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Access to and Utilization of Information and Communication Technologies by Agricultural Researchers and Extension Workers in Zimbabwe

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Studies have shown that any information and communication technology (ICT) intervention that improves the livelihoods of poor rural families is likely to have a significant impact (direct and indirect) on enhancing agricultural production, marketing, and post-harvest activities. Notable ICT services include: online information services; communication between researchers, extension (knowledge) workers, and farmers; updates on current market information; weather forecasting; input supplies; and credit availability. The lack of up-to-date ICTs can negatively affect information access and utilization among information users. The study sought to investigate the levels of ICT access and utilization by researchers and extension workers within the Ministry of Agriculture, Mechanisation and Irrigation Development and how this affected the generation and dissemination of agricultural information among researchers and extension workers. Survey questionnaires were distributed to researchers at the various institutes in the five agro-ecological zones and to extension workers in 10 provinces. The study revealed that the role of ICTs in work and as an information channel was considered inadequate despite the indications by the majority of extension workers and researchers that they had access to ICTs. Findings on the utilization of ICTs in managing information generated by the Departments of Research and Specialist Services and Agricultural Technical and Extension Services revealed that while some ICTs were used to generate documents, most distribution of documents involved hard copies. Available ICTs included computers, printers, telephones, television, Internet, mobile phones, and fax machines, and these were considered effective in the dissemination of agricultural information, although the levels of effectiveness varied according to the resources and respondents.

Keywords: development issues; adoption and diffusion of IT and rate of uptake

1. Introduction

Many studies have shown that any information and communication technology (ICT) intervention that improves the livelihoods of poor rural families is likely to have a significant impact (direct and indirect) on enhancing agricultural production, marketing, and post-harvest activities (Ali & Kumar, 2011; Kalusopa, 2005; Marker, McNamara, & Wallace, 2002, p. 4; Munyua, 2000; Muto & Yamano, 2008; Umrani & Jain, 2010). Marker et al. (2002, p. 4) define ICTs as technologies that facilitate communication and the processing and transmission of information electronically. This includes both "old" and "new" ICTs, from the radio and television, to telephones (fixed and mobile), computers, and the Internet.

Services that can be derived from using ICTs include: online information services; communication between researchers, extension (knowledge) workers, and farmers; updates on current market information; weather forecasting; input suppliers; credit availability, etc. The

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management of information can also be enhanced by developing databases that detail resources. Websites can be used to provide a platform for researchers and extension workers to access the latest information and also to obtain feedback from farmers, while mobile phones have added a new dimension to communication between farmers.

Mittal, Gandhi, and Triphathi (2010, p. 3) addressed the socio-economic impact of mobile phones on Indian agriculture, finding that ICT and mobile-enabled agricultural services act as instruments that deliver extension services and help to raise awareness among farmers. Mittal et al. (2010, p. 4) observed that the Chinese government invested US$1.13 billion in establishing mobile infrastructure for about 26,000 villages over the years, through the state owned Mobile China, to enable farmers to keep track of weather conditions or forecasts and product prices. Muto and Yamano (2008) found that the expansion of mobile phone networks and the increase in mobile-density in Uganda has enabled higher market participation by farmers, who produce perishable crops and who are located in remote areas, and helped them achieve higher prices by reducing the information asymmetry that existed between them and traders.

1.1. *Challenges of ICT in agricultural extension and research*

Although ICT initiatives for rural development have significant challenges to overcome, they have numerous benefits if properly implemented. Munyua (2000) and Kalusopa (2005) attribute the challenges experienced in implementing rural ICT projects to a lack of proper policies coupled with rigid regulations and high telecommunication tariffs and duty on equipment. Kalusopa (2005), for example, observed that the Zambian government's lack of involvement in the development of strategies for ICTs and the absence of a national IT co-ordination center resulted in the duplication of efforts among three ministries in the country. Munyua (2000), Kumar (2005a, 2005b), and Kalusopa (2005) add that telecommunication costs and poor telecommunications and electricity infrastructure (such as low bandwidth for basic Internet access) remain strong deterrents to access and utilization. Kumar (2005a, 2005b, p. 46) proposes that the cost of establishing such communication technology infrastructure and centers can be shared by private and public sectors. There is also a severe shortage of material in local languages and the information available through ICTs is mostly in English, a language that most rural communities cannot read or write.

Mittal et al. (2010, p. 236) and Munyua (2000) also highlight the issue of gender bias, noting that women significantly lag behind men in their access to and use of ICTs, particularly in rural areas where women are likely to be the furthest removed from development opportunities. They also allege that when new technologies are introduced, they are seen as the domain of men, and women have therefore often been sidelined or left out of ICT-related initiatives. Illiteracy also makes the acquisition of basic ICT skills difficult. In order to enhance the development of ICT skills, Mittal et al. (2010, 236) and Munyua (2000) recommend the need to invest in training and advisory services for information intermediaries, telecentre staff, frontline workers, and women's groups. The focus should be on developing skills on how to use ICTs through practical and participatory approaches.

Kumar (2005a, 2005b, p. 46) observes that farmers sometimes become suspicious or fearful that they may lose their traditional methods of farming through the adoption of ICTs. There is a need to win the confidence of these farmers, and make them aware of the benefits of ICT in agriculture (Ali & Kumar, 2011). In order to achieve this, Umrani and Jain (2010, p. 231) suggest that as brokers between communication technologies and farmers, extension agents must be able to examine the appropriateness of various ICTs; their accessibility in rural and remote areas; and how to best reconcile costs and benefits. Extension agents must ensure that ICT access is gender sensitive and covers a diversity of cultures, languages, social strata, and age groups.

