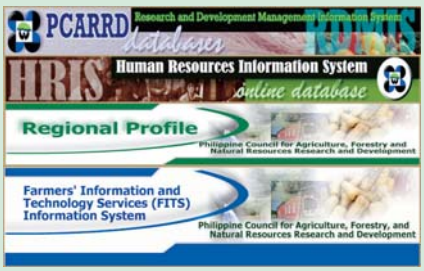
Agricultural Information and Knowledge for All:

Success Stories on ICT/ICM in AR4D in Asia and the Pacific Region



Global Forum on Agricultural Research (GFAR)

Asia-Pacific Association of Agricultural Research Institutions (APAARI)

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March, 2013

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Foreword

APAARI has been instrumental in identifying, documenting and disseminating success stories on agricultural innovation and technologies with an aim to enable all ARD stakeholders to adopt successful practices for their systems. So far, APAARI has published more than 50 success stories on important topics such as cropping systems, conservation agriculture, hybrid rice, BT cotton, dairying, fisheries, biofuels, agro-tourism, linking farmers to markets, IPM, ICT etc., which have been received well by different stakeholder groups. All the success stories are available on APAARI website: www.apaari.org

The Asia-Pacific Agricultural Research Information System (APARIS) - one of the important programs of APAARI, is mandated to foster use and application of ICT for AR4D in the region through capacity development, advocacy and networking of information resources. During 2011-2012, with the support from GFAR and FAO, APAARI augmented the use and application of ICT for AR4D through need-based activities and advocated for 'openness' in sharing agricultural information and knowledge under the theme 'Bridging Knowledge Gap' as part of implementing the GCARD Roadmap in the region. In order to popularize more success stories, APAARI has recently attempted to document four successful initiatives in ICT aiming at open access to agricultural information at the national, regional and global levels.

This publication highlights four success stories namely: i) Open Access to Agricultural Research Journals in India, ii) Empowering Farmers through Rice Knowledge Management Portal in India, iii) AgrobIS: Managing Agrobiodiversity Data and Information in Malaysia, and iv) Knowledge Networking for Agricultural Research for Development: The Philippines K-AgriNet Program. These success stories present different approaches, models, institutional collaboration, partnerships, community participation, and development of need-based information services to promote openness in sharing agricultural information and knowledge and placing it in the public domain for the benefit of wide range of stakeholders.

I am sure these success stories will be immensely useful to all AR4D stakeholders in understanding and adopting better governance and scientific models to manage agricultural information flows at different levels, enabling both coherence and open access to agricultural information for smallholder farmers in the region. I appreciate the efforts of authors for attempting these success stories. I also acknowledge the support of GFAR in bringing out this publication and appreciate the commendable efforts of Dr. S. Attaluri, Dr. Ajit Maru and Mr. Gerard Sylvester in editing the manuscript. Timely help of Mrs. Urairat, Administrative Associate in bringing out this publication is also acknowledged. I do hope that this publication will be immensely useful to all those engaged in promoting ICT/ICM for agricultural development in the Asia-Pacific region.

(Dr. Raj Paroda)
Executive Secretary
APAARI

Abbreviations

AFNR	Agriculture, Forestry and Natural Resources
AGMARKNET	Agricultural Marketing Information Network
AgrobIS	Agrobiodiversity Information System
AICRIP	All India Coordinated Rice Improvement Programme
AIS	Agricultural Information System
APAARI	Asia-Pacific Association of Agricultural Research Institutions
APARIS	Asia-Pacific Agricultural Research Information System
APMCs	Agricultural Produce Market Committees
ARMIS	Agricultural Resources Management Information System
ASTI	Advanced Science and Technology Institute
CBD	Convention of Biodiversity
C-DAC	Centre for Development of Advanced Computing
CGIAR	Consultative Group on International Agricultural Research
CMS	Content Management System
CMU	Consortium Monitoring Unit
CoPI	Consortium Partner Institute
CRRI	Central Rice Research Institute
DA-PhilRice	Department of Agriculture – Philippine Rice Research Institute
DARE	Department of Agricultural Research and Education
DIPA	Directorate of Information and Publication of Agriculture
DKMA	Directorate of Knowledge Management in Agriculture
DOST	Department of Science and Technology
DRR	Directorate of Rice Research
DSL	Digital Subscriber Lines
DSS	Decision Support System
FAO	Food and Agriculture Organization of the United Nations
FAQ	Frequently Asked Questions
FGD	Focus Group Discussions
FITS	Farmers Information and Technology Services
FITS-IS	Farmers Information Technology Services Information System
FLD	Front Line Demonstration
GFAR	Global Forum on Agricultural Research
GIS	Geographic Information System
HRIS	Human Resource Information System
i3R	Indian Rice Research Repository
IARI	Indian Agricultural Research Institute
ICAR	Indian Council of Agricultural Research
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
ICTs	Information and Communication Technologies

IEC	Information, Education and Communication
ITK	Indigenous Technical Knowledge
KM	Knowledge Management
KVK	Krishi Vigyan Kendra
LAN	Local Area Network
LCMS	Learning Content Management System
LGUs	Local Government Units
MARDI	Malaysian Agricultural Research and Development
MCPD	Multi-Crop Passport Descriptors
MS	Magsasaka Siyentista
MSME	Micro-Small and Medium Enterprise
NAIP	National Agricultural Innovation Project
NARES	National Agricultural Research and Extension System
NARRDN	National Agriculture and Resources Research and Development Network
NARS	National Agricultural Research System
NGO	Non-Government Organization
OA	Open Access
OJS	Open Journal System
OOD	Object Orientated Database
OpAPA	Open Academy for Philippine Agriculture
OSEP	Online Submission and Evaluation of Proposals
PCAARRD	Philippine Council for Agriculture, Aquatic and Natural Resources Research and Development (formerly PCARRD)
PCARRD	Philippine Council for Agriculture, Forestry and Natural Resources Research and Development
PDF	Portable Document Format
PGRFA	Plant Genetic Resource for Food and Agriculture
PKP	Public Knowledge Project
PREGINET	Philippines Research, Education and Government Information Network
QID	Quick Information Dispatch
R&D	Research and Development
RDMIS	Research and Development Management Information System
RKMP	Rice Knowledge Management Portal
RLO	Reusable Learning Object
RSS	Really Simple Syndication
RTG	Regional Techno Gabay
SAU	State Agricultural University
SMS	Short Message Service
SUCs	State Universities and Colleges
SWOT	Strength, Weakness, Opportunity and Threat
VoIP	Voice over Internet Protocol

Opening Access to Agricultural Research Journals in India

T.P. Trivedi[1]; Himanshu Varsheney[2]; Aruna, T. Kumar[3]; Hansraj[4] and Sudhir Pradhan[5]

1. Introduction

The Indian Council of Agricultural Research (ICAR) is an autonomous organization under the Department of Agricultural Research and Education (DARE), Ministry of Agriculture, Government of India. Formerly known as Imperial Council of Agricultural Research, it was established on 16 July, 1929 as a registered society under the Societies Registration Act, 1860 in pursuance of the report of the Royal Commission on Agriculture.

The Council is the apex body for co-ordinating, guiding and managing research and education in agriculture including horticulture, fisheries and animal sciences in the entire country. With 97 ICAR institutes and 47 agricultural universities spread across the country, this is one of the largest national agricultural systems in the world.

The ICAR has played a pioneering role in ushering Green Revolution and subsequent developments in agriculture in India through its research and technology development that has enabled the country to increase the production of foodgrains by 4 times, horticultural crops by 6 times, fish by 9 times (marine 5 times and inland 17 times), milk by 6 times and eggs by 27 times since 1950-51, thus making a visible impact on the national food and nutritional security. It has played a major role in promoting excellence in higher education in agriculture. It is engaged in cutting edge areas of science and technology development and its scientists are internationally acknowledged in their fields.

Greater accessibility of agriculture related knowledge, information and services to various stakeholders at national and international level is very critical for agricultural research and development. With many challenges faced by the agricultural sector, the small-scale, resource poor farmers depend heavily on quality and trustworthy information for their agriculture and livelihoods related decisions. By 2050, the global agricultural productivity has to be increased by almost 70 per cent and upto a 100 per cent increase in production in developing countries needed to meet the increased food requirements. In such situation the availability of reliable information and knowledge as vital input at key stages greatly benefit agricultural productivity.

One of the mandates of Indian Council of Agricultural Research is to act as a clearing house of research and development in agriculture through its information systems and publications. Directorate of Knowledge Management in Agriculture (Formerly Directorate of Information and Publications of Agriculture) publishes two research journals namely *the Indian Journal of Agricultural Sciences and the Indian Journal of Animal Sciences* for dissemination of research results and technologies from the Indian National Agricultural Research System (NARS). The

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Agriculture Journal of India and the *Memoirs of the Department of Agriculture* in India were started by the Imperial Department of Agriculture in India as early as 1906. These journals provided a permanent record of the practical results of agricultural research work carried out in India. Later in 1931, *the Indian Journal of Agricultural Science,* and *the Indian Journal of Veterinary Science and Animal Husbandry* were started as quarterly journals to encourage exchange of ideas among scientists engaged in research. The journals changed to bimonthly during 1967-68, and now these are monthly journals since 1969. Since then these journals are being published in print form regularly from ICAR.

Scholarly publications in developing countries suffer from lack of visibility and accessibility. This in turn, results in poor quality and low credibility of journals. Agricultural research in Indian NARS is widely acclaimed, however, there is limited access and visibility to Indian agricultural journals nationally and international subscription to these journals is also limited to a handful of countries only.

2. Need for ICT and Open Access

Ever since their inception in 1931, these journals had been published in print form only till 2010. Although these journals followed all the major international publishing standards, still they suffer from the following limitations:

- Long delay in the workflow to publish research outputs: Mainly due to the heavy dependence on traditional processes and postal communication. Normally the time taken ranges from 18-24 months for reviewing, editing and completing the publishing cycle.
- Limited circulation and access: Due to high cost involved in designing, layout and printing and compounded by the limited marketing, the research journals had limited circulation (1,000 copies per month).
- Problem of attracting quality research articles: Young authors prefer to publish in journals that provide them fast and professional peer review, wide distribution and online discoverability among other things. As all the international journals follow online process for research publishing, it was difficult to attract good research papers for publication in ICAR journals. Due to high postage costs, very few international authors (10-15 articles annually) working in frontier areas of agriculture and allied research used to submit their work in ICAR Journals.
- Reviewing of research articles could only be done with the help of national experts due to the high cost and limitation of time.
- Difficulty in communication with authors: With around 1,000 (2008-09) and 1,400 (2009-10) research paper submissions annually for *the Indian Journal of Agricultural Sciences* and *the Indian Journal of Animal Sciences*, it makes for a very difficult job of keeping the authors informed, at each stage, about the progress because of manual record keeping. This resulted in a lot of postal based communication, e-mails and answering 25-30 telephone calls daily to keep the authors informed about the status of their articles.

In order to overcome these limitations and with a renewed focus on improving access to agricultural research results, ICAR felt it necessary to follow the Open Access models for publishing research outputs thereby ensuring greater ‘openness’ in sharing research outputs for greater impact.

This move provided ICAR's research journals an effective path to distribute their research outputs to global audience with articles being peer-reviewed. Removing the access barriers including subscription cost to scholarly literature is believed to have had a positive impact and increased productivity of the research organisations. The objective to share scholarly knowledge was also achieved through the use of cost effective Information and Communication Technologies (ICTs) for the benefit of all stakeholders.

The committee constituted to review the access policy of ICAR journals made the following recommendations:

- All ICAR research periodicals should be made available in open access immediately upon publication and current issues to be placed in open access starting from March 2010 onwards.
- Downloads and readership of online open access versions should be recorded monthly in terms of hits for the review of access policy after two years.
- Option of sponsorship and advertisement of electronic publications from private sector should be explored and submitted in due course for consideration in the council.

The Open Access policy for ICAR journals was developed and it was approved in May 2010. As per new policy, ICAR was to setup an e-publishing system and make available the journals published by ICAR free of cost through Internet.

Initially, softcopies of the latest issues of journals were hosted on the website of ICAR in PDF format. First time users were required to register by providing a short profile (user e-mail address (mandatory), name, profession, country and affiliation). It was later observed that journals were accessed by wide range of users including students and teachers in institutes, researchers in NARS and CGIAR, extension workers in Krishi Vigyan Kendras (KVK), NGOs and state government departments, entrepreneurs, bank professionals and others (Figure 1).

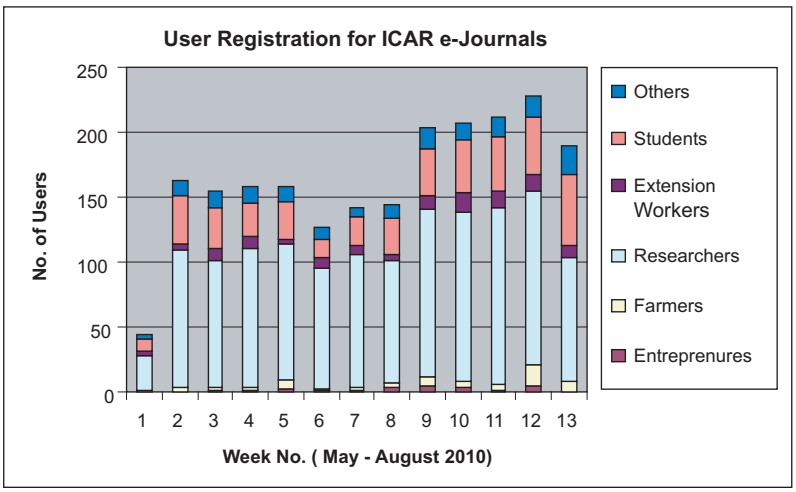

Figure 1: Bar graph showing user registration for accessing ICAR e-journals

3. Open Journal System

Open Journal System (OJS) is a free open source software available for the purpose of making open access publishing a viable option for journals. It was developed under the Public Knowledge Project (PKP), which operates through a partnership among the Faculty of Education at the University of British Columbia, the Simon Fraser University Library, the School of Education at Stanford University, and the Canadian Centre for Studies in Publishing at Simon Fraser University. OJS assists with every stage of the refereed publishing process, from submissions through to online publication and indexing. It is designed to facilitate the development of open access peer-reviewed publishing, providing the technical infrastructure not only for the online presentation of journal articles, but also an entire editorial management workflow, including article submission, multiple rounds of peer-review and indexing. Through its management systems, finely grained indexing of research and the context it provides for research, OJS seeks to improve both the scholarly and public quality of refereed research. Some salient features of OJS are:

1. OJS is installed locally and locally controlled.
2. Editors can configure requirements, sections, review process etc.
3. Online submission and management of all content.
4. Subscription module with delayed open access options.
5. Comprehensive indexing of content part of global system.
6. Reading Tools for content, based on field and editors' choice.
7. E-mail notification and commenting ability for readers.

OJS was found to be suitable for implementing the Open Access system at ICAR considering the features, flexibility it provides for its customization and availability of skills in Linux, Apache, MySql and PHP (LAMP) suite of software in ICAR. Another important factor is that Public Knowledge Project (PKP) team actively updates the OJS software regularly based on inputs from its user community and provides help for new modules, rectification of problems and issues etc.

4. E-publishing of Research Journals

The process of publishing research journals at ICAR was examined thoroughly including the communication sent to authors, reviewers and subscribers. Discussions with editors, production staff, librarians and researchers were helpful in understanding their expectations from the e-publishing system of ICAR. Based on the feedback, OJS was then customized to suite to the requirements of e-publishing and Open Access in ICAR.

It was considered important to develop a scalable hardware infrastructure for Open Access publishing at ICAR. High-end, scalable blade servers with storage area network server were set up at ICAR. As smaller research societies in India could not afford to setup and maintain hardware infrastructure individually for hosting their journals, this platform could serve as national facility for e-publishing of Open Access journals published from various agricultural research societies in India. The ICAR has been publishing *the Indian Journal of Agricultural Sciences* and *the Indian Journal of Animal Sciences* as open access journals by using the OJS based e-publishing system from August 2010.

5. Experiments with Open Access

Most research is published in commercial e-journals, but high subscription costs mean that users in developing and transition countries cannot access them. Open access is the immediate solution to access peer-reviewed research literature free of cost. It also provides the means to maximize the visibility and use of research output and greater collaboration between scientists from different regions and countries and thus helps to promote knowledge sharing.

OJS provides a website for each individual journal, including automatic table of contents, RSS feeds, back issues, description of goals, list of editorial team members etc. All participants need an account to access and perform their roles such as author, reviewer, editor, copy editor and reader. The software has easy to fill in forms. Authors can make their submissions online following a quick five step process. Reviewers can login and make their reviews online in a few simple steps. Much of the communication between participants is automated with customised, pre-written e-mail messages. And the final stages of copy editing, layout editing, and proofreading are all tracked through the system. A complete history is maintained of all actions and communications for each submission. Ultimately, the submission is published as an article in a new issue. The software is useful for Open Access journals and it can also handle delayed open access as well as completely subscription-based journals.

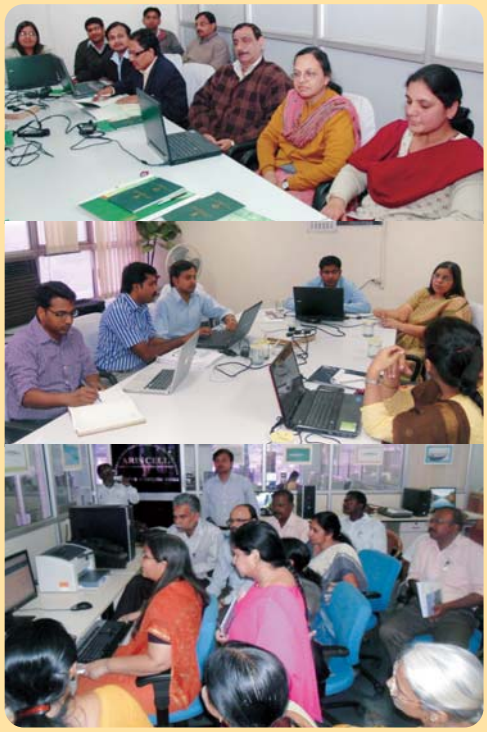

Figure 2. Hands-on training sessions organized for the editors, editorial and production staff at ICAR, New Delhi and CMFRI, Cochin

OJS also has a plug-in architecture, allowing easy connections to new features or other software services like Google Analytics plug-in for recording and tracking web traffic flow and access statistics and Paypal plug-in for e-commerce services, such as for collecting donations, membership fees, subscriptions or author fees etc.

The program team at ICAR comprised of journal editor, editorial staff, IT persons and library professionals including regular and contractual staff. In the pilot phase, computer servers and other ICT resources were installed and OJS was implemented for e-publishing of ICAR's journals. It is essential to host servers with dedicated, high bandwidth Internet connectivity as slow access of content becomes a crucial bottleneck in the implementation of any online system.

Journal editorial staff and editors experimented extensively with the e-publishing system, online discussion groups and tutorials were used for acquaintance with system features. All the important features including registration of various users, article submission, reviewer

assignment, new issue creation, communication with authors and reviewers, assigning articles to various current and future issues etc., were thoroughly explored with a view to learn the new system.

Subsequently, the key learning of electronic publishing were shared with other editors and editorial staff. Hands-on sessions were organized to make them proficient in using the system (Figure 2). In the beginning, handholding support was also provided to the editors in troubleshooting of the unanticipated situations. Authors and reviewers were also provided with the telephonic and e-mail based support for article submission and submission of reviewer's comments.

After successful initial learning phase, the available softcopies of the journal back issues were populated in the archive of the system. Online back issues were made available in the system provided the authors and reviewers registered for accessing the articles of their interest. Subsequently, as the system stabilized, journal policy was modified to consider submission of articles only through online method for publication in the ICAR journals.

The decision to accept articles submitted through online mode was considered appropriate as most of the researchers in Indian NARS have adequate ICT skills and facilities in their respective institutions. Many reviewers are already registered with e-publishing systems of other international journals and have familiarity with the online systems and most of the authors are already submitting their articles online in international journals of their disciplines.

Figure 3. Welcome page of ICAR's Open Access journals

The decision to stop accepting the printed articles was also a boon for the success of e-publishing. The online submissions and online peer-review helped in reducing the paperwork involved in the back office processing considerably and hence better acceptance of the system. ICT awareness of the editorial staff involved in the program was also very high, which was also a major reason for the success of online system.

The editors of the journals were motivated to use the system as it provides them with various functionalities such as ability to refer to archived articles instantly, availability of referee database with exhaustive profile and e-mail based communication facility for smooth peer-reviewing process. With the online submission, authors can track the progress of their articles online thereby reduce number of queries by telephone, e-mails, letters and visits in person. Readers have facilities such as search by author name, title, keywords, and full text search in the articles of current and back issues (Figure 3).

Another important factor that online system offers is the possibility to submit/process the articles asynchronously and the ability to work independent of user's location.

Other agricultural research societies in India are being sensitized to consider Open Access model for their journals, in view of the benefits of enhanced visibility, global dissemination and better usage of research. Most of the agricultural research societies have small setup and limited budget to own ICT infrastructure and manpower individually. Therefore, ICAR's OJS based e-publishing platform is being offered as hosting service without any cost to the societies.

Figure 4. Sensitization workshop on e-publishing and knowledge systems in Agricultural Research

Two sensitization workshops (Figures 4 and 5) were organized for the benefit of stakeholders including editors, researchers, societies and students to prepare them for online, e-publishing system. Detailed presentations on issues like "Open Access", "Electronic Repositories and Archives", "IPR and Copyright Issues", "E-Publishing and Business Models", "Governance of Research Journal Publishing" and "Using WWW for providing Agricultural Research Information in Developing Countries" were given by speakers from National Institute of Science Communication and Information Resources (CSIR), National Informatics Center, Ministry of IT, SciDev.Net, Taylor & Francis, Elsevier and ICAR.

Figure 5. Sensitization workshop on publishing in Agricultural Research organized by ICAR, New Delhi

This endeavor gained support and interest of some senior colleagues and senior researchers and through referral network it was possible to convince five other agricultural institutions/ societies to host their journals online on the National Agricultural Research Open Access Platform to expand the program further.

Medicinal and Aromatic Plants Association of India, Indian Phytopathological Society, Society of Fishery Technologists, Indian Society for Horticultural Research, and Indian Journal of Fisheries are using ICAR's e-publishing system. Two more agricultural research magazines viz. *Indian Farming* and *Indian Horticulture* have also adopted the e-publishing platform.

6. Benefits to Indian Agricultural Research

Under the Indian Council of Agricultural Research, more than three thousand researchers are working to provide technologies that solve the problems related to different farming systems in 20 agro-eco systems and 60 agro-eco subregions in India that represent nearly all geographical and climatic regions across the world. The access to scientific and technical information is essential for economic and social development. The knowledge sharing program (E-publishing and Knowledge System in Agricultural Research (EPKSAR)) at Directorate of

Figure 6. Top ten countries that access Indian agricultural research information (2011). (source: Google Analytics).

