AGRICULTURAL RESEARCH ONLINE SYSTEM: AN APPROACH TO PROMOTE COLLABORATION AND SHARING OF AGRICULTURAL RESEARCH KNOWLEDGE IN TANZANIA

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AGRICULTURAL RESEARCH ONLINE SYSTEM: AN APPROACH TO PROMOTE COLLABORATION AND SHARING OF AGRICULTURAL RESEARCH KNOWLEDGE IN TANZANIA

By

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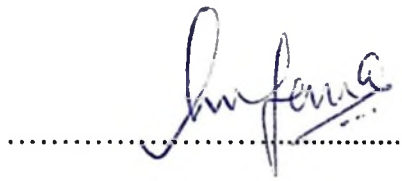
CERTIFICATION

The undersigned certifies that he has read and hereby recommends for acceptance by the University of Dar es salaam a dissertation entitled ***"Agriculture research online system: an approach to promote collaboration and sharing of agricultural research knowledge in Tanzania"*** in partial fulfillment of the requirements for the degree of Master of Engineering Management (MEM) of the University of Dar es salaam.



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I, Edda Lwoga, declare that this dissertation is my own original work and that it has not been presented to any University for a similar or any degree award.

Signature.....

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ABSTRACT

The purpose of this study was to develop a prototype of an agricultural research online system in order to promote collaboration and sharing of knowledge among researchers in Tanzania. Major focus was on the application of the open access (OA) and community of practices (CoP) concepts in order to improve the process of capturing and sharing of the agricultural technologies and knowledge to researchers, subsistence and commercial farmers and other stakeholders for the sustainable development of agriculture in Tanzania. An exploratory survey, system analysis and ICT-based design were the used methodologies to convey the current state and challenges of knowledge sharing activities among agricultural researchers, as well as to assess the user requirements and develop the Agrinet-Tz prototype.

Survey results revealed that the current state of knowledge sharing activities in agricultural research institutes is still not satisfactory within the country. This is mainly due to poor knowledge sharing culture, poor ICT infrastructure, inadequate funds, lack of awareness about the OA issues and inadequate knowledge management support by the research institute management. Major features to be included in the proposed system were also identified in the survey with a greater emphasis on both intrinsic and interpersonal motivational factors in order to stimulate researchers to share their knowledge online.

Prototype (i.e. Agrinet-Tz) of the agricultural research online system in Tanzania was therefore developed with the application features geared at both intrinsic and

interpersonal motivational factors. This was done in order to resolve some of the revealed challenges such as poor knowledge sharing culture among agricultural researchers. The selected open source software (i.e. Dspace, SMF forum and Joomla portal software) were re-designed to develop the Agrinet-Tz prototype. Additionally, the system was also tested in order to assess the system usability, where the positive feedback was received from the respondents. User roles for the developed prototype were also defined in various categories in order to ensure the system sustainability.

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LIST OF ABBREVIATIONS

AGRICOLA	Agricultural OnLine Access
AGRIS	International Information System for the Agricultural Sciences and Technology
BOAI	Budapest Open Access Initiative
CAMARTEC	Centre for Agricultural Mechanization and Rural Technology
CARIS	Current Agricultural Research Information System
COP	Community of Practices
COSTECH	Commission for Science and Technology
DRD	Department of Research Development
FOSS	Free/ Open Source Software
GDP	Country's Gross Domestic Product
ICT	Information and Communication Technology
INASP	International Network for the Availability of Scientific Publications
ISNAR	International Service for National Agricultural Research
KM	knowledge management
NARS	National Agricultural Research System

OA	Open access
OAAs	Open Access Archives
OAI-PMH	Open Archival Information – Protocol for Metadata Harvesting
PERI	Programme for the Enhancement of Research Information
RSS	Really Simple Syndication
SGML	Standard Generalized Markup Language
SUA	Sokoine University of Agriculture
TAFIRI	Tanzania Fisheries Research Institute
TAFORI	Tanzania Forestry Research Institute
TEEAL	The Essential Electronic Agricultural Library
TPRI	Tropical Pesticides Research Institute
UNDP	United Nations Development Programme
XML	eXtensible Mark-up Language

CHAPTER ONE

INTRODUCTION

1. 1 Introduction

Tanzanians main economic pillar is embedded in the agricultural sector, which supports over 33 million people and contributes 60% of the country's GDP and 61% of the export earnings and provides 84% of rural employment (Kapange, 1999). Agricultural research is one of the actors that increases efficiency in productivity and profitability of this sector by adding innovative scientific knowledge to generate improved technologies for the production systems. However, the performance of the agricultural research organizations is still poor, one of the reason being poor collaboration and knowledge sharing mechanisms among researchers and other key players within the country.

Both open access (OA) and communities of practices (CoPs) offer many opportunities for African agricultural researchers including those in Tanzania to share and increase access and visibility of their knowledge contents in the online environment. Knowledge in agricultural research institutes can either be explicit and recorded, or can be tacit (i.e. in people's minds) (Nonaka and Takeuchi, 1995). It is within the communities that tacit knowledge can effectively be shared, often described as a community of practice (Van Wyk, 2005). On the other hand, once knowledge (i.e. both tacit and explicit) has been shared via the communities of practice, it is important to create a mechanism which will facilitate the open accessibility of that shared knowledge. OA offers that possibility by enabling the digital or online information or knowledge to be freely accessed, and to be free from most of the copyright and licensing restrictions (Suber, 2005). That is why open access scholarly communication is taken as an overt intervention with regard to the knowledge sharing processes (De Beer, 2005).

Both OA and CoPs have been utilized with great success by many organizations in the academic, business and manufacturing in order to enhance knowledge sharing. But how

can these OA and CoPs be applied with the same success in the Tanzanians agricultural research institutes? With the utilization of Information and Communication Technology (ICT), this study analyzes the user requirements and builds the prototype for the agricultural research online system by using the open source software. The major aim is to promote the collaboration and sharing of agricultural research knowledge in Tanzania. Both OA and CoPs concepts are applied as models to enhance knowledge sharing among the agricultural researchers.

1.2 Problem statement

Studies in agricultural knowledge have shown that the constraints that hamper the development of agriculture in developing countries including Tanzania are often aggravated by a serious lack of access to reliable and timely agricultural research information and knowledge. This is not only to the farmers, but also extension workers, researchers, policy makers and other stakeholders (Chaila, 2001). This problem is mainly contributed by the poor mechanisms of tapping and sharing knowledge among the agricultural researchers in Tanzania, which are well characterized by the following: inadequate ICT infrastructure and ICT policies, lack of trained experts in ICT, insufficient financial resources (Kapange, 1999; Kapange, 2004; Tumsifu, 2002) and lack of the knowledge management system. Information centres, which were supposed to be active in this area, are not doing so in practice. Instead, they tend to move into the areas of electronic catalogues and digitisation of local collections, rather than setting up full scale knowledge repositories (Rosenberg, 2005). Basically, knowledge repositories could motivate researchers to share their knowledge online.

Another problem within this context is that of low knowledge sharing activities through publishing, due to the uneven reward systems that exist between research and academic environment. Whereas on one hand, the academic staffs of the universities actively conduct research and publish their results because they are rewarded (Kapange, 1999). On the other hand, African agricultural scientists including those in Tanzania, who work in the field of the agricultural applied research usually not related to the universities, are understandably reluctant to share their knowledge online through publishing because they

are not correspondingly rewarded (Kapange, 1999). Other reasons include low funding, scientists' poor writing skills, low staff morale, and narrow opportunities for professional development contribute to this (Kapange, 1999). Problem of recorded prejudice against submissions from the scientists in developing countries (see also Horton, 2000; Lwoga and Sife, 2005) also makes the researchers to loose their confidence in publishing and sharing their knowledge both internationally and locally. Until the challenges of sharing of knowledge (e.g. scholarly literature) are appropriately re-addressed, agricultural sciences in Africa including Tanzania will generally continue to lag behind.

It is therefore clear that there are poor mechanisms to enable the researchers to share their knowledge within the country. CoPs within the agricultural research institutes seem to exist (e.g through team work) but their impact is still insignificant since their value is inadequately recognized by all stakeholders (i.e. researchers, information specialists and research institutes top management). In addition, the awareness and implementation of OA concept is also still very low in most of the African countries including Tanzania. This study therefore analyzes the current state of the knowledge sharing activities among agricultural researchers within the country with the focus on the application of CoPs and OA issues. The user requirements were also analyzed and used for the development of the prototype for the Tanzanian agricultural research online system in order to promote the collaboration and sharing of the knowledge among agricultural scientists.

1.3 Research goals and objectives

1.3.1 Goal

The focus was to develop a prototype for the agricultural research online system by taking advantage of the available open source solutions in order to promote knowledge sharing and collaboration among agricultural researchers. This included the application of the open access and community of practices concepts in order to improve the process of capturing and sharing the agricultural technologies and knowledge to researchers, subsistence and commercial farmers and other stakeholders for the sustainable development of agriculture in Tanzania.

1.3.2 Broad objective

The main objective was to develop a prototype of an agricultural research online system that would promote collaboration and sharing of knowledge among researchers.

1.3.2.1 Specific objectives

The specific objectives included the following:

- To assess the current state of knowledge sharing activities among agricultural researchers in Tanzania;
- To determine the problems that face the researchers in collaborating and sharing knowledge in the online environment; and
- To design and develop a prototype for the agricultural research online system by using open source technology.

1.4 Research questions

The research questions included the following:

- What was the current state of the knowledge sharing activities among agricultural researchers in Tanzania?
- What were the problems that face agricultural scientists in sharing online information and knowledge?
- What were the user-requirements and how could they be fulfilled with the open source technology?

1.5 Relevance of the study

This study was proposed to develop the first prototype for the agricultural research online system in Tanzania by using the open source technology. The developed system is expected to do the following:

- To assist stakeholders including policy and decision makers and agricultural practitioners to determine their agricultural knowledge needs and how the developed system can be used to fulfil those needs and alleviate problems associated with the sharing of agricultural research knowledge contents;

- To increase the quick access and retrieval of Tanzanian agricultural research knowledge contents and other agricultural writings on the web. This will allow scientists to identify the needed documents and then to gain access to them quickly;
- To improve the quality of higher education, agricultural researches conducted within and outside the country and agricultural production within the country because the agricultural research information and knowledge will be disseminated via the Internet to agricultural researchers, subsistence and commercial farmers and other stakeholders;
- To encourage electronic publishing among agricultural scientists within the country;
- To promote the knowledge sharing culture among agricultural researchers in online environment; and
- To be used as a long term objective that leads to development and implementation of the National Agricultural Research Information and Knowledge System.

1.6 Research outcome

This study developed the prototype for the agricultural research online system that will promote collaboration and sharing of knowledge among agricultural researchers in Tanzania. Research outcomes are more explained in the following table 1.1.

Table 1.1: Research outcome

Objective	**Expected output**	**Measurable indicators**
1. To assess the current state of knowledge sharing activities among agricultural researchers in Tanzania	Status of knowledge sharing activities among the agricultural researchers in Tanzania,	Written report
2. To determine the problems that face the agricultural scientists in sharing knowledge	List of problems that face the agricultural scientists in sharing knowledge	Needs assessment
3. To develop the prototype of agricultural research online system by using the open source technology	Tanzania agricultural research online system.	System analysis and design

CHAPTER TWO
LITERATURE REVIEW

2.1 Introduction

Literature review discussed how ICT could be used to enhance collaboration and knowledge sharing among agricultural researchers. Therefore, concept of knowledge management processes was reviewed with a focus on the knowledge sharing processes through the communities of practices (CoPs) and open access (OA). Both OA and CoPs, in turn, were used to review the current state and problems that face agricultural researchers when sharing knowledge in Tanzania. This then provided a big picture on what types of technologies are needed to enhance knowledge sharing processes in CoPs and OA with a major focus on reviewing the potential of open source technology. Further, being among the facilitators of knowledge sharing activities within the research institutes, the information specialists' roles for the online systems or repositories were also reviewed.

2.2 What is knowledge?

Development of ICTs coupled with a change in civilization, led to a new global era of information, also referred to as the era of knowledge. However, knowledge and information are two totally different concepts that now seem, quite frequently, to be presented as synonyms (Segundo, 2002). This ambiguity has been attributed due to the lack of clear distinction between the related concepts: data, information and knowledge. Thus, to differentiate information and knowledge, one must examine the distinctions drawn between all these concepts.

The Web dictionary (2006) defines data as individual measurements, facts, figures, pieces of information, statistics, either historical or derived by calculation, experimentation, surveys and evidence from which conclusions can be inferred. Information is also defined as data that have been processed and presented in a form suitable for human interpretation, often with the purpose of revealing trends or patterns. Knowledge is also

defined as internalization of information, data, and experience. Turban and Frenzel (1992) also regard knowledge as an understanding and learning of a clear and certain perception of something, which can be perceived or grasped by the mind, practical experience or skills, cognizance, recognition and organized information applicable to problem solving. Therefore, knowledge differs from information in that it is predictive and can be used to guide action while information is merely data in context. Knowledge is further differentiated between tacit and explicit knowledge (Nonaka and Takeuchi, 1995).

2.2.1 Tacit knowledge

Tacit knowledge according to Nonaka (1998) is very personal and difficult to formalize and to communicate to others. According to him, tacit knowledge is deeply grounded in action and in individuals' commitment to a specific context. Management of tacit knowledge according to Willard (1999) is only possible when people have the relevant expertise or experience, and are willing and motivated to apply and share their knowledge. The shared tacit knowledge can be embedded in other members' minds, or converted into explicit knowledge in the form of artefacts like newsletters, websites, reports, diagrams.

2.2.2 Explicit knowledge

Nonaka (1998) describes explicit knowledge as formal and systematic knowledge that is easily communicable and shared in product specifications, scientific formula, or a computer programme. Explicit knowledge can be shared through files, reports, etc. This is then converted into tacit knowledge through the process of internalization, using simulation or storytelling. Other types of knowledge found in literature but not pertinent to this study include: indigenous knowledge, cultural knowledge by Sackman (1991), Machlup's five categories of knowledge, namely practical knowledge (also called organizational knowledge by Broadbent), intellectual knowledge, small talk knowledge and past time knowledge, spiritual knowledge and unwanted knowledge, and Jantz's three types of knowledge namely public knowledge, shared expertise and personal knowledge (Jantz 2001; Broadbent, 1998, Machlup 1980). Having an understanding of

the knowledge types and how knowledge is differentiated from information, the following section explores how knowledge is generally managed and processed.

2.3 Knowledge management and knowledge management processes

Knowledge management is a discipline that utilizes and exploits all of an organization's knowledge assets, including all its information (explicit knowledge) as well as its unarticulated experience and expertise (tacit knowledge) resident in individuals so as to ensure sustainability as well as competitive advantage (van Wyk, 2005). Specifically, knowledge management activities can help the research communities to focus on creating, capturing, sharing and utilizing knowledge for such things as problem solving, dynamic learning, strategic planning, conducting research and decision making. Various knowledge management processes exist, but for the purpose of this study, the following processes were adopted from Bouthillier and Shearer, (2002), which include knowledge gathering (i.e. discovery, acquisition and creation) and knowledge sharing.

2.3.1 Knowledge gathering

The "gathering" step has been separated into three different processes, each of which is distinct from the other: discovery, acquisition, and creation of knowledge. Bouthillier and Shearer (2002) note that the refining and representing processes were omitted because refining is not a major process in the knowledge flow. However it is, merely one aspect of the knowledge creation step and knowledge representation generally falls within the scope of the storage and organization process. Discovery involves locating internal knowledge within the organization. Large, non-hierarchical or geographically dispersed organizations find this knowledge gathering process especially helpful as one part of the organization may not be aware of the knowledge existing in its other parts. This also applies to any national based-agricultural research network including the one in Tanzania.

Acquisition step involves bringing knowledge into an organization from external sources. Creation of new knowledge may be accomplished in several ways. First, internal knowledge may be combined with other internal knowledge to create new knowledge. Secondly, information may be analyzed to create new knowledge (Bouthillier and

Shearer, 2002). This therefore adds value to information so that it is able to produce action.

2.3.2 Knowledge sharing

After knowledge has been gathered, it must be stored and shared. Knowledge sharing involves the transfer of knowledge from one (or more) person to another one (or more). Although knowledge can be acquired at the individual level (i.e. tacit knowledge), to be useful it must be shared by a community, often described as a community of practice (Bouthillier and Shearer, 2002) and made accessible on open access basis more often used in scholarly communication. All these can occur through many different media: conversations, meetings, processes, best practices, data bases, and questioning (Smith and McKeen, 2003). In the end, the cycle of knowledge management is neither complete nor successful if no efforts are made to ensure the use of the stored and shared knowledge.

Both universities and research institutes have a somewhat unique character in terms of knowledge sharing activities. As part of their work, they traditionally collaborate and share their knowledge through peer reviewed journals (Carty, 2005), conferences and lectures courses for academics. In the academic and research environment, communities of practices already exist and do not have to be created through the KM processes (Cloete and Snyman, 2003). However, the awareness and implementation of the OA practices especially in the Africa research institutes and universities is still very low (Chan et al, 2005). The challenge is therefore to create a mechanism that will assist and facilitate the existing knowledge-sharing and collaboration processes as well as promoting the initiatives that are insignificantly used (e.g OA). For this case, the agricultural researcher' work is seen as 'knowledge work' through the CoPs and OA, while the online system is automatically seen as a knowledge sharing tool

However, studies show that the researchers' participation in the OA and sharing knowledge more often in the communities has proved not to be satisfactory. Smith and McKeen (2003) reveal that cultures which inhibit knowledge-sharing are widely-held to be significant barriers to creating and leveraging knowledge assets. On the other hand, this is true as compared to Carty (2005) study which reveals that it was harder to build

the culture of open access and sharing than the nuts and bolts of the system itself due to the poor knowledge sharing culture. This implies that knowledge sharing is a critical issue as far as knowledge management is concerned. Therefore, a review of each concept (communities of practice and open access) is important in order to determine to what level knowledge sharing can be enhanced by using these concepts despite of the mentioned constraints.

2.4 Knowledge sharing in online environment

This section reviews how knowledge can be shared among researchers through communities of practices and open access in online environment.

2.4.1 Knowledge sharing through online community of practices

Knowledge is viewed by Brown and Duguid (1991), Lave (1988) and Lave and Wenger (1991) as a public good that is socially generated, maintained, and exchanged within the emergent Communities of Practice (CoPs). This perspective therefore considers knowledge as a collective asset that is maintained by the community, collectively contributed to by the members of the community, and accessible to all members. CoPs are therefore defined as groups of people informally bound together by shared expertise and passion (Wenger and Snyder, 2000).

CoPs are considered as efficient tools for tacit knowledge creation and sharing. This is due to the reality that most of a firm's competitive advantage is embedded in the intangible, tacit knowledge of its people, and that competencies do not exist apart from the people who develop them (Dougherty, 1995). It was also observed that tacit knowledge is embedded in the stories people tell (Horvath, 1999), and not only new knowledge, but also skills are discursively produced and disseminated in conversations and networking activities (Araujo, 1998; Brown and Duguid, 1991; Weick and Westley, 1996). Thus, one of the mechanisms that can be used to help researchers to share and internalize tacit knowledge is to let them share and exchange their ideas and experiences within the communities while working on specific problems such as a research project.

Since opportunities for face-to-face communication are rather limited for the distributed agricultural research systems of any country including the one in Tanzania, online CoP seems to be among the few viable alternatives to live conversations and knowledge exchange. Literatures suggest that online CoPs are becoming a knowledge management (KM) tool of choice for an increasing number of multinational corporations, such as Hewlett Packard (Davenport, 1996), British Petroleum, Chevron, Ford, Xerox, Raytheon, IBM etc (Ellis, 2001).

However, efficient knowledge sharing processes is possible in the online CoPs only if a person is motivated to contribute his/her knowledge and if one will subsequently receive useful help in return, increasing of reputation and status through contribution (Kanter, 1995; Kollock, 1999). It also rests on the existence (and maintenance) of intra-team respect, mutual trust, reciprocity, positive individual and group relationships (Norhayati, 2004), interpersonal factors, especially liking and affiliation (Kwok and Gao, 2004) and when the member share the same visions and goals with sense of efficacy and attachment (Brown and Duguid, 1991; Heumer *et al.*, 1998). Osterloh and Frey's (2000) research on intrinsic and extrinsic motivation for knowledge sharing also suggests that intrinsic (i.e. altruism and reputation) motives are much more powerful enablers of such sharing than extrinsic (e.g., monetary or administrative) stimuli. Thus, the knowledge sharing via online CoPs relies more on the intrinsic and interpersonal factors rather than extrinsic factors. Having highlighted that, the following section reviews how open access framework can be used to enhance the knowledge sharing processes.

2.4.2 Open access as a model to enhance knowledge sharing

Once knowledge has been shared via the CoPs, it is important to create a mechanism in order to facilitate open accessibility of that shared knowledge. Open access (OA) is therefore defined as that information or knowledge which is digital, online, free of charge, and free from most copyright and licensing restrictions (Suber, 2005). The major driving force behind the OA movement is not only the availability of new technologies, but a desire among researchers and scholarly associations to bring some relief to the decades-long "serials crisis" which has eroded library access to journals as a result of

increasing subscription costs (Kyrillidou and Young, 2002). As outlined in the Budapest Open Access Initiative (2002), there are two basic strategies used to achieve OA:

1. self-archiving (making electronic pre-prints and post-prints available on author home pages or depositing them in online archives and repositories); and
2. Open access (OA) journals those that do not charge readers or their institutions for access instead the publishing costs are met by authors. In return, authors retain the copyright in their articles.

2.4.2.1 OA journals

OA journals provide great opportunity to the researchers where authors can avoid copyright problems with private publishers by openly sharing their articles to OA repositories/online systems prior to submitting them to publishers who allow OA movement for peer review (Onsrud, 2004). This is true because in the past year, OA movement has gained momentum where a number of journals have swum into the OA stream, to name a few include Elsevier, Springer etc (Falk, 2004). Harnad and Brody (2004) also reveal that over 8,000 journals that have been sampled, close to 85 per cent of them already permit authors to self-archive their own publications. Further, the results from SHERPA/ROMEO list reveal that there are 76% of publishers who allow some form of self - archiving out of 134 publishers (SHERPA, 2006).

2.4.2.2 Knowledge sharing in open access archives

Open Access Archives (OAAs) are electronic repositories that may include already-published articles (post-prints), pre-published articles (pre-prints), theses, manuals, teaching materials or other documents that the authors or their institutions wish to make publicly available without financial or other access barriers (Lynch, 2003). There are various forms of OA archives, which includes the 'institutional archives', where authors submit e-prints to a server administered by an organization or scholarly society (e.g university or research institute); there are also discipline-based archives and other specialty archives. For example is the open archive for Physics, mathematics, computer science and quantitative biology of the Cornel University (Cornel University, 2006). The later seems to be the most viable solution for the proposed Tanzanian agricultural

research online system since it is also a discipline specific knowledge repository.