2. Conceptual framework

This study has been informed by the diffusion of innovation (DoI) theory. Diffusion is the process by which an innovation is communicated through certain channels, over time, among members of a social system. It is a special type of communication where the messages are concerned with new ideas. It is the "newness" of the idea in the message content of communication that infuses diffusion with its special character (Rogers, 2003, p. 5). Rogers further explains that communication is a process of convergence (or divergence) as two or more individuals exchange information in order to move toward each other (or apart) in the meanings that they ascribe to events. DoIs thus refers to the spread of abstract ideas and concepts, technical information, and actual practices or objects within a social system, where the spread signifies the flow or movement from a source to an adopter, typically through communication and influence (Rogers, 2003). It is a social process via which subjectively perceived information about a new idea is communicated.

According to Wejnert (2002), although the study of DoIs began with Tarde's 1903 book, "The Law of Limitation," a more concerted development of this approach occurred 40 years later when in 1943, Ryan and Gross published results on the spread of hybrid corn use among Iowa farmers. Practitioners have regarded the DoIs as a useful field of social science, with more than 4000 research papers, articles, and textbooks on diffusion research having appeared in the top journals of every discipline (Rogers, 2003, p. 102; Wejnert, 2002). This popularity has been attributed to the following factors: the conceptual nature of the model, which bridges diverse disciplines and methodologies; diffusion research has a pragmatic appeal in getting research results utilized; diffusion research allows scholars to repackage their empirical findings as generalizations of a theoretical nature; the research methodologies used, as well as the methods of analysis, are clear; and data are not difficult to collect (Rogers, 2003). There are four main elements of the DoI theory.

- Innovations – an idea, method or object which is regarded as new by an individual.
- Communication channels, such as the radio, television, and newspapers, are used as a means of informing an audience.
- Time – innovations are not adopted by everyone at the same time or rate, rather, adoption researchers classify people into five adopter categories, i.e. (1) Innovators, (2) Early adopters, (3) Early majority, (4) Late majority, and (5) Laggards.
- The social system, which defines a set of inter-related units that are engaged in joint problem solving to accomplish a common goal (Leeuwis, 2004; Rogers, 2003; Van den Ban & Hawkins, 1996).

Despite its enormous contributions to research, the diffusion model has not been without its shortcomings. Stephenson (2003) observes that the absence of critical viewpoints in the early development of the theory led to the challenges experienced in the long run. Rogers (2003, p. 105), Deshpande (1983), Haider and Kreps (2004), Minishi-Majanja and Kiplang'at (2004) identified four major criticisms of diffusion research: (1) Its pro-innovation bias, which occurs when there is an economic reason to adopt an innovation and when it is being funded by an agency for change, for example, when sponsors of a study already have an innovation in mind; (2) The individual blame bias, which is the "tendency to hold the individual responsible for his/her problems rather than the system in which he/she is part"; (3) The recall problem, and this may occur due to inaccuracies when respondents react to questions at the time of implementation; and (4) The issue of equality in the diffusion process – socio-economic gaps among members of a social system often widen due to the spread of new ideas, a problem that often

arises because researchers pay little attention to the consequences or outcomes of an innovation. We have taken note of the strengths and limitations of the DoI in informing this paper.

3. Purpose of the study

The purpose of the study was to investigate the levels of ICTs access and utilization by researchers and extension workers within the Ministry of Agriculture, Mechanisation and Irrigation Development's research and extension divisions and research institutes and its impact on the generation and dissemination of agricultural information among researchers and extension workers in Zimbabwe. This was achieved by establishing the available infrastructure, ICT resources and services, and the competencies of the respondents. In this paper, we respond to the following research questions:

(a) What means and processes are in place for managing information generated by the Ministry of Agriculture, Mechanisation and Irrigation Development's research and extension divisions and research institutes?
(b) What is the level of ICT development within the Ministry of Agriculture, Mechanisation and Irrigation Development's research and extension divisions and research institutes?
(c) What is the effect of ICT on the generation and dissemination of agricultural information among researchers and extension workers?

4. Methodology

The study utilized both qualitative and quantitative techniques. Data were collected through a questionnaire distributed to researchers and extension workers. The study used a questionnaire with structured and open-ended questions and enabled respondents to provide additional remarks, thus generating both quantitative and qualitative responses. A pilot study was carried out before the main study in order to test the validity and reliability of the research instruments. The questionnaire was pre-tested on researchers and extension staff from the Department of Livestock and Veterinary Services and lecturers from Mazowe Veterinary College and Kushinga-Phikelela Agricultural College. Zimbabwe has 10 provinces of which 2, Harare and Bulawayo, are urban, and were not included in the study. Extension workers were drawn from 8 provinces which yielded 8 provincial extension officers and 60 district extension officers. Additional district extension officers from 14 districts were selected using random sampling to provide field experiences, although this category was extensively investigated in Mashonaland Central Province. The study also targeted the 91 subject matter specialists in the 8 provinces, including those stationed at the head office. The categories of Agricultural Extension Officers, Agricultural Extension Supervisors, and AGRITEX workers were drawn from Mashonaland Central Province to create a representative sample of agro-ecological regions II–V. Due to the large number of extension workers involved at the ward level, the study did not investigate this category at the national level, but restricted the investigation to Mashonaland Central Province which was considered representative in terms of agricultural practices. Purposive sampling was applied to Mashonaland Central Province, with all seven districts investigated. Random sampling was then conducted for the different wards.

