Thchnology of China

4. Main advanced researches
4.1 Study on related criterions
   The description criterions on 16 sets Chinese feedstuff types have been constituted based on international feedstuff classing rule and Chinese feedstuff classing rule (Zhang ziyi ,1984 ), and their contents include from sample collecting, storing, sample making and testing to digital expression of attribute data and its network sharing requirements. Fuhermore, original data recorded cards were designed according to suggested data standards. All of the above supplies the most basic but important top programme for the digital description and network issue of feedstuff nutrients attribute data.

4.2 Data integration and sharing
   From the beginning of the year 1990, CFIC issues the composition and nutritive values in China once a year by the official magazine named “China FEED” and own door website www.chinafeeddata.org.cn ( Fig.1 ). Inside the website, it stores about more 1 GB data which includes digital, text and multi-media type data. The sharing of all the above data is free. Some special data orientedl-service to some enterprises needs a little fee in terms of a specific agreement file each other.
By now, we have issued total 21 versions of the feed composition tables. At the same time, we have edited and published some writings and articles that collected recent feedstuff nutrient assessment data and nutrient requirements of different livestock and poultry from home and international, for example, the feeding standards and feedstuff composition tables around world, and the nutritive parameters and feedstuff composition tables on animals (2th version) etc.

4.3 Data mining and information system development (only examples)

Firstly, by using database managing and linear programming optimizing algorithm technologies, CFIC has developed many specific nutrient analysis and diet formulation computation systems for different animals. In the recent, a new dynamic diet formulation software on dairy cattle was designed based on CNCPs (Fox et al., 1992; Lanzas et al., 2007) system and many estimated equations(e.g. Table.1) for nutrient requirements (Fig. 2)
Fig. 2 A intelligent system on dairy cattle diet formulation (a running section)

Table 1 List of the equations for the expanded caohydrate fractions (g/kg DM)

<table>
<thead>
<tr>
<th>Fraction</th>
<th>Description</th>
<th>Equation</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHO</td>
<td>Total carbohydrates</td>
<td>1000-CPj-EEj-Ashj</td>
</tr>
<tr>
<td>CC</td>
<td>Indigestible fiber</td>
<td>NDFj×Lignin×2.4/1000</td>
</tr>
<tr>
<td>CB3</td>
<td>Digestible fiber</td>
<td>NDFj-(NDFCPj×CPj)/1000-CCj</td>
</tr>
<tr>
<td>NFC</td>
<td>Non-fiber carbohydrate</td>
<td>CHOj-CB3j-CCj</td>
</tr>
<tr>
<td>CA1</td>
<td>Volatile fatty acids</td>
<td>Aceticj+propionicj+Butyricj+Isobutyricj</td>
</tr>
<tr>
<td>CA2</td>
<td>Lactic acid</td>
<td>Lacticj</td>
</tr>
<tr>
<td>CA3</td>
<td>Organic acid</td>
<td>Organicsj</td>
</tr>
<tr>
<td>CA4</td>
<td>Sugars</td>
<td>Sugarj</td>
</tr>
<tr>
<td>CB1</td>
<td>Starch</td>
<td>Starchj</td>
</tr>
<tr>
<td>CB2</td>
<td>Soluble fiber</td>
<td>NFCj-CA1j, CA2j, CA3j, CA4j-CB1j</td>
</tr>
</tbody>
</table>

Secondly, with the help of GIS and CFDB data, we developed a mineral content and its analysis GIS on home feedstuff and forages in China. Fig. 3 shows a special subject map.
The third, we have set up a picture-pattern database on home pasture from their origin places and origin habitats. At the same time, we have gained a lots of typical pictures by living sheep anatomy, and all of these has filled the blank in this subject. All of these pictures supply basic source materials for science research and popularization of sciences. Pictures from Fig. 4 to Fig. 6 show some tipical ones.

**Fig. 3** A special GIS Map of distribution of selenium content in Corn in China

**Fig. 4** entity pictures of pulished chaff and Chinese wildrye
Fig. 5  the entire digestive tract structure anatomy graph on sheep

Fig. 6  the cerebrum anatomy graph on sheep

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Agricultural sector in Thailand is not only an economic sector for food production industry but also a fundamental activity that dominate most people’s way of life. Therefore, any development in this area has a significant impact on Thai society as a whole. Thailand’s agricultural sector needs to adopt modern technologies and, at the same time, utilize valuable local knowledge. It has to take into account national food requirements and preserving the environment.

Thai agricultural information comes from a variety of sources: academic institutions, government agencies, the private sector and local communities. However, these sources have not yet shared a common platform. In order to fully leverage these information resources, there was a need for a centralized repository at the national level to link these agricultural information into one integrated system that can serve the needs of the country most efficiently.

National Research Council of Thailand has announced a project of Thailand Research Indexing Hub. Thai e-Government Interoperability Framework (TH e-GIF) was setting up for data exchange standard. Agricultural knowledge repository is developed as one section of the research indexing hub in collaboration with the Thai agricultural research communities, organized by the Thai National AGRIS Centre. Now there are 18 agricultural organization and 44 faculties participate in this community to create a National Agricultural Repository.

Thai National AGRIS Centre has developed Thai Agricultural Knowledge Repository by using an open source software “DSpace” to create a community environment. DSpace is a software for academic, non-profit, and non-commercial organizations to build open digital repositories. An AGROVOC Thesaurus plug-in for AGRIS DSpace, which used for indexing, was developed with the support of the FAO. Data in the Thai WebAGRIS database will be transferred into the repository. There are more than 140,000 records and millions of pages of full articles in digital format. Thousands of agricultural scholarly journal articles and conference papers have already been submitted. And the rights for full text access has been granted through the system. This system has been established by the effort of Thai AGRIS Centre in partnership with other agricultural communities in the country. This repository is regarded as the Agricultural Knowledge Repository for Thailand.

Table 1 Digital sources of agricultural research information of Thai AGRIS Centre
<table>
<thead>
<tr>
<th>Database</th>
<th>Type</th>
<th>Subject</th>
<th>Bib record</th>
<th>Digital object (file)</th>
<th>Standard</th>
<th>System</th>
<th>Owner ship</th>
<th>Authorized for distribute</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thai Agricultural Database</td>
<td>general and research document</td>
<td>agriculture-general</td>
<td>140,000</td>
<td>60,000</td>
<td>AGMES+ Dublin core</td>
<td>WebAGRIS</td>
<td>Author</td>
<td>-</td>
</tr>
<tr>
<td>Thai Agricultural Research Repository</td>
<td>research document</td>
<td>agriculture-general</td>
<td>3,000</td>
<td>3,000</td>
<td>AGMES+ Dublin core</td>
<td>Dspace</td>
<td>Author</td>
<td>Thai AGRIS</td>
</tr>
<tr>
<td>Agricultural Digital Library</td>
<td>eBook</td>
<td>agriculture-general</td>
<td>500</td>
<td>500</td>
<td>AGMES+ Dublin core</td>
<td>Dspace</td>
<td>Author</td>
<td>Thai AGRIS</td>
</tr>
<tr>
<td>Agriculture Library Catalogue</td>
<td>Book catalogue</td>
<td>agriculture-general</td>
<td>2,300</td>
<td>600</td>
<td>US Marc</td>
<td>KOHA</td>
<td>Author</td>
<td>-</td>
</tr>
<tr>
<td>Sugarcane Database</td>
<td>general and research document</td>
<td>cane and sugar</td>
<td>1,700</td>
<td>700</td>
<td>AGMES+ Dublin core</td>
<td>WebAGRIS</td>
<td>Author</td>
<td>Thai AGRIS</td>
</tr>
<tr>
<td>Thai Rice Database</td>
<td>general and research document</td>
<td>rice</td>
<td>6,500</td>
<td>3,000</td>
<td>AGMES+ Dublin core</td>
<td>WebAGRIS</td>
<td>Author</td>
<td>Thai AGRIS</td>
</tr>
<tr>
<td>Heavea Database</td>
<td>general and research document</td>
<td>para rubber</td>
<td>1,600</td>
<td>500</td>
<td>AGMES+ Dublin core</td>
<td>WebAGRIS</td>
<td>Author</td>
<td>Thai AGRIS</td>
</tr>
<tr>
<td>Corn and Sorghum Database</td>
<td>research document</td>
<td>corn and sorghum</td>
<td>950</td>
<td>950</td>
<td>AGMES+ Dublin core</td>
<td>WebAGRIS</td>
<td>Author</td>
<td>Thai AGRIS</td>
</tr>
</tbody>
</table>
Key factors for information sharing

Benefit derived and knowledge boundary expanded
The possibility of bridging the digital divide relies on the relationships among and the benefits derived by the stakeholders. The motivation of involved stakeholders to participate in the Thai AGRIS Centre depends significantly on the benefits these organizations can derive from the system, whereas, encouraging the use of information is the priority obligation of the Centre.

Most of the agricultural information available is research or academe-based and are used by highly educated people well versed in English. Difficulties for the users in rural and remote areas of Thailand still exist. The Thai AGRIS Centre has adapted its content to meet the local needs by developing the Thai agricultural bibliographic database in both the Thai and English languages. A nationwide agricultural bibliography and other related international databases can be searched through Thai AGRIS Information Service System and Thai AGROVOC (Thai agriculture Thesaurus). Thai AGROVOC, in particular, therefore helps expand the knowledge boundaries of Thai agricultural people from the local context to global knowledge. The system helps local researchers and communities in the country access agriculture information worldwide more easily.

Collaboration and Partnerships
The Thai AGRIS Centre’s partnership with agricultural communities in the country is still in its development stage. Well organized and efficient coordinators are necessary, and capable information specialists are most needed.

Collaboration between the Thai AGRIS Centre and AGRIS/FAO has been mutually beneficial. The Centre receives technical assistance and training support from AGRIS/FAO, then provides training in information management to the staff of collaborated agencies. The Thai AGRIS Centre has provided 3 types of training as part of its information services strategy: 1) in-service training of member organization; 2) on-site training organized at the information provider’s workplace per special agreement; and 3) system demonstration at academic conference sites. The main purpose of the Centre is to enhance capacities of the Thai AGRIS Center on data submission and its search ability to tap appropriate sources of information.

Policy approach and Financial sustainability
Policy and financial are considered as the key to success. Information sharing has to be regarded as a routine function in each agricultural information section together with financial support. As the volume of data increases and services are being expanded, more support in terms of resources is required.

The AGRIS Centre considers that the utilization of more information by policy makers or administrators might eventually impact on Thai national agriculture strategy. In fact, the success and failure of existing information networks depends on whether it can render concrete benefit to the policy-maker. In this sense, a closer relationship with policy makers is critical to make them understand the importance and power of information.

Meeting International Standard
The Thai Agricultural Knowledge Repository was built and structured according to accepted international standards and tools, and was adapted to suit national needs
while contributing to global information resources. The repository was developed based on AgMES standard.

The AgMES (Agricultural Metadata Element set) initiative was developed by the Food and Agriculture Organization (FAO) of the United Nations and aims to encompass issues of semantic standards in the domain of agriculture with respect to description, resource discovery, interoperability and data exchange for different types of information resources.

Value creation
Information is worthless if not used. But the same information becomes valuable when needed. Most of the time, the user does not appreciate how much resources and effort are invested on a piece of information. Preparing ready-to-use information for expected users is therefore vital.

Having been a service provider for the past 30 years, the Thai AGRIS Centre learned a lot from its experiences and has successfully adapted to the always changing demands. The Centre’s mindset is now geared towards a more strategic approach to make use of limited resources more efficiently. The improvement of delivery times to meet customer demand and increasing value-added services are ongoing. Reprocessing and synthesizing existing information is another strategy for adding value and creating a new product for the user.

Thai AGRIS Centre intends to document research article and local knowledge, assemble available Thai agriculture information into a comprehensive knowledge base. The Centre is looking forward to collaborative arrangements with its partners as well as farmers’ communities. Such should result in a better information management for farmers and the entire agricultural sector.

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Thai AGROVOC, http://pikul.lib.ku.ac.th/
Agricultural Metadata Element set, http://aims.fao.org/website/AgMES/sub
DSpace, http://www.dspace.org/

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Extension Agents Call for Contributions from the Universities and Institutes

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1. Background and problem

In Guangdong, it takes provincial bureaus more than ten years to develop and operate projects that promote information technology (IT), IT-enabled applications, and IT capacity building for residents in rural and mountainous area. Most counties have developed and maintained their websites particularly for the sector of agriculture, or as a module of the administration portal. One of the important functions of those websites and modules is to facilitate the agricultural knowledge dissemination by extension agents to local residents who are engaged in cultivation and logistics of agro-products.

Normally the knowledge contents appear as pieces of plain text, question-and-answer pairs, or video clips that cover major related topics of agricultural production and are stored in a database, which can be accessed via a computer connected to the Internet, a mobile phone that supports Short Messaging Service (SMS) or a channel of Cable Television (CATV) service. Popular feedbacks from extension agents on limitations of these contents are two folds: many of information are duplicated to those from other website, and the information update is not frequent as expected. An experienced senior staff from Shunde Agricultural Information Center, Foshan, Guangdong province, once mentioned this requirement by saying that if proportion of the local generated agricultural information cannot reach 70% of the total, it is hard to claim the informatization-based agricultural information service is effective.

2. Requirement analysis

Extension service units are normally located in a center of a town or county, the agents undertake the task of providing consulting service that satisfied the particular technical query from the famers, from pesticides and seeds recommendation to answer hunting from the third party such as asking a regional expert who works in a university or an institute. They might be not
knowledgeable enough to disseminate the applicable research achievement to agro-producers in direct, but they are the nearest and trustable resource for help for local resident. Obviously this requires further intelligent contributions from the colleagues from research organizations, who have almost full access to the resources of purchased electronic publication databases and together with the data sharing platform that has been operated for years, as well as the data and gray publications generated within the organization.

This contribution are expected to produce a matrix of region-oriented, clearly indexed, inter-related online contents and requires the engagement of developing Institutional Repository (IR) for both research organizations and extension service units; as well as frequent communications between extension agents and institutional researches who need to know exact knowledge requirement from the field from time to time.

If this collaboration cannot be established or operate effectively, the extension agents may turn to the output from Internet search engine, and retrieve related but not the exact information, which could be saved locally for later use due to its apparently usefulness. This, perhaps, is the driving force that caused the abovementioned limitations.

3. Possible solution proposed
There are challenges to be faced in following areas: 1) Technical elements for system construction, data management, data publishing and exchanging are almost ready and have flexible options for the extension service unit, activities aims to the capacity building and will of using those tool-kit effectively for local knowledge base development, are to be carried out; 2) Open access of IRs from the research organizations, based on the institutional policy on data sharing and publish; 3) a mechanism between the extension units and research organizations in terms of continuous data publishing and exchanging based on the evolving regional requirement analysis from the frequent communications. A simple combination of a wiki, IR and Question-and-Answer for local typical agro-products will ensure that only region-oriented information is published, and is much easier to be located, indexed and maintained comparing to an encyclopedia system.

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Holistic AGRO-ICT-solutions considering also the integration of horizontal and vertical stakeholders

DI Walter H. MAYER
PROGIS Software GmbH, Austria

The food insecurity situation is effected by global warming, population growth, focus on bio-energy, low technology acceptance, unfavourable policies, sustainability criteria, changing natural risk-situation, subsidies etc. Sustainability-, agriculture-, forestry- and environmental targets belong together and influence each other. Therefore we need new types of ICT based land management, covering protection of land and biodiversity, ensuring sustainable management based on multipurpose use of land, optimising economical benefits and taking into consideration land use potential and its carrying capacity. ICT technologies, integrating local and science based expert data, easy to use software and manageable precision farming technologies will be essential to achieve sustainable bettering. Large and small farms must have access to know-how, equipment and technologies to optimise food/wood production processes to reach nutritional- and/or biomass targets. New advisory services will be a must, more and better advice is necessary to support the farmer in a more and more complex situation regarding the integrated models for agriculture – forestry-environmental management and natural risk management.

We summarize subsequent the benefits of integrated technologies where farmers, advisors, contractors, supply chains, industries and consumers are integrated:

GIS gives detailed information on size and location of fields - base for calculation and logistics. Farm management tools allow cultivation planning, documentation (also GLOBALGAP), nutrient- and CO₂-balance, cost calculations and provide information for trust centers or farm advisory services. Logistic solutions with central and mobile GIS systems allow planning of complete regions and serves farmers, food-industries and contractors. Meteo-data allow better decisions. Business-plans assist cooperation with banks and insurance companies. Machine interfaces allow the set up of precision or virtual farming solutions for groups of users, further statistical analysis for regions or countries and a possible upgrade with forest- or environmental caretaking solutions are supported. Risk management solutions can help to better defining and measuring farmer’s integration into environmental caretaking. We can show solutions and discuss the requirements – technological and organizational - to use these technologies.

THE OVERALL CONCEPT - “AGROffice”

The farmers worldwide must be enabled to feed 10 billion people in 2050, manage sustainable and CO₂-neutral bio-energy and run environmental caretaking and natural risk management.
TECHNOLOGIES BEHIND – “WinGIS + applications”

object-oriented and hybrid raster- (images) and vector- (polygons, lines, symbols, text etc.) GIS (Geographical Information System) named WinGIS that beside the location and the link of an object to a database with an internal or external database also enables the use of an SDK (Software Development Kit) to link any database with AX-technology to the GIS component as well as develop with tools customized user-interfaces that allow an integration of time and activity management as well of an expert information system. Since 2010 in cooperation with Microsoft, their worldwide available Bing maps (www.bing.com) – also other maps can be used instead or crunched – are linked to the system and allow working in any country worldwide. Further around 20 applications are supporting agriculture, forestry, environmental caretaking and risk management and the integrated chain-partners. Further following will be discussed and shown:

- **user interface** integrates geography, db, time management and expert information
- farm management or farm advisory management – with “DokuPlant”
- forest management – with “Forest-office”
- others – “community-gis” and “pipe-gis”
- **horizontal integration**
- logistics – logistic centre and mobgis – just in time delivery of agricultural products
- precision farming - WinGIS based PF tools for cost optimisation
- virtual farming – better cooperation - a new way for smallholders
- land consolidation – for the Austrian government
- environmental and risk management – a new way enabling farmers to be integrated
- **vertical integration**
- chain management – from farm to fork
- trust centre – the rural area notary’s office
- **system integration**
- site analysis and soil management
- agro meteorology integration
• energy and co₂ balance
• banks and insurance integration
• new organisation models
• cooperation is a must
• new advisory centres
• need to be optimized and must use latest technologies
• beneficiaries
• and how to integrate them

BENEFITS IN DETAIL

Not all benefits can be listed, some of them show already the power of an integrated system:

- GIS gives detailed size of the fields as base for exact calculation
- GIS gives exact location of the field for later logistics use
- Farm management allows with underlaying expert data planning and documentation
- Farm management as a tool supports e.g. GLOBALGAP’s documentation needs
- Farm management allows nutrient- and CO₂-balance and is a subsidy tool if needed
- Farm management allows calculations (cost, contribution margin etc.) of fields/farms
- Farm management gives access to traceability (§§) and documents sustainability (§§)
- Farm management and GIS allow the development of modern advisory services
- Logistic and mobile GIS tools allow detailed logistic planning of complete regions
- Logistic and mobile GIS tools serve farmers, food industries and contractors
Meteorology-data integration allows better decisions - just in times of climate change

More benefit comes from business for banks or information for insurance companies

Machine interfaces (ISO- or CAN-BUS) allow integration of precision farming

Group solutions allow statistical analysis for regions or even countries

Upgrade with forestry (forest inventory and forest management or forest logistics)

Environmental caretaking solutions allow even farmers integration into this topic

Risk management solutions allow also farmers integration in risk management

Banks and insurance integration gives a win-win situation also for farmers

A trust center allows the integration of different users of agro-information

IT will support fast distributing of new scientific know how - feedback will support

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IAALD’s Commitment to and Promotion of Agricultural Information Sharing and the CIARD Movement (with an Addendum on Agricultural Knowledge Sharing in the U.S.)

Barbara Hutchinson
IAALD President
University of Arizona, USA

As a founding member of CIARD, the International Association of Agricultural Information Specialists (IAALD) continues to demonstrate its more than 55 year commitment to enabling members and the global agricultural information community “to create, capture, access, and disseminate information to achieve a more productive and sustainable use of the world’s land, water, and renewable natural resources.” Over the years, the Association has evolved from publishing print agricultural information resources to the active use of social media tools to identify and distribute knowledge and relevant resources from around the world. It has also moved to an open electronic publishing format for its international journal. At the same time, IAALD facilitates networking and training opportunities to assist agricultural information professionals to effectively utilize technologies to improve their own information dissemination and knowledge sharing services. Thus, IAALD’s mission and organizational activities are in perfect alignment with the open access and data and information sharing goals of CIARD. Specifically, IAALD:

- **Connects** agricultural information specialists worldwide, providing platforms and spaces for information dissemination, exchange and knowledge sharing;
- **Convenes** agricultural information specialists worldwide, organizing meetings and catalyzing dialogue among all agricultural information stakeholders;
- **Communicates** and **advocates** the value of knowledge and information to its members and others, improving the status and practice of agricultural information management and dissemination; and
- **Collaborates** with members and other partner organizations, facilitating educational and other opportunities across agricultural information communities.

**Background**

IAALD is a professional non-profit organization formed in Ghent, Belgium in 1955 to provide networking and sharing opportunities for agricultural librarians and documentalists and to create products and services to further the dissemination of agricultural information. It now has members representing more than 75 countries and includes Chapters in China, Africa, and Eastern Europe. Through the years, the all-volunteer organization has held 13 world congresses on six continents, multiple regional conferences, as well as training sessions. IAALD has also been instrumental in producing information tools such as *World Agricultural Economics and Rural Sociology Abstracts*, now part of the CABI Database and three editions of...
Agricultural Information Resource Centres: A World Directory, a publication that compiled information on more than 4,000 agricultural resource centers around the world. The organization has also produced a major serial publication. The Quarterly Bulletin of IAALD began as a member newsletter and by 1970 had evolved into a professional journal which became peer reviewed in 1990. In 2008, the journal changed its focus and scope and became an electronic, open access journal titled Agricultural Information Worldwide (http://journals.sfu.ca/iaald/index.php/aginfo).