One of the benefits brought by OA is the improved citation and research impact. Lawrence (2001) found an "average of 336 per cent more citations of online articles compared to offline articles published in the same venue". Harnad and Brody (2004) study also indicates that compared with articles that have not been made available via OA venue by their authors, OA archived articles are cited between 250-550 per cent more often. Other benefits that can be gained by the agricultural researchers from open access include the following: (1) wide access to international research output; (ii) International access to research generated in developing countries including Africa; (iii) Promotion of institutional research output; (iv) OA allows improved access to subsidiary data e.g. grey literature (v) Facilitating peer review, thus reduce duplication of research efforts (Chan et al, 2005).

However, the major concern regarding OA online systems is about garnering information and knowledge contents from the scientists. Key complication is always associated with the lack of awareness about OA issues especially the copyright issues. Rajashekar (2005) and Linde (2006) reveal that many authors who have published in commercial publishers fear to share their knowledge contents (e.g articles) on the OA repositories because they think it would constitute violation to the publisher's copyright. While, other authors concern is that sharing their knowledge contents in the OA archives precludes its later publication in scholarly journals (Gadd et al, 2003) and the potential loss of integrity of their papers (Gadd et al., 2003). Likewise, librarians are also reluctant to archive papers that are published in western journals on faculty's behalf for fear of putting their institution at copyright risk (Rajashekar, 2005). What authors and librarians often fail to realize, however, is that the momentum of the OA movement is accelerating and commercial publishers are realizing that there is no point or possibility in opposing OA itself (Harnad and Brody, 2004) as revealed by the SHERPA/ROMEO list. This means that it is important for the institutions and funding bodies to define strategies that address the issues of copyright, quality and secrecy (Waaijers, 2005).

Lack of peer review process on most of OA repositories also tend to inhibit many authors to submit their contents because they feel that the quality of their research writings is not assured, thus loosing their reputation. However, lack of pear review process has not limited some of the OA archives to have extensive usage and high citation of their contents. For example, the papers in Los Alamos Physics Archive are initially deposited as un-refereed preprints, and they are always replaced by some authors when the final revised draft is accepted for publication (Hitchcock, et al 2000). Yet, Los Alamos is actively used and cited by the physics community (Youngen, 1998). However, this does not mean that peer review is compromised, sacrificed, or put at risk; nor do authors have to give up, even temporarily, submitting to their established journals of choice. All they have to do is sharing their preprints and post-prints in their institutional e-print archives or repositories given that they are allowed by their publishers to retain their rights (Hanard, 2001).

Lack of a clear institutional policy also inhibits the OA repositories from being populated (Chan et al, 2005). This is true as revealed from Brody and Harnad (2005) that the OA repositories with an institutional self-archiving policy (i.e. Southampton Department of Electronic and Computer Science since 2002 and Southampton University since 2004) had high usage. While, repositories without an institutional self-archiving policy were nearly empty, in some cases for several years. Swan and Brown (2004) also found out that the vast majority of authors (81 per cent) would comply willingly with a mandate from their employer or research funder to deposit copies of their articles in an institutional or subject-based repository. That's why, in 2005, OA activists approved the Berlin 3 institutional policy commitment. This calls for universities and research institutions to establish policies requiring academics to share the knowledge contents on OA repositories, as well as encouraging them to publish in OA journals (Suber, 2006)

Concisely, sharing of knowledge in the OA basis requires more than what was revealed from CoPs. Basically, knowledge sharing in the online CoPs relies mostly on the individual scientists (i.e. intrinsic and interpersonal factors). However, OA requires policies in order to mandate the scientists to share their knowledge contents online as

well as awareness programs on OA issues. Having highlighted that, the following section analyzes the current state of knowledge sharing activities in the agricultural research system in Tanzania.

2.5 Knowledge sharing activities in Tanzania agricultural research environment: current state and challenges

Department of Research Development (DRD) of the Ministry of Agriculture and Food Security is the lead institution in the National Agricultural Research System (NARS). It deals with the planning and execution of agricultural knowledge, information and documentation services, in collaboration with other related institutes: SUA, COSTECH, TPRI, TAFORI, TAFIRI, CAMARTEC (DRD, 2005). NARS under DRD comprises 22 major and minor stations in seven agro-ecological zones. In general, most of these NARS research stations are connected to e-mail and some have access to the whole range of Internet services (Kapange, 1999). However, there is no integrated system that captures and promotes the knowledge sharing practices such as through the online CoPs or OA.

CoPs seem to exist in these agricultural related institutes such as through team work in large scientific projects. However, since there is no integrated system to enable online CoPs, then researchers mostly collaborate and share their knowledge through the face to face meetings, or through the available ICT tools (e.g emails) which are still inappropriate. Most research institutes are characterized with few ICT facilities, inadequate ICT skills, poor telephone connections, power interruptions, and lack of appropriate software (e.g knowledge repositories) and hardware (Tumsifu, 2002).

Agricultural-related information centres which were also supposed to be active in this area, they are not doing so in practice. They tend to move into the areas of electronic catalogues and digitisation of local collections rather than setting up full scale knowledge repositories (Rosenberg, 2005). For example, nationally DRD together with other agricultural institutes manage many electronic catalogues such as CARIS, TARD, FAO statistical database, Management of Agricultural Research by ISNAR and others (Kapange, 2003b). Basically, these electronic catalogues do not motivate the researchers

to effectively share their knowledge as could, in principle, result from knowledge repositories with the focus on OA policies.

Publishing as another means for knowledge sharing in the research environment has been rendered ineffective by low funding, poor reward systems and other factors, which include the following: scientists' poor writing skills, low staff morale, narrow opportunities for professional development (Kapange, 1999), and low awareness and implementation of the OA movement in the research environment (Chan et al, 2005) also contribute to this. The problem of recorded prejudice against submissions from the scientists in developing countries (Horton, 2000) including Tanzania also contributes to this situation. Such that, researchers are understandably reluctant and not confident to share their knowledge contents via publishing both locally and internationally.

Further, inadequate accessibility of the agricultural knowledge both from locally and internationally discourages also agricultural researchers to share their knowledge. This mainly emanates from the following: poor state of African indexing and abstracting services, lack of recognition of information services value (Katundu, 2000), poor linkage between research and extension, and lack of adequately trained agricultural information personnel (Ballantyne, 1991). Nevertheless, the international and local initiatives have managed to provide researchers in the developing countries including Tanzania with virtually free access to papers in the journals. However, since the range of journals covered is limited, this does not necessarily provide as much exposure for the work of scientists within these countries as could, in principle, result from the OA policy (Dickson, 2005). Such international initiatives include: AGORA by the Food and Agricultural Organization, and the Programme for the Enhancement of Research Information (PERI) through International Network for the Availability of Scientific Publications (INASP). On the other hand, local initiative includes the Tanzania online.

Generally, this implies that the knowledge sharing activities in the agricultural research environment within the country need to be improved. The development of the agricultural research online system with a major focus on both OA and CoPs can alleviate some of

the problems by providing researchers with many possibilities to openly share their knowledge (e.g research results) in the online environment.

2.6 Open source as appropriate technology for the development of the agricultural research online systems

Open source software (OSS) are programs whose licenses permit users the freedom to run the program for any purpose, to study and modify the program, and to freely redistribute copies of the original or modified program (OSS/FS References, 2005). Open source provides a number of tools that can be used for agricultural research online systems development either from scratch or rebuilding the software from the existing solutions. There is a large number of readily available content management software (CMS) and online communities systems that can be localized and re-developed to implement the agricultural research online system in Tanzania. For example, the best-known and most widely used open source CMC software are Eprints made available by the University of Southampton, United Kingdom (Eprints, 2006), DSpace made available by the US-based Massachusetts Institute of Technology (Dspace, 2006). Among other factors that can be used to evaluate and select the content management and online communities' software for further development, the technical features and the standards for data retrieval and exchange play a very important role as explained in the following sections.

2.6.1 Standards for knowledge exchange in research online systems

There are various sets of standards for data exchange which are now evolving in the online repositories/ systems in order to facilitate the exchange of data between different computer platforms and software applications (Besemer, 2003). Some of these standards include markup languages, metadata, interrogation protocols, and ontologies. Markup standards include SGML and its Internet variant XML & HTML. They have been developed as exchange/ storage formats independent of software application and platform (Besemer. 2003). Generally, most of the agricultural online resources are now migrating to XML meta-language for data storage and access (Besemeer, 2003).

Further, metadata are data about data. It is a structured information that describes, explains, locates, or otherwise makes it easier to retrieve, use, or manage an information resource (National Information Standards Organization, 2004). Particularly in Agricultural Information Systems, there are various metadata (now being called XML schema) such as: Metadata Object Description Schema (MODS) (Beall, 2004), Dublin Core metadata standard, Agricultural Metadata element Set (AgMES) and AIDA schema / IDML. However, mark-up for metadata on online resources is always to some extent based on Dublin core (Besemeer, 2003). Additionally, more importantly is an emerging metadata for encoding and transmission standard (METS) that avoids the transformation issue by taking descriptive metadata in whatever format and with whatever local rules or specific standards metadata follow (Seadle, 2002). This liberal approach can enable both management of digital information within the agricultural research online system and exchange of such information between such systems.

Interrogation protocols provide a means of integrating electronic resources (Zhu, 2004). There are a number of interrogation protocols, such as 'OpenURL', 'web services' or the 'Open Archival Information–Protocol for Metadata Harvesting (OAI-PMH) or the 'Z39.50' protocol (Besemer, 2003) or the 'Simple Object Access Protocol' (Tennant, 2004). Most importantly is the OAI protocol for Metadata Harvesting which presents a promising method by which metadata (i.e Dublin core) regarding archives and manuscripts can be shared and made more interoperable with metadata from other sources (Prom, 2003).

Ontologies are another type of standards which contain terms and the definitions of those terms, and the specification of relationships among those terms. Within the agricultural information community, most subject-oriented vocabularies are either based on CABI thesaurus/CABI codes, AGROVOC/AGRIS/CARIS subject categories, AiDA and Agricultural Ontology Server project (AOSP) (Besemer, 2003).

Generally, all these standards play an important role in the knowledge management, and exchange within and between the agricultural research online systems. However, the

selection of which standards to use depends mostly on the user requirements of the targeted system.

2.6.2 Emphasizing right technical features

Many studies have identified various features to be considered when evaluating the open source systems geared at developing a system that supports both OA and the CoPs. For OA systems, BOAI (2004) and Han (2004) identify various features that can be considered when evaluating the open source CMSs. Those features include: organizational (i.e. metadata, content), presentation (system look and feel), accessibility (internal accessibility of data such as browsing services, interoperability standards such as Z39.5, OAI-PMH, and authentication or authorization services etc), workflow or content submission administration, preservation (i.e. storage, backup and long-term preservation issues for content and metadata) and other system features such as software usage, hardware and software, software quality, system's installation process, training and documentation. Specifically, BOAI provides a useful guide which can be used as a starting point when evaluating the open source CMSs for OA online systems.

Further, since the CoPs are more voluntary driven, studies suggest that the online system needs to contain features that will motivate the participation level of the users. Kwok and Gao (2004) identify some of the application features that can be added to the online system in order to stimulate the level of participation with a greater emphasis on motivational factors (intrinsic, extrinsic and interpersonal factors). These application features include the following: (1) contribution-reward mechanism (e.g knowledge - tracking module); (2) individual identity and profile generation (i.e. building trusted relationships); (3) sub-community organization (i.e. provide community identity and a sense of belonging for an individual – induce altruistic behavior); and (4) reviews and peer recommendation - e.g. peer evaluations, reviews and ratings to increase the quality and relevant information as well as self-reference to ones give out the recommendations.

Table 2.2: Relationship between application feature and motivational factors

	Motivational features					
Application features	**Extrinsic**		**Intrinsic**		**Extrinsic**	
	Reward	Personal needs	Altruism	Reputation	Liking	Affiliation
Contribution-reward mechanism	+			+		
Individual identity and profile generation	+	+	+	+	+	+
Sub-community organization		+	+	+	+	+
Reviews and peer recommendation	+	+		+		

Source: Kwok and Gao (2004)

By integrating all these views, then the agricultural research online system can be developed by evaluating the existing open source system (Both CMSs and online communities) and selecting the candidates' technologies that can be suitable for further development. However, a greater emphasis should be put on user requirements, motivational features as well as the knowledge exchange standards in order to ensure inter-operability with other systems.

2.7 New roles of information specialists in agricultural research online system

Developments of web technologies such as the proposed research online system for this study present new roles to information specialists in order to promote knowledge sharing among researchers. However, due to few African schools which offer librarianship and information sciences education and distance learning, most information specialist face many problems when facilitating knowledge sharing among researchers especially in the online environment (El-Sherbini and Klim, 2004). Despite of the challenges faced, information specialists can not remain behind. Instead they need to be proactive and seek other ways to develop their skills in order to be proactive in this knowledge era.

Literatures suggest new roles to information specialists in regard to OA issues, which are as follows:

- Have a working knowledge of the software for the further development;
- Oversee project management and planning of local implementations of the developed system;

- Create or determine metadata standards tailored to individual collections' unique content and goals (Allard et al, 2005);
- Ensure archival stability;
- Introduce and make available innovative performance indicators or quality assessment, such as counting downloads and citations at the article level (Correia and Teixeira, 2005);
- Advise and support scholars on copyright issues (Correia and Teixeira, 2005);
- Support authors in depositing materials in the system on behalf of them and undertaking file formatting and conversion (Allard et al, 2005);
- Educating institution (academia and administrators) on the importance of open access and community of practice for global sharing of information and knowledge (Horwood, et al, 2004);
- Negotiating with publishers on behalf of the institution/university;
- Training researchers in the use of the software to submit contents (Crow, 2002);
- Provide guidance to define collections to the research community (Allard et al, 2005); and
- Review submissions for the quality of content and metadata consistency (Lynch, 2003).

With regard to CoPs, information specialists' roles are identified as follows by Groenewald et al (2002):

- *Need to identify candidates when checking the possibility of forming CoPs* – identify existing communities, market and sell CoPs to management and potential members, conduct interviews and facilitate group dialogue, act as a community champion;
- *Facilitator when forming CoPs* - set up, facilitate and document informal meetings, map knowledge flows and knowledge relationships, build group identity;
- *Design knowledge capture and documentation systems* - design, convene and facilitate seminars and conferences, develop support strategies for the group learning agenda;
- *Encourage members to stay committed* - convene reunions incase of group break up, helps them create links to other communities, negotiate role of the CoPs, publish in

newsletters, make online links to members' papers, address organizational issues, forge linkages; and

- *Mentor/ teacher when CoPs are adapting to different environment changes* – be facilitator and innovator.

Most importantly is the role of educating the authors about CoPs, copyright and OA issues so that they can deposit their works into the knowledge system/repository. This is because the scientist's decisions to create and share knowledge especially through the CoPs also depends on their viewpoints, personalities, attitudes, values and culture which make it difficult to influence them. This implies that there are also variations in the ability of people to create and share knowledge.

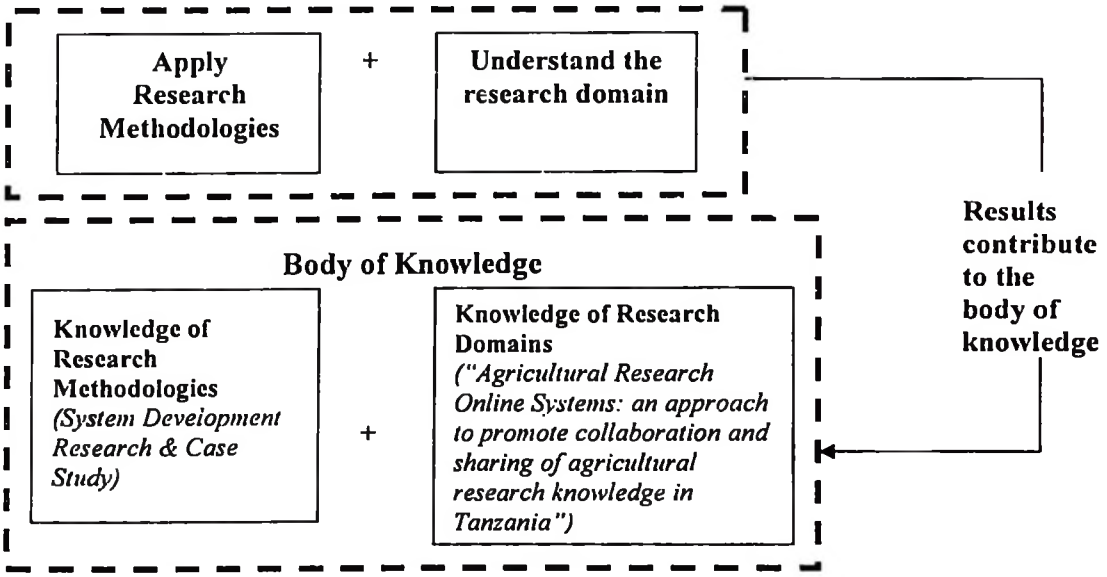
2.8 Conclusions for this chapter

Previous studies show that knowledge sharing activities in developing countries including Tanzania are not satisfactory which is due to poor means of tapping and sharing that knowledge among agricultural researchers. Both CoPs and OA framework present many opportunities for researchers to openly share their knowledge, and increase the visibility of their research results to the global community in the online environment. Open source technology offers alternatives tools that can be used to develop the agricultural research online system with a major focus on both OA and CoPs in order to provide the researchers with many possibilities to openly share and access their knowledge (e.g research results) in the online environment. However, agriculture research institutes need also to enhance knowledge sharing environment such as organizational culture (i.e. norms, values, practices) change, improvement of the physical infrastructure and human resources in order to provide an ideal environment for researchers to openly share their knowledge online.

CHAPTER THREE
RESEARCH METHODOLOGY AND RESEARCH DESIGN

3.1 Introduction

A framework for research, illustrated in Figure 3.1, is a relationship between a body of knowledge (i.e. research domains and research methodologies) and a research process. Research domain is the subject matter under the study. On the other hand, research methodology was taken as a combination of processes, methods and tools that are used in conducting research in a research domain. Further, research process included system analysis and design research and exploratory case study. Research process comprised understanding research domains, asking meaningful research questions and applying valid research methodologies for these questions. Results from the research process contributed to the body of knowledge by promoting clear understanding and enhancing knowledge in a given research domain (Nunamaker et al, 1991).



Source: Adapted from Nunamaker et al., 1991, p. 92.

Figure 3.1: Research processes framework

3.2 Research methodologies

Research methodologies were used as a combination of a continuing process, methods and tools for conducting research in order to inform the readers exactly how research was undertaken and how data was handled. This study employed both system analysis and design research and exploratory case study. Two research methodologies complement and provide valuable feedback to one another. The interaction of the research methodologies is illustrated in Figure 3.2.

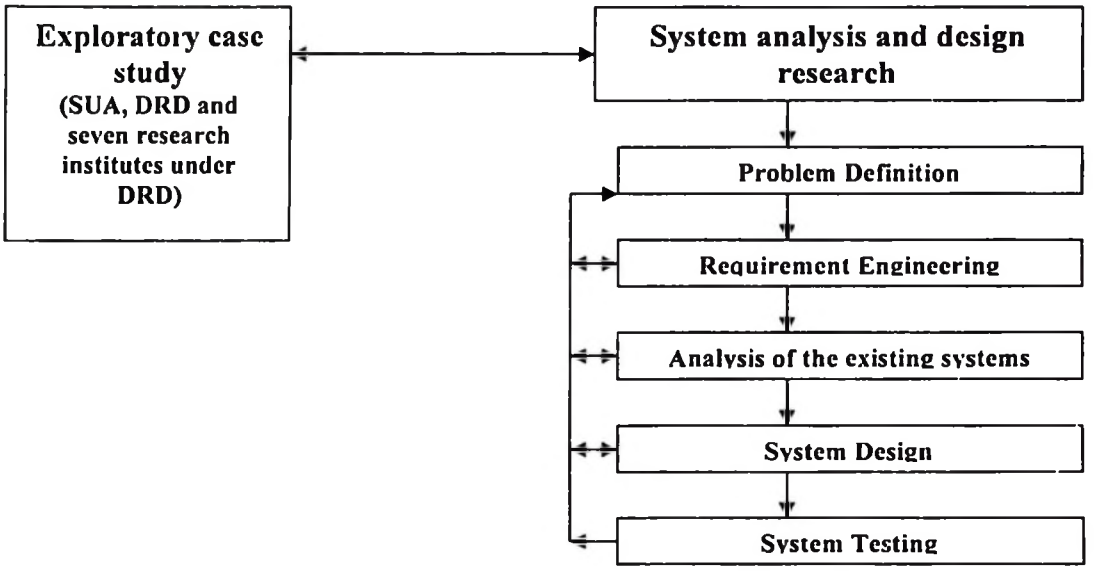


Figure 3.2: Research methodologies

3.2.1 Exploratory case study

Case study research is the most common qualitative method used in information systems (Orlikowski and Baroudi, 1991). Case study is defined as an empirical inquiry that investigates a contemporary phenomenon within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident (Yin, 2002). Clearly, case study research method is particularly well-suited to information systems (IS) research like the one for this study. There are several types of case study methodology in the surveyed literature; some of them include exploratory, explanatory, and descriptive case studies (Yin, 1994).

Explanatory cases are suitable for doing causal studies. In very complex and multivariate cases, the analysis can make use of pattern-matching techniques (Tellis, 1997). Further, the descriptive cases require the formation of hypotheses of cause-effect relationships (Tellis, 1997). In exploratory case studies, fieldwork and data collection may be undertaken prior to definition of the research questions and hypotheses (Tellis, 1997). Where considerable uncertainty exists about program operations, goals, and results, exploratory case studies help identify questions, select measurement constructs, and develop measures. They also serve to safeguard investment in larger studies (Walsh, 2005).

The exploratory case study was therefore selected for data collection in this study due to the limited period of time. The study sample was selected from ten agricultural related research institutes that fulfilled the required criteria, namely the Sokoine University of Agriculture (SUA), the Tanzania Forestry Research Institute (TAFORI), the Department of Research Development (DRD) of the Tanzanian Ministry of Agriculture and Food Security and other seven agricultural research institutes that are under DRD. These institutes were selected based on two criteria, the possibility of collecting data and organizational performance regarding technological issues and sharing of agricultural research knowledge. The main focus of the exploratory case study was to assess the current knowledge sharing processes among researchers and the requirements of both agricultural scientists and information professionals for the developed system. Thus, the collected data were analyzed and used for the development of the agricultural research online system.