From the 111 questionnaires distributed to researchers, 60 were returned (a return rate of 54%). However, errors were identified in four of the questionnaires and they were discarded. Usable returns, therefore, amounted to 56. The total target population for extension workers in this study was 318. Two directors (technical and field) and one deputy director were interviewed and were not required to complete the questionnaires. A total of 172 questionnaires were completed, a return rate of 54%.

5. Results

The results are discussed in Sections 5.1–5.5.

5.1. *ICT access and utilization*

The study sought to investigate the different levels of ICT access and utilization by researchers and extension workers by establishing the available infrastructure, ICT resources and services, and the competencies of the respondents. The aim of this question was to establish the level of computer access in the offices by single or shared users. The majority of respondents (158; 69.3%) had access to a computer in the office. When analyzed by the category of respondent, those with access represented 109 (63.3%) extension workers and 49 (87.5%) researchers. Seventy (30.7%) indicated no access to a computer, i.e. 63 (36.7%) extension workers and 7 (12.5%) researchers.

5.1.1. *Purpose of the computer*

Respondents who stated that they had access to a computer in the preceding question were asked to indicate what they were using the computer for. Four options were provided, with room for additional suggestions. Most of the extension workers (73; 42.4%) were using the computer to access the Internet, while the highest number of researchers (5; 8.9%) were using it for spreadsheet purposes. Table 1 provides a breakdown of the responses.

Word processing was the least mentioned purpose by both categories of respondents, i.e. 19 extension workers (11%) and 3 researchers (5.4%). Overall, the question had a low response rate from both categories of respondents, particularly researchers.

5.1.2. *Respondents' ICT skills/competencies*

The aim of this question was to assess the levels of ICT competence among the respondents. This was considered to be important in influencing how the ICT resources would be used. Among the extension personnel, the responses indicated that 56 (32.6%) believed their skills to be fair, 26 (15.1%) felt that their skills were good, 8 (4.6%) indicated very good, and 19 (11%) felt that their skills were poor. None of the researchers felt that they had poor ICT skills, with 18 (32.1%) indicating very good skills, 23 (41.1%) good and 8 (14.3%) fair. The question attracted multiple responses.

5.1.3. *ICT resources available to the respondents in the office or organization*

This question sought to establish what other ICT resources the respondents had access to in the office or within their organizations. Computers were again mentioned here, and this response

Table 1. Purpose of the computer.

	Agricultural extension worker		Agricultural researcher	
Purpose of the computer	*N*	%	*N*	%
Word processing	19	11	3	5.4
Spreadsheet (Excel)	45	26.2	5	8.9
Storing documents	27	15.7	4	7.1
Internet access	73	42.4	4	7.1

Note: Extension workers $N = 172$ and researchers $N = 56$. Table indicates multiple responses.

was validated on the premise that they were being accessed elsewhere within the organization and not necessarily from the respondents' offices. Table 2 provides a summary of the responses.

Table 2 shows that various ICT resources and services were available to researchers and extension workers in their respective organizations. Among extension workers, the high prevalence of ICTs was not restricted to the immediate environs of the respondents, but to resources that were available at district, provincial, and at the national level. Examples mentioned by the extension workers include the The Essential Electronic Agricultural Library (TEEAL) database (144; 83.7%); online journals (142; 82.6%), which were available through the Central Library; video recorders (138; 80.2%); information management (132; 76.7%); and storage/servers (136; 79.1%). This is corroborated with data from other research instruments (see discussion).

Television, radio, and video recorders were each mentioned by 49 (87.5%) researchers. Researchers also demonstrated access to online electronic journals (29; 51.8%) and the TEEAL database (38; 67.9%). E-mail and printers could each only be accessed by 9 researchers (16.1%), while computers could only be accessed by 3 (5.4%).

5.1.4. *Purpose of ICT resources and services*

The respondents were further requested to indicate the purpose for which the above ICT resources and services were being used, with nine options to choose from. Table 3 provides a summary of the results.

Most respondents (101; 44.3%) cited research purposes, and these were largely extension workers (97 compared to 4 researchers), followed by educational purposes (97; 42.5%) and communicating with friends (81; 35.5%). 97 extension workers (56.4%) indicated research and 83 (48.3%) cited educational purposes. The least number of extension workers (19; 11%) indicated communicating with extension workers. The majority of researchers (31; 55.4%) indicated communicating with farmers, with the least number (4; 7.1%) citing research purposes. Disseminating agricultural information was mentioned by 58 (25.4%) of the respondents, specifically 39 (22.7%) extension workers and 19 (34%) researchers.

Table 2. ICT resources available to the respondents in the office or organization.

	Agricultural extension worker		Agricultural researcher	
Access to other ICT resources	*N*	%	*N*	%
Computers	38	22.1	49	87.5
Printers	45	26.2	9	16.1
Telephones	31	18	19	33.9
Fax	96	55.8	46	82.1
Television	128	74.4	49	87.5
Radio	122	71	49	87.5
Mobile/cell phone	43	25	14	25
Video recorder	138	80.2	49	87.5
Internet	119	69.2	13	23.2
E-mail	117	68	9	16.1
Electronic journals (online)	142	82.6	29	51.8
CD-ROM databases (e.g. TEEAL database)	144	83.7	38	67.9
Storage/server	136	79.1	35	62.5
Information management	132	76.7	33	58.9

Note: Extension workers $N = 172$ and researchers $N = 56$. Table indicates multiple responses.