Knowledge Management in Agriculture (DKMA) involves sharing of Indian agricultural research knowledge at global level (Figure 6). The benefits of Open Access for various categories of users in National Agricultural Research System are as follows:

- *For Authors:* Authors could reach large number of audience worldwide which leads to more visibility of their research work and its use for better impact.
- *For Readers: Readers* are benefited as it gives them free access to the literature they need for their research. Free online literature facilitates full-text searching, indexing, mining, summarizing, translating, querying, linking, recommending, alerting, mash-ups and other forms of processing and analysis.
- *For Universities/Research Institutions:* OA increases the visibility of faculty/ researchers, reduces expenses for publishing research articles in journals; and advances the mission to share knowledge for better development.
- *For Funding Agencies:* OA increases the return on their investment in research, making the results of the funded research more widely available, more discoverable, more retrievable, and more useful. When funding agencies disburse public funds, OA helps ensuring fundamental right to taxpayers through providing public access to the results of publicly-funded research.
- *For Citizens:* OA gives them access to peer-reviewed research, most of which is unavailable in public libraries and gives them access to the research for which they have already paid through the taxes. OA accelerates not only research but also generates new thinking in research, creates new technologies, solves problems and improves informed decisions that benefit everyone in the society.

- *For Journals and Publishers:* OA makes their articles more visible, discoverable, retrievable, and useful. If a journal is OA, then it can use its superior visibility to attract submissions and advertising, not to mention readers and citations. If a subscription-based journal provides OA to some of its content (e.g. selected articles in each issue, all back issues after a certain period etc.), then it can use its increased visibility to attract all the same benefits plus subscriptions. If a journal permits OA through postprint archiving, then it has an edge in attracting authors over journals that do not permit postprint archiving.

Dissemination of agricultural research information in India through Open Access Journals has been a success story as its results are highly encouraging for all stakeholders including researchers, academicians, scholarly publishers, entrepreneurs, farmers, and extension workers (Figure 7). This initiative has been successful in harnessing the benefits of new channels like Internet and ICTs and alternative access models like Open Access. It is evident from the fact that the agricultural information seekers in 175 countries all over the world are downloading the agricultural research information. Prior to the Open Access policy which was adopted by the Council in March 2010, the Directorate of Knowledge Management in Agriculture (DKMA) was publishing just 1,000 copies each of the journals. During 2011, the online system has 5,669 regisered users for *the Indian Journal of Agricultural Sciences* and 4,226 for *the Indian Journal of Animal Sciences* with more than 124,000 visits and accounts for more than 852,000 pageviews. Earlier, *the Indian Journal of Agricultural Sciences* and *the Indian Journal of Animal Sciences* used to receive articles from 9 and 19 foreign countries respectively. But with the Open Access System, their number raised to 35 and 51 countries respectively. The open access approach has given much scope for global visibility as well as popularity to Indian agricultural research. The data analysis also revealed that the users flock the website immediately after the new issue of a journal is hosted; and article-wise download from back issues of journals is also very high.

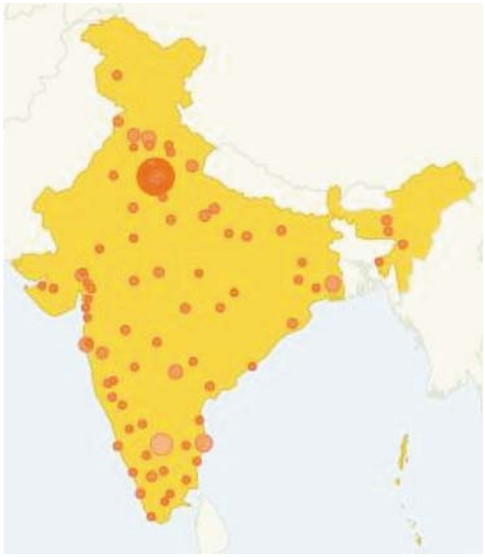

Figure 7: Online Access of e-Journals by users in India

7. How Open Access Publishing Works

The DKMA through its program E-publishing and Knowledge System in Agricultural Research (EPKSAR) has implemented the Open Journal System (OJS) for Open Access publishing of research journals accessible at http://epubs.icar.org.in/ejournal (Figure 8).

The OJS helped to address all the major problems including the most pertinent issues like quality of the content, its reach and online discoverability of research information. The key features of Open Access based e-publishing system are as follows:

The Open Journal System provides role based access to the system resources. Authors and referees can register themselves online. The registration form is very simple and asks details about their profile including research interests and current area of research. Authors can submit their articles through an online submission form (Figure 9). Article submission is a five step process, which collects the metadata besides abstract, full manuscript of the article and supporting files. Authors can also submit any specific message to the editors, if necessary. Immediately on successful submission of the article, authors receive an automatic e-mail with a reference ID number for the article. Further, authors can find the status of their articles at every stage in the process of reviewing and editing works.

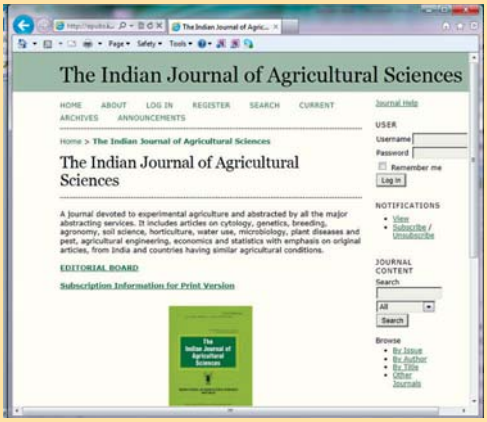

Figure 8. Screenshot of Indian Journal of Agricultural Sciences

The editor can access summary of total number of articles submitted to the journal and know the status of reviewing and editing of each article. Editor can also reject or accept the new submissions on initial scrutiny. On acceptance or rejection of an article, an e-mail alert will be sent to the author automatically. Further, the editor could assign the article to any section editor or to peer reviewer.

Figure 9. Screenshot of the article submission form

The system also supports for blind peer review of the article in a single round or multiple rounds. After assignment of editor or section editor to the article, the article status changes from “Waiting Assignment” section to “In Review” section.

When a section editors logs-in, the system provides them with the database of reviewers registered with the system. The editors/section editors can search for suitable reviewers based on the keywords from the reviewer’s profile and send request to them to review the article(s). An article can be assigned to multiple reviewers, if required.

The reviewer gets e-mail requests to review the article and can access the metadata of the article assigned by the editors. Reviewers can choose to accept the request for reviewing or reject in case they are unable to do it. Their decision is automatically communicated to the editor/section editor by e-mail. Reviewers are required to complete the review of article and submit their comments through the online form as well as by uploading a file separately or making changes to the manuscript itself in track changes mode. The referees can submit their comments with a request to review again after incorporation of changes in the manuscript by

author. In that case, review is not completed unless the same reviewer agrees for the changes by author. The system has provision for sending auto reminder to reviewers completing the review process in time.

In cases where reviewers are unable to submit their comments, editor can cancel the review request and request another referee to review the same article.

The system maintains multiple versions of the manuscript in the server for reference at any stage. Editor can create a new issue of the journal and schedule articles which are through with the reviewing, editing and proofreading. Authors are intimated and can see the pre-print version of the manuscript with the details of volume and issue numbers in which it is scheduled for publication.

After publishing the completed issue, an automatic mail with the table of contents will be sent to the registered readers. Readers then login with their profile and read the articles online along with the back issues.

The online publishing system at ICAR has the following advantages over the print based publishing system:

a. *Automation of routine tasks:* There are about 35-40 predefined e-mail templates available for all possible situations like "acknowledgement of manuscript submission", "request to referee", "acceptance of reviewing request", "auto reminder to author", "auto reminder to referee", "copy edit request to author" etc., which are available during the workflow to various users like reviewers, editor, author, copy editor etc., which help in effective and fast e-mail based communication.
b. *Efficient and reliable record keeping:* Records of research papers and all editorial correspondence are stored automatically in the entire process in the databases. This helps online tracking of the status by authors themselves. This avoided telephone queries and other forms of communication.
c. *Paperless processing:* In the new e-publishing system, article submission by author is completely online. All correspondence carried out between editor-author-referees is via e-mail and online system and complete editorial process is also carried out through e-mail and online system. Hence, it has been possible to eliminate the use of paper in publishing research journals.
d. Digitization of back issues of the DIPA journals has been taken up for development for digital archive. Back issues of *the Indian Journal of Agricultural Sciences* and *the Indian Journal of Animal Sciences* for the last seven years are available online in fully searchable format.
e. Referee database with complete details of experts from all disciplines i.e. agriculture, veterinary and fisheries was developed and integrated in the online system.

8. Motivation for Scientists

An author's main concerns while submitting the articles are: i) journal should be peer-reviewed, ii) quality of the journal, iii) large readership, iv) speed of publishing, v) no authors fee, vi) maintenance of archives, vii) helps in career development and professional collaboration, and viii) appreciation for work. The e-publishing platform has been able to help authors on all these accounts because electronic peer review is faster which helps in faster publication. And

the availability of article on-line gives it global visibility leading to greater impact, international contacts and also helps authors in research collaboration.

9. Impact of Open Access Journals

- Global visibility for agricultural research results and technologies which were generated by NARS/ICAR.
- The e-Publishing and Knowledge Management portal is being accessed by users from more than 175 countries globally. The top ten countries included: India, China, Turkey, Iran, USA, Pakistan, Canada, Mexico, Egypt and Bangladesh (Figure 6). In India there are 86,000 visits from 82 cities. The analytical study of the e-publishing site shows that there have been 7.44 average page views/visit; average time on site by visitors is 6.46 minutes which is very high considering the users' behaviour with regard to online resources. There are a total of 9,895 registered users out of which 6,651 are registered readers.
- Enhanced number and quality of research articles submitted to ICAR journals for publication. On an average, 15-20% of the total submissions in a day are from international authors.
- Earlier global visibility was limited through the abstracting journals. Now, with Open Access and online availability, research articles are visible globally and accessed by the readers immediately upon publication. The open access has helped in faster and more effective sharing of agricultural research results.
- There are 350-650 visits on the working days and 75-150 visits during weekends. Due to online discoverability, ICAR received requests from international universities for collaboration in research with the authors of articles and demands for purchasing the copyrights of articles etc. This will also result in increased impact factor of the journals in forthcoming years.
- Referee Database (having 1,000 experts of different fields) developed resulting in precision and efficient reviewing of articles by the experts.
- Skill up gradation and local capacity building in e-Publishing improved.
- The trends in users' access to Open Access journals would help scientists and policy makers to understand the research direction and priorities. The feedback from readers would also indicate the information needs of different stakeholders in agriculture.
- The Open Access based e-publishing system has made research journal publication eco-friendly as it has helped to save more than 0.5 lakh papers (A-4 size) annually.
- With e-publishing system, editors now don't have to spend their time in the routine record keeping and paper based communications. Due to the e-mail based communication, it is now possible for the editors to have multiple rounds of communication with authors and referees in minimum time, resulting in enhanced quality of research paper publication.
- Availability of research article in soft copy helps in checking through online resources for possible instances of plagiarism, which was very difficult with hard copy.
- Open Access has resulted in enhanced discoverability of the research published in ICAR's journals. There are more than 6,500 registered users (5,500 readers) of the system including authors, readers, reviewers and editorial staff. Within 3 months (December 2010 – February 2011) there have been 33,092 visits, including 246,174

page views by a total of 17,142 unique visitors with 6.46 minutes average time on site (source Google Analytics). See Tables 1-3 for important statistics on open access journals.

- The e-publishing system has resulted in a complete change in the way research publishing was done in DKMA (formerly DIPA), ICAR thereby benefitting all the stakeholders and making it more sustainable. Due to online system, now, there is a visible increase in submission of articles from internationally acclaimed authors, and international reviewers have also registered online for contributing to ICAR's journals.

Table 1: Number of visits to open access journals in India

	December 2010	January 2011	February 2011
No. of visits	4899	7335	6922
No. of Cities	79	80	80

Table 2: Number of visits to open access journals worldwide

	December 2010	January 2011	February 2011
No. of visits	6804	9961	9612
No. of Countries	89	105	114

Table 3: Use pattern of open access journals

	Indian Journal of Animal Sciences	Indian Journal of Agricultural Sciences
No. of Registered Users	5874	4358
Abstract Views Online	109632	104303
No. of Articles Downloaded	28515	28956

10. Future Plan

Opening Access to the Indian agricultural research journals has provided a new dimension to the dissemination of research results and quality improvement in publishing. The future enhancements may include the sharing of open access data sets generated during the process of research programs in the Indian NARS which are used for publishing the research articles. It will provide new avenues in research data sharing among researchers, enhance collaboration and will lead to speeding up of the research processes to better achieve the millennium development goals in agriculture sector.

Acknowledgements

The authors are grateful to Dr. S. Ayyappan, Secretary (DARE) and Director General, Indian Council of Agricultural Research (ICAR) and other senior officers for their guidance and cooperation to launch the agricultural research journals on Open Access platform and adopt an Open Access policy in the ICAR for improving the openness in sharing agricultural research information.

Empowering Farmers through Rice Knowledge Management Portal in India

Shaik N. Meera[1], G.A.K. Kumar[2], P.S. Pandey[3], S. Arun Kumar[4] and B.C. Viraktamath[5]

1. Introduction

ICTs are not really about computers, the Internet, and telephone lines. They are about information and communication. This makes the issue of content a very important priority as we try to use new technologies for the community development and alleviation of poverty. Until early 2002, the main focus was on building or strengthening the digital readiness of developing nations to help people get connected. For example, the principle response to the "digital divide" has been to make available computers, telecommunication links, and Internet Service Providers where these facilities were thinly spread or absent completely.

What appears to be emerging is more of a concern about the "digital information divide". In most developing countries, agricultural institutions have not moved to a level where new and consistent information services to farmers and other stakeholders are offered based on quality and contexts. This necessitates us to develop strong agricultural knowledge management strategies that are built on huge agricultural content (data- Information-knowledge). Now we are beginning to see increasing attention to the content and services that ICTs can deliver.

In this changing scenario, Indian Council of Agricultural Research (ICAR) wishes to promote the use of Information and Communication Technologies (ICTs) in agriculture by developing national level knowledge management portals. As a first step towards achieving this objective, an exclusive portal on rice viz., Rice Knowledge Management Portal (RKMP) is developed by ICAR under the NAIP project (Box 1). The portal is built by the Directorate of Rice Research (DRR), Hyderabad in association with 8 consortium partners, two convergent partners and 20 AICRIP partners. This serves as an information highway for rice sector in sharing rice knowledge through latest ICT tools including mobile telephony. It also helps the on-going activities of agricultural departments in reaching out to the farmers through extension advisory services in most effective way.

The RKMP has several global firsts in terms of comprehensiveness and utility. Perhaps, this is the most comprehensive and one-stop shop source for credible, validated, relevant and contextual information on rice. Built on web 2.0 standards, this portal caters to location specific information needs of many stakeholders (policy makers, farmers, extension professionals, researchers, traders, NGOs etc.) on 24X7 basis. IP based customization helps individuals to browse through location specific content. Providing content in local language is another important feature of this portal.

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4 Co-Principal Investigator – RKMP;

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2. Need and Purpose

The new agricultural paradigm will have to be recast to take advantage of the wealth of knowledge available to achieve multiple goals of sustaining the food security, income, jobs, etc. The ICTs along with Knowledge Management (KM) strategies have significant role to play in evolving such a vibrant agricultural system.

In India, rice is the major cereal crop grown in about 44.6 million hectares. India represents all kinds of diversity under which rice is grown across the globe. No other crop is as versatile as rice. Rice crop is interwoven in the cultural, social and economic life of millions of Indian and it holds the key for food and nutritional security of the country.

Box 1: Project Details

Project Title: Development and Maintenance of Rice Knowledge Management Portal

Vision:

Our vision is to serve wide range of stakeholders and help in better planning to realize higher productivity and production of rice through improved knowledge and skill sets.

Objectives of RKMP Project:

To develop and maintain Rice Knowledge Management Portal to strengthen research, extension, farmers, private subsystems, partnerships and networks through better flow of rice knowledge and information contributing to the overall rice development in the country

Specific Objectives:

1. To develop structure and content for RKMP comprising research information systems, extension information system, service information system, farmers information system, general information system and e-learning platform related to rice
2. To pilot these information systems for uploading, sharing and harnessing rice knowledge amongst rice stakeholders
3. To build capacity of the stakeholders in using the Rice Knowledge Management Portal for effectively transforming rice knowledge and information as a viable factor of production.

Funding by NAIP.

Project Duration: 3 years.

Total funds: INR. 616.803 lakhs.

Rice production scenario in the country during the past decade presents a gloomy picture of compound growth rate of just 1.7 per cent despite the highest production figures (93.3 MT) posted during 2001-02. In near future, land under rice is likely to be reduced further and could stabilize at about 40 Mha. Relative contribution of irrigated rice to the total production is likely to remain same though, on one hand, area under irrigation is likely to increase through popularization of *boro* rice in the eastern part but, on the other hand, likely to be reduced by urbanization, industrialization and crop diversification due to reduced profitability and threat to sustainability in rice-wheat area. To meet a production target of 125 MT by 2025, all inclusive of food requirement, seed for cultivation, storage in buffer stock and a share for exports, productivity in irrigated area needs to be enhanced by 1.5 tons/ha and in rainfed lowlands by about 1 ton/ha. A careful SWOT analysis presented in vision 2025 document of DRR revealed

that there is an opportunity for bridging the yield gap by improving the access to the rice knowledge.

Enormous knowledge has been developed about this crop and there is a need to share this knowledge for the betterment of our society. Indian rice research and rice development programs have been recognized as successful model endeavors all over the world. However, given the burgeoning task of further enhancing the production and productivity of rice, the existing information sharing mechanisms appear to be insufficient.

3. Knowledge Flow Matrix and Information Needs

Organizations that jointly and/or individually contribute to the development, distribution and use of rice knowledge in rice sector may broadly be classified as Rice policy makers (P), Rice research (R), extension organizations (E), Credit Institutes like banks (B), Farmers (F), Input supply firms (I), Rice marketing firms (M), Rice processing firms (Pr), Consumers (C) and External organizations (X). In most of the cases, due to several reasons, there is no knowledge/information and data sharing amongst these organizations (Figure 1). Moreover, building a strong linkage among these organizations is called for in the recent past.

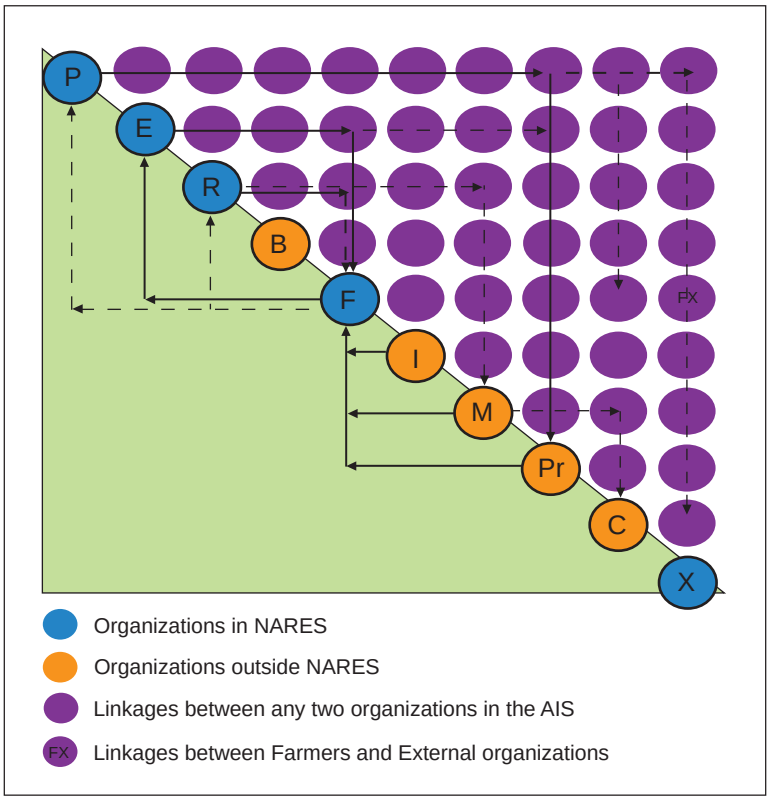

Figure 1: Diagrammatic representation of linkage matrix in rice (Adapted from Tugrul Temel, 2004)

It becomes imperative to strengthen the capacity to enable rice workers to create, manage and share information for the benefit of all stakeholders. This includes scientific, technology-related information for research and research management and for extension outreach; market information for the agencies and farmers; generic information for the public and comprehensive information for better decision making by the policy makers. There is a need to catalyze the mobilization of a critical mass of researchers, extensionists and farmers into leap-frogging the knowledge barriers to modernization of agriculture in India. It is with this vision, the Rice Knowledge Management Portal (RKMP) was developed.

Box 2: Benchmark Analysis

In order to understand and assess the existing rice knowledge dissemination portals, their current status in terms of metrics, average daily views, information craved by netizens on these portals, information requirements of various stakeholders in rice sector viz., researchers, extension workers, NGO's/KVK's, traders, farmers, policy makers etc., a benchmark analysis was carried out based on secondary information and data sets with the following objectives:

1. To analyze knowledge needs of various stakeholders in rice sector with respect to:
    a. Extent of integration of information and Knowledge needs of stakeholders at various hierarchical levels
    b. Accuracy of knowledge perceived by the rice workers
    c. Existing system analysis on knowledge quality, system quality, service quality, users' satisfaction and net benefit derived by various stakeholders
    d. Sustainability options.
2. To delineate a roadmap for development of extensive and exhaustive Rice Knowledge Management Portal auguring the information and knowledge needs of various rice stakeholders.

Output: A document with comprehensive list of information/knowledge needs of rice stakeholders and their choice for information formats.

4. Understanding KM in the Present Context

After having known what are the information needs of rice sector (Box 2) and a complete knowledge flow matrix, next focus was on understanding what KM processes, tools and strategies to be deployed into making of RKMP. The data, information and knowledge differ from one region to other. Knowledge that includes data and information within a particular context varies considerably between the contexts and emerges from the flows of information around the system. When a scientist's knowledge moves into an extensionist's context, it is relegated to information and it is the practitioner/user who has to do the work of making this information into new knowledge. Agricultural research knowledge is just another piece of information to be incorporated into the knowledge of an extensionist. Of course, this works the other way when we think of multiple stakeholders in the agricultural value chain, the interaction between the data, information and knowledge gets much complicated (Shaik N. Meera, 2010). Using the traditional knowledge flow mechanisms, it is not possible to facilitate different processes (from collection to decision making) at various hierarchical levels. The KM practices using ICTs are emerging fast as viable solution.

Knowledge management generally refers to sharing of knowledge inside an organization and from an organization to the outside. This involves generating, capturing and disseminating knowledge. Researchers have pointed out two kinds of knowledge: tacit (context-specific

personal knowledge embedded in individual experiences, and thus difficult to share) and explicit (that can be easily articulated and transmitted). Knowledge management deals with both the experience and understanding of people in organizations (mostly tacit) as well as information artefacts such as documents and reports (which are explicit) available within and outside of organizations. While explicit knowledge is easy to share or transmit, sharing tacit knowledge is difficult, although not entirely impossible. Tacit knowledge plays an important role in providing meaning to explicit knowledge as well as contributing to the development of new knowledge. ICTs can support the transformation of tacit knowledge to explicit and vice versa (Table 1).

Table 1. Example of processes identified to support knowledge transformation

Tacit to Tacit E-learning, Videoconferencing, Blogs, Synchronous collaboration (chat)	**Tacit to Explicit** Answering questions Annotation, Theme and status papers
Explicit to Tacit Visualization Browsable video/audio of presentations	**Explicit to Explicit** Text search, RLOs, i3R Document categorization, CMS

The efficiency of future extension efforts will be determined by how effectively these KM practices are incorporated into the existing extension system. The Rice Knowledge Management Portal (RKMP) tried to translate valuable data and information into useful knowledge for the extension workers working in the rice sector.

5. Project Implementation

Portal is not a simple web site. It is a lot more and provides at least a modicum of data services. The design is done as a combination of repositories, data containers, work flows (that facilitate document creation and review), folders to receive dynamic data, servers to host audio/video clips, news blogs etc. While efforts are on for development portal design and development and hosting by DRR, the content development strategies is implemented simultaneously. Portal is less of softwares, but more of content. In the content development strategies, the development of six kinds of information systems is taken up in an intensive way. A brief description of workplan is given below.

Defining the functional requirements for a portal, that addresses information needs of 700 rice scientists, 110,000 public sector extension officers, 225 civil society organizations, 600 Farm Science Centres, 4.26 lakhs stakeholders etc., was going to be a herculean task. Since RKMP was envisaged to be ‘content portal’ rather than ‘collaborating portal’, it was decided to involve the partners with a focus on content development.

The project is implemented in a consortium mode. Each consortium partner has specific roles to play based on their core competency. DRR lead the consortium. ICRISAT and C-DAC are technical partners focusing KM models and font technologies respectively. Other partners are called ‘content collaborators/partners’, whose primary responsibility is to develop local content in collaboration with the AICRIP centers, SAUs and other stakeholders from the states within their jurisdiction. A conceptual model for content development for one state is given in Figure 2.

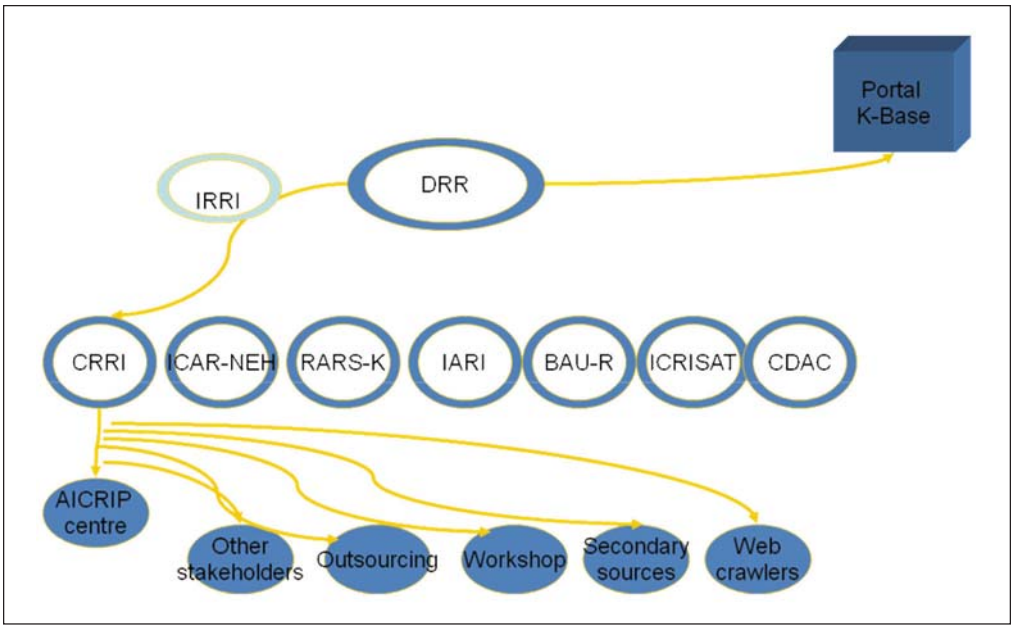

Figure 2: Conceptual model for content development

The design, planning, coordination, execution, technical expertise, and hosting and maintenance of the proposed Rice Knowledge Management Portal were taken up by the Directorate of Rice Research, Hyderabad in association with its collaborating institutes. The information support is provided by the selected stakeholder in rice sector of the country.

Research Information System: It is developed by DRR in consultation with CRRI and all AICRIP centers spread across the country. The static information is developed by digitizing the existing AICRIP and other data sets that have relevance to the present research systems. Skilled helpers are employed for four months to digitize the relevant data. The portal design will have inbuilt ability to provide indexed research results, and research prioritization data (Figure 3).

The dynamic dimensions are developed by incorporating the management information system in the existing AICRIP setup. An online discussion is launched with the available e-mail IDs of rice researchers across the country.

Extension Information System: The content for EIS is developed for fifteen major rice growing states of India. Huge amount of extension information/knowledge is collected and documented for EIS upto state level.

For effective content generation and customization, the country has been divided into six regions and each region had one or two Content Collaborators responsible for organizing the content development workshops for each state involving concerned AICRIP Centers and all the stakeholders. For example, IARI has taken care of Punjab, Haryana and Uttarakhand. Further, they are supported by AICRIP scientists (who are called as RKMP nodal officers) and other stakeholders as their team members with a view that once the project period is over, existing AICRIP set up will be able to regularly update the portal content as per their mandate.

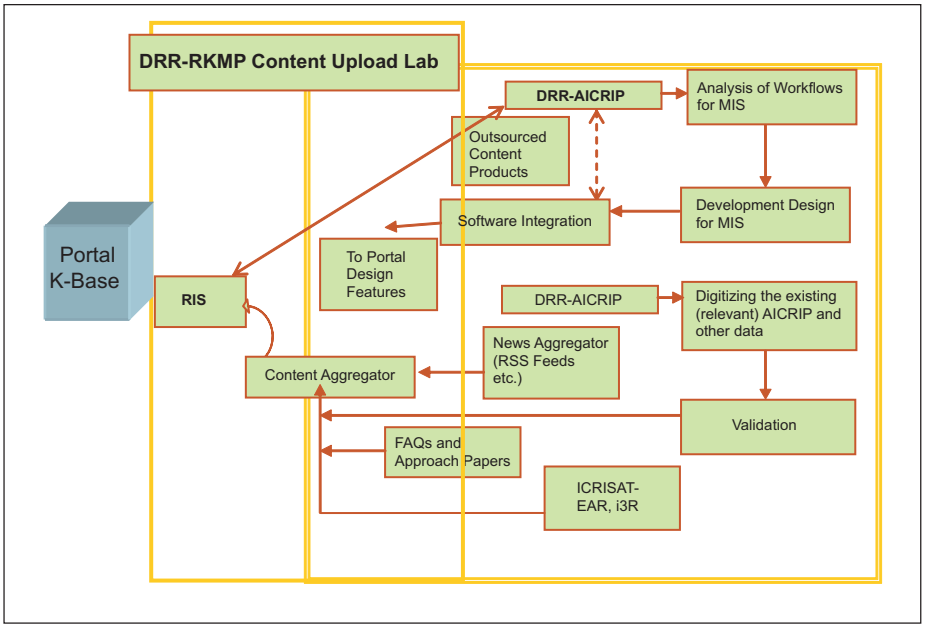

Figure 3: Conceptual model for development of Research Information System

These Content Collaborators had identified resource persons for developing and validating state level knowledge resources like location specific production technologies and post production technologies; diagnostic tools for diseases, pests, nutrients and abiotic stresses; and FAQs. The information on development programs were also collected from the state departments during the workshops and will be made available through portal (Figure 4).

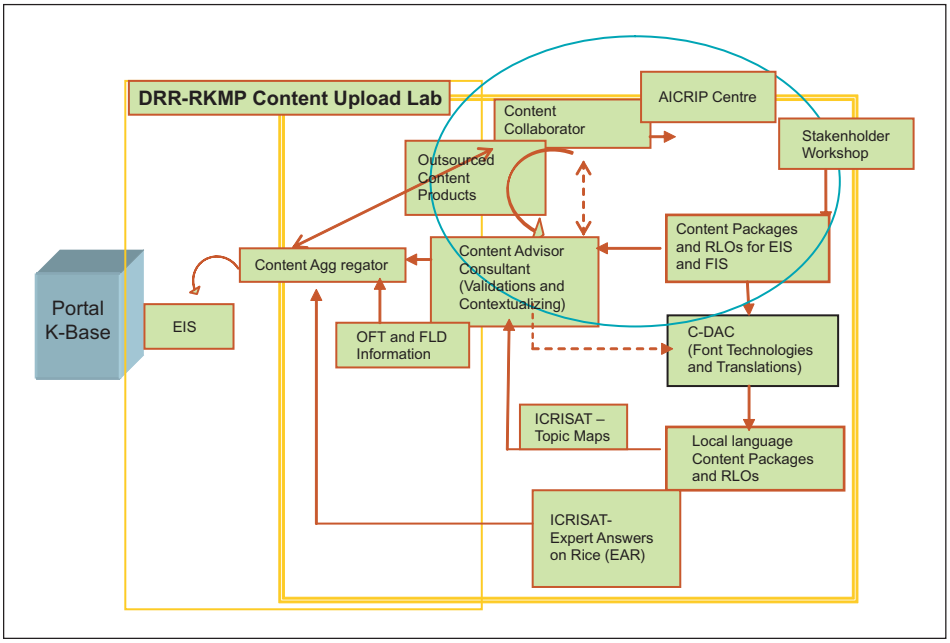

Figure 4: Conceptual model for development of Extension Information System

The static (archive) information on FLD results along with the varietal performance were hosted on the portal. To begin with, information available with DRR was made available. This regular updates from different agencies working on FLDs will later on be placed in this domain.

Farmers Information System: C-DAC along with regional consortia partners were involved in developing FIS in local languages. The content was translated into Hindi, Telugu, Kannada, Tamil, Oriya, Marathi, Bengali and Punjabi (Figure 5).

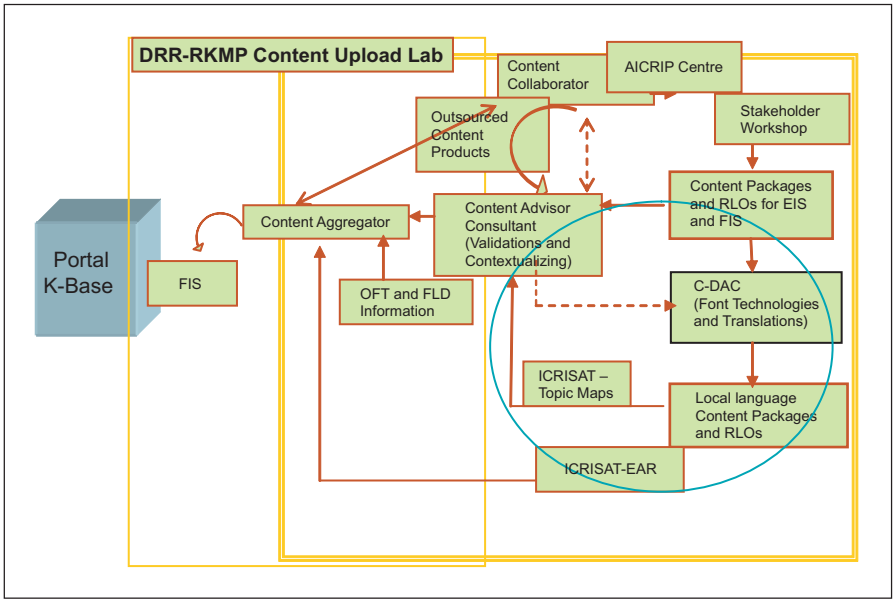

Figure 5: Conceptual model for development of Farmers Information System

Service (Market/Export/Input Supply) Information System: CRRI has coordinated the development of SIS by outsourcing the task to various agencies involved in provision of this information. Some of the information provided by them include: private sector information, input supply information, marketing information, export/import information and export/import information particularly for basmati.

General Information System: CRRI along with DRR and ICRISAT has develop GnIS on history, evolution, crop profile, recipes, rice in day-to-day life, rice regions, value added products, fact sheets, directories, linkages to vortals, rice statistics along with interactive GIS map interfaces, digital photo library, rice news feeders, digitized rice almanac and rice wikipedia. DRD was associated as convergent partner, whereever required (Figure 6).

E-learning/Virtual Platform for Distance Learning: DRR and ICRISAT developed e-learning courses on the basis of the content developed for RIS, EIS and FIS. Synchronous on-line training support and asynchronous knowledge support were developed using commercial and open source content management system/software. Capacity building and training workshops were organized to enable stakeholders for use, customize and edit the content based on location specificity. Once developed in English, relevant courses were translated into local languages by C-DAC (Figure 7).

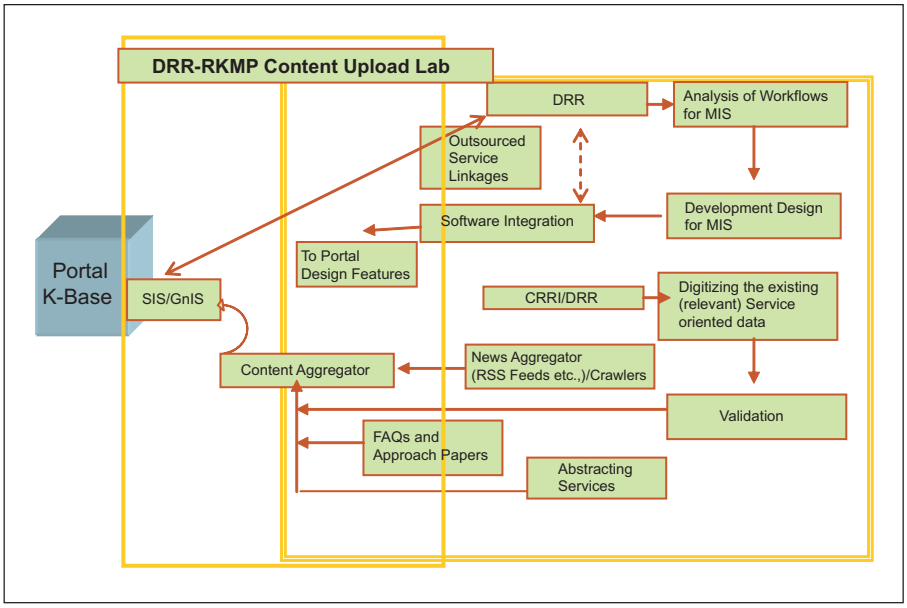

Figure 6: Conceptual model for development of Service Information System/ General Information System

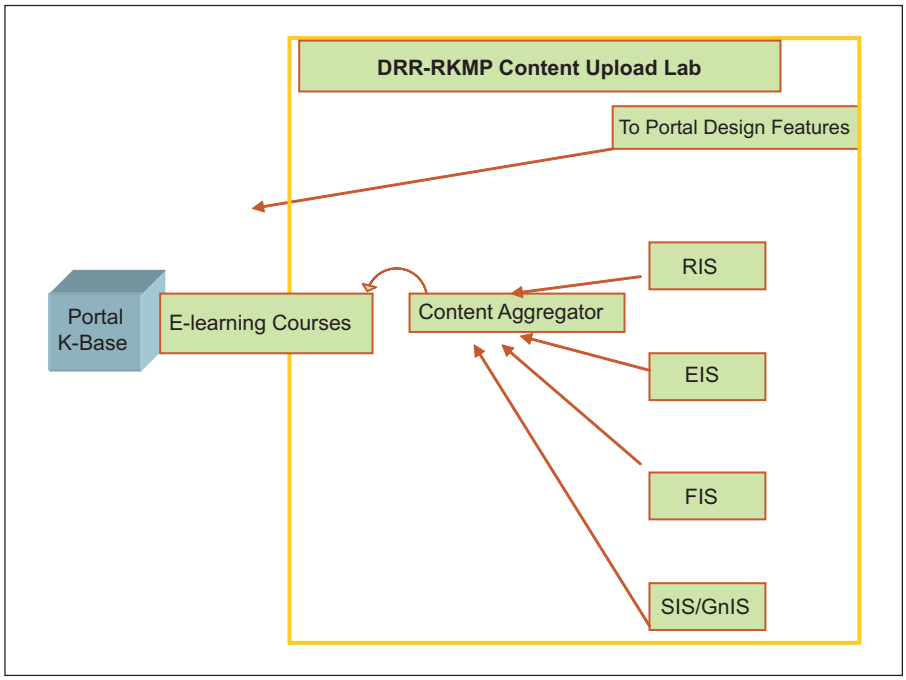

Figure 7: Conceptual model for development of E-learning platforms

6. Portal Development

Portal back-end development comprised of development of information architecture, defining the platforms in terms of content management systems, database types, web servers, script, handlers, concept maps and user interfaces etc. Main portal is built on open source Content Management System with a lot of plug-ins to support the content flow customization. The basic information unit for the portal is an RLO (Reusable Learning Object). In the Information architecture defined for the portal, there are about 4,500 content heads with data attributes (both in terms of technical – format and agriculture domain expertise). For ontologies related to rice, a compendium of Rice Vocabulary (RiceVocs) with about 2,500 terms was prepared. These terms are again clubbed with other generic terms (such as seasons, geographic location, user types etc.) to make it more semantic enabled. For example, in most of the ontologies, 'Package of Practices' is not defined as a term for tagging. In such cases, the searches for a package of practice for a specific location will not yield desirable results (Figure 8).

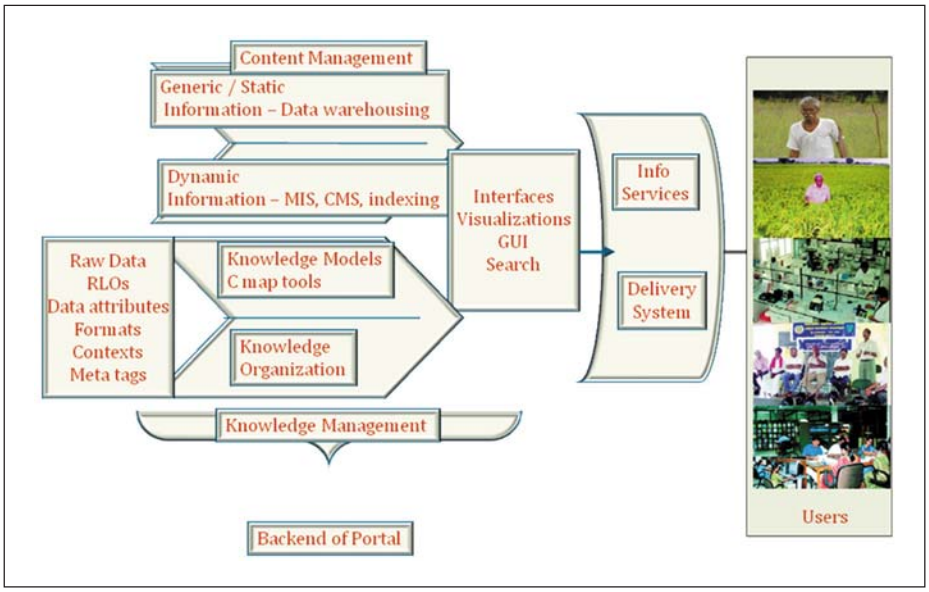

Figure 8: Conceptual model of portal back-end development and user interfaces

Building a semantic portal in agriculture was another challenge. Such portal should enable multidimensional search by means of rich domain ontology. For that, different types of information were categorized by expert groups (Figure 9) into semi-structured and extensible sub-heads allowing for bottom-up evolution and decentralized updates. Effectively tagging of these terms hierarchically made users add new classification and organizational schemas and extend the information structure. With concept maps at application

Figure 9. A group working on card sorting exercise for design features

layer, portal content is stored and managed in a decentralized way with effective manual tagging and auto-tagging processes.

6.1. Content Validation Process

One of the important activities of RKMP is a thorough and hierarchical validation process undertaken by the experts (Figure 10). The model format is given below;

Content Validation Form

Topic/ RLO/ Functional Requirement	Content Suitability											
	Sources are acknowledged/ Copy right issues are involved?	Relevance		Coverage		Clarity Content/ Language		Continuity (flow)		Adequacy of Tables/ Visuals		Needs Improvement (Specify in the draft)
		Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	

Certified that the content provided by the RKMP Lab has been validated to the best of my knowledge
The content may go online (as such/little modification/complete revision).
Signature and Designation of the Validator

6.2. Monitoring & Evaluation Plan

A Consortium Monitoring Unit (CMU) was established as per the NAIP guidelines (for other Components) at DRR. In addition to some regular scientists, contractual staff are appointed to man the unit. The CMU is responsible for preparing the M&E work plan and budget, preparing half yearly and annual progress reports, coordination with the consortia partners and liaison with the National Coordinator and the external review teams from time to time.

Figure 10. Content validation process in progress

For all the consortium partner institutes, the benchmark indicators are fixed and the CMU was particularly tracking the progress for these indicators and monitoring on half yearly basis. Besides assessing component productivity, the total system productivity was also quantified. Also, the submission of regular progress reports by the CoPIs was tracked. The key activities undertaken by the CMU included consortium formation, research plan preparation and implementation, knowledge management, capacity building and impact evaluation.

6.3. Capacity Building

Knowledge Management in agriculture is relatively a new concept. The mammoth task of driving the knowledge sharing process in rice requires lot of capacity building exercises. The following capacity building activities were undertaken:

1. Organised training on Knowledge Management strategies, exposure training to knowledge management initiatives in agriculture worldwide, acquiring the first hand information and managerial skills for sustaining the RKMP etc. The CoPI from CRRI also got training in this direction. This helps strengthening and sustaining the RKMP in all future endeavors.
2. Trainings on orientation towards the RKMP, content development strategies and basic skills of KM strategies are of utmost importance to the Consortium Partners. Hence, it was proposed to get CoPIs of the sub-project to get trained in these areas. This helped strengthening the organizational capacity to harness KM strategies in the overall agricultural development. IRRI organized country specific training workshop at Bengaluru.
3. Third category of training is imparted to the "Communities of Practice". Representatives from all the rice stakeholders of the country got exposed to different areas of RKMP. Training includes orientation to RKMP, content sharing procedures, capacity building in harnessing the power of RKMP, workshops for motivating the stakeholders to trickle down the utility of RKMP. Senior rice workers got orientation to KM strategies in rice sector (Figure 11).
4. Online support for effective browsing/adding/editing/use of content is provided for all the registered users.