3.2.2 System analysis and design research

Systems analysis and design approach generally consists of preliminary investigation, problem identification, requirements analysis, decision analysis, system implementation or design and finally operation and support (Whitten, 2001). For this study, this approach was used in order to evaluate the existing open source Content Management Systems (CMS) and select the system that will further be re-designed to develop the prototype for this study. The functional requirements (both general and technical features and

functionalities) identified from the survey results (requirement analysis) and the literature review were used to evaluate open source CMS. A preliminary set of functional requirements was also identified and used to narrow down the number of the identified open source CMS from sixteen to three systems. These three systems were closely examined by using a set of detailed specific requirements, which involved both general and technical features which led to the selection of the most viable candidate technology. Further, evaluation and selection of the available online communities open source software (i.e. forum and portal open source software) was carried out in order to add some missing features from the selected candidate technology. Eventually, stakeholders such as academicians, researchers, various scholars, librarians and information professionals tested the system behaviours and impacts on any factors of concern in order to refine and improve the system.

3.3 Research design

A research design is the plan, structure and strategies of investigation conceived in order to obtain answers to research questions and to control variance (Kerlinger, 1967). It also provides an overall framework for systematic and feasible methods of data collection, handling multiple natures of data, and analyzing or interpreting the data. Research designs depend also upon statements of problem. Thus, it is a format for detailed steps in a study to tackle previously identified research questions.

3.3.1 Research design framework

Research design for this study based on system analysis and design approach, which comprises the following stages: problem definition (system conceptualization), requirement engineering, analysis of the existing systems, system design and implementation, system testing and documentation, and operation and maintenance. However, for the case of this study, final stages (operation and maintenance) were not conducted since the aim of this study was only to develop the prototype.

1. **Problem definition:** This stage involved the definition of system boundaries and statement of the problem through the following: topic selection, collection of information with respect to topic and problems from literature review and documents.

This also involved knowledge acquisition through a pilot study interviews to information scientists to understand the existing status of the system. This enabled the conception of the study problem, feasibility study and preliminary investigation.

2. **Requirement engineering:** This involved knowledge acquisition through the distribution of questionnaires to agricultural scientists and agricultural information professionals in order to determine their requirement for the developed system.
3. **Analysis of the existing systems:** Both results from literature review and end-users requirements from previous stages were used to identify the functional requirements. Sixteen CMS were identified through market research where they were preliminary evaluated by using the broad functional requirements. This led to the selection of three systems which were closely examined by using the detailed specific requirements. Thus, this led to the selection of the most viable candidate technology. Evaluation criteria to rate each feature on a scale of [0.5] was used as already mentioned. The criteria were evaluated in both general and technical features and functionalities, where each group carried 20% and 80% of the weighted scale respectively. The totals and the weighted scales are provided in the appendix C and D. Further, the evaluation and the selection of the available online communities open source software (i.e. forum and portal software) was carried out in order to add some missing features from the selected candidate technology.
4. **System design and implementation:** Results from the decision analysis stage were used for further development of the agricultural research online system according to user requirements in order to develop a working prototype.
5. **System testing and documentation:** The developed prototype was tested by researchers and agricultural information professionals through questionnaire in order to determine if the system met their needs. Then, recommendations were used to refine the system and the documentation was also prepared.

Research design framework was undertaken in order to provide answers to the identified research questions for this study.

- The first research question (i.e. What is the current status of current state of knowledge sharing activities among agricultural researchers in Tanzania?) was answered at the end of research design Stage 1 and 2.
- The answers for second research question (i.e. What are the problems facing agricultural scientists in sharing information and knowledge online?) was also answered at the end of research design Stage 1 and 2.
- The answers for third research question (i.e. What are the user-requirements and how can they be fulfilled with the open source technology?) was derived from the research design Stages 3 to 5.

3.4 Method of data collection

The study comprised three methods of data collection which included the interviews, questionnaires and documents.

- **Interviews:** This study conducted both unstructured and semi-structured interviews to computer scientists of the agricultural research institutes in Tanzania. Computer scientists were interviewed in order to determine the current status of information and communication technologies within the agricultural research institutes. This enabled the study to understand the agricultural researchers' capacities in participating to share knowledge in the developed system.
- **Questionnaire:** The study employed both open-ended and closed questionnaires distributed via email to both groups of respondents, which were agricultural researchers and information specialists during the requirement engineering phase. Further, questionnaires were also used during the system testing which were distributed to a small group of respondents (i.e. both agricultural researchers and information specialists) to assess the system usability.
- **Documents:** The documents of this study were derived from the written data obtained from related literature, observations, interview transcriptions, written questionnaires, information from the library technologies, other records and publications of SUA and DRD.

3.5 Data analysis

All the derived data were analyzed using SPSS software in order to detect answers for the identified research questions. Answers to the first research question, "What is the current status of current state of knowledge sharing activities among agricultural researchers in Tanzania?" was derived by using content analysis of the documents, questionnaires which were sent to agricultural researchers, information specialists and interviews which were conducted to computer scientists.

The study employed content analysis as a method of data analysis by identifying the material to be analyzed (e.g. conversation, interview, and the content of articles, publication and questionnaire), then classifying and summarizing the findings (Seaman, 1987). Content analysis is therefore defined as a research technique for making replicable and valid inferences from data to their context (Krippendorff, 1980).

Answers for the second research question, "What are the problems facing agricultural scientists in sharing knowledge online?" was also derived by using content analysis of documents and questionnaires which were distributed to agricultural researchers and information specialists.

Answers for the third research question, "What are the user-requirements and how can they be fulfilled with the open source technology?" was derived from the end-users requirements, which were also determined from the contents analysis. These end-user requirements were used for the analysis of various open source technology and further development of the selected system candidate.

3.6 System testing

The developed prototype was tested by the researchers and agricultural information professionals through the distribution of questionnaires in order to determine if the system met their needs. Their recommendations were used for the system revisions and improvement. The documentation was also prepared. Specifically this testing was done at the Sokoine University of Agriculture.

CHAPTER FOUR
SURVEY RESULTS

4.1 Introduction

This study sample was selected from ten agricultural related research institutes that fulfilled the required criteria (see section 3.2.1), namely the Sokoine University of Agriculture (SUA), TAFORI, Department of Research Development (DRD) of the Tanzanian Ministry of Agriculture and Food Security and other seven agricultural research institutes that are under DRD. The questionnaire survey was conducted via email to agricultural researchers and information specialists in these respective research institutes via emails in January 2006. Agricultural researchers were the core group of the survey. On the other hand, information specialists were involved into the survey in order to determine the end-user requirements for the proposed system from the knowledge organizers and providers point of view. On the whole, 55 agricultural researchers and 24 information specialists took part in the survey, with the rate of return of 55% and 64.9% respectively. Some of the major problems that the study encountered were of a technological kind. Some of the respondents could not be reached due to the lack of internet connectivity, and others had connection problems, with regard to downloading and software compatibilities. Hence, most of the times the questionnaire had to be sent again to the respondents via email or via snail mail in a diskette. On the whole, since the focus of this study was to conduct the explorative survey and not necessary a representative survey, the collected data was considered satisfactory.

4.2 Characteristics of the respondents

4.2.1 Agricultural researchers

This was the core survey group since they are the ones who mostly share and use the agriculture research knowledge in order to carry out their research activities. This group comprised more educated respondents by having 49.1% of Phd and 40% of Masters holders as shown in the following table 4.1.

Table 4.1: Description of agricultural researchers

Characteristic		Researchers
Gender	Male	89.1%
	Female	10.9%
Age range	20-29	10.9%
	30-39	34.5%
	40-49	29.1%
	50+	25.5%
Education level	Bachelor	9.1%
	Postgraduate Diploma	1.8%
	Master	40%
	Phd	49.1%

4.2.2 Agricultural information specialists

This group was included in order to determine the end-user requirements for the proposed system from the information organizers and provider's point of view. Unlike the agricultural researchers group, this group contained many educated respondents with Masters' degree (45.8%) and few Phds (12.5%) as shown in the table 4.2. This situation is probably contributed by the unsatisfactory number of information science schools that exist within the country and Africa at large (see section 2.8).

Table 4.2: Description of agricultural information specialists

Characteristic		Information scientists
Gender	Male	70.8%
	Female	29.2%
Age range	20-29	8.3%
	30-39	41.7%
	40-49	29.2%
	50+	20.8%
Education level	Diploma	29.2%
	Bachelor	8.3%
	Postgraduate Diploma	4.2%
	Master	45.8%
	Phd	12.5%

4.3 ICT usage and access in research institutes

ICT status was analyzed in order to determine if the researchers would be able to use the existing ICT infrastructure to share their knowledge in the proposed system for this study.

Results revealed that all agricultural researchers had access to computers, with few respondents who had access to other ICT resources namely, printers (7.3%) and scanners (25.9%). Further, almost all of the surveyed researcher's respondents (98.2%) had access to the internet. However, many researchers (55.6%) were not satisfied with the internet services provided in their institutes, as shown in the following figure 4.1. This was because of the unreliable and slow internet connectivity due to the low bandwidth, few ICT facilities that are connected to the internet, high cost of internet connectivity charged to the research institutes by the internet service providers and unreliable power supply.

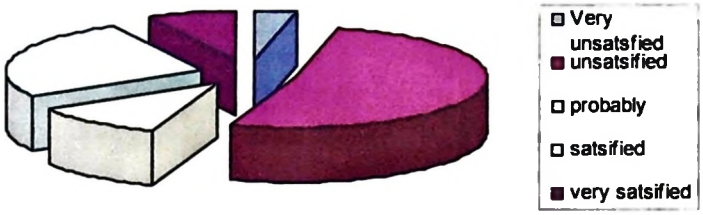


Figure 4.1: Researchers' internet satisfaction level

Despite of being unsatisfied with the internet connectivity, however many researchers (87.3%) proved to be using internet everyday, with a small percentage (10.9%) who acknowledged to be using internet on a weekly basis and 1.8% seldom used the internet.

4.4 Knowledge sharing in online environment by agricultural researchers

Having highlighted the ICT usage in the research institutes, it was important to assess if the agricultural researchers have the knowledge sharing culture. Since the major aim of the study was to develop the system that is aiming at promoting knowledge sharing among researchers. Therefore, the sharing of tacit knowledge was determined by analyzing how aware and how frequent the researchers share their knowledge by using various facilities found in the online CoPs (e.g email discussion groups, instant messaging, online meeting, web conferencing etc). On the other hand, the sharing of explicit knowledge was assessed by determining the rate of awareness, e-publishing and the accessibility of the local content to the researchers within the country. As a matter of fact this involved the evaluation of various online databases that are accessible within the country. The major focus was on OA, although the commercial based databases were also assessed in order to get more relevant results.

4.4.1 Rate of awareness and knowledge sharing activities in online communities of practice

Results revealed that many agricultural researchers (87.8%) were aware about the online CoPs. However, the frequency of using these online communities' resources was not satisfactory as revealed from the survey. Only the email discussion (69%) and instant messaging (56.4%) were more frequently and very frequently used by most of the researchers. The expert databases and search tools (47.1%), online meetings (13.9%) and web conferencing (8.3%) were not found to be frequently used by most of the researchers as shown in the following figure 4.2.

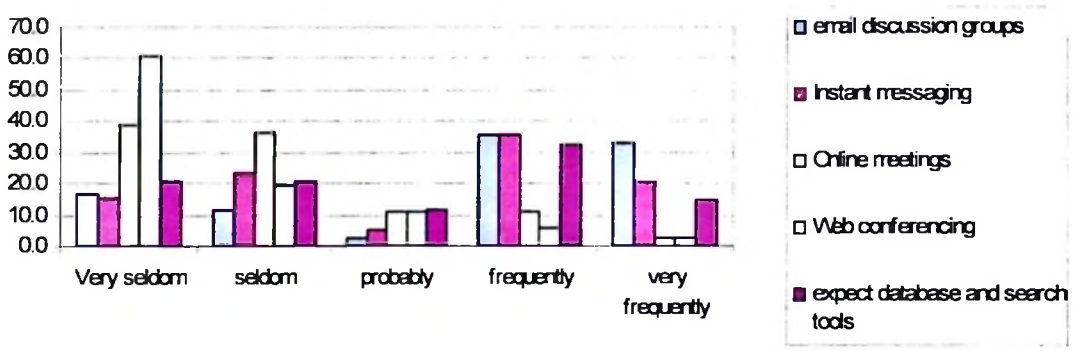


Figure 4.2: Rate of knowledge sharing in online communities of practices by researchers

Despite of low usage rate of these e-resources for CoPs, most of the agricultural researchers (92.5%) highly ranked these e-resources as very useful resources to facilitate the knowledge exchange and sharing.

4.4.2 Rate of awareness, publishing and access of agricultural local knowledge content in the online environment

4.4.2.1 Electronic publishing

Before analyzing the rate of awareness of OA publishing, it was important to determine the level of the respondents' web publishing awareness, since OA publishing centers around the general web publishing. More than half (52.9%) of agricultural researchers were aware about the electronic publishing as shown in the figure 4.3.

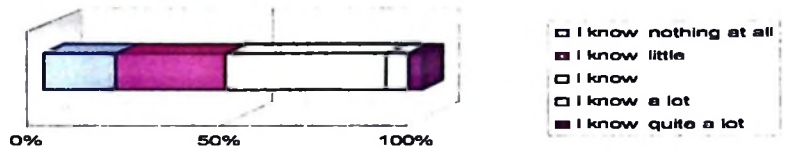


Figure 4.3: Rate of researchers' awareness about electronic publishing

4.4.2.2 Open access publishing

The rate of awareness of OA publishing was also found out to be unsatisfactory. Very few researchers 5.6% admitted that they know quite a lot, 9.3% know a lot and 42.6% acknowledged that they simply know what OA publishing means as shown in the following figure 4.4.

Figure 4.4: Rate of researchers' awareness about open access publishing

Further, researchers publishing rate in OA journals was also assessed in order to determine if the researchers had a culture of sharing their knowledge on the OA venue. Very few agricultural researchers (18.2%) admitted to have published on the OA journals while 70.5% have not published at all on the OA journals but they knew about it and about 11.4% were not even aware about the OA journals.

4.4.2.3 Publishing rate in open access online environment

The analysis was done to determine if researchers do publish on any OA repositories or online systems apart from publishing in OA journals. This included the personal homepage, institutional repository, institution website, and open archive or online database. This was also assessed in order to determine if the researchers had any culture of sharing their knowledge contents in OA repositories or online systems. Results revealed that few researchers (44.7%) had published in one of these OA repositories or systems.

Further, researchers were assessed on how frequent they do publish in these OA repositories or systems. The results discovered the following: from often to very often

categories, few researchers (28.6%) had published on the local online databases, while at least 25% researchers had published on the institution repository and institution website. This was followed by the personal homepage (20%) as shown on the following figure 4.5.

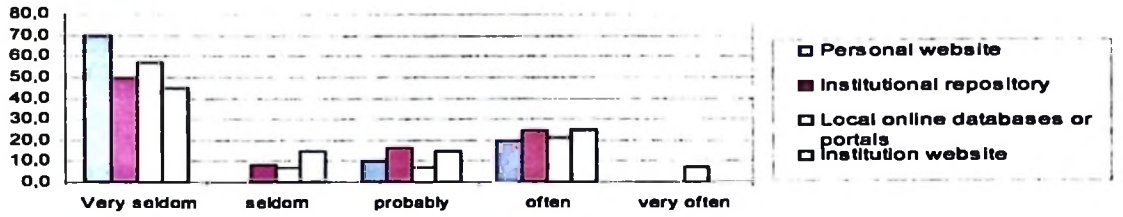


Figure 4.5: Rate of researchers' publishers activities in open access online environment

Agricultural researchers were also asked as to why some of them were not willing to submit and share their knowledge contents on the OA venues. The reasons that were brought forward include the following: (1) fear of intellectual property rights and issue of copyright if the article is published in other journals; (2) confidential policies being imposed by the research funding agencies; (3) Bureaucratic nature of some publishers; (4) lack of relevant facilities and poor technology that could motivate agricultural researchers to submit their knowledge contents online; (5) lack of relevant ICT skills that would enable them to prepare and publish the digital documents; (6) fear of plagiarism and content alterations; and (7) lack of awareness on the electronic publishing outlets such that some respondents acknowledged that they do not know where to submit their knowledge contents (e.g research papers) so that they can be widely accessible online.

4.4.3 Accessibility of local content knowledge from research online databases

Despite of the fact that there is low level of e-publishing activities from the agricultural scientists within the country, however, it was important to assess the extent of local content that can be accessed from the existing databases. This would enable the study to determine if agricultural researchers are satisfied with the local contents that can be accessed from the existing agricultural databases.

Therefore, agricultural researchers were asked to evaluate if the existing databases do provide the access to agricultural knowledge produced from Tanzania or about Tanzania.

This included three types of digital resources, which are CDROM, International and local online databases. CDROM were highly ranked by many respondents (72.2%) from important to very important resources in providing the agricultural local content. This was followed by the International online databases (68.5%) and local online databases (65.6%). On the other hand, these results were also the same when compared to the information specialists' findings. Information specialists highly ranked the CDROM (91.7%) from important to very important resources in providing the agricultural local content. This was followed by the International online databases (87.5%) and local online databases (66.7%). Other respondents also indicated the search engines and other local CDROM as important resources for accessing agricultural contents. However the extent of the information and knowledge that is provided from the locally produced CDROM was not assessed since their production is still low within the country.

4.5 Problems facing agricultural scientists in sharing knowledge in online environment

Problems that face researchers when sharing their knowledge in digital environment (e.g. internet, online database, CDROM, online–based CoPs) were also analyzed. Survey also explored on the possible solutions that can be provided to improve the knowledge environment (i.e. knowledge creation and sharing) within the agriculture research institutes.

Slow internet connectivity (77.8%) was revealed as the biggest problem (i.e. between the big and very big problem) by the agricultural scientists. This was followed by the lack of access to local and regional information (75.5%), absence of online publishing outlets (63.8%), lack of access to current information (63.3%), lack of access to relevant information (62%), few computer facilities (56%) were also highly cited as both big and very big problems as shown in the following figure 4.6.

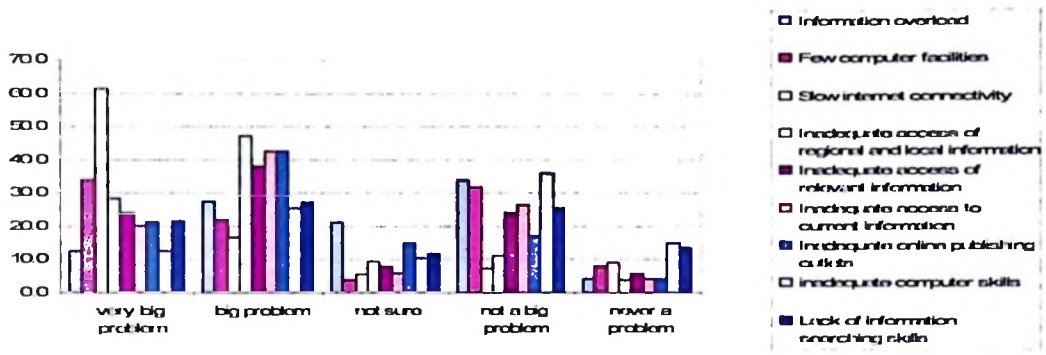


Figure 4.6: Problems that face researchers when sharing agriculture knowledge in online environment

On the other hand, from the information providers' point of view (i.e. the agricultural information specialists), the slow internet connectivity (79.2%) was also referred as the biggest problem (i.e. between the big and very big problem). This was followed by the lack of access to local and regional information (66.7%), few computer facilities (54.2%), lack of access to relevant information (45.8%) and information overload (41.7%). However, some the mentioned problems by the agricultural scientists were not highly considered by the information specialists as big problems that can hinder researchers from sharing their knowledge. Few information specialists considered the following from very big problems to big problems categories: the absence of online publishing outlets (29.2%) and lack of access to current information (17%).

Further, few agricultural researchers (39.2%) proved to possess the basic information literacy skills as acknowledged from not a big problem (25.5%) to never a problem (13.7%). However, 87.5% of the surveyed agricultural research institutes acknowledged conducting the information literacy training to the researchers. Additionally, information specialists indicated that the inadequate information literacy to agricultural scientists was never a problem by 73.9% respondents.

Findings also revealed that more than half of the agricultural researchers' respondents (51.1%) revealed to possess the basic computer skills by acknowledging that it was not a big problem (36.2%) and never a problem (14.9%). Likewise, findings from information

specialists also revealed the same results that the inadequate researchers' computer literacy was never a problem by 70.8% respondents.

Researchers' respondents also pointed out that the financial constraints that face many agriculture research institutes was also a big problem inhibiting them from sharing their knowledge in the online environment. Other problems that were given by agricultural scientists that limited them from sharing their knowledge in the online environment are summarized below: (1) lack of awareness about the whole issue of digital/online resources; (2) lack of the online national agricultural information system that could provide an environment for the researchers to share their knowledge online; (3) CDROMs are not easily availabe to every one. One has to go to the library in order to access them; and (4) poor knowledge sharing culture.

Despite of the mentioned problems, improvement of the ICT infrastructure was seen as the possible and very possible solution to the mentioned problems by most of the respondents by 96.2%. This was followed by the information literacy training (88.5%), development of the local online system that will cater for agricultural knowledge sharing purposes (79.6%), and business proposal writing for funds solicitation (70.6%).

4.6 Requirement for the development of agricultural research online system

The set up of an agricultural research online system was seen as among the very useful solution to improve the collaboration and sharing of agricultural information and knowledge among researchers in Tanzania. It was highly ranked by both the agricultural researchers (64.8%) and information specialists (95.7%).

4.6.1 Preferred features

Important features that are necessary to be included to the proposed system were also analyzed. The online full text databases (96.1%), member networking profiles (92.6%), announcements (92.5%) and subject links (92.3%) features were found to be highly ranked by most of the researchers as important and very important features as shown in

figure 4.7. Other features included the expert databases and search tools (86.5%), user sub groups (81.1%), online discussions (78.4%) and online meetings (71.7%).

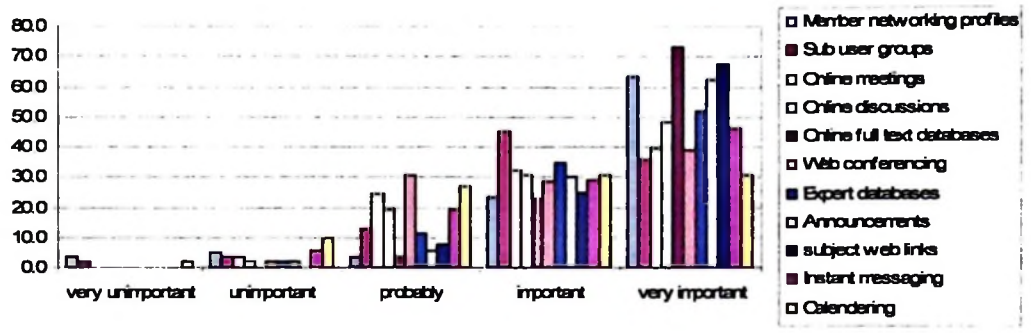


Figure 4.7: Preferred features to be included in the proposed system by researchers

On the other hand, results from information specialists were almost the same as those ones of agricultural researchers. They highly preferred the Online full text feature (95.8%) followed by the online discussions (95.7%), member networking profiles (87%), subject links (83.3%), announcements (79.2%) and expert databases and search tools (79.2%).