Table 3. Purpose of ICT resources and services.

Purpose of ICT resources and services	Agricultural extension worker		Agricultural researcher		Total	
	N	%	*N*	%	*N*	%
To communicate with agricultural extension workers	19	11.0	30	53.6	49	21.5
To communicate with agricultural researchers	67	40.0	12	24.1	79	34.6
To communicate with farmers	31	18.0	31	55.4	62	27.2
Professional communication with colleagues	38	22.1	9	16.1	47	20.6
Personal communication with friends, etc.	67	40.0	14	25.0	81	35.5
To disseminate agricultural information	39	22.7	19	34.0	58	25.4
For purposes of research	97	56.4	4	7.1	101	44.3
For educational purposes	83	48.3	14	25.0	97	42.5
To communicate with publishers	45	26.1	24	42.9	69	30.3

Note: Extension workers $N = 172$ and researchers $N = 56$. Table indicates multiple responses.

5.1.5. *Effectiveness of ICTs in disseminating agricultural information*

The study also sought to determine which ICT resources and services were considered to be effective in disseminating or communicating agricultural information by researchers and extension workers. For each item on the list, respondents could choose "very effective," "effective," "less effective" or "not effective." The question attracted multiple responses, as shown in Table 4.

From the responses, computers were considered to be effective/very effective by the majority of both extension workers (102; 59.3%) and researchers (41; 73.2%). The majority of extension workers (48; 27.9%) considered printers to be very effective, while 20 (35.7%) researchers considered them to be effective. Twenty-five (11%) of the total respondents found printers to be either less effective or not effective.

The telephone was again considered effective by only 6 (3.5%) of the extension workers. Only 1 (1.8%) researcher indicated that the telephone was not effective. Fax was considered to be less effective by the majority of researchers (12; 21.4%), yet it was considered to be very effective by the majority of extension workers (40; 23.3%).

The media were considered to be effective in disseminating agriculture information, with the majority of extension workers (59; 34.3%) and researchers (35; 62.5%) finding that the television was effective or very effective. The radio was not effective according to 18 extension workers (10.5%), with 6 researchers (10.7%) sharing this view.

The mobile phone or cell phone was considered to be effective/very effective by 114 extension workers (66.3%) and 35 researchers (62.5%). Only 9 (5.2%) and 1 (1.8%) of the extension workers and researchers, respectively, indicated that the mobile phone was not effective. The frequency of use of mobile phones is discussed in the next section.

The video recorder was considered to be very effective by 27 extension workers (15.7%), with a significant 14 (8.1%) and 23 (13.4%) mentioning that it was less effective and not effective, respectively. Equally, among researchers, the majority (12; 21.4%) found the video recorder to be effective, with 9 (16%) believing that it was not effective. The Internet was considered to be very effective by the majority of extension workers (39; 22.7%), although a significant number (22; 12.8%) thought that it was not effective. A similar pattern was observed with respect to electronic mail (e-mail); 32 extension workers (18.6%) believed it to be very effective against 21 (12.2%) who felt that it was not effective. Among researchers, 20 (33.7%) and 19 (33.9%) considered the Internet and e-mail to be very effective, respectively.

Table 4. Perceived effectiveness of ICT resources and services in disseminating agricultural information.

		Extension workers		Researchers		Total	
Information resource	Relative effectiveness	*N*	%	*N*	%	*N*	%
Computers	Very effective	57	33.1	22	39.3	79	34.6
	Effective	45	26.2	19	33.9	64	28.1
	Less effective	7	4.1	3	5.4	10	4.4
	Not effective	10	5.8	3	5.4	13	5.7
Total		**119**	**69.2**	**47**	**84**	**166**	**72.8**
Printers	Very effective	48	27.9	19	33.9	67	29.4
	Effective	45	26.2	20	35.7	65	28.5
	Less effective	13	7.6	2	3.6	15	6.6
	Not effective	7	4.1	3	5.4	10	4.4
Total		**113**	**65.8**	**44**	**78.6**	**157**	**68.9**
Telephone	Very effective	74	43	15	26.8	89	39
	Effective	40	23.3	20	35.7	60	26.3
	Less effective	9	5.2	11	19.6	20	8.8
	Not effective	6	3.5	1	1.8	7	3.1
Total		**129**	**75**	**47**	**83.9**	**176**	**77.2**
Fax	Very effective	40	23.3	7	12.5	47	20.6
	Effective	31	18	8	14.3	39	17.1
	Less effective	8	4.7	10	17.9	18	7.9
	Not effective	19	11	12	21.4	31	13.6
Total		**98**	**57**	**37**	**66.1**	**135**	**59.2**
Television	Very effective	29	16.9	23	41.1	52	22.8
	Effective	30	17.4	12	21.4	42	18.4
	Less effective	14	8.1	6	10.7	20	8.8
	Not effective	22	12.8	5	8.9	27	11.8
Total		**95**	**55.2**	**46**	**82.1**	**141**	**61.8**
Radio	Very effective	29	16.9	21	37.5	50	21.9
	Effective	37	21.5	14	25	51	22.4
	Less effective	12	6.9	5	8.9	17	7.5
	Not effective	18	10.5	6	10.7	24	10.5
Total		**96**	**55.8**	**46**	**82.1**	**142**	**62.3**
Mobile/cell phone	Very effective	85	49.4	21	37.5	106	46.5
	Effective	29	16.9	14	25	43	18.9
	Less effective	11	6.4	8	14.3	19	8.3
	Not effective	9	5.2	1	1.8	10	4.4
Total		**134**	**77.9**	**44**	**78.6**	**178**	**78.1**
Video recorder	Very effective	27	15.7	10	17.9	37	16.2
	Effective	21	12.2	12	21.4	33	14.5
	Less effective	14	8.1	10	17.9	24	10.5
	Not effective	23	13.4	9	16	32	14
Total		**85**	**49.4**	**41**	**73.2**	**126**	**55.2**
Internet	Very effective	39	22.7	20	35.7	59	25.9
	Effective	20	11.6	18	32.1	38	16.7
	Less effective	13	7.6	3	5.4	16	7
	Not effective	22	12.8	6	10.7	28	12.2
Total		**94**	**54.7**	**47**	**83.9**	**141**	**61.8**
E-mail	Very effective	32	18.6	19	33.9	51	22.4
	Effective	25	14.5	16	28.6	41	18
	Less effective	14	8	4	7.1	18	7.9
	Not effective	21	12.2	7	12.5	28	12.3
Total		**92**	**53.5**	**46**	**82.1**	**138**	**60.5**

