

Recent developments in information and communication technology: Implications for agricultural, forestry and fisheries R & D in developing countries

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Modern information and communication technologies (ICT) have been seen as an integral part of the effective acquisition and exchange exploitation of information and knowledge in the CGIAR. Any organization wishing to fully exploit digital ICT should be aware that the challenges are not just concerned with infrastructure and connectivity, but rather comprise a multi-faceted problem of effective knowledge exchange and management of information content, as well as human resources and institutional capacity.

The CGIAR's stakeholders have also consistently recognized the important role of information in the Centers' work, and indeed information and knowledge have been considered at a strategic level in the CGIAR on several occasions. A major paper entitled "*The Future of Information Activities in the CGIAR: A System-Wide Strategy*" was prepared in 1994 for the CDC, and looked towards a more system-wide approach coupled concluded the stronger partnerships with NARS and key international organizations. The strategy set the following three goals: (a) to enhance the quality and relevance of research and decision making of CGIAR staff, their clients and partners; (b) to disseminate effectively the results of IARC and partner research; and (c) to contribute to the development of an efficient and effective global information system on agricultural research. The strategy called for: a common electronic communications network; networked information systems and databases; stronger information partnerships; the use of common technical standards for information products; joint acquisition of inputs and production of outputs; and high system-wide standards for staffing and human resource development policies. Secondly, the Organizational Change Program (OCP) of the CGIAR has focused on the theme of "knowledge management" or "knowledge sharing" in its efforts develop innovative ways of managing collaborative alliances and improving knowledge management between Centers. Development of this theme has been seen as a key factor in improving individual and organizational performance. Thirdly, the appointment of a Chief Information Officer was made recognizing the need for a more integrated system-wide approach to information.

So, some progress has been made towards these objectives developed in these strategic reviews, but much remains to be done. The view that the CGIAR should play a catalytic leadership role in the evolution of a global information system on agricultural research has been a consistent theme for many years. On the other hand, there has also been a consistent awareness of the CGIAR centers' limited ability to address these subjects given their autonomous status, their often incompatible systems, and their limited sharing of resources and information. This paper seeks to highlight some issues for consideration with regard to the more effective use of ICTs across the CGIAR in pursuit of more effective information and knowledge exchange, doing so from firstly an internal perspective and then from an external one.

A. Improved access to and management of information across the CGIAR

Information Standards & Vocabularies: The exponential growth of information available on the World Wide Web in general, and from the CGIAR centers, has increased the difficulty of locating specific information and knowledge, which is scattered across widely distributed sources and archives, and in different domains. The efficiency of "resource discovery" depends on the structure, type and content of the information resources being searched, and on the interests of the owners of the information, which are often complex. The notion of the "semantic web"¹ defines this goal, and various initiatives are underway

¹ "The Semantic Web is an extension of the current web in which information is given well-defined meaning, better enabling computers and people to work in cooperation." -- Tim Berners-Lee, James Hendler, Ora Lassila, *The Semantic Web*, *Scientific American*, May 2001

to improve resource discovery and knowledge mining. Only adoption of agreed semantic standards has the capacity to offer optimum information sharing and knowledge discovery. Development of such standards also requires agricultural information producers' agreement and active participation. This calls for a synergy of collaboration from the various interested groups including the CGIAR. The following potential benefits are expected from these technologies and methodologies.

- Greater agricultural information integration and interoperability, whereby systems can recognise and analyse intended meaning (semantic analysis) of vocabularies so as to integrate information from different sources.
- User-friendly information organisation, allowing organization of information into knowledge maps to guide retrieval without using complicated Boolean logic.
- Automated information processing, allowing machine-assisted indexing and text annotation, classification, and semantic clustering of information in a dynamic way.
- Integrated Information search/browse support, towards text mining on the web through meaning-oriented access, dynamic organisation of information with possibility for cross-domain links.
- Natural Language processing support, for improved machine translation and for queries using natural language.

The Agricultural² Metadata Standards Initiative (AgMES³) was launched in November 2000 at a workshop in Brussels, jointly organized by the Food and Agriculture Organization (FAO) of the United Nations and OneWorld Europe. In relation to the development of these standards, FAO has been initiated an Agricultural Ontology Service (AOS) initiative as a co-ordinated collaborative approach to develop a multilingual and multidisciplinary vocabulary system in relation to promoting food security and sustainable development. The engagement of the CGIAR in the process to develop and apply these standards and tools would be key if the System really is to be the focus of the development of a global information system for agricultural research.

Spatial data, mapping and policy/decision support: Following the considerable investment in Geographic Information Systems (GIS) by the CGIAR, a critical mass of data and expertise has been accumulated in its centers and challenge programmes. Greater efforts now need to be made to use geographic information to add value to the System's research and its outputs. Measuring and monitoring natural resources provides essential data that can underpin decision support models and tools that can in turn guide policy making. Expanded allocation of resources to building such models and tools would increase the Systems's visibility at national level and in the international development community. The CGIAR should also consider syndicating its content into a Geographic Image Service on a system-wide basis, adopting internationally accepted standards for spatial data being developed by the UN Geographic Information Working Group.

Photo and video image processing: With the increasing power of desktop computers, the PC has become a publications layout device, a photo editor, and even a video production device. New standards⁴ now mean that "video" now includes a range of new features such as interactivity. Every CGIAR center should use these new photo and image technologies, given their potential application in managing several types of data/information: images of scientific samples; integration of aerial, satellite, and ground-based images for characterization of a local setting; training materials (see e-learning below); presentations; and promotional media.

Sensors: Advances in design have meant that sensors can detect ever smaller changes in their environment (e.g. temperature, chemical levels), but more importantly some can now report their data remotely using wireless data communications. This has many implications for biological and specifically agricultural research, such as when a researcher is based some distance from the field site or would prefer not to visit regularly. CGIAR centers should look to exploit these technologies, and

² Agriculture here is used not in a restricted sense but covers all subject areas in the domain and the available different types of information resources.

³ AgMES Website: <http://www.fao.org/agris/agmes>

⁴ e.g. MPEG-4

where necessary explore applications of such sensors that are specific to their work, such as in smallholder agriculture.

B. Outreach and Capacity Building

Strengthening research-extension linkages: For knowledge and information acquired through agricultural research to truly contribute to improving food security, it must be effectively communicated to farmers through one or more of the methods related to agricultural extension. This “outreach” function is a generally recognized weakness of many research organizations, including some parts of the CGIAR. Weak linkages between the extension and research functions result in systematic knowledge and information “bottlenecks” that limit the effectiveness of research to contribute to agricultural development. Digital ICT provide a potentially powerful tool for improving communication between research, extension and even farmers, by establishing and/or strengthening linkages among and within the human and institutional elements of agricultural research and extension systems. The aim should be improving linkages between and within agricultural research and extension institutions through two fully integrated and co-dependent components: the human component and the technological component.

The human component should be a network (e.g. staff of research and extension institutions, faculties of agricultural education, NGO workers and in some cases agricultural producers themselves) committed to strengthening collaboration, communicating, sharing information and supporting improved agricultural production. The boundaries of the network are flexible and can expand to include more stakeholders or can contract to focus more closely on specific actors and their information or communication requirements and functions. The technology component can achieve effective linkages by connecting geographically dispersed people and enhancing two-way communication, managing large volumes of data, and rapidly collecting, processing and dispersing information in a variety of forms. The Internet's multi-media capabilities facilitate the development, sharing, storage, retrieval and dissemination of a range of information and support communication in many forms (e.g. e-mail, discussion lists, chat forums). These capabilities allow network members to inform each other and engage in two-way horizontal communication to address problems, discuss solutions and coordinate local, regional and national agricultural activities. By using Internet standards, the network can link seamlessly with the vast (and ever increasing) information resources available on the Internet, thus broadening and strengthening the network.

The conceptual model for a Virtual Extension Research Communication Network (VERCON)⁵ is one framework that could be examined and developed by CGIAR centers, in collaboration with FAO and other interested parties.

AGRIS: a network for sharing of agricultural science and technology assets: There have been strong recent efforts by FAO and partners in the international agricultural research community to strengthen the AGRIS initiative. This new moves goes far beyond the traditional approach of creation and development of bibliographical databases. The challenge is how to improve accessibility of science and technology information about agricultural development and food security. This challenge is multidimensional, covering language issues as well as those of intellectual property and physical accessibility. AGRIS has a role in diminishing the knowledge divide not only between developing and developed countries but especially in the developing countries with agriculture as a central part of their society. This effort is based on the awareness and goodwill of the international community. The intention is that AGRIS will include a focus on improving electronic publishing of documentation in agricultural science and technology, linking information about institutions, scientists and researchers, and activities, without imposing too rigid a collaborative framework. One key aspect of the approach would be to establish better collaboration with international initiatives on support to and co-ordination of agricultural research for development. The following principles have been developed in collaboration with the Member Countries for the AGRIS network to achieve its objective:

⁵ <ftp://ftp.fao.org/sd/vercon.pdf>

- a *decentralised* approach with greater emphasis on national partnerships with greater autonomy but with improved links;
- a greater *diversity* of research-oriented organisations participating in a strengthened global AGRIS network;
- a strengthened role in *capacity building*, including improved linkages between the AGRIS network and other FAO initiatives in Member Countries;
- a focus on management of *full text* of documents in agricultural science and technology information resources;
- a greater availability of *associated information* about activities, organisations, and people in agricultural science and technology;
- a continually improving set of *web-enabled* AGRIS methodologies and tools (with a focus on the establishment of standards), aimed at effective exchange and retrieval of science and technology information in a multilingual environment, developed and disseminated by FAO in consultation with Member Countries and AGRIS partners.

The CGIAR System needs to consider and define the potentially crucial role available to them in the new approach to AGRIS.

Electronic Distance Learning: Distance education and learning are potentially powerful ways for organizations such as the CGIAR Centers to communicate with and impart knowledge to their stakeholders. Modern ICT provide means of communication and presentation of materials to the target beneficiaries/learners that are available, reliable and affordable. Electronic learning, or e-learning as it is commonly referred to, offers numerous possibilities to use state-of-the-art technologies to create an interactive, self-paced learning environment which are highly suited for distance learning and distribution to a wide audience. Considerations of the choice of technologies for developing and delivering learning content should be based on the pedagogic and operational considerations:

- provision of a highly motivating and interactive environment to facilitate self-paced learning for users unfamiliar with such technologies;
- easy access to learning content through well structured curricula;
- choice of delivery technology (i.e. CD-ROM or internet) bearing in mind slow, unreliable, and expensive internet access for most users in developing countries;
- platform independence to accommodate a variety of operating systems;
- minimize the impact on the learners' computers by avoiding installation of non-standard applications, third party tools etc. ; and
- structured materials to permit easy translation and modification of content into different languages.