In addition to the above, to provide the effective hands on experiences to the stakeholders, various capacity building workshops have been organized across the country by various partners.

Figure 11. Hands-on experience to stakeholders at DRR, Hyderabad

6.4. Workshops Planned & Conducted

S. No.	Type of Workshop (Figures in parenthesis indicates the total number of workshops)	Deliverable/ Monitoring Indicator
1.	Launch Workshops of the Project (16)	Role definitions of Consortium partners, refinement of the work plan (month level activities).
2.	Workshop for finalizing the design features and functional requirement of the portal	Finalized design features and functional requirements.
3.	Content Development Strategies Workshop for Content Collaborators and their team members	Finalization of content development strategy and Dimensions of location specific knowledge/ information to be collected and fed into RKMP
4.	Review Workshop	Review of the status of RKMP work and action points finalized
5.	Content Development Phase-I Content Development for 1st Batch States Content Development Workshops (6)	Complete digitized content for EIS and FIS DRR & ZARS (South) CRRI (Eastern) ICAR-NEH (North-east) IARI (North) RARS-K (West) BAU-R (North Central)
6.	Capacity building workshop for rice researchers (3)	45 AICRIP scientists from all the regions got hands-on experience
7.	Capacity building workshop for NGOs, KVKs and State Department (extension) Officials (3)	60 personnel from all five regions to get hands-on experience DRR CRRI IARI
8.	Capacity building and Upscaling workshop for Private sector Upscaling Opportunities for the RKMP (1)	Representatives from 20 private companies/ agencies. Upscaling strategy Phase-I Refinement of RKMP select features in tune with their requirements
9.	Content Development Phase-II Content Development for 2nd Batch States Content Development Workshops (9)	Complete digitized content for EIS and FIS for the states organized by AICRIP Nodal officers. Facilitated by: DRR & ZARS (South) CRRI (Eastern) ICAR-NEH (North-east) IARI (North) RARS-K (West) BAU-R (North Central)
10.	IRRI's Orientation Workshop	Orientation and action points from IRRI's perspective by IRRI-India/IRRI
11.	Content Translation and Capacity Building Workshop	Sharing the content translation strategies by C-DAC

12.	Review Workshop	Review of the status of RKMP work and action points finalized CRRI
13.	Expert Answers on Rice Workshop (1)	24X7 Online web based question-answer platform. Experts identified for all the states ICRISAT
14.	Rice Topic Map and Agopedia Workshop (1)	Topic maps with user friendly interfaces ICRISAT
15.	Capacity building workshop in rice regions	At least 60 to get hands-on experience DRR CRRI IARI
16.	Capacity building and Upscaling workshop for Private sector Upscaling Opportunities for the RKMP. Sponsored by Private sector	Representatives from 40 private companies/ agencies. Upscaling strategy Phase-II Refinement of RKMP select features in tune with their requirements DRR CRRI IARI
17.	Sustainability Planning Workshop	Review of the status of RKMP work Sustainability Plan finalized DRR

6.5. Technologies Used

The portal is built on Drupal (open source) with effective tagging of 1,000 content heads. This is the most comprehensively defined agricultural semantic portal of the country. Plug-ins and add-on platforms (such as.Net and java based) give additional strength to the portal.

This portal is hosted on www.rkmp.co.in connected to 100 mbps line of National Knowledge Network scalable upto 1 GBPS in two years time from now.

6.6. Services and Investments

The portal and the platforms have been developed at very nominal investments. In most of the cases, open source CMSs/LCMSs are used, where in-house expertise (indirect costs such as contractual staff, CoPI time contribution) with some level of customization (direct costs) is done.

Some platforms such as AICRIP-Intranet were developed using commercial software wherein there is direct cost. EAR and i3R platforms are developed by consortium partners (ICRISAT). High quality video films are developed by outsourcing. The direct cost for developing all these platforms is about Rs. 37.50 lakh.

These are all developed as one time investment. Effective knowledge management will have far reaching consequences in bridging the knowledge gap in rice sector. Since there is an in-built sustainability of these platforms (to be owned by AICRIP from 12th Five Year Plan onwards), there will be continuous use of these platforms. This makes all these platforms economically viable. Indirect benefits of these platforms include: integration of context specific

information and knowledge needs of stakeholders, relative easiness, speed and accuracy of knowledge access etc.

7. Overview of RKMP Features

For providing the most comprehensive agricultural knowledge directly from the scientific community, Rice Knowledge Management Portal was launched in the presence of Honourable Prime Minister of India during 83rd ICAR Foundation Day on 16th July 2011.

With about 20 platforms, more than 12,000 pages of content, 3,000 minutes of audio, 50 video clips, this is the first comprehensive agricultural portal of the country. This first of its kind from the public sector R&D organization providing the credible and context specific information to farmers and other stakeholders of rice. Figure 12 shows the RKMP landing page.

Figure 12. RKMP landing page

- **Language Selector**

RKMP supports different vernacular language content along with English. Important languages include Hindi, Telugu, Kannada, Tamil, Oriya, Marathi, Bengali and Punjabi. It also supports authoring in local languages (Figure 13).

Figure 13. Local language support

- **Automated Tagging**

Flexible auto tagging of the content types via a pluggable interface is provided in the portal. It doesn't rely on pre-defined vocabularies. Instead, this module sends node content through any number of third party services to determine what the content is about. If an user does not know the heirarchy of vocabulary, then auto-taggers come in handy for help (Figure 14).

Figure 14. Automated tagging

- **Video Gallery and Digital Photo Gallery (Figure 15)**

Figure 15. Video and photo galleries

- **Search Functionality**

Hierarchical search at every point of browsing is the important feature of RKM Portal. Semantic searches is the key and powerful feature of the portal (Figure 16).

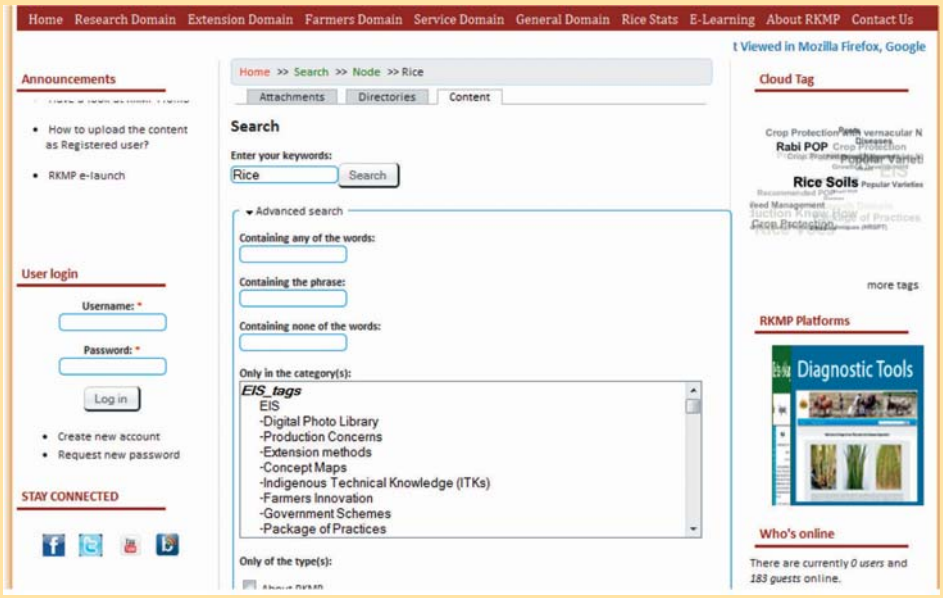

Figure 16. Search facilities of RKMP

- **Archive (Figure 17)**

Figure 17. RKMP archive

- **Tag Clouds (Figure 18)**

Figure 18. Tag clouds on RKMP

8. Description of the Portal Services

Rice Knowledge Management Portal (www.rkmp.co.in) comprising of 1,300 RLOs of generic content, 1,580 RLOs of State specific content, 822 RLOs of State specific content in local languages, 52 video clips and 4,000 minutes of audio clips on different topics of rice, 37 theme papers, 2,800 RiceVocs terms, 48 rice researchers in directory, 75 Government schemes, 48 RLOs of extension methods, 459 FAQs, 37 innovative farmers profiles, 8 RLOs of history & evolution, 40 RLOs of rice in Indian culture, 56 rice facts, 62 recipes in rice in human nutrition, 12 rice end products, 62 news & events and 37 virtual rice resources, 12 recap sheets, 91 local language Government schemes, 27 local language innovative farmers profiles, 254 RLOs of local language weed management, 522 photos in digital photo library (as on 26 December 2011). The features of web 2.0 standards supports for continuous content addition and the existing volume of content is bound to grow regularly. For delivering the information services to different stakeholders, the portal operates through several domains as follows:

Domain	Target Users	Content Provided/Services
Research domain	Researchers	Data Repository AICRIP Intranet Status of rice production state wise RiceVocs (2,500 rice relate vocabulary) Bio-informatics Tool Research Themes Research Fora (Community of Practices) Directory of Rice Researchers India Rice Research Repository (i3R)

Domain	Target Users	Content Provided/Services
		Guidelines Tools and Techniques History of Rice Breeding Rice Research in India
Extension domain	Extension Professionals	Production Know How of rice (2,500 heads) Package of Practices (state specific) Expert Answers on Rice (EAR) Government Schemes Extension Methods Diagnostic Tool FAQs Frontline Demonstrations Production Concerns of the Month Farmers Innovation Ferti-meter Spot nearest Research/Extension Office/Dealer Recap Sheets Audio Gallery Video Gallery Weed Management Weed Information System (WISY) Indigenous Technical Knowledge (ITK)
Farmers domain (in local languages)	Farmers	Production Know How Package of Practices Expert Answers on Rice (EAR) Government Schemes Farmers Innovation Audio Gallery Video Gallery Digital Photo Library Weed Management
Service domain	Traders	Trade Information System (Trade Know How) Mandi (Market) Prices Spot nearest Research/Extension Office Dealer Weather Information
General domain	Home Makers Student community	History and Evolution of Rice Rice in Indian Culture Rice Facts Rice in Human Nutrition Rice End-Products News and Events Virtual Rice Resources Rikipedia Virtual Tour
Rice Stats	Policy Makers	Rice Almanac GIS Maps
E-learning	Researchers Extension Professionals	LearnRice-Moodle LearnRice

There are several offshoot platforms that provide in depth focus on highly specialized information needs of the stakeholders. Some of them are:

- **AICRIP Intranet**

All India Coordinated Rice Improvement Project (AICRIP) is a major activity in DRR involving several locations all over the country to test various technologies developed in rice production. Such all India testing of promising breeding material (varieties, hybrids, composites, agronomical practices and other input use) helps in identifying the most stable, high-yielding or superior genotypes suited for different agro-climatic conditions and possessing the required level of resistance to the targeted insect pests and diseases. AICRIP Intranet is targeted to automate the whole process of AICRIP data starting from centers, cooperators, trials, technical program, seed dispatch and confirmation, crop condition to final summary tables for the reaction of aboitic/biotic stress on genotypes (Figure 19).

Figure 19. AICRIP Intranet

- **Data Repository**

RKMP believes in the data-information-knowledge transformation continuum and provides access to a large database of about 27,000 datasets related to AICRIP multi-location trials conducted for last 45 years across the country. With effective tagging based on disciplines, year, season in searchable pdf format. The RKMP is catering to data requirements of rice researchers of the country with an aim to improve their performance that can make a difference, if used and reused effectively (Figure 20).

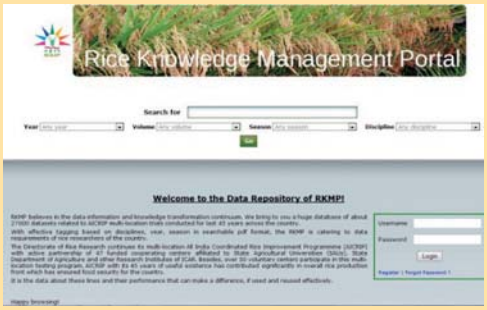

Figure 20. AICRIP data repository

- **Bioinformatics Tool**

The RKMP Bioinformatics Tool Suite is developed and implemented for the saving, retrieving and analysis of biological data and extracting the information from them. It provides data on DNA or protein sequence (Figure 21). It focuses on developing and applying computationally intensive techniques. Major research efforts in the field include sequence alignment, gene finding, pattern recognition, prediction of gene expression.

Figure 21. Bioinformatics tool

Analysis in molecular biology and bioinformatics is an automated, computer-based examination of characteristic fragments. This set of tools allows you to carry out further, more detailed analysis on your query sequence including query sequence statistics, identity and similarity, sequence format conversion, DNA translation, ORF finding, compositional biases, restriction digestion, restriction maps and prediction of PCR (Polymerase Chain Reaction) products. The identification of these and other biological properties are all clues that aid the search to elucidate the specific function of your sequence.

- **Directory of Rice Researchers**

Indian rice research and rice development programs have been recognized as successful model endeavors all over the world. In fact, with about 700 scientists working on rice, the All India Coordinated Rice Improvement Project (AICRIP) is the largest network of scientists on a single crop. The diversity of rice scientists is as good as that of the rice growing regions of the country. At a single place, Directory of Rice Researchers provides the access to find all those champions, who have been working on various researchable issues related to the most important crop of the country (Figure 22).

Figure 22. Directory of rice researchers

- **E-Books/E-Manuals**

Certain types of information can only be comprehended when in it is available in total. Realizing this, a series of e-books and manuals of interest are being provided as e-books. These are the most valuable resources on different areas of rice research and extension that deal with in depth analysis of 'know how and do how' (Figure 23).

Figure 23. E-books on RKMP

- **India Rice Research Repository**

i3R is an acronym for India Rice Research Repository. i3R consists of conference papers, journal articles, book chapters, books/bulletins, slide bank, conference proceedings and other type of articles (Figure 24).

Figure 24. i3R on RKMP

• Communities of Practice

The implicit knowledge of individuals has lot of utility when it comes to enhancing production and productivity of rice at farm level. To capture such knowledge from individual experts in rice research and development institutes, a platform RKMP CoPs (Communities of Practice) is being maintained (Figure 25).

Figure 25. CoPs on RKMP

• Research Themes

Sharing the tacit/implicit knowledge in the minds of individuals from diverse backgrounds and experiences is very important. In a move to capture the implicit knowledge that exists among various experts in different fields of rice research, they were requested to write for RKMP. This has resulted as an excellent repository of high value review papers (approach papers) describing rice research conducted so far and the future thrust areas in a specific field that will be very useful for the rice researchers (Figure 26).

Figure 26. Repository on research themes

• Rice Research in India

A comprehensive paper “Rice Research in India” covering different facets of rice research carried out in India since independence written exclusively for the portal by one of the eminent scholars Padma Shri Prof. Siddiq. The transformation of rice research and development that the country has seen in last five decades can be experienced by the readers (Figure 27).

Figure 27. Rice research in India page on RKMP

- **State Wise Information**

Figure 28. State wise information on rice

Many a times we wish to understand rice production scenario in different states of the country. Even though area, production and productivity statistics are available, there is a need to understand the contexts in which rice is cultivated and various issues related to the rice production scenario. Keeping in view, this information requirement, the eminent personalities from different states have provided the general rice production scenario as per their experiences and records in the form of comprehensive status papers for each state (Figure 28).

- **Audio Files**

Figure 29. Audio files on RKMP

For those who wish to "listen rather than read", the portal have options such as 'click and hear'. This enables the users to work on other documents and can still listen to some valuable stuff (Figure 29).

- **Diagnostic Tools**

RKMP consists an exciting and completely image driven rice pest and disease diagnostic tool. This has been designed to help extension workers, farmers and other stakeholders in identifying the field problems they face in Indian rice fields. The diagnostics is based on the stage of the crop, but has options to select or search at any point based on symptoms and type of problems. The tool helps to identify the possible causal agent and the management options in brief. If diagosed by a farmer, it is advised to contact the nearest extension office or research station for confirmation (Figure 30).

Figure 30. Rice diagnostic tool on RKMP

- **Expert Answers on Rice (EAR)**

The Expert Answers on Rice (EAR) will provide answers to the questions posed by different users/clients/stakeholders by using a three tier structure as follows:

- Web-based Question and Answer Forum
- SMS based alerts
- Web-based Questions answered through SMS

The expert has to login and answer the question which will be delivered directly to the user on the mobile through SMS (Figure 31).

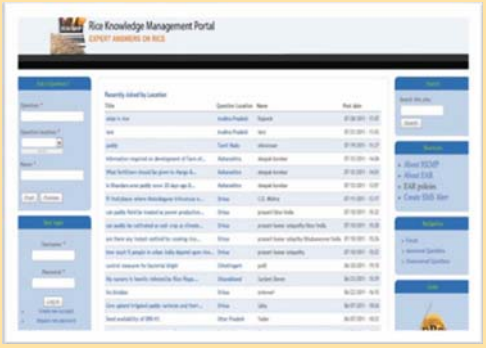

Figure 31. EAR system

- **Extension Methods**

Extension methods have been seen as viable factor of agricultural production in India and elsewhere. Whether a public or private sector extension system, it should work on viable extension strategies based on various parameters existing at grassroots level. The strategies will trickle down to what are known as extension methods/tools/techniques which remain the same for any kind of extension system. Even though, there are efforts to document the extension methods and tools elsewhere, making these available through online or offline CD format has never been thought over. It is in this context, it is felt that a comprehensive database is created and made available in the most readable format (Figure 32).

Figure 32. Extension methods

- **Farmers' Innovations**

Some of the Indian farmers have always been innovative in showing the world about best rice cultivation practices with their innovations, adaption or reinvention of recommended technologies or look for opportunities to compete in the global economy. To help spur this innovative spirit, RKMP brings various innovations related to rice crop (Figure 33).

Figure 33. Farmers' innovations on RKMP

- **Soil Information System**

Soil Information System is the platform of RKMP in which complete information about soils and fertilizer management and personalized recommendations are found. It consists of information on soil resources and extent of fertility related stress, district wise soil fertility status, soil degradation and related production constraints, fertilizers consumption scenario and nutrient demands, rice soils and related constraints in rice production and nutrient management for sustainable productivity and growth. The user can calculate the requirement of manure dose, individual fertilizer need, biodegradability index of the compost, dung and their nutrient generator, nitrogen generator from organic matter and vermi manure generator. Online soil health card can be generated by supplying information related to the soil samples. It covers soil information across the districts of India (Figure 34).

Figure 34. Soil information system

- **Indigenous Technical Knowledge (ITKs)**

Careful amalgamation of ITK and modern scientific knowledge would be most promising, while leaving the choice, the rate and the degree of adoption and adaptation to the farmers. To foster rapid transfer of technology related to rice cultivation, an understanding of indigenous technical knowledge is needed. ITK in rice farming is important for reducing the cost of cultivation, reducing the pollution and also safeguarding the natural resource base. The information on ITKs remains largely inaccessible to development workers and researchers (Figure 35).

Figure 35. Information ITKs

The portal brings a series of ITKs categorised based on various parameters for the benefit of all the stakeholders.

- **Package of Practices**

A compendium of state specific and location specific recommended package of practices are provided under this head. IP based customisation facilitates that only home state (the state from users access RKMP) specific information is available. For almost all the states of the country are covered under this head (Figure 36).

Figure 36. Package of practices on RKMP

- **Production Know-How**

RKMP serves the extension information related to rice cultivation in more than 2,500 Reusable Learning Objects (RLOs). In other words this information is not context specific and may be useful to extension workers cutting across the states (For example – principles of land levelling).

The contents are effectively tagged in order to provide content with little effort on part of the users (Figure 37).

Figure 37. Rice production know-how information

The access to RLOs can be availed using any of the following methods:

1. Search for a specific information object by typing a key word/phrase. The user will get to see several related links. By clicking on the links the user will be directed to the content page.
2. While going through the links, the user may feel appropriate to cross navigate to other information related to his/her search. Then simply, the user click on the tags (terms) that appear below that results in the listing of the information in a sequence of upload.
3. The user can look for any other related information heads on right side box which can be accessed by simple click.

- **Mapping Extension Offices**

The users can explore the maps to locate nearest Extension Office/Research Station/ KVK/Dealer and can find the complete contact details (Figure 38).

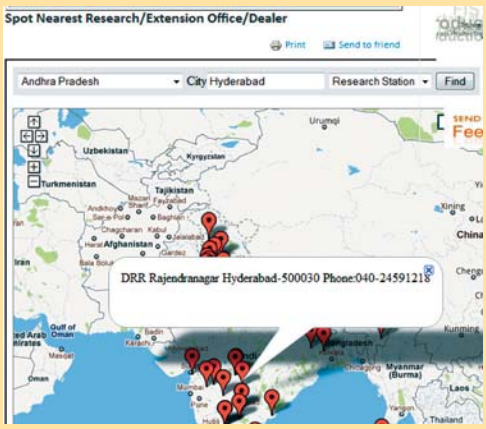

Figure 38. Mapping extension officer

- **Recap Sheets**

Indian extension officers have the reputation dealing with a variety of extension information cutting across the disciplines. While they deal with a variety of extension advisory services, they need to have cutting edge knowledge on various technologies that are in vogue.

For those extension officers, who wish to recapitulate already existing knowledge on rice crop, the portal brings a cafeteria one page sheets comprising of most comprehensive information on select topics. The recap sheets may be used as ready reckoners that can be printed and used as a flyer at the field level.

- **Video Gallery**

For “how to” content, the only answer we have is to give access to a cafeteria of video clips on rice. The NGO/KVK/SDA staff can request for delivery of offline CD of video clips. The users can also create own account and upload useful videos (Figure 39).

Figure 39. Video gallery on RKMP

Video films produced and made available online:

• Rice journey	• DNA & Fingerprinting
• Germplasm and Gene Bank	• C4 plant
• Land preparation	• Iron toxicity
• Seedling of rice	• Rice grain quality
• Transplanting of rice	• Brown rice & Bran oil
• Bio intensive pest management	• Parboiler & Husk stove
• Pest traps	• Threshers
• False smut	• Traditional post harvest practices
• Brown spot	• Mat-type transplanter
• Sheath blight	• Combine harvester
• Yellow stem borers	• Rice winnowers
• Gundhi bug	• Climatic change and rice productivity
• Bacterial leaf blight	• Green house gas emission and mitigation
• Brown plant hopper	• Hybridization
• Rice Gall Midge	• System of Rice Intensification
• Rice tungro disease	• Seed production
• Weed management	• Bio fertilizers
• Integrated Nutrient Management	• Hill ecosystem
• Pokkali rice	• Coastal saline ecosystem
• Medicinal rice of Kerala – Navara	• Irrigated ecosystem
• Aromatic basmati rice	• Upland ecosystem
• Organic rice	• Lowland rainfed ecosystem
• Hybrid rice	• Deep water ecosystem
• Transgenic rice	• Rice delicacies
• Marker assisted breeding	• Rice festivals in India
• Double haploid breeding	• Role of women in rice cultivation

- **Weed Information System (WISY)**

In India, the losses caused by weeds exceed the losses from any other category of agricultural pests like insects, nematodes, diseases, rodents etc. In this backdrop, effective weed management gains significance. Identifying different types of weeds in the field conditions is essential component of weed management. In an attempt to equip rice stakeholders with the details in respect of weeds that affect rice, WISY (Weed Information System) has been developed (Figure 40).