4.6.2 Type of information, knowledge and media resources

Agricultural researchers were also asked on type of information, knowledge and media resources that they would prefer the proposed system to include. The scientific journals (98.2%) were highly ranked as relevant and very relevant contents. This was followed by the conference papers (96.3%), technical reports (92.7%), theses (85.2%), working papers (83.3%), handbooks (84.9%), policies (84.6%), newsletter (85.2%), software (83.6%), articles and preprints (81.2%), and images (81.5%) as shown in the following figure 4.8. Findings were also the same when compared to information specialists, who highly preferred the following digital resources (i.e. from very relevant to relevant categories): the scientific journals (100%), followed by the conference papers (95.8%), technical reports (95.8%), working papers (95.83%), thesis (95.7%), articles and preprints (87.5%), and images (86.7%).

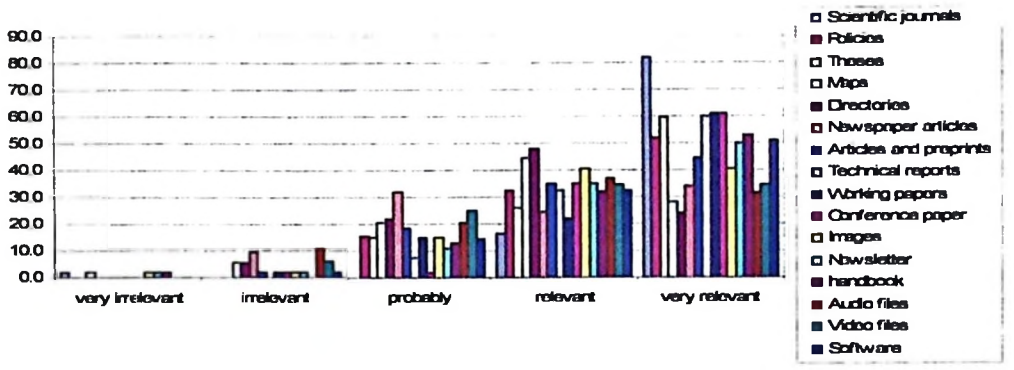


Figure 4.8: Types of information, knowledge and media resources to be included to the proposed system by researchers

4.6.3 Collection development

Many agricultural researchers (89.1%) and all information specialists emphasized that it was from important to very important for the system to allow any researchers, academicians or information specialists to contribute the knowledge contents to the proposed system given that the authorization features will be put in place. Researchers were also asked if they would be willing to contribute or submit their knowledge or information or media materials to the proposed agricultural research online system. Many researchers (88.9%) revealed that it was from possible to very possible for them to submit the conference papers. This trend was followed by the technical reports (81.1%), working papers (81.1), articles from scientific journals (86.8%), newsletters (77.4%), newspaper articles (74%), articles and preprints (68.6%) and theses (56.9%) as shown in the following figure 4.9. Survey also revealed that most of the researchers were not willing to submit images (40%), audio files (18%), video files (20%) and software (28%).

On the other hand, findings were also the same when compared to information specialists, who acknowledged that it was from possible to very possible for their libraries to contribute the technical reports (95.8%), working papers (95.8%), and conference papers (91.7%) to the proposed system. This was followed by the theses (87.5), scientific journals (87.5%), and newspaper articles (70.8%). This was assessed in order to determine if librarians were also willing to archive the past knowledge contents of researchers to the proposed system.

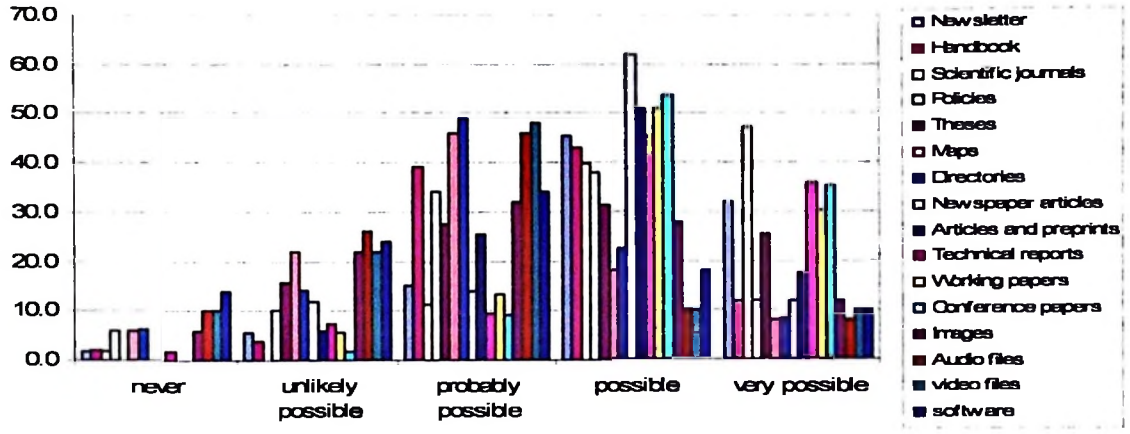


Figure 4.9: Possibility of submitting the knowledge contents to the proposed system by agricultural researchers

4.6.4 Quality assessment of submitted knowledge contents

Both open peer review (i.e. commentaries and ratings) and closed approval process were analyzed in order to determine the preferred method for the quality assurance of the submitted knowledge contents to the online system. Many agricultural researchers (92.5%) and information specialists (79.2%) highly ranked the commentaries and item ratings as important features in order to ensure and continuously improve the quality of the submitted knowledge contents. Most of the respondents, both agricultural researchers (54.5%) and information specialists (66.7%) also preferred to hide their user identity of the item ratings for the privacy purposes. On the other hand, most respondents (81.5%) agricultural researchers and 91.3% information specialists) also preferred the submitted contents to be approved first before they are accessed in order to ensure the knowledge contents quality.

On the approval management aspect, many agricultural researchers (80.4%) and information specialists (73.9%) considered that it was from relevant to very relevant for each institute to independently have its own group of approvers for the submitted contents. On the other hand, as compared to the former response, not many agricultural researchers (70.9%) and information specialists (71.4%) preferred a formation of a nationwide group of people selected from all research institutes to be involved in the approval of the submitted contents.

4.6.5 Preservation issues

Agricultural researchers' respondents were asked to identify how long they would you like the proposed system to provide access to the submitted knowledge and information contents. Most of agricultural researchers (66%) preferred to keep the online contents for a limited period of time (e.g ten years) rather than keeping the knowledge contents for unlimited period of time (47.2) as shown on the figure 4.10.

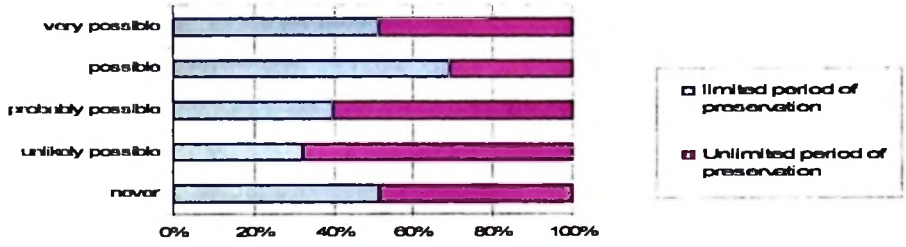


Figure 4.10: Preferred preservation period of digital contents for the proposed system by researchers

Likewise, findings from information specialists revealed same results as agricultural scientists' findings, where most of them (68.2%) preferred to keep the online contents for a limited period of time (e.g ten years) rather than keeping the knowledge contents for unlimited period of time by 41%.

4.7 Role of information specialists for the proposed system

The roles of information specialists were analyzed in order to determine how they will fit in the proposed online system. These roles were determined in the following categories: open access and the community of practices.

4.7.1 Open access

Information specialists were assessed in the following roles in order to enhance the open sharing of knowledge contents: collection management, user education, system development, implementation and maintenance, and archives management.

In the collection management roles, the selection, evaluation and organization of useful website links were highly selected by 92% of respondents from important to very

important categories. This was followed by the evaluation and promotion of information resources (91.7%), assurance of the quality of content and metadata consistency (83.3%), negotiation with the publishers on copyright and open access issues (83.3%), support authors in depositing knowledge materials (83.3%), setting collection management policies (83.3%), setting innovative performance indicators for quality assessment (75%) and create or determine the metadata quality standards (73.9%). Most respondents selected all these collection management roles from important to very important categories.

In user education, both roles of user training and guidance to researchers and promotion of discussions about OA advantages to scholars were highly marked from important to very important roles by all information specialists (100%). Additionally, other roles were also selected between important and very important categories as follows: demonstrate the OA benefits to the researchers (91.7%) and advice and support author on copyright issues (91.3%).

In the system development and implementation process, from important to very important categories, many information specialists (95.8%) highly preferred the provision of the guidance to the definition of the different types of collections to the research community. This was followed by the project management role (91.7%) and possession of a working knowledge of information management software (87 %).

In the archiving content, the archival stability assurance was highly preferred between the important and very important categories by all respondents (100%). This was followed by the establishment of preservation policies (83.3%). One respondent also suggested that the information specialists should be proactive in creating awareness about the knowledge contents which are already archived in the online system.

4.7.2 Community of practices

Information specialists were assessed in the following categories: building, facilitation, and activation of the CoPs to the agricultural researchers' communities. In building CoPs,

the information specialists highly preferred the identification of the existing communities (95.5%) as their important role. This is followed by the conduction of interview (90.9%), market CoPs (81.8%) and act as community champions (77.3%). Generally, all roles were considered as important roles to be performed by the information specialists when building the CoPs.

In facilitating the CoPs, the development of the support strategies for the group learning agenda was highly considered by 87% respondents from important to very important role. Other roles were also considered as important roles as shown in the following figure 4.11.

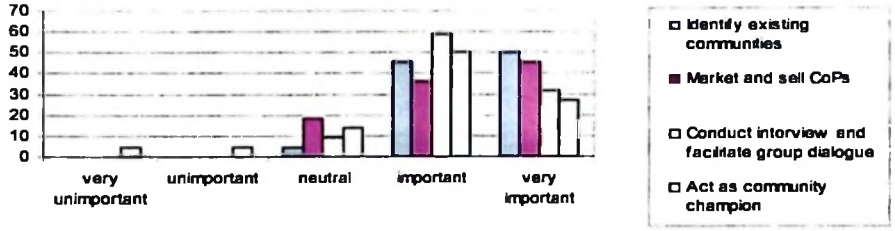


Figure 4.11: Information specialists roles in building the communities of practices

Despite of building and facilitating the CoPs, information specialists also highly selected the following roles in order to ensure that the CoPs do not fail. This included the reunions convention in case of group break up, which was selected from important to very important categories by 87% respondents. This was followed by newsletter publishing (83.3%), CoPs role negotiation (73.9%) and information specialists' assistance in linking the existing CoPs to other communities (66.7%). Generally, most information specialists selected all roles (i.e. OA and CoPs) from important to very important categories which show that all roles were keenly considered as important roles.

4.8 Conclusions for this chapter

Results revealed that agricultural scientists face many problems while sharing their knowledge in the online environment. However, despite of the problems, results show that the set up of an agricultural research online system could improve collaboration and sharing of agricultural knowledge among researchers. Eventually, the implications of these findings are well discussed in the following chapter five.

CHAPTER FIVE
DISCUSSION OF SURVEY RESULTS

5.1 Introduction

The findings of the exploratory study are discussed according to the study research questions, which were as follows:

- The first research question (i.e. What is the current state of knowledge sharing activities among agricultural researchers in Tanzania?) was answered by assessing the awareness, access and usage of ICTs and online systems that focus on enhancing the sharing of the agriculture knowledge within the country;
- Answers for the second research question (i.e. What are the problems facing agricultural scientists in sharing knowledge in online environments?) was answered by looking at the problems that face researchers in sharing knowledge in various electronic systems; and
- Answers for the third research question (i.e. How will the agricultural research online system be developed to enable collaboration and knowledge sharing among agricultural researchers in Tanzania?) was derived from the end-users requirements which included both agricultural researchers and information scientists. These end-users requirements were then used for the analysis and development of the agricultural research online system.

Each of the research questions will now be discussed in detail in the following sections, where the first, second and third research questions are discussed in 5.2, 5.3 and 5.4 respectively.

5.2 Current state of knowledge sharing activities among agricultural researchers in Tanzania

Survey depicted that the current state of knowledge sharing activities in the online environment in Tanzania is not satisfactory. This is mostly contributed by the poor ICT infrastructure and knowledge sharing activities in online environment. The following sections explain how these factors were determined.

5.2.1 Current state of ICT usage and access in the agricultural research institutes

Poor ICT infrastructure was determined by the inadequate internet connectivity that exists in most of the surveyed agricultural research institutes. Although, most of the surveyed agricultural researchers revealed to have the internet connectivity, but they were not satisfied with its speed of which most of the times it was very slow and unreliable due to the low bandwidth. The accessibility of the computers that are connected to the internet was also revealed to be a major problem. For example, one respondent commented that the researchers have to queue to access the computers that are connected to the internet. Other reasons contributing to poor infrastructure were also the unreliable electricity power supply in most parts of the country and high Internet connectivity costs. For example: the internet service is usually over 300 US$ a month which is high as compared to the small budget that the government allocates to the agriculture research institutes.

Regardless of the ICT infrastructure problems, most of agricultural researchers revealed to possess the basic computer skills needed to access and share knowledge in the online environment. Besides, this study was conducted through emails, of which shows that agricultural researchers now have the basic skills that they can use to share their knowledge online. Since the agricultural research online system is expected to use the web technology, then its usage will not impose many problems to the researchers because they have already revealed to possess the basic skills required for such a system.

Further, results also revealed that most of agricultural researchers daily use the internet, with few of them who use it weekly. Therefore, if well implemented and populated with the required knowledge contents, the agricultural research online system could have a high usage due to the researchers' interest and experience of using the internet.

5.2.2 Knowledge sharing activities in online environment by agricultural researchers

Survey results depicted that most of agricultural researchers have poor knowledge sharing culture which limits them to openly share their knowledge in the online

environment. This was indicated by the low frequency of knowledge exchange and sharing activities revealed in most of the online CoPs (i. e web conferencing, online meeting and the expert search tools). This is probably due to low bandwidth that exists in most of the surveyed agricultural research institutes. Only the email discussion groups and instant messaging features were found to be more commonly used and popular known resources for online CoPs to the agricultural researchers. This also depicts that the CoPs already exist within the research institutes; however their importance towards promoting knowledge sharing is still inadequately recognized by the research institutes management.

Despite of having low usage rate, agricultural researchers highly ranked these e-resources for CoPs as very useful services in facilitating the knowledge exchange and sharing. Therefore, this researcher's interest in knowledge sharing should be used to nurture CoPs. This also demonstrates that if this system is put in place, then these resources will have a high usage since the researchers revealed to be interested in using these online CoPs. However, more awareness programs are needed to promote the usage of these e-resources for CoPs of which information specialists together with the top management of the research institutes play a key role in this.

Poor knowledge sharing culture was also indicated by the low rate of awareness and e-publishing activities (i.e all general electronic publishing, OA journals and other OA repositories). This also implies that most of the agricultural scientists including those who work in the field of the agricultural applied research inadequately publish since they are not rewarded. On the other hand, academic staffs of the universities tend to publish on the commercial-based journals, since their rewards and academic reputation are basically derived from their publishing pace. Therefore, more awareness about OA journals and repositories is needed within the country in order to motivate researchers to openly share their knowledge where information specialists have to play a key role in this regard. For example, information specialists need to demonstrate benefits brought by OA movement such as the high level of article citations (see section 2.4.2.2), also publishing in OA

journals allows the authors to maintain their copyrights, and be able to share their publications in any OA repository.

Poor knowledge sharing culture was also indicated by the low extent of local agricultural content that exist in the online environment. Most of the respondents commented that they were not satisfied with the extent of the local contents that can be accessed from the online databases and CDROM. Additionally, findings also revealed that most researchers rely more on CDROM for accessing local agricultural contents rather than the international and local online databases. As brought forward by many respondents, this was due to the slow and unreliable internet connectivity, inability to subscribe to the international databases by most of the research institutes, low level of OA publishing rate and many other problems as discussed in the following section.

5.3 Problems facing agricultural scientists in sharing knowledge in online environment

Inadequate funding was revealed to be the major problem that hinder agricultural scientists to access and disseminate their knowledge contents in the online environment. This is because the government allocates little budgets to the research institutes to run their activities (e.g to invest in ICT development), since all of them are public research institutes. This situation has made most of these institutes to rely on donor support for their ICT investments. Many times, the donor support has also not been enough to solve all the problems regarding ICT developments. Such that, most of the research institutes are now incapable of establishing the required ICT infrastructure with the following: adequate internet connectivity, procuring necessary ICT facilities (e.g computers, CDROM), developing e-publishing outlets or digital repositories, subscribing to the international online databases, and paying for the internet fees etc. For example, one respondent pointed out that the agricultural research institute has to pay 450,000 TShs per month (i.e. 430 Euro) to access internet which is very expensive.

Inadequate access to knowledge that is locally generated was also found out to be another problem. Low e-publishing activities and absence of online publishing outlets that exist

within the country explain why there is this big gap of content divide. Not only this, but also researchers revealed to inadequately have access to knowledge that is current and relevant to their needs. However, survey results show that some of the mentioned problems were not highly considered by the information specialists as big problems that can hinder researchers from sharing knowledge. Few information specialists considered the absence of online publishing outlets and lack of access to current information as big problems. Being the major information providers in the agricultural research institutes, this implies that information specialists still need to conduct more user studies in order to evaluate the impact of their information services. This will also enable them to determine their users' information and knowledge needs as well as their users' information seeking behaviours.

Poor knowledge sharing culture that exists within the agriculture research institutes was also revealed to be another problem that hinders researchers to share their knowledge. Knowledge sharing is not being well integrated into the agricultural research institutes including the universities within the country. The existing organizational norms, structure and reward system do not motivate researchers to openly share their knowledge (e. g. to the OA online systems). The existing reward structures motivate the scientists to collaborate and share their research results through the peer-reviewed journals, not in the OA online systems. Thus, the research institutes need to establish policies which will motivate the agricultural researchers not only to share their knowledge contents in the peer reviewed journals, but also to openly share their knowledge to the OA online systems and fully participate in the CoPs.

Inadequate information searching skills was revealed to also contribute towards poor knowledge sharing culture among agricultural researchers. However, many research institutes admitted to conduct information literacy training in their research institutes. Many information specialists also indicated that the inadequate information literacy to the agricultural scientists was never a problem. This implies that, the information specialists still need to increase their efforts in conducting information literacy (IL) training in order

to equip the agricultural researchers with the necessary IL skills. They also need to conduct user studies in order to evaluate the impact of their training.

Further, poor knowledge sharing culture is contributed by the lack of awareness about the OA issues. Such that most researchers revealed to be scared to openly share their explicit knowledge because they think that they might infringe the publisher's copyrights laws. Other reasons included the following: confidential aspects being imposed by the funding agencies, lack of awareness about the existing digital repository which would allow them to openly share their knowledge contents, inadequate e-publishing outlets, bureaucratic nature of some publishers, lack of relevant ICT facilities to prepare their digital contents, and plagiarism/ content alterations where some of the information may be subjected to "unfair use" e.g. used for profit purposes without the approval of the original author etc.

On the whole, this also shows that the establishment of the local agricultural research online system in Tanzania should contain the application features that will stimulate the level of agricultural researchers in sharing their knowledge online with a greater emphasis on motivational factors (i.e. intrinsic and interpersonal factors) (See section 2.7.2). If well implemented, these application features might promote the knowledge sharing culture among the researchers and hence boost the accessibility and visibility of the local agricultural knowledge (e.g grey literature) both within and outside the country. It will also provide quick access of current and more relevant contents that are required by the researchers, since researchers will be the core creators and disseminators of knowledge.

Apart from the developed system, there was also a feeling that research institutes should take steps in creating the knowledge sharing culture within their institutes. Such as by developing policies that can motivate the researchers to openly share their knowledge in the online environment since their value would not be dissipated. Additionally, the researcher's interest in knowledge sharing should be used to nurture the CoPs and OA models.

Further, the major constraints such as the poor internet connectivity, financial constraints, poor ICT infrastructure (e.g networking, computers, and video conference facilities) will still need to be tackled by the government together with the agricultural research institutes and universities. Such as, by having a national Internet X-Change Point could improve the internet speed, reduce costs and make internet service more affordable within the country. Many respondents also stressed that greater emphasis should be put on the business proposals development in order to solicit funds for the improvement of the already established ICT investments.

5.4 Requirement for the development of the agricultural research online system

The establishment of the online system was then seen by both respondents groups (i.e agricultural researchers and information specialists) as among the solutions that could enable the creation of the knowledge sharing environment in the agricultural research institutes within the country. Generally, findings show that the following application features were highly preferred by both agricultural researchers and information specialists to be included in the proposed system, which are online structured databases, member networking profiles, web-based subject links, announcements, user sub groups, online discussions and online meetings. The inclusion of these application features are expected to motivate the agricultural researchers to share their knowledge online. Such as the user sub groups and member networking profiles can be used for relationship building among researchers.

Broadly, findings also show that both researchers and information specialists highly preferred the following knowledge contents to be included in the online structured databases, which are scientific journals, technical reports, working papers, theses, articles and preprints to be included in the proposed system. However, the inclusion of the articles from scientific journals would be realized if agricultural researchers would publish in the OA journals, or to the commercial journals that support the OA movement.

5.4.1 Collection development

Although the most preferred contents to be included into the system were articles from the scientific journals, but most respondents were more willing to contribute or submit the conference papers, technical reports and working papers rather than articles form scientific journals to the proposed system. Since, the conference papers, technical reports and working papers are not so much imposed by the copyright laws. This also explains why most researchers and information specialists were more willing to submit such types of knowledge contents. The promotion of the OA concepts might encourage authors to submit their knowledge contents to the OA repository like the one which is proposed in this study, since the OA publications are free from most of the copyright issues.

Survey also revealed that most of the agricultural researchers were not willing to submit the images, software, audio and video files. This is because of that most of the researchers do not posses the necessary skills to produce such types of knowledge materials. Generally, this also depicts that there is a lot of knowledge contents that already exist in the hands of agricultural researchers, but it is neither collected nor made accessible via the web, and the libraries or information organizations inadequately collect such type of contents.

