



CASE STUDY

The Ghana Agricultural Information Network System (GAINS)

TABLE OF CONTENTS

Abbreviations and Acronyms	3
Executive summary	4
1. Introduction	6
1.1 About GAINS	6
1.2 About CIARD and the Framework	8
1.3 The Context for Openness of Agricultural Research	8
2. The state of openness of agricultural research	11
2.1 Institutional readiness	11
2.2 Availability, accessibility and applicability	14
3. Key issues and conclusions	21
3.1 Developing Institutional Readiness	21
3.2 Availability, accessibility and applicability	22
3.3 Key lessons	24
List of references	26
Appendix	28

ABBREVIATIONS AND ACRONYMS

AGRIS	Information Systems for Agricultural Sciences and Technology
AIC	Agricultural Information Centre
ARI	Animal Research Institute
CAGRIC	College of Agriculture Education, University of Education, Winneba
CGIAR	Consultative Group on International Agricultural Research
CIARD	Coherence in Information for Agricultural Research for Development
CRIG	Cocoa Research Institute of Ghana
CSIR	Council for Scientific and Industrial Development
CID	Communications and Information Directorate/Division
CTA	Technical Centre for Agricultural and Rural Development
DFID	Department for International Development
FBO	Farmer Based Organization
FAO	Food and Agriculture Organization of the United Nations
FARA	Forum for Agricultural Research in Africa
FRI	Food Research Institute
FORIG	Forestry Research Institute of Ghana
GAEC	Ghana Atomic Energy Commission
GAINS	Ghana Agricultural Information Network System
GAPP	Ghana AGRIS Pilot Project
GFAR	Global Forum on Agricultural Research
GIFEC	Ghana Investment Fund for Electronic Communications
ICM	Information and Communication Management
ICTs	Information and Communications Technologies
ICT4AD	Information and Communication Technology for Accelerated Development
IICD	International Institute for Communication and Development
IMC	Institution Management Committee
INSTI	Institute for Scientific and Technological Information
ISNAR	International Service for National Agricultural Research
KNUST	Kwame Nkrumah University of Science and Technology
LAN	Local Area Network
MEST	Ministry of Environment, Science and Technology
MoFA	Ministry of Food and Agriculture
NARP	National Agricultural Research Project
NARS	National Agricultural Research System
NGO	Non Governmental Organization
OA	Open Access
PI	Pilot Institution
PMC	Project Management Committee
QAS	Question and Answer Service
SRI	Soil Research Institute
STI	Science, Technology and Innovation

EXECUTIVE SUMMARY

New production technologies have become the most important factor for the success of agricultural development. But in many developing countries such as Ghana their impact on agricultural development is limited as information on most of them is not easily accessible or available due to inadequate information systems.

However recent advances in ICTs, such as the increasing availability of personal computers, digital databases and the Internet, offer numerous opportunities for the removal of these restrictions. In Ghana, from 2007-2010, CSIR-INSTI with funding from the FAO/DFID project (DGP/INT/997/UK) - Information Systems in Agricultural Science and Technology - implemented the Ghana AGRIS Pilot Project (GAPP). The main goal of GAPP was to develop open access to public domain scientific and technical information on agriculture through interlinked full-text repositories at institutional level as part of a Ghanaian national agricultural science and technology information system.

The purpose of this report is to document local evidence and lessons learned on the ways in which public research outputs are made truly accessible to audiences in Ghana. This was done through exploration of reports, websites and semi-structured interviews, using the CIARD Checklist and Framework for Questioning, with key individuals involved in research information management, communication, strategy and/or policy in the seven institutes where the GAPP was implemented.

Results showed that based on the first group of the CIARD Checklist of actions - *Developing Institutional Readiness* - GAINS is ready for opening access to agricultural research for innovation. Basic ICT equipment has been supplied and information professionals and ICT specialists have acquired skills in the creation and management of metadata and associated full-text documents. The degree of this institutional readiness however varied among the pilot institutions with CSIR-INSTI being the highest performer and MoFA being the lowest performer.

But this readiness is yet to have the desired impact on the implementation of the second group of Checklist actions on *'Increasing the Availability, Accessibility and Applicability of Research Outputs'*. This is due to unreliable Internet connectivity, fluctuating power supply and inadequate information management skills of information specialists and scientists who are the main users of the system. The poor information management skills and low commitment from some Directors seem to be the major factors responsible for the low (4.5%) increase in the number of records digitized after GAPP ended in 2010.

Nonetheless, availability of information on research outputs has improved as a result of the creation of a repository in each pilot institution albeit at varying degrees of scale, with CSIR-INSTI once again being the highest performer and MoFA the lowest. These repositories are yet to be interlinked due to inadequate Internet connections (GAINS, 2010) and are therefore not even accessible on the websites of the four PIs (i.e. CSIR-INSTI, CSIR-FORIG, CSIR-FRI and CRIG) which have websites. The level of visibility and accessibility of local research outputs is therefore low in the country.

The Director of CSIR-INSTI, the institute that hosts GAINS has, however, indicated that this situation will soon improve as the CSIR is prepared to pay for Internet access on Glo-1 when Glo, the latest mobile telephone service provider in the country to be registered, starts to operate. In April 2011, Glo launched the Glo 1 submarine fibre-optic cable which will enable the country soon to start experiencing high speed, reliable and cheaper Internet and telecommunications services.

On the applicability of research outputs, efforts are being made to improve this aspect through formal and informal networks with FBOs, public/private sector organizations, radio and TV broadcasts and publications in some local languages.

The poor performance of MoFA as compared to the other institutions in the implementation of the GAPP may be attributed to the differences in the political and cultural environments in which the PIs operate. MoFA has several directorates, projects and units while the other PIs are single organizations. Therefore MoFA's participation in the GAPP and implementation of the project's activities were subjected to more pressures and challenges than in the other PIs. This resulted in the poor performance of the GAPP in MoFA.