(*Continued*)

Table 4. Continued.

Information resource	Relative effectiveness	Extension workers		Researchers		Total	
		N	%	*N*	%	*N*	%
Electronic journals	Very effective	12	6.9	20	35.7	32	14
	Effective	24	14	11	19.6	35	15.3
	Less effective	21	12.2	7	12.5	28	12.3
	Not effective	27	15.7	6	10.7	33	14.5
Total		**84**	**48.8**	**44**	**78.5**	**128**	**56.1**
CD-ROM databases (e.g. TEEAL)	Very effective	12	7	12	21.4	24	10.5
	Effective	20	11.6	12	21.4	32	14
	Less effective	19	11	6	10.7	25	11
	Not effective	31	18	9	16.1	40	17.5
Total		**82**	**47.6**	**39**	**69.6**	**121**	**53**

Note: Extension workers $N = 172$ and researchers $N = 56$. Table indicates multiple responses.

Responses for electronic journals and CD-ROM databases completely reversed the above trend, particularly among extension workers. The majority of extension workers (27; 15.7%) indicated that electronic journals were not effective, with 21 (12.2%) suggesting that they were less effective. Similarly, the majority of extension workers (31; 18%) found databases to be less effective. The majority of researchers (20; 35.7%), however, considered electronic journals to be very effective. This was also the case with CD-ROM databases, with 12 researchers (21.4%) finding them to be very effective, and the same margin indicating that they were effective. The majority of the respondents (40; 17.5%) felt that databases were not effective.

A contrast is noted between Table 2 (ICT resources available to respondents in the office or organization) and Table 4 (perceived effectiveness of ICT resources and services in disseminating agricultural information). While some respondents had access to some ICTs, they did not find them effective as dissemination tools. Contradictions also arise where the responses were from respondents who did not have access to such tools.

5.1.6. *Frequency of use of mobile phones/cell phones in communicating agricultural information*

This question specifically focused on the use of mobile phones. Respondents were required to indicate their frequency of use of mobile phones/cell phones in communicating agricultural information from a list of "quite often," "often," "sometimes," or "never." Most of the respondents (97; 42.5%) indicated that they used mobile phones quite often, with 24 (10.5%) indicating that they never used the device. Table 5 summarizes the responses.

The majority of extension workers (85; 49.4%) indicated that they used mobile phones quite often to communicate agricultural information. Only 15 (8.7%) indicated that they never used the device. The majority of researchers (23; 41.1%) indicated that they sometimes used mobile phones for the mentioned purpose, while 9 (16.1%) indicated never.

5.1.7. *Communicating agricultural information using mobile phones*

The aim of this question was to find out with whom the respondents communicated agricultural information using mobile phones. The majority of extension workers (69; 40.1%) indicated communicating with researchers; reciprocally the majority of researchers (21; 37.5%) indicated

Table 5. Frequency of use of mobile/cell phone.

	Agricultural extension worker		Agricultural researcher	
Frequency of use of mobile/cell phone	$N = 172$	100%	$N = 56$	100%
Quite often	85	49.4	12	21.4
Often	41	23.8	12	21.4
Sometimes	31	18	23	41.1
Never	15	8.7	9	16.1
Total	**172**	**100**	**56**	**100**

Note: Extension workers $N = 172$ and researchers $N = 56$.

Table 6. Communicating agricultural information using mobile phones.

	Agricultural extension worker		Agricultural researcher	
Person whom you communicate with using mobile/cell phone	*N*	%	*N*	%
Farmers	28	16.3	18	32.1
Extension workers	17	9.9	21	37.5
Researchers	69	40.1	7	12.5
Colleagues	33	19.2	6	10.7
Agribusiness companies	31	18	21	37.5

Note: Extension workers $N = 172$ and researchers $N = 56$. Table denotes multiple responses.

communicating with extension workers, and equally with agribusiness companies. Table 6 summarizes the results.