On the other hand, findings were also the same when compared to information specialists, who also acknowledged that it was possible for their libraries to contribute the technical reports, working papers, and conference papers to the proposed system. This shows that it is easy for the librarians to archive the mentioned knowledge contents rather than archiving journal articles to the proposed system. So, more awareness is needed to educate them about the OA issues. Many journal publishers now allow the librarians and authors to archive the past documents to their repositories or online systems on OA basis.

5.4.2 Quality assessment of the submitted knowledge contents

Findings show that many researchers and information specialists highly considered the open peer review (i.e. commentary and ratings) as an important process to ensure the quality of the submitted knowledge contents. Both agricultural researchers and

information specialists also preferred to hide their user identity of their item ratings for the privacy purposes. If implemented, this will encourage more researchers to rate the items thus improving and ensuring the quality of the submitted contents, since the user identities will not be revealed by the system.

Apart from open peer-review, many researchers and information specialists also considered the traditionally used, closed approval process as an important process to ensure content quality. In this process, most respondents believed that it is more relevant for each institute to independently have its own group of approvers for the submitted contents from researchers of the same agricultural research institute. If implemented, this would enable quick access of the submitted contents to the system, since each group of approvers will concentrate on its small amount of contents to approve. Additionally, the usage of the open peer-review (i. e. commentaries and ratings) will compliment the approval process in case of its absence in the proposed system.

5.4.3 Preservation issues

Most of the agricultural researchers and information specialists preferred to keep the knowledge contents for a maximum of ten years more than keeping the knowledge contents for unlimited period of time in the proposed system. This implies that both respondents groups were not aware about the advantages that can be brought by the digital preservation. Thus more awareness programs are needed in the research institutes with regard to the digital preservation issues, which can be done through training, workshops, conference etc. With the right preservation policies, planning, funding and the powerful hardware machines, the proposed system can keep the knowledge materials for unlimited period of time and ensure a long-term preservation of the research materials.

5.4.4 Role of information specialists for the proposed system

Results revealed that information specialist' roles for the proposed system should be emphasized on facilitating the OA and the CoPs aspects in order to promote knowledge sharing culture among agricultural researchers. In the OA roles, the survey revealed that

information specialists have to be proactive in collecting the knowledge contents, conducting user education and OA promotion, be involved in the whole process of system development and implementation as well as ensuring the archival stability of the collected knowledge contents. Most importantly is the user education and OA promotion, which if effectively conducted, can contribute towards creating knowledge sharing culture in the agricultural research institutes. On the other hand, results also suggested that information specialists have to be active in not only building and facilitating the CoPs, but they also need to continuously activate them in order to ensure that they are not terminated.

Further, survey also disclosed that the information specialists are well aware about their roles in facilitating OA and CoPs however in practice, these roles are not performed due to lack of enthusiasm, inadequate support from the organizations' top-management, organizational culture as well as the absence of technological infrastructure. Thus, information specialists need to be dynamic in facilitating both OA and CoPs in order to contribute towards the creation of knowledge sharing culture among researchers so that they can be active players in the new era of knowledge society.

5.5 Conclusions for this chapter

Generally, the current state of knowledge sharing activities among agricultural researchers in the online environment in Tanzania is not satisfactory mainly due to the poor ICT infrastructure and knowledge sharing culture. However, both agricultural researchers and information specialists revealed to be interested in sharing their knowledge in the online environment. Hence, the set up the agricultural research online system should contain the application features that will motivate researchers to collaborate and openly share their knowledge by using both the OA and CoPs models. Apart from that, the individual agricultural research institutes, agriculture universities, funding agencies and the government will have also to play a great role in establishing the policies and promoting the importance of knowledge sharing in order to create a knowledge sharing culture and ensure digital preservation.

CHAPTER SIX
ANALYSIS OF EXISTING SYSTEMS

6.1 Introduction

System analysis approach was applied in order to evaluate the existing content management open source software that may provide all or part of the solution needed for the development of the proposed system. The following methodology was used for system analysis approach:

- Identification of the functional requirements through the user needs assessment (i.e. through the exploratory case study) and the literature review;
- Identification of the content management open source software through market research in order to locate candidate technologies;
- Preliminary evaluation of the identified content management open source software was conducted in order to narrow down the scope of the identified software to three systems by using the broadly defined functional requirements; and
- Closer examination of the selected three software alternatives by using the detailed specific requirements in order to select the most viable candidate technology for further development.

Closer examination of the three open source content management systems led to the selection of the Dspace open source software for further localization and development as per user requirements. Further, the evaluation and selection of the available online communities open source software (i.e. forum and portal software) was carried out in order to add some missing features from the selected candidate technology (i.e. Dspace software).

6.2 Functional requirements

Functional requirements identified from the literature review and the end-user requirements for the proposed system fall into the general features and the technical features and functionalities categories

6.2.1 General features

General features include the assessment of the following features: usability, ease of use and user documentation, user adoption or current user community, openness, reliability, scalability and hardware and software considerations.

6.2.1.1 Usability and user documentation

This assesses the accessibility and availability of the end–user documentations, how-to-guides, training and online help/support and the responsiveness of the support that is provided. It also analyzes if the program will require lots of training or is it fairly intuitive to use and how well this program will help an average group of agricultural researches to deliver their knowledge contents online.

6.2.1.2 User adoption or current user community

This assesses if there is a strong development community associated with the program such as the listserv, formal support and bug track or feature request of the systems in order to ensure future support and sustainability. The end-users communities are also analyzed on how active they are, by counting the number of topics and/or posts in the community message boards, forums or mailing lists. It also assesses if the software has a wide geographic coverage and if there are comparable research institutes or agencies utilizing the program.

6.2.1.3 Openness

This analyzes how open is the source code is by assessing if the system allows some level of local customization, such as via Application Programmer Interface (API) which allows programmers to modify the systems functionality. The systems are also analyzed if they have a clear code of specifications for writing new modules.

6.2.1.4 Reliability

This assesses if the system is reliable such as the stored data should not be easily corrupted by defective code, concurrent access, or unexpected process termination

6.2.1.5 Scalability

This assesses if the system is suitable for both small and large installations. The program is also assessed on how easily it can allow for growth of users, content and functionality.

6.2.1.6 Hardware and software considerations

Software is assessed if it runs under any open source operating system. Also other features are assessed which include: the client browser requirements, the database requirements, any additional server software requirement, and the hardware specifications.

6.2.1.7 System administration

This assesses if the system setup or installation by determining if the system has the automated installation script, system update script for the system set-up/installation and system update without over-writing the system customization. This will ensure that the localized system is not overwritten when updating the system. It also assesses if the system can allow the system administrators to track the use and adoption of the system by analyzing the existence of the system generated usage reports and statistics.

6.2.2 Technical features and functionalities

This category include the assessment of the following features: metadata and ontology, collaborative features, presentation, collaborative features, content delivery, preservation and workflow management features.

6.2.2.1 Metadata and ontology

This feature deals with the metadata, content, and other features, which mainly address how to organize the content and its associated metadata in the structured databases for the proposed system. Such as, the selected system should support standard metadata (e.g Dublin Core).

- It should allow metadata review, so that it can be enhanced, corrected and/or approved prior to being made available to the system in order to allow authors to share their knowledge contents and provide their own metadata;

- The system should disallow metadata harvesting. This would effectively disable the repository's interoperability in case it is not needed;
- It should allow metadata extensibility and complexity, since as a lowest common denominator; the unqualified Dublin Core will not be sufficiently detailed to serve the needs of the collections for the proposed system;
- It should allow the metadata records creation, modification or deletion;
- The system should support Unicode character for metadata;
- The system should allow real time updating and indexing of accepted contents; and
- It should support the standard ontology or thesaurus for subject keywords such as AGROVOC or any other.

6.2.2.2 Presentation

This deals with the system's look and feel. Thus, this requires the system to support personalization, email notifications for newly added contents, announcements, feedback facility on systems problems, online help and system usage statistics and reports such as statistics per user logins, items views, most popular searchers etc.

6.2.2.3 Collaborative features

This requires the system to at least have among of the following collaborative features in order to motivate the researchers to collaborate, share and improve the quality of the shared contents:

- Discussions forums with communities and sub communities in order to provide community identity and a sense of belonging for an individual – induce altruistic behaviour;
- End-users commentaries and ratings in order to enhance the quality and relevant information as well as self-reference to ones give out the recommendations;
- End–users profile generation with the end-users document folders and personalized web links in order to build trusted relationships;
- It also requires the system to have the RSS (Really Simple Syndication) feeds features, which are a lightweight XML format designed for sharing headlines and other Web content. The existence of these features is expected to motivate the

researchers to use the system for the purpose of collaborating and sharing their knowledge; and

- Other features include suggest an item, group calendaring and events features.

6.2.2.4 Content delivery

This requires the system to allow both internal and external accessibility and delivery of contents. Internally, the system should allow the individual and volume import and export of contents and its associated metadata in original formats for easy management of the content collections. It should also allow browsing and full text searching mechanisms in order to satisfy the users' needs to access content and metadata. The system should also allow the contents to be indexed by Google or any other search engine for the wider accessibility and visibility of the digital contents.

Externally, the proposed system should allow other systems' needs to access content and metadata. For instance, it should allow the interoperability standards such as Open Archives Protocol for Metadata Harvesting (OAI-PMH) in order to ensure that the implemented online system can participate in a global network of interoperable research repositories. The system should also be both OAI data and service provider. By being Data provider, it will enable the system to expose its metadata (i.e willing to share its metadata), while the service provider will enable the proposed system to use metadata harvested via the OAI-PMH as a basis for building value-added services.

6.2.2.5 Preservation

This requires the system to have the following features:

- System should have persistent document identifier in order to allow the online system to change its internal retrieval mechanisms and/or physical move contents without compromising reference citations and other links. These persistent identifiers always remain valid even were the online system content to be migrated to a new system or were management responsibility for the online system is to be assigned to a third party. Thus ensure the preservation of the contents for perpetuity;

- System should have a defined long-term preservation strategy for submitted content and metadata. These can be important features, as preservation best practice suggests taking steps early in the lifecycle of an electronic resource mitigates the cost and technical difficulty of preserving it in the future. However, a successful digital preservation program also requires extensive policy development, funding, and planning to support such preservation support features;
- System should allow data integrity checks and content version control. Content version control is necessary for legal accountability, backup and disaster recovery; and
- System should also support the preservation of metadata in order to store the technical information that supports the preservation decisions and action, documents preservation action taken, records the effects of preservation strategies, to ensure the authenticity of digital resources over time, and notes information about collection management and the management of rights.

6.2.2.6 Workflow management

This requires the proposed system to support authentication and authorization services and content submission processes. The authentication and authorization services should support the password administration to registered users and user registration verification or any other security mechanism. On the other hand the content submission processes should include the following:

- System should be able to define multiple communities and sub-communities which should be able to contain a set of contents collections (i.e. groupings of related content) and/or groups of users within one installation of the system. Collections should be defined in various ways, including subject matter, content type or purpose, audience etc. This will provide community identity and a sense of belonging for individuals with the same interest in the system;
- System should be able to define a set of different submission roles for each collection e.g. submitters (i.e. for agricultural scientists), metadata reviewers (i.e. for information specialists), approvers or community moderators and system administrators;

- System should allow configurable submission roles within collections in order to allow the proposed system to offer different submission roles and review processes for each collection;
- It should have segregated submission workspace in order to allow users to store incomplete or pre-approval submitted contents;
- System should have the personalized system features for registered users to enable them to view their pending content submissions, pending content administration and approved contents; and
- System should allow the usage of distribution licenses. Such license should be used to request each submitter to grant the proposed online system an irrevocable, non exclusive, royalty–free license to distribute the content, to translate it for the purpose of digital preservation and to maintain the content in perpetuity.

6.3 Preliminary evaluation of the content management systems

Sixteen open source content management software were identified, which included the following: Archimedes, ARNO, CERN Document Server Software (CDSware), Dienst, Dspace, Eprints, Fez for FEDORA, Greenstone, HyperJournal-0.3a, i-Tor, iVIA, Keystone DLS, MyCoRe, OpenDlib, OPUS, Virtual data center (VDC). The preliminary analysis approach was therefore applied in order to narrow down the scope of the identified CMS from sixteen to three CMS packages.

The following broadly defined functional requirements were used to narrow down the scope:

- *Availability and sustainability.* This assesses if the system has wider user community, localization and installation scripts were considered to ensure future support and sustainability;
- *Standards.* This assesses if the systems support any interoperability (i.e. OAI- PMH) and metadata standards (e.g Dublin core);
- *Suitability.* This assesses if the systems provide an intuitive and efficient user interface, as well as if they provide any collaborative features such as commentaries, ratings, email alerts, discussions forums, statistics requirements etc; and

- *Preservation strategy.* This assesses if the systems have any pre–defined digital preservation strategy.

6.4 Closer examinations of the content management systems

The preliminary review allowed the number of the selected software to be narrowed down to three (i.e. Archimedes, Dspace and Fez open source software) for a closer examination. The software were then installed and tested in order to select the most viable candidate technology for further development of the proposed system. The evaluation criteria to rate each feature on a scale of 0 to 5 was used, where 0 = non existent or poor, 3 = an average basic standard and 5 = exceeds standard expectation. The criteria were evaluated in both requirements general and technical features where each group carried 20% and 80% of the weighted scale respectively. The following table provides a general view of the results revealed form both categories. The detailed overview of the evaluation of both criteria categories are shown in the appendix A (i.e Technical features) and appendix B (i.e. General features).

Table 6.1: Closer examination of the open source content management software

Criteria (0 = non-existent or poor , 3 = an average and 5 = exceeds standard expectation)	**Archimede**	**Dspace**	**Fez**
1. Technical features *(Weighted at 80%)*	39.11%	51.81%	43.43%
2. General features *(Weighted at 20%)*	1.54%	1.89%	1.68%
Maximum weighted scale	**40.65%**	**53.7%**	**45.11%**

6.5 Selection of the candidate system for further development

Based on the feasibility analysis, Dspace open source software received the maximum weighted scale (53.7%) than other candidates as shown in table 6.1. Dspace open source software was also selected because it possesses most of the desired features that were needed for the proposed system. Summary is also given below on how the decision was made about Dspace open source software, while the further design of the Dspace open source software is well explored in chapter seven of the system development.

6.5.1 Archimedes

Archimede open source software is flexible and not dependent on a specific platform. It is developed by using java and lucene is used for search engine purposes (Archimede, 2006).

Presentation features: Apart from Dspace, Archimedes is also developed in a multilingual perspective, which enables the users to switch easily from one language to another anywhere and anytime during his search and retrieval process. However, it does not support systems generated usage statistics and reports which was also the required feature for the proposed system.

Collaborative features: Apart from Fez and Dspace, it also has collaborative feature where the end-users document folders are supported. This feature allows the end-users to store the repository contents in the personalized document folders within the system

Preservation features: This candidate lacks data integrity checks which were also the most desired feature for the proposed system. Further, it only supports the persistent URL for access to the content, but does not consider any methods to deal with an object's changes in the future.

Metadata and ontology features: Archimedes uses a Dublin Core metadata set, but there is no support for extended metadata. Presently, there is no support for any vocabulary/ontology although there is a future development for the controlled vocabulary application. This application is expected to automatically generate a proposed set of controlled vocabulary subject headings by translating them from the text and the abstract.

Content delivery features: Its most enhanced feature is on full text searching, where it allows the usage of word stemming. Word stemming enables the search to return results based on the root form of a word (e.g "land" will also match "landed", "landing" and "lands") thus bringing better search results.

Workflow management features: Archimedes allows the definition of multiple communities and collections; however it is the only candidate that does not allow a set of different submission roles per each collection. It only has few submission roles (i.e administrator, community administrator and user), while the desired submission roles for the proposed systems are four (i.e. submitters, metadata reviewers, approvers and administrator) in order to suite different needs of the stakeholders for the proposed system (i.e. researchers, information specialists, selected approvers and system administrators). It also does not support any distribution license, which is also a desired feature for the purpose of digital preservation.

System features: The installation process of Archimedes is not very simple, it needs effort to set and install a whole system due to the license issue of the open source software. However, with the provision of a standalone system, it simplified the evaluation and testing processes of the whole system since it only required a single installation.

Other features: Most of the documentation and user support community forums are based in French language, which imposed some limitations (i.e. language barrier) for the implementation and future support of the proposed system.

To sum up, Archimedes is the only software among the surveyed ones that has been developed in a multilingual perspective which enables the users to easily switch from one language to another anywhere and anytime during his search and retrieval process. However, it lacks data integrity checks, it has limited collaborative features and its workflow process is only limited to three roles which shows some limitations for the proposed system.

6.5.2 Fez

Fez is also the open source software to produce and maintain a highly flexible web interface to FEDORA (i.e Content management open source system) for publishing or archiving documents of any type sustainably (Fez, 2006). FEDORA is not a complete institutional repository software application out-of-the-box, it is repository storage layer

software, and accordingly needs workflow management and user interface front-ends to perform as an institutional repository, or indeed to perform any specific digital library function. Fez is among the well advanced open source web interfaces to FEDORA developed by using PHP and MySQL.

Presentation features: Apart from Dspace open source software, fez also supports the basic image handling through the AJAX based Image datastream previewer. Apart from Dspace, it also supports usage of reports and statistics with another added feature of personalized services e.g. authors can view the statistics on use of their research material.

Collaborative features: Like other surveyed candidates, it also allows permissions to be set in order to allow a group of researchers to work on a certain project before publishing that research project to the public. The future released version (i.e. 1.3) is expected to support more collaborative features such as annotations, commentaries and tags.

Preservation features: Each object (whether a single object, a collection or a community) has layers of associated metadata-structural, rights, and preservation. This ensures that all objects in the repository remain usable over the long term. It also supports automatic metadata preservation extraction.

Metadata and ontology features: It supports the Dublin core metadata and other metadata standards. It also supports a set of different metadata per each collection. Controlled Vocabularies/ontology based on Australian Standard Research Classification is also supported. The extensibility of the controlled vocabulary is also allowed.

Content delivery features: It supports OAI-PMH 2.0 as a service provider as well as supporting the persistent URL for access to the content. However, it does not consider any methods to deal with the future object's changes. It also does not support full text searching, however it supports basic browsing and searching which imposes some limitations for the proposed system.

Authorization, authentication and content submission features: It supports LDAP (or Active Directory) and internal group Authentication and Authorization. Its security is based on FezACML to describe user roles and rights per object basis or through parent collection or community security inheritance. This can enable the online system to limit some materials to a certain group of people. It also allows the GUI configurable document workflow and document lifecycle management. Fez workflow is also configurable which enables it to be adapted to suit a variety of situations including the proposed system. Fez workflow also allows the definition of a set of roles that can be associated with each object, which include the creator, editor, approver, commentator, annotator, community administrator.

System features: Fez installation process is also not simple due to license issues of multiple open source packages utilized in it. Experience shows that it also takes some efforts to get it running.

Other features: Most of the Fez administrative tasks are performed centrally using the administration user interface, part of the Web UI. Additionally, Fez system has been designed to be as flexible as possible.

On the whole, Fez open source software adds more innovative new features although it has similar functionality with the other surveyed software. However, Fez was not selected for further development since Dspace open source software showed more future sustainability for the proposed system, which is due to its wide coverage and its quick development which is more contributed by the collaborative effort through the Dspace users' community.

6.5.3 Dspace

Dspace is digital institutional repository open source software designed to preserve, index and redistribute the intellectual output of an organization in digital formats (Dspace, 2006). It is the only software among the reviewed packages that has a worldwide usage.

Dspace open source software is developed by using java with postgreSQL or oracle as databases back-end.

Presentation features: Dspace open source software is the best among these candidates as its theory is to make the content outlast the system. It supports modification of the user interface to local context with user notification on current tasks and system usage statistics and reports.

Collaborative feature: Just like other candidates, it also has a supervision order system which can allow a group of users to work and collaborate on a particular submission in someone's pre-submission workspace. However, through the various add-ons features, Dspace supports a large number of collaborative features, such as suggest an item and researcher's pages through the add-on feature. The researcher page allows users to create their own web pages, end-user documents (i.e. like in Archimedes software), personalizes web links and members profile. All these features present an opportunity for the researchers in the proposed system to be motivated to collaboration and share their knowledge.

Metadata and ontology feature: Dspace open source software also support Dublin Core metadata standard and a vocabulary/ontology through the add-on features.

Authorization, authentication and content submission feature: Dspace's authorization meets almost all of the user requirements, since it allows the definition of multiple user groups and users, which include: general users, submitters, reviewers and approvers. It also allows the definition of multiple collections, where different submission parameters for each collection can be set. This is a good feature for the proposed software to allow users to have different submission criteria for different collections. It also supports the distribution license which can enable the proposed online system host to administer and disseminate the materials submitted to repository.

Content delivery feature: It also supports OAI-PMH 2.0 as a data provider. Its most enhanced feature is on full text searching, where it allows its digital contents to be indexed by Google or any other search engine. It also allows the usage of word stemming searching through its descriptive metadata thus bringing better search results.

Preservation feature: The implementation of a CNRI (Corporation for National Research Initiatives) handle system in Dspace open source software advances an additional step above the concept of persistent URL, which allows an object to persist over its changes in location/system and to be accessed in the future which is a desired feature for the proposed system. It also keeps a file's original name, size and created date. Additionally, it also has built-in data integrity check by using MD5 (a "message digest" algorithm for security applications) to ensure the correctness of each file.

System features: The installation process of Dspace open source software is also not simple due to license issues of multiple open source packages utilized in Dspace open source software. The experience shows that it takes some efforts to get it running.

Other feature: Among the three systems, Dspace open source software has the most extensive documentation, ranging from the system architecture to developer resource. Presently, the majority of Dspace administrative tasks must be performed centrally using the administration user interface, part of the Web UI. Web UI can easily be customized by using the style sheets and layout jsp.

As a matter of fact, all the surveyed candidates have shown to consist most of the desired features for the proposed system. However, Dspace was selected since it received the maximum weighted scale (53.7%) in the feasibility analysis when matched against the user requirements. Dspace open source software was also selected because it is a mature, robust product with a wide usage and quick development being contributed by the collaborative effort through the Dspace users' community which ensures future sustainability. It also contains most of the desired features required for the proposed system which were not found in other systems such as CRNI handle used for preservation

of digital contents, the researcher's pages which allow authors to create their own web pages, end-user documents, personalized web links, member profiles etc, which allow some form of collaboration and motivation among researchers to share their knowledge contents etc.