Institutional politics and cultural factors also contributed to this poor performance in MoFA as compared to the other PIs. While research institutes are more likely to consider opening access to their information resources, this is less likely to happen with government institutions, and this was the case with MoFA.

For the GAPP the predefined period of three years was enough to achieve specified results of a tangible and short term nature, such as policies and the creation of repositories, but not enough to produce the change in behaviour of stakeholders which is needed to achieve the long term goal of open access to information on agricultural research outputs in Ghana.

The three year period was also enough for the GAPP as a pilot project to prove that it is feasible to implement a complex modern information system such as AGRIS in Ghana. But more significantly as a pilot project it provided key lessons on how the likelihood of success can be increased when the AGRIS is being implemented on a large scale. These lessons are: improvement in skills of key staff, more commitment and support from Directors, attention to political and cultural factors in the project's environment, and improvement in Internet connectivity.

1. INTRODUCTION

Records from various parts of the world during the past four decades have shown that new production technology – the fruit of the labours of any scientist – has become the most important factor for the success of agricultural development.

However, in most developing countries such as Ghana the impact that new technologies can have on agricultural development is limited because information on most of them are not easily or widely accessible. Thus scientists in developing countries are not often able to achieve one of the basic objectives of science. According to Ekboir et al (2009) scientists seek to create new knowledge which must be freely diffused as quickly as possible by specialized means. That is to say that the scientists' objective is the creation of information, a public good.

Diffusing information in the past as quickly as possible was not easy, but recent advances in ICTs, such as the Internet and digital databases, give many opportunities for the public good nature of information to be satisfied by specialized means, including implementing open access (OA). OA makes scholarly or scientific information available to the public free of charge through the Internet. The essential principle of the OA movement is that knowledge derived from public funding should be freely accessible online, for public use.

OA facilitates the availability and distribution of scholarly literature freely, as a means and effort to solve the problem of inaccessibility, primarily due to financial constraints, particularly in developing countries. In Ghana, from 2007 to 2010, CSIR-INSTI implemented GAPP with sponsorship from FAO to promote opening access to research outputs in Ghana. However, before the implementation of GAPP the country had been using other mechanisms to diffuse research outputs such as the Question and Answer Service (QAS) by GAINS.

The purpose of this report is to document local evidence and lessons learned on the ways in which public research outputs are made truly accessible to audiences in Ghana. This was done through exploration of reports, websites and semi-structured interviews with some key individuals in the seven institutes where GAPP was implemented. These seven institutes are CSIR-INSTI, CSIR-FRI, CSIR-ARI, CSIR-FORIG, CRIG, CAGRIC and MoFA.

1.1 About GAINS

In Ghana research is conducted by institutions that belong to more than one organization. These organizations are CSIR, the universities, GAEC, COCOBOD and MoFA. ISNAR, quoted by the NARS Newsletter (2006), observes that when agricultural research is conducted in several organizations in one country, all sharing related goals even if the organizations are not administratively linked, it is useful to refer to them as the NARS.

From 1992-1999 the Ghana NARS was strengthened during the implementation of NARP when for the first time almost all the entities involved in the conduct of agricultural research in the country were brought together under one umbrella. NARP also brought together all the libraries of agricultural research institutes through the establishment of GAINS within one of its components known as 'Improvement of Libraries and Information Systems'. GAINS is basically an information exchange network of agricultural libraries of various member institutions in Ghana.

Thus the institutions which implemented GAPP and from which data was collected all belong to different organizations but are part of the Ghana NARS and also members of GAINS (see Appendix for a list of NARS institutions). GAINS is hosted by one of the institutes of the CSIR i.e. the Institute for Scientific and Technological Information (INSTI). GAINS's vision, mission and structure are:

GAINS Vision - To be a network of excellence for agricultural information and knowledge for improved agricultural production and productivity for Ghana's socio-economic development.

GAINS Mission - To provide effective coordination among libraries and information centres of the network for improved information and communications management.

GAINS Structure - GAINS has a Coordinating Centre at CSIR-INSTI in Accra. The Centre coordinates the activities of 20 participating libraries and acts as a national focal point on information requests in Ghana. GAINS is managed by an 11-member Board with the Deputy Director-General (Research and Development) of CSIR as the Chairperson and with representatives from various stakeholders.

The services provided by the GAINS Coordinating Centre are:

- Collection development activities
- Literature search services
- Provision of inter-library lending and document delivery
- Current awareness services
- Selective dissemination of information
- Advisory services
- Organizes training workshops in agriculture information management
- Creation and updating of databases
- Promoting the use of ICTs in information management

The main research outputs from GAINS and its participating institutions are: Articles in scholarly journals or conference proceedings, Technical publications; Theses; Research reports commissioned; Technologies (e.g. improved crop varieties, improved food products); Books; Papers or articles (informal, non-peer reviewed); Databases and datasets; Radio and television reports; Annual reports;

1.2 About CIARD and the Framework

CIARD was launched in 2008 by global partner institutions, among them FAO, GFAR and CGIAR, after a series of international workshops and consultations that lasted for over a decade. CIARD is a global initiative working to make agricultural information publicly available and more accessible. Its aim is to enable organizations that create or possess public agricultural knowledge to disseminate it more effectively. The CIARD partners coordinate their efforts, promote common formats for information sharing and exchange, and adopt open information systems approaches.

CIARD believes that creating a global network of truly accessible research outputs greatly increases the chance that they can be put to use locally, nationally and globally. There are technologies for achieving this, but CIARD is not just about technology. It actually addresses the way that technologies are used. This includes building and improving information systems, and empowering the institutions and people using them with a framework and tools that open access to their content resources.