IAALD’s guiding principle is to improve and promote the practice of information and knowledge dissemination and management in agricultural and all related areas. IAALD does not publish information on agricultural topics; however, the Association does enable members to better serve their communities by facilitating access to this information. The organization brings together a growing global and dynamic community of practice representing a multi-disciplinary membership of traditional and non-traditional agricultural information professionals, as well as information technologists and extension professionals from both developed and developing countries. IAALD also partners with a wide number of organizations, including a formal affiliation with INFITA (International Network for Information Technology in Agriculture) as well as liaisons with FAO, CGIAR, GFAR and CTA.

**IAALD Knowledge Sharing and Social Media Services**

IAALD’s listserv (IAALD-L@cals.arizona.edu) is a primary means for the IAALD Community of Practice to receive updates from the Executive Committee and announcements about meetings, upcoming events, and professional development activities such as the new IAALD webinar series. Internal member discussions are facilitated through an IAALD Community Ning (http://iaaldnetwork.ning.com/).

IAALD maintains a website (http://www.iaald.org) providing extensive information about the Association, and also featuring a variety of social media tools that bring current news and events to the IAALD community of practice in a variety of formats. Very soon a newly redesigned website, implemented by Valeria Pesce (GFAR), Maria Folch (FAO), and Giampaolo Rugo (FAO), will go live. The site more fully integrates all social channels using a Drupal content management system platform. These social media services will promote greater information access including the following:

IAALD’s primary information sharing service is the AgInfo News blog / AgInfo RSS feed (http://iaald.blogspot.com), an online newsfeed maintained by Peter Ballantyne, Edith Hesse, and other members which highlights current agricultural information activities and initiatives taking place throughout the world. AgInfo News is syndicated content powered by FeedBurner which makes it easy to receive content updates from most all news readers such as My Yahoo!, Newsgator, Bloglines, and other news readers. News feeds are available by region (Africa, Latin America), and by language (English, French, and Spanish). IAALD News can also be followed on Twitter: http://twitter.com/#!/iaald.
Agricultural Information Worldwide or 'AgInfo World' is an electronic peer-reviewed journal covering all aspects of the agricultural information profession. Currently, subscriptions to the current year of the AIW are included in IAALD membership and to other subscribers. The archives are open access. Topics are generally of a practical and applied nature. Subject coverage includes articles on information and knowledge sharing related to agriculture, life sciences, food, natural resources, the environment, and agricultural extension and education. To access the AIW online go to: http://journals.sfu.ca/iaald/index.php/aginfo

IAALD’s photo stream is available on FlickR: http://www.flickr.com/photos/iaald/. This includes photos from a variety of IAALD events and related member activities. Members can share their own digital photos by opening a free account on Flickr and uploading them with an “IAALD’ tag.

Presentations by members of the IAALD Community are available on Slideshare: http://www.slideshare.net/iaald. In addition, there are relevant Powerpoint presentations from people the IAALD Community follows as well.

Currently, IAALD Community videos are available through BlipTV: http://blip.tv/iaald. A new YouTube option may be available in the coming months.

To access IAALD’s Facebook page, use the following link. Check out related like-minded organizations and current news and comment postings - http://www.facebook.com/pages/International-Association-of-Agricultural-Information-Specialists-IAALD/12172668666

ADDENDUM

An Overview of the Agricultural Information and Knowledge Sharing Situation in the U.S.

For more than a decade, various agricultural information groups\(^1\) in the United States have been discussing the need for and working toward a more coordinated approach to provide easy and open access to the wealth of critical agriculture-related knowledge located in universities (particularly Land-Grant Universities (LGUs)), government entities (such as the National Agricultural Library (NAL) and US Department of Agriculture agencies), as well as related organizations. While there has been some progress at certain levels – a number of LGUs have implemented institutional repositories with strong agricultural components\(^2\), NAL has developed a National Agricultural Library Digital Repository for USDA publications (http://naldr.nal.usda.gov/), and AgNIC (http://www.agnic.org/) (a

\(^1\) United States Agricultural Information Network (USAIN) , the U.S. National Agricultural Library (NAL), AgNIC and its Born and Reborn Digital Committees, American Distance Education Consortium (ADEC)
\(^2\) Texas A&M CALS Repository - http://repository.tamu.edu/; UC Davis Ag & Natural Resources Repository - http://ucanr.org/repository/; University of Minnesota Digital Conservancy - http://conservancy.umn.edu/handle/48246; University of Florida Food and Agriculture Sciences Digital Collection - http://ufdc.ufl.edu/fao1
CIARD partner), provides access to subject-based agricultural resources through its partnership - there is no one central point of open access to all of these agricultural information resources. In fact, the situation remains quite fragmented and the players, whether at the institutional or governmental level, remain under-resourced to achieve this end.

Numerous attempts to raise the awareness of this need have been made with minimal success to date. However, at the request of the Western region College of Agriculture Deans, a new opportunity is beginning to be organized. This past February both Library and Agriculture Deans at all Western Land-Grant Universities received letters from the University of Arizona inviting their institutions to participate in discussions to explore the development of an online Land-Grant University Knowledge Discovery System - an initiative to build on, strengthen, and expand agriculture-related institutional repositories. The response to this call was quite positive. Ten of the Western LGUs said they would send representatives to such a meeting, and another four from other regions who were contacted separately also said they were interested in participating. At the time, the expectation was to hold a face-to-face meeting of interested parties. However, during a conference call between the University of Arizona and University of Florida counterparts, the idea of holding a virtual meeting was determined to be a more inclusive and economical approach. Now, the tentative plan is to hold the virtual meeting during the latter half of this September, hosted by the University of Florida, and co-facilitated with the University of Arizona. A multi-institutional planning team for the meeting is currently being formed. Each participating institution is being asked to designate up to two official representatives for the proposed virtual meeting who can represent both agricultural information and IT perspectives and expertise. The intent is to produce a brief proposal that will be made available to the Western Library and Agriculture Deans for advocacy purposes. Additionally, this proposal will be disseminated to administrators in other regions and will provide the basis for submitting competitive grants applications to targeted funding agencies and sources. It is the hope of many agricultural information specialists throughout the U.S. that this planning meeting will lead to greater support for developing comprehensive agricultural institutional repositories and a means for openly sharing and accessing the resources contained in them.

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Information and Data Sharing in NARS of India

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Management and Sharing of information and Data

The National Agricultural Research System (NARS) of India comprises 97 institutes established by the Indian Council of Agricultural Research (ICAR) and 58 Agricultural Universities established in various states by their respective state governments, or as agriculture faculties in central universities and as private institutions. While the ICAR institutes are involved in basic and strategic research except few deemed universities which are involved in education, the universities are involved in applied research and education. However, all the institutes and universities take up extension activities and training. Every year, substantial research output is produced from these institutes and universities and they share their research achievements with all of their stakeholders through technical bulletins, leaflets, newsletters, annual reports, books, research highlights, research achievements and research journals. The education and teaching materials are rarely shared with the world. Most of these publications are print only form and are rarely shared through their websites. The institutes and universities share the leaflets freely during various programmes but many of their publications are priced publications and are only available upon purchase.

While almost of the ICAR institutes make their annual reports and vision documents available online, very few universities (~24%) make them online. In case of peer-reviewed research articles and conference proceedings, only bibliography is made available online that too only by ~35% institutes and ~9% universities on their respective websites. These institutes and universities do not show much importance for sharing the research articles with other stakeholders freely. This may be because of the absence of a policy and publication of research articles are seen as individual’s job and not of the institutes. There is no provision of reimbursement of pay per page/author pay charges. Exception to this are Central Marine Fisheries Research Institute (CMFRI), Indian Agricultural Research Institute (IARI), Indian Institute of
Spice Research (IISR) and Indian Institute of Horticultural Research (IIHR) which have established their Institutional Repositories (IRs) to showcase their research and other publications to the world. They are using Free/Open Source Software (FOSS) which is Open Archives Initiative Protocol for Metadata Harvesting (OAI-PMH) complaint. The repository of CMFRI, 'Eprints@CMFRI' is the most populated repository till date having ~8000 records followed by 'Eprints@IARI' of IARI with ~226 records. Another ICAR institute, the Central Research Institute for Dryland Agriculture (CRIDA) thought has not established its repository, but has made all its publications online except that for research articles which can be accessed upon sending email request. For this, CRIDA is providing email address of the author in the bibliography. Unfortunately, no agricultural university in India has established its repository till date. However, Indian Institute of Technology, Kanpur has established 'OpenAgri' an open access repository for agricultural research in India under 'Agropedia', a sub-project of World Bank supported National Agricultural Innovation Project (NAIP) and few institutes/universities are utilizing it for depositing their journal articles, book chapters and conference proceedings. Now twelve institutes and universities in NARS are in the process of establishing repositories housing digital collection of rare books and old journal available at their libraries under the NAIP sub-project 'Strengthening of digital library and information management under NARS (e-GRANTH)'. The 'CaneInfo' is a project supported by Department of Scientific and Industrial Research (DSIR) at Sugarcane Breeding Institute (SBI) and is aiming at becoming a repository of knowledge on sugarcane.

In every ICAR institute, there is at least one scholarly society supported by the institute/ICAR for publication of research journal in their subject/discipline. These societies organise seminars/symposia/conferences periodically and also publish the proceedings as supplements to the journal. Though all these publications are in print only form and are only accessible on subscription either at libraries or with individual subscribers, few of the societies are making their journal issues accessible to their members, library and consortia upon subscription only with the help of a private web hosting service provider. While the Indian Society of Soil Salinity and Water Quality has uploaded one of its journal issues of 2009 online, others are only hosting abstracts and table of contents of forthcoming issues. For running the business, the scholarly societies are selling their publications rather than making them available freely on the web.
Recently under E-Publishing and System for Knowledge Sharing in Agricultural Research (EPSKAR), a sub-project under NAIP, at Directorate of Knowledge Management in Agriculture (DKMA), ICAR has started publishing its two journals viz., Indian Journal of Agricultural Sciences and Indian Journal of Animal Sciences as open access journals using Open Journal Systems (OJS) a FOSS software on the http://epubs.icar.org.in platform under name Indian Agricultural Research Journals and is also offering hosting support to scholarly societies for making their journals online. Apart from journals, DKMA also brings out various information products of which some are available in e-formats on CD/DVD but its text books are all in print only formats and are available only on payment. Few universities (~9%) are also publishing peer-reviewed publications as university research journals. While the Acharya N.G. Ranga Agricultural University is sharing complete issues from 2007 to 2009 by uploading them online, others are only sharing abstracts/table of contents on their websites. However, two universities viz., Kerala Agricultural University and University of Agricultural Sciences, Dharwad are completely publishing them online using OJS. The University of Agricultural Sciences, Bengaluru the process to publish its journal online using OJS but could not publish it till date even after hosting one of its issue as test issue. Scholarly societies in universities are also publishing journals but they are also print only journals except the MASU Journal which is being published using Google sites by the Madras Agricultural Student's Union.

Under NAIP sub-project, Consortium for e-Resources in Agriculture (CeRA), ICAR is making available various research journals both closed and open access, published by various scholarly societies and national/international publishers to all the institutes and universities in NARS till June 30, 2014 and would be supported by national level through its plan funds. Like wise, under another NAIP sub-project the Indian Agricultural Dissertations Repository, 'Krishi Prabha' is developed in which all the post graduate and doctoral thesis submitted to various agricultural universities during 2000-2009 were digitized and made available to all the institutes and universities in NARS under Internet Protocol (IP) authentication. However all of these entire theses are in image format and are not available in full-text searchable format and are available as online view only. One can only search titles, authors and the specified keywords submitted author. While, the Maharashtra Animal and Fishery Sciences University is making few of its submitted thesis available for full-text download,
College of Veterinary Science and Animal Husbandry under Anand Agricultural University is making all its 67 thesis as full-text downloads on OpenMED@NIC an open access archive for Medical and Allied Sciences established by National Informatics Centre.

Till the time of NAIP launch, the data sharing is observed to be almost nil in ICAR institutes. Under various sub-projects of NAIP Component-1, there are some efforts in the direction of making information and data available for which some guidelines were developed under the AGROWEB – Digital Dissemination System for Indian Agricultural Research (ADDSIAR) sub-project of NAIP. Under this sub-project, IIHR is making available market data in the form of graphs. In entire NARS, the best example for market and weather data sharing is the Tamilnadu Agricultural University (TNAU). It is making available various market locations data as well as weather data of all the districts of Tamilnadu online on its TNAU Agritech Portal. This portal has recently awarded with National Award for e-Governance 2010-2011 by Government of India.

The other institutes and universities in NARS are only sharing weather based advisory for various agricultural operations. Every year the Indian Agricultural Statistics Research Institute (IASRI) publishes Agricultural Data Book and is available on its website but in a PDF format. All the data is not in retrievable mode and there is less scope for interoperability of the data to make meaningful analysis and visualizations. Whereas, the Directorate of Economics and Statistics under Ministry of Agriculture, Government of India is making available all the agricultural statistics in spreadsheets.

Data with respect to germplasm at few institutes is only restricted to the number of accessions available in a particular genotype/genus on websites. Exception to this is IISR which is making available passport data of all the germplasm on its website which can be accessed by anyone upon registration. The National Bureau of Plant Genetic Resources (NBPGR) which is the national repository of plant genotypes has created an online platform in association with Food and Agricultural Organisation (FAO) for sharing the information of passport data of various germplasm available at various institutes/universities in India. It has also published Inventory of Registered Crop Germplasm (2009-2010) registered under ICAR system. Digital Herbarium at Directorate of Medicinal and Aromatic Plants (DMAPR); Digital Library on Bruchids, National Information Sharing Mechanism on Global Plan of Action for Germplasm Conservation, Utilization and Implementation and Information Management System
for Biodiversity Conservation are hosted at NBPGR website are aimed at information and data sharing of available germplasm. The National Agricultural Bioinformatics Grid is established at IASRI under NAIP for capturing and sharing genomic data produced in NARS. The Rice Knowledge Management Portal (RKMP) is being developed at Directorate of Rice Research to strengthen the better flow of rice knowledge and information of rice. It is also aimed at development of Data Centre which captures all the All India Networking Rice Research Project spread across various agro-climatic zones of India.

The Indian Institute of Soil Science (IISS), Bhopal has developed, GIS based Nutrient Status of Soils in India showing soil types, mineral nutrition deficiencies but are only in PDF formats. Similarly, under National Animal Disease Referral Expert Management System (NADRES) of Project Directorate on Animal Disease Monitoring and Surveillance (PDADMAS), Bengaluru, developed GIS maps of disease outbreaks but are only available in PDF format.

Organisation Polices

As such till date, no adopted organisation policy on 'Information and Data Sharing' in NARS is noticed. However, under ADDSIAR sub-project, a policy booklet 'Uniformity Guidelines for Agricultural Institutes/Universities Websites' was released to bring about uniformity in the websites and for proper information and data sharing. It advises to use FOSS content management systems for information and data sharing. As it is proposed to establish National Agricultural Data Centre for web hosting and housing information/data sharing products in NARS, it is necessary to formulate a structured policy guidelines on information, data sharing & management that is to be implemented at all levels in NARS system. An Open Access policy similar to Council of Industrial and Scientific Research (CSIR) should be adopted by the ICAR. During the meeting on "Information and Communication Technology in ICAR” on November 29, 2010 at NASC Complex, New Delhi, it was proposed and agreed that the requirements of ICT in ICAR would be worked out in the form of immediate, short term and long term perspectives and partnerships with private/foreign organisations would be explored for expeditious and time-bound benefits of ICT for the farmers. It was also agreed that all ICAR institutes and SAUs should be linked to CIARD and a strategy for utilization of National Knowledge Network bandwidth would be prepared for knowledge
sharing. The standards would also be created and enforced at all levels for data collection, analysis and data sharing. It was also proposed to set up an advisory group comprising the following persons to guide ICAR from time to time on various ICT related issues.

1. Dr. Ajit Maru, Senior Knowledge Officer, GFAR, FAO
2. Shri Rikin Gandhi, CEO, Digital Green
3. Dr. T. V. Prabhakar, Prof. (IIT), Kanpur
4. Shri Pier Paolo Ficarrelli, ILRI
5. Dr. Sanjay Chaudhary, Prof. (DA-IICT), Gandhinagar
6. Dr. Krishna Alluri, British Columbia, CANADA

Obstacles and constraints

The scholarly societies are not well versed with latest publishing technologies and they express that they cannot afford to hire an information technologist for online management of journals. Now with the entry of private web-hosting providers, they are able to make their journals online for wide visibility but no efforts are being made for free availability and accessibility of research articles to all stakeholders without subscription. They say that they loose revenue and their subscribers and hence, both libraries and individuals prefer printed journals. Similarly, in order to generate revolving fund revenue, most of the ICAR institutes’ publications are in print only form and are for sale. The institutes are of the opinion that when publications are made online, none would buy and they would not get back the cost/expenditure incurred on publishing/printing and they cannot make only e-books as the clients/stakeholders needs print form too. None of the institute and university is willing to take up the job of establishing a repository to showcase their publications without monitory support in the form of a project. Lack of a data centre of their own for web hosting, skilled manpower in use and application of modern open source content management software and lack of awareness on the issues of 'availability & accessibility' of information and data with respect to are few other obstacles in information and data sharing in NARS. The existing computer application scientists' potential was not harnessed to the possible extent and were lacking in working as national teams for address issues of ICT in agriculture for information and data sharing. They were all working remotely and now with the change in policy, not to recruit any more
scientists at entry level in the field of computer applications in agriculture may add to existing obstacles for free flow and sharing of information/data.

**Examples of interoperability**

The Eprints@IARI and Eprints@CMFRI are all indexed in BASE (Bielefeld Academic Search Engine), Bielefeld University Library, Germany, ScientificCommons.org project of Institute for Media and Communication Management at the University of St. Gallen, Google Scholar, Scirus, science-specific search engine on the Internet whereas, open access journals are indexed in Directory of Open Access Journals (DOAJ).

**Priority areas, current and potential**

In India, about 60 open access institutional repositories have been established by various public and private institutes and universities. Whereas only five repositories have been established till date. In NARS. Now under e-Granth sub-project of NAIP, 12 consortia partners from NARS are in the process of establishment of repositories in which their library collections as well as research publications would be deposited. These repositories should be built on OAI-MHP compliant software and the contents should be made interoperable for further harvesting by search engines viz., Google or Google Scholar to make them available to the world. All the repositories should be made of OAI complaint and awareness workshops should be conducted along with the policy implementation at each and every institute and university.

A database of all the copyright policies of all the publishers in India could also be developed and integrated with SHERPA/RoMEO. With all these efforts, an Open Access NARS Research Database could be made available to the world as National Open Access Periodicals Repository of CSIR or as Asian Journals Online (AsiaJOL) which collects information from the Journals Online (JOL) databases of journals published in Bangladesh, Nepal, The Philippines, Vietnam, Sri Lanka and Indonesia.

With regards to the thesis, the ICAR/NARS should adopt the policy of Shodhganga Repository established by Information and Library Network (INFLIBNET) Centre that all theses and dissertations submitted would be available in open access to the academic community world-wide and authors/research scholar/university can impose
restrictions on access if so they desire. The INFLIBNET has so far Signed Memorandum of Undestanding (MoU) with 23 Universities and has ~1748 thesis deposits. When such an open access research landscapes of ICAR/NARS institutes and universities are showcased, they can invite collaborative proposals and the ICAR/NARS should work towards this goal. The citation & impact analysis metrics should be used for assessment of researchers in the NARS for this ICAR may establish Indian Agriculture Scientific Citation and Impact Analysis Unit at its headquarters. To make agricultural research information publicly available and accessible to all, Agropedia is working and it should be made content rich with reliable information. For this, a national programme may be launched on the lines of Wikipedia and periodic workshops for capacity building and sensitisation should be conducted.

The for the entire NARS, a e-commerce ICT project in agriculture on the lines of 'e-krishi' project of the Department of Agriculture, Kerala administered by Kerala IT Mission and oriented towards business and giving market advisory for agriculture and aquaculture for Kerala state should be adopted. An advisory group may be formed to guide ICAR/NARS from time to time on various issues related to information and data sharing. The information and data sharing services with the institutes and universities should be registered with Coherence in Information for Agricultural Research for Development (CIARD) to make them available & accessible.

The NARS system institutes and universities are present in various agro-climatic zones, this strength should be exploited to build a huge database on agro-meteorology collected over the period of time and with the help of data mining techniques, meaningful analysis could be made out and a reliable micro-level forecasting could be developed. Mapping of biodiversity, biosecurity, diseases, pathogens, etc. should be taken up with integration of Geographical Information System (GIS). There is a need for large scale capacity building at the national level for dissemination of information to the farmers in all local languages. So, the existing ARIS cells in all the institutes and universities should be strengthened with necessary manpower and infrastructure. With the existing various advisories and decision support systems, a robust interlinked ICT Farming Systems could be developed with the integration of infrastructure and contents management.
All the data of output from various All India Networking Projects (AINP) should be deposited in a central 'Data warehouse' and be made available under a suitable 'Data Licence' in NARS system. The standards should be created and enforced at all levels for data collection, analysis and data sharing and there should be a policy in place which has a system of accountability and reward for data sharing. With the recent changes in policies across the globe, the Government of India has also planned to share its data. It was announced that a portal [http://data.gov.in](http://data.gov.in) would be established for data sharing on the lines of United States and United Kingdom in July 2011. This opportunity and platform should be utilized by the NARS system to share their data. The following are some of the points that emerged during the meeting on “Information and Communication Technology in ICAR” on November 29, 2010 at New Delhi.

- To make agricultural research information publicly available and accessible to all, "Agropedia' is being developed and it should be made content rich with a reliable information. For this, a national programme may be launched on the lines of Wikipedia and periodic workshops for capacity building and sensitisation should be conducted.
- The information and data sharing services with the institutes and universities should be registered with Coherence in Information for Agricultural Research for Development (CIARD) and a advisory should be formed to guide ICAR/NARS from time to time on various issues related to information and data sharing.
- There is a need for large scale capacity building at the national level for dissemination of information to the farmers in all local languages. So, the existing ARIS cells in all the institutes and universities should be strengthened with necessary manpower and infrastructure.
- With the integration of infrastructure and contents management of existing various advisories and decision support systems, a robust interlinked ICT Farming Systems could be developed.
- The NARS system institutes and universities are present in various agro-climatic zones, this strength should be exploited to build a huge database on agro-meteorology collected over the period of time and with the help of data mining techniques, meaningful analysis could be made out and a reliable micro-level forecasting could be developed.
• Mapping of bio-diversity, bio-security, diseases, pathogens, etc should be taken up with GIS.

