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Krishikosh: A new dimension of digital repository in agriculture

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ABSTRACT

Krishikosh, a digital repository, is a collection of online resources. It is a large collection of Indian resources in agriculture and allied sectors which is both institutional and discipline wise of Indian National Agricultural Research and Education System (NARES). A large collection of thesis, old and valuable books, institutional publications, technical bulletins, project reports, lectures, preprints, reprints, records, etc. is available in Krishikosh (https://krishikosh.egranth.ac.in/). The repository has been designed using open source software with efficient Integrated Content Management System (ICMS), configured to meet the user requirements of a reliable digital repository. It is a customized digital repository platform where users can upload and manage their content in compliance with the open access policy of the Indian Council of Agricultural Research. This is a unique platform for sharing the intellectual outputs of the agricultural fraternity hosted by the ICAR-Indian Agricultural Research Institute, (IARI), New Delhi. At present over 2,01,000 items are available on the krishikosh platform which includes students research work (>150,000 theses), old and valuable documents since 1948 in all major subjects of Agricultural and allied disciplines. The Krishikosh analytics shows over 1,87,23,710 hits on the website from 175 countries since 2017. The top ten countries visiting this digital platform were India, United States of America, Sudan, China, Russia, Ethiopia, Iran, Philippines, Nigeria and Indonesia**.** Google analytics, during the COVID 19 lockdown period (April-May 2020) indicates a monthly average hit of 6,93,295 indicating higher users on the Krishikosh repository during this time.

Keywords: Digital repository, Integrated Content Management System (ICMS), Krishikosh, Open Source Software

The agriculture research and education has become knowledge intensive in the present context. In India, a strong National Agricultural Research and Education System (NARES) exists with a vast array of agricultural knowledge and technologies. Timely access to the right information is crucial for agricultural growth and development. Quick access to authentic information is absolutely important to optimize the agricultural productivity, mitigate adverse effects of climate change, ensure sustainability of natural resources and quality for nutritional security. Therefore, the demand for fast access to authentic and credible digital information sources has risen in the agricultural research, education and extension.

Information played very important role even during the ancient time when people evolved from agri-pastoral society to the present day society. The crucial difference between today and yesteryear is the speed with which one can access information along with the magnitude of available information and practically no geographical boundaries to access the digital information. The development in computer technology revolutionized the world and the sudden growth in telecommunication methodologies provided the necessary synergy to create a catastrophic change breaking every boundary and connecting the planet into one giant network of information and knowledge.

The Indian Council of Agricultural Research (ICAR) initiated several digital initiatives for transformation of the agricultural research and education System. Earlier the Consortium of e-Resources in Agriculture (CeRA), RKMP (Rice Knowledge Management Portal, Agroweb, Agripedia, etc. were the major platforms to access the information. The Consortium of e-Resources in Agriculture (CeRA) provides access to the latest research directly from publisher through an aggregator (Chandrasekharan *et al*. 2012). However, the organizational knowledge which is available free within NARES is equally important for informed growth of the agriculture sector in the country. To bring all such resources on one platform, the E-Granth project was initiated under National Agricultural Innovation Project (NAIP) under the aegis of Indian Council of Agricultural Research (ICAR) to enable digital access to vast amount of information available

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in the NARES, which is one of the largest agricultural research and education system in world (Jain *et al*. 2014).

KrishiKosh: A Digital Repository for NARES

In the present era of knowledge revolution and knowledge organization, capturing, preserving and reusing the knowledge has become absolutely essential for any organization to keep itself competitive and relevant. Krishikosh (https://krishikosh.egranth.ac.in) is a versatile open access digital repository catering to the needs of NARES and has architecture for centralized hosting of content and a decentralized management. Krishikosh is hosted at the data center of ICAR-Indian Agricultural Research Institute (ICAR-IARI), New Delhi. The partner institutes and agricultural universities can administer their own resources which are an integral part of Krishikosh. This digital repository captures, preserves, archives and provides policy based access to the intellectual output of Indian NARES. It is a unique repository of knowledge in agriculture and allied sciences, having collection of old books, institutional publications, bulletins, project & technical reports, lectures, preprints, reprints, theses, records and various documents from all over the country. It is a customized digital repository platform for the users of NARES Institutions, where they can upload, manage content in compliance to open access policy of the ICAR.