It encourages such institutions to interconnect and work together in ways that complement each other so that they can more effectively tackle the fundamental issues involved in making local, national, regional and global information systems available and accessible.

CIARD has three policy areas. These are: make content accessible; develop capacities; and advocate better investments.

The CIARD partners have developed a ‘Manifesto’ and ‘Values’ and a ‘Checklist of Actions’ that build on existing initiatives. Subscribing to international standards, adopting policies on intellectual property, and raising awareness on accessibility options, are examples of actions that CIARD encourages.

The benefits that agricultural research institutions derive from CIARD are:

- Increased visibility and use of their research outputs
- Increased exchange of information content with other systems
- Increased awareness of other research outputs
- Access to expertise on information and solutions used by others.

1.3 The Context for openness of agricultural research for innovation in GAINS

Current thoughts on development place much emphasis on innovation. The reason is simply that innovation underpins improvements in all socio-economic activities (Essegbey et al. 2008).

An innovation is defined as the successful introduction of a novelty into social or economic process. According to the OECD (1999) one element of this definition is the creative use of knowledge in response to social or market needs or opportunities. Thus

Fagerberg (2005) notes that it is not enough to invent something: it only becomes an innovation when it is used productively. This means that researchers do not create innovations; they create inventions (Ekboir et al. 2009). However, these inventions can only be used productively to become innovations when they are disseminated after production.

In Ghana, various initiatives are being implemented at national/institutional levels to create enabling environments. These are improving the context of agricultural research for innovation. Policies have been formulated and infrastructures are being improved at both the national and institutional levels to enhance OA. On policies at the national level, in 2001 the Government of Ghana launched the ICT4AD policy which provides the framework for deploying and exploiting ICTs in the country; and in 2004 it established the GIFEC at the Ministry of Communications to enhance its implementation.

This policy was followed with another one in March 2010 known as the National Science, Technology and Innovation Policy. The concept of innovation is strongly welded into it to apply science and technology to achieve social and economic objectives.

At the institutional level, the most remarkable development in policy formulation that has improved the context for openness of agricultural research was the implementation of GAPP from 2007-2010. One of the major outputs of GAPP is the formulation of ICM policies and strategies for six of the seven PIs.

On infrastructures, GAPP implemented a pilot network to facilitate open access to public domain research information through digital repositories that make agricultural research outputs accessible to all. This was done by drawing on the resources, tools, and technologies available from FAO through the AGRIS network and from other sources over three years.

At the national level, the most significant development in infrastructure was the launch of the Glo 1 submarine fibre-optic cable in April 2011. The fibre-optic cable will deliver high speed, reliable and cheaper Internet and telecommunications services in Ghana. The 9,800 kilometre cable, which will link Ghana to the rest of Africa, Europe and America, has been laid under the sea from Lagos to Accra.

Ghana thus became the third country in West Africa, after Nigeria and Benin, to have the under-sea fibre-optic cable. There is also widespread availability of mobile broadband Internet services in the country provided by five mobile telephone service providers. Reports available from the press show that mobile phone penetration in the country at the end of August 2011 was 80.5% (Daily Graphic, 20 October 2011).

Mobile phones have brought about a rediscovery of radios in the context of new ICTs in Ghana as is the case in other parts of the world. Mobile phones have made radio into a more two-way medium and are helping to bridge the digital divide by providing a powerful tool for information dissemination and access, especially for hard-to-reach rural audiences (Myers 2010). Baah (2006) also observes that the limitation that radio was a one-way communication channel has been overcome in Ghana through massive

improvement in telecommunication which enables the audience to respond via telephone to radio broadcasts. This development has resulted in an explosion in the number of radio stations in the country and has raised radio's role as the dominant mass-medium in Africa with the widest geographical reach and the highest audiences compared with television (TV), newspapers and other information and communication technologies (ICTs). There are now more than 130 radio stations in the country.

Radio programmes have been identified as a major medium through which the information needs of farmers can be met (GAINSNEWS 2007) due to the increasing number of FM stations. According to Myers (2010) radio stations can be divided roughly into four categories: state-controlled public radio; privately owned commercial radio; community-controlled radio; and international radio. In Ghana all four categories can be found. However, GAINS works with community-based FM stations as they broadcast programmes in local languages which are better understood by farmers and fishermen. It is currently working with Radio Peace, Royals FM, Lorkorlonyo FM and Rite FM, which are all community radio stations

Other institutional initiatives are international workshops on OA that have been organized by universities. In 2009 and 2011 the KNUST in Kumasi, in collaboration with BioMed Central, a UK-based open access publisher in partnership with Computer Aid Foundation, organized the International Open Access Week.

Through the efforts of KNUST support was obtained from the Consortium of Academic and Research Libraries in Ghana (CARLIGH) for the setting up of repositories and provision of training at four institutions. These institutions were the University of Cape Coast, University of Education, Winneba, Methodist University College of Ghana and the Ghana Institute of Management and Public Administration (Corletey, 2011).

The University of Ghana, Legon, in collaboration with The Royal Swedish Institute of Technology (KTH) and Ghana Academic and Research Network (GARNET), also hosted the 7th International Conference on Open Access in Accra in November 2009. These workshops have made significant contributions towards improving awareness of the benefits of OA in the country.

2. THE “STATE OF OPENNESS OF AGRICULTURAL RESEARCH FOR INNOVATION” IN GAINS

This was determined mainly through conducting semi-structured interviews with members of GAPP IMC and some members of an institute’s management team, using the CIARD Checklist and Framework for Questioning (see Appendix for a list of those interviewed). Reports written during GAPP implementation were also consulted.