6.6 System analysis for additional modules to Dspace open source software

Since Dspace open source software does not possess all the required features such as the online discussion and subject web–based features, it was then important to analyze the available open source software in order to identify the right candidates for these features. Five forum open source software were then identified and analyzed in order to select software that is appropriate for the implementation of online discussion forum. This included the MyBB, UseBB, phpBB, XMB, SMF forum software where the SMF software was selected. This is because it was easy to install, and it composes most features which were required by agricultural researchers. Those features include the following:

- Comprehensive template system which allows forum members' personalization;
- Advanced permission and user management–major actions are time and IP locked, preventing 'hammering';
- It allows users to search the entire forum, a category/ board or within a topic or their own messages;
- It allows the system to set different forums categories and sub–categories with various permissions to member groups, including guests only. This is a useful feature since it focuses on relationship building among researchers;
- It can be integrated into existing system such as the proposed system for this study by using SSI or PHP;
- It supports WAP, WAP2 and I-mode protocols where the users can browse through boards/topics/messages with reduced page size. Also users have ability to post new messages as well as login and logout (not with WAP 1) ; and
- Other features which can be viewable to the public include news, announcements, calendar which shows various events, recent topics or posts and old posts, recent news posts in a board, recent polls, and attachments. It also includes several

forum statistics and list of users online which are accessible by permission. Additionally, the forum data can be exported by using XML/RSS in the latest members, news, recent posts.

For the web–based subject links, five portal open source software were also identified and analyzed. This included the CMS made simple, EcwCMS, eZpublishing, Joomla, MODx where Joomla portal software was then selected for the implementation of the web-based subject links. This is because it possesses most of the required features for the proposed system such as it was easy to install, edit and customize according to the local user requirements. It also has the following modules which are desired for the proposed subject guide to be included in the proposed system for this study: full text searching capability, news, web-based subject links, templates that can be customized, contact management module, polls module, menu and banners modules which can be customized. It also allows settings of syndication and also definition of the categories and sub-categories into the subject links, which was also the desired feature. Since these categories settings can enable the developed web guides to have a sense of belonging for individuals with the same interest in various categories in the subject web guides.

6.7 Conclusions for this chapter

System analysis approach was used in order to evaluate the existing open source content management systems (CMS) in order to select the system that will be further designed to develop the prototype for this study. Functional requirements identified from the survey results and the literature review were used to evaluate the open source CMS. Sixteen open source CMS were identified and preliminary evaluated, which led to the selection of the three systems (Archimedes, Dspace and Fez open source software). Closer examination of these three systems led to the selection of the Dspace open source software with a maximum weighted scale of 53.7%. Further, the evaluation and selection of the available online communities open source software (i.e. forum and portal software) was carried out in order to add some missing features from the selected candidate technology (i.e. Dspace open source software).

CHAPTER SEVEN

SYSTEM DEVELOPMENT AND IMPLEMENTATION

7.1 Introduction

System development process aimed at developing the Agrinet-Tz prototype in order to promote the sharing of knowledge among researchers through the CoPs and OA models. Since the survey results revealed that there is poor knowledge sharing culture among the agricultural researchers within the country, the system therefore contains the application features that are focusing on the individual factors (intrinsic and interpersonal motivational factors) in order to motivate researchers to share their knowledge online. Although, knowledge sharing in the OA model depends mostly on awareness programs and policies, but for this case, it will depend mostly on the initiatives taken by the agricultural research institutes, the government and funding agencies rather than the developed system. Such initiatives may include policy development, changing knowledge sharing culture etc. Thus, Dspace software together with other selected software (i.e. forum and portal software) were further customized and developed with a major focus on these motivational factors. The different roles for the developed system users were also identified at the end of the system development.

7.2 Selection of relevant features for technical application

A ready-to-go prototype based on Dspace open source software original version (release 1.3.2), immediately available together with other selected software (i.e. forum and portal software), was further customized and developed. The following application features which focus on motivational factors were included into the developed Agrinet-Tz prototype:

i. *General knowledge sharing features* are expected to motivate researchers to participate in the developed prototype. This includes the online structured databases, web–based subject links, announcements, frequent asked questions etc

ii. *Relationship building features* include the following categories:
    - *Individual identity and profile generation features* are expected to build the trusted relationships among researchers. This includes the personalized members profile with the end-user documents and user-personalized web links features;
    - *Sub-community organization feature* is expected to provide the community identity and a sense of belonging for an individual to a community, thus induce altruistic behaviour. The application features include the user groups and user sub-groups, set-up of communities and collections in the online structured databases, online discussion groups, and the web–based subject links; and
    - *Other features* are also expected to motivate researchers to share their knowledge online. This includes online discussion, online calendar and events, suggest an item from the online structured databases, suggest a link from the web–based subject links, RSS (Really Simple Syndication) feeds etc.

iii. *Reviews and peer recommendation feature* in order to increase the quality and relevant information as well as self-reference to ones give out the recommendations. This includes the set up of the user polling system on the web–based subject links module and the user–ratings feature in the online discussions module.

7.3 Prototype development

Dspace open source software was already found to contain most of the needed features such as online structured databases with a suggest an item feature, RSS feeds, user groups and sub-groups, communities and multiple collections, etc. Therefore, within this work, the following features were added to the Dspace open source software in order to meet the user requirements:

- Customized user interface to include different features such as the frequent asked questions, copyright and policies;
- Web–based subject links was integrated as a module through the customization and development of the Joomla open source software;
- Online discussions (with other features like online calendar and events) were integrated as modules through the customization and development of the SMF open source software; and

- Other features were also added from various add-on packages from the Dspace community, including the researcher pages add-on (i.e. personalized end - user documents, user personalized links, members' profile) and the controlled vocabulary.

7.3.1 Customized user interface

The user interface was customized to include various features such as the frequent asked questions, copyright and policies etc as shown in the following figure 7.1.

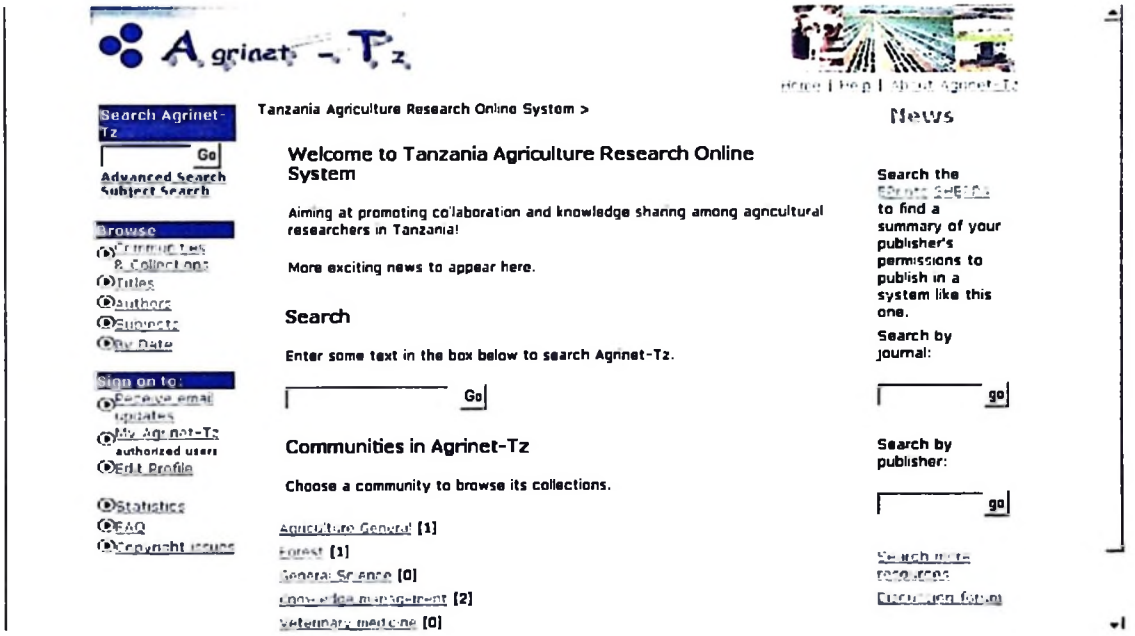


Figure 7.1: Customized user interface

7.3.2 Web–based subject links

The web based subject links was integrated as a module to the Dspace open source software through the customization and design of the Joomla open source software. This module will enable researchers to search or browse web-based subject links which relate to their specialized fields. Researchers will also be able to rate the site by polling and they can also receive the newly added web-links via the RSS feeds. They can also suggest a link which they think that they are useful to be included in the system via a suggest link feature as shown in the following figure 7.2.

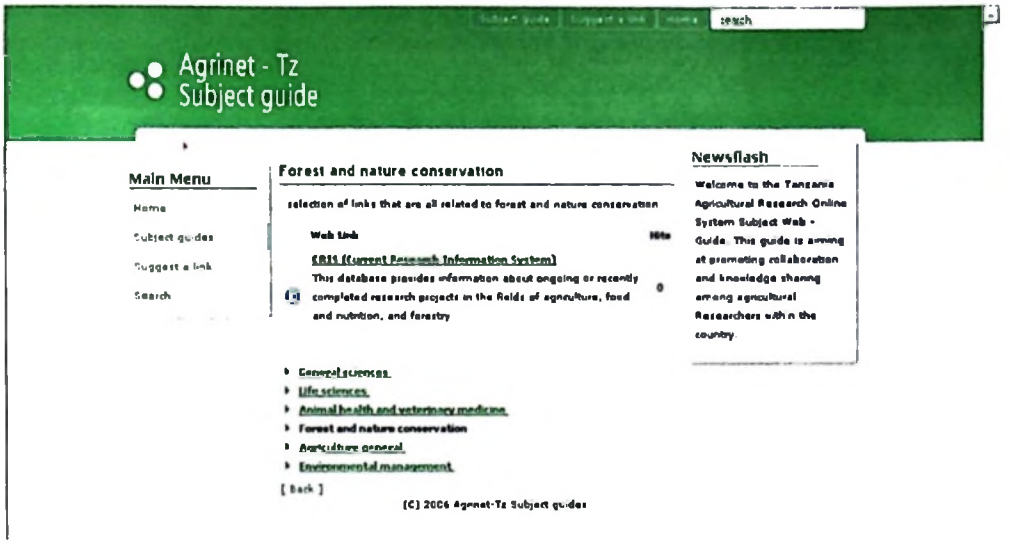


Figure 7.2: Web-based subject links

7.3.3 Online discussions with online calendar and events

Online discussions with online calendar and events were integrated as modules to the Dspace open source software through the customization and design of the SMF open source software. This module can enable the researchers to post their ideas, search for recent and old discussions, they can also rate the discussions, view various statistics, view who is online, they can also use the calendar to view various events (e.g conferences), they can also post various events which they think are necessary to be seen by others as shown in the following figure 7.3.

Figure 7.3: Online discussion forums

7.3.4 Researcher page add–on

This add-on allows systems' users who have opted to be designated as "researchers" to create a customized page to display their personal profiles and their work to the world in an organized and unique manner via personalized web folders. The tool also allows researchers to link to external works that extend or complement their works that are within the system via personalized links. Researchers can also decide to either make their customized paged private or public to be viewed by everyone. This is a feature that if used effectively, could promote researchers in Tanzania to collaborate and share their research outputs as shown in the following figure 7.4.

Figure 7.4: Researcher page

7.3.5 Controlled vocabulary add–on

The controlled vocabulary add-on enabled the system to allow users to use a confined set of keywords to describe their submitted items and also to search for items within the system. Controlled vocabulary is important since it eliminates the ambiguity of a free description system, consequently simplifying the task of finding specific items of information as shown in figure 7.5. This add-on also allows users to choose from a defined set of keywords organised in a tree and then use these keywords to describe items while they are being submitted..

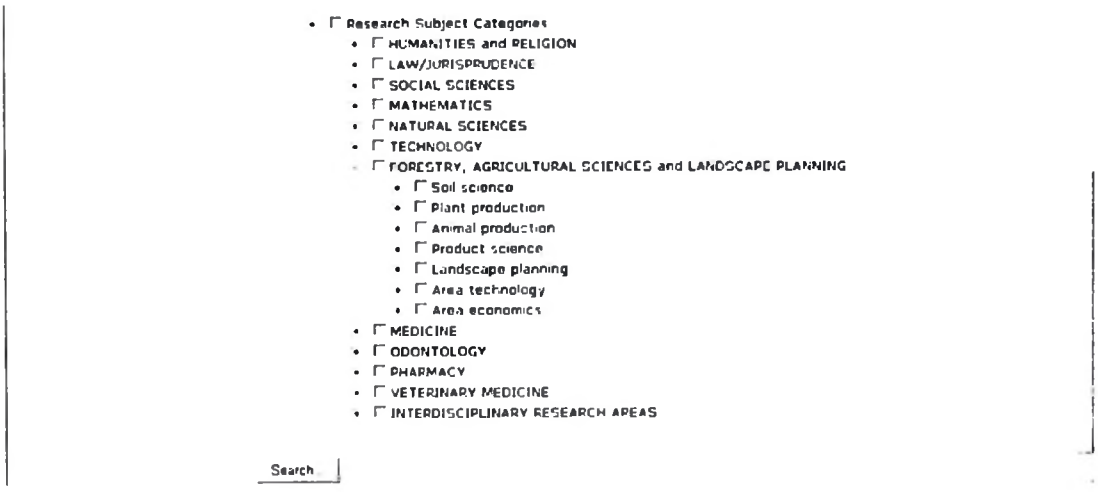


Figure 7.5: Controlled vocabulary

7.4 User roles in the developed prototype

Generally, the developed prototype allows the users in the following categories to perform various functions. Those categories include the system administrator, agricultural researchers, approvers, information specialists and viewers.

7.4.1. System Administrator

This group will mainly involve computer scientists in the selected agricultural research institutes who will be responsible to administer and ensure data integrity of the system as explained below:

- Create and manage users and user groups of the repository;
- Create authorization schemes for users and types of research material;
- Create meta-data schemes to be associated with research material; and
- Create workflow schemes to manage the status of research material.

7.4.2 Agricultural Researcher

This is a core user group of the system, since they will be the core knowledge creators and disseminators. However, some of them can also be involved in approving and moderating the knowledge contents in the developed system. The core roles of agricultural researchers are outlined as follows:

- Self registration to the online system;
- Upload, update or remove their research material from the repository with a given permission;
- View the research material they have added to the repository;
- Suggest a useful research material to a colleague;
- Create and share their materials through their end-users document folders;
- Create and share their personalized links;
- Share their member profiles through the customized researcher pages;
- View statistics on use of their research material;
- Request the community moderators to set permissions which will allow a group of researchers to work on a certain project before publishing that research project to the public;
- Share their ideas and knowledge via discussion forums where they can post their ideas, rate their ideas via the polling system, search the recent and old posts. It also includes several forum statistics and list of users online which are accessible by permission;
- View calendar which shows various events (e,g conferences and workshops); and
- Search for more resources via a subject–web based links and also suggest a link which they think it is useful but it is not included into the system.

7.4.3 Approver or community moderator

This should be a selected group of agricultural researchers from agricultural research institutes, who will be responsible for the knowledge contents submitted from each institute. They will be responsible to either approve or reject the submitted items as part of a work-flow by setting its status according to workflow rules. They will also be responsible in the following areas:

- Work together with the information specialists in setting collection development and management policies to the researchers in order to ensure the quality of the submitted contents; and
- Work together with the information specialists in order to motivate the researchers to share their knowledge contents online. This can either be by

sending reminders or setting the online discussion group which will mainly contain issues that focus on motivating the researchers to openly share their knowledge in the developed system. Thus, creating knowledge sharing culture among the researchers etc.

7.4.4 Information specialists

This group will involve information specialists who will work together with the approvers/community moderators and the systems administrators with major focus on the following roles:

- Work together with the community moderators in setting collection development and management policies and practices including copyright issues;
- Provide guidance to define different types collections to the research community
- Create or determine metadata standards tailored to individual collections' unique content and goals;
- Review and manage submissions for the quality of content and metadata consistency (i.e. Editing metadata records) as part of a work-flow by setting its status according to workflow rules;
- Add / Modify meta-data about submitted material;
- Train the researchers on how to submit the knowledge contents in the proposed system in order to motivate them to participate in the developed system;
- Support authors in depositing materials in the system on behalf of them and undertaking file formatting and conversion;
- Establishing preservation policies and ensure archival stability;
- Upload multiple items (e.g scanned images) and add metadata about those uploaded items for archival purposes;
- Keeps track of which items need metadata;
- Identify the existing communities of practice and facilitate them via the online discussions forums;
- Work together with the community moderators in setting up and activating the discussion groups in order to motivate the researchers' participation level in the developed system. For example the demonstration of the various benefits that are

brought by open sharing of knowledge such as high article citation level (see section 2.4.2.2) can motivate the researchers to share their knowledge in the developed system;

- Ensure data integrity; and
- Selection, evaluation and organization of useful website links.

7.4.5 Viewer

This involves web-browsers who are not subscribed to submit their contents to the developed system. Therefore this group will be able to perform the following in the developed system:

- Search the repository by either a keywords with dependencies on meta-data or full–text searching;
- Search and view various researchers profiles which have been made public with their personalized links and documents;
- Search for more resources via a web-based subject links; and
- Search and view various posts on the discussion forums.

7.5 System evaluation

The developed system was tested at the Sokoine University of Agriculture (SUA) in Tanzania in order to assess the user acceptance. 14 agricultural researchers and 8 information scientists who had already participated in the former exploratory study were therefore selected to test the developed system in order to check the system usability and "look and feel". Then, their feedback was used to refine and improve the system. As a matter of fact, the system was tested in the following categories: general knowledge sharing features, relationship building features, quality assessment, user support submission features and the approval system.

The agricultural researchers' response to the general knowledge sharing technical features was simply positive where almost all features were highly ranked from good to very good features as shown in the figure 7.6. Such features include structured databases (100%), Calendar (100%), Email alerts (92.86%), subject links (92.86%). Almost the

same results were revealed from information specialists' respondents, where the following features were highly ranked by 100%, which include structured databases, RSS, metadata standards, subject links, email alerts, and suggest a link.

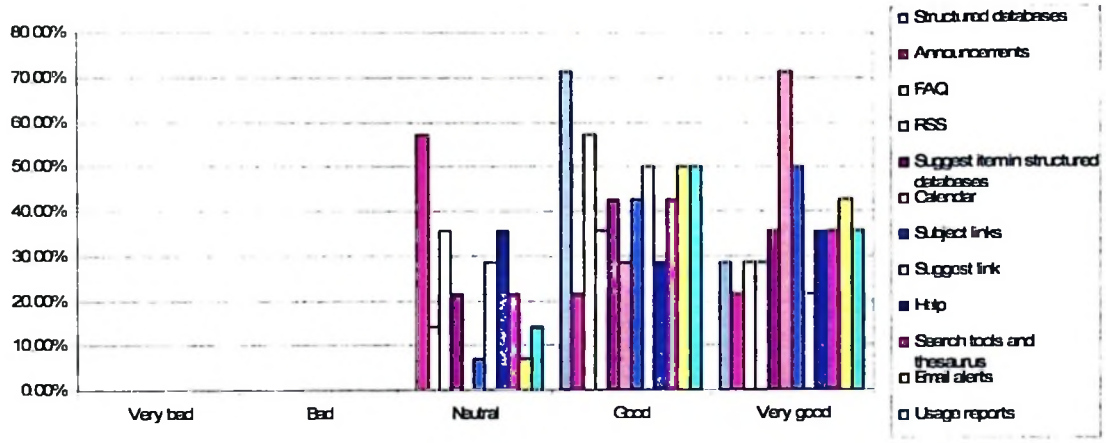


Figure 7.6: Evaluation of the general knowledge sharing features by agricultural researchers

In the relationship building features, almost all features were highly ranked from good to very good features in promoting relationship/networking among researchers. In the agricultural researchers' respondents category, the features that were highly ranked as shown in the figure 7.7 are as follows: the suggest links (100%), subject links (92.31%) and the communities and collections in the structured databases (90.91%). Whereas, in the information specialists' category, the following features were highly ranked with 100%, which include the communities and collections in the structured databases, communities and collections in the online discussion, RSS, calendar, and subject links.

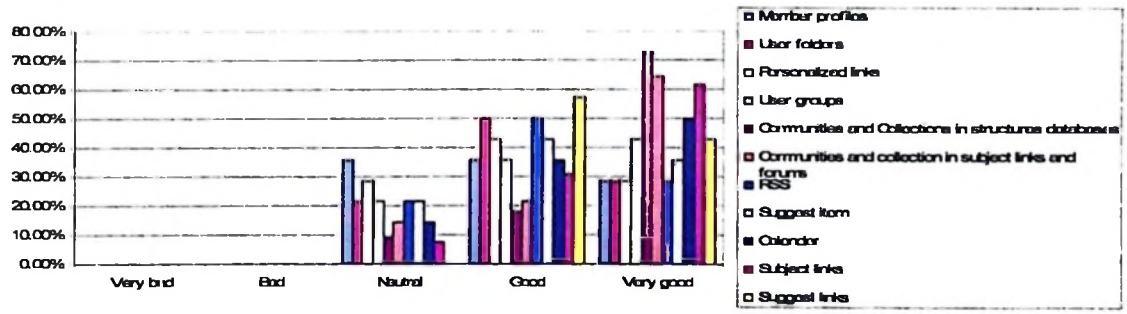


Figure 7.7: Evaluation of the relationship building technical features by agricultural researchers

In the evaluation the systems features which will be used to ensure the quality of the shared knowledge, the agricultural researchers highly preferred the user ratings (85.71%) rather than the polling features (71.43%), while the information specialist highly ranked both features by 100% from good to very good. Thus shows that both technical features were highly preferred by both respondents groups from good to very good categories.

In the user-supported submission features, all features were also highly preferred by both respondents groups from good to very good features as shown in the following figure 7.8 by the agricultural researchers' respondents. Such highly preferred features include the license request (87.5%), email notifications for submitters (86.67%), view pending submissions (84.62%), view approved contents (83.33%), view pending administration tasks (84.62%) and the whole submission process (84.62%). Results were the same to the information specialists' category, where the following features were highly preferred by 100%, which include the license request feature, email notifications for submitters, email notifications for administrators, view pending submissions and the whole submission process.

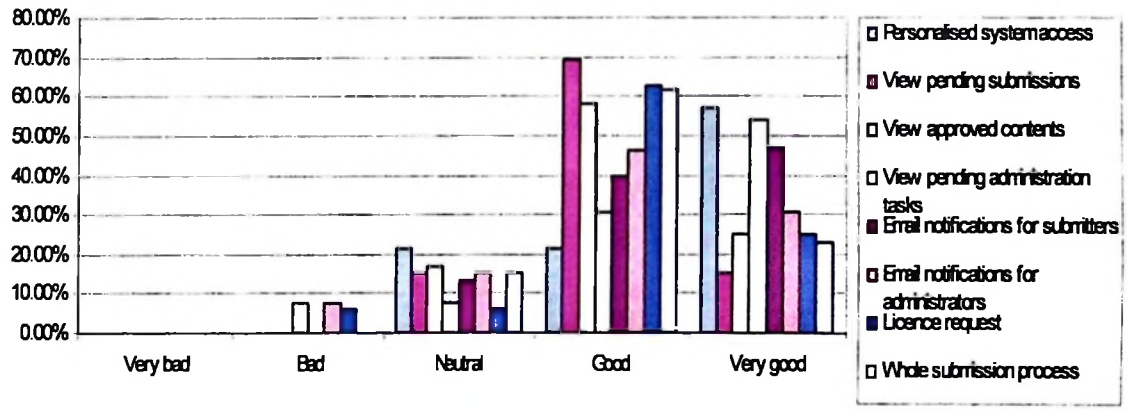


Figure 7.8: Evaluation of the user-supported submission features by agricultural researchers

The approval process set in the online system was also highly ranked from good to very good by both agricultural researchers (92.31%) and information specialists (100%). Further, the set up of the whole Agrinet-Tz system was also assessed and the positive feedback was also received. Both agricultural researchers and information specialists

highly ranked the whole Agrinet-Tz system from good to very good by 100% and 87.5% respectively.