• The standards should be created and enforced at all levels for data collection, analysis and data sharing and there should be a policy in place which has a system of accountability and reward for data sharing.
CASE STUDIES
Information and Data Sharing in NARS

Eprints@CMFRI: An Open Access Institutional Repository of CMFRI
The Eprints@CMFRI <http://eprints.cmfri.org.in> institutional repository takes a place of special mention in the National Agricultural Research System of India. It was made live on 25 February 2010 by Central Marine Fisheries Research Institute (CMFRI) and since then article were deposited till date it has collection of 8134 records. It has collections since year 1948. This credit mainly goes to the Director, CMFRI and the Librarian, Mr V. Edwin Joseph who has taken special interest to create the repository to house their vast collection of publications. This repository has both open access and closed access publications in its collection. This institution has also so far not declared any open access policy.

Eprints@IARI : An Open Access Institutional Repository of IARI
The Eprints@IARI http://eprints.iari.res.in> is made live by Unit of Simulation and Informatics (USI), Indian Agricultural Research Institute (IARI) on 9th November 2009. From that the time of hosting till date the repository received 226 records of deposits mainly of research articles and conference proceedings and few book chapters. The IARI has so far not adopted an open access policy but the repository was approved to be in place. Frequently, the USI organises sensitisation workshops on open access and how to deposit the publications into the repository. However, the rate of deposition and number of articles are less when compared with other existing repositories. The main reason is the absence of a policy and reward system as expressed by the authors themselves. When there are no issues of copyrights the deposits were made open access otherwise as restricted access only to the registered users of IARI.
Open Access Journal of Medicinal and Aromatic Plants

The Open Access Journal of Medicinal and Aromatic Plants (OAJMAP) <http://www.oajmap.in> is a unique journal in NARS. It is the very first journal to be launched as open access journal from a scholarly society housed in an ICAR institute. It was initially supported by Open Knowledge Society, India for hosting online but now it has migrated onto 'epubs' platform of ICAR for more recognition and visibility. It has so far received 11582 page visits as per its webpage counter. But as per the Google analytics, 3,238 visits came from 85 countries/territories from Nov 1, 2010 - Jun 6, 2011. It has 2,550 absolute unique visitors, 16,025 page views and returning visitor were 689 with 14.85 visits/day. It has publishing frequency of two in a year and so far it has published two journal issues. It has received articles from various parts of the world and few from Iran were published. It has successfully organised a nation seminar in the year 2010 and has published selected abstracts in its latest issue [2010 (2)]. The journal is indexed in Scoups, CABI, Chemical Abstracts Service and Open J-Gate etc.

Indian Agricultural Research Journals

The Indian Council of Agricultural Research (ICAR) has made its two journals the Indian Journal of Agricultural Sciences and the Indian Journal of Animal Sciences using Open Journal Systems (OJS) software on the platform <http://epubs.icar.org.in> as the part of the project E-Publishing System for Knowledge Sharing in Agriculture (EPSKAR), a sub-project under world bank assisted National Agricultural Innovation Project (NAIP). Trivedi et al (2011) reports that the 'epubs' platform has ~6800 registered during last six months (November 2010 – May 2011) there have been more than 60,000 visits as per source Google Analytics. They also report that the platform is getting visitors from 157 countries with the order of top 10 countries India, China, Turkey, Iran, USA, Pakistan, Canada, Mexico, Philippines and Bangladesh. It is reported by the project team that on an average, 15-20% of the total submissions in a day are from international authors (Trivedi et al 2011).

Consortium for e-resources in Agriculture (CeRA)

As a sub-project under National Agricultural Innovation Project, the Consortium for e-resources in Agriculture (CeRA) is providing access to ~2000 journals both closed and open access from its platform Members/members.asp to ~134 institutes and universities in NARS. Apart from this, the non-subscribed journal articles are being made available to various researchers in NARS by Document Delivery Request (DDR). It is conducting various awareness seminars on use of CeRA. It is also providing calculated citation index/h-index by Scopus/ISI Citation Index to researches upon request.


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Knowledge as a Service for Agriculture Domain

Asanee Kawtrakul

Abstract

Three key issues for providing knowledge services are how to improve the access of unstructured and scattered information for the non-specialist users, how to provide adequate information to knowledge workers and how to provide the information in situations requiring highly domain-specific, related and time critical information. This paper introduces a platform of knowledge acquisition and services, called CyberBrain, which using ontology as a backbone. Based on specially designed ontology and engineering, the system ensures that knowledge service could be improved the user benefit. Users are presented with the necessary information closely related to their information need and thus of potential high interest.

Introduction

The agricultural domain is one of the most significance domains in need of multimedia knowledge management that can aid farmers, extension workers and researchers in their daily information search. However, sources of these data are scattered at several locations and websites with heterogeneous formats that offer structured information to large volumes of unstructured information. Moreover, the needed knowledge has been too difficult to find since the traditional search engines return ranked retrieval lists that offer little or no information on the semantic relationships. As a consequence, many approaches elaborate web search by combining standard web search with ontological background knowledge, called Semantic web search. However, even if the semantically related information has been found, often overload since there is no content digestion. Accordingly, one-stop shop knowledge service for the users or knowledge workers, especially non-specialist users is needed in order to reduce time browsing and reading to find out how various information are related and where each falls into overall structure of the problem domain such as how to solve the problems of pest.

Since the benefits from knowledge accessing, only gained by others who have online and ready access to the information, a new knowledge services for knowledge transfer with different strategies including knowledge delivery are needed for multi-types of the end users. In order to provide the knowledge services that could improve the user benefit, the system needs to go beyond providing not only their information requested but necessary information added.

In this paper, Cyberbrain is introduced as a platform equipped with ontology and reasoning capabilities to acquire, process the knowledge and provide the users with the necessary information closely related to their information need and thus of potential high interest.

Issue of Knowledge services

There are keys issues for providing knowledge services

- how to provide adequate support to knowledge workers in situations requiring highly domain-specific and time critical information
how to improve the access of unstructured and scattered information for the non-specialist users

The above issues bring to the development of robust, extensible but user-friendly semantic based knowledge access with the following functions:

• to structure and present the domain knowledge objects (Text documents, images, graphics, maps video, audio recording) at the level of cognitive capabilities of intended users, in the enriched information spaces underlying a given domain specific ontology, visually rich and adaptable style, facilitating filtering and aggregation,

• to turn the web browser into a comprehensive, rich client platform for aggregating the disparate elements through a variety of relationships, and in general to enrich their view using thematic map or semantically driven navigation,

• to find the way of representing the information expressed in the unstructured text, to amalgamate all the available data for a particular collection,

• to deliver information or knowledge that meet the needs of intended users and allows for corrective actions,

**CyberBrain: A Framework of Knowledge Acquisition and Services**

Figure 1 shows an overview of knowledge acquisition concept and knowledge services customized to different users and a tailored summary based on the user’s initial query. Ontology is used for both information extraction and integration. At extraction level, task-oriented and real-world taxonomy ontology are used to construct information schema and scenario construction. At integration level, demand-driven or pragmatic-oriented ontology is used to aggregate information from multiple heterogeneous sources. The developed system is consisted of three main components as shown in Figure 1.
• Distributed Information Gathering. The information, both unstructured and semi-structured documents are gathered from many sources. Periodic web crawler and HTML parser are used to collect and organize related information. Domain-specific parser are used to extract and generate metadata for interoperability between disparate and distributed information. The output of this stage is represented in RDF format.

• Knowledge Portal Construction. Ontologies are used as a key to facilitate both information extraction and integration. There are two types of integration: summarize into relational database; such as <Rice varieties and yield, Disease dispersion, Pest characteristics >, and document hyperlink such as Product processing, Cultural practice and Fertilizing. Additionally, the process of knowledge extraction from text is needed to pursue the goal of generating useful knowledge, such as general symptoms of plant diseases, from the large amount of text. The output of this stage is structured knowledge and rules.

• Knowledge Service Provision. Four different target users groups, i.e., farmers, researchers, SME and Intelligent Command Centre, are distinguished by different viewpoints that are characterized by each user's interest. At this stage, knowledge tracking and summarization are applied for knowledge service provision. Moreover, K-service in the form of Knowwhat, Know-why, Know-where, Know-when, Knowhow, and Know-who has been also provided.

Figure 2 shows the platform for providing the knowledge services. Four different target users group are distinguished from the different points of views depending on their objective, interest, affectation and benefit.
The farmers require some useful information, i.e. how to analyze the type of pests, or symptom of plant diseases and how to protect plant from diseases,

The researchers prefer to track the problems and literate the previous researches,

Small and Medium Enterprise requires to follow up the state of business,

Intelligent Command Center of the Government needs portal of Executive information, cross sector analysis, and Intelligent Real-time warnings/ alerts or event tracking.

Figure 2 Multi-types of knowledge services for different knowledge consumers

Based on ontology, knowledge services platform is developed for combining several strategies for modeling the target of questions and optimizing the extractions of the answers. Besides presenting the possible answers to a given question, the system can offer additional information based on the answer's type:

- an integrated answers for one-stop shop of knowledge accessing,
- multimedia answers that are image related with the answer of what kind of disease or pest analyzing from symptom, photos of who will be the contacted person for giving the consultant, and video for answers the procedures of methods of preventing, planting,
- a map for answers that are location names of disease dispersing,
- personal knowledge delivery through sms.

Scenario 1: PMM based Knowledge services

Providing information and knowledge services with collecting and maintaining weakly structured text sources is time-consuming activities. This project targets for building specific services and knowledge infrastructures to support decision-making and problem solving in Agriculture domains. This collaboration project is currently implemented by using Orchid, Rice, Casava and Rubber domains. The generated PMM
(see Figure 3) consists of Disease Problems identification, huMan experts who could solve that disease problem and the Method for solving the disease problem both in corrective and preventive ways.

Figure 3 A model of PMM for providing knowledge service

**Scenario 2: Event tracking and Monitoring**

To provide adequate support to knowledge workers in situations requiring highly domain-specific and time critical information, as was the case during the outbreaks of disease. During those outbreaks, information service providers had an urgent need to communicate with the target end-users and to participate on the rapidly evolving state of the outbreak. For this reason, knowledge accessing and delivery are being increasingly applied to support knowledge broker to transform the information and to support decision making of government or communities.
Figure 4 shows a customizable portal collecting information from a multitude of distributed data sources, mapping this diverse information onto spatial information system such as google earth, and providing users with a coherent information. Specific services provided by this portal will include event tracking, e.g., of disease outbreaks, with a multi-channel alert system disseminating information about a specific event, event type, region, etc.

**Scenario 3 Multimedia knowledge asset management: Case study Kasetsart University Radio Network**

Figure 5 shows a portal of multimedia knowledge for providing services through the radio network of Kasetsart University. Starting with radio-broadcast content collection, the related and necessary information either text format or video format will be integrated as complementary knowledge.
Scenario 4 Delivery Information

Knowledge service via a mobile phone as “a right information for a right man at a right time” is a challenging task. Therefore, Short Message Service (SMS) is a better way for giving knowledge service, especially automatic interchange of short text messages, by providing the information from an automatic Question & Answering System. Nowadays, providing a knowledge service through SMS is not limited to only a Question-Answering Services System, but also for such one-way services as early warning systems, for example, a Tsunami Alert System1, a FloodSMS – Early Detection and Warning of Catastrophic Flooding via SMS2, etc.

Discussion

- The key success factors for knowledge sharing
- The governance and multisectoral engagement
- System and data Interoperability
- Infrastructure
- Human Capital Development such as ICT training Center for the community.

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1 http://www.wap.aiit.ac.th/tsunami.html
This presentation will defend the thesis that needs for information, and mechanisms available, in developing countries differ markedly from those in industrialized countries:

**Subsidies to research:**
Most industrialized countries subsidize their agriculture either in direct benefits to farmers or through research institutions supported by their governments. This facilitates both the conduct of research and its dissemination as funds are more readily available for this purpose in the industrialized countries.

**Agricultural systems:**
Agricultural production systems are very different as between industrialized and developing counties. In the former, large scale, energy-intensive systems predominate. In the latter, family-based small scale systems with low energy inputs are the dominant model. The research and information needs of the former are quite different from those of the latter model.

**Use of information:**
Measures of the impact of research through publications in industrialized countries are used widely as a means of evaluating the research outputs of scientists (eg: the “impact factor” of a journal based on citations). The quality of the “science” is often strongly emphasized. In developing countries, research publications play a more practical role in informing local scientists of recent developments in their respective fields. The emphasis is also much more on “science for development”.

**Finance:**
The research budgets of scientists in developing countries are usually small and emphasis must be put on financing the practical aspects of doing the research. It is therefore invariably difficult to find funds to support the publication of their research, especially as the sums involved are considerable, of the order of USD 1,000 per publication.
Livestock Research for Rural Development (LRRD) is a peer-reviewed online international journal for sustainable livestock-based agriculture in developing countries.

It was first published as a stand-alone program on a 3.5in diskette which was distributed freely with the support of International Aid agencies (FAO, IFS and CTA). In 1996, the format was changed to HTML language and dissemination was on the web site (http://www.cipav.org.co/lrrd.org) hosted by CIPAV, an NGO in Colombia. In 2009, the web site was changed to http://www.lrrd.org

At the present time the LRRD web site receives 2500 visits daily. In 2010, 250 papers were published – 98% of them from researchers in developing countries in Africa, Asia and Latin-America.

LRRD receives no financial support and is voluntarily managed by an editor (preston@lrrd.org) and two assistant editors (lrrdrs@wanadoo.fr and segura52@hotmail.com). The web site is hosted by CIPAV (http://www.cipav.org.co).

The medium of publications.

The media constantly emphasize that paper comes from trees and we need to save the trees (eg: a typical signature of an email message :Please consider the environment before printing this email. “. Most journals in industrialized countries produce a “print” version, indeed this is a requirement to be registered by the ISI system, and hence eligible for assessment of the “impact factor”. Online publications are the preferred medium for scientific publication in developing countries. Search engines such as “Google” now play the major role in the search for, and dissemination of, research information. Online publications are obviously the most appropriate medium for presentation of data.

Formats:

The two major formats for online publications are “PDF” and “HTML”. The former plays a dual role in facilitating the “protection” of scientific content. This is an important issue in industrialized countries. In many respects, it is a barrier to free and easy dissemination of information. The HTML format, on the contrary, is designed to facilitate dissemination, searching and free movement of information. It is the appropriate format for sharing sources of information in developing countries.

The actors:

Researchers in developing countries have different needs in the light of the above considerations. They need to learn how to "referee" scientific content. This is usually a prerogative of scientists in developed counties. They need to learn how to plan and execute research which will have an impact on the social and agricultural development of their country; this is not necessarily synonymous with "good science".

Financial support:

In developing countries, scientific institutions have a major reliance on Government and more so on Funding Agencies to finance their research and publications. Societies and Associations of scientists are common in industrialized countries, and are frequently the source of funds for supporting publication of scientific journals. Such institutions are rare in developing countries, where there is a much greater need for "voluntary" contributions, in time and effort, to support the publication of their data.

Conclusions:

The needs and ways to support dissemination of information in developing countries differ markedly from those in industrialized countries. It is not appropriate to transfer
“models” in common use in the latter to the former. It is also necessary to promote autonomous initiatives to disseminate information in developing countries. The impact in their own institution and country, of research produced in a developing country, is much less if that research is published in a journal in an industrialized country, as compared with dissemination in a national media that is free access and with no charges for publication.

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A. Observations on aspects of how CABI manages and shares its information and data related to agricultural research

CABI is committed to contributing to the management, preservation and access of agricultural research information. We contribute in several ways, as a generator of knowledge and as a knowledge service provider as a publisher and as a partner in global thematic database development.

CABI has focused much of its efforts in harnessing the World Wide Web as the channel for sharing the knowledge we generate and the databases and services we provide to a global audience. We work with third parties to host our commercial databases including a new e-books platform, and in some cases we also have versions that we host ourselves. We work with technology partners to develop seamless content discovery and user centred design. We have an in-house content management system and many of our websites and databases are built on this platform. These systems and services are costly in terms of technology development and editorial input, hence value for money, efficiency, robustness, scalability and technical support are key in our decision making.

Our databases are open URL compliant and generate XML outputs. We apply DOIs to CAB Abstracts records and we have developed templates and metadata standards for each of our databases to match the needs of the users. The CAB Thesaurus is a key tool in applying index terms and keywords and has more than 62,000 plant, animal and micro organism names and the relevant CAS registry numbers for chemicals and commission notation for enzymes. The content in our database is therefore discoverable from web search engines.

Our priority at the moment is looking at the interoperability issues of matching pest and disease occurrence data with diagnostic and treatment information. This will enable farmers, extension workers, and agricultural research workers to plan and anticipate pest and disease threats.
### B. Case studies

<table>
<thead>
<tr>
<th>Name</th>
<th>Information type</th>
<th>Subject scope</th>
<th>Amount of digital information</th>
<th>Ownership and access</th>
<th>Information management standards</th>
</tr>
</thead>
<tbody>
<tr>
<td>CAB Direct</td>
<td>Bibliographic records and full text</td>
<td>Agriculture and Environment Research</td>
<td>&gt;9 million bibliographic records &gt;100,000 full text (Europe 29%; South Asia 29%; Central and South America 13%; Asia 9%; Middle east 8%; North America 6%; Africa 5%, and; Australasia 2%)</td>
<td>CABI owns copyright on the whole database and has permission from the copyright holders to host their full text. Access is by paid subscription. Global Agricultural Research Archive, a subset of CAB Direct is openly accessible.</td>
<td>Open URL compliant, DOIs (more than 1.5 million with 460,000 added to the Archive back to 1914), CAB Thesaurus, meta search compliant, API compatible</td>
</tr>
</tbody>
</table>

| Invasive Species Compendium   |Datasheets/Factsheets                       | Invasive species management                 | ~ 1500 detailed factsheets on invasive species ~ 7000 basic factsheets ~ 65,000 bibliographic references ~ 4,000 images ~ 750 full text reports | CABI owns copyright on the whole database. Openly accessible to all | Open URL compliant, CAB Thesaurus, built on in-house content management system |

| Biofuels Information Exchange | Information portal to relevant documents and discussion space | Biofuels crop production and impact | ~35,000 bibliographic references ~ Links to related information ~ Discussion forum ~ Membership space | CABI owns copyright on the site. Most of the site is openly accessible to all. Closed area for Members discussion fora. | Built on Ning platform |

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Persistent identifiers: comparing schemes for their use in the CIARD Framework

Hugo Besemer

Applying the CIARD values implies that more digital objects will become available on the web. These objects may have relations. For example datasets may underly research publications, or preprint versions are related to publisher’s versions of journal articles. (“Green Route to Open Access”) If we want to make full use of these relations and create enriched documents we need to establish stable links between objects. Therefore we cannot go on characterizing many of these objects only by their URL, indicating its temporary location One of the first challenges for those wanting to set up data repositories is choosing an identifier scheme and make sure that there is a resolver service that will redirect the user who wants to access a resource to its current location. The need to identify digital objects uniquely, independent of their location, has been recognized early when the architecture of the web was developed - the Uniform Resource Name was meant to go side-by-side with the URL. A few years later a successful real life implementation of an identifier scheme with a resolver service we developed by the publishing industry, i.e. the Digital Object Identifier (DOI) This paper discusses the most appropriate identifier schemes that could be used in the CIARD framework (URN, Purl, DOI, ARK, Handle) as well as the Handle resolution protocol. Suggestions will be made for a role that CIARD can play.

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Perspective on Efforts to Share Data and Information in the Central Asia and Caucasus Region

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Five countries of Central Asia (Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, Uzbekistan) and Caucasus (Armenia, Azerbaijan, Georgia) occupy the geographic area exceeding 4 million sq. km (about 3 % of the Earth's dry land), which is characterized by a great variety of agricultural directions, plant and animal species, etc. They have a total population of more than 75 million, a large number of which (up to 40%) live in rural areas and are dependent on agriculture for their livelihoods. The GDP per capita is highest in Kazakhstan (USD 8,500, 2010), and lowest in Tajikistan (USD 800, 2010).

Developments in the CAC region's diversified agriculture, with up to 100 agricultural research institutions and universities take place in the very unusual context of the Research and Development Sector in the post-soviet era in these countries, as well as overall declining of agriculture production.

Improving agricultural information services can enable improve agricultural research and innovation in the CAC region, helping to restore agriculture production and contributing significantly to poverty reduction in rural areas where 70% of poor reside.

Since 2000, FAO and later (since 2004) GFAR and CACAARI (Central Asia and Caucasus Association of Agriculture Research Institutions) have had contributed essentially into development of the Regional Agricultural Information System of CAC region. From the very beginning efforts were focused on the creation of conditions for efficient agriculture information exchange regionally and internationally, as well as locally for the benefit of agricultural and rural producers. The task was complicated by changing organizational environment. For example, in a number of countries the National Centers for Scientific and Technical Information, – the most experienced bodies in agricultural information in CAC region, - supposed to take part in the RAIS were close done. The corresponding agriculture information resources were lost.

CACAARI, perhaps in difference from other regional associations, had to solve several problems in parallel: finding new partners for RAIS, create local and regional (joint) information resources and establish information exchange among them. A very positive role in solving the problem had played the assessment survey of RAIS initiated by GFAR in 2007.

Currently the new National Nodal Information Points are identified and their local and regional tasks are determined. Existing national data bases are identified as well. National Nodal Information Points are organizations which will constitute the initial
core of RAIS. These are State Agricultural University libraries, remained National STI centers (in Kazakhstan and Georgia) and some other organizations. Their tasks are:

- To develop National agro information resources
- Insuring their accessibility and interoperability regionally and internationally
- To develop jointly regional data bases on institutions, experts, projects and project outputs, as well as Farmers Organization, NGOs, universities, extension, private sector agricultural research organizations, etc.
- To improve information services for local agriculture related organizations using local, regional and international information resources
- To involve more local agricultural and related organizations into local, regional and international information exchange (in the framework of CIARD initiative and through other available mechanisms)
- Strengthening CACAARI.RAIS Website and Electronic infrastructure so that GCARD related activities such as e-discussions, document repository, etc. can be undertaken appropriately.