Figure 40. Weed information system on RKMP

- **Rice in Human Nutrition**

Rice is one of the most consumed grains on the planet. In fact, half of our planet's population actually depends on it for survival. With approximately 200 calories per cup serving, it is free of fat, cholesterol, and sodium. Rice is easily digestible, making it suitable for all ages and individuals with sensitive digestive systems, and its naturally mild flavour is a suitable complement to many dishes. The portal provides information on 80 rice recipes.

- **Rice in Indian Culture**

India has the largest paddy output in the world and is also the second largest exporter of rice in the world. Paddy fields are a common sight throughout India spread across the northern gangetic plains or the southern peninsular plateaus. The paddy cultivation plays a major role in socio-cultural life of rural India. Many festivals such as Onam in Kerala, Bihu in Assam, Sankranthi in Andhra Pradesh, Thai Pongal in Tamil Nadu, Makara Sankranthi in Karnataka, Nabanna in West Bengal celebrates harvest of Paddy. Andhra Pradesh is historically known as the "Rice Bowl of India", while Thanjavur is historically known as the "Granary of South India" and the Rice bowl of Tamil Nadu. Nanchinadu was known as the rice bowl of the former Kingdom of Travancore. In Kerala there is a place (which spreads into three districts) called Kuttanadu, which is famous for paddy cultivation. Kuttanadu is called the rice bowl of Kerala. The access to this kind of information is made possible at the portal.

- **RikiPedia**

RikiPedia is Rice Knowledge Initiative under NAIP's Flagship Project RKMP. RikiPedia aims at capturing the implicit knowledge about rice that exists across the stakeholders.

- **News and Events**

Portal provides regular news and events related to rice sector of the country.

- **Learn Rice Moodle**

With a view to bringing about knowledge based sustainable rice development, an e-learning platform namely Learn Rice has been created. This will help in linking the effective learning with the immediate working conditions of the farmers and other rice workers. Supporting immediate application of the learning in local situation will be an important outcome of the project. It is expected that such an innovative extension approach using Open and Distance

Learning methods will enhance the access to improved rice knowledge and information across the country contributing to the agricultural development. This endeavour will also help opening up new vistas in the distance learning and capacity building in the agriculture sector, a sector on which 65 per cent Indian population depends for its livelihood (Figure 41).

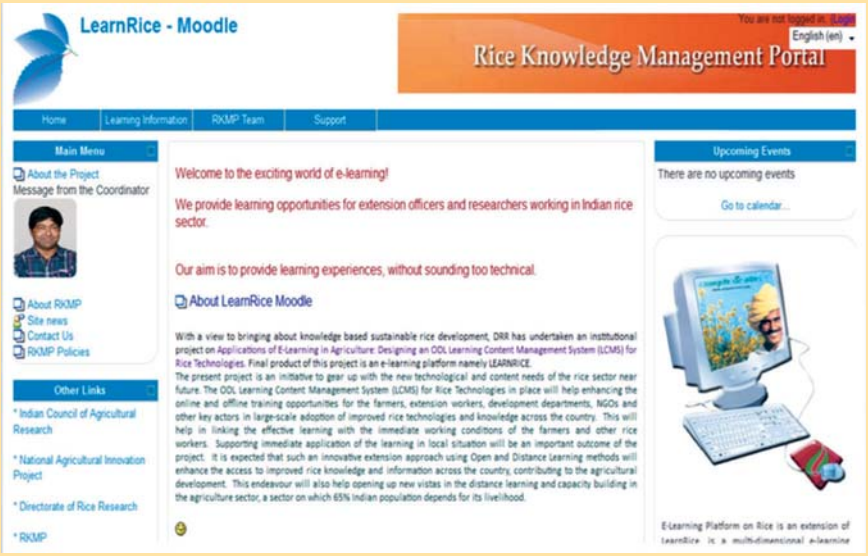

Figure 41. Learn Rice

Learn Rice is a multi-dimensional e-learning platform of Rice Knowledge Management Portal, an initiative under National Agricultural Innovation Project (NAIP) of ICAR. In the current scenario of fast changing technology world, learning is considered to be a lifelong exercise. A large number of rice stakeholders across the country has limitations in terms of access, quality and cost-effective learning opportunities. Not all the stakeholders are privileged to get their rice knowledge updated on 24x7 basis. It is in this context, it is felt that there is a need for platform like Learn Rice in local language for enabling and supporting the capacity building exercises in the rice sector of the country (Figure 42).

Figure 42. Learn Rice in Hindi language

- **Rice Almanac**

Rice Almanac is the most comprehensive databook on rice. At national level it provides the contents like agro-ecological regions in India, rice in India, rice ecosystems, mechanization in rice production, rice genetic resources, AICRIP Network, quality seed production districts, rice mills retention of rice for various purposes, MSP of rice, state-wise procurement of rice, nutritional status of rice grains, rice exports and by-product utilization. The general information, information on rice area production, varietal information popular varieties, major rice production constraints, rice research centers and growth rates are provided at the state level.

- **Mandi (Market) Prices**

Market prices of rice that are prevailing in the regulated market yards across the country are made available for better decision making. This is only indexing service from agmarknet.nic.in. The arrivals and prices of different agricultural commodities as received from the Agricultural Produce Market Committees (APMCs) of different States are uploaded at AGMARKNET portal for information only and shall not be considered as guidance, invitation or persuasion. Users/ visitors have to make their own decisions based on their own independent enquiries, appraisals, judgments, wisdom and risks. The Government of India shall not be liable or responsible for any loss or cost or any action whatsoever arising out of use or relying on the arrivals and prices and other related information disseminated at the portal (Figure 43).

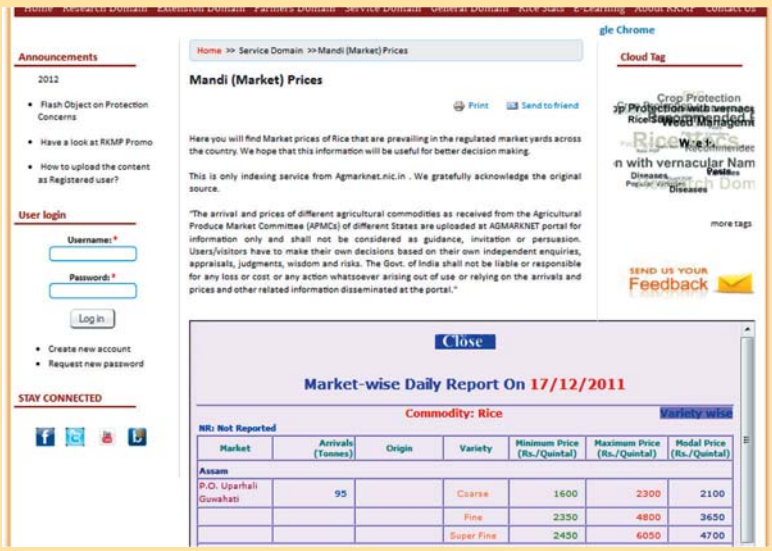

Figure 43. Market information on rice

- **Trade Know-How**

In order to leverage the production advantage of rice in India, there is a need to provide continuous updated data on market information, market access, procedures etc., which can be utilized in the identification of the right product market mix essential to reflect these production advantages in the form of enhanced presence in the international market.

This trade portal will act as a readymade solution towards solving domestic marketing as well as international trade issues. It would be helpful to all the stakeholders i.e., farmers, processors, and exporters in India as well as importers in the foreign markets (Figure 44).

Figure 44. Trade related information on rice

- **Weather Information**

Indian agriculture is highly dependent on vagaries of weather. Any abnormalities in the weather during the rice growing season will affect the plant growth and the productivity. The prime objective of this short term weather forecast is to render timely information to the extension agents for real time decision making.

Other products available with RKMP are RKMP in 3 minutes (Flash object), E-Books/ E-Manuals, protection concerns of the month (Flash object), CD on In Vogue Extension Tools and Techniques, CD on Indigenous Technical Knowledge in Rice Cultivation.

9. Users' contribution and feedback

9.1. How can users contribute to RKMP?

As registered user, one can upload the content into RKMP, irrespective of his/her institutional affiliation. RKMP nodal officers (AICRIP Centre Scientists from State Agricultural University) will validate and approve the content before it is displayed online. At RKMP, source of each content is acknowledged. It is suggested that before uploading, better to go through RKMP Content Upload Policy which is available online. RKMP is reaching to its stakeholders in various forms with options for ease of use and interactivity as follows:

a) IP based customization helps individuals to browse through location specific content.

b) Video and audio galleries will help providing "do-how" skills and knowledge on rice production technology.

c) Expert Answers on Rice – A platform in which interactivity is involved between the user and the expert.

d) RKMP provides content/information in the local languages like Hindi, Telugu, Kannada, Tamil, and Marathi along with English for the ease of farming community.

e) Cafeteria of platforms helps accessing the information at various hierarchical levels of stakeholder organizations.

f) Off-line CDs and non-digital delivery mechanisms help users without connectivity as well.

9.2. Best usage scenarios

- The Rice Knowledge Management Portal provides content/information in the local languages like Hindi, Telugu, Kannada, Tamil, and Marathi along with English. This caters the needs of farming community who will understand their local languages in a better way rather than English.
- RKMP can be accessed through any of the search engines (it supports Google Chrome, Mozilla Firefox, Internet Explorer 7.0 etc.)
- All the stakeholders who have connectivity can access huge amount of information. It is expected that in agricultural organizations, connectivity is going to be strengthened for effective use of this portal. Mobile interfaces will help reaching out to farmers as well.
- Knowledge Management in agriculture is relatively a new concept. The mammoth task of driving the knowledge sharing process in agriculture requires lot of efforts at various hierarchical levels among agricultural organizations. In India, there is an urgent and strong need to adapt the KM strategies in agriculture. In line with RKMP, there is a need to upscale KM initiatives in agriculture. But before that, relevant human resources, tools, processes, strategies should be in place to transform agricultural organizations into "learning organizations". Relevant frameworks and success stories of KM need to be analyzed to prepare a roadmap for "KM in Agriculture".

9.3. Users' Feedback

There has been a felt need for a single gateway of knowledge using differential platforms. It is expected that these platforms will have high degree of consumer acceptance. RKMP has redefined the way organizations access rice related information in the country.

Many officials and delegates from ICAR and other organizations appreciated RKMP in various contexts about its several global firsts in terms of comprehensiveness and utility (Box 3).

Box 3: Users' feedback

- *"RKMP is one model we wish to promote across agriculture & allied sectors at country level. We are happy to have funded this innovative project"* – Dr. Bengali Babu, National Director, NAIP
- *"When the Principal Investigator has this kind of clarity, the projects ought to be successful. Congratulations"* – Prof. SL Mehta, Chairman, RPC NAIP
- *"Amazing work"* – Martin Parr, KM Programme Manager, CABI, UK

- *"RKMP is the only portal with full and complete information on rice"* – Ms. Shilpa Deshpande from Symbiometrics Innovations Private Limited, Ahmedabad
- *"I visited your RKMP and it is definitely a good resource of information on rice. Congrats for the exhaustive work your team has done"* – Sarah M. Fernandes, Information and Knowledge Management, Africa Rice Center (AfricaRice), Benin
- *"RKMP will eventually be admired as an outstanding mobilization of ICT and agri sciences. RKMP is for me not only a product, but a model, a framework too. You can discontinue developing the product but you can continue to refine the framework – that is how your leadership will come to be recognized"* – Dr. Venkataraman Balaji Director, Technology & Knowledge Management Commonwealth of Learning, Vancouver, BC, Canada

10. Issues and Constraints in Implementation

It is too early for us to assess the impact. But we have been tracking the user's satisfaction and global rank. As on 28 December 2011 (six months after launch of the Portal), the global rank of the www.rkmp.co.in is 386,572 standing apart. The Indian rank is about 31,740 which is remarkable. As on this day, globally google searches on rice are directing to this portal.

Managing information is the easiest job in the portal development. Difficult part of the portal development is bringing together the critical mass of scientists together for developing the content. Lack of proper incentives and apathy in sharing the information is another constraint faced by the team. This was overcome by providing the source name and user details along with the content. Providing the name of the scientist/stakeholder has also added to the credibility of the content.

The read and write web (Web 2.0 standards) are relatively new to the targeted users of the portal and it is believed that the sharing/contribution from the users is expected to increase gradually.

11. Conclusion

RKMP is the first step in terms of the application of ICTs and KM strategies in agriculture to build a product like this semantic portal with enormous content. The portal serves as an information highway for rice sector for farmers, researchers, extension professionals, policy makers, students etc. The vision is to realise higher productivity and production of rice through improved knowledge and skill sets. The efforts will pave the way to reduce the gaps of the growing "digital information divide" specifically in the important cereal crop of the country namely the rice. The success of these strategies can be up scaled to reach the rice stakeholders with more features and can be emulated in other important crops. The efforts are coinciding with the increasing technological advances, technological reach and ICT readiness at the grassroots level which is a positive signal for investing more in knowledge management initiatives in agriculture.

Contact Details:

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Consortia Partners

S. No.	Consortium Partners	Name of the CoPIs
1.	CRRI, Cuttack	Dr. G.A.K. Kumar
2.	ICRISAT Hyderabad	Dr. N.T. Yaduraju
3.	IARI, New Delhi	Dr. P.S. Pandey
4.	C-DAC, Hyderabad	Dr. C. Kathiresan
5.	Birsa Agricultural University, Ranchi	Dr. B.N. Singh
6.	ICAR-NEH, Umiam (Barapani)	Dr. A.K. Mohanty
7.	ZARS, Mandya (University of Agricultural Sciences, Bangalore)	Dr. M.P. Rajanna
8.	RARS, Karjat (Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli)	Dr. Kunkerkar
9.	DRD, Patna	Dr. M.C. Diwakar
10.	IRRI, Philippines	Dr. Noel Magor
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12.	DRR, Hyderabad	Dr. Brajendra
13.	DRR, Hyderabad	Dr. Chitra Shanker
14.	DRR, Hyderabad	Dr. Mangal Sain
15.	DRR, Hyderabad	Dr. P. Muthuraman
16.	DRR, Hyderabad	Dr. P. Senguttuvel
17.	DRR, Hyderabad	Dr. S. Arun Kumar

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AgrobIS: Managing Agrobiodiversity Data and Information in Malaysia

Tosiah Sadi[1]

1. Introduction

Malaysia is considered as one of the mega diversified countries and ranks 12th in the world according to the National Biodiversity Index, which is based on estimates of country richness and endemism in four terrestrial vertebrate classes and vascular plants. Located near the equator, Malaysia consists of 13 states and 3 federal territories with 877 islands within the political boundaries.

The daily temperature ranging from 21^{O}C to 32^{O}C in the lowland and lower temperature range in the mountain and hilly areas with high humidity, offer and ideal habitat and ecosystem for diversity of live. More than 55% of the total area is covered by forest and the rest is occupied by agricultural crops, rubber plantations, oil palm plantations and others.

Malaysia recorded a total number of 15,000 species of flora (Saw and Chung, 2005), 298 mammals (Davidson and Zubaid, 2005), 742 birds species (Jeyarajasingam, 2005), 242 amphibians, 567 reptiles (Das and Norsham, 2005), more than 290 species of fresh water fish (Ahmad and Khairul-Adham, 2005), and 500 marine fish (Md Akhir and Padilah, 2005), 1,031 species of butterflies (Chey, 2005), 1,700 beetle species (Chung, 2005) and 1,200 ant species (Idris, 2005).

Recognizing the importance of conservation and wise use of biodiversity, the conservation of natural resources and biodiversity started prior to the CBD. Malaysia signed the Convention of Biodiversity (CBD) on 12 June 1992 in Rio de Jeneiro and ratified on 24 June 1994 as the aims and objectives of the convention were not very far from its own management of natural resources. Three main objectives of CBD are:

1. The conservation of biological diversity
2. The sustainable use of the components of biological diversity
3. The fair and equitable sharing of the benefits arising out of the utilization of genetic resources.

The word 'biodiversity' or biological diversity is defined by the Convention on Biological Diversity (CBD) as 'the variability among living organisms from all sources including, *inter alia*, terrestrial, marine and other aquatic ecosystem and ecological complexes of which they are part; this includes diversity within species, between species and of ecosystem' which make into the 7 thematic program of the CBD. One of the thematic programs that received serious commitment by the Malaysian Government was the agricultural biodiversity, which focus on the plantation, rice, fruit, orchards and vegetables; livestock rearing and aquaculture farm ecosystems.

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2. Genetic Resources and Information Sharing

Established in 1969, Malaysian Agricultural Research and Development Institute (MARDI) under the Ministry of Agriculture and Agro-Based Industry (MOA) is the country's primary agricultural R&D agency. It is a statutory body and undertakes research and development (R&D) related to food and tropical agriculture such as fruits, vegetables, rice, ornamental plants, flowers and medicinal plants.

As the agricultural and scientific research institute, MARDI generated huge amount of data and information and disseminated it through several means such as in-house publications, workshops, seminars, conferences and exhibitions organized both at the national and international levels.

With the advancement of the ICT in the 1980s, the government intensified use of Information and Communication Technology (ICT) was further with conceptualization of the Multimedia Super Corridor in the mid 1990s. MARDI also embraced ICTs for effective sharing of agricultural information. Several expert systems, decision support systems (DSS) and databases have been developed using several computer languages such as Pascal and Fortran.

Together with the development of ICT, research at MARDI was also intensified especially in the area of plant genetic improvement targeted for high yielding and resistant varieties. The work on breeding and plant varieties selection requires the collection and conservation of genetic resources activities. The enormous data of varieties or accession of each species that were studied from all over the country together with the data on their pest and diseases is significantly useful in adaptation of more sustainable utilization of Plant Genetic Resource for Food and Agriculture (PGRFA) and sustainable agricultural approach. Importance plant genetic resources collected by MARDI are given in Table 1.

Table 1. Plant genetic resources for food and agriculture (PGRFA) in MARDI

No.	Crop	No. of Species	No. of Accession	Type of Collection
1	Rice	12	17,486	Seeds
2	Fruits	164	2,831	Living plants in field genebanks
3	Coconut	1	45	Field genebanks
4	Traditional vegetables	69 60	12,091 800	Seeds Living plants
5	Medicinal plants	307	532	Field genebanks
6	Aromatic plants	1	40	Field genebanks
7	Biopesticidal plants	9	15	Field genebanks
8	Spices		300	Field genebanks
9	Root and tubers	2	120	Field genebanks
10	Ornamental	1	1,000	Field genebanks
11	Coffee	2	74	Field genebanks
	Total	**628**	**35,334**	

Salma *et al.* 2010.

Although the huge collections of genetic resources were currently being conserved in MARDI's genebank, only a small percentage of the materials conserved have contributed to crop improvement. One of the reasons for the low percentage of utilization is the poor and limited accessibility of information to the potential users of the genetic resources. Efforts to improve the utilization of these conserved materials have been enhanced by several means such as publicity in seminar, and launch of the material identified to be potential for further up-scaling and also dissemination of the information through effective use of ICTs.

3. Development of AgrobIS

Several meetings and extensive communication among researches involved in collection and conservation of genetic resources in MARDI since the year 2000 had recognised to the importance of sharing information of the collection in order to enhance the use of genetic resources especially those related to agriculture. Furthermore, some of the researchers involved in the PGRFA research had reached their retiring phase and the research work needed to be handed over to the new recruited officers, including the information of their collection. The problem occurred when the new officers, with little knowledge on basic taxonomy, botany and agriculture, were asked to take responsibilities of PGRFA activities.

It was then agreed that more efficient data management system of plant genetic resources has to be established with their direct involvement. This will encourage the new officers working in PGRFA to learn and have better understanding on how to describe plant species and manage information on genetic resources. Besides the collection work, several plant descriptors, a scientific standard for documenting plant genetic resources were introduced to them as basis for documenting their collection (Gotor *et al.* 2007). This will enable breeders to search for needed information and choose appropriate genetic materials to be utilized in crop improvement research as the descriptors constitute the basis for a standardized characterization system that provides an internationally agreed format and universally understandable language for plant genetic resources data.

Thus the development of efficient information system would help genebank curators to better manage germplasm activities such as collection, preservation, regeneration, distribution, and their exchange. In view of this, MARDI has established Rice GeneBank Information System (RGBIS) in 2002 (Abdullah and Quswa, 2005). The system was developed for Rice GeneBank operations.

Figure 1. Stand-alone databases

Subsequently, several individual stand-alone databases (Figure 1) were developed using Microsoft Access and Visual Basic 6 interface such as *Nephelium lappaceum* (*rambutan*), *Mangifera odorata* (*kuini*), medicinal plants, arthropods and microbes. The reason for

developing such stand-alone database was to protect unique characters of each agrobiodiversity group, especially for the plant group. The database was launched for public awareness on the 6 November 2006, in conjunction with the first National Agrobiodiversity Conference in Kuching Sarawak by Tan Sri Datuk Mohyiddin Yassin the Minister of Agriculture and Agro-Based Industry (Figure 2). However, the database has limited access, not efficient for multisearch function and tedious when it comes to its management and system updating.

Figure 2. The launch and demonstration of the stand-alone databases

After six months, the databases have been made as web-based system by name Agrobiodiversity Information System (AgrobIS). AgrobIS is an innovative technology tools for handling agrobiodiversity information. It was based on license-free software-MySQL (multithreaded, multi-user SQL database management system) for database development and PHP (computer scripting language, originally designed for producing dynamic web pages) for the web interface.

4. Descriptors Engine

The main constraint in developing the database was related to plants accession collection. The plants species that were collected and conserved such as *Mangifera*, *Durio*, *Baccaurea*, *Solanums*, *Cucurbits*, *Oryza*, *Labisia*, and *Gingers* have different characters and difficult to put together in one database. Although, the Multi-Crop Passport Descriptors (MCPD) by International Plant Genetic Research Institute (IPGRI/Bioversity) and Food and Agriculture Organization (FAO) available, it is not adopted in the development of AgrobIS. The researchers (data provider) involved in the AgrobIS development suggested for a system that enable them to develop their own descriptors based on the descriptors by IPGRI (Bioversity). This is where the challenge came in and the idea of a customized “Virtual Object Database” was develop using Object-Relational Mapping technique by converting data between incompatible type systems in relational databases (MySQL) and object-oriented programming languages. The conceptual model of AgrobIS is shown in Figure 3.

As an Object Orientated Database (OOD), AgrobIS offers open-ended features which support and evolve with progress of ICT and needs in agriculture. The current version of AgrobIS supports multiple collection of different datasets by using object-hierarchical design to enable inter-relations between each component, even with different data formats (database, pictures, geographical data). It has the capabilities to customize the extent of the data, such as hierarchy and relation of the data, content definition of each of the dataset, details of the item

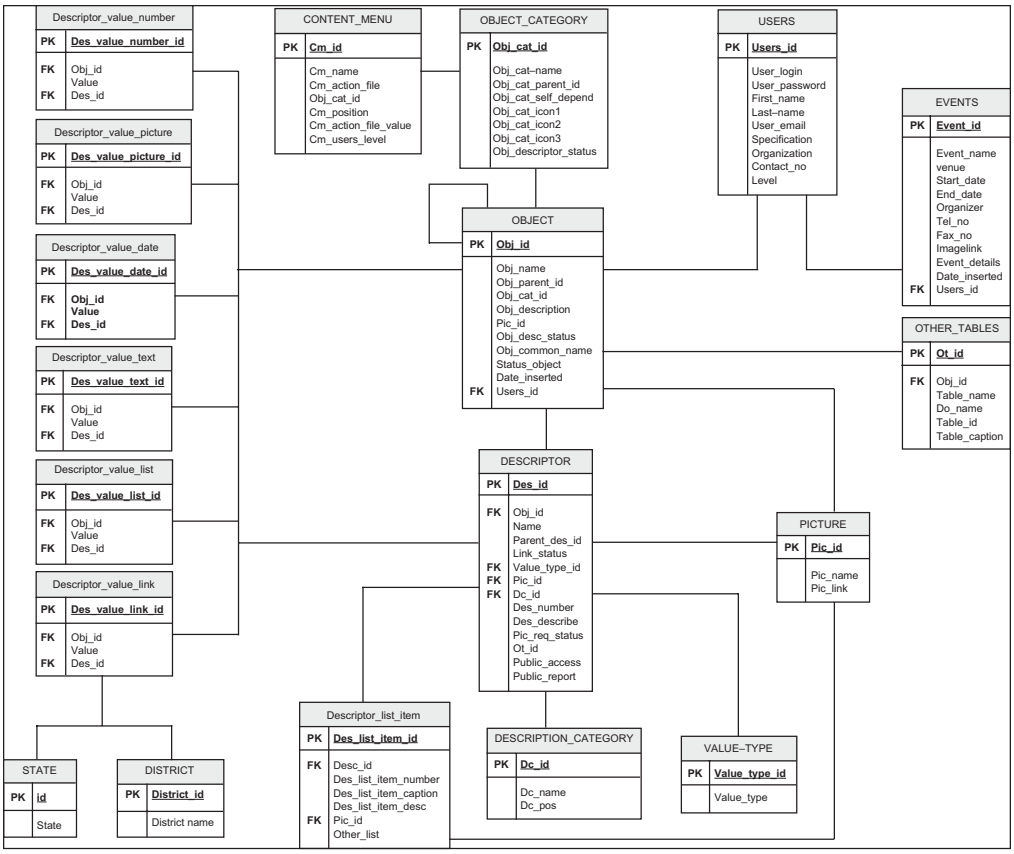

Figure 3. AgrobIS conceptual model

in the data, security and accessibility of the data for each user. AgrobIS is also capable in handling geographical information (spatial data), and can be expanded for advanced biodiversity approach.

Although the AgrobIS do not follow the MCPD, the approach is similar in the sense of data and information collected for each plant accession under the following 5 categories through an interface (Figure 4).

1) passport data – contains basic information of the collection, such as, accession number, collector's name, collection date, cultivar name, and donor name
2) environment and site – consists of data or information on site where the accession are collected
3) management – consists of information on how the collection being managed, duplicated area, preservation techniques and other related information
4) characterization – data and information on characters of vegetative growth, leaf, inflorescence, fruits and seeds
5) evaluation – data and information of pest status, fruiting times, biochemical contents, cytology characters and molecular markers.

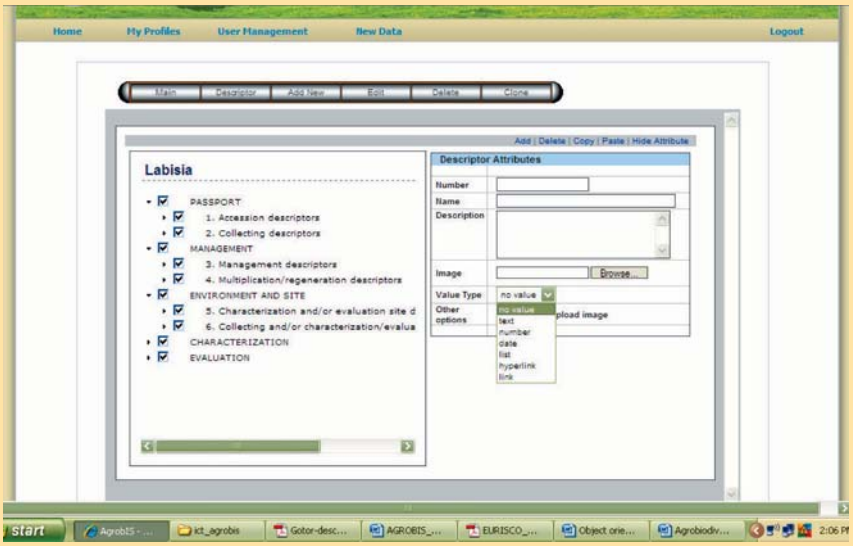

Figure 4. Interface for developing the descriptors

AgrobIS architecture consists of two interfaces namely owner interface and public interface as shown in Figures 4 and 6. There are 2 steps involved in data provider interface before they can key in their data: 1) development of the descriptors 2) customizing information that they want to share with public. In the development of descriptors, the senior researchers facilitate the junior researchers in characterization of plant species. This is done in several workshops (Figure 5).

Figure 5. Workshops on development of descriptors

After verification, of descriptors the data is up-loaded for public viewing. AgrobIS data can be viewed using any standard web browser that support javascript (e.g. Internet Explorer 5.7 and above, Mozilla Firefox 1.7 and above). Reports or data can be opend or saved in several document types such as word document (.doc), Excel (.xls) and html.

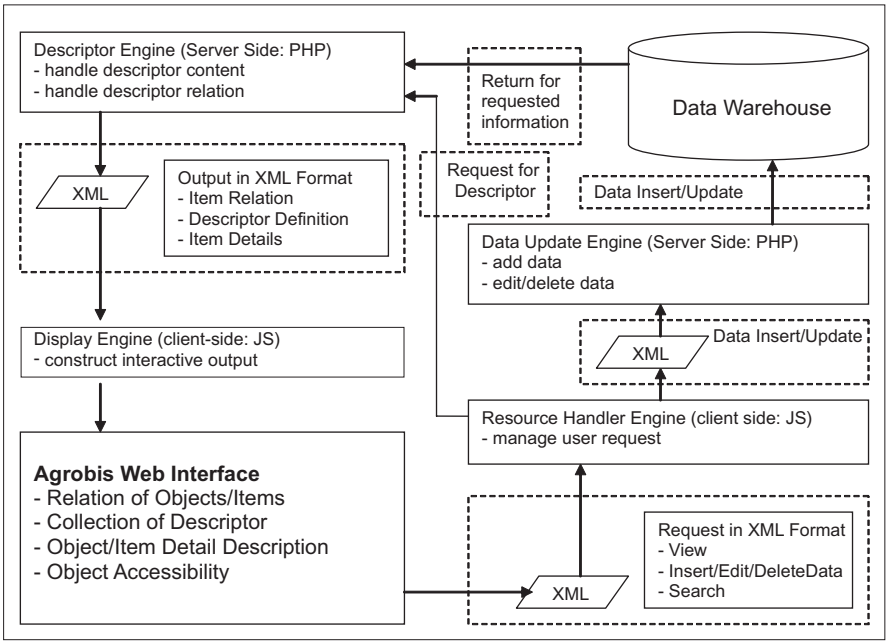

Figure 6. System achitechture of the AgrobIS

5. AgrobIS Outcome

• *Information*

There are approximately 14,391 records of passport data from the total of 35,334 plant genetic resources accession representing medicinal plants, rice, indigenous vegetables and fruits in the AgrobIS. These data represent 94 species of 628 plant species studied by MARDI. The summary on data records of AgrobIS is shown in Table 2. However, to some extent the data on the passport and characterization are far beyond completion and will be added from time to time based on data or results gathers by the responsible researchers.

Table 2. Data of germplasms and the number of accessions recorded in AgrobIS

Plant group	Scientific name	Local name	No. of Accession	Passport	Characterization
Medicinal Plants					
	Labisia pumilla	Kacip fatima	61	/	/
	Eurycoma longifolia	Tongkat ali	20	/	Nil
	Zingiber officinale var nubrum	Halia	52	/	/
Rice	*Oryza*	Rice	12,054		
				/	/
Vegetables					
	Amaranthus blitum	Bayam itik	8	/	/
	A. gracillis	Bayam	2	/	/

Table 2. ***(continued)***

Plant group	Scientific name	Local name	No. of Accession	Passport	Characterization
	A. spinosa	Bayam pasir/hutan	11	/	/
	A. tricolor	Bayam merah	11	/	/
	A. viridis	Bayam pasir	22	/	/
	Abelmoschus esculentus	Bendi	6	/	/
	Anacardium occidentale	Gajus	85	/	/
	Archidendron jiringa	Jering	11	/	Nil
	Capsicum anuuam	Cili besar	7	/	/
	C. frutescens	Cili api	95	/	/
	Colubrina asiatica	Peria pantai	28	/	/
	Cosmos caudatus	Ulam raja	55	/	Nil
	Cucurbita muschata	Labu	6	/	Nil
	Luffa acutangula	Petola segi	12	/	Nil
	L. aegyptiaca	Petola bulat	3	/	/
	Leucaena leucocephalis	Petai belalang	7	/	Nil
	Limnocharis flava	Paku rawan	4	/	Nil
	Momordica charantia	Peria	17	/	/
	Morinda citrifolia	Mengkudu	18	/	Nil
	Muraya koenigi	Daun kari	5	/	Nil
	Oenanthe javanica	Selom	15	/	Nil
	Pareskia sacharosa	Jarum tujuh	6	/	Nil
	Piper samantosa	Kaduk	22	/	Nil
	Pluchea indica	Beluntas	49	/	/
	Polygonum minus	Kesum	15	/	Nil
	Premna foetida	Bebuas	63	/	/
	Psophocarpus tetragonolobus	Kacang botol	54	/	Nil
	Solanum ferox	Terung asam	20	/	Nil
	S. macrocarpon	Terung susu	10	/	/
	S. nigrum	Terung ranti	3	/	/
	S. tarvum	Terung rembang/ terung belanda	16	/	Nil
	S. melongena	Terung telunjuk	63	/	/
	Syzygium polyanthum	Serai kayu	9	/	Nil
Indigenous Fruits					
	Archdendron globosum	Kerdas	5	/	/
	Artocarpus elasticus	Terap nasi	28	/	/
	A. integer	Cempedak	4	/	/
	A. lanceifolius	Keledang	11	/	/
	A. rigidus	Tempunik	32	/	/
	A. scortichinii	Terap hitam	1	/	/
	A. sylvistris	Bangkong	11	/	/
	Baccaurea macrocarpa	Tampoi	55	/	/
	B. motleyana	Rambai	27	/	/
	B. reticulata	Tampoi kuning	2	/	/

Table 2. ***(continued)***

Plant group	Scientific name	Local name	No. of Accession	Passport	Characterization
	Barringtonia acutangula	Putat	1	/	/
	Bouea macrophylla	Kundang	13	/	/
	B. oppositifolia	Remia	6	/	/
	Durio acutifolius	Durian burung	1	/	/
	D. dulcis	Durian tulang	3	/	/
	D. graveolens	Durian kuning	61	/	/
	D. kutejensis	Durian nyekak	23	/	/
	D. lowianus	Durian sempa	77	/	/
	D. malaccensis	Durian batang	1	/	/
	D. oblongus		2	/	/
	D. oxyleyanus	Durian beludu	15	/	/
	D. singaporensis		3	/	/
	D. testudinarium	Durian kura-kura	5	/	/
	D. zibethinus	Durian	46	/	/
	Dialium indum	Keranji	10	/	/
	Dimorcarpus longan subsp *Malesianus*	Mata kucing	6	/	/
	Diospyros discolor	Mentega	5	/	/
	Elatiospermum tapos	Perah	4	/	/
	Flacourtia jangomas	Kerkup	4	/	Nil
	Fortunella polyandra	Limau pagar	1	/	/
	Garcinia cambogiana	Gelugur merah	2	/	/
	G. dulcis	Mundu	3	/	/
	G. hombroniana	Beruas	5	/	/
	G. parrifolia	Kundong	8	/	/
	G. prainiana	Cerapu	84	/	/
	Mangifera caesia	Binjai	144	/	/
	M. foetida	Bacang	265	/	/
	M. gryfithii	Rawa	1	/	/
	M. indica	Mangga	27	/	/
	M. longipetiolata	Sepam	2	/	/
	M. panjang	Bambangan	11	/	/
	M. pentandra	Pelam bemban	2	/	/
	M. torquendra	Kemantan	5	/	/
	M. odorata	Kuini	271	/	/
	Musa sp.	Pisang nipah	19	/	Nil
	Nephelium maingayi	Redan	5	/	/
	N. ramboutan-ake	Pulasan	85	/	/
	N. lappaceum	Rambutan	13	/	/
	Pouteriacaimito	Abiu	7	/	/
	P. hampehiana	Kuning telor	1	/	/
	Psidium littorale	Jambu ceri	5	/	/
	Rheedia madruno	Rhedia	1	/	/

Table 2. ***(continued)***

Plant group	Scientific name	Local name	No. of Accession	Passport	Characterization
	Rhodomyrtus termantosa	Kemunting	1	/	/
	Sandorioum koetjape	Sentul	10	/	/
	Syzygium jambos	Jambu mawar	1	/	/
	Xanthophyllum ameonum	Bedaling	4	/	/
	Xerospermum sp	Rambutan pacat jantan	1	/	/
	Total No .of Accession		**14,391**		

Besides the PGR, AgrobIS also possess data related to arthropods and microbes. Among the arthropod, insect class is the most prominent with a total specimen number of 657 from more than 30,000 specimen of eleven insect orders kept in the Arthropod Repository and Collection Center of MARDI (Table 3). This is only about 2 per cent of arthropod specimens held in the center. This gap is due to constraints such as lack of human capacity, incomplete and missing data.

Table 3. Number of insect specimens data in AgrobIS

Insect order	No. of specimens
Hemiptera	68
Diptera	63
Coleptera	170
Homoptera	47
Orthoptera	31
Odonata	11
Lepidoptera	212
Trichoptera	4
Thysanoptera	3
Hymenoptera	41
Neuroptera	7
Total	**657**

- ***Capacity Building***

Capacity building is also one of the outcomes of the AgrobIS. Besides the establishment of infrastructure such as computer, server and related physical requirements, the AgrobIS also contributed in the development of human resources especially the junior researchers in PGR.

6. Benefit of AgrobIS

Although the data handled by AgrobIS are relatively small, its development has brought several benefit such as;

1. It encouraged utilization of conserved biological resources by providing specific information of crop accession to the public that can be potentially used in crop improvement or as a new source for food and income.
2. It can be used as digital pest list (since the current and only pest list available was in hard copy published in 1973 by K.G. Singh).
3. Primary data from various researches were integrated into one system for better management and cost effectiveness.
4. It provided mechanisms to allow users or scientists to judge the data and provide comments for further improvement.
5. It can also be used as e-learning portal by students and also those who intent to work on related fields especially taxonomy.

The importance of the AgrobIS is acknowledged by the scientific community and it bagged several awards such as:

1) Award from MARDI Science and Exhibition (2007)
2) Invention and Innovation Competition Award during Malaysia Technology Expo (2008)
3) Invention and Innovation of Industrial Design and Technology during ITEX Malaysia (2008)
4) Selected as top ten poster during the GFAR poster competition on the theme "ICTs: Enabling agricultural science to be a social endeavour" during the Science Forum 2009.

7. Future Direction of AgrobIS

With regard to location data that usually relates to the accession, samples and the specimens, it is actually a precious information about distribution of species and diversity. Thus, at present the AgrobIS is being improved with standardized geo-referencing protocols to ensure and enhance the usefulness of the database. The geo-referencing protocols enable AgrobIS database to be spatially integrated with other land resources datasets such as soil, topography and environment to provide venue for data integration that will enable information of related agrobiodiversity component and their relationship with the environment extracted and further used. (Muhamad Radzali *et al.* 2010).

The AgrobIS will be continuously upgraded with the current ICT tools and systems. The awareness of public, scientific community especially the breeders and the agriculture society on the existence and importance of AgrobIS will be increased. Other Malaysian scientist who had collection and willing to share the information are encouranged to contribute to AgrobIS. The validity of data will be checked from time to time to ensure the quality of data in AgrobIS and to make sure that the database will be sustained to share information of the Malaysia's precious agricultural biodiversity.

Acknowledgement

The author thanks all data providers for sharing information, Dr Salma Idris and Dr Muhamad Radzali Mispan for their encouragement, MARDI for providing funds (WRM-048) for the development of the database and all IT staff for their technical assistance.

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Knowledge Networking for Agricultural Research for Development: The Philippines K-AgriNet Program

Lily Ann D. Lando[1] and Ricaredo V. Manzanilla[2]

1. Introduction

The need for a more advanced and proactive approach to assist Filipino farmers, fisherfolk and agricultural communities pushed the creation of the Knowledge Networking Towards Enterprising Agricultural Communities (K-AgriNet) program. K-AgriNet is funded through the Philippines Commission on Information and Communications Technology (CICT) and aimed to develop and modernize the country's agricultural sector through the use of information and communication technologies (ICTs) (Saliendres, 2009).

K-AgriNet sought to improve access to information on modern and indigenous technology through the use of ICT, develop a well-informed, information driven, and digitally-connected agriculture and fisheries sector ushering a shift from a traditional to a knowledge-intensive farm management; and link policy makers, researchers, service providers, markets, business providers, business organizations and farm communities in an open environment.

The program aims to improves its stakeholders the ability to use ICTs, uses government networks to inform them about the latest agricultural breakthroughs, develops content and information systems for its stakeholders, and provides appropriate and useful ICT hardware and software for the community.

K-AgriNet worked with various groups which are also its primary beneficiaries. These are:

- Organizations
  - Cooperatives
  - Farmers/fisherfolk and agriculture-based people's organizations
- Local Extension Service Providers
  - Agricultural technicians
  - Extension agents
  - Magsasaka Siyentista (farmer scientists) and technical experts in different field units
  - Government and non-government organizations hosting the Farmers Information and Technology Services (FITS)
- Private sector
  - Agricultural traders
  - Agri-business entrepreneurs
  - Civil society organizations.

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2 Supervising Science Research Specialist, Management Information Services Division (MISD), Philippine Council for Agriculture, Aquatic and Natural Resources Research and Development (PCAARRD), Los Bonos, Laguna 4030, Philippines.

2. Institutional Arrangements and Synergy

K-AgriNet was formed from a partnership of four institutions in the Philippine agriculture, each partner handling specific program components that focus on key service areas and assigning key players for service delivery (Figure 1).

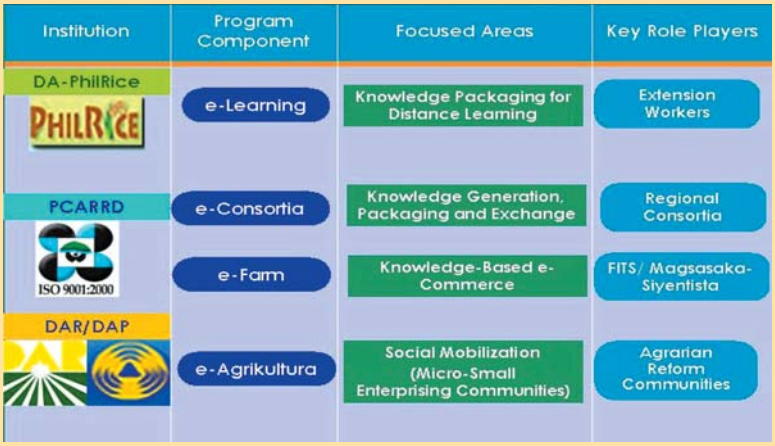

Figure 1. Institutional arrangement of the K-AgriNet program

Each of these agencies used to implement its programs independently. Through K-AgriNet, the agencies reduced redundancy by concentrating on specific complementary activities in line with their respective mandates.

The Development Academy of the Philippines (DAP), through its Center for Quality and Competitiveness, led the program. It (1) managed funds, (2) procured and deployed ICT equipment, (3) led community preparation and advocacy activities, (4) provided technical assistance and (5) analyzed and consolidated project reports through a Program Management Information System (PMIS).

The Department of Agriculture – Philippine Rice Research Institute (DA-PhilRice) used its Open Academy for Philippine Agriculture (OpAPA) to increase the capacity of agricultural extension workers in the local governments. Through e-extension and distance learning, the component sought to bring back the extension workers into the “information loop”.

The Pinoy Farmers’ Internet web portal provided agricultural information (production guides, databases, directories, visual resources, and market guides) venue for easy interaction between farmers and experts (online diagnostic tools, text queries, e-mail, forums, and video conferencing) and online training, diploma and certification programs.

The Department of Agrarian Reform (DAR) and DAP together implemented e-Agrikultura, which involved the establishment of e-community centers in the Philippine rural areas. These centers provided online access to agricultural information and social services for farmers, fisherfolk and agri-business owners.

The Department of Science and Technology-Philippine Council for Agriculture, Forestry and Natural Resources Research and Development (DOST-PCARRD[1]) led e-consortia and e-farm. E-consortia was expected to sustain R&D information and technology delivery through ICT-enabled Regional R&D Information Service. While e-farm provided electronic access to information, technology and other services of the 80 Farmers Information and Technology Services (FITS) Centers and their Magsasaka Siyentista (farmer scientists).

The e-Consortia intensified knowledge generation and exchange among R&D institutions and other member agencies of the consortia, while the e-Farm promoted the use of various knowledge-based opportunities for improving farm productivity and income.

The following sections will cover only the PCARRD-DOST component, herein referred to as K-AgriNet PCARRD.

3. K-AgriNet PCARRD: Introduction to E-Consortia and E-Farms

K-AgriNet PCARRD involved various institutions that interacted within the "knowledge networking" perspective. The Council, as repository of knowledge derived from R&D, provided central direction and served as the national information hub for the program.

The e-consortia and e-farms arose from PCARRD's pioneering information and communications technology (ICT) initiative, the "Agriculture and Natural Resources Information Network" or AgriNet. Another foundation program was the Techno Gabay Program or TGP which comprised of four components: The FITS Centers, the Magsasaka Siyentista, IEC and ICT.

Under the e-consortia are the 14 R&D consortia and their member-agencies (Figure 2) which served as the knowledge-base for the K-AgriNet PCARRD at the regional level. Their member-agencies generated technologies and provided experts for the FITS Centers and other clients.