The Checklist is at the core of the CIARD initiative. It is a set of actions through which organizations, research systems and individuals can progress towards achieving openness of research information, as represented by the CIARD Manifesto and Values.

This set of actions is aimed at developing necessary institutional readiness, as well as approaches to managing digital content, licensing and 'opening up' that content, and then communicating and disseminating it. The actions have therefore been divided into two groups in this Framework for Questioning.

The first group corresponds to *Developing Institutional Readiness* in the Checklist. The second group corresponds to *Increasing the Availability, Accessibility and Applicability (3As) of Research Outputs*.

2.1 Developing Institutional Readiness for openness of agricultural research outputs for innovation

Under Institutional Readiness, the CIARD Checklist addresses the following five checklist items:

1. Introduce and gain support for the openness of agricultural research outputs for innovation in the organization.
2. Raise awareness of CIARD in the institution
3. Adopt a formal institutional information/communication strategy.
4. Develop the capacities of your institution to achieve the Checklist.
5. Develop national/local partner networks to share resources and skill.

2.1.1 Support for Openness of Agricultural Research Outputs

The CIARD Manifesto and Values were introduced to the Directors of the CSIR research institutes in February 2009. In addition seminars held in three of the seven PIs also introduced the manifesto and values to research scientists and management of the institutes. These activities were part of an organized process developed by GAINS for gaining support for its digitization initiatives through organization of seminars and presentations at meetings. However, while Directors and the institutions appreciated CIARD, formal support for the CIARD Manifesto and Values are yet to be declared by the institutes.

In 2006 CSIR-INSTI – the institute that hosts GAINS - in partnership with CTA, FAO and IICD, organized a meeting titled '*Enhancing the Impact of Agricultural Information Systems and Services in Ghana: Building the Next Generation of GAINS*'. The goal of the workshop was to identify mechanisms to best address the information needs of a wider range of agricultural stakeholders in Ghana, including research, extension, academics, broadcasters, NGOs, AICs, and farmers. This meeting contributed significantly towards the establishment of GAPP and in line with the goal of the workshop MoFA was included in its implementation.

During the implementation of GAPP, GAINS organized two seminars in 2008 and 2009 titled '*Repositioning of GAINS*' to gain further support for digitization initiatives being implemented. In February 2010 it followed these seminars with a conference, under the CIARD initiative, titled '*Knowledge Sharing in the Agriculture and Rural Development Sector in Ghana*' with support from FAO and CSIR.

The launching of the GAINS ICM strategy document by the Director-General during the conference showed the commitment of the CSIR management to the digitization activities and its preparedness to support them. The CSIR management confirmed its commitment when it adopted a paper presented by the Director of CSIR-INSTI on its digitization activities during a meeting of CSIR Directors later in 2010 for implementation in the rest of the institutes controlled by CSIR.

There has also been improvement in funding from some donors, especially the Technical Centre for Agricultural and Rural Cooperation (CTA) of the Netherlands. On the local scene GAINS strengthened collaboration with FAO, FARA and the College of Agriculture and Consumer Sciences of the University of Ghana.

But some of the PIs, especially those outside the CSIR, have through their own initiatives established collaboration and gained support from some local/foreign partners. CAGRIC for example has established linkages with the Carnegie Corporation of New York, Cornell University and the Royal Tropical Institute of the Netherlands (KIT). These have contributed greatly towards strengthening digitization capacities in CAGRIC. In the case of CRIG, such partnerships are limited to local organizations such as WIENCO – a dealer of agricultural inputs – but dissemination activities are limited to the use of radio and TV.

2.1.2 Awareness of CIARD in GAINS

In general, there is a good level of awareness of the CIARD initiative within GAINS. This is due to several awareness-raising initiatives that have been implemented. They include: the introduction of the CIARD Manifesto and Values to the Directors of the CSIR research institutes in February 2009; the two-day conference on *Knowledge Sharing in the Agriculture and Rural Development Sector in Ghana*, organized within the framework of the CIARD initiative, in 2010; and seminars held in three of the seven PIs by GAINS and FAO.

2.1.3 Adoption of a formal institutional information/communication strategy

Out of the seven PIs that implemented GAPP, six of them have formulated and adopted formal ICM policies and strategies. The key elements are: (i) Collection of agricultural information; (ii) Processing of agricultural information; (iii) Dissemination of agricultural information; (iv) Capacity building in agricultural information management; and (v) Coordination of agricultural information management;

2.1.4 Development of capacities of GAINS to achieve the Checklist

Each PI that took part in GAPP was given basic ICT equipment for the development of and access to digital institutional repositories. The equipment included personal computers, scanners, UPS, printers and external hard drives. In addition, a server was supplied to the GAINS Coordinating Centre at CSIR-INSTI.

Human capacity was also enhanced through various training workshops. These workshops were on: (i) marketing of agricultural information services; (ii) management of AGRIS tools and methodologies; (iii) website development and management; (iv) copyright and institutional repositories; and (v) open access to public domain agricultural scientific and technical information.

The development of these capacities has resulted in the creation of repositories in seven of the 20 participating member institutions of GAINS, albeit at varying degrees of scale. This is one of the most recent important accomplishments in the area of digitization and openness of agricultural research outputs in GAINS. The creation of these repositories shows a strong readiness of GAINS for openness of agricultural research outputs and the strengthening of the foundation for improved availability, accessibility and applicability of research outputs in Ghana.

Apart from the need for management's support for the creation of repositories, other issues relevant to the digitization and communication of research outputs were found to be the technical challenge of skills, and restrictions on providing OA access to articles published by scientists in some journals because of copyright issues. It appears that the technical challenge of skills may be due to poor understanding of the concepts and principles of database management and information management in general.