Some of NNIPs already have entered the CIARD.Ring.

There a number of National bibliographic data bases available on-line in the region, for the most part multidisciplinary, embracing agriculture as well. These are databases on books, papers published in local journals, doctoral thesis, R&D reports, as well as on articles from newspapers and magazines, papers by local researchers published in international journals, national patents, etc. The databases are in national languages, English and Russian. A number of systems of classification are used for indexing: UDC, Russian State STI classification, IPC, Thomson ISI classification, etc. The MICROSOFT SQL SERVER software is in use predominantly for data bases’ management.

A number of measures to improving ICM for ARD in the region are envisaged in 2011 and the following period. The ICM Status Report for ARD in the CAC Region will be prepared.

This will provide evidence and direction for investment, capacity building and activities to be initiated at National and Regional levels. A CIARD and CIARD-related advocacy and support workshop is planned in Tbilisi, Georgia as the NNIPs’ capacity building measure.

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**Agricultural Information Sharing in – the Gains Experience**

Joel Sam  
CSIR-Institute for Scientific and Technological Information

**INTRODUCTION**

Agricultural research and development are influenced by unimpeded flow of information among the sector’s stakeholders including lecturers, researchers, students, policy makers and farmers. In the past, however, provision of agricultural information support services in Ghana remained largely uncoordinated and several useful documents were scattered in various agricultural institutions and among researchers and generally had limited distribution. Besides, useful international and local journal articles were also generally not accessible to Ghanaian lecturers and researchers. This situation was partly remedied in 1991 when the Ghana Agricultural Information Network System (GAINS), a network of 18 Ghanaian agricultural research and academic libraries, was established to revive the library and information system in the agriculture sector to support agricultural research and development.

It facilitates a question-and-answer service to address stakeholders’ agricultural information needs, attempts to improve the accessibility of locally produced research, and builds the capacity of stakeholder institutions' libraries and information management professionals. It is managed by a coordinating centre based at the Institute for Scientific and Technological Information of the Council for Scientific and Industrial Research (CSIR-INSTI).

GAINS, therefore, plays a frontal coordinating role in the harnessing and sharing of agricultural information (both locally and internationally generated) in Ghana. Though GAINS has performed well over the years and has considerably increased and facilitated the flow of information among stakeholders, it faces some operational challenges not the least of which are inadequate capacity to harness and share generated agricultural information especially in digital forms to be readily accessed by potential end users. It is against this background that the Ghana AGRIS Pilot Project (GAPP) was established in 2007.

**GEOGRAPHIC COVERAGE**

GAINS has a relatively small coordinating secretariat, but is composed of stakeholders across Ghana, including the nine agriculture-based institutes within the CSIR network, the Biotechnology and National Agricultural Research Institute (BNARI), the agriculture faculties of most of Ghana’s universities, and the library of the Ministry of Food and Agriculture. Though until recently it has only focused on research institutions, it is intended to serve all stakeholders in agricultural information in Ghana.
PURPOSE
GAINS' purpose is to bring together the creators and disseminators of agricultural research information in Ghana to increase information sharing and collectively address their common needs. GAINS' coordinating centre has been increasing stakeholders’ collective access to scientific information, especially international journals.

OBJECTIVE
The objective of GAINS is to establish a coordinated information network that seeks to collect, process, share and repackage for dissemination, agricultural information generated in Ghana or elsewhere in any format to support agricultural research and development in the country. In this capacity, it is intended to:

i. To encourage generation and sourcing of agricultural information and knowledge;
ii. To develop capacity in agricultural information/knowledge management to ensure effective networking;
iii. To enhance access, sharing and dissemination of locally generated agricultural information and knowledge;
iv. To develop repositories, including databases of experts, of locally generated agricultural information/knowledge resources;
v. To provide tailor-made information services, including question and answer (Q & A) services, selective dissemination of information (SDI), current awareness services (CAS), radio broadcasts, etc to research scientists, policy makers, extension officers, faculty, students, farmers, etc;
vi. To improve communication among all stakeholders in agricultural information;

vi. To advocate for investment in agricultural information.

RELATION TO NATIONAL POLICY ON INFORMATION AND COMMUNICATION
From the outset, GAINS has been funded by the Government of Ghana as the information sharing component of its World Bank Agriculture Projects under the National Agricultural Research Project (NARP). The government’s recent National ICT for Accelerated Development Policy discusses the need for increased access to and exchange of research information, and the Ministry of Food and Agriculture's ICT strategy mentions strengthening GAINS as a key strategy of its plan to revitalize agricultural research and development.

The priority areas that the policy document has identified and seeks to address include:

- Developing scientific and industrial research capacity to promote the attainment of an efficient, diversified, technologically progressive, and market-driven industrial sector that is capable of sustainable economic growth; and also encouraging the transformation of the society to become more scientifically based and improve technology for increased productivity in all economic sectors.
Modernizing agriculture and developing agro-business by encouraging rural development and promoting the establishment of a robust and diversified agricultural sector. This will ensure national food security and adequate supply of raw materials at competitive prices for industrial production.

Therefore, within the framework, the CSIR has clearly outlined its ambition to position itself to ensure that its activities fit very well into the overall policy goals of the Government of Ghana in terms of:

- Strengthening the information facilities and capacities; and
- Supporting the establishment of a sustainable national network that will provide STI using appropriate ICT tools to improve access to S & T materials to support R & D activities in the country.

**PRODUCTS AND SERVICES**

**Information content**

GAINS offers web-based access to agricultural research information, both from local research institutions and from international journals. Resources of specifically Ghanaian information include:

- The Ghana Agricultural Research Information (GHAGRI) database - a database of records of locally produced agricultural research
- Union List of Agricultural Serials (ULAS) - a list of journals held by stakeholder institutions
- An Experts database of Ghanaian specialists on various agricultural subjects (AGRIEX)
- Records from the Ghana Science Abstracts Bulletin (GHASAB) - The Ghana Science Abstract database is a bibliographic database of refereed journal articles in the area of science and technology.
- RESPRO - This is a database of on-going research projects in science and technology with indications of the principal researcher(s), collaborators, objectives, start and ending dates, funding, etc.
- A directory of the agricultural databases held by the various GAINS stakeholder institutions
- A directory of Ghanaian agricultural student theses and dissertations
- Institutional repositories of metadata and selected associated full-text documents in some stakeholder institutions.

AGRIEX, GHASAB, GHAGRI and the thesis database, as well as the GAINS newsletter archive, are accessible from the GAINS website. GAINS sends out lists of available materials to institutions and includes them in its newsletter, and researchers or librarians are expected to request it.

**Content development and management**

Internationally generated information is made available from various journals through databases of abstracts and full-text articles. Generally the choice of databases and CDs is based on what is made available by donors. Locally generated information is developed by researchers at stakeholder institutions and is verified by the submitting institutions.
**Language and medium**
The information provided by GAINS generally consists of scientific documents, which are sent to stakeholder institutions on request in hard copy or made available online. All are in English, and most of the language used is relatively complex. GAINS has recently begun supporting the repackaging of information requested by farmers and extension workers into less complex, more accessible formats such as video and radio programmes, some of which are in local languages.

**INFORMATION SHARING MECHANISMS**
A number of mechanisms are used in Ghana to share agricultural information among the various stakeholders. These are:

**Question & Answer Service**
GAINS operates a CTA funded Question and Answer Service which provides information on demand mainly to researchers, lecturers and students. The service allows stakeholders in agricultural development to access information services on demand in the form of responses from researchers, bibliographic references and full text documents. The service has been enhanced through the use of radio to respond to the information needs of farmers and agricultural extension agents. Agricultural research scientists, willing to participate in the service and share their knowledge, are identified through the experts database and either respond to questions in their area of specialization or serve as guests on radio programmes.

**GAINS Publications**
GAINS publishes GAINSNEWS, a quarterly publication of GAINS activities and highlights of agricultural technologies. The newsletter is available and distributed in print format. In addition to the print version, the newsletter is also available in digital version on the GAINS website.

**GAINS website**
One of the mechanisms used to share information is the GAINS website. It is used to link people through a database of experts (research scientists and agricultural information professionals), provide links to institutional repositories and online documents, i.e. documents from GAINS activities such as project reports, annual reports, consultants’ reports, workshop reports, etc.

In 2000, GAINS developed a website, with the initial support of CTA, from which GHAGRI and other databases were searchable. In 2001/2002, KIT connected GAINS to IICD, which helped the coordinating centre install a local area network (LAN), arranged improved web-hosting, and trained member institute librarians in information retrieval.

**Making information available to scientists**
GAINS has several different processes for making information available to scientists. Many of GAINS resources are available online to institutions that have
connectivity. These online resources are expanding to include almost everything GAINS has on CD. However, for information not available online, once or twice a year the GAINS coordinator drives around the country and updates electronic databases at each stakeholder institution. When scientists find an article or journal they want, they (or their librarian) call or email the request to GAINS and then GAINS mails it to them. This is a slow process, but is unavoidable because it would cost too much to buy full electronic copies of the journals for every research institution. In addition, due to copyright issues, most of GAINS’ CD-Rom articles cannot be emailed or made available online. GAINS also sends out local journals and its own newsletter and the abstracts bulletin.

**Repackaging information**

GAINS’ pilot project with extension agents and farmers (funded by IICD) consisted of partnering with an agricultural information centre of the Ministry of Food and Agriculture to show videos describing different agricultural technologies to selected communities. Communities were then trained in a chosen technology, the training was videotaped and the tape made available at the information centre. The training was also broadcast on a local community radio station. GAINS is planning to expand this effort to other communities. Many of GAINS stakeholder institutions also disseminate and repackage information autonomously, through the RELCs or other means. Many also put their scientists on their area radio stations to discuss different agricultural issues.

GAINS already collaborate with two community-based FM radio stations – Radio Peace, Winneba and Royals Radio, Wenchi. Within this framework, GAINS will encourage member institutions, especially agricultural research institutes, to identify appropriate technologies that could be of interest to farmers and fishermen, and in collaboration with the Radio stations, produce suitable radio programmes for dissemination to farmers.

**Face-to-Face Interactions**

Face-to-face interactions, mainly in form of meetings, workshops and conferences, are the most effective approaches for knowledge sharing. Already there are several face-to-face forums organized in the country in which organizations and individuals within GAINS participate. Among these the CSIR Research Staff Association’s Annual Meeting, CRIG Research Staff Annual Review Meeting and the Ghana Library Association Annual Meeting, etc. GAINS will encourage member institutions to make use of these forums as knowledge sharing mechanisms.

**National Conference**

To facilitate sharing of agricultural information and knowledge in the country, the GAINS Coordinating Centre initiated and coordinated in February 2010, the organization of a national biennial conference on various aspects of agricultural information and knowledge for development for a broad range of stakeholders (researchers, policy-decision makers, farmers, information professionals, farmers’
organizations, Ministry of Food and Agriculture and related ministries, etc) in the country as a face-to-face knowledge sharing forum. The conference provided GAINS member institutions, including national and international stakeholders, an opportunity to meet and share knowledge in the field of agricultural information and knowledge for socio-economic development of the country.

TECHNOLOGY AND SYSTEMS
Information Technology (IT) system architecture
GAINS' back office IT system includes a database-driven website that can be updated from the GAINS coordinating centre and from stakeholder institutions. Several of GAINS’ resources are available online, allowing researchers to use them directly if they have connectivity. Others are housed on CDs at the coordinating centre, and abstracts of their contents are put on the computers of stakeholder institutions.

GAINS relies in large part on the IT systems of stakeholder institutions, which vary a great deal. All institutions have been given some sort of infrastructure under different donor projects, but at many institutions, investment in IT infrastructure is still not a priority. Many institutions have broken-down hardware, and at times computers containing the GAINS abstracts have broken, rendering the information inaccessible. All institutions now have connectivity, but often the connections are so slow that scientists go to cybercafés or wait until late at night to browse. For years, CSIR has been trying to set up a wide area network with all stakeholder institutions, but has not yet succeeded. Several institutions now have LANs, and one university will begin running a LAN version of TEEAL in November 2006, but none are connected to other institutions. Scientists at some institutions have now taken it upon themselves to pay for connectivity out of their own salaries.

Software
GAINS’ databases and website are all run on software available free online. The GHAGRI database, hosted at INSTI, runs on WebAGRIS, a multilingual web-based system¹. GHAGRI is linked to GAINS' website using the interface software GenISIS². Librarians at GAINS stakeholder institutions have been trained to develop their own institutional databases using CDS-ISIS³. WebAGRIS training was also given to stakeholder institutions, but no institutions decided to use it.

One stakeholder institution, FORIG, runs its own database using another system, Adlib, which it received from an external donor. The coordinating centre finds this problematic because it has difficulty translating the records into its ISIS format. FORIG’s information is therefore not available on GHAGRI, though it is accessible worldwide through the GFIS database. Adlib is thought by some stakeholders to be more user friendly, but it is too expensive for the network to be able to pay for all member institutes to use it.

¹ downloadable at www.fao.org/agris/tools/WebAGRIS/Webagdw.htm
³ www.unesco.org/webworld/isis/
Benefits and challenges

The key benefits of GAINS are:
- improved capacity among stakeholder institution information management professionals
- improved stakeholder access to agricultural information
- increased accessibility of locally generated information

However, GAINS still faces many challenges, which are summarized below.

Scarcity of local research content
Despite the efforts of the coordinating centre, locally generated research output is still quite difficult to access, as very few of GAINS’ member institutes have functioning repositories for their research output, and even fewer effectively share their output with the rest of the network.

Lack of information sharing and institutional prioritization by scientists
In many cases, scientists are either unaware that they are supposed to submit their work to the network, or are not motivated to do so. Published works are already available in international journals, and scientists do not seem to be interested in whether they are available locally. A great deal of research is also donor-funded, which has meant that scientists often feel that they and the donor, rather than the institution, own their research, and therefore they are not obligated to submit it to the library. Scientists are also reluctant to share unpublished works for fear of plagiarism. This has all resulted in severe underpopulation of the online databases of Ghanaian research. Scientists also do not frequently write institutional capacity-building elements into their research proposals.

Lack of capacity in libraries
Librarians at institutions are supposed to be the key connection between researchers and GAINS. However, they generally have fewer academic qualifications than scientists, they are paid very little, and there is high turnover. Many years of under-resourcing of institution libraries has also weakened the relationship between researchers and librarians, because researchers no longer go to libraries for information, not expecting to find anything current. This has meant that librarians have not been very successful at promoting GAINS’ resources, motivating researchers to submit their outputs, or taking advantage of the trainings they have been given. Many also have had hardware problems. Scientists at several institutions have discussed creating their own database of information. Some of the systems used by GAINS, such as CDS-ISIS and AGORA, also require some learning before they can be effectively used, and high turnover has meant that this has sometimes been a problem for librarians.

Lack of knowledge of GAINS by other users
GAINS information is not sought out by all potential users, such as extension agents and NGOs. This seems mainly due to a lack of knowledge of GAINS on the part of many potential users outside the research community. GAINS non-online
resources cannot be accessed without coming to Accra, or visiting one of the research institutes, looking at lists of the resources available, and writing to GAINS. Most non-researchers do not seem aware of this possibility.

**Lack of infrastructure at stakeholder institutions**

Poor or no connectivity, power outages and computer breakdowns in many cases block scientists from easily accessing GAINS resources, and have affected the capacity of many institutions to create databases of their libraries.

**Conclusion**

GAINS is now attempting to re-position itself to face these challenges. One course of action discussed is to develop clear Memoranda of Understanding with member institutions outlining their roles and responsibilities and requiring minimum contributions of resources to the network or their libraries, and to only include those willing to accept these responsibilities to join the network. The hope is that building the capacity of several key institutions that have shown motivation, and demonstrating the benefits they gain, will inspire others to follow.

**References cited**


DIGITAL SOURCES OF AGRICULTURAL INFORMATION IN GHANA

CASE STUDY ONE

Title: Ghana Agricultural Research Information (GHAGRI) Database

Description: GHAGRI database is a bibliographic collection of information on all aspects of agriculture and rural development in Ghana. Records in the database dates back to 1900 when agricultural research started in Ghana.

Information type: Information in the database includes research reports, technical reports, conference papers, journal articles, books, and theses.

Subject scope: Mainly agricultural science and technology, rural development and related disciplines.

Amount of digital information: This is a bibliographic database and contains ?9647 records.

Ownership and access: The database is owned by the participating research institutes that contribute data to it and can be accessed at the CSIR-INSTI or online at: www.gains.org.gh.

Information management standards: Database was developed using the WINISIS software and indexed using AGROVOC Thesaurus. The GHAGRI database, hosted at INSTI, runs on WebAGRIS, a multilingual web-based system. GHAGRI is linked to GAINS’ website using the interface software GenISIS.
DIGITAL SOURCES OF AGRICULTURAL INFORMATION IN GHANA

CASE STUDY TWO

Title: Ghana Science Abstracts (GHASAB) Database

Description: The GHASAB database is a bibliographic database of refereed journal articles published in Ghana or about Ghana in the area of science and technology.

Information type: Information in the database includes research reports, technical reports, conference papers, journal articles, books, and theses.

Subject scope: Contains information on science, technology and innovation.

Amount of digital information: This is a bibliographic database and contains 2450 records.

Ownership and access: The database is owned by CSIR-INSTI and can be accessed either at CSIR-INSTI or online at: www.gains.org.gh.

Information management standards: Database developed using the WINISIS software and indexed using Spine Thesaurus for Science and Technology.
### DIGITAL SOURCES OF AGRICULTURAL INFORMATION IN GHANA

#### CASE STUDY THREE

**Title**: Ghana AGRIS Pilot Project (GAPP) Institutional Repository Database

**Description**: GAPP Institutional Repository is made up of metadata and associated full-text collection of information on all aspects of agriculture and rural development in Ghana.

**Information type**: Information in the database includes research reports, technical reports, conference papers, journal articles, books, and theses.

**Subject scope**: Mainly agricultural science and technology, rural development and related disciplines.

**Amount of digital information**: This is made up of metadata and associated full-text documents and contains \( \textbf{3505} \) records.

**Ownership and access**: The database is owned by the participating research institutes that contribute data to it and can be accessed either at the GAINS Coordinating centre, participating research institute or online through the respective local area networks.

**Information management standards**: Database developed using the WINISIS software and indexed using AGROVOC Thesaurus.

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Review and Outlook of National Agriculture Data Center: Key Technology and Data Resource

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1. Overview of National Agriculture Data Center
NADC is a nation-wide datacenter of agricultural data including original data, documents, images, videos, as well as knowledge, standards, applications that manage, process, publish and exchange those various information. With a hierarchical structure of 7 sub-center and 31 subject branch as well as 10 area service centers, the NADC contains more than 2TB data in 62 topic databases and serves almost 10 thousands registered individuals and organizer by more than 200 millions accessing. It has become the biggest agri-data center in china.

2. Key Technology of NADC
Data resource management and sharing are supported by distributed shared web group. Application sharing service system provides the tools and convenience for data resource management and sharing.

3. Future and Development of NADC
More resources, higher level, better service: Steadily improving the existing standard specification system for the larger rang of data integration and sharing. Strengthening management and technology of data sharing to improve the ability of data resource management and service level. Exploring the technology of automated data processing and quality control to enhance the efficiency of data resources processing and quality level. Further expanding publicity and training to increase data resource and service capabilities of the platform

4. The Search Engineer of Agriculture Web Resource
SDD is a web search engine specified for agri-relatives. Since running from 2006, it has attracted more than 20,000 registered and 30,000 regular individual and organizational users that cover farmers, businessmen, researchers, technical developers, government officers, etc. with average 1000 new users per month. SDD outstands its competitors and general web
search engines for its high-efficiency algorithm, high user experience, and the intelligence similar to agri-experts.
Perspectives for Agricultural education information sharing

Li Sijing
Graduate School, CAAS

1. The Graduate School of CAAS
The Graduate School of the Chinese Academy of Agricultural Sciences (GSCAAS), founded in 1979, was approved by the State Council of China in 1981 as one of the earliest degree conferral institutions for Master and Ph.D. degree. Characterized by its integration of instructional programs and the frontier research activities in the CAAS research institutes, the Graduate School of CAAS has been successfully educating a patch of highly talented agricultural scientific and technological professionals for years. GSCAAS’ faculty and staff include two academicians of the Chinese Academy of Sciences, nine academicians of the Chinese Academy of Engineering, more than five hundred Ph.D. student advisors and one thousand Master’s student advisors. The four categorical discipline areas in the Graduate School include agriculture, natural sciences, engineering and management science, covering fifteen primary disciplines in which seven are Ph.D. level primary disciplines (crop science, horticulture, plant protection, agricultural resource utilization, animal science, veterinary, and agricultural economics) and eight are Master level primary disciplines. The Graduate School of CAAS offers 44 Ph.D. programs, 8 postdoctoral research stations and 56 Master programs. The GSCAAS has more than 1,300 supervisors, including more than 500 doctoral supervisors. Instructors, provincial and ministerial experts 156, senior staff of professional and technical positions 2041 people. There are also over 350 teachers, including nearly 70% of the teachers belong to CAAS, 30% professors, experts and academics are invited from other universities.

2. The professional degree education
The professional degree education is one of the important programmes of the GSCAAS. Professional degree is mainly for the social needs of a particular career field to develop strong professional competence and professionalism and make the students to be able to engage in practical work creatively. GSCAAS started its professional education since 2002, till 2011, the total of Graduate Students (including agricultural extension and veterinary Master Degree) enrolled more than 2500; granted 723 Agriculture promotion of a master's degree and 33 veterinary degree. It offers great opportunity for young people in agricultural Extension fields to mater high tech and practical skills in their services to farmers. It also provides various training courses in management, technology and fields demos to help them to give a full play in their professional activities.

3. Changing rural educational information sharing in remote areas through networks
As China is one of largest country in agriculture and there are huge amount of technical staffs at grass roots. The education and training has been especially needed at the remote and rural areas. The extension and technical staffs are eager to learn and improve their ability and skills in their services to farmers. So, I agree with the comments that “The information and knowledge flow is not unidirectional but multidirectional. One important direction of the flow that GFAR is also very much
concerned is from User communities to research. This flow can help research not only blend indigenous and local knowledge and customize technology but also identify research problems and innovations that are needed by users”. We hope that we may have more international agricultural learning information through the web to meet the needs of the users in rural areas.