On the whole, from the results discussed above, it can be summed up that there was a positive feedback from both respondents groups (i.e. agricultural researchers and information specialists). However, some of the respondents gave out the following comments which will have to be considered if the Agrinet-Tz system is to be implemented: (1) the system needs a lot of training and awareness in order of people to know and make use of it; (2) the system should be implemented in all the academic institutions, research institutes etc; and (3) the system should also include the Swahili language, so that users can select the language between English and Swahili since most of the Tanzanians (50 -70%) are not English speakers.

7.6 Conclusions for this chapter

Agrinet-Tz prototype for the agricultural research online system in Tanzania was developed by using the Dspace open source software together with the SMF and Joomla open sorce software. The application feature that were included in the prototype were more focused on the individual factors (i.e. intrinsic and interpersonal) rather than extrinsic factors (monetary and administrative), since the CoPs are more voluntary driven. Further, Agrinet-Tz system was tested were it received a positive feedback from the users, and lastly user roles for the developed prototype were also defined.

CHAPTER EIGHT
SUMMARY, CONCLUSION AND RECOMMENDATIONS

This chapter provides a summary of the whole study together with the conclusions and recommendations as well as possible themes for further research.

8.1 Research objectives

The major objective of this study was to develop the prototype of the agricultural research online system in order to promote collaboration and sharing of knowledge among agricultural researchers in Tanzania. The focus was on the application of OA and CoP concepts in order to improve the process of capturing and sharing the agricultural technologies and knowledge to researchers, subsistence and commercial farmers and other stakeholders for the sustainable development of agriculture in Tanzania. Within this context, the first objective assessed the current state of knowledge sharing activities among agricultural researchers within the country. This was assessed in order to provide a greater picture of the ICT infrastructure and how this infrastructure is being used for such a knowledge sharing process, and also to determine what needs to be improved in such a distributed knowledge sharing environment. The second objective analyzed the problems that face researchers while sharing their knowledge online. Lastly, the other objective focused on determining the user requirements and the development of the Agrinet-Tz prototype for collaboration and knowledge sharing among agricultural researchers by using the open source technology.

8.2 Summary

First of all, the state of art was discussed in chapter two. As a matter of fact, other studies revealed that the current state of knowledge sharing activities in agricultural research institutes is still not satisfactory in most developing countries including Tanzania. This mainly emanates from the poor knowledge sharing culture, poor infrastructure,

inadequate funds, lack of awareness about OA issues, inadequate knowledge management support from the research institutes information centers and the top management. Literatures also suggested that both OA and the communities CoPs are useful to be applied in the researchers' communities in order to enhance the open knowledge sharing and accessibility of the shared knowledge. Open source technologies revealed to provide different alternatives for developing the online system geared at enhancing OA and CoPs either from the scratch or from the readily available solutions. Studies also revealed that the technological tool should include application features that will motivate the participation level of the researchers, which include the intrinsic, extrinsic and interpersonal motivational factors. Information exchange standards were also revealed to be important features to be included into the system in order to ensure system inter-operability.

Methodology was discussed in chapter three, which involved both exploratory case study and system analysis and development approaches. Exploratory study was used to determine the user requirements. The available open source alternatives were then analyzed as per user requirement which led to the selection of the candidate technologies. These candidates were further designed to develop the prototype for the agricultural research online system.

Survey results discussed in chapter four and five also revealed the same results as what was already found from the literatures. It was found out that the current state of knowledge sharing activities in agricultural research institutes is still not satisfactory in Tanzania. Further, CoPs were found to already exist in the research institutes. However they are neither recognized nor being facilitated by information specialists together with the research institutes top management. Additionally, survey revealed that there is low rate of awareness and publishing activities in OA venues by researchers. Major features to be included in the proposed system were then identified with a greater emphasis on both intrinsic and interpersonal motivational factors in order to stimulate researchers to share their knowledge online. The roles of information specialists for the developed system were also determined.

System analysis approach as extrapolated in chapter six was used in order to evaluate the existing open source content management systems (CMS) and select the system that was further designed to develop the prototype for this study. The functional requirements identified from both the survey results and literature review were used to evaluate the open source CMS. Sixteen CMS were identified and preliminary evaluated, which led to the selection of the three systems (Archimedes, Dspace and Fez). Closer examination of these three systems led to the selection of the Dspace open source software with a maximum weighted scale of 53.7%. Further, the evaluation and selection of the available online communities open source software (i.e. forum and portal software) was carried out in order to add some missing features from the selected candidate technology (i.e. Dspace open source software).

The selected candidates' technologies were further designed to develop the prototype for the agricultural research online system as shown in chapter seven. The developed prototype was further tested by the respondents (i.e. agricultural researchers and information specialists) where it received positive feedback which was used to refine the system. Lastly, different user roles were also determined in order to ensure the system sustainability.

8.3 Conclusive considerations

On the whole, it can be mentioned that the knowledge sharing activities among researchers in Tanzania are not satisfactory. This is due to the poor knowledge sharing culture, poor ICT infrastructure, inadequate funds, lack of awareness about the OA issues and inadequate knowledge management support by the research institute management. CoPs were found to already exists in the research institutes but they are neither recognized nor facilitated by the research institute top management nor the information specialists. A prototype (i.e. Agrinet-Tz) for the agricultural research online system in Tanzania was hence developed as per user requirements in order to resolve some of the revealed challenges such as poor knowledge sharing activities among the agricultural researchers. The selected technology candidates (i.e. Dspace open source software, SMF

forum and Joomla portal open source software) were further designed with the inclusion of the application features which were more focused on both intrinsic and interpersonal motivational factors. These application features are expected to stimulate researchers to collaborate and share their knowledge in the developed system since the survey revealed that there is poor knowledge sharing culture among agricultural researchers in Tanzania. New user roles for the developed prototype were also defined in various categories in order to ensure system sustainability. Moreover, the ability to create a knowledge-sharing culture within an online environment will have to rest with the existence (and maintenance) of intra-team respect, mutual trust, reciprocity and positive individual and group relationships among agricultural researchers.

As far as this study is concerned, further researches which are strictly related to this project should further assess the effectiveness of the online system in enhancing the collaboration and knowledge sharing among agricultural researchers with a focus on the OA and CoPs. Flowing from these findings and conclusions a number of recommendations can be made.

8.4 Recommendations

It is recommended that there should be a well concerted action from agricultural research managers, national policymakers, and funding agencies in ensuring that the developed system is being sustained. Greater emphasis should be put on collaboration with international and national partners such as UNDP (which helps African countries to bridge the digital divide) in the improvement of the online systems, sharing of knowledge contents, financial support, and technical advice and assistance. This study also recommends the following:

- **Establishment of non-financial aspects of reward system.** This can be through internal recognition through newsletters, prizes and promotions in order to encourage the researchers to share their knowledge in the OA venue such as a platform for this study. This reward system will also motivate the researchers to return to their station to analyze and publish instead of staying in the field since the current incentives encourage them to do so (Gavian et al, 2001).

- **Establishment of the content submission and preservation policies.** The agricultural research institutes, funding agencies and governments need to establish policies which will mandate the scholars to make their pre-prints and e-prints of their research available via an OA venue, and that scholars report on having done so on their performance appraisals. This will create some form of knowledge sharing culture among agricultural researchers thus ensuring that the developed system is being used. Further, the research institutes together with information specialists should play a key role in planning and establishing digital preservation policies in order to ensure the long term preservation of the submitted knowledge contents in the developed system.
- **Promotion of the knowledge sharing culture.** Research institutes, universities and information centres are argued to recognize and promote the importance of knowledge sharing in the online environment to researchers through conferences, workshops, and training. This will enable the creation of the knowledge sharing culture among agricultural researchers. Information specialists can also play a key role here by demonstrating the benefits brought by the sharing of knowledge in the online environment through the communities of practices and open access models. Such benefits include the increase the citations number and the commercial publishers' movement to open access movement as revealed in the Romeo site (see section 2.4.2).
- **Improvement and enhancement of the information literacy training.** Information specialists are also argued to conduct more information literacy training in order to equip researchers with the necessary skills. These skills will enable them to access and share their knowledge online.
- **Establishment and collaboration through the library consortia.** The research institutes libraries should establish and collaborate in terms of library consortia and with other international initiatives in order to actively participate in the growing OA movement. Such international initiative includes the EIFL.net which works with developing countries libraries consortia to establish knowledge repositories in the OA model (EIFL.net, 2005).

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Appendix A

Agricultural researchers Questionnaire

Section A: Personal Information

1.1 Age:

O 20 - 29yrs O 30 - 39yrs O 40 - 49yrs O 50+ yrs

1.2 Gender:

O Female O Male

1.3 Institution:

1.4 Level of education:

O Diploma O Bachelor O Postgraduate Diploma O Masters O Phd

1.5 Area of specialization:

Section B: Agriculture research information systems: needs and problems

1. Access and use of ICT facilities

1.1 Do you have access to any of the following ICT facilities in your institution?

☐ Computer ☐ Printer ☐ Scanner Others:

1.2 Do you have internet access in your institution?

O Yes O No

1.3 Are you satisfied with the internet connectivity you have?

O Not Very satisfied O Not satisfied OProbably satisfied O Satisfied O Very satisfied

1.4 If not you are not satisfied in the 1.2, please give reasons: .....

1.5 How often do you use the internet?

O Seldom O Monthly OBimonthly O Weekly O Daily

2. Agriculture research online systems

2.1 How do you evaluate the following existing online systems in providing access to agricultural knowledge and information produced from Tanzania or about Tanzania? *(Please use the legend to answer the question)*

Online systems	1	2	3	4	5
International Online databases (e.g EBSCO, AGORA, etc)	O	O	O	O	O
CD-ROM (e.g TEEAL, CAB, Tropag & Rural)	O	O	O	O	O
Local online databases (e.g Tanzania online, Tanzania gateway etc)	O	O	O	O	O
Any other:	O	O	O	O	O

Legend 1: Very unimportant 2: Unimportant 3: Probably important 4: Important 5: Very important

Comments:_____

2.2 What problems do you face when accessing and retrieving agricultural information from the internet/ online database (i.e. both local and international) and/ CDROM?

	1	2	3	4	5
• Information overload	O	O	O	O	O
• Few computer facilities	O	O	O	O	O

•	Slow Internet connectivity	O	O	O	O	O
•	Lack of access to locally and regionally produced information	O	O	O	O	O
•	Lack of access to relevant information	O	O	O	O	O
•	Lack of access to current information	O	O	O	O	O
•	Absence of online publishing outlets	O	O	O	O	O
•	Inadequate information searching skills	O	O	O	O	O
•	Inadequate computer skills	O	O	O	O	O
•	Others:	O	O	O	O	O

Legend 1: Really a big problem 2: Probably a big problem 3: Not sure 4: Unlikely a big problem 5: Never a problem

2.2 What do you think should be the possible solution for the problems above?

	1	2	3	4	5
• Develop a local online system that will cater for local information and knowledge needs	O	O	O	O	O
• Establish agricultural library consortia to help in developing a centralized repository or institutional information systems	O	O	O	O	O
• Business plans /proposal development for funds solicitation	O	O	O	O	O
• Training researchers for information searching and computer skills	O	O	O	O	O
• Strengthen the information and communication technology infrastructure including internet connectivity					
• Others:	O	O	O	O	O

Legend 1: Very impossible 2: Impossible 3: Probably possible 4: Possible 5: Very possible

Section C: knowledge sharing: experience

1. Open access publishing knowledge

1.1 Do you have knowledge about electronic publishing or publishing on the web? (i.e publishing articles in the electronic format)

O I know nothing at all O I know a little O I know O I know a lot O I know quite a lot

1.2 Do you have knowledge about open access publishing? (i.e. Journal articles or other research results that are freely available on the internet to the research community and the general public. Author may be charged or may not charged for publishing costs but they retain the copyright)

O I know nothing at all O I know a little O I know O I know a lot O I know quite a lot

1.3 If the answer is yes in 12, then have you ever published in an open access (OA) journal?

O Yes, I have published O No, but I know about it O I don't know about it

1.4 Have you ever published or deposited your scholarly work in any of the electronic systems for wider dissemination on a free access basis (e.g personal homepage, institutional repository, and open archive or online database)?

O Yes O No

1.5 If yes in 1.4, at which frequency?

	1	2	3	4	5
• On the personal homepage or website	O	O	O	O	O
• Institutional repository e.g eSap	O	O	O	O	O
• Online databases / portal e.g Tanzania online, Tanzania gateway	O	O	O	O	O
• Institution website	O	O	O	O	O
• Others:	O	O	O	O	O

Legend 1: Very seldom 2: Seldom 3: Probably 4: Often 5: Very often

2. Online services for knowledge exchange and sharing

2.1 Have you ever used any of the online services for knowledge exchange and sharing (e.g email discussion groups, instant messaging, online meeting, web conferencing etc)?

O Yes O No

2.2 If yes in 1.6, at which frequency?

	1	2	3	4	5
• Email discussion groups	O	O	O	O	O
• Instant messaging	O	O	O	O	O
• Online meetings	O	O	O	O	O
• Web conferencing	O	O	O	O	O
• Expert database and search tools	O	O	O	O	O
• Others:	O	O	O	O	O

Legend 1: Very seldom 2: Seldom 3: Probably 4: Often 5: Very often

2.3 How do you evaluate these online services in facilitating knowledge exchange and sharing?

O Very useless O Useless OProbably O Useful O Very useful

Section D: The requirements for the development of the Agricultural Research Online System

1. Type of information content and services

1.1 How do you evaluate the set up of an agricultural research online system in improving the collaboration and sharing of agricultural information and knowledge among researchers in Tanzania?

O Very useless O Useless OProbably O Useful O Very useful

1.2 How important are the following features to be included in the proposed system?

	1	2	3	4	5
• Member networking profiles	O	O	O	O	O
• Sub groups that are defined by administrators or that allow members to self-join	O	O	O	O	O
• Online meetings	O	O	O	O	O
• Online discussions	O	O	O	O	O
• Online Full text databases for scientific information materials	O	O	O	O	O
• Web conferencing	O	O	O	O	O
• Expert database and search tools	O	O	O	O	O
• Announcements	O	O	O	O	O
• Website links arranged in various subjects	O	O	O	O	O
• Instant messaging	O	O	O	O	O

• Individual and group calendaring	O	O	O	O	O
• Others:	O	O	O	O	O

Legend 1: Very unimportant 2: Unimportant 3: Probably important 4: Important 5: Very important

1.3 What type of the information, knowledge and media resources would you like the proposed system to include?

	1	2	3	4	5
• Newsletters,	O	O	O	O	O
• Handbooks,	O	O	O	O	O
• Scientific journals,	O	O	O	O	O
• Policies,	O	O	O	O	O
• Theses/dissertations,	O	O	O	O	O
• Maps,	O	O	O	O	O
• Directories,	O	O	O	O	O
• Newspaper articles	O	O	O	O	O
• Articles and preprints	O	O	O	O	O
• Technical reports	O	O	O	O	O
• Working papers	O	O	O	O	O
• Conference papers	O	O	O	O	O
• Images: visual, scientific, etc.	O	O	O	O	O
• Audio files	O	O	O	O	O
• Video files	O	O	O	O	O
• Software	O	O	O	O	O
• Others:	O	O	O	O	O

Legend 1: Very irrelevant 2: Irrelevant 3: Probably 4: Relevant 5: Very relevant

2. Content collection for the online system

2.1 Is it important for the system to allow any researchers, academicians or information specialists to contribute the contents to the proposed system given that the authorization feature will be put in place?

O Very unimportant O Unimportant OProbably O Important O Very important

2.2 How do you evaluate commentaries and rating processes in improving the quality of the submitted contents online?

O Very useless O Useless OProbably OUseful O Very useful

2.3 Is it important for the submitted contents to also undergo approval process for authors on request before it can be accessed online?

O Very unimportant O Unimportant OProbably O Important O Very important

2.4 What type of approval process for the submitted contents would you prefer?

	1	2	3	4	5
• One stage review of submitted contents before they are accessed online	O	O	O	O	O
• Multistage review with multiple individuals participating at each stage to the submitted contents before they are accessed online.	O	O	O	O	O
• Others:	O	O	O	O	O

Legend 1: Very irrelevant 2: Irrelevant 3: Probably 4: Relevant 5: Very relevant

2.5 How do you think the approval of the submitted information contents should be managed?

	1	2	3	4	5
• Each research institute should be responsible for selecting a group of people for the approval of the submitted contents from the	O	O	O	O	O

researchers in their institute

- A group of people selected from different institutions relating to agriculture such as at the Department of Research Development (DRD), Ministry of Agriculture and Food Security, Sokoine University of Agriculture (SUA), TAFORI, COSTECH, TPRI etc O O O O O

Legend 1: Very irrelevant 2: Irrelevant 3: Probably 4: Relevant 5: Very relevant

2.6 Is it possible for you to contribute your information, knowledge and media resources to the proposed agricultural research online system in the following categories? *(Please use the legend to answer the questions)*

	1	2	3	4	5
• Newsletters,	O	O	O	O	O
• Handbooks,	O	O	O	O	O
• Articles from open access scientific journals,	O	O	O	O	O
• Policies,	O	O	O	O	O
• Theses/dissertations,	O	O	O	O	O
• Maps,	O	O	O	O	O
• Directories,	O	O	O	O	O
• Newspaper articles	O	O	O	O	O
• Articles and preprints	O	O	O	O	O
• Technical reports	O	O	O	O	O
• Working papers	O	O	O	O	O
• Conference papers	O	O	O	O	O
• Images: visual, scientific, etc.	O	O	O	O	O
• Audio files	O	O	O	O	O
• Video files	O	O	O	O	O
• Software	O	O	O	O	O
• Others:	O	O	O	O	O

Legend 1: Never 2: Unlikely possible 3: Probably possible 4: Possible 5: Very possible

2.7 What are the problems of submitting and sharing information and knowledge contents online?

O Not accepted legally O Confidential Others: _____

3. Preservation issues

3.1 How long would you like the proposed system to provide access to the submitted knowledge and information contents?

	1	2	3	4	5
• To keep the information contents for a limited period of time (e.g Ten years)	O	O	O	O	O
• To keep the information contents for unlimited period of time	O	O	O	O	O
• To cancel/ remove information content from the archive after it has been published by the authors	O	O	O	O	O
• Others:	O	O	O	O	O

Legend 1: Never 2: Unlikely possible 3: Probably possible 4: Possible 5: Very possible

3.2 Any recommendations or further comments: _____

Appendix B

Agricultural information professionals Questionnaire

Section A: Personal Information

1.1 Age:

O 20 - 29yrs O 30 - 39yrs O 40 - 49yrs O 50+ yrs

1.2 Gender:

O Female O Male

1.3 Institution:.....

1.4 Level of education:

O Certificate O Diploma O Bachelor O Postgraduate Diploma O Masters O Phd

1.5 Area of specialization:.....

Section B: Agriculture Information systems – Needs and problems

1. Access and use of ICT facilities

1.1 Do you have internet access?

O Yes O No

1.2 If yes in 1.1, are you satisfied with the internet connectivity you have?

O Not Very satisfied O Not satisfied O Probably satisfied O Satisfied O Very satisfied

1.3 If not you are not satisfied in the 1.2, please give reasons: .....

1.4 Do you conduct information literacy / information searching training to researchers?

O Yes O No

2. Agriculture research online systems

2.1 How do you evaluate the following existing online systems in providing access to agricultural knowledge and information produced from Tanzania or about Tanzania? *(Please use the legend to answer the question)*

Online systems	1	2	3	4	5
International Online databases (e.g EBSCO, AGORA, etc)	O	O	O	O	O
CD-ROM (e.g TEEAL, CAB, Tropag & Rural)	O	O	O	O	O
Local online databases (e.g Tanzania online, Tanzania gateway etc)	O	O	O	O	O
Any other: _____	O	O	O	O	O

Legend 1: Very unimportant 2: Unimportant 3: Probably important 4: Important 5: Very important

Comments: _____

2.2 What problems do you face when accessing and retrieving agricultural information from the internet/ online database (i.e. both local and international) and/ CDROM?

	1	2	3	4	5
Information overload	O	O	O	O	O
Few computer facilities	O	O	O	O	O

Slow Internet connectivity	O	O	O	O	O
Lack of access to locally and regionally produced information	O	O	O	O	O
Lack of access to relevant information	O	O	O	O	O
Lack of access to current information	O	O	O	O	O
Absence of online publishing outlets	O	O	O	O	O
Inadequate information searching skills	O	O	O	O	O
Inadequate computer skills	O	O	O	O	O
Others: _____	O	O	O	O	O

Legend 1: Really a big problem 2: Probably a big problem 3: Not sure 4: Unlikely a big problem 5: Never a problem

2.3 What do you think should be the possible solution for the problems above?

	1	2	3	4	5
• Develop a local online system that will cater for local information and knowledge needs	O	O	O	O	O
• Establish agricultural library consortia to improve open access issues	O	O	O	O	O
• Business plans /proposal development for funds solicitation	O	O	O	O	O
• Training researchers for information searching and computer skills	O	O	O	O	O
• Strengthen the information and communication technology infrastructure including internet connectivity					
• Others: _____	O	O	O	O	O

Legend 1: Very impossible 2: Impossible 3: Probably possible 4: Possible 5: Very possible

Section C: The requirements for the development of the Agricultural Research Online System

1. Type of information content and services

1.1 How do you evaluate the set up of an agricultural research online system in improving the collaboration and sharing of agricultural information and knowledge among researchers in Tanzania?