Figure 2. The sites of the Regional R&D Consortia

The e-consortia aimed to intensify knowledge generation and exchange among partner R&D institutions and make regional R&D activities and outputs relevant through quick information

[1] PCARRD is now renamed as the Philippine Council for Agriculture, Aquatic and Natural Resources Research and Development (PCAARRD). However, PCARRD is used throughout the report for consistency.

dispatch (QID). They also enhanced the agriculture S&T governance of PCARRD through improved and sustained ICT tools and applications.

The e-farms promoted knowledge-based e-commerce through the various FITS Centers and their respective Magsasaka Siyentista (MS).

They strengthened the capacity (i.e., hardware, software and human resources) of 80 identified FITS Centers (Figure 3) as providers of ICT-based information and technology services for Agriculture, Forestry and Natural Resources (AFNR) sectors and Micro-Small and Medium Enterprise (MSME) development. E-farms also promoted the Magsasaka Siyentista's use of ICT-based services through FITS Centers' websites.

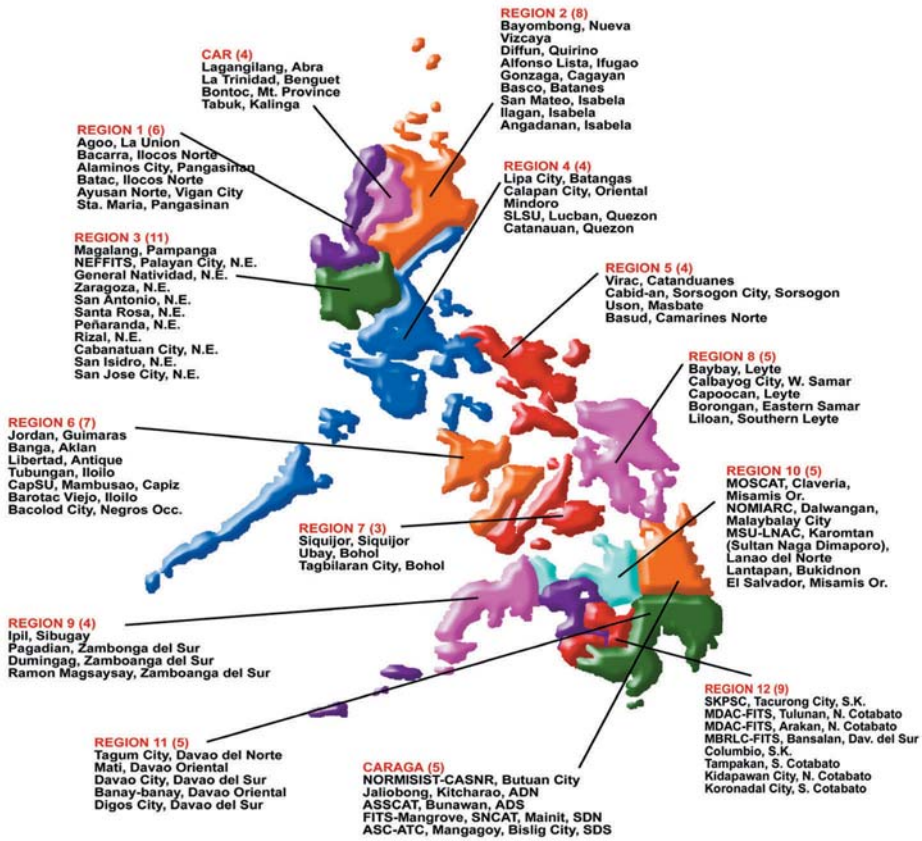

Figure 3. Distribution of the 80 e-farm sites

3.1. Organizational Structure

K-AgriNet PCARRD used existing institutions and organizational structures at the regional and local levels for program implementation and management (Figure 4). Foremost among the institutions were the regional R&D consortiums. The consortium is a conglomeration of R&D institutions: state universities and colleges, regional government line agencies, local government units and in some regions, private-owned universities.

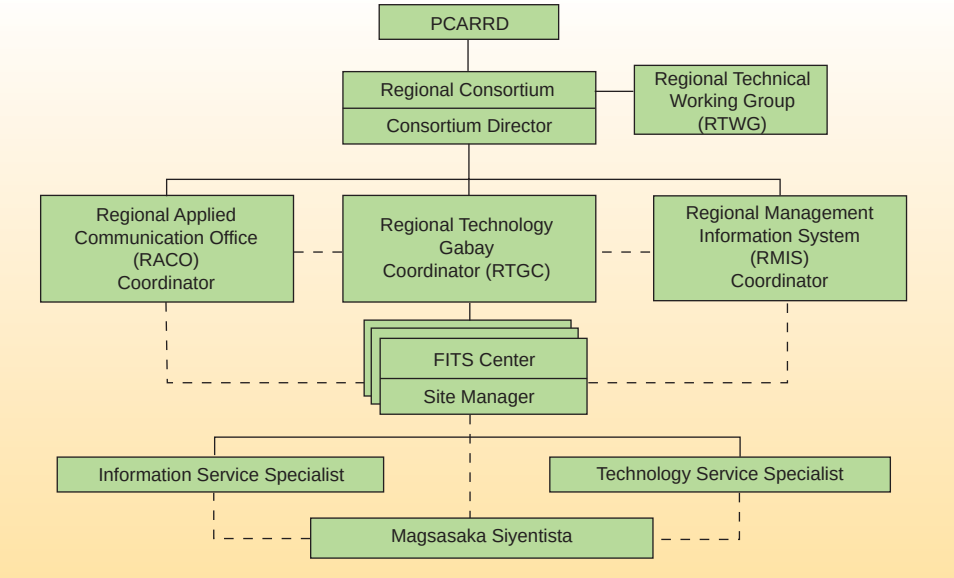

Figure 4. Organizational structure of the e-consortia and e-farm components

Program Management rested in several key people in the consortium, each performing specific tasks. Nationwide, the program was implemented by the 14 Regional Consortium Directors, and their respective sectoral coordinators: Regional Techno Gabay (RTG), Regional Management Information System (RMIS) and the Regional Applied Communication Office (RACO).

The team acted as a clearing house of the K-AgriNet activities in the regions, while closely monitoring and coordinating with their respective Farmers Information and Technology Services (FITS) Centers. Each FITS Center is manned by a FITS Manager, Information Service Specialist (ISS) and Technology Service Specialist (TSS), each with specific terms of reference (Table 1).

Table 1. Designations of the FITS Center team and their terms of reference

Designation	Terms of reference
FITS Manager	Leads in making plans (including annual work and financial plan) and programs of the FITS Center • Manages (implements, monitors and evaluates) the operation of the FITS Center based on the approved work and financial plan • Coordinates technology promotion, commercialization and extension services in collaboration with relevant institutions/partners • Generates resources such as human, material and financial to facilitate and sustain the operation of the center • Submits quarterly and annual reports to Regional Techno Gabay Coordinator

Table 1. ***(continued)***

Designation	Terms of reference
Information Service Specialist	• Spearheads the development and implementation of an information and communication plan of the center • Spearheads the gathering of data and content build-up of the FITS Center database and web page • Spearheads the development of IEC/ICT materials from the documented best practices of the MS • Submits to the FITS manager the reports on IEC/ICT services provided and other IEC/ICT needs
Technology Service Specialist	• Supervises the establishment and operation of S&T-based farms (STBF) of MS based on the approved research proposal • Coordinates the conduct of technology services (Exhibits, forums, clinics, assistance on provision of quality planting materials/animal stocks, field days, etc.) in the center • Leads in the selection of MS and in coordinating their activities.

3.2. Interventions and Services

Table 2 shows the interventions provided by K-AgriNet PCARRD through the e-consortia and e-farms. The 14 regional R&D consortia and 80 FITS Centers were connected to the internet and provided the necessary hardware for this.

Table 2. Interventions through e-consortia and e-farms

PCARRD Program Component	Interventions
1. Inter-connectivity	• DOST-PREGINET • DA-NIN • AGRINET • AFRDIS clusters interconnected • Last mile connection of 80 FITS Centers
2. Hardware and software provision	Sophisticated ICT equipment bundled with license software (open source also an option)
3. System and Content Development	• Information portal (common website) • Videoconferencing • Existing and new need-based information systems • Mobile technology • Multimedia (radio, print, etc.)
4. Social Mobilization	• Orientation/consultation • Workshops • Skills upgrading • Value formation • Awareness campaign • ICT-training
5. Project Management	• Planning, monitoring and evaluation

3.3. Networking

The Advanced Science and Technology Institute (ASTI) of DOST was commissioned to negotiate with providers for the most appropriate internet service for the various recipients. ASTI maintains the Philippines Research, Education and Government Information Network (PREGINET), the network backbone that links government agencies and education institutions. In order to connect all the consortia, ASTI required different service providers in the regions to peer with PREGINET's main provider and ensure a cohesive information exchange. Peering interconnects administratively separate internet networks and allows the exchange of traffic between their customers.

The FITS Centers on the other hand were directly connected to the internet mostly through wireless technology while a handful utilized Digital Subscriber Lines (DSL). These centers are hosted, operated and maintained by Local Government Units (LGUs), State Universities and Colleges (SUCs) and Department of Agriculture units (DA) among others.

Figure 5 shows the current network configuration of PCARRD. The K-AgriNet traffic passes through the PREGINET backbone using Globe Telecommunications (private telecom) facilities and the peered providers of the regional consortia. The regional consortia's access to the commodity internet is granted through the Globe link (MK2) while entry to the Research and Education (R&E) network is through ASTI. PCARRD subscribed to a separate link (PLDT) for its internet access. This strategy provided sufficient bandwidth to clients of online services such as databases, portal, videoconferencing, and Voice over IP (VoIP), which are delivered through the PREGINET/Globe connection.

Several ICT equipment bundled with software were deployed to the Regional Consortia and to the FITS Centers. The Council also developed information system databases for use by the recipients, and employed mobile technology and videoconferencing throughout the program.

As part of social awareness activities, PCARRD capitalized on various forms of mass media and promotional materials. Training, workshops and value formation activities became integral to the social mobilization component. Under program management, planning, monitoring and project evaluation were undertaken.

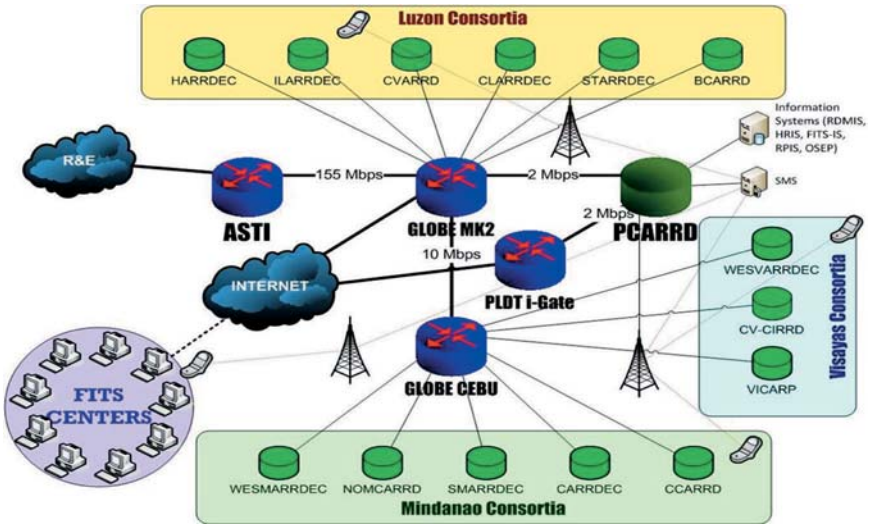

Figure 5. The current network configuration of PCARRD

4. E-Consortia and E-Farms Components

4.1. Component 1. Internetworking/Convergence among Government Networks

This component's main thrust is to enhance the ICT infrastructure of PCARRD and its regional partners to enable them to access and use the online services offerred by the national partners. These include databases and multimedia over Internet Protocol (IP), which in turn includes videoconferencing, video streaming, and Voice over IP (VoIP). Internet connectivity was also provided for each program beneficiary.

The program acquired ICT hardware (bundled with software) to augment the existing equipment of the regional partners. Partners received desktop computers, PC notebooks (bundled with licensed operating systems and antivirus software), printers, network switches, digital still cameras, video cameras, multimedia projectors, videoconferencing terminals, and cellular phones. Furthermore, new servers with scaled capabilities were purchased for the national operations center (NOC) stationed at PCARRD to enable the efficient delivery of online services.

The enhanced hardware and software capability, coupled with connectivity presented the regional partners with extensive access to online information systems (ISs) developed by PCARRD and other national partners. For R&D management, the Agricultural Resources Management Information System (ARMIS) was updated to keep pace with the infrastructure. ARMIS is composed of three databases: the Research and Development Management Information System (RDMIS), Online Submission and Evaluation of Proposals (OSEP) and the Human Resource Information System (HRIS).

For Technology Management, various systems were also put in place. These included the Farmers Information Technology Services Information System (FITS-IS), Regional Profile Information System (RPIS) and the Short Messaging System (SMS). These vastly improved information systems can be accessed 24x7.

The provision of the videoconference terminals introduced a new way of communicating for the regional partners. By providing real-time audio and video communication between or among partners who are remotely located, videoconferencing enhanced information sharing and saved money for the partners.

Specifically, travel costs were reduced or eliminated when partners used videoconferencing on the following occasions. In addition, time and safety, although unquantifiable, are added benefits.

- Meetings where many participants cannot be present at the venue
- Technical consultations between experts and clients (e.g. farmers)
- Major events such as launching, opening ceremonies, press conferences
- Trainings
- Exchange of information and expertise

The program introduced "live" video streaming for use especially during anniversary celebrations, meetings, training and other functions where interaction is not necessary. This is equivalent to television broadcasting with one plus feature – it makes use of the Internet to deliver its content. Video streaming offers a near real time delivery of live events with 5-10

seconds difference from the actual affair. The service can reach and serve more audience than videoconferencing; however, it is not interactive.

VoIP is another service used to reduce the cost of communication. PCARRD arranged with the Advanced Science and Technology Institute (ASTI) to allow the registration of the regional partners to their SIP[2] server. The service offers "free" voice calls to the registered members and to sites where ASTI has IP gateways (e.g. Metro Manila).

The Short Message Service (SMS) technology was also introduced as an alternative in facilitating quick information dispatch in the Agriculture Forestry, and Natural Resources (AFNR) sectors. With its wide scale availability and affordability, especially where Internet is not accessible to farmers, SMS readily provided available technologies for adoption.

The use of SMS also allowed farmers to directly consult with experts as well as with other farmers listed in the FITS-IS. They developed linkages with research institutions and processors using the facility.

4.2. Component 2: Development and Packaging Integrated information and Advisory Services

The component aimed to develop and package integrated information and advisory services and general knowledge in agriculture. Specifically, it involved the (1) design and development of web-based ICT applications in support of the e-consortia and e-farm programs and the (2) deployment and maintenance of existing information and knowledge-based systems and services.

Existing web-based information systems that support the R&D management mandate of PCARRD were enhanced (Figure 6). These are Research and Development Management Information System (RDMIS), Human Resource Information System (HRIS), and Online Submission and Evaluation of Proposals (OSEP).

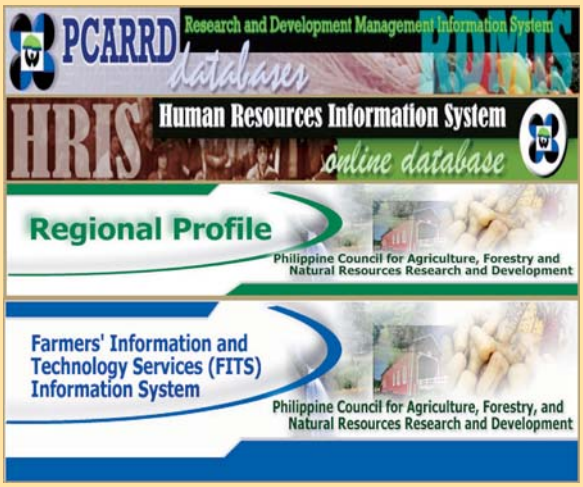

Figure 6. PCARRD web-based information system

RDMIS is a complete and comprehensive inventory of all new, on-going and completed R&D projects in agriculture, forestry and natural resources. Listed are the projects (whether funded by government or not) implemented by the agencies in the National Agriculture and Resources Research and Development Network (NARRDN).

[2] Session Initiation Protocol. An IP Telephony signaling protocol

By accessing the RDMIS, users can determine areas in which R&D is needed, how much has been invested in R&D on certain commodities or themes and who have been doing research along these themes. It provides information as well for research managers in developing their respective R&D agenda and thus prevents duplication of activities and waste of public resources.

HRIS is designed to effectively collect, systematize, process and retrieve relevant and updated information on human resources in agriculture, forestry, and natural resources (AFNR), specifically belonging to the National Agriculture and Resources Research and Development Network (NARRDN). The system will improve the planning, implementation, monitoring, and evaluation of human resource development in the AFNR sectors.

Finally, OSEP is for the submission and evaluation of R&D proposals via the PCARRD website. The system captures actions/comments of the different evaluators and tracks the proposal status during the whole process of evaluation for the information of proponents.

For the technology management mandate, the Farmers Information and Technology Services Information System (FITS-IS) and the Regional Profile Information System (RPIS) were enhanced, integrated and made web-based. These IS used to be stand-alone systems.

FITS-IS is designed to facilitate access to information and fast track the delivery of services to clients of FITS Centers at municipal and barangay (village) levels. The RPIS is a database that contains profiles of the 14 Regional Consortia, their member agencies, FITS Centers & Magsasaka Siyentista.

To ensure a wider reach especially to areas where Internet connectivity is not yet feasible, the PCARRD Short Message Service (SMS) was developed. The SMS uses the existing PCARRD protocol of tapping the subject matter/commodity specialists and experts pool of its technical research divisions in answering queries from registered users.

As of June 2009, content build-up for the seven modules of the FITS-IS in 80 FITS Centers identified under the program totaled 111,560 records: 1) Farmers – 43,880, 2) Experts – 1,555, 3) Contact Firms – 1,220, 4) Publications – 30,656, 5) Videos – 1,859, 6) Technologies – 2,899, and 7) Clients – 29,491. To date, the PCARRD SMS (0917PCARRD8) has 1,177 registered users. The migration of the system from InfoTxt to BizTxt-TxtConnect is on-going to adapt the system to the rigors of broadcasting to a wider range of users.

4.3. Component 3: Capacity Enhancement and Capability Building of Regional Consortia and FITS Centers

Adequate ICT infrastructure was developed (Tables 4 and 5) in order to strengthen the e-consortia, e-farms and PCARRD activities and interconnectivity.

Besides the hardware facilities, implementers were trained to maintain information systems and networks. First, they were trained on ICT Frontline Delivery Service (Basic ICT/ Networking, Open Office, Introduction to Internet) and Interconnectivity (VoIP, LAN, VCon, Video Stream).

Table 4. ICT equipment deployed

Description	Quantity
DELL OPTIPLEX GX	174
DELL Latitude D410	14
HP Scanjet 2400 Flatbed Scanner	14
HP Deskjet 1280 Printer	94
Creative Vista PRO with Headset	80
PQ1 512 MB Thumb Drive	94
SONY DCR VX2100 Digital Video Camcorder	14
SANYO PLC XU48 Multimedia Projector with stand type screen	28
Sony Cybershot DSC-T7 (128 MB)	94
Sony Ericsson K700i	174

Table 5. ICT equipment deployed for enhancing interconnectivity

Description	Quantity
HP NX 6120 Notebook Computer	29
Asustek A8FM Notebook	14
Huawei E220 (HSDPA) 3G (UMTS)	90
Huawei E620 - 3.5G (HSDPA) - 3G (UMTS)	81
INNOMTEK HSDPA USB Modem	58
Network Hub D-Link 10/100 MBPS 8 Port Switch	49
FSW-0808TX Fast Ethernet Switch, 8 UTP Level 1	45
Video Conferencing Terminal	14
HP NX 6320 Notebook Computer	42
HSDPA USB Modem ZTE MF620	12

These were followed by Trainers/Users Training on Information Systems/Databases (FITS-IS, RPIS, SMS, HRIS, OSEP, and RDMIS) for the e-consortia and e-farm implementers/users of the K-AgriNet.

A Center Staff Handbook and User's Manual was produced for training the program implementers at the national and field levels. Using Moodle, an e-Learning site for PCARRD was developed with modules on Basic ICT and Internet courses.

4.4. Component 4: Stakeholders Participation in the Network-based ICT Applications Development and Delivery

Documentation and Promotion. Since the launching of the program in 2005, K-AgriNet PCARRD has continuously promoted the program and informed the public. Among the activities are: development of multimedia promotional materials, and conduct of public awareness activities to generate support and participation in the program. Forming part of the

Council's Quick Information Dispatch (QID), multimedia promotionals include web-based articles and press releases, radio clips, radio coverages, photo documentation and media conferences. These were then disseminated to various clients along with flyers, tarpaulins, stickers, and t-shirts.

Partners documented the activities and successes of e-consortia and e-farm. It was aimed to enhance the appreciation of program implementers of the value or critical role of "innovations" in continuously improving the provision of R&D/Technology Management and Information and Technology Services.

a) Lakbay-Aral: Lakbay-Aral (literally "Travel-Learn") or cross-visits were also conducted as part of the Continuing Education for K-AgriNet implementers. Over 700 implementers benefited from this activity, gaining insight into how other regions were implementing e-consortium and e-farm and widening their perspectives based on observed best practices.

The K-AgriNet ICT Caravan toured 7 Regions, 20 provinces, 12 cities and 12 municipalities in Northern and Central Luzon, Davao, Bicol, Region 10 and the CARAGA region for three months. The caravan aimed to link the farmers and extension workers to agricultural information available online and create public interest in ICT (Figure 7a-b).

Using the Mobile IT Classroom of the Department of Science and Technology (DOST), the caravan kicked off in Bacnotan, La Union (northern Luzon) and ended at the CARAGA region and Misamis Oriental (Mindanao).

At each stop, activities such as cyber farm forum, agriculture science and technology update, e-learning and ICT training were organized. Over the three months of the caravans, they reached a total of 3,130 farmers, extension workers, and LGU officials with an average of 118 participants per stop.

Participants were taught the basic computer skills especially how to use the internet and access the websites of the following agencies to avail of their online services: Open Academy for Philippine Agriculture, IRRI's Rice Knowledge Bank, PCARRD-DOST and, K-AgriNet.

Figure 7a-b. K-AgriNet ICT caravan

At the stops, farmers and extension workers were able to "konek" (connect) through the K-AgriNet ICT Caravan and get up-to-date agricultural information, advice from experts online, and trade products and services online.

b) Training-cum-Writeshop on Valuing ICT Innovations in Providing Information and Technology Services: As part of social mobilization, the Training-cum-Writeshop on Valuing ICT Innovations in Providing Information and Technology Services was conducted in each of the major islands: Luzon, Visayas and Mindanao clusters. Eighty-eight participants composed of Regional Techno Gabay Coordinators, Regional Management of Information System Coordinators, Regional Applied Communication Office Coordinators, selected FITS managers and their respective Information Service Specialist attended the activity.