4. Developing and sharing international teaching information

International Degree level education has been improved constantly for years. It has accumulated rich experience in professional degree education. Through CIARD community, we may learn from each other and sharing international successful experiences and good practices, teaching methods, management, teaching materials and cases to accelerate the pace of Professional Education development for local agricultural extension staffs. Also, using ICTs in the agricultural learning and development will certainly show economic and social impacts on partners especially on students themselves. Over a period of time we have realized that using ICTs do save costs of both schools and students in accessing, teaching and learning of course materials and information related. ICTs offer new avenues and means of sharing the information in a large user community. Some cooperative projects can be considered in order to share the information and other resources in the field and make the agricultural research output to be disseminated, transferred and used by the rural community.

5. Enhancing agricultural teaching and learning quality and capacity

The ability to provide the information, knowledge and skills needed by rural stakeholders are still not adequate in GSCAAS. Sometimes capacities in organize, manage and disseminate the learning materials to needed and rural stakeholders are particularly weak which needs us to give more considerations. We expecting more changes have been appeared when CIARD community information sharing are realized and new ICTs to be used. In many cases, collaboration and contribution in promoting of the information sharing platform are more critical in order to enhance the ability and quality within the real cooperation and services.

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Sharing experience in the Network of Aquaculture Centres in Asia-Pacific

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About NACA
The Network of Aquaculture Centres in Asia-Pacific (NACA) is an intergovernmental organisation that promotes rural development through sustainable aquaculture. Our main activities include facilitation of collaborative aquaculture research and development programmes, capacity building through education and training, and sharing of knowledge and experience. NACA's eighteen member states collectively produce more than 90% of global aquaculture production by volume, or nearly 50% of the global foodfish supply.

The knowledge sharing dream
As a networking agency, NACA facilitates technical cooperation between member states. Member governments share their technical expertise and facilities, thereby gaining access to a larger pool of technical resources and infrastructure, and allowing them to avoid duplication of effort and build on one another's strengths.

NACA works with a broad range of stakeholders including small scale farmers, scientists and government officials. Much of our activities concern the development of improved farming practices for aquaculture commodities through collaboration of scientists and farmers. We also facilitate the organisation of small scale farmers into cooperatives to share experience, improve their practices and gain the economies of scale they need to remain competitive.

As NACA is a highly distributed organisation with limited resources, we place a lot of emphasis on using the web to share information and communicate with our stakeholders. NACA has been online since 2001. We introduced an open access policy in 2003 and started making all of our publications available for free download, mainly in PDF format. We expect the number of downloaded publications to exceed one million sometime this year.

The knowledge sharing reality
Most of our stakeholders have limited IT skills. Non-electronic forms of communication such as printed publications, practical training courses and face to face meetings are very important, and for some stakeholder groups absolutely necessary.
Most institutions do not have electronic information systems beyond a simple website, and have yet to establish the internal policies and technical skills to maintain them. Much of the research they do is not captured in a form that is available to the external world. Some institutions still do not have basic internet access. Network scientists often face severe restrictions in access to scientific literature, due to funding constraints. Due to the international nature of the network, language is also major barrier to sharing experience.

The web has enabled NACA to communicate with more people than ever before, but to a large extent this is a new and different audience to our traditional stakeholders. A large proportion of people that use our website are not from NACA member states. Of our stakeholders, some groups have better access and capacity to use internet resources than others, for example scientists are better represented than farmers, and countries where English is widely spoken are better represented than countries where it is not. Despite these disparities, the absolute number of stakeholders who access NACA's services via the web is much larger than the number of people the organisation can interact with by "traditional" means, and so well worth pursuing.

**Looking ahead**

The growth of internet usage in Asia is above the global average. While the per capita penetration of internet usage in Asia is about half of the global average, Asia has about 40% of the world’s internet users. These figures are skewed towards urban populations and young people, but rapid advances in mobile computing are bringing the internet to rural areas as well.

Mobile phones have finally reached a level of competence where they are actually useful as internet devices. Today's 'smartphone' functionality and touch interface looks set to become mainstream, affordable and ubiquitous in the near term. Internet access via mobile phones is forecast to overtake conventional computers sometime around 2013. For many people a mobile phone is likely to become their primary, and perhaps only, entry point to the internet. Android in particular is worth investigating as an opportunity for networking agricultural knowledge.

Hosted web publishing platforms such as Facebook, Blogger, Youtube, Flickr, Squarespace and similar allow individuals or institutions to start sharing their content without need for sophisticated IT skills and at little or no cost. Such services offer a useful way for institutions to 'get online' while developing their internal capacity. They represent an opportunity to lower barriers to entry and address issues of standardisation, if tools appropriate to agriculture could be developed.

The web is expanding from its original 'document-centric' focus to encompass a web of data, services and devices. In 2003, PDFs were a very convenient way to share documents with people but today, we also need to consider sharing data with machines. NACA has begun exploring mechanisms to make our website content interoperable with other systems and more accessible by mobile devices.

**Moving towards standards and interoperability**

The NACA website is based on an open source content management system (ImpressCMS). Like most such tools, it has been primarily designed to publish content...
for online viewing by people. Little consideration has been given to issues of interoperability with other machines/systems or of mobile access.

To address these issues we have started writing our own software modules for the system. Our first release is a module called "Podcast", which is focused on the publication of audio records. Podcast is designed to publish audio recordings of workshop presentations and to facilitate their distribution to mobile devices and to external libraries and publication catalogues:

- Internally, the module uses Unqualified Dublin Core fields to describe each programme or soundtrack that is added to the database.

- The module provides a minimal implementation of the Open Archives Initiative Protocol for Metadata Harvesting (OAIPMH), which is used to share the soundtrack records with external partners such as Avano, a marine and aquatic sciences OAI harvester operated by IFREMER.

- The module generates an RSS feed with enclosures, which allows soundtracks to be automatically discovered and downloaded by podcasting clients, including mobile devices.

- As you would expect, the module allows soundtrack metadata to be viewed on the website and recordings can be downloaded or streamed online.

- The module is deliberately designed to "just work". Installation is a simple two-click process. The module sets up a functioning OAI repository without any further action on the part of the user.

We intend to offer a set of OAIPMH-compliant modules covering essential CMS content functionality for this system. We hope this will enable ImpressCMS users to share their content more broadly and stimulate further interest by other developers. A more generic 'library' module, geared towards a broader range of content types is in public beta and a news module and several others are in development. Development of OAI harvester functionality to enable ImpressCMS sites to consume OAIPMH content is planned.

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The role of the CIARD RING in the Building of the CIARD Framework for Data and Information Sharing: now and in the future

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The RING now.

The RING (Routemap to Information Nodes and Gateways: [http://ring.ciard.net](http://ring.ciard.net)) is a categorized registry of information sources/services in agriculture.

The services registered in the RING are described in details and categorized according to both content criteria (subject area, quantity and type of resources...) and technical criteria that are relevant to the use of the service and its interoperability (such as metadata standards adopted, subject vocabularies used, technologies used, protocols implemented etc.).

The RING was created with the objective of making information sources more easily “discoverable” and to facilitate the re-use and re-packaging of their information by other services that need to make it accessible in different ways (different browsing and search options, different formats, different channels for different users).

The current functions of the RING are:

- to provide a map of accessible information sources with details on standards and technologies adopted and instructions on how they can be searched and re-used effectively;
- to provide examples of services that show good practices on implementing “interoperability”;
- to provide references to relevant information management standards and tools and to infrastructural services (web services, endpoints) that facilitate their usage;
- to provide instructions for building enhanced integrated services that repackage information in different ways.

Who uses the RING?

The RING is designed mainly for agricultural information managers and IT professionals. The main objective is to help them provide better information services.

However, the RING was created with the needs of the end-users of agricultural information in mind.
Consumers of agricultural information will benefit from the RING infrastructure to the extent that the RING will be exploited by information service managers in order to: a) create better interoperable sources and b) leverage existing interoperable sources to provide better integrated information systems for their users.

**Current role of the RING in the CIARD framework for information sharing**

The potential impact of the RING in improving information sharing is not so much in the collected data itself as in what can be built out of it. Providing structured information on the metadata sets, formats, protocols and vocabularies used in each registered source will help information service managers find what they need for the building of applications like:

- services that offer a common browsing or searching interface to different sources;
- aggregating and harvesting services;
- integrated services providing relations between entities (organizations, projects, experts, documents) through semantic-web technologies;
- services that re-package information and make it available through different channels (text messaging, radio etc.);
- services that interface the different knowledge organization systems (KOS) used by different sources;
- applications providing value-added services like digests, bibliographies, best practices, surveys etc.

**The way forward: the infrastructural role of the RING in the future**

The RING exposes all its data as RDF\(^1\) and makes it remotely queryable through a SPARQL endpoint\(^2\). This makes all the information collected in the RING readable and processable by machines, thus potentially allowing advanced services like harvesters or aggregators to automatically link to new sources that have the required thematic coverage and use the required standards, protocols, vocabularies etc.

Once the descriptions collected about services are detailed and structured enough, and once the number of registered services is sufficiently large, the RING can become a digital infrastructure that services can query directly (machine-to-machine) in order to include new sources and/or look up namespace definitions or standard vocabulary endpoints.

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\(^1\)“Resource Description Framework” (see [http://en.wikipedia.org/wiki/Resource_Description_Framework](http://en.wikipedia.org/wiki/Resource_Description_Framework)). Basically, all the data in the RING are structured into triples that are serialized as XML, using widely known RDF vocabularies.

\(^2\)SPARQL is a query language for RDF (see [http://it.wikipedia.org/wiki/SPARQL](http://it.wikipedia.org/wiki/SPARQL)).
Examples of such services can be:

- A global harvester of all registered providers of Open Archives
- A viewer/navigator for registered RDF stores
- Thematic aggregators that harvest from registered RSS (for example AgriFeeds could use the RING as a directory of RSS feeds)

Examples of such services could be built directly within the RING itself. However, the main objective of the RING is not that of providing direct access to information coming from the registered sources / services, but that of providing valuable information and examples to the managers of information systems so that they can provide better access to information. But sample services (like sample consumers of web services or sample programming code on how to implement services) with ample documentation can help information managers and web developers to build similar services.

This is why the advanced services that may be built in the RING are mainly for demonstrative purposes, while the RING wants to support the development of actual services by the various actors that have a mandate to serve specific stakeholder groups / communities and improve their access to information and knowledge.

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As the agricultural sector in Yemen has grown rapidly during the past 10 years, the need for information in agriculture was increased to help decision makers and researchers in policy development and to serve farmers needs of information. Despite the fact that there are more than 20 governmental and non-governmental institutions, concerned with research and information in various fields, this was not associated with the development of proper national information and communication strategies and policies. This situation has created confusion and mismatch in division of tasks between the different government institutions in one hand and with other non-governmental organisations in the other hand. Moreover, most of the efforts that were started to develop information strategies and policies came to a stand still situation with no ultimate outputs.

Generally speaking, several organisations, information centres and departments that deal with agricultural information could be found within the different ministries of the public sector. The National Information Centre (NIC) within the Ministry of Telecommunication and Information Technology, the Central Statistics Organisation (CSO) within the Ministry of Planning and Development, the General Directorate of Agricultural Statistics (GDAS), and the Documentation and Agricultural Information Centre (DAIC) within the Ministry of Agriculture and Irrigation, and the Agricultural Research and Extension Authority (AREA), are all organisations functioning at the National level and are concerned with collecting, processing, documentation and communication of agricultural information.

With regards to the mechanisms of data and information sharing between the different public and private institutions and their branches, available studies show that communication by telephone and fax is still the most commonly used. Communication by post comes second and the use of traditional communication tools comes third. The least used systems of communication is e-mail and networking.

For data and information storage and retrieval systems, the use of paper work (books and recording sheets) comes first, while the use of computers for storage and retrieval of data and information comes second, followed by the use of photography and microfilms. More than that, about 50% of the development organisations do not have libraries, and if found, these libraries lack many important facilities.

The Agricultural Research and Extension Authority (AREA) is the main agricultural research institution in Yemen that serve as an important source of agricultural farm information at the national level. AREA has 13 branches and centres of which 8 regional research stations, 4 specialised national research centres, and one national
agricultural training centre (NATC). The 4 specialised research centres are concerned with food and post harvest research, livestock research, renewable natural resources with GIS data processing, and genetic resources collection and preservation.

More than that Information are published in AREA through a scientific journal, research and extension linkage periodical, and AREA compendiums of improved and new research technologies. Hard copies of these data forms are distributed to various governmental organisations (Ministries, agricultural offices, development projects, universities and research and information centres), non-governmental and private agencies (private agricultural companies, agricultural cooperatives, and some input dealers), and regional and international organisations working in the country. Technical support is also provided by AREA for extension and rural development agencies.

Recently, AREA has established its own data entry systems concerned with financial and personnel aspects, and research projects (institutions, activities, scientists, and research outputs). These systems were locally developed using visual basic system and Microsoft access software. AREA has also its own website, www.area.gov.ye, to communicate its own final research outputs (mostly in news feeds and PDF formats) and create public awareness.

Until the year 1990, AREA was involved in receiving AGRIS information packages and started to develop data entry under CDS/ISIS run by DOS system. But this was stopped, as the responsibility of this work was shifted to the Documentation and Agricultural Information Centre in the Ministry of Agriculture and Irrigation. The DAIC, then could not continue with the process due to several reasons of which lack of IT specialised persons, lack of financial resources and decision support, and the week links with local and regional institutions.

At regional and sub-regional levels, AREA has established linkage mechanisms to coordinate and exchange agricultural information through specialised research associations such as the Association of Agricultural Research Institutes in the Near East and Northern Africa (AARINENA), and the International Centre for Agricultural Research in the Dry Areas (ICARDA). Example of the established research networks are the Nile Valley & Red Sea Research Network (focusing on draught resistance, water use efficiency, some virus and bacterial diseases, and socio-economic studies), Arabian Peninsula Research Programme (focusing on management of green houses, water management, and range and fodder research), and Neglected and Under-utilised Plant Species Research Programme, which includes distribution and marketing studies and information exchange.

The role of the private sector in the agricultural information system is still limited, although a considerable number of private companies are working in production and marketing of agricultural produce and agro-inputs. Some of the big private companies have their own information departments and websites, but most of the information is used to serve their own purposes.

It could be indicated that there is still a lack of real basis of information systems development and information sharing, particularly in the agricultural and rural development sectors, as there is a lack of survey data on information systems, Lack of proper national and institutional information strategies and policies, lack of interest
or awareness about the importance of information, the tendency among researchers in dealing with information as a "personal good" rather than a "public good", making it difficult for institutional interoperability, the little scope for the development of culture of information sharing, and the lack of allocated budgets, incentives and decision support, within government institutions, for building mechanisms of information processing and information sharing.

In order to facilitate proper information processing and information sharing, some actions need to be taken at national, regional and international levels as follows:

- To encourage government authorities to prepare and implement proper information strategies, policies and regulations and to remove barriers affecting information processing and information sharing.
- To encourage role definition between the different divisions within the same agency and creating incentives that encourage researchers to publish research information for public interest.
- To encourage Institutional capacity building and staff training in information systems development and interoperability.
- To encourage mobilisation of financial and human resources to support building a comprehensive agricultural information systems.
- To encourage the exchange of success stories of information management and exchange at various levels.
- To facilitate research studies that focus on technical, cultural and socio-economic barriers affecting information publishing and information sharing.
- To encourage research institutions to register with the CIARD RING for better information services.
- To encourage AARINENA to advocate and facilitate the adoption of shared web application tools and vocabularies by research institutions for the promotion of proper interoperability.

Case studies of available digital sources of agricultural research information

Only two case studies, where agricultural research information are processed and shared or made ready to be shared, could be described. These are the GIS and PGR systems within AREA that are summarised as follows:

1. GIS & Remote Sensing Section was established in 1995, by AREA and an FAO project. Digital sources of agricultural research information/data are prepared in various fields such as soil, land use, water, agronomy etc. for the design and implementation of rural land use plans. The section focuses its activities on utilizing of satellite remote sensing and GIS techniques for improvement and development of natural resources database through studying and mapping of different aspect related to Agriculture such as Agricultural Lands of Importance to the ROY, Land Use / Land Cover Mapping, Land Use / Land Cover changes over times, Agricultural Land Use Maps, Agricultural acreage Assessment for different crops, Major Land Resource Areas, Land Degradation Assessment, Land Evaluation and Site Assessment, Land and Soil Classification, Land suitability for different types of crops, Prior Agricultural Lands, Prior Agricultural crops distribution, Vegetation Maps, Watersheds, Aquifers Maps, Water Quality Monitoring Sites, Waste lands, Agro-Climatic Mapping (Rainfall, Solar Radiation...etc.), and Flood Hazard Zones and others.
The section was equipped with hardware and GIS & Remote Sensing software as ArcInfo, ArcView and analysis programs in GIS, AIMS and ERDAS Remote Sensing in activities. Several agricultural maps are produced using the new computerized technology of GIS and Remote Sensing applications using satellite imagery – Landsat™ 7 band (27 scenes), spot Satellite imagery, aerial photos, and topographic maps.

2. Another case study is the information sharing mechanism on Plant Genetic Resources. In 1995, within the efforts made by the AREA Genetic Resources Centre, Yemen have joined the Global Plan of Action (GPA) that represents an important contribution for the implementation of the Convention on Biological Diversity in the field of food and agriculture. The Global Plan of Action includes 20 priority activity areas, organized into four groups, namely: In Situ conservation and development, Ex Situ conservation, Utilization of plant genetic resources, and Institutions and Capacity building.

In 2008, Yemen, with support from FAO, has established Information Sharing Mechanism on Plant Genetic Resources for Food and Agriculture that is based on the participation of stakeholders at national level and seeks to promote information exchange and strengthen stakeholder cooperation, thereby contributing to enhance the capacity of the National Program in the conservation and sustainable utilization of plant genetic resources and agro-biodiversity (http://www.pgrfa.org/gpa/yem/description1.html). The Mechanism takes advantage of a computer application to facilitate the management of the information on the implementation at national level of the Global Plan of Action.

Available information are institutes (information on 58 institutes), contact persons (contact information on 277 persons), projects (1108 projects with activities, plans, and courses), taxatab (data on 75656 scientific plant names and authorities), cultivars (data on 238 cultivated varieties, their pedigree and origin), areas (data on 41 geographical areas within countries), references (data on 462 references), and agreements (data on 2 bilateral or multilateral agreements).

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i) Article 17 of the International Treaty states that "Contracting Parties shall cooperate to develop and strengthen a global information system to facilitate the exchange of information, based on existing information systems, on scientific, technical and environmental matters related to plant genetic resources for food and agriculture".

ii) At its Third Session, the Governing Body requested the Secretariat to develop a vision paper to be presented to the Fourth Session of the Governing Body to take stock of existing information systems and to outline a process for the development of this global information system.

iii) The present document was presented to the Fourth Session and describes the existing major information systems on plant genetic resources for food and agriculture as well as number of related initiatives. The document outlines a number of activities that may be undertaken in the next biennium for the effective development and strengthening of a coherent global information system pursuant to Article 17 of the Treaty. The document also presents in the last section the guidance provided by Contracting Parties.
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*Appendix 1*  Compendium of technical strategic studies for the implementation of Article 17 of the International Treaty

*Appendix 2*  Major rice databases on the web relevant for research
I. INTRODUCTION

1. Article 17 of the International Treaty, placed under Part V “Supporting Components”, states that “Contracting Parties shall cooperate to develop and strengthen a global information system to facilitate the exchange of information, based on existing information systems, on scientific, technical and environmental matters related to plant genetic resources for food and agriculture, with the expectation that such exchange of information will contribute to the sharing of benefits by making information on plant genetic resources for food and agriculture available to all Contracting Parties”.

2. At its Third Session, the Governing Body “welcome[d] the efforts underway to coordinate and improve information systems documenting plant genetic resources for food and agriculture, based on existing information systems, which should build the basis of the Global Information System, foreseen in Article 17, consistent with Article 12.3b, of the International Treaty”.1

3. The Governing Body also requested the Secretary “to continue to collaborate with FAO and other relevant stakeholders on information technologies to facilitate their contribution to the continuous development of the global information system in the context of Article 17 of the Treaty, in order to promote greater access to relevant information and information systems by Contracting Parties and other relevant stakeholders, and [...] the Secretariat to develop a vision paper to be presented to the Fourth Session of the Governing Body to take stock of existing information systems and to outline a process for the development of this global information system”.2

4. The Commission on Genetic Resources for Food and Agriculture (Commission), at its Twelfth Regular Session, requested its Secretary "to collaborate with the Secretary of the International Treaty in the development of the vision paper that had been requested by the Governing Body of the International Treaty at its Third Session, to take stock of existing information systems and to outline a process for the development of the global information system in the context of Article 17 of the International Treaty, in order to ensure that the roles of the Facilitating Mechanism, WIEWS, and the National Information Sharing Mechanisms are adequately considered without duplicating efforts.”3

5. This document constitutes the vision paper that the Governing Body requested. It contains:

   a. An analysis of Article 17 in the context of other articles of the International Treaty and the decisions adopted by the Governing Body;

   b. Preliminary information on the major existing information systems on plant genetic resources for food and agriculture (PGRFA);

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2 Resolution 7/2009, Cooperation with the Commission on Genetic Resources for Food and Agriculture, para. 22.
3 CGRFA-12/09/Report, paragraph 27.
c. An identification of some of the major gaps at global level in the area of information exchange;
d. An outline of possible future work by the Secretariat in relation to the establishment of the global information system of Article 17 with a view to strengthening cooperation on this matter.

II. ANALYSIS OF ARTICLE 17 IN RELATION TO OTHER ARTICLES OF THE TREATY AND THE DECISIONS OF THE GOVERNING BODY

6. The main goal of the global information system, as described in Article 17.1, is

"to facilitate the exchange of information, based on existing information systems on scientific, technical and environmental matters related to plant genetic resources for food and agriculture with the expectation that such exchange of information will contribute to the sharing of benefits by making information on plant genetic resources for food and agriculture available to all Contracting Parties."