O Very useless O Useless OProbably O Useful O Very useful

1.2 How important are the following features to be included in the proposed system?

	1	2	3	4	5
• Member networking profiles	O	O	O	O	O
• Sub groups that are defined by administrators or that allow members to self-join	O	O	O	O	O
• Online meetings	O	O	O	O	O
• Online discussions	O	O	O	O	O
• Online Full text databases for scientific information materials	O	O	O	O	O
• Web conferencing	O	O	O	O	O
• Expert database and search tools	O	O	O	O	O
• Announcements	O	O	O	O	O
• Website links arranged in various subjects	O	O	O	O	O
• Instant messaging	O	O	O	O	O
• Individual and group calendaring	O	O	O	O	O
• Others: _____	O	O	O	O	O

Legend 1: Very unimportant 2: Unimportant 3: Neutral 4: Important 5: Very important

1.3 What type of the information, knowledge and media resources would you like the proposed system to include?

		1	2	3	4	5
•	Newsletters,	O	O	O	O	O
•	Handbooks,	O	O	O	O	O
•	Scientific journals,	O	O	O	O	O
•	Policies,	O	O	O	O	O
•	Theses/dissertations,	O	O	O	O	O
•	Maps,	O	O	O	O	O
•	Directories,	O	O	O	O	O
•	Newspaper articles	O	O	O	O	O
•	Articles and preprints	O	O	O	O	O
•	Technical reports	O	O	O	O	O
•	Working papers	O	O	O	O	O
•	Conference papers	O	O	O	O	O
•	Images: visual, scientific, etc.	O	O	O	O	O
•	Audio files	O	O	O	O	O
•	Video files	O	O	O	O	O
•	Software	O	O	O	O	O
•	Others: _____	O	O	O	O	O

Legend 1: Very irrelevant 2: Irrelevant 3: Probably 4: Relevant 5: Very relevant

2. Content collection for the proposed online system

2.1 Is it important for the system to allow any researchers, academicians or information specialists to contribute the contents to the proposed system given that the authorization feature will be put in place?
O Very unimportant O Unimportant OProbably O Important O Very important

2.2 How do you evaluate commentaries and rating processes in improving the quality of the submitted contents online?

O Very unimportant O Unimportant O Probaly important O Important O Very important

2.3 Is it important for the submitted contents to also undergo approval process for authors on request before it can be accessed online?
O Very unimportant O Unimportant OProbably O Important O Very important

2.4 What type of approval process for the submitted contents would you prefer?

	1	2	3	4	5
• One stage review of submitted contents before they are accessed online	O	O	O	O	O
• Multistage review with multiple individuals participating at each stage to the submitted contents before they are accessed online.	O	O	O	O	O
• Others: _____	O	O	O	O	O

Legend 1: Very irrelevant 2: Irrelevant 3: Probably relevant 4: Relevant 5: Very relevant

2.5 How do you think the peer review/ approval of the submitted information contents should be managed?

	1	2	3	4	5
• Each research institute should be responsible for selecting a group of people for the approval of the submitted contents from the researchers in their institute	O	O	O	O	O
• A group of people selected from different institutions relating to agriculture such as at the Department of Research Development (DRD), Ministry of Agriculture and Food Security, Sokoine University of Agriculture (SUA), TAFORI, COSTECH, TPRI, TAFIRI, CAMARTEC etc	O	O	O	O	O
• Others: _____	O	O	O	O	O

Legend 1: Very irrelevant 2: Irrelevant 3: Probably relevant 4: Relevant 5: Very relevant

2.6 Is it possible for your library to contribute both information and media material to the proposed agricultural research online system in the following categories? *(Please use the legend to answer the questions)*

	1	2	3	4	5
• Newsletters,	O	O	O	O	O
• Handbooks,	O	O	O	O	O
• Articles from open access scientific journals,	O	O	O	O	O
• Policies,	O	O	O	O	O
• Theses/dissertations,	O	O	O	O	O
• Maps,	O	O	O	O	O
• Directories,	O	O	O	O	O
• Newspaper articles	O	O	O	O	O
• Articles and preprints	O	O	O	O	O
• Technical reports	O	O	O	O	O
• Working papers	O	O	O	O	O
• Conference papers	O	O	O	O	O
• Images: visual, scientific, etc.	O	O	O	O	O
• Audio files	O	O	O	O	O
• Video files	O	O	O	O	O
• Software	O	O	O	O	O
• Others: _____	O	O	O	O	O

Legend 1: Never 2: Unlikely possible 3: Probably possible 4: Possible 5: Very possible

2-7 What are the problems of submitting and sharing information and knowledge contents online?

O Not accepted legally O Confidential OAny other: _____

3. Preservation issues

3.1 How long would you like the proposed system to provide access to the submitted knowledge and information contents?

1 2 3 4 5

• To keep the information contents for a limited period of time (e.g Ten years)	O	O	O	O	O
• To keep the information contents for unlimited period of time	O	O	O	O	O
• To cancel/ remove information content from the archive after it has been published by the authors	O	O	O	O	O
• Others:	O	O	O	O	O

Legend 1: Never 2: Unlikely possible 3: Probably possible 4: Possible 5: Very possible

Section D: Role of information specialists

1. Open access knowledge repository

1.1 How do you evaluate the expected roles of the information specialists/librarians in the collection development and management?

	1	2	3	4	5
• Review submissions for the quality of content and metadata consistency (i.e. Editing metadata records)	O	O	O	O	O
• Create or determine metadata quality standards tailored to individual collections' unique content and goals	O	O	O	O	O
• Negotiating with publishers on behalf of institutes/universities or encouraging institutes to retain the right to publish to the information system/repository as well as in scholarly publications	O	O	O	O	O
• Support authors in depositing materials in the system on behalf of them and undertaking file formatting and conversion	O	O	O	O	O
• Setting collection development and management policies and practices including copyright issues	O	O	O	O	O
• Selection, evaluation and organization of useful website links	O	O	O	O	O
• Introduce and make available innovative performance indicators or quality assessment, such as counting downloads and citations at the article level	O	O	O	O	O
• Others: _____	O	O	O	O	O

Legend 1: Very unimportant 2: Unimportant 3: Neutral 4: Important 5: Very important

1.2 How do you evaluate the expected roles of the information specialists/librarians in the Education and user - training?

	1	2	3	4	5
• Promote discussion on the advantages of open access deposition among academia and administrators at the highest level	O	O	O	O	O
• Demonstrate to scholars the benefits of wider exposure via open access.	O	O	O	O	O
• Coordinate programmes to advise and support scholars on copyright issues and how best to negotiate the right to deposit their materials on information systems/repository	O	O	O	O	O
• Train and give guidance to researchers in the use of the software to submit contents	O	O	O	O	O
• Others: _____	O	O	O	O	O

Legend 1: Very unimportant 2: Unimportant 3: Neutral 4: Important 5: Very important

1.3 How do you evaluate the expected roles of the information specialists/librarians in the system development, implementation and maintenance?

	1	2	3	4	5
• Evaluating and promoting information resources	O	O	O	O	O

• Have a working knowledge of information management software	O	O	O	O	O
• Provide guidance to define different types collections to the research community	O	O	O	O	O
• Oversee project management and planning of local implementations of the developed system	O	O	O	O	O
• Introduce and make available innovative performance indicators or quality assessment, such as counting downloads and citations at the article level	O	O	O	O	O

Legend 1: Very unimportant 2: Unimportant 3: Neutral 4: Important 5: Very important

1.4 How do you evaluate the expected roles of the information specialists/librarians in archiving information?

	1	2	3	4	5
• Ensure archival stability	O	O	O	O	O
• Establishing preservation policies	O	O	O	O	O
• Others: _____	O	O	O	O	O

Legend 1: Very unimportant **2**: Unimportant **3**: Neutral **4**: Important **5**: Very important

2. Community of practices

2.1 How do you evaluate the expected roles of the information specialists/librarians in building community of practices (CoPs)?

	1	2	3	4	5
• Identify existing communities	O	O	O	O	O
• Market and sell CoPs to management and potential members	O	O	O	O	O
• Conduct interviews and facilitate group dialogue	O	O	O	O	O
• Act as community champion	O	O	O	O	O
• Others: _____	O	O	O	O	O

Legend 1: Very unimportant 2: Unimportant 3: Neutral 4: Important 5: Very important

2.2 How do you evaluate the expected roles of the information specialists/librarians in facilitating community of practices (CoPs)?

	1	2	3	4	5
• Set up, facilitate and document informal meetings	O	O	O	O	O
• Map knowledge flows and knowledge relationships	O	O	O	O	O
• Build group identity	O	O	O	O	O
• Design, convene and facilitate seminars and conferences	O	O	O	O	O
• Develop support strategies for the group learning agenda	O	O	O	O	O

Legend 1: Very unimportant 2: Unimportant 3: Neutral 4: Important 5: Very important

2.3 How do you evaluate the expected roles of the information specialists/librarians in activating the community of practices (CoPs)?

	1	2	3	4	5
Convene reunions in case of group break up	O	O	O	O	O
help them to create links to other communities	O	O	O	O	O
Publish in newsletters	O	O	O	O	O
Negotiate role of the CoPs	O	O	O	O	O
Others: _____	O	O	O	O	O

Legend 1: Very unimportant 2: Unimportant 3: Neutral 4: Important 5: Very important

2.4 Any recommendations or further comments:_____

Appendix C

Closer examination of open source content management software evaluation as per technical features and functionalities

Criteria (0 = non-existent or poor , 3 = an average and 5 = exceeds standard expectation)	Archimede	Dspace	Fez	Comments
1. Metadata and ontology				
1. 1 Metadata				
1.1.1 Must support a metadata schema (e.g Dublin core, Marc 21)	3	3	3	
1.1.2 Must allow records/ fields creation/ modification /deletion	3	3	3	
1.1.3 Must support metadata extensibility and complexity	0	3	5	Fez allows definition of metadata as per document type
1.1.4 Must support metadata review	3	3	3	
1.1.5 Must provide support to disallow metadata harvesting	3	3	3	
1.1.6 Must support Unicode character set for metadata	3	3	3	
1.2 Ontology/Thesaurus				
1.2.1 Must support thesaurus or authority control for subject keywords	0	5	5	Both Fez and Dspace thesaurus can both be used when submitting and searching the contents
2. Content delivery				
2.1 Content Import/ Export				
2.1.1 Must support upload of compressed files	3	3	3	
2.1.2 Must allow volume import for objects	3	3	3	
2.1.3 Must allow volume import for metadata	3	3	3	
2.1.4 Must allow volume export/content portability	3	3	3	
2.2 Document/object formats				
2.2.1 Must support of upload new digital objects in multiple files and / or file types	3	3	3	
2.2.2 Can allow the submitted contents to comprise multiple files	5	5	5	
2.3 Real time updating and indexing of accepted contents				
2.3.1 Must allow real time updating	3	3	3	

2.3.2 Can support indexing of the accepted contents when appropriate	3	3	3	
	Archimede	**Dspace**	**Fez**	**Comments**
2.4 Searching				
2.4.1 Must support searching of contents via all descriptive metadata	3	3	3	
2.4.2 Can support any descriptive metadata Searching techniques (i.e. Boolean logic, Truncation/wildcards, Word stemming)	5	2	2	Only Archimede allows all searching techniques, which are boolean logic, truncation/wildcards and word stemming
2.4.3 Must support searching of the selected metadata	3	3	3	
2.4.4 Must allow full–text searching	5	5	0	Fez is planning to include full-text searching
2.4.5 Can allow full-text searching techniques (i.e. Boolean logic, Truncation/wildcards, Word stemming)	5	0	0	
2.4.6 Must support browsing of the digital objects by using metadata (e.g author, title, issue date, subject etc)	5	5	4	Fez does not allow to browse by using title but allows browsing by using the recently added items
2.4.7 Can sort search results by using metadata and relevance	3	0	5	Fez can sort search results by using almost all metadata such as by title, date, subject etc
2.4.8 Must be indexed by Google/ Other search engine	3	5	0	Archimede has a possibility of being indexed by Google, while Dspace offers that feature
2.5 System interoperability				
2.5.1 Must support OAI-PMH 2.0 either data provider or data provider	3	3	3	Archimede and Dspace allow OAI-PMH data provider while Fez allows OAI-PMH service provider
2.5.2 Can provide support for other interoperability standards (e.g Open url)	0	3	3	
3. Workflow management				
3.1 Authentication and authorization				
3.1.1 Must allow password administration (i.e. both system assigned password and User selected password)	5	5	5	
3.1.2 Must possess forgotten password function	3	3	3	
3.1.3 Must allow user registration verification process and any other security mechanisms	3	5	5	Both Dspace and Fez allow more mechanisms such as LDAP, For Archimedes provides pluggable mechanisms where other security mechanisms can be added
3.1.4 Can allow user to edit their profiles	3	3	3	
3.2 User groups				

3.2.1 Must allow the set up of the multiple user groups assigned to one or more roles	0	3	3	
	Archimede	**Dspace**	**Fez**	**Comments**
3.2.2 Must allow users to be assigned to one or more groups	0	3	3	
3.3 Content Submission Administration				
3.3.1 Must allow the definition of the multiple collections within the same instance of system	3	3	3	
3.3.2 Must allow the set up of the different submission parameters for each collection	0	5	5	
3.3.3 Must support the homepage for each collection	3	3	3	
3.4 Submission stages				
3.4.1 Must allow segregated submission workspace (i.e. separate pre-public workspace that stores incomplete and/or pre-approval stage content submissions)	3	3	3	
3.4.2 Must allow the following submission roles - submitters, reviewers, approvers, editors, administrators	2	5	5	Dspace and Fez have more - Submitters, Moderators, Reviewers, Approvers etc
3.4.3 Can allow configurabie submission roles within a collection	3	3	3	
3.5 Submission support				
3.5.1 Must have a personalized system access for registered users	3	5	5	
3.5.2 Must allow users to view their pending content submissions (i.e. Users can access submissions that were interrupted while uploading)	3	3	3	
3.5.3 Must allow users to view their approved content	3	3	3	
3.5.4 Must allow users to view their pending content administration tasks	3	3	3	
3.6 Distribution licence				
3.6.1 Must users to accept the distribution licence during content submission	0	5	3	Apart from distribution licence, Dspace also contains the Creative of commons licence, Fez future release will contain also this type of licence
4. Presentation and Collaborative features				
4. 1 Presentation				

4.1.1 Must allow the modification of the user interface to local context, "look and Feel"	5	5	5	
	Archimede	**Dspace**	**Fez**	**Comments**
4.1.2 Must apply a custom header/footer to static and dynamic pages	5	2	3	
4.1.3 Must support the web-based interface for all its functionalities	3	3	3	
4.1.4 Must support Unicode – compatible interfaces	3	3	3	
4.1.5 Must support users to submit feedback on systems problem	0	3	3	
4.1.6 Must support online help	3	5	5	
4.1.7 Can possess RSS feeds	0	3	0	Fez future release will include the RSS feeds
4.2 Collaborative features				
4.2.1 Must support discussion forum	0	0	0	
4.2.2 Must support user-subscription (e.g email alerts about new added contents)	3	3	3	
4.2.3 Must support end-users documents	3	5	0	
4.2.4 Must support end-user comments	0	0	0	Fez and Dspace are on process of including user comments
4.2.5 Must support end-user rating	0	0	0	
4.2.6 Can support end-user personalized links	0	5	0	
4.2.7 Must support members profile	0	5	0	
4.2.8 Can support suggest an item feature	0	3	0	
5. Preservation				
5.1 Data preservation				
5.1.1 Must have a defined digital preservation strategy	3	5	3	Persistent document identifier add more advanced digital preservation feature for Dspace
5.1.2 Must support metadata preservation	4	4	5	Fez automatically extracts the preservation metadata
5.1.3 Must allow data integrity checks	0	3	3	Dspace uses MD5 Checksum, while Fez through Fedora uses SIP Schema validation
5.2 Content version control				
5.2.1 Must support content versioning/ object history	3	3	3	
5.3 Persistent document identification				
5.3.1 System assigned identifier	3	3	3	
5.3.2 Persistent document identifier	0	5	0	Dspace uses more advanced feature which is CNRI handle
Total	**154**	**204**	**171**	
Weighted scale (80%)	**39.11%**	**51.81%**	**43.43 %**	

Appendix D

Closer examination of open source content management software evaluation as per general features

Criteria (0 = non-existent or poor, 3 = an average and 5 = exceeds standard expectation)	Archimede	Dspace	Fez	Comments
1. Usability, Ease of Use, and User documentation	3	5	3	All systems are easy to use, however Dspace has more extensive documentation ranging from end-users to developers
2. User Adoption / Current User Community	3	5	3	Only Dspace is used worldwide with an active user community
3. Openness - Module – level API(s) for local customization of the system	4	5	4	Dspace allows APIs for each module
4. Reliability	4	4	4	
5. Scalability - Handle scalable storage	5	5	5	
6. Hardware and Software Considerations	5	5	5	
7. System administration - 1 System generated usage reports and statistics, and set-up/ installation and update	3	4	5	All systems have at least the same complexity in system set-up/ update. However, in Usage reports and statistics, Fez shows more statistics (eg Downloads per Author, per Community, per Collection, per Subject etc).
Total	**27**	**33**	**29**	
Weighted scale (20%)	**1.54%**	**1.89%**	**1.68%**	

Appendix E

Questionnaire administered to both agricultural researchers and information specialists during system testing

Section A: Personal Information

1.1 Age:
O 20 - 29yrs O 30 - 39yrs O 40 - 49yrs O 50+ yrs
1.2 Gender:
O Female O Male

1.3 Institution: _____
1.4 Level of education:
O Certificate O Diploma O Bachelor O Postgraduate Diploma O Masters O Phd
1.5 Area of specialization: _____

Section B: Agriculture research online systems: system testing

1.1 How do you evaluate the following online systems features in the promotion of the knowledge sharing among agricultural researchers in Tanzania? *(Please use the legend to answer the question)*

	1	2	3	4	5
• Online Full text databases for scientific information materials	O	O	O	O	O
• Announcements	O	O	O	O	O
• Frequently Asked Questions (FAQs)	O	O	O	O	O
• Really Simple Syndication (RSS) feeds	O	O	O	O	O
• Suggest an item from the online structured databases	O	O	O	O	O
• Online calendar and events	O	O	O	O	O
• Website links arranged in various subjects	O	O	O	O	O
• Suggest a link in the web-based subject links	O	O	O	O	O
• Online Help	O	O	O	O	O
• Searching tools and the thesaurus	O	O	O	O	O
• Subscription (e.g email alerts about new added contents)	O	O	O	O	O
• Usage reports (e.g. items number per collections)	O	O	O	O	O

Legend 1: Very bad 2: Bad 3: Neutral 4: Good 5: Very good

1.1.1 If the answer was 1 or 2, what do you think should be improved in relation to this feature? _____
1.1.2 Comments: _____

1.2 How do you evaluate the following online systems features in the relationship building among agricultural researchers in Tanzania? *(Please use the legend to answer the question)*

	1	2	3	4	5
• Personalized member profiles and search tools	O	O	O	O	O

Appendix E

Questionnaire administered to both agricultural researchers and information specialists during system testing

Section A: Personal Information

1.1 Age:
O 20 - 29yrs O 30 - 39yrs O 40 - 49yrs O 50+ yrs
1.2 Gender:
O Female O Male

1.3 Institution: _____
1.4 Level of education:
O Certificate O Diploma O Bachelor O Postgraduate Diploma O Masters O Phd
1.5 Area of specialization: _____

Section B: Agriculture research online systems: system testing

1.1 How do you evaluate the following online systems features in the promotion of the knowledge sharing among agricultural researchers in Tanzania? *(Please use the legend to answer the question)*

	1	2	3	4	5
• Online Full text databases for scientific information materials	O	O	O	O	O
• Announcements	O	O	O	O	O
• Frequently Asked Questions (FAQs)	O	O	O	O	O
• Really Simple Syndication (RSS) feeds	O	O	O	O	O
• Suggest an item from the online structured databases	O	O	O	O	O
• Online calendar and events	O	O	O	O	O
• Website links arranged in various subjects	O	O	O	O	O
• Suggest a link in the web-based subject links	O	O	O	O	O
• Online Help	O	O	O	O	O
• Searching tools and the thesaurus	O	O	O	O	O
• Subscription (e.g email alerts about new added contents)	O	O	O	O	O
• Usage reports (e.g. items number per collections)	O	O	O	O	O

Legend 1: Very bad 2: Bad 3: Neutral 4: Good 5: Very good

1.1.1 If the answer was 1 or 2, what do you think should be improved in relation to this feature? _____
1.1.2 Comments: _____

1.2 How do you evaluate the following online systems features in the relationship building among agricultural researchers in Tanzania? *(Please use the legend to answer the question)*

	1	2	3	4	5
• Personalized member profiles and search tools	O	O	O	O	O

• End-user documents	O	O	O	O	O
• Personalized web links features	O	O	O	O	O
• User groups and sub groups	O	O	O	O	O
• Communities and collections in the online structured databases	O	O	O	O	O
• Communities and sub-communities in the web-based subject links and online discussions	O	O	O	O	O
• Really Simple Syndication (RSS) feeds	O	O	O	O	O
• Suggest an item from the online structured databases	O	O	O	O	O
• Online calendar and events	O	O	O	O	O
• Website links arranged in various subjects	O	O	O	O	O
• Suggest a link in the web-based subject links	O	O	O	O	O

Legend 1: Very bad 2: Bad 3: Neutral 4: Good 5: Very good

1.2.1 If the answer was 1 or 2, what do you think should be improved in relation to this feature?_____
1.2.2 Comments: _____

1.3 How do you evaluate the following online systems features in the improvement of the quality of the shared knowledge by the agricultural researchers in the developed online system? *(Please use the legend to answer the question)*

	1	2	3	4	5
• Polling system on the web-based subject links	O	O	O	O	O
• User ratings features on the online discussions	O	O	O	O	O

Legend 1: Very bad 2: Bad 3: Neutral 4: Good 5: Very good

1.3.1 If the answer was 1 or 2, what do you think should be improved in relation to this feature? _____
1.3.2 Comments: _____

1.4 How do you evaluate the following user-supported submission features in the online structured database?

	1	2	3	4	5
• Personalized system access to the registered users with password administration	O	O	O	O	O
o View pending content submissions (i.e. Users can access submissions that were interrupted while uploading)	O	O	O	O	O
o View approved content	O	O	O	O	O
o View pending content administration tasks	O	O	O	O	O
• Email notification for submitters	O	O	O	O	O
• Email notification for content administrators	O	O	O	O	O
• Request distribution licence during content submission	O	O	O	O	O
• The whole process of content submission	O	O	O	O	O

Legend 1: Very bad 2: Bad 3: Neutral 4: Good 5: Very good

1.4.1 If the answer was 1 or 2, what do you think should be improved in relation to this feature?_____
1.4.2 Comments: _____

1.5 How do you evaluate the approval process for the submitted contents on the online structured databases in the developed online system?

O Very insufficient O Insufficient O Neutral O Good O Very good

1.5.1 If the answer was very sufficient or insufficient, what do you think should be improved in relation to this feature?_____

1.5.2 Comments:_____

1.6 How do you evaluate the set up of an agricultural research online system in improving the collaboration and sharing of agricultural information and knowledge among researchers in Tanzania?

O Very insufficient O Insufficient O Neutral O Good O Very good

1.6.1 If the answer was very sufficient or insufficient, what do you think should be improved in relation to this feature?_____

1.6.2 Comments:_____

1.7 Any recommendations or further comments: