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DIGITAL PRESERVATION OF AGRICULTURAL INFORMATION AT KENYA AGRICULTURAL RESEARCH INSTITUTE

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Abstract

Kenya Agricultural Research Institute (KARI) through its research and related activities generates a lot of digital agricultural information and records. While some of the information and records are born digital, others are the product of digitization. The information and records generated serve to improve and promote transfer of agricultural technologies, provide knowledge, inform the clientele, respond to demands and opportunities leading to the enhancement of agricultural production. The article examines the current practices underpinning digital preservation of agricultural information and records at KARI, the KAINet Pilot Project, and challenges in preservation of digital agricultural information and records at Kenya Agricultural Research Institute. The article further reviews literature pertaining to digital preservation and concludes with some recommendations directed towards improving and promoting preservation of digital agricultural information.

Introduction

Digital preservation still remains an unexplored territory although digital preservation is increasingly being adopted as a key method of securing information for future use. It encompasses materials that are created or born digital, in addition to those converted from conventional to digital formats. In the process of the current research, it became apparent that agricultural information is increasingly being produced and captured in a digital environment raising concerns for its preservation. The vast amounts of agricultural information produced in Kenya are now in large part digital. The wide variety ranges from databases on CD-ROM, networks, researchable DVDs, websites, emails, word-processed documents, digitized records and other agricultural research findings produced and captured in digital formats.

The agricultural sector is entrusted with conducting research and preserving agricultural information in both paper and digital formats. This has raised questions as to which of the digital information materials should be kept for future generations, and how to go about selecting and preserving them. In the digital world today, new types of materials have come into being that are hard to preserve. For instance Websites combine files with various types of content in the form of data, texts, images and sound. Websites are also distributed sites including materials stored on different servers at different locations in the world. Digital preservation therefore remains a challenging professional activity in which techniques, costs, and skills are still being developed.

Much of the agricultural knowledge generated at KARI today and the institution's intellectual assets are now in digital form. Unless significant effort is put urgently into digital preservation to secure long-term access to these digital resources, uncertainties over archiving will continue to

impede the growth and take-up of digital services. On the other hand, digitization practices and digital content will also only secure short-term rather than lasting benefits.

The study adopts the definition of digital records proposed by National Archives of Australia (2004) which refers to digital records as records created, communicated and maintained by means of computer technology. They may be born digital thus created using computer technology or they may have been converted into digital form from their original formats, for instance, scans of paper documents. Word-processed documents, spreadsheets, multimedia presentations, email, databases on CD-ROM, websites and online transactions have been cited as common types of digital records.

The National Archives of Australia (2004) argues that organizations create and store digital records in a variety of ways. However, digital records can be found in many systems throughout an organization including databases and business information systems, shared folders and hard drivers, records in online and web-based environments, and electronic messages from communication systems among others.

Background Information on Kenya Agricultural Research Institute

The Kenya Agricultural Research Institute (KARl) is the premier national agricultural research organization. The Institute has the legal mandate to carry out research in fields specified in the fifth schedule of the Science and Technology Act, Cap 250, which include; agriculture and veterinary sciences. Its mandate also extends to cooperation with other organizations and institutions of higher learning in training programmes and on matters of relevance to research; liaising with other research bodies worldwide carrying out similar functions; dissemination of research findings; cooperation with relevant ministries, the National Council for Science and Technology (NCST), and relevant research committees in matters pertaining to research policies and priorities. Last but not least, its mandate requires it to do all things as appear to be necessary, desirable or expedient to carry out its functions.

As a state corporation, the management of KARl is vested in the Board of Management (BoM) comprising of six appointed members and seven members representing relevant line ministries. The appointed members are eminent scientists and managers and the representatives of the line ministries are senior officers in those ministries. The day-to-day management of the Institute is vested in the Director - KARl as the Chief Executive of the organization. The Director is assisted by Deputy Directors, Assistant Directors, Chiefs of Divisions and Centre Directors in the management of the Institute.

Currently the institute has three deputy directors (Deputy Director Finance and Administration, Deputy Director Outreach and Partnership and Deputy Director Research). There are also 15 Assistant Directors in total. There are 15 chiefs of divisions.

KARI research network

The Institute has 22 main research centres and 14 sub-centres located throughout the country to cater for different agro-ecological zones and socio-economic systems. The centres are allocated mandate areas within their locality for adaptive research and strategic research mandates depending on their comparative advantages to carry out this research.
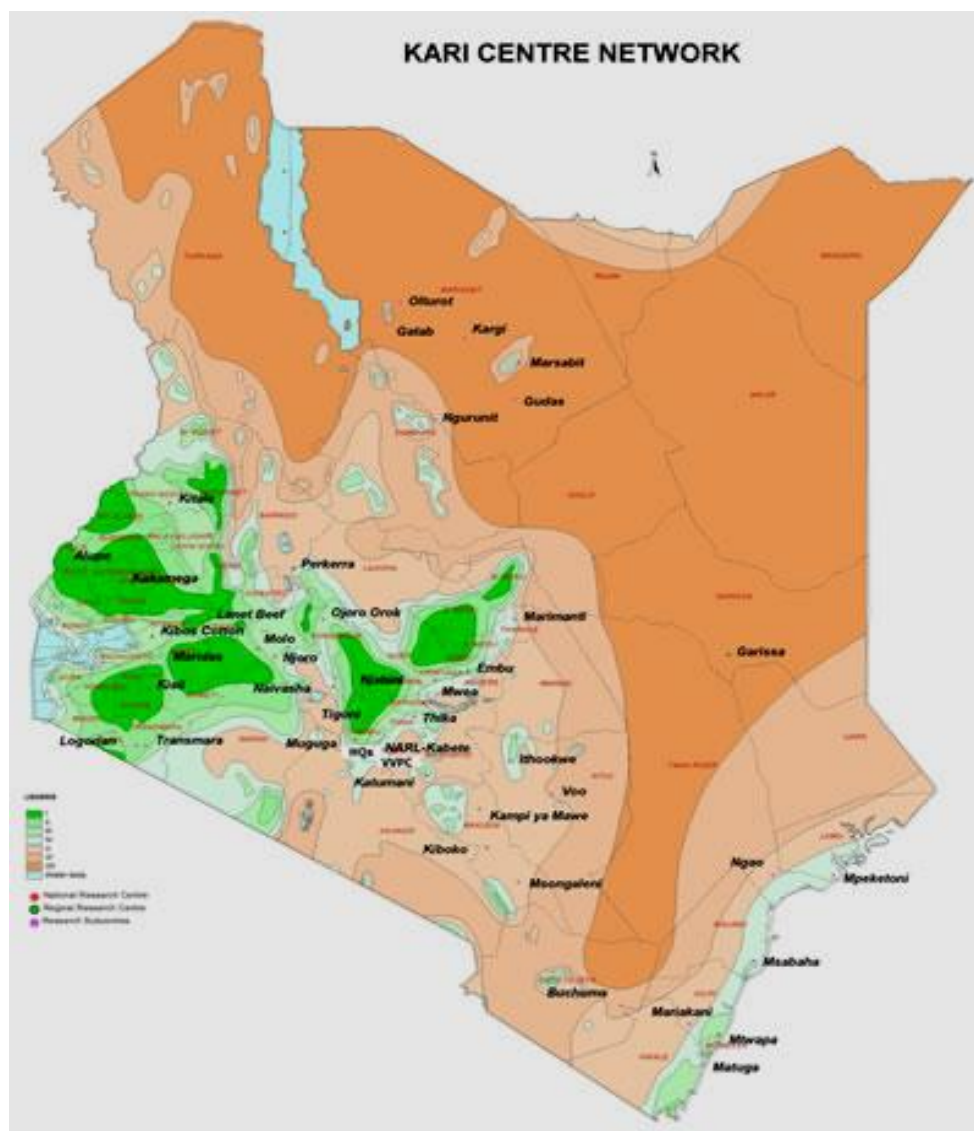
Figure 1: Kari distribution network (KARI 2009)

KARI research activities/projects

KARl has moved from undertaking research activities that are designed from outside by expatriates to participatory, client and demand-driven planning processes by Kenyan scientists. The Institute has also moved from separate, isolated projects into a strategic organization that is responding to key relevant development goals. The institute remains a leading centre for research and development in the country and in sub-Saharan Africa. This evolution has been achieved through the dynamic process of programmed research planning and implementation conceptualized as the National Agricultural Research Program (NARP) which has the support of the Kenya Government and more than thirteen development partners.

KARl has institutionalized research planning and implementation processes to be responsive to the national development agenda, including the salient problem of smallholder farmers and all the stakeholders in agricultural research and development. KARl plans its research programmes in five-year phases with possible extensions of one to two years.

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Main programmes in KARI

Research activities in KARl are organized in the form of programmes and projects. The programmes which are long-term and focus on resolving different problems at different time periods, are the main commodity/factor research and are implemented by multidisciplinary teams. These are:-
1. Food crops research on cereals, root and tuber crops, legumes and pulses.
2. Horticultural and industrial crops research on flowers, vegetables, fruits, fibre crops, herbs and spices.
3. Animal production and range research on dairy, beef, small ruminants, poultry, pigs, pastures and fodder crops, and range.
4. Animal health research on livestock diseases.
5. Socio-economics and biometrics for crop, livestock and natural resources including impact assessment, priority setting, market and policy research.
6. Land and water management including soil fertility, survey and conservation; vegetation survey; agro forestry; irrigation and drainage.
7. Biotechnology research for crops and livestock improvement including development of livestock vaccines and diagnostic kits.

Information Management Communication Technology (IMCT) Division

Appropriate and improved technology and information are key to growth in not only agriculture but every other sector. To achieve and sustain growth in the agricultural sector, there is need for effective dissemination of research technologies and information. KARI proactively seeks to acquire and contribute knowledge and creative solutions that are participatory and client oriented towards enhanced agricultural production and alleviation of poverty in Kenya.

Agricultural information and documentation services division has been established to strengthen information management within KARI. The division is geared towards collection, exchange, preservation and dissemination of research findings in agriculture and related fields within and between all organizations undertaking research and extension services related to agricultural development so as to improve the transfer of technologies to farmers and enhance agricultural production and efficiency. The division constitutes five units linked to each other. They are library and information services section, publication services and product unit, information technology unit and database unit.

Library and Information Services Section

The Library and Information Service (LIS) section was established within the Information and Documentation Service (IDS) department in 1996 during the KARI/DFID NARP II project. The purpose for the establishment of LIS was to support agricultural research for increased productivity through acquisition, processing, preservation and dissemination of information, knowledge and technologies. The section ensures that KARI generated information is appropriately processed and availed to all stakeholders as a critical input to agriculture. Additionally, the section identifies appropriate information resources for acquisition and retrieval to meet various information needs for all users. The library also provides a framework within which KARI generated and acquired information resources are organised, preserved and accessed. The section also facilitates collaboration and networking within KARI and other institutions. This has enhanced information sharing and exchange, especially for those resources that KARI needs for the short term.

Information Technology Unit

The Information Technology (IT) unit ensures delivery of products and services within the full range of electronic technologies theory, design and equipment related to the processing, storage and retrieval, and transfer of information and knowledge. It also deals with monitoring and evaluating the relevance and optimal application of existing technologies and techniques, in support of national and institutional development goals. The unit manages and maintains the IT hardware and software facilities in the institute for improved productivity, commercialisation and competitiveness of the agriculture. It analyses and prioritises the IT requirements of the institute.

Publications Services and Products Unit

The publications services and products unit acquires, processes and packages agricultural information, knowledge and technologies in various forms for diverse users. The Unit also conducts user surveys to continually improve the quality of products and services.

The Unit analyses and prioritises the publication of products and services requirements for different users along the lives of agricultural production to consumption continuum. It works with different clients to ensure prompt provision of publication products and services in response to demands and opportunities.

The Unit is responsible for the production of annual reports, technical notes, KARI achievements, the institutional newsletter (*KARI Highlighter*), brochures, flyers, conference proceedings and the East African Agriculture and Forestry Journal and other ad hoc publications.

Database unit

The database unit focuses on development and maintenance of databases that responds to needs of users of all types such as researchers, extension workers, personnel and planners. The database unit has the responsibility of preserving digital agricultural information. The unit further embraces digital technologies that are enable information to be created, manipulated, disseminated and preserved in a digital environment. The unit is also linked to all KARI centres and international agricultural databases and websites.

Through various activities, programmes, and projects undertaken by KARI enormous information is generated which constitutes born digital and digitized records. This calls for a framework to mange diverse and ever-growing array of digital materials, and publications to be preserved and made available.

Need for digital preservation at KARI

Preservation of digital agricultural information is increasingly becoming important for a wide range of activities within KARl. Therefore, much of the knowledge in the form of research findings in digital form needs to be preserved.

The Institute invests substantial sums of money in acquiring electronic agricultural resources and also investing heavily in digitization, developing e-farmers materials, newsletters, technical notes and other publications. KARl is a major user of and is heavily dependent on digital resources created and generated within and also by other research institutions. Digital information

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preservation has enabled new methods of research, dissemination and collaboration in diverse areas of agriculture by KARI researchers.

KARl website contains a wealth of agricultural research findings including research papers, information bulletins and KARI technical notes with content updated almost on daily basis that needs to be preserved and disseminated. The ease with which digital information can be created, combined with the huge increase in computer generated formats and network connectivity has led to the proliferation of a vast amount of born-digital information/ records especially in agriculture. Digital information gives an insight into how to address issues of long-term preservation and to ensure that generated agricultural information today can survive the changes of technology and can be accessed in the future.

Current situation on preservation of digital agricultural information at KARI

KARI through its research and related activities generates a lot of agricultural materials that are born digital and others that are the result of digitization. The information generated is required to improve and promote transfer of agricultural technologies, provide knowledge, inform the clientele, respond to demands and opportunities leading to the enhancement of agricultural production. There is need therefore for preserve generated digital information to be preserved properly.

However, the materials are affected by technological obsolescence of both the hardware and software. This is made worse by rapid changes taking place in the development of digital technology which do not pay any particular attention to issues of permanence. This has resulted in rendering digital agricultural information stored or captured inaccessible and difficult to retrieve. Preserving agricultural information on KARI website remains a challenge too.

Permanence and durability continues to be of great concern for the Kenya Agricultural Research Database (KARD) and Gender Agricultural Research Database (GARD) among other bibliographic databases in KARI. Digital agricultural information life expectancy cannot be predicted and therefore copying information to new software and hardware has become too expensive even to sustain. Besides, digital agricultural information media are fragile and greatly affected by environmental factors and poor handling.

Through the Kenya AGRIS Pilot Project, KARI has been facilitated to digitize its agricultural information resources. The activity has not been quite fruitful due to lack of digital preservation strategies, well structured policies and standards on digitization. Since these policies are lacking, the exercise has continued to be undertaken as an ad hoc activity.

With the advent of digital media, KARI faces major challenges on how to preserve digital agricultural information. Digital agricultural information preservation is a complex process that highlights many unresolved issues that KARI has to address. Having access to sources previously consulted by the researchers is not a problem, but the critical issue that requires attention is one of preserving digital agricultural information for use by future generations. This issue is what the study seeks to address.

Digital preservation

Preservation is an umbrella term under which most librarians and archivists cluster all the policies and options for action, including conservation treatment of different formats of information materials. Therefore digital material preservation is a way of preserving information

materials including digital surrogates created as a result of converting analog materials to digital form (digitization) and those that are born digital for which there has never been and is never intended to be an analog equivalent.

The terms digital preservation and digital archiving are often thought to be synonymous and therefore used interchangeably. However, there is a fundamental difference between the two. As defined by DPC (2002), digital preservation refers to a series of adopted management activities necessary to ensure continued access to digital materials for as long as needed.

Types of digital records

UNESCO (2003) provides a definition of digital records that suits this study. Digital materials comprise texts, databases, still and moving images, audio, graphics, software and web pages, among a wide and growing range of formats. It has been acknowledged that such resources have lasting value and significance, and therefore constitute heritage that should be protected and preserved for current and future generations. Thus, digital heritage consists of unique resources of human knowledge and expression. It embraces cultural, educational, scientific and administrative resources, as well as technical, legal, medical and other kinds of information created digitally or converted into digital form from existing analog resources.

Legislation and standards governing long term preservation of digital records

The National Archives of Australia (2004) contributes to this study by opining that it is vital for a digital preservation framework to ensure compliance with all relevant legislative requirements. For instance, the National Archives has endorsed the Australia standard for records management, AS ISO 15489 for best practice guidance on recordkeeping for Australia government agencies.

The National Archives of Australia is of the view that policies and procedures for preserving digital records are an important element of a digital recordkeeping framework. Policies define the organization's approach to preservation of digital records and provide the necessary authority for the implementation of the framework. Procedures on the other hand outline how the policies will be implemented and provide clear instructions for their practical application.

Agricultural institutions can facilitate preservation efforts by using official or *de facto* standards. Emerging standards like XML and TIFF are promising because they are open standards not dependent on a specific platform. Others, like PDF, are so widely used that this offers some hope that they will be supported over a long time. The use of proprietary software complicates matters not only because they are protected, but also because they are often inadequately documented. Even when programmes are taken off the market, source codes are not usually brought into the public domain. Adaptations made during the life of the software are not always documented, so that one cannot predict the outcome of a conversion in every detail.

Therefore, the legal framework defines responsibilities and procedures that need to be adapted or extended to be able to deal with the digital environment. Adequate legislation in this area is a necessary instrument for institutions to define tasks and select materials for preservation.

Challenges encountered in preserving digital records

The introduction of digital technologies into information creation, storage and dissemination processes challenges the capacity of information centres and their responsibilities for

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preservation. Hedstrom and Montgomery (1998) contributions regarding challenges encountered during preservation of digital records are in line with this study.

Hedstrom and Montgomery (1988) discusses that digital preservation problem has been the focus of numerous reports designed to raise awareness of digital preservation issues and to propose general strategies for addressing them. The general outline of digital preservation challenges is well established.

Digital materials are especially vulnerable to loss and destruction because they are stored on fragile magnetic and optical media that deteriorate rapidly and that can fail suddenly from exposure to heat, humidity, airborne contaminants, or faulty reading and writing devices.

Even if the media are preserved intact, digital materials become unreadable if the playback devices necessary to retrieve information from the media become obsolete or if the software that translates digital information from machine- to human-readable form is no longer available.

Information centres that have traditionally assumed responsibility for preserving information face technical, legal, and organizational challenges in responding to the new demands of digital preservation.

Institutions also face legal obstacles in fulfilling their mandates to preserve valuable information when copyright or licensing agreements prohibit duplication or local storage of digital information.

Preservation of digital materials also engenders further problems (Caplan 2004; Garret & Lyons 1993; Lin, Ramiah & Wal 2003):
- Continuous migration
- Lack of legislation, policy and strategy
- Lack of awareness
- Lack of collaboration and partnership
- Lack of disaster planning and recovery

Tembo, Zulu and Kalusopa (2006) identified the following problems as commonly affecting most developing countries:
- Lack of national policy frameworks on digital material preservation
- absence of relevant legislation on digital material preservation
- Lack of clearly defined agencies with statutory responsibility for digital material preservation
- Absence of coordinated national initiatives and programmes on digitization
- Gaps in human resources in terms of knowledge, skills and competencies to drive digital material preservation in heritage institutions
- Lack of standards in digital material preservation in terms of hardware, software, storage media and metadata
- Haphazard approach to digital material preservation in most heritage institutions
- Absence of local institutions that could serve as models for best practices or centres of excellence in digital material preservation
- Lack of prioritisation of disaster planning and recovery in most heritage organizations

KARI Pilot Digital Preservation Project (KAInet)

KARI has a pilot digitization and digital preservation project by the name Kenya Agriculture Information Network (KAINet). Kenya Agricultural Information Network (KAINet) is a national network that provides a platform for managing and sharing information among all stakeholders in the agricultural sector. KAINet started in April 2006 as Kenya AGRIS Pilot Project. It was an initiative aimed towards contributing to the transformation of Kenya's agricultural sector, to move it towards modernization, productivity, profitability and competitiveness nationally, regionally and internationally. In the last few years, the Network has established efficient and effective partnerships with other stakeholders in the generation, collection, processing, archiving and dissemination of agricultural information.

The network is funded by the Department for International Development (DFID) through Food and Agriculture Organisation of the United Nations (FAO) and has been implemented through collaboration between the Association for Strengthening Research in Agriculture in East and Central Africa (ASARECA), FAO and CAB International and Kenya Agricultural Research Institute (KARI) where it is currently housed.

KAINet evolved from an initial three-year Kenya Pilot AGRIS Project whose aim was to establish systems to promote information exchange and access among researchers and other agricultural stakeholders. The project established a national electronic repository of agricultural information based on the International Information System for the Agricultural Sciences and Technology (AGRIS). At the onset, KAINet set out to address constraints to the management and sharing of information among agricultural-sector stakeholders, starting with the institutions in the pilot project. These included, among others, inadequate capacity in terms of equipment and skills in information management, lack of institutional policies and strategies in information and communication management (ICM), and lack of a framework for fostering collaboration in ICM among institutions.

Recommendations

This article makes the following recommendations which KARI is free to adopt and implement if it finds them relevant to improving the situation at hand. The recommendations are as follows

Develop means to coordinate digital preservation activities at the Institute

Digital preservation activities are dispersed in KARI centres and among different program and project heads. Digital preservation therefore lacks a co-ordinated approach. Some centres lack expertise and responsibility for digital records preservation activities. The institute needs to come up with a strategy to enhance co-ordination of preservation activities.

Implementation of digital preservation strategies

Digital preservation strategies are needed to ensure digital records remain authentic and usable for agricultural research and development. They must also ensure preservation of digital records in the simplest way possible. One such strategy which the institute should consider for adoption is a migration strategy.

Migration strategy enables given formats such as WordPerfect's, Microsoft Excel's, and Microsoft word among others to be migrated to other formats and stored. Migration helps to preserve the integrity and usability of digital records and to retain the ability for information

professionals, programme and project heads to retrieve, display, and use them in the face of constantly changing technology. Migration provides periodic transformation of files to new digital formats to ensure continuing compatibility between file formats and applications. They also design utilities to migrate data types. On the other hand migration sets up a chain that must be extended over time, because every format will eventually become obsolete. Therefore, the institute ought to develop and implement a migration strategy regulated through an institutional migration policy.

Emulation is also another recommended method for digital records preservation. Emulation allows an institution to keep records in their original digital formats. It also enables obsolete systems to be run on future unknown systems, making it possible to retrieve, display and use digital documents with their original software. Emulation strives to maintain the ability to execute the software needed to process data stored in its original form. However, inspite of the possibilities and opportunities provided through emulation, thus strategy is quite costly, making it unaffordable by many institutions.

Need for additional resources

There is need for additional staff, funds and modernization of infrastructure to support digital records preservation at KARI. The volume of digital records is growing rapidly in KARI centres, thus posing a handling problem. To address these challenges, KARI needs to employ more staff with technical expertise. This calls for additional financial allocation to support staff capacity building, training and modernization of infrastructure.

Establishment of standards to govern digital records preservation

Standards and protocols are needed to govern storage; data formats, access, retrieval and distribution. This calls for the adoption of records management standards and functionalities which should be embedded in the infrastructure to make digital records accessible, manageable and useable. KARI needs to seek expert advice on how to achieve this.

Development and implementation of digital records preservation policy

The institute should come up with a preservation policy for digital records. This will ensure adequate care and usability of digital agricultural information generated and maintained by KARI.

Methods for error detection and correction during creation and reformatting processes

Errors normally occur during scanning or while using given software to either create, scan or save a digital record. This often leads to loss or alteration of digital information. The institute needs to seek expert opinion on how to minimize such errors during creation, migration or other means of reformatting digital records to avoid loss of information.

Legal issues

Legal issues such as Intellectual Property Right (IPR) in digital records preservation are arguably more complex and significant than for traditional media and if not addressed can impede or even prevent preservation activities. Consideration should be given not only to content issues but also to any software and hardware related issues. Software for emulation and migrating content to new hardware and software all involve activities which can infringe upon intellectual property

rights. Statutory exemptions should be sought and specific permission obtained from rights holders.

Develop means to coordinate digital preservation activities within the institution

Information professionals recommend that, since digital records preservation activities are dispersed at various KARI centers. This creates challenges for the institute with regard to the coordination of digital preservation activities. Therefore, the institute needs to establish proper mechanisms to enhance co-ordination of digital preservation activities across all its centres.

Development of digital records preservation programs

Lack of expertise in digital records preservation appears to be a significant obstacle to developing digital preservation programs. There is therefore, need to employ staff with digital preservation expertise in centres with limited skilled staff.

Security of digital records

Information professionals recommend that technology is changing every day. Digital records are emerging daily and also transferred and copied from one media to another on routine basis. The network is being upgraded often. There is therefore need to improve the security situation of both digital records and the network.

Conclusion

Success in preservation of digital agricultural information can only be achieved depending on availability of adequate infrastructure, appropriate technology and qualified personnel. It is encouraging that KARI is beginning to pay more attention to digital records preservation. Digital preservation is new to the institute and remains a major technological challenge. However, the institute is beginning to confront these challenges head-on. To succeed, the institute needs to lay a firm foundation by investing more resources in modern technologies, human capital, training, storage, infrastructure, as well as paying attention to policy related issues.

As the institute sets out to seek better methods and more affordable ways to tackle the problems posed by technology obsolescence, insufficient resources and inadequate planning for digital records preservation have emerged as major obstacles to digital records preservation. Presently, only a few KARI centers have experts in digital records preservation. Another challenge is the absence of a clear consensus regarding effective strategies and methods for digital records preservation. The institute needs to develop and promote internationally and professionally recognized best practice standards for digital records preservation. Such standards are already available internationally and there is no need to re-invent the wheel. What KARI needs to do is to customize the available standards to suit its needs.

Further, it needs to invest more funds in new research initiatives that will not only advance digital records preservation of agricultural information but will also lead to the discovery of new knowledge on the subject. Digital records preservation will continue to remain a challenge due to rapid technology changes. Therefore, KARI needs to give more attention to the issues underlying digital records preservation.

The digitization pilot project by KAINet has continued to offer great advantages for access to agricultural information resources, allowing users to find, retrieve, study and manipulate material.

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However, reliance on digitization as a preservation strategy could place much material at risk. Rapid obsolescence of digital technologies and media instability could render the digitized objects vulnerable to loss. While digitization has sometimes been proposed as having a preservation advantage in terms of deflecting the use of original materials, it has also been asserted that enhanced awareness of a resource will result in greater demand for the originals. The KAINet digitization project has certainly had an impact on agricultural institutions in Kenya by enhancing the sharing of agricultural information regionally and internationally.

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