7. The reference in Article 17.1 to "existing information systems" suggests that there is a need for assessing carefully existing mechanisms, analyzing the relevance of their structure and content, and reviewing the interest and technical capacities of the institutions that operate those systems to contribute to the development and strengthening of a global system before new systems are established.

8. The reference to Article 17.1 to sharing of benefits through exchange of information reflects Article 13.2 which considers the exchange of information as part of the benefit-sharing in the Multilateral System:

"The Contracting Parties agree to make available information which shall, inter alia, encompass catalogues and inventories, information on technologies, results of technical, scientific and socio-economic research, including characterization, evaluation and utilization, regarding those plant genetic resources for food and agriculture under the Multilateral System. Such information shall be made available, where non-confidential, subject to applicable law and in accordance with national capabilities. Such information shall be made available to all Contracting Parties to this Treaty through the information system, provided for in Article 17."

9. The Governing Body discussed the linkage between the global information system and benefit-sharing at its Third Session, when, in fact, it welcomed the efforts underway to coordinate and improve existing information systems that should build the basis of the “Global Information System, foreseen in Article 17”.

10. Article 17.2 of the Treaty refers to “early warning” about hazards that threaten the efficient maintenance of plant genetic resources for food and agriculture (PGRFA) as one of the components of the information system, based on the notifications sent by Contracting Parties, with the aim of safeguarding the material. In fact, information is of fundamental importance to the conservation and sustainable use of PGRFA. While most genebanks

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4 Resolution 4/2009, see footnote no. 1.
have some form of information system or inventory, it is not always easy to have access to them, as many of those systems and inventories are not online and there are still few linkages among them. Furthermore, the information on the status of in situ genetic material is more difficult to document, systematize and share.

11. It is to note that the Resolution refers not only to FAO, but also to "other relevant stakeholders" and that such decision broadens the scope of collaboration beyond the activity of information exchange as it refers to "information technologies".

12. Article 17.3 of the Treaty states that "Contracting Parties shall cooperate with the Commission on Genetic Resources for Food and Agriculture of the FAO in its periodic reassessment of the state of the world’s plant genetic resources for food and agriculture in order to facilitate the updating of the rolling Global Plan of Action referred to in Article 14".

13. It can be concluded from the above analysis that the main thematic areas for which the global information system will be relevant are:

   a. Scientific, technical and environmental and socio-economic matters, including characterization, evaluation and utilization;
   b. Benefit sharing and access to genetic resources, deriving from:
      i. catalogues and inventories;
      ii. information on technologies;
   c. Early warning;

14. In addition, Article 17.1 requires Contracting Parties, in the development and strengthening of the global information system, to cooperate with the Commission in its periodic reassessment of the state of the world’s plant genetic resources for food and agriculture in order to facilitate the updating of the rolling Global Plan of Action.

III. STOCK-TAKING OF MAJOR EXISTING INFORMATION SYSTEMS

1. Information systems and tools in support of the Multilateral System

15. The Multilateral System of Access and Benefit-sharing started its operation in January 2007 and since then the Secretariat of the International Treaty has been gaining experience on information systems. In the inter-sessional period from the First to the Second Sessions of the Governing Body, the Secretariat organized the First Technical Consultation on Information Technology In Support to the Implementation of the Multilateral System of Access and Benefit-sharing, as a forum to discuss ways in which information technology could support, simplify and, as far as possible, automate and reduce the transaction costs of the processes involved in the Multilateral System.
16. In the following inter-sessional period, the Secretariat organized a second consultation in December 2008 and worked with potential providers and recipients of material from the Multilateral System in order to better identify users’ needs as well as simplify and automate the use of the Standard Material Transfer Agreement (SMTA), and develop and test responsive prototypes.

17. Both consultations gathered representatives from Contracting Parties, stakeholders and experts on information systems on PGRFA and other relevant fields. They promoted fruitful discussions among managers of information systems and databases in order to identify potential synergies for implementation of the Multilateral System.

18. Based on the outcomes of such consultations, the Secretariat designed an information system in support of the Multilateral System that facilitates the reporting obligations of SMTA parties and other activities relevant to the smooth operation of the Multilateral System.

19. The Secretariat also developed, in collaboration with the French Agricultural Research Centre for International Development, a stand-alone information tool to facilitate the generation of SMTAs for the transfer of material within the Multilateral System.

20. The Secretariat reported to the Governing Body at its Third Session in 2009 on these achievements and on a three-party project with Bioversity International and the Global Crop Diversity Trust which led to the design and implementation of a new system called “Genesys”. The system is described below in this document.

21. Since its inception, the Secretariat of the Treaty has informally collected information on the main features and status of systems and tools with high potential synergies for a possible integration into a global system information system on PGRFA.

2. Early warning systems and monitoring and facilitating tools

22. In the last twenty years, FAO has accumulated relevant experience on information systems on PGRFA, especially since the establishment of the World Information and Early Warning System (WIEWS) in 1993.

23. WIEWS was established as a world-wide dynamic mechanism to foster information exchange among FAO Member Countries by the gathering and dissemination of information on PGRFA, in conformity with Articles 7.1 (e) and (f) of the International Undertaking on Plant Genetic Resources. WIEWS has evolved over the years: in 1998 its first web version was released allowing users to retrieve information on about 6 million accessions from 1,400 ex situ collections; in 2000 remote updating capabilities were added to the web system to facilitate direct information uploading from national programmes. Automatic data gathering procedures for the update of the ex situ collections database have also been activated for web published genebank documentation systems and inventories for plant genetic resources for food and agriculture, such as CGN, USDA GRIN, EURISCO and SINGER.

24. WIEWS has been a key information source for the periodic assessment of the state of the world’s plant genetic resources for food and agriculture in 1996 and 2009, in particular with its unique meta-database on germplasm ex
situ holdings which now covers over 7.4 million accessions conserved in some 1,750 genebanks around the world.

25. A global network of country correspondents for information exchange on plant genetic resources for food and agriculture, who are officially nominated by their respective governments has served as focal nodes for information flows between countries and WIEWS.

26. Article 5 of the International Treaty requires Contracting Parties to survey and inventory PGRFA, assessing threats and to minimize or, where possible, eliminate them. The long-term objective of the early warning system as stated in para 281 of the Global Plan of Action, is "assembling information to enable remedial or preventive action to be taken". WIEWS works towards this goal through its network of correspondents, who are asked to provide information on threats to PGRFA. This network mechanism presents a great potential and should be expanded, to further facilitate the exchange of additional information among its members and others interested users. In this regard, three main forms of reporting on cases of plant genetic resources loss, including ex situ collections, crop wild relatives and local varieties, have been made available through WIEWS. However, further research on genetic erosion is required to define key indicators and methods for assessing it and its drivers over time.

27. Information exchange is one of the areas specifically listed in Article 14 of the International Treaty, as follows:

"Recognizing that the rolling Global Plan of Action [...] is important to this Treaty, Contracting Parties should promote its effective implementation, including through national actions and, as appropriate, international cooperation to provide a coherent framework, inter alia, for capacity-building, technology transfer and exchange of information, taking into account the provisions of Article 13."

28. Through the network of WIEWS country correspondents that currently covers more than 110 countries, participatory and capacity building activities for monitoring the implementation of the Global Plan of Action has been conducted in more than 65 countries worldwide during the past seven years. As part of this monitoring effort, key national PGRFA stakeholders have established National Information Sharing Mechanisms (NISM) and published through web portals and databases detailed information on the state of conservation and sustainable use of PGRFA in their respective countries. NISM data, which inter alia includes information on more than 24,000 publications, 18,000 projects, 61,000 cultivars and 18,000 stakeholders, can be accessed also through the World Information Sharing Mechanism on PGRFA and automatically feed the WIEWS database on ex situ collections.

29. It is worth noting that the Commission on Genetic Resources for Food and Agriculture stated that WIEWS should be further developed in the context of developing the Global Information System on Plant Genetic Resources for Food and Agriculture of the International Treaty. The Commission on Genetic Resources for Food and Agriculture expressed its willingness to work with the Governing Body of the International Treaty for

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this purpose, and further invited the Governing Body to consider utilizing national information sharing mechanisms established through WIEWS, as contributions to the development of its global information system.

30. In order to promote the provision of technical and financial resources to developing countries - especially least developed countries, and to countries with economies in transition - to address national priorities, FAO, together with Bioversity International and the Global Forum on Agricultural Research (GFAR), in 2007 launched the web-based portal of the Facilitating Mechanism for the implementation of the Global Plan of Action. The portal is a friendly access point to information on sources and availability of financial, technical and information resources on subjects related to the priority activity areas of the Global Plan of Action. Under the Facilitating Mechanism more than 730 funding programmes can now be searched for funding opportunities.

3. Information systems and research at the international level

31. Conservation of crop diversity in genebanks involves a wide range of diverse activities, each of which is necessary for the safeguard of the collections and to make that diversity available to other users. In doing so, there is no doubt that the Centres of the Consultative Group on International Agricultural Research (CGIAR Centres) have also accumulated large expertise in information exchange on PGRFA individually and in a collaborative way. Almost all the CGIAR Centres have developed their own documentation systems and inventories.

32. One of the most well-know initiative is the System-wide Information Network for Genetic Resources (SINGER), which is the germplasm information exchange network of the CGIAR Centres and its partners. Together, the members of SINGER hold around 693,752 samples of crop, forage and tree diversity in their germplasm collections. SINGER, which is an initiative of the CGIAR System-wide Genetic Resources Programme, provides easy access to information about that diversity.

33. As mentioned above, the Secretariat of the International Treaty, in partnership with Bioversity International and the Global Crop Diversity Trust, has supported the development of Genesys, which is an online information portal capable of linking all genebanks worldwide. The project has started to connect existing information systems, such as SINGER, and EURISCO, the web-based catalogue of European National Inventories for Plant Genetic Resources hosted at and maintained by Bioversity International on behalf of the Secretariat of the European Cooperative Programme for Plant Genetic Resources (ECPGR). At present, EURISCO provides passport information of more than 1 million samples (accessions) of crop diversity representing 5,383 genera and 34,823 species conserved ex situ in 41 European countries.

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7 http://singer.cgiar.org/
9 http://www.genesys-pgr.org/
34. Genesys is an accession level information system with a user-friendly interface that is being developed to improve the global information exchange. Practically, it works as a gateway distributing information on germplasm accessions. It is currently the largest catalogue of accession information obtainable by breeders, scientists and other interested users. At the end of year 2010, it published full data updates from EURISCO, SINGER and GRIN which lead to an increase in the total number of data records up to 2.33 million. This update also included an increase in the number of accessions with geo-references which doubled from 300,000 to 610,000.

35. The portal invites users to generate searches not only by using accession number or name, but also based on certain desired traits such as plant height, growing periods at given locations, seed color, response to specific pests or diseases and response to various climatic conditions. That type of characterization and evaluation data, along with environmental data based on the longitude and latitude at collection sites is included in the portal complementing the passport data currently available.

36. At the time of this document, the portal provides information on accessions for all major food crops with a focus on the following twenty-two crops: banana, barley, beans, breadfruit, cassava, chickpea, coconut, cowpea, faba bean, finger millet, grass pea, lentil, maize, pearl millet, pigeon pea, potato, rice sorghum, sweet potato, taro, wheat and yam. All of them belong to the list in Annex I of the International Treaty. It is foreseen that the portal will expand to a wider number of crops by including further information from databases.

37. The work of the CGIAR Centers on crop informatics has also rapidly expanded in the last years, in particular on maize and rice. IRRI’s International Rice Genebank Collection Information System (IRGCIS) publishes passport, as well as characterization and evaluation data of more than 112,952 accessions. Published data from other information systems and databases on germplasm for this crop is also very wide. An indicative sample list is being provided in Appendix 2 of this document for reference.

4. The Clearing House Mechanism of the Convention on Biological Diversity

38. Article 17.1 sets forth that

"In developing the Global Information System, cooperation will be sought with the Clearing House Mechanism of the Convention on Biological Diversity."

39. The Clearing-House Mechanism (CHM) of the CBD, which is coordinated by the Executive Secretary, has been established based on Article 18.3 of the Convention. Its mission is to contribute significantly to the implementation of the Convention through the promotion and facilitation of technical and scientific cooperation, among Parties, other Governments and stakeholders. The Strategic Plan of the Clearing-House Mechanism identifies three major goals:

a. the promotion and facilitation of technical and scientific cooperation;
b. the promotion and facilitation of information exchange among Parties, other Governments and stakeholders;
c. a fully operational mechanism with the participation of all CBD Parties and an expanded network of partners.

5. National and regional initiatives

40. There are quite a large number of national and regional networks initiatives, including NISM, that currently address knowledge and information exchange on plant genetic resources, among other activities such as training and capacity building. They support the sharing of expertise and provide backstopping in cases where certain members of the network lack the capacity to implement certain activities.

41. In the area of characterization and evaluation of PGRFA, a number of national genebanks have published collection data on the web over recent years or are in the process of doing so, often offering the option of ordering material online.

42. However, a significant imbalance exists among regions and countries within regions, according to the Second Report of the State of the World on Plant Genetic Resources for Food and Agriculture, which was released in October 2010.  

43. The large majority of countries still do not maintain an integrated national information system on germplasm holdings and “important ex situ holdings in at least 38 countries are still, at least partly, documented only on paper (16 countries) and/or in spreadsheets (32 countries). 21 Dedicated information management systems are used to manage passport and characterization data on ex situ collections in only 60 percent of the countries that provided information on this topic, while generic database software is used in about 34 percent of countries.”

44. The lack of a freely available, flexible, up-to-date, user-friendly, multi-language system has limited improvements in documentation in many countries, although in some cases regional and/or bilateral collaboration has helped meet information management needs through the sharing of experiences and tools.

45. A global analysis of existing information indicates that where characterization and evaluation data exist, there are yet frequent problems in standardization and accessibility, even for basic passport information.

IV. PRELIMINARY IDENTIFICATION OF GAPS AND NEEDS AT GLOBAL LEVEL

11 http://www.fao.org/docrep/013/i1500e/i1500e00.htm
46. Based on the above preliminary information and experience gained, the Secretariat of the Treaty has identified a number of areas where needs and gaps exist and where further activities could support Contracting Parties in developing a strategic vision of the global information system under Article 17 of the Treaty. Those areas and activities are the following:

   a. Facilitating further work on information standards related to PGRFA, including the updating of the multi-crop passport descriptors (MCPD) to reflect the new set of information available under the Treaty, including the legal status of the material and its status with respect to the Multilateral System.

   b. Promoting free and flexible multi-language systems and tools for the characterization and evaluation of PGRFA and the necessary training of staff for their adoption.

   c. Coordinating partnerships for the connection of existing inventories and documentation systems with databases containing molecular information on PGRFA.

   d. Promoting the integration of online data sets related to PGRFA with information on other seed related issues (e.g. OECD; UPOV; etc.).

   e. Enhancing linkages within existing international, regional and national information repositories on PGRFA (e.g. EURISCO, SINGER, USDA-GRIN, NISM, etc.).

   f. Establishing linkages with traditional and indigenous knowledge information systems, with particular emphasis on the documentation of techniques and practices for the conservation and sustainable use of PGRFA.

   g. Conducting regular surveys of users’ needs and creating feedback mechanisms and tools to gather users’ preferences.

   h. Harmonizing the international networks of national focal points providing information on PGRFA.

47. All the above listed needs and gaps are to be further detailed and investigated in collaboration with major organizations and networks.

V. THE ROLE OF THE SECRETARIAT IN THE ESTABLISHMENT AND STRENGTHENING OF THE GLOBAL INFORMATION SYSTEM

48. The large number of ongoing initiatives on PGRFA information, their diverse nature and scope, and the variety of stakeholders involved, may require a further intensive and detailed assessment of needs and the definition of concrete activities and partnerships for those activities at the global level, for the progress of the global information system in the long term.

49. The development of the global system may benefit from the definition of general principles, which not only form the basis of the system but also shape the content of implementing activities and constitute the core elements of collaborative partnerships. The principles of the global information system may be the following:
a. voluntary;
b. coherent;
c. neutral;
d. quality focused;
e. user oriented;
f. sustainable;
g. decentralized;
h. supportive of decision-making.

50. The following are some general strategic activities that the Secretariat of the International Treaty could undertake during the 2012/2013 biennium, if the Governing Body so wishes, in response to the current gaps and needs for the initial development of the global information system of Article 17:

a. Establishing a forum for the harmonization and sharing of PGRFA data with experts from Contracting Parties and relevant stakeholders;
b. Preparing a detailed elaboration of existing gaps in the development and strengthening of the global information system based on the results of a world survey on user’s needs by target groups;
c. Elaborating an up-to-date detailed inventory of existing strategic initiatives with a high potential for integration into the global information system;
d. Starting a pilot global system, based on existing advanced systems and users’ needs and available financial resources;
e. Consulting relevant stakeholders for the development of a comprehensive strategy and a work plan to be presented to the Governing Body at its next session.

51. A number of technical strategic studies may be envisaged to pave the way for those activities. The list and content of those studies is described in Appendix 1 of this document.

52. The global information system should support the main programmes of the International Treaty, in particular the Multilateral System of Access and Benefit-sharing, and the role of the Secretariat could be the promotion of international partnerships and cooperation, the exchange of information and the development of a network of partners, building on existing networks and initiatives. The System should ensure universal access to the Treaty’s official records reports and documents, with similar functions to those of the CBD’s Clearing House Mechanism.

VI. FURTHER DEVELOPMENT OF THIS VISION PAPER
53. At its Fourth Session in March 2011 the Governing Body "welcome[d] the efforts underway to coordinate and improve information systems documenting plant genetic resources for food and agriculture, based on existing information systems, in order to develop and strengthen the Global Information System, foreseen in Article 17, consistent with Article 12.3b, of the International Treaty, and requested the Secretary to further develop this Vision Paper”.

54. It also "Recognize[d] that improving access to and availability of information in the Multilateral System continues to be an important priority and that there is a need to support the relevant authorities and entities, particularly in developing countries, in improving their capacity to provide, manage or access information in respect of the Multilateral System".
**Appendix 1**

**COMPENDIUM OF TECHNICAL STRATEGIC STUDIES FOR THE IMPLEMENTATION OF ARTICLE 17 OF THE INTERNATIONAL TREATY**

The technical strategic studies will be elaborated by the Secretariat of the International Treaty during the 2012-2013 biennium in collaboration with regional and international organizations and other stakeholders, as appropriate, for the implementation of Article 17.

*Technical study 1 on users’ needs by target groups and thematic areas*

This document will gather valuable information on gaps, expectations and ways in which users from different ways would benefit from a strengthened global information system. It will help to establish priorities and how to best meet their needs and on training requirements.

*Technical study 2 on inventories of existing strategic initiatives and networks on PGRFA*

This document will generate an up-to-date internet-based index of globally distributed networks of interoperable databases that contain scientific, technical and environmental information related to PGRFA. It will be useful for the identification of content and to avoid duplication of efforts. It will also provide information on governance and institutional mandates and capacities across countries and at regional level.

*Technical study 3 on the harmonization and sharing of PGRFA data*

This document will include an analysis of information infrastructure and community-developed tools, standards and protocols. It will serve as the basis for future technical discussions. Data must be made more accessible and data format should be compatible as much as possible across different systems.

*Technical study 4 on the linkages of the Global Information System with the CBD Clearing House Mechanism and other relevant systems*

This document will analyse the main functions of the CBD Clearing House Mechanism and other reporting systems of the multilateral environment agreements and will put together lessons learnt and recommendations for the future development of the global information system.

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13 This is the proposal presented to Contracting Parties at the Fourth Session of the Governing Body.
There are many rice databases available on the world Web that are helpful for rice research. The following are presented to provide the reader with a general idea of the number and nature of them.

1. BGI-RIS - [http://rice.genomics.org.cn/rice/index2.jsp](http://rice.genomics.org.cn/rice/index2.jsp). The Beijing Genomics Institute - Rice Information System (BGI-RIS) is reputed to be the most up-to-date integrated information resource for rice genomes as well as a benchmark for comparative genomic analysis among cereal crops.

2. DRTF (Database of Rice Transcription Factors) - [http://drtf.cbi.pku.edu.cn/](http://drtf.cbi.pku.edu.cn/). It is a collection of known and predicted transcription factors.


5. MOsDB - [http://mips.helmholtz-muenchen.de/plant/rice/](http://mips.helmholtz-muenchen.de/plant/rice/). The MOsDB is a resource for publicly available sequences of the rice (Oryza sativa L.) genome.


7. OrygenesDB - [http://orygenesdb.cirad.fr/](http://orygenesdb.cirad.fr/). The aim of this Oryza sativa database was first to display sequence information resulting from the activities of our group, such as the T-DNA and Ds flanking sequence tags (FSTs) produced in the framework of the French genomics initiative


10. REDB (Rice EST Database) - [http://bioinfo.hzau.edu.cn/](http://bioinfo.hzau.edu.cn/). It builds on the recent development in genomics research of rice at National Center of Plant Gene Research.


14. Rice functional genomic express database (RiceGE) - http://signal.salk.edu/cgi-bin/RiceGE

15. Rice Genome Annotation Project - http://rice.plantbiology.msu.edu/. The MSU Rice Genome Annotation Project Database and Resource is a National Science Foundation project and provides sequence and annotation data for the rice genome.


Agricultural Information Resources Sharing in China and Perspectives for CIARD Framework Development

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1. Agricultural Information Sharing in China
1.1 Development of Chinese Agricultural Research Documents
China is a large agricultural country. With the rapid growth of the national economy, investments in agricultural research and technology development are on the increase. As a reflection of this increase in this field, research outputs in terms of publications in scientific and technical journals are also growing rapidly (see Table 1 and Figure 1 for details).

Table 1  Agricultural science and technology papers published in Chinese

<table>
<thead>
<tr>
<th>Year</th>
<th>2000</th>
<th>2001</th>
<th>2002</th>
<th>2003</th>
<th>2004</th>
</tr>
</thead>
<tbody>
<tr>
<td>papers</td>
<td>114,533</td>
<td>116,265</td>
<td>117,003</td>
<td>122,374</td>
<td>126,007</td>
</tr>
<tr>
<td>Year</td>
<td>2005</td>
<td>2006</td>
<td>2007</td>
<td>2008</td>
<td>2009</td>
</tr>
<tr>
<td>papers</td>
<td>135,053</td>
<td>149,900</td>
<td>165,208</td>
<td>177,750</td>
<td>185,632</td>
</tr>
</tbody>
</table>
Figure 1  Agricultural science and technology papers published in Chinese

Data source: CNKI citation database

For those papers published in international journals by Chinese agricultural scientists, the increasing trend is similar to that published in Chinese journals (see Table 2 and Figure 2 below for details). Citation analysis showed that in 2007 scientists from 190 countries (regions) cited papers authored by Chinese scientists. Figure 3 shows the citation distribution by country (region) at a rate of 1% and above.