Other concerns were: (i) the need to improve upon existing digitization capacities in the institutes; and (ii) the unwillingness of some researchers to provide information on their research outputs for digitization. It was noted that to improve existing digitization capacities, each PI should organize workshops on digitization for the beneficiaries of the GAINS workshops, and that they should also train others. Furthermore, to ensure that such workshops would be organized, memoranda of understanding (MoU) should be signed between CSIR-INSTI and the PIs.

The second concern is not limited to Ghana alone. Chisenga et al. (2011) have noted that the most serious barrier to further development of open archives in Kenya and

Ghana is the reluctance of scientists to archive the outputs of their research in institutional repositories, and this barrier is known to be a worldwide issue that by no means is confined to developing countries.

2.1.5 Development of national/local partner networks to share resources and skills

PIs of GAPP are members of GAINS. These PIs are sharing resources and skills through a pilot network that facilitates open access to public domain research information through digital repositories that make agricultural research outputs accessible to all.

In addition, through its membership of the CSIR-Directors Management Committee, CSIR-INSTI, which hosts GAINS, has been sharing the resources and skills for openness of agricultural research outputs with the rest of the CSIR institutes. For instance, it assisted in the preparation and publication of ICM Policies and Strategies for agriculture-related institutes of CSIR. As a result CSIR-SRI, which did not participate in GAPP, sought and obtained funding from JICA and started digitizing its research outputs.

2.2. Availability, accessibility and applicability of research outputs

2.2.1 Ensuring that research outputs are available digitally

Six of the seven PIs have digitized most of their research outputs (see Table 1 below). Document workflows to facilitate the capture of research documents in digital formats at source have also been implemented. However, these outputs do not include teaching resources, software and patents.

Among the seven PIs, CRIG was found to be the only one that is capturing older documents, which are in pre-digital format, in its digitization programme. Through collaboration with Cadbury it has contributed metadata to Cocoa Research Ghana (<http://www.cocoaresearchghana.com/>) an online database providing access to metadata of cocoa research articles originating in Ghana since 1938.

In addition to CRIG, CSIR-FORIG is the other PI that has special needs to improve access to what happened in the past to avoid repetitions of activities that took so many years to complete and at very high cost to them. The research activities of these two institutes are carried out with trees which take many years to mature unlike the short duration maturity periods of commodities of most research institutes

2.2.2 Development of institutional or thematic repositories of outputs as open archives, using agricultural information standards

The development of repositories is in line with the main objective of GAPP which is to establish electronic repositories of public domain agricultural and technological information at the PIs. Much seriousness was, therefore, attached to this activity. A major bottleneck to this activity was the fact that generally the electronic repository concept was initially a novelty at the PIs and the key staff lacked the mindset for such an activity. The institutions also lacked the relevant material capacity.

As capacity was built through workshops and provision of ICT equipment, some documents were processed as full-text documents and many more as metadata using AGRIS tools and methodologies. All the seven institutions in GAPP have therefore developed repositories based on AGRIS tools and methods (WebAGRIS and AGROVOC). Contents of the various institutional repositories as at 31 March 2010 and November 2011 are presented in Table 1 below.

Table 1 - Metadata and Full-text Documents processed as at 31 March 2010 and November 2011

Total Documents (Estimate)	Total Documents (Estimate)		Metadata		Full-Text Documents	
	2010	2011	2010	2011	2010	2011
CSIR-ARI	389	389	328	328	170	170
CSIR-FRI	640+	640+	291	291	291	291
CSIR-INSTI	2000+	2000*	1032	1172	1032	1152
CAGRIC	1725	1725	589	589	587	587
CSIR-FORIG	517	517	503	503	503	503
CRIG	-	-	143	158	130	145
MOFA Information Resource Centre	-	-	520	520	40	40
Total	5271+	5271+	3406	3561	2753	2888

Source: Case study report. Ghana. AGRIS Pilot Project (GAPP) 2010 and Consultancy Study

But none of the repositories can be assessed by anyone, anywhere in the world as they have not been put on the Internet. Corleley (2011) also observes that repositories created in four institutions in Ghana could not be seen on the Internet due to problems with getting public Internet Provider (IP) addresses. Thus Internet connectivity is a major challenge to efforts being made to improve openness of agricultural research outputs in Ghana. The repositories are therefore not being used and hence usage cannot be assessed in any planned way.

Institutional political and cultural factors have also had an impact on the provision of access to outputs of research. Among all the seven PIs MoFA is the only one with several directorates (organizations) while the others are single organizations. According to a 'Case Study Report of the GAPP'

published in 2010, MoFA is made up of 10 regional, 10 national technical and 138 district directorates. This situation posed major challenges to MoFA GAPP IMC and the PMC in coordinating the activities of the numerous stakeholders at MoFA and also serving their interests.

The power of political influence was therefore far more felt in MoFA than the other PIs resulting in the poor performance of GAPP in MoFA. Some of the key deliverables expected by GAPP were not achieved. For example, the ICT/M Policy document, the Workflow document for generated information, all lagged behind while the number of full text documents that were digitized was the lowest among the seven PIs.

Cultural factors also contributed to this poor performance in MoFA as compared to the other PIs. As a civil service organization MoFA is less likely to immediately adopt the concept of Open Access as compare to the other PIs. Its mandate is also different from the other PIs which are research institutes/university with clear mandates to generate technologies. Thus the culture of the other PIs is more suitable than that of MoFA for implementing GAPP.

Cultural and political factors can also be used to explain the differences in the status of digitization in the PIs as shown in Table 1 below. The Table shows CSIR-INSTI as the highest performer in the digitization programme during GAPP. Long before the implementation of GAPP this institute had developed a culture for information management due to the focus of its mandate which is on information management. This mandate is also responsible for the high political influence from CSIR-INSTI's management.