Krishikosh has provided a digital Institutional Repository of important institutional publications including reports, theses, rare books, old journals, reprints, success stories, newsletters, annual reports, special bulletins, convocation addresses, lectures, author’s collections, preprints, reprints, periodicals, grey literature and make them open access under NARES. Krishikosh repository has the various functionalities including: (i) Improved accessibility: it makes the holdings more accessible to scholars, teachers, academics and the general public, through the internet, under open access policy, (ii) Enhanced search ability: all holdings are grouped into communities and collections based on institutions, subjects, themes or other criteria which makes large amount of information easily available thereby making the searching much easier and faster, (iii) Preservation: once the documents are scanned and digitized, preservation of the originals can be ensured for a much longer period as the need to handle the physical documents is eliminated or minimized to a great extent since documents are made available through the ICMS. It is NARES's intention to make the Metadata for all records (and categories) freely available to all, however the actual records would be accessible based upon its access category. All of NARES's holdings are classified under the three access categories, viz. Public Access, Privileged Access and Prohibited Access. In this repository, some important terminology such as Community, Sub Community, Collection, Item and Bitstream needs to be understood. Community is the top level reference term which describes the University/ICAR Institute group. Generally, the right to create a Community is with the Administrator of the Krishikosh. Sub community is the second level of hierarchy. It may describe Departments/Divisions under the University/ICAR Institute. Collection is a part of Community or Sub-community in which we can add different categories like books, thesis, journals, newsletters etc. Creating collection is necessary to post the document under Krishikosh. Item is the record/document which is uploaded in collections. Bitstream is the file which is uploaded in the Krishikosh, preferably a searchable pdf/a or pdf file.

At present, Krishikosh digital repository has 45 million digitized pages in two lakh forty five thousand digital items (volumes) like old books, old journals, reports, proceedings, reprint, research highlights, training manuals, historical records, which includes more than one lakh fifty thousand theses digitized from various ICAR institutes and agricultural universities (AUs). The status of institute/AU wise thesis submitted in the Krishikosh repository from January 2017 to March 2020 is given in Table 1.

Table 1 Year wise theses uploaded on Krishikosh repository from various University

State	State Agricultural University	March 2017	March 2018	March 2019	March 2020
Andhra Pradesh	ANGRAU, Hyderabad	227	227	573	1062
	DYSRHU, Venkatramangudem	260	389	389	388
	SVVU, Tirupati	196	1164	1754	1803
Assam	AAU, Jorhat	101	1015	205	299
Bihar	BAU, Sabour	58	89	90	136
	DRPCAU, Pusa , Bihar	110	246	327	425
	BASU, Patna	0	0	431	729
Chhattisgarh	CKV, Durg	33	102	125	374
	IGKV, Raipur	2169	2501	3506	3810
Delhi	IARI, New Delhi	4029	4612	4881	5286
Gujarat	AAU, Anand	537	1988	4524	4762
	JAU, Junagarh	188	1679	1935	2002

Contd.

Table 1. (*Continued*)