Table 2  Papers published in international journals by Chinese researchers

<table>
<thead>
<tr>
<th>Year</th>
<th>2000</th>
<th>2001</th>
<th>2002</th>
<th>2003</th>
<th>2004</th>
</tr>
</thead>
<tbody>
<tr>
<td>Papers</td>
<td>1,561</td>
<td>1,870</td>
<td>2,116</td>
<td>2,940</td>
<td>3,401</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Year</th>
<th>2005</th>
<th>2006</th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
</tr>
</thead>
<tbody>
<tr>
<td>Papers</td>
<td>4,806</td>
<td>6,018</td>
<td>6,626</td>
<td>8,913</td>
<td>10,247</td>
</tr>
</tbody>
</table>

Figure 2  Papers published in international journals by Chinese researchers

Data source: Incites database
The point here is that formal publications authored by Chinese scientists, published in both Chinese journals and international journals are increasing steadily. There are a lot to be shared internationally, especially those publications in Chinese.

1.2 Agricultural information networks and information resources

With the rapid development of ICTs, the agricultural information networks have been making constant progresses in recent years in China including its network environment, various information searching and storage techniques, web publishing, cross platform searching and etc. According to MOA Information Center, it has reached currently 2200 agricultural information networks. Some examples are as follows:

-- China Agricultural Information Network (http://www.agri.gov.cn) hosted by MOA links 3000 local networks which mainly distributes information on marketing and agricultural products.

-- China Agricultural Scitech Information Network (http://www.caas.net.cn) hosted by the Chinese Academy of Agricultural Sciences (CAAS) provides Scitech Information in agriculture to support the R&D activities.
-- National Agricultural Information System (http://www.nais.net.cn) hosted by the National Agricultural Library, AII/CAAS, provides bibliographic data and full text service to support agricultural R&D activities.

-- The network of the Library of China Agricultural University (http://www.lib.cau.edu.cn/bggk_1.htm) provides agricultural and education related electronic information to its users.

-- Provincial agricultural academies and universities networks. Each agri university or research institute has its local area networks, such as “China Agriculture Online” (http://www. Agrionline.net.cn) which provides information on agri news, scitech and education, expert forums, agri economy, human resources, laws, business, etc.

-- Golden Agriculture Network (http://www.agrie.com) provides information on agricultural product supply and need, international agricultural trade, prices, references, rural China, Chinese peasants etc.

-- North China Agricultural Information Network (http://www.agri.net.cn) provides information on seeds, production materials, forest products, feeds, fisheries, flora, agricultural products marketing, international food market, rich-becoming information, crop pest and disease predictions and control etc.

-- 168 municipality and county level agricultural information networks.

1.3 Other types of agri-data and information resources

-- Agricultural science data center (http://www.agridata.cn) undertaken by AII/CAAS with other research institutes hosts agricultural science data resources in crop science, animal and veterinary sciences, basic agricultural scientific and technical infromation, fisheries and aquaculture, tropical crops, pasture science, agricultrual resources and environment, agribiology, food engineering and agricultural quality standards, and agricultural information and scientific development. Currently, the system contains some 600 datasets.

-- Crop Germplasm Resources Information System (http://www.cgris.net) run by the Institute of Crop Science, ICS/CAAS provides crop germplasm information that can be accessed through the Internet.

-- China Feed-DataBase Information Center (www.chinafeeddata.org.cn) hosted by the Institute of Animal Science, CAAS, provides
comprehensive data and information on feedstuff.

-- CAAS also provides a directory of more than 4000 titles of open access journals in 17 disciplines such as agriculture, forestry, medicine, engineering, business and economics etc, to help Chinese users access more of foreign OA journals. Moreover, sponsored by National Science and Technology Library (NSTL), agricultural subject portals have been set up to integrate relevant network information and data from foreign and domestic networks. Now we have three portals, “Food and Nutrition Portal”, “Water Saving Agriculture Portal” and “Agricultural Tridimensional Pollution Control Portal”. Through those portals, users of interested groups may find their interested information and web links easily.

Most of these data and information in the above systems/platform could be shared, especially for the bibliographic data/information, while most of full text resources are shared through IPR agreement.

2. Perspectives for the framework development
2.1 Considering 4 factors in the framework

At national system level, we need to consider at least four factors related to the framework.

The First is data and information, which are the objects we want to share with others. The framework may describe a list of types of data and information required from each national system.

The Second is technologies and standards, which are the ways we share data and information in today’s information environment. Each national system should use similar technologies and standards to enable interoperability.

The Third concerns data and information providers. Should we rely on individual scientist, research team, or institute to provide data, information and related service? Or a combination of all of them?

The Fourth is investment. Data and information processing, providing service, building infrastructure, developing systems, etc will need investment. The framework may suggest a common strategy for each national system to locating necessary investment.

2.2 Setting up a mechanism of regular contact for CIARD partners

The CIARD Vision is very clear in itself. The way ahead to achieve it would be very long. There are difficulties and obstacles that lie between the Vision and where we are now. So, setting up a mechanism of regular (or irregular)
contact for all partners is very important to share new ideas, suggestions, technologies, standards, experience gained and lessons learned, and so on, as we go forward.

2.3 Advocacy of information/knowledge sharing to the Administrations
Policy support and project setting has been important for the development activities in agricultural information sharing in each country. Both international and national supports are needed.

2.4 Setting up financial sustainable mechanism from multi sources
Any development and progress in agricultural information sharing needs greatly the financial support for coherent and cooperative activities especially in the situation of different starting points of each country. There must be a financially sustainable mechanism to guarantee the development of the activity. Financial sources can be of various channels such as governments, institutions, foundations and international organizations, etc.

2.5 Attracting more institutions to join by real benefits
Effective collaboration and integration of resources, even the registry of resources or services depends significantly on the benefits the participating organizations can derive from the system. So, it is necessary to encourage the use and sharing of CIARD services or setting up some pilot studies to lead and stimulate the participating stakeholders to contribute to the CIARD community just as their obligation.

2.6 Enhancing training of participants
Since the CIARD RING is still at its developing stage, training is especially needed for new participants including on-site training of linked data base description, cataloging and indexing etc though there are standards exist, it needs practical instructions and system demonstrations.

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Access to Philippine Agricultural Knowledge

The Agriculture, forestry, and fisheries sector forms a vital component of the Philippine economy as it accounts for 12.13% of the Philippines’ gross national product (Gross, 2011). Although there are many agricultural research institutions in the country, the products of research from these institutions are not widely disseminated and utilized. One has to search individual web sites, library catalogs and international databases like Agricola, AGRIS, CAB Abstracts to avail of this wealth of information. And the latter do not cover every technical agricultural research publication produced in the Philippines.

Up to 1991, the monthly Philippine Agricultural Bibliography of the University of the Philippines at Los Banos, linked Philippine agricultural literature and agricultural scientists worldwide. Since then, there has been no vehicle to enable access to Philippine agricultural research output. There is an urgent need to capture Philippine agricultural knowledge and to make it accessible via a central platform so that users may be aware of them at the right time.

The disparate agricultural information tools which need to be searched individually result in costly duplication of efforts. Scientists normally fail to find all of the most relevant information.

The obstacles to the smooth flow of information are as follows:
1. Lack of awareness of what exists in each agricultural institution;
2. The need to cultivate the culture of sharing among local scientists
3. The scattered initiatives in information sharing resulting in waste of time and resources
4. Lack of a central electronic database that captures most, if not all, of the agricultural research output in the country.
5. Late publication of data
6. Inadequate IT infrastructure and varied software used by existing databases
7. Lack of interoperability among existing databases
8. Need for staff who are knowledgeable in database management
9. Limited finances to update and sustain these databases

Agricultural Knowledge Providers in the Philippines

1. PhilAgriNet stands for Philippine Agricultural Information Services Network. Created in 2004, the network aims to bridge the gap between information and researchers by creating a web-accessible database, now available at http://webagris.uplb.edu.ph. Specifically, PhilAgriNet aims to link member institutions as well as other researchers for efficient scholarly
access to agricultural knowledge. Content development, however, has been very slow owing to the following obstacles: inadequate IT infrastructure, software problems, lack of expertise on the part of staff assigned to manage databases, and the limited budget. PhilAgriNet has conducted a good number of capacity building initiatives with the support of FAO and the local Bureau of Agricultural Research and continues to do so regularly. It is now focused on enriching the PhilAgriNet database, in order to meet the needs of local and international researchers.

2. Web Sites of government agencies related to agriculture, e.g. Bangko Sentral ng Pilipinas, Bureaus attached to the Department of Agriculture, and the Philippine Council for Agriculture and Resources Research (PCARRD)

3. Web sites of universities offering agriculture in their curriculum, e.g. University of the Philippines at Los Banos, Benguet State University, Leyte State University, etc.

Some Examples of Agricultural Information Providers in the Philippines

<table>
<thead>
<tr>
<th>Database Name</th>
<th>Information/Data types</th>
<th>Subject Scope</th>
<th>Data Content</th>
<th>Ownership</th>
<th>Standards. Database architectures, models, used</th>
</tr>
</thead>
<tbody>
<tr>
<td>PhilAgriNet (open to the public)</td>
<td>Document s</td>
<td>Agriculture, forestry, fisheries</td>
<td>5,000 +</td>
<td>PhilAgriNet; accessible to the public</td>
<td>AgroVoc, WebAGRIS</td>
</tr>
<tr>
<td>CountrySTAT Philippines [<a href="http://countrystat.bas.gov.ph/">http://countrystat.bas.gov.ph/</a>]</td>
<td>Statistics</td>
<td>Agriculture, forestry, fisheries</td>
<td>No data available</td>
<td>Bureau of Agricultural Statistics; accessible to the public</td>
<td>FAO standards</td>
</tr>
<tr>
<td>Farmers Information and Technology Services Information System (FITS IS)</td>
<td>Names of experts and farmers, addresses, documents, images</td>
<td>Agriculture, forestry, fisheries</td>
<td>208,059 as of May 25, 2011</td>
<td>Philippine Council for Agriculture, Forestry and Natural Resources Research and Development (PCARRD) (accessible to the public)</td>
<td>Uses MySQL; no standards used</td>
</tr>
<tr>
<td>DA-BAR databases:</td>
<td>Projectper</td>
<td>Agriculture</td>
<td>No</td>
<td>Bureau of</td>
<td>No</td>
</tr>
</tbody>
</table>
R&D Projects; R&D Manpower; Directory of Scholars & Grantees; Institutional development grants http://www.bar.gov.ph/

While international as well as Philippine rice literature is adequately covered by the rice database (IRRI, 2011) of the International Rice Research Institute, other aspects of agriculture need a similar vehicle for scholarly access to agricultural information. But this tool should be one that focuses on Philippine agricultural research output on all aspects of agriculture, forestry, and fisheries, and must be comprehensive enough to cover most, if not all, of the products of research of agricultural institutions in the country. Barring many obstacles, PhilAgriNet can champion this by transforming its database into the most comprehensive and up-to-date electronic resource available to agricultural researchers worldwide.

References:


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Facing rather poor status of data sharing among scientific community of Japan, Council for Science and Technology Policy, Japan (CSTP, http://www8.cao.go.jp/cstp/english/index.html) has been keeping its strong policy to develop databases as a basic platform for researches in last decade. Several funds have been being provided for developing scientific databases by Ministry of Agriculture, Forestry and Fishery (MAFF, http://www.maff.go.jp/e/index.html), Ministry of Education, Culture, Sports, Science and Technology (MEXT, http://www.mext.go.jp/english/), Japan Society for Promotion of Science (JSPS, http://www.jsps.go.jp/english/index.html), Japan Science and Technology Agency (JST, http://www.jst.go.jp/EN/index.html), etc. Actually, several databases have been developed and some of them are targeted for agricultural researches.

Though data sharing and interoperability of databases are always highly requested under such a policy, particularly the interoperability issue was not overcome in most of the cases. Amongst them, Data Integration and Analysis System (DIAS) is an exception. The DIAS project has been being conducted since 2005 under a strong support of MEXT to follow the above policy. It is also conducted as a part of the Japanese contribution to GEOSS (Global Earth Observation System of Systems).

The missions of DIAS are:
- to coordinate the cutting-edge information science and technology and the various research fields addressing the earth environment
- to construct data infrastructure that can integrate earth observation data, numerical model outputs, and socio-economic data effectively
- to create knowledge enabling us to solve the earth environment problems
- to generate socio-economic benefits.

DIAS is tackling a large increase in diversity of the earth observation data by
developing a core system (Fig. 1) for data integration and analysis that includes the supporting functions of life cycle data management, data search, information exploration, scientific analysis, and partial data down-loading. For improving data interoperability, DIAS is developing a system for identifying the relationship between data by using ontology on technical terms and ideas, and geography. DIAS also is acquiring data base information from various sources by developing a cross-sectoral search engine for various databases.

By utilizing the core system of DIAS, we are to develop several application to contribute to socio-economic benefits;

- Agricultural Production Management

DIAS develops an information system for agricultural production managements by integrating the real-time monitoring data of farmland, the growing condition of each crop cultivar, meteorological data, numerical weather predictions, and climate model predictions. This system will be usable by the farming community, enabling
them to make improved management decisions especially in regions which are susceptible to global warming impacts.

- **Ecosystem Conservation and Participatory Monitoring Program**
  DIAS compiles data bases of a number of important indices of biodiversity, including invasive alien species and endangered species through participatory monitoring programs, integrates to analyze the data with other earth observation data, and disseminates the products in a form to be easily used for decision making related to biodiversity conservation.

- **Integrated Water Resources Management**
  The Asian countries cooperatively integrate data from earth observation satellites and in-situ networks with other types of data, including numerical weather prediction model outputs, geographical information, and socio-economic data, to generate information for making sound water resources management decisions.

- **Ocean Circulation and Fishery Resources Management**
  DIAS provides usable information for a sustainable fishery resources management by constructing an oceanography-fishery cooperative platform that enables resource managers to investigate relationships between fluctuations in the fishery resources and the seasonal to decadal ocean variations derived from an ocean re-analysis based on the data assimilation by applying the four dimensional variational assimilation methods.

DIAS contains ca. 1.5 PB data and a part of DIAS database has been open since October, 2010. In addition to the DIAS projects, several database developments are now going on. Table 1 shows some typical databases in Japan useful for agricultural researches. DIAS, MetBroker and YMC are databases being developed under research projects while NIAES and NIES are collections of databases supported by institutions. Such institutional databases were also originally developed under national research projects. AGROPDIA and MAFF STAT are databases managed by MAFF, Japan.
### Table 1 Typical databases for agricultural research in Japan

<table>
<thead>
<tr>
<th>DB names</th>
<th>Information type</th>
<th>Subject scope</th>
<th>amount of digital Information/data content</th>
<th>ownership</th>
<th>Access</th>
<th>management standards, URL</th>
</tr>
</thead>
<tbody>
<tr>
<td>DIAS/Data Integration and Analysis System</td>
<td>Climatic scenario data, satellite image data, GPV data, sensor network data, water resource data, downsampling data</td>
<td>Climate change, integrated water resource management, agricultural production management, environment studies, ocean circulation and</td>
<td>1-2PB</td>
<td>U. Tokyo</td>
<td>half open</td>
<td>ontology based search engine for data interoperability</td>
</tr>
<tr>
<td>NIAS (National Institute of Agrobiological Sciences) Databases</td>
<td>Mainly genome data</td>
<td>Genome researches</td>
<td>unknown</td>
<td>NIAS</td>
<td>open</td>
<td>international standard for genome</td>
</tr>
<tr>
<td>NIAES (National Institute of Agro-Environmental Sciences) databases</td>
<td>Land use, environmental data, weather, crop calendar, CO2 flux, soil</td>
<td>Agroenvironmental studies</td>
<td>NIAES</td>
<td>open, only in Japanese</td>
<td>open</td>
<td>Wrapper based standardization</td>
</tr>
<tr>
<td>AGROPEDIA-MAFFIN (MAFF Research Network)</td>
<td>Documents, research reports, satellite, weather</td>
<td>undet</td>
<td>800TB</td>
<td>MAFF</td>
<td>partially open, mainly in Japanese</td>
<td></td>
</tr>
<tr>
<td>MetBroker</td>
<td>Observed weather data and predicted weather data (GPV)</td>
<td>Any that uses weather data</td>
<td>300GB ( 30000 data point of 25 weather database s)</td>
<td>NARC/NA RO, JP</td>
<td>open</td>
<td></td>
</tr>
<tr>
<td>YMC (Youth Mediated Communication) System</td>
<td>Agricultural Q&amp;A for rice farmers</td>
<td>Agricultural technology transfer to illiterate farmers through their children</td>
<td>hundreds Q&amp;As</td>
<td>YMC Project/Japan</td>
<td>closed</td>
<td>original</td>
</tr>
</tbody>
</table>
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1. Introduction
Drupal as a third-party free and open source Content Management System (CMS), and is strongly oriented towards standard-based information management and the integration of semantic technologies[1]. AgriDrupal is both a suite of Drupal-based solutions for agricultural information management and a community of practice around these solutions[2]. AgriDrupal is maintained and promoted around the world by FAO. This summery paper introduces a function module, Agris4Drupal (A4D) that facilitates AgriDrupal users to index the text contents automatically based on multiple related domain ontologies.

2. Functionality
A4D provides two types of service:
1) Fundamental service:
   - Importing, browsing, and retrieval functionality for domain ontology files.
   - Importing namespace files to help mark and exporting customized format.
2) Auto Indexing service:
extract or mark the terms that can characterize the text through certain keyword extraction algorithm or service, such as OpenCalais[3] and MeaningTool[4], the output as tags;

- look up those tags in the ontology reservoir, which may stores AGROVOC, GEOPOLITICAL and other related ontologies, to retrieve the formally defined concepts and terms in their respective knowledge domain;

- output those retrieved concepts and terms as RDF format and display them as a marker/tags of the text for indexing.

3. A4D box
A4D consists of four sub-modules:

1) **agris**: a module that provides the basic operations through which users can
   - import ontology,
   - create new repository,
   - add new namespace,
   - select the method of keyword extraction, and
   - query on rdf data.

2) **rdf4Agris**: the original RDF module from Drupal community with an essential modification to make it work for agris.

3) **opencalais4Agris**: a module that is used for keyword extraction by calling service from OpenCalais, rewritten based on the OpenCalais module from Drupal community[5].

4) **generateRdf**: a module for user to generate RDF file with indexed concepts from the content or the URL they input.

4. Potential applications and performance issues
The A4D module is designed as an open component that can interface with different online services that provide keyword extraction and ontology
concept mapping, therefore, as initial tests have indicated that performance of A4D is depended on following factors: 1) a well-trained domain-oriented keyword extracting algorithm, such as the one Agrotagger has deployed[6], works better than the one for general purpose; 2) the structure and size of a to-be loaded ontology file may affect the performance by time consumed for loading and concept retrieval; 3) the index result for the same piece of content may vary significantly with different referral ontologies.

Reference:
5. http://drupal.org/project/opencalais

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Accessing agricultural content in Africa has not always been easy for most researchers and other stakeholders in agriculture hence the need to implement policies and strategies that would enable sharing and exchange of information and data. Policies and strategies both at National and institutional level are key in ensuring the three AAA”s (Availability, Accessibility and Applicability) of information/data.

In the case of Kenya, the government has placed a lot of emphasis on using ICT to improve the livelihoods of Kenyans. To this end, a number of documents have been put in place for example the Government Strategy and National Information & Communications Technology (ICT) Policy paving the way for institutes like KARI to develop policies that meets its specific needs. Unfortunately at Institutional level (for example the KAINet Partners) little has been done to implement policies or strategies to foster sharing of scientific information/data. In cognizance of this KAINet’s institutional partners, developed of ICM strategies for each partner institution was done they still have to get formally endorsed by senior management.

![Figure 1: Content Accessed from Africa](image)

**Mechanism of sharing information**

To support the lack of agricultural related content accessibility and visibility, the Food and Agriculture Organization (FAO) of the United Nations in conjunction with DFID made available to Kenya financial and technical contribution in support for the establishment of the Kenya Agricultural Information Network (KAINet) .This is to build a common and freely accessible information system for the generation, collection, processing archival and dissemination of agricultural information.

KAINet adopted Webagris as its platform to implement partner institutional and national repositories and from lessons learnt from the implementation, it is adopting
the Agridrupal and AgriOcean Dspace to enhance accessibility and visibility of local metadata. These are complete, multilingual web-based systems used for processing and dissemination of agricultural bibliographic information.

With IRs developed at KARI-HQ, KEFRI, MoA and JAUAT the national repository (KAINet) harvested from them. A KAINet website was then developed using drupal for the purpose of enhancing web visibility to KAINet. A web-based repository developed on Webagris with a search engine that makes the repository accessible and visibility was then integrated onto the site give KAINet a one stop platform of both the web presence and online repository.

KAINet Database accessible through [http://www.kainet.or.ke](http://www.kainet.or.ke) includes both research literature and local agricultural knowledge with more than 38,000 records and 1,500 full text documents. The scope of content ranges from climate change, forestry research literature, agricultural related literature, water use, and simple brochures/leaflets of which is mostly metadata with 0.5% of the it is full text attachments.

**Figure 2: KAINet Network Structure**

**Interoperability**

For the past 20 years or so, the need to exchange information between various partners pushed researchers to develop architectures for the interoperability of information systems. To ensure KAINet partners and other stakeholder are able to exchange data amongst themselves we adopted systems that meet specific architectural and functional requirements for information exchange. Using WEBAGRIS and Agridruapal that have AGRIS Application Profile, this was achieved .The AGRIS Application profile is a standard created specifically to enhance the description, exchange and subsequent retrieval of agricultural Document-Like Information Objects (DLIOs) .It is a format that allows sharing of information across dispersed bibliographic systems and is based on well-known and accepted metadata standards. Some partners within the KAINet family have implemented other tools
that promote interoperability using the Open Archives Initiative Protocol for Metadata Harvesting and Internal/External RSS Feeds (Agrifeeds and e-Agriculture).