The trend was also noticeable in Table 3, where 67 extension workers (40%) indicated that they used ICTs to communicate with researchers. The responses also indicate that there was intra communication within the two categories, and also with agribusiness companies, as shown by 31 extension workers (18%).

5.1.8. *Status of ICT infrastructure in the respondents' office or department*

The respondents were also requested to rate the ICT infrastructure in their offices or departments. The ICT infrastructure within the research and extension systems was considered to be poor by 147 (64.5%) of the respondents. Among the extension workers, 116 (67.4%) felt that the infrastructure was poor, 51 (29.7%) good, and 5 (2.9%) believed that it was very good. A similar pattern was observed among researchers where the majority (31; 55%) believed the infrastructure was poor, 23 (41.1%) good, and 2 (3.6%) very good.

5.1.9. *ICTs and services required to improve job performance*

Having indicated the ICT resources and services and commented on the status and challenges of ICTs, the respondents were requested to indicate, from a list provided, ICT resources and services that they would require to improve their job performance. Table 7 provides a summary of the findings.

Table 7. ICTs and services required to improve job performance.

ICTs and services required to improve performance	Agricultural extension worker		Agricultural researcher	
	N	%	*N*	%
Desktop computer	92	53.5	37	66.1
Laptops	33	19.2	16	28.6
Printer	78	45.3	23	41.1
Internet	66	38.4	25	44.6
E-mail	86	50.0	23	41.1
Access to databases	149	86.6	25	44.6

Note: Extension workers $N = 172$ and researchers $N = 56$. Table indicates multiple responses.

An overwhelming majority of the extension workers (149; 86.6%) indicated that they required access to databases. This is despite earlier indications (5.1.5) where their perceived effectiveness was low, a situation that can be attributed to generally held views on services that they did not have. Laptops were the least mentioned item. Among researchers, the majority (37; 66.1%) required desktop computers, with laptops being the least required item. Other resources were highly recommended, for example, e-mail by 86 (50%) of the extension workers and the Internet by 25 (44.1%) of the researchers.

5.1.10. *Management of information generated from research and extension services*

The aim of this question was to establish how divisions or departments managed information that was generated by researchers and extension workers. This could be in the form of research reports, periodic reports, etc. Table 8 provides a summary of the findings.

Over half of the researchers (34; 60.7%) indicated that copies were kept in a central database. The least number of extension workers (41; 23.8%) indicated that copies were kept in departmental collections.

5.1.11. *Access to information generated by research and extension services*

The respondents were asked to indicate whether the information generated was readily accessible to both internal and external users. According to most of the respondents (131; 57.5%), information was generally not easily accessible, representing 101 (58.7%) of the extension

Table 8. Management of information generated by research and extension services.

Information management	Agricultural extension worker		Agricultural researcher	
	N	%	*N*	%
Copies are kept in the library	99	57.6	18	32.1
Records are kept in a central database	104	60.5	34	60.7
Copies are retained by individual researchers/extension workers	88	51.2	21	37.5
Copies are sent to the Research Council of Zimbabwe	144	83.7	33	58.9
Copies are kept in departmental collections	41	23.8	10	17.9

Note: Extension workers $N = 172$ and researchers $N = 56$. Table denotes multiple responses.

workers and 30 (53.6%) of the agricultural researchers. 97 (42.5%) of the respondents felt that information was accessible, i.e. 71 extension workers (41.3%) and 26 researchers (46.4%).

5.1.12. *Management/coordination of information generated by DR&SS and AGRITEX*

The study also sought to establish whether respondents felt that the information generated by departments was being adequately captured by the Departments of Research and Specialist Services (DR&SS) or the Department of Agricultural Technical and Extension Services (AGRITEX). The majority of respondents (205; 90%) felt that information was adequately captured, i.e. 153 (89%) of the extension workers and 52 (92.9%) of the researchers. This information corroborates data collected during the interviews with key informants. Only 23 (10%) of the respondents indicated that information was not adequately captured.

5.1.13. *Suggestions for the improved management of information generated by departments or divisions*

The respondents were asked to offer their suggestions for improving the management of records generated by the divisions and sections within DR&SS and AGRITEX. The summarized suggestions in Table 9 were proposed.

The summarized responses show that the majority of respondents (82; 40%) felt that there was a need to develop and place information on websites for all stakeholders to access. 17 (7.5%) of the respondents indicated the need to improve computer networks, both at local area network (LAN) and wide area network (WAN) levels. These sentiments were shared by the majority of both extension workers and researchers. Suggestions also included the need for the decentralization of research institutes, mentioned by 2 (1.2%) of the extension workers, and the need to establish research offices at the district level, mentioned by 1 (1.8%) of the researchers.

Table 9. Suggestions for improving information management.

	Agricultural extension workers		Agricultural researchers		Total	
Suggestions for improving information management	*N*	%	*N*	%	*N*	%
Management to make use of mobile phones	3	1.7	2	3.6	5	2.2
Need to improve computer networking (LAN and WAN)	14	8.1	3	5.4	17	7.5
Develop and place information on website for easy access	64	37.2	18	32.1	82	40
Decentralization of research institutes	2	1.2	2	3.6	4	1.6
Establish research offices at the district level	4	2.3	1	1.8	5	2.2
Improve communication	5	2.9	2	3.6	7	3.1
Send information to the field officers on the ground	5	2.9	2	3.6	7	3.1

Note: Extension workers $N = 172$ and researchers $N = 56$. Table denotes multiple responses.