State	State Agricultural University	March 2017	March 2018	March 2019	March 2020
	KU, Amreli	0	7	11	19
	NAU, Navsari	561	929	2166	2546
	SKDAU, Dantiwada	28		0	327
Haryana	CCSHAU, Hisar	2465	3018	8158	8500
	LLRUVAS, Hisar	34	554	594	624
	NDRI, Karnal	2054	2325	2787	4774
Himachal Pradesh	CSKHPKV, Palampur	235	261	2250	2485
	DYSPUHF, Solan	1128	1452	3951	4415
Jammu &Kashmir	SKUAST, Kashmir	244	335	462	559
	SKUAST, Jammu	48	198	358	454
Jharkhand	BAU, Ranchi	33	585	640	684
Karnataka	KVAFSU, Bidar	397	426	426	1749
	UAHS, Shimoga	3	3	3	191
	UAS, Bengaluru	2076	3267	3899	12738
	UAS, Dharwad	2109	2231	2382	5412
	UAS, Raichur	2	74	74	707
	UHS, Bagalkot	26	127	413	522
Kerela	KAU, Thrissur	195	1029	1560	4163
	KUFOS, Kochi	5	5	5	5
	KVASU, Wayanand	0	51	38	434
Mizoram	CAU, Imphal	0	0	57	78
Madhya Pradesh	JNKVV, Jabalpur	1029	4594	4802	8020
	NDPCVV, Jabalpur	23	104	746	925
	RVSKVV, Gwalior	451	1448	1565	1808
Maharashtra	CIFE, Mumbai	208	531	761	857
	DBSKVV, Dapoli	283	565	674	790
	DPDKV, Akola	111	179	610	2747
	MAFSU, Nagpur	451	2529	3043	3377
	MPKV, Rahuri	2094	3986	6121	8577
	VNMKV, Parbhani	82	410	6799	7154
Odisha	OUAT, Bhubaneswar	744	1281	5203	5328
Punjab	GADVASU, Ludhiana	40	95	796	1473
	PAU, Ludhiana	1202	2018	2419	5679
Rajasthan	MPUAT, Udaipur	100	1495	1500	1653
	RAJUVAS, Bikaner	234	252	394	1239
	SKNAU, Jobner	346	501	593	1623
	SKRAU, Bikaner	54	55	631	685
	AU, Jodhpur	0	0	0	14
	AU, Kota	0	4	0	21
Telangana	PJTSAU, Hyderabad	5929	6465	8395	8538
	SKLTSHU, Hyderabad	0	0	0	102
	SPVNRTVU, Hyderabad	110	143	205	284
Tamil Nadu	TNAU, Coimbatore	436	695	1520	2072
	TNFU, Nagapattinam	0	135	150	196
	TNVASU, Chennai	2536	2807	2792	3142

Contd.

Table 1 (*Concluded*)

State	State Agricultural University	March 2017	March 2018	March 2019	March 2020
Uttarakhand	GBPAUT, Pantnagar	963	1137	2395	3407
	UUHF, Bharsar	17	65	85	111
Uttar Pradesh	CSAUAT, Kanpur	186	186	185	186
	IVRI, Izatnagar	1106	1106	1106	3114
	IAgS, BHU, Varanasi	452	452	704	1095
	NDUAT, Faizabad	118	118	118	168
	DUVASU, Mathura	112	340	1014	1960
	SHIATS, Allahabad	47	139	291	513
	SVPUAT, Meerut	0	0	93	93
West Bengal	BCKV, Mohanpur	279	279	279	794
	UBKV, Cooch Behar	55	192	383	452
	WBUAFS, Kolkata	48	578	1039	2048

Krishikosh repository has theses from the year 1948 and the number of MSc, PhD, MVSc and MTech including MBA and other theses available in the Krishikosh repository are 85382, 29486, 16745 and 5327, respectively. Data indicates the numbers of thesis (decade-wise) available in uploaded in 2016 (6118) increased by 6 times compared to 1981 (1304). The number of theses uploaded in 2019 are not included in this analysis as most of theses are under embargo period. An embargo is a process for temporary access restriction placed on metadata. Using the embargo settings, submitters are able to define embargoes bound to specific dates, that are applied to all anonymous and default read access. The simple embargo settings interface assumes that embargoes always start immediately upon submission, so only end dates are configurable.

Platform for Krishikosh

The Krishikosh has been designed using open source software Dspace which has an efficient Integrated Content Management System (ICMS), effectively configured to meet the requirements of NARES and create dependable digital repository. Each institution in NARES has been configured as a community in DSpace having its own collection and logo. Each community and collection can be given independent rights to register users for uploading and managing the content. Dspace is based on three-layer architecture which consists of storage layer, logical layer, application layer and each layer includes various components as depicted in Fig 1.

Storage layer: The lowest layer is the storage layer which consists of relational database, viz. postgres SQL (Structured Query Language) and bitstream storage module for storing the data and metadata, respectively. The relational database management system (postgres SQL) is an open source licensed software i.e. there will be no barriers to implement Dspace anywhere or if the system deals with multiple instances (DSpace reference manual 2002). JDBC (Java Database Connectivity), which defines how a user may accesses postgres SQL bitstream storage systems, stores the content by two different means viz. File system and Storage Resource Broker (SRB). The two units (postgres SQL and bitstream storage module) of the storage layer have

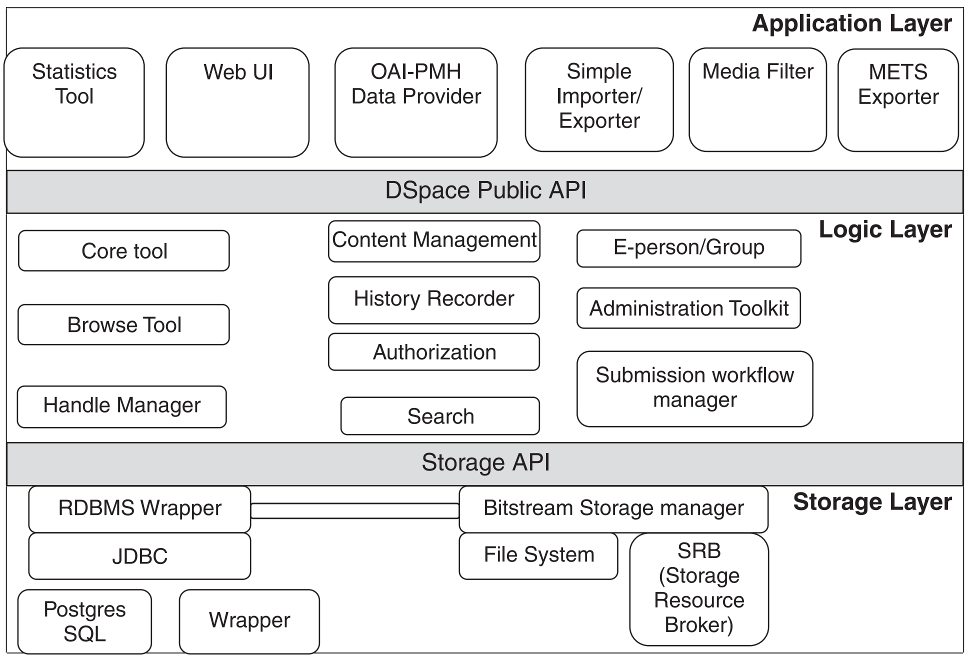

Fig 1 Architecture of Krishikosh repository.

Application Programming Interface (API) which is required to access the upper layer of the architecture.

Logic Layer: The architecture of logical layer consists of several modules such as core tools, administration toolkit, authorization, browsing tools, E-group/person, workflow, handle manager, content manager, history record etc. The layer deals with managing these contents. Each module has its own API through which the upper layer can be accessed. These APIs are together termed as Dspace public API. The workflow system models the states of an item in a state machine with various stages (submit, granting of license, archiving). The submission workflow manager is invoked by events as per collection and its steps are defined by creating corresponding entries in the List named workflow group. Administration Toolkit contains classes for administering a DSpace system. To create Administrator class, a simple command-line tool was executed via /dspace/bin/create administrator, that creates an administrator e-person with information entered from standard input.