Interoperability within KAINet has increased the accessibility of the information/data and has resulted in partner institutions harvesting metadata from the FAO Database and **via verse** with Institutions like KERFI growing its repository from 236 records to 1,156 records over a period one year. Access of real time news and events from other agricultural related sources like Agrifeeds and e-agriculture has improved the information/data on KAINet.

Visibility has been enhanced with the KAINet repository being registered at the CIARD Ring and the KARI repository being among the few African repositories at the OPENDOAR ([http://www.opendoar.org](http://www.opendoar.org)). While via the google analytics the access hits have grown from to almost 5,000 since last year June for KARI to almost 40,000.

To ensure further interoperability, members of the KAINet need to join KARI example and implement Web 2.0 tools for example a simple RSS feeds that ease exchange and sharing of information. As we look at improving sharing in the near future we need to implement RDF (**Resource Description Framework**) that would enable exchange of richer metadata that can easily be re-processed and re-packaged as new information/data. A long term solution is conduct research into the possibilities of making data sets available and accessible.

**Figure 3: A image of the KAINet site with the RSS feeds**

**Challenges (obstacles and constraints)**

Access to information is critical for enabling citizens to make informed decisions which affect their lives. According to Justin Chisenga (2006), even with the development of ICT and other tools for sharing information, unfortunately the responsibilities of information managers in developing countries is not simple.

The first challenge is the development of the institutional repositories, design and set up of platforms that promote sharing and exchange of data. This is occasioned by the lack or limited capacity and skills in the new emerging web 2.0 tools that foster exchange. The second challenge is the lack of proper institutional policies and strategies that support the use of open access software’s added to the lack to awareness on copy rights and IPR (Intellectual property rights) issues by content generators. The last bit as to some extent hindered the collection of metadata from the content generateors. The third challenge, as noted by Ahmed Rafea, poor mechanisms and infrastructure for sharing and exchanging agriculture knowledge generated from research at national and regional levels continue to bedevil the conceived goals. Many research activities are repeated due to the lack of such mechanisms and infrastructure at the national level. The fourth challenge, for accessible and visibility of institutional repositories should be published on Internet, for those institutions that maintain their institution repositories and dynamic website separately, the website is hosted by an ISP (Internet Service Provider) or single machine (unless mandatory), they are lagging behind others and find it a challenge to share and exchange information/data. Most of the institutions lack the ICT infrastructure and capacity in understanding of the new information trends to publish their resources online. There have been several lessons learnt one of which
is to do with, System comparability. Most government-based institutions largely depend on proprietary software systems that limit them in sharing and disseminating information. In addition there is a need to choose the right tools for the different member institutions based on a sound requirements analysis. Clearly, in view of the above, there is great need to inform and educate academics and researchers so that they have a clear understanding of the role of IRs, how they relate to their rights and how they may advance their visibility Kgomotso H. Moahi (2009).

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Section 1
The importance and role of organizational and/or national policies and strategies in your country in fostering sharing of scientific information/data

The national government and its agencies generally encourage sound policies and strategies as important framework for effective planning, implementation and productivity. This is true for the agriculture sector in which national and organisational policies and strategic frameworks have been developed over the years. The importance of communication and sharing of scientific information/data are thus accounted for in such initiatives.

The Government of PNG, through the Department of Communication and Information, has recently introduced a National ICT Policy (2009). This policy sets out a strategic framework for meeting the Governments objectives in the ICT sector; which is crucial for the agriculture sector as well. The National Agriculture Development Plane (2007-2016), a sectoral blueprint, outlines strategies for agricultural development in which ICT use and communication are regarded as important mechanisms for greater sharing of information/data.

The NARS, through a paradigm shift in the context of AR4D, have realigned and prioritized their programmes and activities in which the function of sharing of scientific information/data is given equal prominence. This is well accommodated in institutional strategic plans.

These policy initiatives and plans aim at contributing towards organisation goals and achievement of overall national plans such as the Medium Term Development Plan (2011-2015) and Vision 2050 set by the Government.

Mechanisms, channels, obstacles and constraints for sharing and exchange of research information/data within your country and with the outside world

The following are some of the common mechanisms and channels in sharing and exchange of research information/data.

ICT Tools: The trend in access and use of computers is very high with almost every person in ARD organisations having fulltime access during working hours. Therefore information processing, storage and transfer happen on daily basis. Scientists and information professionals also have email accounts either
through domain name or free, search-based webmail service such as Gmail and yahoo. Access to internet varies across institutions as many use modems and lease line systems while NARI is the only institute that has broadband across all its research centres. ARD organisations have their own fully functional websites with web links to other partners and collaborators. There is a cell phone SMS project on market information for vegetables with mobile company Digicel; a collaborative initiative involving the private sector. Facilitated by email and internet services, electronic resources such as electronic newsletters, blogs and social networking have become a timely and speedy media of information/data sharing which a lot of research organisations have adopted.

Information systems: National Agricultural Information System, Research Management Information Systems and Geographical Information System are becoming important tools and resources for knowledge acquisition, management and sharing and for planning and development of resources.

Tractional Media: Use of traditional media is still common in sharing scientific information. Such media include newspapers (newspapers give prominence to agriculture news and features in their daily issues. Of particular importance are the weekly columns provided free to agriculture); use of television is occasional with PNG’s two television stations, especially in their news and feature programs; news and agriculture programs are also common with radio stations, which still main a wider coverage including the rural areas.

Print publications: Information resources such as newsletters, magazines, posters and banners, leaflets, and banners are common in all ARD organisations. Also popular are a range of scientific and extension publications and journals.

Office Correspondence: Telephone and facsimile still remain the instant mediums of sharing research information/data within and between institutes and stakeholders. Other compacted media for information/data storage and usage such as CD-ROMs/DVDs are common.

Resource Centres: NARI is promoting the Community Based Resource Centre concept to bridge the gap between rural communities and researchers. These centres should become one-stop-centres in which scientific information can be distributed to stakeholders. This arrangement can also take advantage of ICT interventions.

Public events – Research organisations have engaged their scientists to participate in public forums such are innovations shows, open days, field days, cultural shows, ceremonies, conferences, seminars, road-shows and festivals. They also organise information boots and displays of sample materials of technologies. The advantages are the face-to-face question and answer engagement between sciences and stakeholders and distribution of scientific information materials.

However, there are also obstacles and constraints faced in the exchange and sharing of scientific information/data.

- Human Resource capacity is a critical challenge. Scientists and information professionals involved in packing and disseminating of scientific
information and data need specific skills to deliver results at expected levels.

• Institutional capacity in terms of infrastructure and technology is lacking due to prioritization and investment issues.
• Funding is a major constraint, as most ARD organisations rely on the Government which has its own priorities and budget allocation limits.
• Besides there are high costs of equipment and telecommunications, poor infrastructure facilities with unreliable power supply, poor quality of internet connectivity, and lack of broadband technology in most NARS.
• Attracting and maintaining critical mass in the agriculture sector is a major challenge as IT professionals prefer the industrial and mining sectors due to better working conditions and pay packages.
• There is no IT manufacturing industry in PNG. All computer hardware and software are imported from the Asian or Australian markets, thus making the country rely entirely on foreign IT industries.
• Further, though hardware sales and service have increased in recent years, service and support in most cases are unreliable.
• Telecommunication infrastructure was limited to the major urban centres, leaving centres in rural areas unserved. However, this is slowly changing since the introduction of the National ICT Policy (2009) with private sector driving the cell phone industry with reduced costs.
• The rugged geographical terrain and other social issues such as vandalism also pose major challenges.
• While PNG development partners are keen in adopting changes in technology, resources for ICT are limited. This is a challenge at hand that requires input from all actors.
• Due to technology wise constraints mentioned above, scientists’ and information processors’ access to information systems and databases is limited thus not many of them are aware of the pool of useful knowledge that is available in the public domain.

Concrete examples of interoperability between types of digital information/data and the outcomes and benefits derived

NAIS and GIS are examples of such interoperability in digital information which involves a lot of resources from different scientists and institutions. See the explanation on NAIS and GIS below in case studies.

NAIS is extensively used by scientists and scholars for research and education purposes, journalists for reporting and news purposes, information professionals for documentation and packaging communication resources while other stakeholders use for training and meeting other information needs.

The use of GIS has been critical in development planning and resource management especially by research and development organisations, local level governments, resource developers, NGOs and government agencies.

Priority areas, current and potential, where interoperability between types of digital information/data will really enhance sharing of agricultural research outputs
A regional system, known as Melanesian Agricultural Information System (MAIS) for three Western Pacific countries – PNG, Vanuatu and Solomon Islands is being developed presently under an EU ACP Science and Technology programme. This new system is intended to consolidate and increase wider sharing and exchange of individual NAIS (National Agricultural Information System) of each country at the regional level. This is a promising intervention in the making for the benefit of the Pacific Island nations and territories. It should be expanded to the entire Pacific region and further linked with the CIARD system.

The CIARD initiative on building framework for data and information sharing is a promising development at international level which will be of benefit in PNG. Having registered with CIARD, contributing resources and accessing the pool of knowledge made available in the public domain through is initiative should become a priority for all NARS in PNG. However, more advocacy and training is needed for the NARS members to be fully informed of the initiative. This means more awareness and sensitization is required locally; to-date, NARI may be the only institution from PNG to register with CIARD.

The development of communication strategies at institutional level has been sensitized and efforts are being made to develop such framework to strategize information exchange and sharing initiatives. NARI already has a draft Communication Strategy.

Section 2
Case study descriptions

1. PNG National Agricultural Information System
The PNG National Agricultural Information System (NAIS) is an information database system of ARD organisations in the country. The NAIS database has over 32,000 records of information resources in books, journals, papers and other publications. The system is managed using Inmagic DB/TextWorks. The objective is to maintain and exchange library and information resources for the benefit of the individual institutions and the country as a whole. There are seven partner institutions currently contributing to the system. All PNG NAIS partners are committed to identifying, documenting and sharing their information assets, including the libraries and publications. The system is available in all partner organisations and copies distributed to other stakeholders (eg schools) in CD runtime versions.

2. Geographical Information System
NARI’s GIS unit provides technical advice on GIS and produces maps that when retrieved and manipulated can enable one to have a "birds eye view" of natural resources and agricultural practices or crops grown in different parts of the country. There are three (3) major agricultural databases maintained which are available in a GIS format - map-linked databases. They can be presented as maps, tables and graphs. These databases are relevant to researchers, agriculturalists, planners, investors, environmentalists, schools and universities or to anyone involved in planning development and land management in PNG. The GIS databases include:
   1. Papua New Guinea Resources Information System (PNGRIS)
   2. Mapping Agricultural Systems of PNG (MASP)
3. National Agricultural Insect Collection (NAIC)
The National Agricultural Insect Collection (NAIC) is NARI’s reference insect collection of a large number of insect specimens (~200,000) collected from all over the country, and maintained in electronic database. The focus is on insects of agricultural importance. The specimen records contain information on distribution, host ranges and pest statuses, which can be used as reference information for identification. The system also contains images of pests, maps of host communities and other related information. NARI owns and maintains this collection however contributions are made from different organisations and individuals especially in the natural resource sector. The collection is accessible to those in research, education and the general public.

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Building the CIARD framework for Data and Information Sharing - Summary Paper from Mauritius

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Proposed area: Coordination, Strategy development, Capacity Building, Content Development

Introduction:
The Republic of Mauritius stands out as a good example of telephony and internet connectivity penetration rates in Sub-Saharan Africa (Box 1). The small size of the island and investment in infrastructure by the major telecoms player in the country has enabled the establishment of a network of optical fibre connectivity across the island (Fibre to the Cabinet), with the ‘last mile’ of connectivity through copper wires to the home. Thus, broadband connectivity is accessible to a large proportion of the country: the population in urban areas and those living close to the connection points in the rural areas (2km radius) can now even benefit from television programmes through connectivity to the web. Despite this development in the field of connectivity, together with the government vision of turning Mauritius into a cyber-island, these investments are yet to achieve an impact on the rural population.

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<thead>
<tr>
<th>Internet Connectivity in Mauritius Population size: 1.2 million</th>
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<tr>
<td>Fixed Line Population Penetration Rate (%) 30.21</td>
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<td>Fixed Line Household Penetration Rate (%) 95.75</td>
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<td>Mobile Penetration Rate (%) 92.79</td>
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<td>Internet Population Penetration Rate (%) 22.14</td>
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<td>Broadband Internet Population Penetration Rate (%) 20.14</td>
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(source: Information Communication Technology Authority (ICTA) website, 2011)

Box 1. Telephony and Internet connectivity penetration rates in Mauritius

Findings:
Along with the stated Government vision, national policy documents have also been developed both in the ICT and the Agricultural sectors (National ICT Strategic Plans 2007-2011; 2011-2014; Blueprint for a sustainable diversified Agri-Food Strategy for Mauritius, 2008-2015). The National ICT Strategic Plan specifically describes the concept of an e-Agriculture project (p91-93) which has reached the stage of finalizing the functional specifications, following consultations among the Ministry departments and parastatal organisations in the agricultural sector. Since 2003, the strategic plans on Agriculture have specifically stressed on the importance of establishing agricultural information systems for the benefit of decision-making at the level of farmers, but also for policy-makers. Unfortunately, many programmes
of this nature end up taking longer than anticipated for the planning stages and implementation is further delayed.

When projects are designed at such a large scale, there is a natural tendency to focus in the administrative aspects of information management, hence a bias towards automatisation of administrative procedures and hence the development of Management Information Systems from the institutional perspective rather than Information Management Systems with the purpose of serving information to all stakeholders. Furthermore, ICT initiatives at the level of the participating institutions are generally held up, awaiting the publication of the initial reports of these national projects, while complementary actions could have been carried out. While this tendency may be characteristic of any institution in the developing world embracing Information and Communication Technologies for the first time, there is no reason why the development of Management Information Systems cannot be developed in tandem with Information Management Systems, such that the development of information systems gradually shifts from an administrative function towards making use of the technology to improve information and service delivery to their stakeholders.

Case studies:
Currently, several projects are being implemented at institutions to promote the potential applications that improved internet connectivity offers to the agricultural sector. These range from national sector-wide projects (such as the e-Agriculture Project mentioned above) to internal institutional initiatives to adopt ICTs to facilitate institutional information management processes. One such example is the availability of national statistics, including agricultural statistics, in electronic format from the Central Bureau of Statistics (http://statsmauritius.gov.mu). The latter has traditionally provided its information in the form of printed publications but now also as electronic publications (pdf and MS Word). The tabular datasets are now also downloadable as Excel spreadsheets through their website.

The Agricultural Research and Extension Unit (AREU) of the Food and Agricultural Research Council (FARC) is the Agricultural Production and Marketing Information System (APMIS) which provides data such as the area under cultivation and prices in the markets for major horticultural crops in the country (http://apmis.areu.mu). The data are available in tabular and chart form, the tabular data being downloadable. The datasets are the result of surveys carried out on a fortnightly basis and compiled and reported on every month. The Agricultural Research and Extension Unit publishes information materials for dissemination, many of them now also being made available online. The Food and Agricultural Research Council (FARC) has compiled a database of agricultural research projects in the country and has produced compilations of the project titles in the form of booklets. However the database itself is not yet accessible online (http://farc.gov.mu). Among the research institutions, the Mauritius Sugar Industry Research Institute (MSIRI) provides access to its publications through its website as downloadable files. The Library database with over 7000 records is accessible online (http://www.msiri.mu).
In July 2010, as a result of a workshop on Web 2.0 technologies, facilitated by the regional ICART project of the SADC Secretariat, a grouping of ARD stakeholder representatives in Mauritius, dealing with the management of agricultural information in its various forms, established themselves as a network, as had also been established in other SADC countries. The creation of the Mauritius Agricultural Information Specialists Network (MAISNET) both as a physical network and as a virtual network uses a Dgroups forum for interaction amongst its members as they collaborate on the development of a national strategy for Agricultural Information, Communication and Knowledge Management. Members of the MAISNET also established a common weblog as a means of sharing news from the ARD institutions in Mauritius: rather than having blogs at each institution, the members of the network have been appointed as collaborators on the blog and contribute news items from their institutions. The Food and Agricultural Research Council has taken the lead to facilitate meetings of the MAISNET working group which is elaborating the strategy document.

Discussion & Conclusions:
While the conditions are established for effective use of ICT for information sharing and collaboration in Mauritius, coordination of the initiatives of the various institutions is still weak. Meanwhile, national projects with sufficient financial resources are struggling to move beyond the conceptualization and planning of implementation, without yet moving to the training and implementation phase. This seems to have resulted in the practical applications of the web and its contents have not yet been fully internalised by the agricultural stakeholders in the country, hence the relatively poor use of the technology across the sector.

Although large-scale national projects are needed, these could also be complemented by smaller modular projects that are implemented by the institutions. This requires good facilitation of the process of coordinating these interventions, rather than just good coordination alone. The adoption of certain guidelines for implementation, such as the use of standards for information storage and exchange, would mean that institutions can already start developing their systems, albeit at a slower pace, that would be compatible with the large-scale projects that are also being developed.

The establishment of the MAISNET network in Mauritius is seen as an opportunity to facilitate communication among the information specialists across the country such that the common vision for information management is implemented. The guidelines and principles of the CIARD are very relevant to the network at this stage, and steps are being taken to extract whatever experiences and best practices are available from the CIARD community. An exercise that is being proposed is the unpacking of the CIARD Checklist for local application. Discussions held through face-to-face meetings will be shared through the electronic forum and such debates will help build consensus on the approaches and the contents of the systems being developed. Sharing of similar experiences among other members of the CIARD community would also be most useful at this stage.

References:
Food and Agricultural Research Council (FARC) website, 2011 [ http://farc.gov.mu]
Information & Communications Technologies Authority (ICTA) website, 2011 [ http://icta.gov.mu]

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<td>Chinese Agricultural Literature Auto-Annotation System</td>
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<td>Chinese Crop Germplasm Resources Information System (CGRIS)</td>
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<td>Agricultural Knowledge Sharing in the Philippines</td>
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<td>VIVO</td>
<td>John Fereira</td>
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<td>Genesys</td>
<td>Michael Mackay</td>
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International Expert Consultation on
“Building the CIARD Framework for Data and Information Sharing”

Date: 20-23 June 2011

Jointly organized by GFAR, FAO & CAAS
Hosted by CAAS

Language: English

Schedule of Sessions

Monday 20th June

14:00-14:30 Participant Registration
14:30-18:00 InfoShare Marketplace: Exhibition and Knowledge Share Fair by participating systems/institutions on experiences, capacities and competencies in managing and sharing AR4D related data and information
[Venue: Beijing Capital Xindadu Hotel]
18:00 Cocktails

Tuesday 21st June

07:30-08:30 Participant Registration

Session 1: Opening & Setting the Stage
Chairperson: Gong Xifeng

08:30-09:15 Statements from organizers (International Conference Hall)
GFAR: Mark Holderness
FAO: Stephen Rudgard
CAAS: Liu Xu
Launching CIARD China: Liu Xu
09.15-10:00 Group photo and Coffee/Tea
10.00-11.00 Introductory Statements by invited experts
10:00–10:30 Summary of E-Consultation (Tom Baker)
10:30–10:40 Technical Issues to be considered in the Framework Development (Johannes Keizer)
10:40–10:50 Institutional Issues to be considered in the Framework Development (Ajit Maru)
10:50–11:00 National Systems (China) - Perspectives to be considered in the Framework Development (Meng Xianxue)

Session 2: Priority Services and Capacities
International Expert Consultation on
“BUILDING THE CIARD FRAMEWORK FOR DATA AND INFORMATION SHARING”

11:00-12:30 Working Groups (modalities to be provided)
12:30-14:00 Lunch
14:00-15:30 Plenary: Presentation of outputs from Working Groups and facilitated discussion. Facilitators: Stephen Rudgard, Viviana Palmieri

15:30-15:45 Coffee/Tea

**Session 3: Tools, Standards and Infrastructures**
Chairperson: Meng Xianxue/Qiaoqiao Zhang

15:45-17:30 Plenary presentations on status of interoperability standards (from e-consultation) followed by discussion.
   a) RDF, and what we can get from RDF (Tom Baker)
   b) The CIARD-RING, now and in the future (Valeria Pesce)
   c) agINFRA and its contribution to CIARD (Johannes Keizer)
   d) To be Announced (Seishi Ninomiya)

18:00 Dinner

**Wednesday 22nd June**

**Session 4: Next Steps**

09:00-11:00 Working Groups (modalities to be provided)
11:00-11:15 Coffee/Tea
11:15-12:30 Plenary: Presentation of outputs from Working Groups, and facilitated discussion. Facilitators: Barbara Hutchinson, Simon Wilkinson

12:30-14:00 Lunch

**Session 5: Case Studies**
Chairperson: Pan Shuchun

14:00-17:00 Presentations of 10 minutes on examples of sharing research data/information, focusing on innovative aspects.
   - VIVO (John Ferreira)
   - CABI - future plans (Zhang QiaoQiao)
   - AGRIS - future plans (Johannes Keizer)
   - GAINS (Joel Sam)
   - CAAS - Review and outlook of National Agriculture Data Center: Key technology and data resources (Zhou Guomin)
   - CAAS - Crop germplasm resources (CGR) information sharing in China (Fang Wei)

18:00 Dinner
Thursday 23rd June

Session 6: Agendas for Action and Report
09:00-10:30  Plenary: China agricultural informationalization in rural areas (Mei Fangquan)
09:00-10:30  Facilitated Discussion on Draft Statements of Outcomes and Agendas for Action from the Workshop. Facilitators: Stephen Rudgard and Ajit Maru
10:30-10:45  Coffee/Tea
10:45-12:00  Plenary: Facilitated Discussion on Draft Statements of Outcomes and Agendas for Action from the Workshop
12:00-12:30  Closing Statements from Organizers: Future Events, links to GCARD process and to other major initiatives.
CAAS(Feng Dongxin/Gong Xifeng)
FAO(Stephen Rudgard)
GFAR(Ajit Maru)
12:30-14:00  Lunch
14:00-18:00  Optional Field Trip
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