Date submitted: 27/05/2009

Open access initiatives for agricultural information transfer systems in India

Paraj Shukla
Division of Agricultural Chemicals
Indian Agricultural Research Institute,
PUSA Campus, New Delhi – 110 012 (India)

Anand P. Singh
University Information Resources Centre
Guru Gobind Singh Indraprastha University,
Kashmere Gate, Delhi – 110 403 (India)

Meeting: **101. Agricultural Libraries**

WORLD LIBRARY AND INFORMATION CONGRESS: 75TH IFLA GENERAL CONFERENCE AND COUNCIL
23-27 August 2009, Milan, Italy
http://www.ifla.org/annual-conference/ifla75/index.htm

Abstract

The Indian National Agricultural Research System generates substantial and quality Research Information which mostly remains within the confines of the respective stakeholders. It needs to be shared among the farming and research community globally. Since most of these documents are available in libraries, it is essential that libraries create an appropriate platform to share the research information. The current situation with regard to food prices in many countries has led policy makers to re-evaluate options for improving access to agricultural information in general. The Indian agricultural research needs visibility to manifest impact on intended users and peers around the world. This study presents various facets of rich agricultural heritage while noting the challenges and their mitigation through access to information. The study attempts to review the need and current status of Open Access and its evolving equation with respect to Agricultural Information Transfer Systems in India. It also presents the facts collected through an Internet-based study of various organizations involved in the process of amelioration of agricultural information transfer system. The article explores the problems and strategies for 'Open Access' implementation with suggestions.

Keywords: Open Access; Agricultural Research; Indian NARS; ICAR; Institutional Repository; Agriculture; India

1. EVERY FOURTH FARMER IN THE WORLD IS AN INDIAN

India is the seventh largest country in the world (by geographical area) extending nearly 3000 km from both, its south to north and west to east. Being a land of many varieties of soils and climates (20 Agro-ecological zones across the country) has afforded India ample scope for intense and diverse agriculture. As a matter of fact, Indian agriculture (IA) is the single largest private enterprise in the country with over 10 crore farm holdings. IA took a major leap forward after the onset of Green Revolution and since then continues to be the mainstay of the Indian economy. Agriculture and allied activities sustain livelihood of about two-thirds of the population, and contribute around 18 per cent to the National Gross Domestic Product. Since 20 per cent farming community is extremely poor[1], growth in

GDP from agriculture benefits their incomes two to four times more than growth in other sectors of the economy (Asenso-Okyere, K., et. al., 2008).

The Indian National Agricultural Research System (NARS) has played a pivotal role in transforming the face of country's agriculture, ushering it from 'ship-to-mouth' era of imports-based food security to the rainbow revolution period with country's food grains production touching 230 million tonnes in the year 2007-2008. The flagship organization of the Indian NARS and twice awardee of the "King Baudouin Development Prize International" (1988; 2004), the Indian Council of Agricultural Research (ICAR) is running into its 80th year of existence. As an apex body of NARS, the Council coordinates, administers and manages entire country's research, education and information dissemination through extension in agriculture, inclusive of horticulture, fisheries and animal sciences through its vast network of institutions and establishments (Table 1). The network includes institutes, research centres, bureaux, directorates, all-India coordinated research projects, all-India research projects, ad-hoc scheme projects, revolving fund scheme projects and externally funded projects[2]. The network also includes 42 state agricultural universities, 01 central agricultural university, 44 agricultural technology information centres (ATIC), 08 zonal coordinating units, and 562 *krishi vigyan kendras*. Out of total manpower of about 30,000 personnel of the ICAR, scientific cadre strength engaged in active research and its management is around 7000. This strength is further augmented by over 26,000 scientists from state agricultural universities engaged in teaching, research and extension[3].

Table–1: Institutions of the ICAR Network

Division (no. of institutions)	Institutes	National Bureaux	National Research Centres	Project Directorates	AICRPs**
Crop Science (25)	10	02	07	06	31#
Horticulture (22)	10	--	12	--	20#
Animal Sciences (19)	08^	01	06	04	14#
Fisheries (08)	06	01	--	01	--
Natural Resource Management (13)	09*	01	02	01	14#
Agricultural Engineering (07)	06	--	--	01	06
Agricultural Education	01	--	--	--	01
Agricultural Extension	--	--	01	--	--
TOTAL	**50**	**05**	**28**	**13**	**86**

^ Includes National Centre for Agricultural Economics and Policy Research; # Includes all-India network projects;

* Includes three research complexes; ** All-India Coordinated Research Projects

The Indian government's Ministry of Agriculture comprises Department of Agricultural Research and Education (DARE; administering agricultural research and education), Department of Agriculture & Cooperation (DAC; administering extension), and Department of Animal Husbandry, Dairying and Fisheries. Apart from the Indian NARS, state agriculture departments provide localized services and solutions to the farmers. Out of the 15 international centres of the Consultative Group on International Agricultural Research (CGIAR), the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) is headquartered in India.

2. "EVERYTHING ELSE MAY WAIT BUT NOT AGRICULTURE"

The IA is at the crossroads once again. In the last decade, growth rate of agriculture has remained below 2 per cent. The insightful words of Pandit Jawahar Lal Nehru, "Everything else may wait but not agriculture" are contemporary in the face of tremendous new challenges faced by IA. Stagnation in farm-level productivity in intensive farming areas,

rapid population growth, and globalization-affected production & market dynamics are only some of the issues affecting IA. Besides, agriculture being a social sector, the over-arching non-trading concerns such as employment and income generation, nutritional and food security, gender equity, poverty alleviation, environment and ecology demand prior attention. Indian per caput availability of resources is 4 – 6 times less compared to world average. With that said India supports 16.8 per cent world's population with just 4.2 per cent world's water resources and 2.3 per cent of global land. Country's population is estimated to be nearly 1230 million by 2010 A.D. and 1.5 billion by 2050 A.D. The demographic pressure and consequent demand for food, inordinate pressure on natural resources, threatened energy supply, increasing biotic and abiotic stresses, diversion of land for non-agricultural use, along with climate-change-related risks, rapidly evolving trade regime and global competitiveness in terms of cost and quality will continue to be major issues before the Indian NARS.

3. VISIBILITY & ACCESS TO INFORMATION ARE CRITICAL

Dr. Montek Singh Ahluwalia, Deputy Chairman, Planning Commission of India, once[4] mentioned that "the path-breaking research and innovation happening inside closed chambers should be disseminated to the farming fraternity" and lamented the fact that "a huge disconnect still exists between the fields and knowledge development sources like universities and academic institutions". To meet the existing and emerging challenges, IA would need to retrospect on green revolution (GR). It is important to note that in addition to the "miracle seeds", productivity in GR was knowledge-driven. Even the best technology in the world, in order to make an impact upon the lives of the people, needs to be disseminated through information about its use and attributes. Impact in case of GR was higher because of wider spread of information and subsequent adoption of agricultural practices already tested and perfected by farmers in developed countries. Organized efforts were made during that period to fill the gaps between and within the countries. Knowledge, shared by developed countries was adapted according to the local needs & habits by the researchers. This led to wider spread and adoption of knowledge. The yields increased, and consequently, improved livelihoods of farmers spurred quite a revolution. Crop production data of the country seemed like a miracle.

Agricultural information transfer system (AITS) is ever-evolving due to ongoing development in information and communication technology (ICT). Development of new improved ICT technologies, transform the methods of development, documentation, dissemination, and diffusion (4 Ds) of information (Reddy, D.E., 2008). Recently, Indian NARS has initiated steps to modernize the methods of the four Ds of AITS. Unfortunately, so far, access to information and visibility of Indian agricultural research has critically crippled impact and progress of Indian agricultural sciences (Swan, A., 2008). In a data released by *Thomson Reuters*, quite interestingly, no institution from southern hemisphere featured in the list of world's 20 best agricultural institutions. The study included institutions with minimum 5000 citations in agricultural sciences and was based on institution-wise citations per paper.

Presuming that Indian scientists are doing quality research and results are being published in sufficient quantum, impact is still hard to come by. Indian agricultural research is aimed at the farmers of the country but ironically it fails to make an impact even on the research community, who doesn't need extension workers to understand it.

In another exclusive study, *Thomson Scientific* analyzed a decade of influential research to rank countries on the basis of top one percent of scientific papers (Table-2). The study features Indian performance but indisputably shows that the USA, Japan and England had profound influence on the science during the last decade and they are leading the scientific thought across all concentrations. Indian share of 0.33 per cent among top 1 per

cent most cited papers is enough to prove that the country's research is of no less quality (But then why is it not cited enough?).

Table–2 Country rankings by volume of research output and research influence

Country	Total Papers (1996-2006)	Papers Among Top 1% Most Cited	Percentage of Papers Among Top 1%
Australia	248,189[10]	2,804[8]	1.13[5]
Canada	394,727[7]	5,301[6]	1.34[3]
China	**422,993**[6]	**2,189**[9]	**0.52**[10]
England	660,808[4]	10,090[2]	1.53[2]
France	535,629[5]	5,967[4]	1.11[6]
Germany	742,917[3]	9,427[3]	1.27[4]
India	**211,063**[11]	**694**[12]	**0.33**[12]
Italy	369,138[8]	3,825[7]	1.04[7]
Japan	790,510[2]	5,662[5]	0.72[9]
South Korea	180,329[12]	929[11]	0.52[10]
Spain	263,469[9]	2,155[10]	0.82[7]
Taiwan	124,940[13]	550[13]	0.44[11]
United States	**2,907,592**[1]	**54,516**[1]	**1.87**[1]

[1–13] Rankings
Source: Press release, *Thomson Scientific* (May 15, 2007); URL: http://thomsonreuters.com/content/press_room/sci/206286

In a comparative study done between the years 2003 and 2007, *Thomson Reuters* showed that Indian research falls short of the world's average in terms of cites-per-paper (Table-3).

Table–3 Percentage of research output of India and its relative impact (2003-2007)

Field	Percentage of papers from India	Relative impact compared to world
Materials Science	5.45	-25
Agricultural Sciences	**5.17**	**-55**
Chemistry	5.04	-32
Physics	3.88	-20
Plant & Animal Sciences	**3.40**	**-61**
Pharmacology	3.37	-41
Engineering	3.10	-27
Geosciences	2.90	-49
Ecology/Environmental	**2.66**	**-48**
Space Science	2.55	-42
Microbiology	**2.33**	**-48**
Overall Per Cent Share (all fields)	**2.75**	
Biology & Biochemistry	**2.18**	**-52**
Computer Science	1.72	-33
Mathematics	1.63	-37
Immunology	1.35	-64
Molecular Biology & Genetics	**1.27**	**-59**
Clinical Medicine	1.26	-54
Economics & Business	0.82	-46
Social Sciences	0.70	-46
Neurosciences & Behavior	0.60	-50
Psychology/Psychiatry	0.33	-36

SOURCE: National Science Indicators, 1981-2007 (listings of output and citation statistics for more than 170 countries).

The study indexed 1,16,862 scholarly papers that had at least one Indian author to arrive at India's world share spanning 21 fields from science and social science. Highest research paper output was registered in the field of materials science closely followed by agricultural

sciences though the difference in cites-per-paper was significant. For materials science, India's cites-per-paper average was only 25 per cent below the world's cites-per-paper average, whereas, in case of agricultural sciences' cites-per-paper average could attain only 45 per cent of the world average and hence remained 55 per cent below the world's cites-per-paper average. Fields closely associated with agricultural sciences such as plant & animal sciences; ecology/environmental science; microbiology; biology and biochemistry; and, molecular biology and genetics also had similar cites-per-paper average.

4. WHY 'OPEN ACCESS'

It is paradoxical to note that despite the intent of scientists to make their published research as widely be read as possible, most of the world cannot access their work. Since the scientific journal publishing's birth[5] in the year 1665, scientists and scholars have been publishing their research work without expecting any payment. Royalties as in the case of textbooks and monographs are not expected by the authors for journal articles. What scientists achieve by publishing articles in journals includes time-stamp on their research work, citations of their work by other scientists which gradually builds up impact of their work. It helps in career advancement, gaining more funding and last but not the least, the prestige. It is considered prestigious amongst scientists/scholars to peer-review the work of their colleagues, and they do it free of cost. The prestige driving 25000 journal strong industry, publishing over 2.5 million articles annually – Imagine! And, quite amusingly, the industry's revenue model is based on hiding (exorbitantly tolled access) the science from the people who create it. In a study (Table-4) conducted on the rise in subscription charges of the commercial journals, it was found that between the years 2004 and 2008 it was close to 34 per cent (Orsdel, L.C.V. and Born, K., 2008).

Table–4 Average prices/per cent price changes of agricultural and allied sciences

Subject	Average No. of Titles 2004-2008	Average Cost per Title 2008 (US$)	Per cent Change '04-'08
Agriculture	186	1034	34
Biology	251	1810	40
Botany	65	1491	41
Chemistry	236	3490	35
Engineering	336	1919	32
Food Science	17	1554	37
General Science	73	1213	33
Technology	187	1776	34

Rising journal costs ('commodification' of information) 'have" forced the community of Indian researchers and library & information science professionals to deliberate on attaining subscription status which would optimally enhance the information base in the field of agriculture and plant sciences. Deliberations, however, have resulted in more or less following publishers' model of providing access to the online journals. Mostly cost-cutting measures and belligerent negotiations for lowering the subscription prices are employed by forming consortia. Regretfully, like many developing countries, it is not uncommon in India to find authors not having a hard/soft copy of their own published work. National Science Advisor to the Canadian Prime Minister, Arthur Carty said, "For everyone to benefit from scientific progress, developing countries must be able to access research — and share their own work — as easily as any developed country"[6].

40 leading publishers under the aegis of Food and Agriculture Organization of the United Nations started a programme called, 'Access to Global Online Research in Agriculture' (AGORA)[7], which provides toll-free or low-cost access to major scientific

journals in the disciplines of agriculture and related sciences to public institutions in developing countries. Started in October 2003, AGORA programme provides access to 1278 journals across 107 countries (Wu, J. and Ochs, M.A., 2006). Although, institutions in countries with GNP per capita below $1000 are eligible for free access, programme suffers from publisher-bias. The programme has brought literature on global agriculture and related sciences to the door-step of many developing countries, but India, despite fulfilling the condition of inclusion, has been excluded.

5. ENTER THE 'OPEN ACCESS'

"Support for public goods research and development is equally important. I fully believe in Open Access.....Mahatma Gandhi said that we should behave as trustees and not as owners of both physical and intellectual wealth", says[8] Dr. M. S. Swaminathan. "OA implies providing immediate, permanent, toll-free online access to the full-texts of peer-reviewed research journal articles", points out Richard Poynder, an OA activist journalist. OA is gaining popularity with global information seeker and providers. The faculty of whopping 791 universities in 46 European countries unanimously voted to approve OA mandates at their institutions (Orsdel, L. C. V. and Born, K., 2008). The move would make self-archiving mandatory in the participating universities for the accepted/pre-print/post-print research & scholarly papers published in traditional or OA journals. OA policies have been adopted by some of the leading research organizations including, all National Institutes of Health, Britain's Wellcome Trust, all seven UK research councils, and the European Research Council. If universities, institutions and organizations continue to follow the suit, which they sooner or later will, the revenue model of US$ 7 billion market of journals is bound to collapse.

5.1 When Harvard Leads the Movement….

The prestigious Harvard University joined the Open Access movement last year (2008) in an unprecedented move by its faculty. The Faculty of Arts and Sciences unanimously voted for green road to OA and gave the University, permission to archive their scholarly articles in the University's institutional repository. With this move Harvard became the first American university to have mandated self-archiving. A professor of computer science at Harvard, Stuart M. Shieber, proposed the new policy[9]. He said about the policy change that it "should be a very powerful message to the academic community that we want and should have more control over how our work is used and disseminated". Notably, Harvard's OA mandate also carries the distinction of being the first in the world to be initiated by the faculty instead of administrators. Unlike Harvard, Massachusetts Institute of Technology holds the distinction of adopting first institution-wide OA mandate. Like Harvard, Stanford University also adopted a department wide OA mandate (School of Education & Law School). National Institute of Technology, Rourkela (Madhan, M., et. al., 2006) is the first Indian institution to adopt OA mandate followed by Bhartidasan University. Much increase in OA adoption is anticipated with the pending mandates of Council of Scientific & Industrial Research (CSIR; multi-institutional).

Table-5 Summary of World-wide OA Mandates

CONFIRMED		PROPOSED	
Mandate Type	**No. of Mandates**	**Mandate Type**	**No. of Mandates**
Institutional	35	Institutional	01
Departmental	06	Multi-institutional	06
Funder	36	Funder	07
TOTAL	**77**	**TOTAL**	**14**

Source: http://www.eprints.org/openaccess/policysignup/

On OA day last year, CSIR decided to implement OAI-PMH compliant repositories in it's 38 laboratories and thus became first scientific council in India to initiate OA implementation of its generated research and 21 CSIR-published journals (Sreelata, M., 2009). NISCAIR, a CSIR-institute, created national open access periodicals repository (NOPR) for the e-journals and built DSpace-based national science digital library (NSDL) for e-books. The institute also provides free online accessibility of Indian Science Abstracts, which includes Indian agricultural research.

5.2 IRRI Leads OA in Agricultural Sciences

International Rice Research Institute (IRRI), headquartered in the Philippines, is one of the leading agricultural institution in the world and an authority in rice research. The IRRI, in the year 2006, 'dared' to change its copyright policy from "all rights reserved" to "some rights reserved" (Borrero, A., et. al., 2007). The policy change elicited an organization-wide change in the outlook of agricultural researchers towards knowledge dissemination, forcing a review of strategies and operations. IRRI embraced 'Open Access' by removing all toll barriers on the institute's research and resources, including knowledge products, photos, books, training modules and software.

5.3 Definitions of 'Open Access'

OA has been interpreted in many ways by different organizations but the definitions from Budapest Open Access Initiative, and Bethesda & Berlin OA statements are regarded as de facto reference for the movement (Table-6).

Table - 6 Declarations and Statements regarding 'Open Access'

S.No.	Declaration/Statement	URL
1.	**Berlin Declaration**	http://oa.mpg.de/openaccess-berlin/berlindeclaration.html
2.	**WSIS Declaration**	http://www.itu.int/wsis/docs/geneva/official/dop.html
3.	**Bethesda Statement**	http://www.earlham.edu/~peters/fos/bethesda.htm
4.	**Budapest Open Access Initiative**	http://www.soros.org/openaccess/read.shtml
5.	**Public Library of Science**	http://www.plos.org/oa/definition.html
6.	**Wellcome Trust Statement**	http://www.wellcome.ac.uk/About-us/Policy/Policy-and-position-statements/WTD002766.htm
7.	**IFLA Statement**	http://archive.ifla.org/V/cdoc/open-access04.html

5.4 Types of 'Open Access'

There are two types of OA. They can be best explained in the words of Mr. Stevan Harnad; "The *Green Road* to 'Open Access' is for authors to publish their articles in the traditional journals of their choice, and then to make their peer-reviewed, accepted final drafts freely accessible online, by self-archiving them in their institution's Open Access repository. The *Gold Road* to Open Access is for authors to publish their articles in an "Open Access journal," which is a journal that makes all of its articles freely accessible online. The choice of journal, however, remains entirely up to the author" (Harnad, S., et. al., 2004).

5.5 Tools for 'Open Access'

A. Gold Road

a. Open Journal Systems (OJS) is one of the most popular open source journal management and publishing solutions, developed by the Public Knowledge Project (PKP;URL: http://pkp.sfu.ca/ojs-journals)

b. Many tools listed at (URL: http://library.queensu.ca/webir/planning/e-journal_publishing_support.htm)

B. Green Road

a. Dspace: Developed by MIT, USA
   i. Allows customization of the system to manage authorization, content, and Intellectual Property issues of the implementing institution
   ii. Captures interdisciplinary intellectual output
   iii. 27 repositories in India (15 not yet registered with DOAR)

b. Eprints: Developed by University of Southampton, UK
   i. Runs as both, centralized, discipline-based and as distributed, institution-based archives of scholarly publications
   ii. 12 repositories in India

c. Fedora: Flexible Extensible Digital Object Repository Architecture is being developed by Cornell University and University of Virginia jointly; Often confused with RedHat Fedora (here it means a type of hat) Linux operating system (11th reference in Meitei, L.S. and Devi, P., 2009)
   i. The software defines interfaces for disseminating and accessing digital content and for administering the repository
   ii. Biggest implementation is at Public Library of Science (PLoS; URL: http://www.plos.org/)

d. Others: ICRISAT uses now open source, integrated library management software, NewGenLib (URL: http://www.newgenlib.com/) for its online digital repository (URL: http://openaccess.icrisat.org/); Archimede, being developed by University of Laval, Canada (URL: http://www.bibl.ulaval.ca/archimede/index.en.html); Greenstone Digital Library (URL: http://www.nzdl.org/) – Many installations in India but institutions now switching to Dspace/Eprints (for repository) and OJS (for journals). For example, DESIDOC (DRDO), since the year 2008, adopted open journal system for publishing its journals online. Although, its earlier-implemented Green Stone Digital Library for archiving the e-journals (e.g. DESIDOC Bulletin, DESIDOC Bulletin of Information Technology) from the year 1981 to 2007 remains openly accessible; IR Plus – New generation digital repository software – currently in its alpha-stage of development at University of Rochester (URL: http://code.google.com/p/irplus/); Koha – meaning a gift, contribution or donation in *maori* language (New Zealand) – is an open source integrated library system.

5.6 Impact of 'Open Access'

The former UN Secretary-General Mr. Kofi Annan said, "We are fortunate to live in an age that offers new opportunities for involving all nations in science and technology" (Annan, K., 2004). For sure, he referred to the age of Internet and cutting-edge Information and Communication Technology – An age, which suddenly overruled a 300 year old order of traditional scholarly information delivery[10]. A recently published enormous study[11] in the *Science* journal (Evans, J. A. and Reimer, J., 2009) empirically echoes the sentiments of Mr. Annan. The study found impact of OA twice stronger in developing countries, highlighting their increased involvement in global science. In developed nations such as Germany and England, only five per cent increase in citations was found due to OA, whereas, in India and Brazil, the increase was as high as 25 and 30 per cent, respectively.

In an another comparative study relating to the issue of quality and impact of OA journals, Thomson ISI, by using its 'Web of Science' tool, reported "no discernable difference in terms of citation impact or frequency of citation between open-access and other journals" (Testa, J. & McVeigh, M. E., 2004). This is a very positive finding for OA movement because of the two important facts.

- 191 out of total 8700 journals included in the database of Thomson ISI are OA journals. And the figure is on the rise. OA journals passing the rigorous quality tests[12] of Thomson ISI puts to rest speculations and apprehensions regarding their quality.
- Secondly, OA journals, mostly in their early years of publications, start at par with subscription journals in probability of their citations, underlining the prospect of their reach and impact as the OA movement matures further.

A study done to assess the impact of self-archiving on citations revealed that the self-archived articles were proportionately higher among the more highly cited articles. The finding however may be interpreted in two ways – in terms of Quality Bias (tendency of authors to preferentially self-archive higher quality articles) and/or in terms of Quality Advantage (higher quality articles tend to get benefited more from self-archiving). It would be really interesting to see the results of a comparative study done on impact of self-selected self-archiving, mandated self-archiving and no self-archiving (Harnad, S., 2006).

In a study done by *Bioline International* and *MedKnow Publications* (Sahu, D.K. and Chan, L., 2003), it was revealed that closed access model is expensive to implement because collection of money costs more than the price of the article download (US$ 8). In a part of study published elsewhere, one of the authors of the above study revealed that the print subscription of nine journals of *MedKnow Publications* "increased" after they went 'open'. In addition, the study claimed that not only their overall article-submission increased but also the submissions from abroad were more (Sahu, D.K. and Parmar, R.C., 2006).

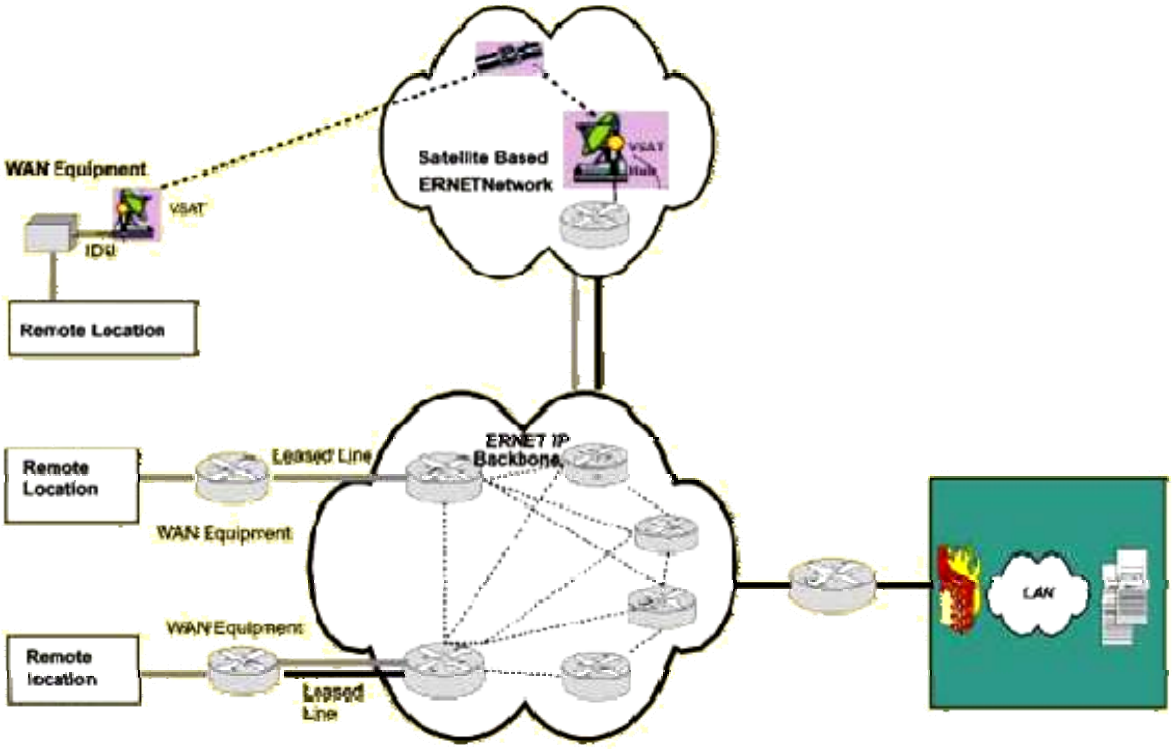
6. EVOLUTION OF AGRICULTURAL INFORMATION TRANSFER SYSTEMS (AITS) IN INDIA

The earliest writings on agriculture in the world were traced from the Indian scripture, Rigveda (5000 BC). The Aligarh Institute Gazette (1866) and agricultural books translated and published by Aligarh scientific society and agricultural books translated by Bihar Scientific Society formed the basis of AITS in India. But the modern AITS is believed to have originated in 1906 from the establishment of Imperial Agricultural Research Institute, Pusa, Bihar (R.D. Sharma, 1998) later renamed as Indian Agricultural Research Institute. Since the year of its establishment (1929), ICAR has promoted development of AITS in India (Singh, G. and Pal, K., 1988; Lal, C., 1998).

7. ICT INITIATIVES IN AGRICULTURAL RESEARCH, EDUCATION AND TECHNOLOGY DISSEMINATION

Till the year 2006, the emphasis of the ICAR and other public-funding agencies was on creating required Information & Communication Technology (ICT) infrastructure and familiarization/orientation of the personnel, for agricultural knowledge exchange and dissemination (Jain, S.P. and Goria, S., 2006). Post-2006, parallel implementation of functional objectives of the infrastructure was also initiated (Jain, P.K. and Babbar, P., 2006); the progress, though, is slow. An informative study (Aneeja, G. and Sridhar, G., 2008), targeted mainly on Gold road for implementing OA in the ICAR system reveals tremendous scope for bringing journals published by various (about 50) agricultural societies under OA domain. Under Digital Library of India initiative, out-of-copyright books, journals and research reports from libraries of Indian Agricultural Research Institute (6,023 items), Delhi and G.B. Pant University of Agriculture and Technology (126 items),

Pantnagar, were digitized and are freely accessible (Ambati, V., 2006). Through National Agricultural Innovation Project[13], ICAR has targeted a major revamp of its organization and management system. Consequently, NAIP (component 1) included several ICT initiatives which are being implemented in a project mode.



Schematic Diagram of Data Centre of ICAR being developed by ERNET at New Delhi for hosting Agroweb

Pic Courtesy: ICAR website (URL: http://www.icar.org.in/)

7.1 Network Strengthening (ICAR-Net), Archival content digitization, and knowledge management and dissemination system

The Indian NARS, under NAIP, is developing a model for modern ICT-based Knowledge Management and Dissemination system through a limited number of partners for knowledge acquiring, storage, value addition and dissemination. Content development includes agricultural databases, data-warehouses, expert-systems for advice-archives, training modules, and extension modules. It involves development of a secured, functional and accessible network of legitimate stakeholders including 252 ICAR institutes and state agricultural universities[14], connected through bandwidth capacity and need-based enhancement support by Educational and Research Network (ERNET)[15]. The objective is to implement network-wide services such as e-Content, e-Knowledgebase, e-Governance (MIS), e-Services. The plans for establishing 'commodity portal', developing and implement library information system, and establishing market intelligence network are in the offing.

7.2 E-Publishing and Knowledge System in Agricultural Research (E-PKSAR)

Being implemented by Directorate of Information and Publications of Agriculture (Consortium leader) as one of the subprojects under NAIP, E-PKSAR is a potential OA platform because it is developing a web-based agricultural research journal publishing portal – a potential Gold Road to OA. Also a web-enabled, full-text, searchable (OCR-based digitization) digital archive is being created to host back issues of periodicals/journals published by DIPA and a few selected professional agricultural

societies, and national agricultural research database (NARD) – a potential Green Road to OA. Since DIPA is developing suitable business model, guidelines and policies for marketing/sale of e-Journals, obviously, ICAR is looking at it with a revenue-generating viewpoint and not 'Open Access'.

7.3 Consortium for e-Resources in Agriculture (CeRA)

Government of India Funded by NAIP, CeRA[16] is a 124-member national consortium – a strategic alliance of ICAR network institutions and state agricultural universities. Headquartered at Unit of Simulation and Informatics (USI), Indian Agricultural Research Institute (IARI), New Delhi, CeRA is formed with the objectives of subscribing to e-journals; developing a science citation index facility for evaluation of scientific publications (agri-informatics & crop-informatics); and to promote and e-access culture amongst scientists. More than 200 print journals are being made available to the members through *Designated Document Delivery* Libraries. Initially, over 1947 e-journals have been subscribed from *Springer* (1190), *Annual Reviews* (22), *CSIRO* (08), and *Open J-Gate* (727). Due to absence of many 'essential' journals, more money was sourced recently into the consortium to expand the subscription. Consequently, subscription for journals from *Nature*, *John Wiley*, *Elsevier*, *Taylor & Francis*, *IndianJournals.com* and *Thomson Reuters* (for SCI, Scopus & Web of Science) is also being negotiated. The consortium is using a commercial product of an information products and services company, M/s *Informatics (India) Ltd.*, called *J-Gate Custom Content for Consortia* (JCCC). The product is an IP-based e-Journal access gateway customized according to the CeRA requirements and subscriptions. One of the strengths of the portal is the 'keyword search' feature across entire subscribed journals.

Notably, *Open J-Gate* is an 'open access' version of the subscription-based product '*J-gate*'. The 727 OA journals provided by *Open J-Gate* are cumulatively categorised under Agricultural (400) and Life Sciences (327) groups (Sathyanarayana, N.V., 2008). The authors empirically observed that the number of such journals is increasing on a daily basis.

In all probabilities, planning and design of CeRA is influenced by its three non-agricultural but similar precedents (CSIR e-Journal Consortium; INDEST; and UGC-Infonet) on consortium-based e-journal subscription model. Their salient features are mentioned below, though, it is important to note that CeRA is different from them in its implementation. Instead of developing a web based monitoring system to administer the consortium-wide subscription, the consortium is using JCCC e-journal portal of *Informatics* (*India*) *Ltd*. Other consortia have merely subscribed to JCCC as a bibliographic database.

CSIR E-Journal Consortium is the true precedent of CeRA because of the facts that it was initiated by one of the ICAR counterpart, Council of Scientific & Industrial Research and secondly, it was also initially established as a project. National Institute of Science Communication and Information Resources (NISCAIR) implemented the consortium of all 38 laboratories of CSIR in June, 2002 for providing council-wide selective e-journal subscription. For this NISCAIR developed web based monitoring system to administer the subscription and usage. Currently the consortium subscribes to over 6000 titles from leading publishers.

The Indian National Digital Library in Engineering Sciences and Technology[17] (INDEST) Consortium (2003) caters to engineering and technology domain mainly. Member institutions which include all Indian Institutes of Technology (IITs), Indian Institute of Science, and National Institutes of Technology have now increased from 45 centrally-funded core institutions at the time of inception to now over 700 member institutions. The INDEST also boasts of biggest subscription base of all consortia with more than 20,700 electronic journals. Headquartered at IIT, Delhi, the INDEST Consortium is a member of International Coalition of Library Consortia (ICOLC).

UGC–INFONET E-Journals Consortium is being implemented jointly by UGC bodies, Information and Library Network (INFLIBNET)/Educational and Research Network (ERNET). Commenced from January 01, 2004, with just 30 universities, it now has 175 member universities, providing access to around 5000 titles from 19 publishers, five bibliographic databases and various open access resources.

7.4 KrishiPrabha - Indian Agricultural Dissertations Repository

KrishiPrabha is established as a sub-project under NAIP, mainly to develop, organize and sustain knowledge base of Indian Agricultural Dissertations in digital form and make it accessible on-line[18]. The repository is created by Chaudhary Charan Singh Haryana Agricultural University, Hisar, (Haryana), and is targeting archive of 10,000 electronic thesis and dissertations (ETDs) submitted to state agricultural universities and agricultural deemed universities of the country since the year 2000.

7.5 Farmer-Extension-Agricultural Research / Education Continuum

Funded by NAIP, this multi-institutional consortium-mode sub-project involves scientists from diverse fields of agricultural, technological, basic and management sciences. The consortium-aims include building, demonstrating and sustaining a model agricultural knowledge organization and system (slated to become part of future ICAR portal) in support of extension in India. It involves specialized areas of integration of back-end digital systems, geospatial data and knowledge organization systems, multi-modal information delivery arrangement, and management of farm level Q&A and discussions. The consortium partners are using DRUPAL – an open source content management system. Development of *Agropedia* (agriculture knowledge repository of universal meta-models with localized content) is taking place at Indian Institute of Technology (IIT), Kanpur. *Agropedia*[19] is being developed as a platform for archiving interactive contributions by agriculture specialists, educators, students and other stakeholders in agriculture, thus populating a vast knowledge base. The option of contributing to '*gyan dhara'* (certified content) or participating in the farmer-interaction space to contribute to '*janagyan'* (emergent knowledge) is being developed for specialists. '*Janagyan*' database would build up through participation of registered users in the *agrowiki*, *agro-blog*, *agro-forum* and *agro-chat* like interaction spaces. *aAQUA*[20] is being developed at Developmental Informatics Laboratory (DIL) of IIT, Bombay and a private concern conceived at DIL, *Agrocom Software Technologies Pvt. Ltd.* (ASTPL). The company arranges for the provision of agro-weather network engineering, information technology for remote extension and crop protection, and agri-insurance support services. *aAQUA* portal functions as an Internet channel to communicate with farmers (and answer their queries) of over 290 districts of the country. Textual and audio feeds as RSS, SMS and Audio content on mobile are also being standardized.

8. OPEN ACCESS INITIATIVES IN INDIAN AGRICULTURE

8.1 e-Granth: Strengthening of Digital Library & Information Management under NARS

e-Granth is the first ever initiative by ICAR designed with 'Open Access' as one of its objectives. The consortium, sponsored by NAIP (ICAR), has 12 partner institutions. They will be using *NewGenLib* or *Koha* software for implementing online public access catalogue (OPAC). The local catalogues would be converted into union catalogue which would eventually be uploaded to *WorldCat*[21]. Simultaneously, the library resources (old journals and rare books) of three institutions, IARI, New Delhi; Indian Veterinary Research Institute, Izatnagar; and University of Agricultural Sciences, Bangalore; will be digitized to

searchable portable document format (PDF) documents. The digitized documents would then be hosted on Dspace/Eprints based digital repository.

8.2 AGROWEB – Digital Dissemination System for Indian Agricultural Research

It is technically inappropriate to discuss AGROWEB under OA initiatives because the concept of OA is not built into its design. But the authors take this liberty because AGROWEB involves development of a comprehensive digital repository for archiving details of technologies, activities of consortium partners, research papers, newsletters, project reports, annual reports, and copy free publications of last 10 years (Authors consider mixing a repository of research papers with other information sources as not a 'good' practice). AGROWEB, also a NAIP sub-project is a consortium of 9 member institutions. It aims at developing an ICAR portal as centralized consolidated information source of NARS with dynamicity, apart from implementing uniformity in websites of ICAR Institutes through content management system. Over 30 databases are being developed for online availability by the consortium partners. AGROWEB is slated to be hosted on a secured data centre being established at National Agricultural Science Complex, New Delhi.

8.3 Journal of Tropical Agriculture (JTROPA[22])

The Journal of Tropical Agriculture is an international journal published by Kerala Agricultural University (KAU), located at Thrissur, Kerala. JTROPA publishes scientific articles on all aspects of agroecosystem management and conservation, crop science, application of engineering, biology, ecology, and social knowledge for management of agricultural crops including horticultural and plantation crops. Started as "Agricultural Research Journal of Kerala" in the year 1961, it was renamed in the year 1993. Although JTROPA has the distinction of being the first OA journal to be published by the Indian NARS, it was ironically initiated with a non-ICAR grant (Department of Scientific and Industrial Research (DSIR), a part of the Ministry of Science and Technology, Government of India, New Delhi under the "Technology Information Facilitation Programme (TIF). The issues from volume 39 (2001) to 46 (2008) are digitized so far.

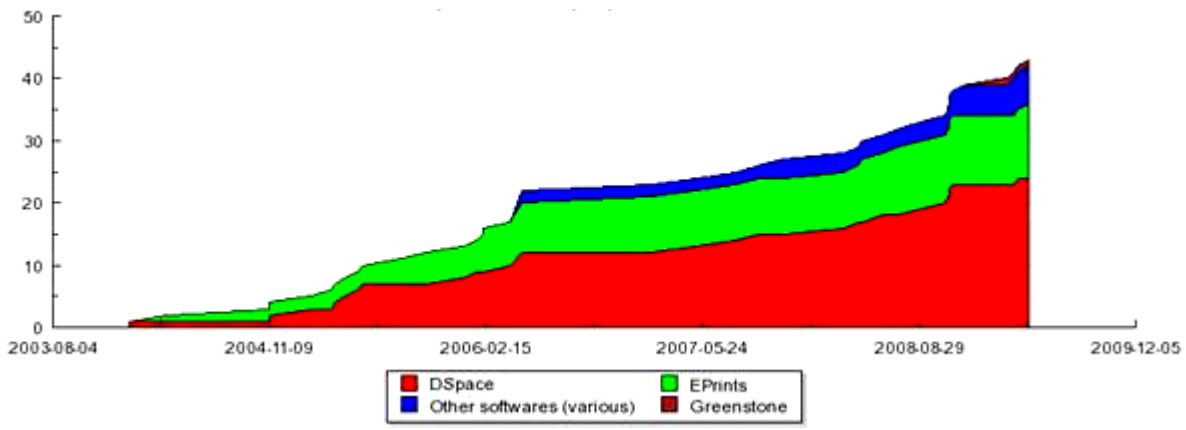
8.4 Open Access Journal of Medicinal and Aromatic Plants (OAJMAP)

OAJMAP carries the distinction of being the first OA journal conceived by scientists of an ICAR institute. It is promoted as an international, scholarly, peer-reviewed, online, half-yearly journal, published by Medicinal and Aromatic Plants Association of India (MAPAI) located at Directorate of Medicinal and Aromatic Plants, Boriavi, Anand 387310, Gujarat, India. The first issue is likely to be published in July 2009.

8.5 OA Repositories

The number of Indian repositories registered in Directory of Open Access Repository (University of Nottingham, UK) is 35 while it is 43 in Registry of Open Access Repository (University of Southampton, UK). To the best of knowledge of authors, the repository of ICRISAT is the sole agricultural open access digital institutional repository in the country (Table-7), though, based on the information initiatives presented above, many more seem to be in pipeline from the Indian NARS. The scenario of self-archiving policies of publishers looks rather gloomy if looked at with 'number of publishers allowing self-archiving'. Only little more than half of 523 publishers allow self-archiving of peer-reviewed articles by the authors. It is however much better to see that out of 10190 journals, 63.2 per cent (6440) journals allow self-archiving of peer-reviewed post-print articles by authors; and 31.68 per cent (3228) journals allow pre-print self-archiving. Only 5.12 per cent (522) journals linger in Gray area.

Stack Diagram: Development of Repositories in India (sorted software-wise)



Source: http://roar.eprints.org/

Table-7 List of Open Access Indian Digital Repositories registered in DOAR

Repository name	Num. Recs.	Software
ICRISAT Open Access Repository	--	NewGenLib
Delhi College of Engineering Repository	326	DSpace
Digital Knowledge Repository of Central Drug Research Institute	135	DSpace
Digital Library at Indian Statistical Institute, Bangalore	191	DSpace
DRS at National Institute Of Oceanography	1058	DSpace
CUSAT	1912	DSpace
IBS Ahmedabad	171	DSpace
Indian Institute of Management Kozhikode	290	DSpace
National Chemical Laboratory	407	DSpace
NCRA	84	DSpace
Vidyanidhi	54778	DSpace
IIT – Bangalore	25	DSpace
INFLIBNET	428	DSpace
National Institute of Technology, Rourkela	653	DSpace
TIET		DSpace
eGyankosh	6190	DSpace
Electronic Theses and Dissertations at Indian Institute of Science	206	DSpace
IIT – Delhi	2141	DSpace
Indian Institute of Astrophysics Repository	4211	DSpace
Kautilya Digital Repository at IGIDR	172	DSpace
Librarians' Digital Library	249	DSpace
Management Development Institute - Open Access Repository	325	DSpace
NISCAIR Online Periodical Repository	2020	DSpace
Petrospace - PDPU Open Repository	1	DSpace
Raman Research Institute Digital Repository	3568	DSpace
Catalysis Database	1225	EPrints
DU Eprint Archive	170	EPrints
National Institute of Immunology	10	EPrints
BICMKU	31	EPrints
IMSc	5	EPrints
National Aerospace Laboratories Institutional Repository	1320	EPrints
Open Access Repository of IISc Research Publications	5090	EPrints
OPENMED	1632	EPrints
Sardar Vallabhbai National Institute of Technology	14	EPrints
Mahatma Gandhi University Theses Online	913	Nitya

8.6 OA Journals of Agricultural and Related Sciences (DOAJ data)

Globally, 229 'Open Access' journals (registered with Directory of Open Access Journals (DOAJ)) are available in the field of Agricultural (79) and related sciences such as Animal Sciences (60); Aquaculture and Fisheries (11); Forestry (24); Nutrition and Food Sciences (20); and Plant Sciences (35). However, agricultural and related science journals published from India are meagre (09; Table – 08)

TABLE - 8 List of Open Access Indian Journals Being Published in the Field of Agricultural and Related Sciences

S.No.	Name of the Journal	ISSN No.	Year of Start	Hyperlink
1.	Current Science	00113891	1932	http://www.ias.ac.in/currsci/
2.	Journal of Biosciences	02505991	1998	http://www.ias.ac.in/jbiosci/
3.	Journal of Tropical Agriculture	0971636X 09735399*	2001	http://www.jtropag.in/index.php/ojs
4.	Madras Agricultural Journal#	00249602	2003	http://sites.google.com/site/majmasu/Home
5.	Bioinformation	09732063	2005	http://www.bioinformation.net
6.	Journal of SAT Agricultural Research	09733094	2005	http://ejournal.icrisat.org/
7.	Vet Scan	09736980	2005	http://www.vetscan.co.in/
8.	International Journal of Integrative Biology	09738363	2007	http://www.classicrus.com/IJIB/
9.	Journal of Biopesticides	0974391X	2008	http://www.jbiopest.com/

* EISSN Number; # Published by Madras Agricultural Students Union
Source: Directory of Open Access Journals URL: http://www.doaj.org/doaj?func=subject&cpid=115

9. PROBLEMS AND STRATEGIES TO ACCELERATE ADOPTION OF OA

There is a greater need of changing the mindset of researchers and policy-makers regarding the public-funded research and access to information (Arunachalam, S., 2008a and 2008b). It is essential to bring the agricultural policy-makers on the discussion table to brainstorm on key issues concerned with OA to country's agricultural research in the public domain (Kirsop, B., 2008). Such a series of sessions should eventually yield OA policies for agricultural research, policies regarding copyrights/IPR and guidelines for creation and maintenance for centralized/decentralized institutional repositories. The latter outcome is very important for achieving immediate and substantial open access to agricultural research (Harnad, S. and Swan, A., 2008). Gold road to OA has limitations because best agricultural research is found behind the tolled barrier of journals from developed countries. Simultaneous self-archiving of best peer-reviewed research papers would not only provide immediate and wider access, and greater visibility but also preservation of institutional research output (Papin–Ramcharan, J. I. & Dawe, R. A., 2006). The strategy for implementing OA should be based on enlightening the intended users about the need and advantages of self-archiving - a "will-to-way-to-will" approach. The authors of this paper believe that in any institution, generation of demand for institutional repository would not only lead to establishment of repositories but also generate further demand for using them to increase visibility of the research work and institutional prestige.

The challenges to generate 'will' for OA within scientist community are:

- Scientists mostly are ill-informed about copyright and prior-publication issues and fear losing opportunity of publishing their work in a high impact journal.
- Scientists are apprehensive that due to swift spread of OA concept, publishers of the 'elite' journals would change the subscription-based model of revenue to 'author pays' and levy charges for publication.

- Also, many scientists think website to be an adequate substitute for repository and lack understanding of advantages of using institutional repositories.
- Many scientists do not understand data on the impact of their work and how their performance compares against peers.
- Level of awareness about OA and its inherent advantages is low amongst scientists; even if they are aware, they have little understanding of self-archiving modes and methods.

In a top-down approach to focused advocacy of OA, the world's best research institutions/universities are adopting OA by institutionally or departmentally mandating open access (as mentioned elsewhere in this paper). Copyright/IPR policies are being formulated as per the need and discipline of the department/institution/university (Willinsky, J., 2002; Clarke, R., 2005). The National Knowledge Commission[24] of India under the chairmanship of Mr. Sam Pitroda recommended an 'Open Access' mandate for publicly funded research. A study done at University of Tasmania, University of Queensland and Queensland University of Technology convincingly shows that for implementing green road to OA the tripartite approach of combining, creation of repositories, and incentives to the authors, with an institution-wide mandate is best to achieve 100 per cent self-archiving (Sale, A., 2006a and 2006b). As pointed out in the above study, repositories (Green Road) are fundamental to OA implementation and success. There could be many models for implementing OA (Puschmann, C. and Reimer, P., 2007) and it varies with users on the basis of their specific use, preferences regarding technologies for implementation, and approach adopted for implementing OA. But in India, the hindrances in building institutional repositories are many.

The challenges for implementing 'way' to OA are:

- Confusion and lack of awareness amongst Library & Information Science professionals about technical and functional differences between Digital Library, Archive, Repository, etc., and their respective uses.
- Policy makers and administrators have little understanding of both physical and functional aspects of repositories.
- At many libraries and network centres of agricultural institutions, minimum scalable infrastructure for establishing repositories is not available.
- Availability of trained manpower for creating and maintaining repositories is a problem at most of the institutions. Many agricultural institutions lack an independent cell for IT-related support.
- Most of the agricultural institutions seldom collect feedback from the scientists regarding their needs and preferences. It is important to incorporate the latter into implementation of OA.
- The need of compliance with OAI-PMH protocol is not appreciated by policymakers within Indian NARS. Free access is often confused with OA[23].

For journals published by agricultural societies across the country, an inception of OA is to be made by implementing a Dspace/Eprints-based archive of the back issues. The aim is not to compete with print journals but to 'open' the content availability. However, it is important to make the editors realize the significance of online availability of the journal content. Their understanding needs to be augmented by imparting knowledge about protocols such as OAI-PMH, and benefits from compliance (Abraham, T. and Minj, S., 2007; Struik et. al. 2007).

10. CONCLUSION

One of the major problems affecting impact, quantum and quality of Indian agricultural research could be limited-access to information and insufficient visibility due to use of 'tolled access' information dissemination modes. Authors' understand that research should be disseminated, as widely as possible, to realize its impact. The whole public-funded agricultural research establishment (scholarly publishing chain) not only in India but across the world would like to effectively deliver the knowledge generated within their systems to the intended users — stakeholders within and outside agricultural research, education and extension systems which mainly include researchers, development specialists, extension workers, food processors, policy-makers, educators, students and farmers. The call for self-archiving freedom by faculty of internationally renowned institutions is worth emulating. ICAR is strengthening AITS by bringing major reforms and building a planned ICT infrastructure through NAIP. Although, the need exists to bring change in the outlook of system towards 'opening' the 'content'. The authors conclude with a firm conviction that formulation and implementation of 'Open Access' mandate within Indian NARS is not a distant dream.

NOTES

[1] URL: http://www.thehindu.com/2005/11/28/stories/2005112800340900.htm

[2] Multi-million US$ World Bank funded National Agricultural Technology Project followed by National Agricultural Innovation Project; both preceded by World Bank funded National Agricultural Research Projects and Agricultural Human Resource Development Project.

[3] DARE/ICAR Annual Report 2008-09

[4] URL:http://southasia.oneworld.net/Article/research-can-revive-indian-agriculture

[5] In the year 1665, Henry Oldenburg created the first peer-review journal for the Royal Society of London: *Philosophical Transactions*

[6] URL: http://www.scidev.net/en/new-technologies/opinions/making-science-open-access-demands-a-new-mindset.html

[7] URL: http://www.aginternetwork.org/en/about_agora/

[8] URL: http://cis-india.org/advocacy/open-access/open-access-day/open%20access%20day%20flyer.pdf

[9] URL: http://www.news.harvard.edu/gazette/2008/05.22/07-shieber.html

[10] Development timeline of online access services for journals by various publishers

S.No.	The Year	Response
1.	1970	Mead Data Central (LexisNexis) launched: first professional online service (around 300 years after Oldenburg)
2.	1972	Dialog launched by Lockheed Corporation
3.	1983	The American Chemical Society offered full-text versions of eighteen primary journals through the BRS online system
4.	1991	ADONIS service launched (400 journals on CD-ROM: Blackwell, Elsevier, Pergamon and Springer-Verlag)
5.	1993	Elsevier launches TULIP (The University Licensing Program) for networked access to 45 journals)
6.	1996	IDEAL from Academic Press
7.	1997	ScienceDirect launches (Online access to 1,200 journals); InterScience launched by Wiley
8.	1999	Synergy launched by Blackwell

[11] Using Thompson Scientific's Citation Indexes and Fulltext Sources Online, 26 million articles were surveyed from more than 8,000 journals, their associated citations from 1945–2005 and online availability from 1998–2005.

[12] ISI has rigorous selection criteria to ensure that only top quality content is indexed. It reviews nearly 2,000 journals each year, but accepts only 10-12 per cent.

[13] URL: http://www.naip.icar.org.in/

[14] URL: http://www.icarnet.ernet.in/

[15] URL: http://www.ernet.in/
[16] URL: http://www.cera.jccc.in/
[17] URL: http://paniit.iitd.ac.in/indest/
[18] URL: http://202.141.47.8:8080/HAU/thesis.html
[19] URL: http://agropedia.iitk.ac.in/
[20] URL: http://www.aaqua.org/
[21] URL: http://www.oclc.org/worldcat/
[22] Abbreviation not a standard; Given by the authors for the sake of convenience only.
[23] Slide no. 10 and 11 of presentation at URL:
http://www.eindia.net.in/2008/eagriculture/Presentation/T_P_Trivedi-ICAR.pdf
[24] URL: http://www.knowledgecommission.gov.in/downloads/documents/wg_open_course.pdf

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