During the writeshop, participants wrote 38 stories on various ICT mediated practices in their respective consortia and FITS Centers. These focused on good ICT practices with focus on increasing productivity through provision of access to information (via interconnectivity and acquisition of ICT-ware), information and technology dissemination approaches and IEC production.

The stories from the e-consortia and e-farm sites captured and showcased the initial benefits and gains from the K-AgriNet program which included:

- easier access to information and technology services through the use of internet and mobile technology
- massive information technology utilization
- faster and efficient monitoring, evaluation and coordination of meetings, training, techno forum and clinic
- speedy and appropriate production of IEC materials through acquired skills on the electronic editing, lay outing and multimedia presentation
- online coordination in the preparation of IEC materials
- reduced transaction and travel expenses
- improved and efficient delivery of extension services
- enhanced network and market linkages among many other benefits.

c) Science and Technology Based-Farm: Through the e-Farm component, PCARRD has promoted the use of ICT services to Magsasaka Siyentista (MS) thus empowering them as major players in information dissemination.

Magsasaka Siyentista's are the main players in the Science and Technology-Based Farm (STBF). Through the S&T-based farm, the MS introduces and showcases appropriate S&T interventions derived from outputs of various R&D institutions. These may include production, processing or marketing and other necessary interventions based on gaps identified through the supply chain analysis.

The supply chain analysis is first used to identify specific gaps in the supply chain for the focus product of the MS. Among the focus commodities of these farms are organic vegetables, rice, fruits, root crops, cutflowers, swine and goat. MS then promote the use of relevant science-based technologies to at least 30 farmers/entrepreneurs in their locality (Figure 8a-b).

Successful e-Farm sites were recognized during the National Techno Gabay Summit. Best practices were shared and outstanding implementers were recognized. Awards were given to outstanding FITS Centers and Magsasaka Siyentista. Of the implementers in the progam,

FITS Banga won for Best FITS Center while MS Gary Andrade placed second in the search for Outstanding Magsasaka Siyentista.

Figure 8a. (Left) MS Vicky Motril (in red shirt and dark apron) demonstrating how best to prepare banana chips from the Bongulan variety. 8b (Right) Speaking at his Field Day, MS Josh Balderama describing the interventions on his S&T-based farm on goat.

d) K-AgriNet Local and International Study Missions. For the local study mission, a group of implementers/ beneficiaries traveled the roads of Davao and Butuan Provinces. K-AgriNet major institutional players composed of PCARRD, PhilRice, Department of Agrarian Reform (DAR) and Development Academy of the Philippines (DAP) led that five-day mission (Figure 9a).

Figure 9a. Participants of the local study mission

The visitors interacted with representatives of local government units, cooperatives, civil society and non-government organizations with ICT-based projects. In addition, gains and benefits derived from the program were also documented into major classifications as follows: project implementation, information dissemination, sustainability and policies developed/implemented.

PCARRD sent four delegates to the international study mission held in Hyderabad, India. These included PCARRD Deputy Director Richard M. Juanillo and Mr. Ricaredo Manzanilla, one RMIS Coordinator (Engr. Sean Villagonzalo) and one Magsasaka Siyentista (Mr. Ursulo B. dela Pena) (Figure 9b).

Figure 9b. Participants of the international study mission

The agencies, institutions and programs visited by the group were the National Productivity Council, National Information Center, Farmers' Call Center at Bagumpet, ICRISAT VASAT Addakal Project, MANAGE at Rajendranagar, National Institute of Rural Development, E-Sagu Project, Ashiwini Project and ITC e-Choupal. The group observed ICT initiatives that are working in India and identified successful cases that may be replicated for the Philippine setting.

4.5. Component 5: Program Management

K-AgriNet PCARRD's Program Management Team convened yearly to develop the workplans. Regional Consultation and Operational Planning Workshops were conducted at the start of the program to discuss implementation guidelines among the regional partners. Also, the Steering Committee and the Technical Working Group met quarterly over the program duration (Figure 10a-b).

Figure 10a. Regional consultation and planning workshop

PCARRD has assisted DAP-Project Management Office in the Random Physical Monitoring of ICT Wares both in the regions and in PCARRD. It has also helped in the production of the K-AgriNet videobriefer and the K-AgriNet User's Manual.

Figure 10b. Steering committee meeting

5. Assessment of Performance and Results of the Program

The PCARRD K-AgriNet accomplished the following in the five years of its implementation:

- All implementers were interconnected
- Seven modules of the information systems were developed and deployed as planned
- All project implementers were trained on the use of these information systems and on the mechanics of content build-up.

The enhanced hardware and software capability, coupled with the connectivity facility helped the regional partners with extensive access to online information systems (ISs) that the national partner has developed.

For R&D management, the Research and Development Management Information System (RDMIS), Online Submission and Evaluation of R&D Proposals (OSEP) and The Human

Resource Information System (HRIS) collectively known as the Agricultural Resources Management Information System (ARMIS) were improved with improvements in the infrastructure and connectivity.

Also, the Information Systems for Technology Management were improved and can now be accessed 24x7. These include the Farmers Information Technology Services Information System (FITS-IS), Regional Profile Information System (RPIS) and the Short Messaging System (SMS).

The PCARRD K-AgriNet interventions have resulted in ICT-enabled practices that made the delivery of e-Consortia and e-Farm services more efficient. For instance, project implementers reduced their transaction costs and through videoconferencing, are now able to communicate with remotely-located partners. Since the advent of videoconferencing in 2006, the national and regional partners have saved in travel expenses. In addition, they point to unquantifiable benefits like time saved and enhanced safety.

The “Impact Assessment Study and Performance Evaluation of the Techno Gabay Program” showed that FITS Centers are accessible to the farmers and other clients because they are located near market/trading post (2.4 Km) and roads are in good condition. This proves the wisdom of locating the centers near the centers of trade/commerce.

The study further concluded that the provision of mobile phones and interconnectivity has facilitated and enhanced the provision of technology and information services. It also noted that the transition from a stand-alone system to a web-based system hastened the build-up of records in the FITS-IS.

The impact study results showed that technical efficiency, productivity and profitability of farms provided with FITS interventions were significantly higher than those without interventions. For instance, 37% of rice farmers provided with FITS services produced at a range of 4.01-10.0 MT/ha/season compared to only 21% among farmers not covered by the FITS services.

Figure 11. Participants of FITS training program

Improvement in farm technical efficiency can be attributed to access to FITS IEC materials, FITS consultation/referral services, consultation with Magsasaka Siyentista, and FITS training services (Figure 11). While use of ICT tools and applications were not yet maximized at the time of the study, there are clear indications that the most significant FITS services mentioned above could be made more effective and efficient with full utilization of ICT.

As an information hub and a one-stop-info-shop, the FITS Centers were able to encourage active participation of stakeholders as information seekers and facilitators and not just passive recipients of information. With FITS Centers turning into sophisticated resource centers, modern equipment such as computers and other digital materials are now within the access of farmers. The achievements of K-AgriNet are as follows:

1. **Acquired and deployed ICT equipment**. Computers and other equipment, such as laptops, web cameras, scanners, printers, digital video cameras, multimedia projectors, cellular phones and digital still cameras were deployed in 14 e-consortia and 80 e-farm sites.
2. **Interconnected 14 regional consortia and 80 FITS Centers** via wired and wireless technologies.
3. **Developed web-based Information Systems (IS)**. The five web-based IS unified the information and advisory services and complemented the ICT facilities. The systems are: FITS-IS, Regional Profile IS, PCARRD Text, MSMEs, and Training Database.
4. **Built ICT capability in 14 regions**. Implementers and clients in 14 regions learned the proper use of ICT equipment (hardware) and gained skills on the use of the computer programs and databases (software).
5. **Held information campaigns for e-Consortia and e-Farm clients/stakeholders**. Information campagins drummed up widespread awareness of the program and of ICT applications in agriculture. Multimedia promotional materials were produced and distributed, and ICT information caravans were conducted.

6. Impact Assessment and Client Feedback

An external panel conducted surveys and Focus Group Discussions (FGD) among program implementers and beneficiaries. The study covered the progress of the program in terms of results achieved after almost four years of implementation and examined its overall effectiveness in meeting the objectives of the program.

It examined the progress of the program in relation to the overall objectives of the program, problems encountered during implementation, processes and structure employed by the program. Some of the panel's findings and the feedback (Box 1) it elicited from implementers and clients are given below:

6.1. Program Design and Interventions

The panel found that in general, the program design was able to accommodate different implementing modalities depending on the local situation. Quoting from the panel's report – the K-AgriNet program design "allowed continuous and open development and promotion of services among the knowledge developers and extension service providers. It allowed the adoption of existing implementation modes, processes and models."

The respondents said that the program design was open to opportunities for the diffusion and adoption of technology by including effective ICT systems to improve existing extension systems. It was also receptive to the derivation of new extension modalities (new project models).

The participants of the FGD also agreed that program interventions were very relevant because these addressed their problems such as outmoded farm practices and presence of pests and diseases. The farmers claimed that their collaboration with their peers improved and this has strengthened social association among them.

Because of this collaboration, they became actively involved in providing new information to farmer-clients. They also cited that through the program's interventions, they were connected with the pool of experts of various government line agencies from whom they have obtained advice on various appropriate technologies.

The project interventions to some extent changed the mindset of both the extension workers and farmers from the traditional farming technologies to the affordable and friendlier technologies developed by the K-AgriNet knowledge generators.

Box 1. Feedback of clients

"With FITS-IS it is easier for me to get information on new farming technologies especially on the diseases of my crops"
– Lucio Bano of Asuncion, Davao del Norte

"This cellphone is good,
I can get information fast on how to deal with insects and diseases of vegetables and rice. I don't have to go to the offices in the province."
– Samuel Barril, MS of Batuan, Bohol

"I just like to say that your website has so far been the most informative I found."
I am a returning overseas worker and your website has saved me much of the running for my business start ups. I'm sure there are a lot of people who likewise appreciate what you are doing. Keep up the good work."
– cronnie2@yahoo.com

ICT opened up opportunities for farmers ranging from new farming technologies, product marketing, networking, access to inputs, and fund sourcing. Agricultural communities were given equal opportunities to expand their economic activities and develop empowered agricultural enterprises.

Extension service providers also gained significantly from the project. Internet when combined with other information dissemination tools became a powerful information research and extension tool. They used the internet to gather information, needed by their farmers but which were not readily available to them. With the internet they were able to provide adequate and timely service to their clientele. The Internet facilitated networking and sharing of information with other extension workers across the country. The Internet, together with the database systems, became valuable tools for monitoring and strategic planning and decision-making.

However, Internet development in some project areas was constrained by several factors: the high entry costs for the purchase of equipment, leased lines, the creation and upkeep of websites, the insufficient bandwidth to support fast and efficient up- and downloading of information and a low educational level and the lack of computer skills among the population.

The instructional CDs and reading materials were acknowledged as sources of information. However, their limited reach and one-dimensional nature, particularly the reading materials, reduced their utility compared to the other educational materials. Radio broadcasting was

a popular choice in accessing farming information. Two FITS- managed community radio programs in Negros and Alfonso Lista, for instance, reached a wide following of farmers in remote villages even beyond the intended service areas of the FIT centers.

One of the drawbacks cited by the FGD participants was that the community was not fully explored as a feedback mechanism for ICT content development. Information flow was largely top-down, with the information coming from the knowledge generators to the user communities.

The institutions did not get feedback on the information needs of the beneficiaries although there were documented experiences on innovations developed by communities. The Magsasaka Siyentista however, were identified as effective information intermediaries of appropriate technologies developed by the research institutions.

6.2. People-Centeredness

When asked during the FGD about the benefits they derived from the interventions, the target beneficiaries pointed to the effectiveness of the person-focused strategy of the program. The survey, on the other hand, surfaced the following: positive effect on the people's income, awareness of development in technology that helped them improve farm management, marketing of products and improved social interactions.

Exchange of information on production technologies and best practices among the target beneficiaries is one of the strong highlights of the project. As an offshoot of the various capability and public awareness and participation activities, communication ties were established among farmers around the country. Farmers from Luzon are now communicating with their counterparts from Visayas and Mindanao. They share information on production techniques and solutions to common production problems. Although rare, several farmers reported to have used ICT in transacting business. More now use SMS to sell their products.

The respondents said the program was citizen friendly. The training modules for agriculture workers and extension workers covered lessons on the basics of computer and internet use and its application to their work with the farmers and their internal office activities like planning and peer-networking. The training modules for the farmers were designed according to their own literacy level. The teaching objectives and strategies on the use of the computer and the internet were more simplified.

Training programs covered use of computers besides use of other tools such as SMS and radio. The medium of instruction was generally in the local dialect. The website designs employed a point-click system and made a wide use of colorful designs and icons to make the ICT training more interesting.

6.3. Use of Internet

Of the 85 farmer respondents, 18 reportedly knew how to use the computer and 15 farmers knew how to access the Internet even before the project. However, the use of the Internet to gather information increased at least three times among the beneficiaries (Table 6). The same trend was observed among the agriculture extension workers.

Both the farmers and extension workers accessed the Internet more frequently. After the Internet centers were established, the number of farmers who reportedly used the internet as the need arose tripled. With the Internet service, the time spent accessing and retrieving

Table 6. Indicators of initial gains from the use of Internet

Indicator	Farmers		Agric. Extension Workers	
	Before	After	Before	After
Knows how to use the computer	18	45	6	16
Knows how to use the Internet	15	44	4	16
Frequency of using the Internet				
Everyday	2	5	1	4
1-3 times per week	3	10	3	8
Once a month	1	10	–	1
As the need arises	7	19	–	3
Time spent to access/retrieve information (minutes)	49	28	21	5

information from the Internet was reduced by at least average of 59 percent for both beneficiaries.

6.4. Short Message Service

Among the beneficiaries interviewed, the mobile phone was the most popular means of getting information from the program. The number of farmers using mobile phones to get information from the program agencies more than doubled (109%) after the program. The same was true among the extension workers (129%) (Table 7).

Table 7. Indicators of initial gains from the use of SMS, Before and After the Program

Indicator	Farmers			Agric. Extension Workers		
	Before	After	% Change	Before	After	% Change
Has a mobile phone	47	53	13	12	16	33
Uses mobile phone to get information from the project	23	48	109	7	16	129
Answered by the project	22	45	105	6	14	133
% Answered	96	94	96	86	87	–
Types of information requested						
Production technology	6	22	497	4	9	125
Prices of inputs	5	8	60	1	3	200
Markets	–	2	–	–	1	–
Market prices	5	10	100	–	2	–
Others	–	–	–	1	3	200

After the program, 90% of those with mobile phones used it to access information from the program implementers. Questions on production technology increased tremendously after they were informed of the available program services. Information on prices and markets were also solicited. The number of beneficiaries using SMS to transact business also increased when the program was implemented.

6.5. Stand-Alone System

A stand-alone system is a system that is completely operational without requiring external support. The program provided the field implementers with stand-alone information materials which were subsequently made available to farmers.

Of the 85 respondents, 63 or 74% used agriculture related stand-alone materials (Table 8). Majority of these 63 farmers learned about the system from the program and used it during the implementation of the program. More than 50% of the farmers opined that the quality of information is good and 29% farmer found excellent.

Table 8. Initial gains in the use of stand-alone system

How did you learn about the stand-alone system?			How long have you been using the system?				
Self-study	Through a family member	Through ICT program	Less than 6 months	6-12 months	1 to 3 years	4 to 6 years	7 or more years
16	9	38	15	15	20	4	3
25.00%	14.00%	60.00%	26.00%	26.00%	35.00%	7.00%	5.00%

How would you rate the quality of the info found in the ICT stand-alone system			How would you rate the completeness of the information?			
Excellent	Good	Okay	I found everything I needed	I found most of the info I needed	Average	Lacks some important info
18	32	13	20	20	20	3
29.00%	51.00%	21.00%	32.00%	32.00%	32.00%	5.00%

A third of those who used the system found most of the information they needed (32%). The same number said that they found everything they needed. During the group discussion, they said that the system helped them in their farming activities. They were able to learn proper farming practices and new techniques.

All the extension workers claim to have been helped in their work by the materials provided them. These allowed them to make the materials available to the farmers who have no access to the FITS centers or to the trainings conducted. It also made teaching or delivery of the topics easier.

6.6. Welfare Improvements

Respondents described improvements in their welfare, specifically on household income and quality of life.

a) Household Annual Income. Beneficiaries increased their income by 12%, with their total farm income increasing by a significant 35%. Income of the control respondents likewise increased (Table 9). The one percentage difference between the average total annual income of the core and control may belie the program's benefits. However, the income aggregates show that on-farm income of the control decreased compared to the significant increase in the beneficiaries' farm-based income.

This could imply that because of the ICT assistance provided to the farmers, their production improved, and/or they were able to access to better markets, thereby increasing their income. On the other hand, the increase in the control's income was from their off-farm activities, i.e., they may have signed on as temporary workers in other farms.

Table 9. Average annual household income by source (in Philippine Peso)

Type of income	On-farm	Off-farm	Total farm	Non-farm	Average total income
Core					
Before	70,367	26,140	96,507	54,575	105,759
After	105,744	41,639	147,383	61,336	120,419
% Change	33.00	37.00	35.00	11.00	12.00
Control					
Before	70,000	104,000	174, 000	48,000	154,500
After	62,500	120,000	182, 500	46,000	173,600
% Change	-12.00	13.00	5.00	-4.00	11.00

b) Perception on Quality of Life (QoL). The Quality of Life (QoL) indicates the level of satisfaction in the socio-economic situation of a person. Based on a scale of one to ten, with one as lowest (not satisfied) and ten as highest (very satisfied), the respondents were asked to rate their satisfaction with the health of the family, accumulation of assets, education, and additional sources of income for women and youth, recreation and other collective activities.

There was a very significant increase in the positive perception of the quality of life after the program by the respondent beneficiaries. About 46% of the respondents reported to have a higher level of QoL after the program. Most felt that they are more satisfied after the program and only 7% felt dissatisfied (Tables 10 and 11).

Table10. Percent distribution of respondents according to QoL perception

	Quality of Life Levels									
	1	2	3	4	5	6	7	8	9	10
Before the Project	4	6	9	10	41	12	14	4	0	0
After the Project	1	0	4	1	16	12	20	25	17	4

Table 11. Distribution range of respondents according to QoL perception

Type of respondents	Range of QoL Perception		
	1 – 4	5	6 – 10
	Core		
Before the Project	29	41	30
After the Project	7	16	77
	Control		
Before the Project	70	20	10
After the Project	60	10	30

7. Lessons Learned and Recommendations

K-AgriNet ended in 2010, but PCARRD-DOST will continue various activities. To do this, the Council forged a Supplemental Memorandum of Agreement with the regional consortia and the FITS stating among others that they will continue providing their services even after program life to ensure sustainability of such services and facilitate the institutionalization of K-AgriNet program in the regular program of the consortia and the FITS Centers.

Further, Executive Order (EO) No. 801 on May 14, 2009 augurs well for the K-AgriNet. Through EO 801, then President Gloria Macapagal-Arroyo mandates the local government units (LGUs) to adopt PCARRD-DOST's Techno Gabay Program (TGP) in their agricultural extension programs. EO 801 specifically states that TGP will be employed in the provincial and municipal levels of the LGUs in collaboration with the Department of Interior and Local Government, Department of Agriculture, Commission on Higher Education – State Universities and Colleges, among other concerned agencies.

One of the major problems encountered in the implementation of e-Consortia and e-Farm was the difficulty in providing the connectivity to the 14 e-Consortia and 80 e-Farm sites. The most common reason cited by telephone companies was that capacities were already fully subscribed in the areas covering the selected sites. Thus, connection was delayed for one e-Consortia site (out of 14 sites) while of the 80 e-Farm participants, only 8 have been connected through wired facilities. The rest made use of wireless technology with signals coming from cellular phone towers. These wireless signals vary based on the location of the subscribers. Some can receive UMTS (3.6 Mbps maximum) or 3G, while majority of them settled for 236 Kbps (GPRS signals). Because of the inconsistency of the wireless signal, VOIP was not fully implemented in the selected e-Farm sites. For the e-Consortia partners, unsynchronized installation of the links and VoIP device acquisition were the primary problems encountered.

Constant dialogues were the mainstays of "trouble-shooting" within the program. Dialogues were held with ASTI to mitigate most of the problems cited and with the regional partners to assist them in dealing with the problems associated with the telephone companies and the device acquisition. The national center even served as guarantor so that one telephone company will participate in the bidding process.

Some other issues were raised by implementers/key players especially on the need for a monitoring and evaluation mechanism to determine the effects/impacts of technologies and information accessed by farmers from the Center. In terms of interconnectivity, they point to the sustainability of interconnectivity in some areas.

Regarding use of the facilities, implementers say it is difficult to encourage older farmers to use computers. However, they report interesting cases where FITS centers encourage the children of farmers to use the computer and search for useful agricultural information on the Internet for their parents.

Local government executives in the project sites have opened their eyes to the benefits of the use of ICT and this realization has encouraged them to invest in ICT for agriculture in their respective localities. It may take some extra lift to sustain what has been started and immediate follow up activities may be needed to capitalize on the momentum built and initiated/spearheaded by the project.

Overall, the K-AgriNet project is a plus factor to agricultural development, specifically in harnessing potentials of farmers, their families, and other beneficiaries through the joint efforts of agencies involved. In the five years spent for the project, its targets have been accomplished and it can be considered as a pioneering program in ICT-based agriculture.

The following recommendations are hereby forwarded:

- ***Strong advocacy to telephone companies/internet service providers and FITS centers and host agencies/LGUs.*** PCARRD should seek the assistance of the Commission on ICT in advocating with telephone companies/internet service providers for the improvement/expansion of their internet services so that benefits from interconnectivity could be maximized. Where applicable and appropriate, host agencies of the FITS centers/LGUs shall be encouraged to use DSL in sustaining connectivity so that they can take full advantage of ICT applications such as VOIP, videoconferencing and others for their information and technology delivery services.
- ***Improving off-grid access to ICTs.*** PCARRD, consortia, and FITS centers and/or LGUs were able to establish "virtual communities" through interconnected ICT infrastructure and knowledge systems. However, access provision or sustaining interconnectivity for off-grid FITS centers was one of the program's significant problems. Alternative ways of interconnectivity should be promoted such as inexpensive cellular phones to ensure sustainability and effectiveness of ICT program in the remote areas.
- ***Determining impacts/effects of ICT interventions in agriculture.*** The monitoring system should be reviewed to ensure that major impact/effect indicators are captured. A simple impact assessment study has been conducted in 2010 to determine more concrete impact/effects of ICT interventions on project implementers' R&D/technology management capabilities, and on improvement in productivity and income of their intended clients.

- ***Continuing information campaign on advantages of using ICT tools and applications.*** Various IEC strategies to promote the utilization of ICT tools and applications to improve knowledge generation, sharing, dissemination and utilization should be continuously pursued.

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