6. Discussion of findings

The level of ICT development within the Ministry of Agriculture and its effect on the generation and dissemination of agricultural information in Zimbabwe leave much to be desired, as described in Section 5.1.8. Addison (2006, p. 3) observes that while information before the advent of the Internet was mostly disseminated on paper, it is now available to virtually anyone who can access the Internet through a proliferation of services that include organizational websites, document servers, and electronic versions of journals, project databases, and news and events in the form of blogs or Rich Site Summary (RSS) feeds. Researchers and extension workers were found to have access to various ICTs within their organizations. The majority of both extension workers and researchers had access to a computer in the office, although the study did not seek to establish whether the computers were shared or not. Inadequacies within the agricultural research system were, however, evident as most research institutes were devoid of Internet access, email, and other services. In order to access these facilities, researchers would have to travel to their national headquarters. Extension planners and policy-makers thus need to be equipped with analyses and arguments to bolster the case for agricultural extension playing a broader role in adopting and using ICTs (Meera, Jhamtani, & Rao, 2004; Richardson, 2006, p. 8).

All the key informants had access to laptops and Internet services and were able to access databases like Access to Global Online Research in Agriculture (AGORA) and other online journals. Other ICTs that were available to them include printers, telephones, and fax machines. While the results indicate a high percentage of extension workers accessing the Internet and e-mail, some of the ICTs that the extension workers purported to have access to were not necessarily located within their immediate environs (the ward level), but available at their district offices or the head offices in Harare. These ICTs include storage servers (79.1%), electronic journals (82.6%), and the TEEAL database (83.7%), which was only available at the Central Library. This may point to the contradiction between what was available to the respondents (located elsewhere) and what they could use effectively in their day-to-day operations. The librarians and observations confirmed that the other libraries were poorly equipped in terms of computers and other ICTs.

ICTs such as the television, radio, and video recorders were accessible to the majority of both extension workers and researchers in the office, while mobile phones were accessible to a quarter of both the extension workers and researchers. Although various ICTs were available to the researchers and extension workers, the majority of respondents and the key informants felt that the infrastructure was poor.

Access to ICTs without use is not enough. According to Kalusopa (2005, p. 422), ICTs can enhance systematic collection, repackaging, and the provision of current and accurate information by opening up new sources of information and new communication avenues. The study demonstrated that the available ICTs were being utilized for various purposes and to different extents by the respondents. The respondents indicated that their ICT skills and competencies were good to excellent, save for 11% of the extension workers who felt that their skills were poor. Generally, ICT skills and competencies tend to have a perceived influence on ICT utilization (Mugwisi, 2002; Nkomo, 2009). As demonstrated in the theoretical framework, this indicates that as innovations, ICTs have been adopted by researchers and extension workers based on their various purposes and levels of competence.

Overall, the computer was used as a storage device, for word processing, and to access the Internet. The ICTs were mostly used for research and educational purposes, and to communicate with publishers. Extension workers were also involved in research, although the study did not distinguish between work-related research and personal research. However, the majority of extension workers indicated that they used ICTs for research purposes. As pointed elsewhere

in the study, extension workers were also involved in the production of extension material (for internal use and for other stakeholders) and research publication, which may point to the high utilization of ICTs for this purpose. The study revealed that ICTs were utilized by extension workers when communicating with agricultural researchers and correspondingly by researchers when communicating with extension workers. Extension workers' utilization of ICTs in communicating with farmers was low (18%), although 22.7% mentioned using ICTs to disseminate agricultural information. In contrast, a large number of researchers utilized ICTs to communicate with farmers.

We noted that various ICTs were considered to be effective in the dissemination of agricultural information. However, the level of effectiveness of different ICTs varied between researchers and extension workers. Mobile phones were considered to be effective/very effective in communicating agricultural information by the majority of the respondents, despite the fact that only 25% from each category could access them from the office. This suggests that the respondents were using their personal mobile phones for work-related purposes. The study did not, however, ascertain whether they were compensated for airtime, as is the practice in some organizations. Only 5.2% of the extension workers and 1.8% of the researchers considered the mobile phone to be less effective, with an overall non-response rate of 21.9%.

Interestingly, the number of people using mobile phones in Zimbabwe has increased exponentially, with the mobile-cellular subscription estimated at 7.7 million subscribers in 2010 (International Telecommunication Union, 2010). The Zimbabwean government supports the development and application of ICTs and has a Ministry of ICT dedicated to this purpose. The growth in mobile phone utilization is partly attributed to the implementation of government policy that allowed the import of ICT products duty-free, which resulted in a drastic drop in the prices of products, including handsets and starter packs (SIM cards). The latter were drastically slashed from US$100 to US$1 on the official market.

The majority of researchers indicated that they sometimes used mobile phones, while most extension workers indicated that they used them quite often. The majority of extension workers indicated that they used mobile phones to communicate with researchers, results which support their stated use of ICTs. Researchers also indicated communicating mostly with extension workers and agribusiness companies. The new generation of gadgets (like mobile phones), although not readily available to respondents in their work environment, was highly preferred. The use of mobile phones in communicating agricultural information is evident in this study; communication occurred not only between researchers and extension workers, but also between themselves and farmers, agribusiness companies, and other colleagues.