Application layer: The uppermost layer is the application layer which communicates with the end user as it consists of web user interface. It also consists of web related services, viz. Statistical tools, OAI-PMH (Open Archives Initiative Protocol for Metadata Harvesting) data Provider, Simple importer/exporter, media filter and METS (Metadata Encoding and Transmission Standard) Exporter. The web user interface of DSpace is built on java servlet and JSP (Java Server Page) Technology, which allows users all over the world to access DSpace conveniently. OAI-PMH can be used to harvest bitstreams and metadata into DSpace from an external server. The layers only invoke the layer below it, for example the application layer can't invoke the storage layer directly. It helps in preparing digital resources and metadata by creating METS export. Media filters are used for transformation of file/bitstreams into a new content which may be used for full text searching; it also creates thumbnails for an item that has images.

Uses of Krishikosh

Analytics of Krishikosh during October 2017-March 2020 indicates 1,85,06,248 hits on the Krishikosh website (Fig 2). India, United States, Sudan, China, Russia, Ethiopia, Iran, Philippines, Nigeria, Indonesia are the top ten countries that visited the digital platform. The average daily hits on this digital repository during April 2019 to March 2020 were 12186 from all over world.

In demographic terms, the highest number of users of Krishikosh are in the age group of 25–34, it can be concluded that highest number of users are mostly the students and researchers across the world. The users visit Krishikosh through various devices such as mobiles, laptops, desktops etc. Currently, desktop users are more than mobile and laptop users, but with growing popularity of mobile application of Krishikosh, mobile users are also increasing rapidly. Krishikosh repository is being viewed by 175 countries. Google analytics shows that Krishikosh is visited through various browsers which also indicates that this portal is independent of the browser platform. It can be viewed via any web portal system in the world. Usage statistics for community, collection, items are configured with Dspace to provide the usage details of the server to

Fig 2 Analytics of Krishikosh

Table 2 Average daily hits on Krishikosh in pre covid-19 and lockdown periods in India

Era	Average daily hits	Top 10 Countries
Pre covid-19 period (April, 2019 to March 2020)	12186	United States, India, Sudan, China, Russia
During lockdown period due to Covid-19 (April-May 2020)	11554	India, United States, China, Russia, and Philippines

the administrators of Krishikosh (http://wiki.duraspace.org). Statistics on total visits of the communities, collections, items, etc. countries along with cities from where the visits originate are available on this repository.

Usage statistics during Covid-19 specially the lockdown period (since April 2020)

Google analytics of Krishikosh during April 2020 and May 2020 indicates that monthly average hits on this repository are 693295. During this period, India, United States, China, Russia, and Philippines were among the top five countries that visited the digital platform. The average daily hits on Krishikosh in precovid-19 era and lockdown period are presented in Table 2. This indicates that there was no effect of lockdown due to covid-19 on use of Krishikosh repository. Top ten countries visiting this digital platform were India, United States, Sudan, China, Russia, Ethiopia, Iran, Philippines, Nigeria, Indonesia. Monthly average hit of around 693295 indicates a large number of users of the Krishikosh repository. Krishikosh digital repository that provides a digital platform for publishing can help and advice on IPR issues, research programme formulation and efficient management of institutional information assets.

Conclusion

Institutional repository is a digital collection which captures, preserves, archives and provides the access of intellectual output of any institution to the end users. It can be perceived as a set of services which the organization offers to the members of its community for the management and dissemination of digital materials generated by the organization and its community members. The researchers, faculty and authors are interested for a wider outreach of their intellectual research and output in the form of research papers, technical bulletins, books etc., for its wide dissemination and further follow up. On the other hand, the publishers owing to commercial interest put high subscription cost, thus, restricting the circulation thereby creating an impact and access barrier. These structural problems with scholarly publishing can be addressed to a great extent by creating Open Access Digital Repositories. In long-term such digitally accessible organizational knowledge repository results in cost savings also. For the research community it provides an alternative route to free research communication process and helps avoid time lag and unnecessary duplication. However, the concerns with respect to quality control, viz. peer review, IPR and copyright, issues, etc. need to be addressed appropriately. In fact, institutional repository can be seen as complementary to the commercial publishing. The open access (OA) institutional repository can help and advice formulation of further policy issues for acquisition of relevant knowledge resources for the organization.

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