CAGRIC performance as the second highest, however, appears to be due more to political influence as a result of the high level of commitment from the Principal of the College rather than cultural factors. As indicated earlier CAGRIC was one of two institutes which through their own initiatives obtained support from some other organizations apart from GAPP.

However, Table 1 shows that after GAPP ended in March 2010 the increase in number of metadata digitized has only been 4.5%, from 3406 to 3561, whilst for full text documents it was 4.8%, from 2753 to 2888 records. This unimpressive performance raises much concern for the sustainability of digitization activities in the country and hence the future of OA. As the Table further shows the increases came from only two institutes, CSIR-INSTI and CRIG.

There were no increases in the other four PIs and this was attributed to problems with the use of WebAGRIS by the ICM specialists and technicians. This, according to them, makes them unable to make any data entry. However, these low increases seem to be a reflection of the poor information management skills of the staff observed earlier and lack of commitment to the implementation of the system by some Directors. These same factors were responsible for the failure of INFORM – an MIS – that was implemented under NARP.

GAINS decided to go ahead with digitization to improve the availability and accessibility of the increasing number of research outputs that the scientists were generating. In this way agricultural development can be enhanced for poverty alleviation and in line with the mandate of its host institute. Decisions on what types of content to capture are made by the GAPP IMC in each institute using the document on ICM/ICT policies and strategies as a guide.

On this checklist, the positive factor is that all the institutes have developed skills in the creation of repositories, but the negative factor is that their impact on openness of research outputs is yet to be felt. In all the PIs the Directors, in consultation with the GAPP IMC, took the decisions to create the repository and also as to what types of content would be held in the repository. The attempts to implement the repository faced some disagreements: there were some views that opening up the institute's research outputs would lead to theft, but this was overshadowed by the need to preserve institutional memory. GAINS uses Dublin Core, CAB Thesaurus and AGROVOC to meet international standards.

2.2.3 Development of a clearly defined licensing policy for outputs

None of the institutes surveyed has a licensing policy covering its research outputs. But the CSIR institutes and other institutes including the universities have been holding workshops to create awareness on the importance of IP. As a result plans are far advanced to create an IP system for CSIR based on the National IP System.

2.2.4 Optimization of the structure and content of web sites for search engines, and sharing metadata by participating in international information systems

Four of the seven PIs, CSIR-INSTI, CSIR-FORIG, CSIR-FRI and CRIG have websites. However, the repositories are not accessible through these websites and therefore cannot be searched by global search engines. According to an 'After Action Review Report' published in April 2010, prepared by GAINS, on GAPP, this problem is due to inadequate Internet connection and the inability of the GAINS Coordinating Centre to develop a mechanism to facilitate sharing and access to the resources in the absence of the physical link of the repositories.

Another limitation to openness of research outputs is that there is no written policy for encouraging researchers to publish in OA journals and other high visibility places. However, at various seminars in the PIs the GAINS Coordinator and the FAO Information Management Specialist have been creating awareness on other alternatives for publishing research outputs, which includes OA journals.

But the response to these calls has not been satisfactory as the institutions are yet to accept OA and OA journals as credible alternatives. In a review of the performance of INFORM - an information system for agricultural research managers - Vernon (1994)

observed that an MIS implementation requires a sequence of several different interventions that go beyond a single workshop.

These seminars might therefore not be enough to institutionalize OA in Ghana based on AGRIS, which is a more complex information system than INFORM. In addition, the period of three years for implementation of GAPP is enough for a pilot study to generate lessons for enhancing the success of AGRIS under large scale implementation, but is rather too short for changing attitudes which often takes long periods.

Experience gained from NARP shows that seven years of implementation of INFORM did not change the attitudes of most research managers and scientists towards digital management of information. As a result information management in the Ghana NARS, which includes the GAINS PIs, is still poor.

Scientists are also encouraged to publish in journals which are part of collections that are freely available or available at low cost to developing countries, such as AGORA (Access to Global Online Research in Agriculture) and AJOL (African Journals Online). Currently, there are about 19 journals in Ghana on AJOL, which includes four CSIR related journals. These are the *Ghana Journal of Agricultural Science*, the *Ghana Journal of Science*, *Journal of Applied Science and Technology* and the *Ghana Journal of Forestry*.

Some of the PIs such as CSIR-INSTI, CSIR-FRI, CSIR-FORIG have some of their research outputs indexed in CAB Abstracts and AGRIS databases. Some publications by individual scientists in international journals are available in CAB Abstracts and other international databases. Currently the institutions do not actively export metadata to AGRIS.

2.2.5 Using 'social networking' media and applications to share our outputs

GAINS is championing the use of informal methods of research communication through the organization of workshops on the use of Web 2.0 because they are emerging trends which can be used to improve availability and accessibility of information. These informal methods make communication cheaper and easier. With the support of CTA, GAINS has been organizing workshops for scientists to acquire skills to use these informal communication methods. However, none of the institutes has developed any policy to support this activity. FARA also provides support for sensitization and training through an information system known as e-RAILS.

CRIG appears to be the leading institute which is promoting the use of this approach. Some of its scientists are on Facebook, one of the most popular Web 2.0 tools in the country. It supports scientists to communicate informally through this medium by purchasing mobile phone units for some of them to use the Internet. According to one of the scientists, though they use it for personal/social communication, it also helps in improving collaboration in the conduct of research activities.

In collaboration with World Cocoa Foundation, Ghana Cocoa Board (COCOBOD) and The Hershey Company, GRIG is piloting CocoaLink – a mobile telephony-based

platform which uses voice and SMS text messages to connect cocoa farmers with practical agricultural and social information that will help them increase their incomes and improve their livelihoods¹. It is difficult currently to identify any positive factors in this environment as there is no monitoring of the use of these informal communication methods among the scientists.

2.2.6 Building formal and informal networks to repackage outputs

The links between agricultural research and technology transfer in developing countries are generally recognized as a major bottleneck in agricultural development. GAINS has therefore established linkages with FBOs, radio stations, and the Directorate of Extension Services of MoFA to improve dissemination of information to reach more clients and remove the bottleneck.

One way by which it is reaching more clients is through the repackaging of research information into forms that are more useable by other stakeholders and broadcast through FM Radio Stations. It also publishes some of this information in five Ghanaian languages.

GAINS started its repackaging of information into radio programmes in 2004 with Radio Peace – a community-based FM station under QAS. The programmes have phone-in facilities through which farmers can call into the programmes and make comments or ask questions which are answered by experts on the radio. Currently, it performs similar activities with three other FM Stations i.e. Royals FM, Rite FM and Lorloronyo FM. QAS started in 2000 with support from CTA. Since then it has continued to receive regular support from CTA due to its impressive achievements and is now in its seventh phase

At the GAINS Coordinating Centre, the translation into local languages is done by the Science Publishing Unit in collaboration with the Bureau of Ghana Languages, while at CRIG experts are hired to do the translation. But some of the PIs, for example CRIG and CSIR-FRI, offer classical examples of this innovation systems approach through partnerships with the public and private sector. Under its innovation system approach, CRIG is a member of CEPP (Coco Extension Public Partnership) which is a platform for improving communication with farmers. This is supported by the use of flyers and newsletters that carry research information that has been transformed into useable forms by our scientists. The institute also publishes technical bulletins which are simplified versions of research information for extension and literate farmers.

When research information is to be transformed into Twi – the local language spoken in most cocoa growing areas - experts are hired to do the translation. In collaboration with Cadbury Ghana Limited, CRIG also launched a cocoa farmers' newspaper written in simple language to not only inform farmers on the management of cocoa pests and diseases, but to also provide farmers with reference materials on these pests and

¹ <http://www.worldcocoaafoundation.org/what-we-do/current-programs/CocoaLink.asp>

diseases. The transformation is managed by a team of scientists coordinated by the Scientific Secretary.

CRIG also collaborates with WIENCO, a private agro inputs dealer, and on every week day during the News Broadcast by GTV – the National TV Station – improved farming practices are broadcast to cocoa farmers. .

The positive factors of this approach are that more farmers are reached with information to help to increase their yields than can be reached through extension agents, and it is more economical to use these community FM stations than the national broadcasting station.

The activities of CSIR-FRI in the use of the innovation systems approach are however donor driven. Most donor funded projects at this PI require that scientists work with the private sector and FBOs to transform research outputs which are more easily understood by other stakeholders. A typical example is the manuals that the institute has prepared for training small and medium enterprises (SMEs). This transformation is done by scientists supported by CID and supervised by an Editorial Committee. The institute uses videos to disseminate its research outputs, especially during exhibitions.

Another example of the innovation systems approach in GAINS is in the contract research that CSIR-FORIG undertakes with the private sector. The transformation of research into more usable forms is done by the Scientific Secretary with assistance from the scientists. This approach enhances the image of the institution and sometimes results in more collaboration with other organization.

3. KEY ISSUES AND CONCLUSIONS

3.1 Developing Institutional Readiness for openness of agricultural research outputs for innovation

3.1.1 Support for Openness of Agricultural Research Outputs

Benefit

- Institutes are now better informed, by CIARD, of the benefits that they can obtain through openness (see section on CIARD).

Challenge

- Full understanding of CIARD's Manifesto and Values not yet in place. Thus CIARD is yet to obtain formal support from the institutes for its Manifesto and Values.

3.1.2 Awareness of CIARD in GAINS

Benefit

- GAINS obtained support from CIARD to hold a conference on 'Knowledge Sharing' in 2010.

Challenge

- Inadequate funds to organize more seminars to improve awareness of CIARD in GAINS.

3.1.3 Adoption of a formal institutional information/communication strategy

Benefit

- Management of information can now be done through a structured approach in the GAINS PIs.

Challenge

- Low commitment from some Directors to implementation of policy/strategies.

3.1.4 Development of capacities of GAINS to achieve the Checklist

Benefits:

- PIs have acquired capacities for digitization of research outputs.

- Foundation has been laid for scientists in PIs and the country as a whole to start enjoying the benefits of open access soon.

Challenges

- Some staff yet to develop adequate skills in information management.
- Problems of copyright.
- Reluctance of scientists to archive their outputs in institutional repositories.
- Availability of funds to continue strengthening of capacities to cope with a fast-changing ICT world.

3.1.5 Development of national/local partner networks to share resources and skills

Benefits

- Improved information sharing.
- More effective use of limited resources.

Challenge

- Funds for the maintenance of the network to make it always functional.

3.2. Availability, accessibility and applicability of research outputs

3.2.1 Ensuring that research outputs are available digitally

Benefits

- Preservation of institutional memory in more secure forms to prevent loss due to, for example, fire or any other disaster.
- Timely access to information and in forms suitable for analysis.
- Digitization of older documents allows for analysis of historical data which is essential for monitoring performance of trees, which take a long time to mature.

Challenges

- Poor skills of staff in information management.
- Reluctance of scientists to make available their outputs for digitization.

3.2.2 Development of institutional or thematic repositories of outputs as open archives, using agricultural information standards

Benefits

- All the institutes are still building their institutional repositories (IRs) so scientists at the institutes are yet to experience their benefits. Capacity has however been built for repository development.

Challenges

- Poor internet connectivity in some institutions making it impossible for the repositories to be accessed anywhere in the world by anybody.
- High cost of information infrastructure.

3.2.3 Optimization of the structure and content of web sites for search engines, and sharing metadata by participating in international information systems

Benefit

- Scientists are yet to enjoy any benefits as repositories are not accessible through websites.

Challenges

- Poor internet connectivity.
- Getting scientists to accept open access of research outputs as a credible alternative to traditional journals.

3.2.4 Using 'social networking' media and applications to share outputs

Benefits

- Faster, easier and cheaper means of communicating research outputs.

Challenge

- Poor internet connectivity in some of the institutes.

3.2.5 Building formal and informal networks to repackage outputs

Benefits

- Programmes in local languages are better understood by farmers. ICTs make it possible to give farmers information quickly, when it is needed, but it has to be in a format that can be easily understood and applied (Woperies-Pura, 2011).
- More farmers are reached at lower costs through community FM radio stations than through the national broadcasting station (GAINSNEWS 2007).
- More farmers are reached by radio stations than by extension agents.

Challenge

- Most technical words and terms cannot be easily translated into local language. When it comes to reaching small-scale producers the challenges of access and literacy remain substantial (Spore, 2009).

3.3. Key Lessons

Support for Openness of Agricultural Research Outputs

Chances of gaining support for digitization initiatives could be enhanced through organized processes such as seminars.

Mandate of an institute and commitment of its management are key factors that drive digitization.

Awareness of CIARD in GAINS

Awareness of CIARD in GAINS can be enhanced through more seminars that highlight its manifesto and values.

Adoption of a formal institutional information/communication strategy

Implementation of information systems is complex. Institutions therefore need well formulated strategies to ensure their successful implementation.

Development of capacities of GAINS to achieve the Checklist

Need for regular update of staff as IT is a revolutionary technology changing at fast rates.

High cost of site maintenance may affect ability of institutes to meet the demands of developed countries when open access is institutionalized in the Ghana NARS.

Development of national/local partner networks to share resources and skills

In the search for partners the focus for networks should be on institutes which have high chances of environmental acceptance of the projects.

Ensuring that research outputs are available digitally

Digitization provides not only an easy and quick access to information but also a more secure means of storing institutional memory.

Digitization of older documents provides easy access to historical data for following trends in an institute's achievements over many years, for better planning and decision

making. Very suitable for an institute whose mandated commodities are trees and tree crops.

Development of institutional or thematic repositories of outputs as open archives, using agricultural information standards

Change is a process and not an event. Therefore training and sensitization that were undertaken under GAPP need to be continued for attitudes towards open access to be changed so that it can become institutionalized in Ghana.

For digitization to succeed in Ghana, knowledge and skills in information management should be improved in all the institutes.

Cultural and/or political factors are responsible for the varying degrees of digitization found in the seven PIs.

Optimization of the structure and content of web sites for search engines, and sharing metadata by participating in international information systems

Reliable internet connectivity is essential for access to institutional repositories by anyone, anywhere in the world.

Inability of institutional repositories to be searched by global search engines limits the visibility of research outputs developed in Ghana to the outside world.

Using 'social networking' media and applications to share outputs

More training is needed to promote the use of Web 2.0 in the NARS to enhance communication among the NARS stakeholders and the development of effective value chains for promotion of agricultural development in the country.

Building formal and informal networks to repackage outputs

Innovation systems have become essential tools for the development of agriculture in the country.

Like any other activity, transforming research outputs into more usable forms and therefore more understandable by other stakeholders requires that they are properly managed for their benefits to be realized. Special committees must be formed to manage the process.

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APPENDIX

Table 1: List of people interviewed

Institute	Interviewees	Position
CSIR-INSTI	Sam Joel	Director
	Osei Simon	Librarian/Research Scientist
	Acquaye Eric	IT Specialist
	Yeboah Jeffrey	Principal Library Assistant
CSIR-FRI	Johnson Paa-Nii	Ag. Director
	Kavi	Librarian
	Bugyei Kwabena	IT Specialist
	Atta-Sonno Stephen	IT Specialist
	Nketia Stephen	Scientific Secretary
CSIR-ARI	Botchway Vincent	Scientific Secretary
CSIR-FORIG	Asante Andrews	Systems Administrator
	Sraku-Lartey, Margaret (Mrs)	Librarian
CRIG	Agyeman, Victor	Director
	Johnson, Victress (Mrs)	Scientific Secretary
	Baah, Francis	Head, Social Sciences and Statistics
	Marji, Vincent (Rev)	IT Specialist
	Gyamfi, Larbi	Librarian
CAGRIC	Kogya-Agyemang, J.	Dean, Faculty of Agriculture
	Fiawortofofor, Theophilus	College Librarian
	Partey, Divine	Systems Analyst

APPENDIX

Table 2: NARS Organizations

Organization	Institute/Station, Faculty/School/College	Location
CSIR	Animal Research Institute	Accra
	Food Research Institute	Accra
	Crops Research Institute	Kumasi
	Plant Genetic Resources Research Institute	Bunso
	Savanna Agricultural Research Institute	Tamale
	Water Research Institute	Accra
	Soil Research Institute	Kumasi
	Institute for Industrial Research	Accra
	Forestry Research Institute of Ghana	Kumasi
Ghana Cocoa Board	Cocoa Research Institute of Ghana	Tafo
Ghana Atomic Energy Commission	Biotechnology and Nuclear Agriculture Research Institute	Accra
Ministry of Food and Agriculture	Wenchi Research Station Asuansi Research Station Kpeve Research Station	
Public Universities	Faculty of Agriculture, UG; Faculty of Agriculture; KNUST Faculty of Agriculture; UDS, College of Agricultural Education, UEW, School of Agriculture, UCC.	