Although the telephone was considered to be effective/very effective in communicating agricultural information by the majority of respondents, theft, and vandalism of telephone and copper cables has affected the effectiveness of telephones, particularly in farming areas, leading to a greater reliance on cell phones wherever networks are available. However, it is important to note the contradiction in Table 2; the availability of fax machines was high for both extension workers and researchers when normally these two (fax and telephone) would run together or closely related. Computers were considered to be effective/very effective by the majority of the respondents for various purposes, including word processing, spreadsheets, etc. Computers were one of the most highly recommended ICTs by the respondents. Printers are generally used in conjunction with computers and were likewise considered to be effective/very effective as a communication tool by the majority of the respondents. The circulation of information generated by research was affected by the lack of printing facilities, particularly ink and paper, among other factors.

The radio and television as communication channels were considered to be effective/very effective by the respondents. The radio's main advantages are that it can reach a wider audience

and transmit vernacular content. The state run Zimbabwe Broadcasting Corporation (ZBC) is the only radio and television broadcaster in Zimbabwe. ZBC radio operates four channels: Radio Zimbabwe (broadcasting in Shona and Ndebele), National FM (minority languages), Sport FM (sports and current affairs), and 3FM (pop/entertainment). ZBC TV operates two channels. Channel one is the main channel that broadcasts news, sports, and entertainment, while Channel two focuses mostly on entertainment. The observations above are in tandem with the framework of the study with regard to communication channels in conveyance of the messages or information to various groups, and these include communication channels between and among researchers and extension workers (peers) and with the farmers.

The use of ICTs as tools and vehicles for communicating and disseminating agricultural information is evident from the above discussion. A contrast was noted between the availability of resources and their utilization or perceived effectiveness. For example, while mobile phones, telephones, computers, and printers were the least available ICTs (Table 2), their perceived effectiveness was high compared to the television and radio, which were not considered to be effective by many, despite high availability (74.4% and 71%, respectively). Electronic journals were not considered to be effective by 15.7% of the extension workers, with 51.2% not responding to this question, while 10.7% of the researchers considered e-journals to be ineffective, with a non-response rate of 21.5%. A similar trend was observed with databases (e.g. TEEAL), where 18% of the extension workers and 16.1% of the researchers indicated that they did not consider them to be effective in disseminating agricultural information. This is surprising considering the statements by 42.5% and 40.4% of the respondents that the Internet and e-mail, respectively, were effective tools in communicating agricultural information. Compared to the information purposes cited in Table 3, it was noted that there was poor use of ICTs in disseminating agricultural information despite their availability.

The responses for ICT requirements for improved access and utilization were contradictory. For example, while in Table 4 only 20.9% and 18.6% of the extension workers considered electronic journals and databases, respectively, to be effective, 86.6% indicated that they required access to databases in order to improve their job performance. This also contradicted the responses in Table 2, where 82.6% and 83.7% of the extension workers indicated that they had access to e-journals and databases, respectively. Listed among the requirements of the respondents were desktop computers, printers, e-mail, and Internet access. Laptops were the least required ICT among both researchers and extension workers. The need to develop and place information on a website was considered to be important by 40% of the respondents. The importance of websites to their respective organizations and for communication was emphasized by these respondents.

According to Richardson (2006, p. 13) the use of ICTs in extension provides for several key benefits in relation to traditional media, and their potential strengths include a new range of additional media provide for communication for development mix, and this makes information more accessible. Van den Ban and Hawkins (1996), Leeuwis (2004), and Rogers (1995) highlight the importance of traditional media and the significance of ICT enhanced hybrid media as communication channels. Richardson (2006) and Kumar (2005a, 2005b) observe that benefits include reduced costs of communicating while speeding up the communication process. The unavailability of telecommunications infrastructure is seen to limit what new ICTs can be adopted.

The respondents reported that most documents were being stored and circulated as hard copies, meaning that the means and processes in place for managing information generated by research and extension systems are inadequate. According to Kalusopa (2005, p. 422), agricultural development activities are based on the utilization of information, and in order for this information to be effective, it has to be systematically collected, organized, and repackaged to

supply the consumer as and when needed. The study looked at what information management processes were in place, the availability of ICTs, and their utilization in managing and disseminating agricultural information. The significance of ICTs in generating and communicating research to extension workers and farmers points to the need to strengthen ICT capacity and infrastructure in both research and extension institutions.

Researchers and extension workers generate information during the course of their work as research results, reports, manuals, commissioned projects, and private studies. While there was some use of ICTs to manage information generated by DR&SS and AGRITEX, most documents were distributed/disseminated as hard copies. Although there was no defined policy on the management of information, a large number (90%) of the respondents felt that the information generated was adequately captured, and this view was supported by evidence from key informants. In terms of how the information was managed, the respondents explained that copies were sent to the library (as hard copies) and to the Research Council of Zimbabwe (as hard copies and containing abstracts of current and completed projects). The respondents also indicated that copies were kept in a central database and by individual researchers and extension workers, but they did not reveal where or to whom and in which format.

Interviews with key informants revealed that most research publications did not circulate due to printing challenges, and some of the publications could no longer be retrieved as the technology of floppy disks is obsolete. Due to limited printing and reproduction facilities, most of the respondents indicated that the material was not readily accessible. Despite its unavailability, internally generated information was found to be important, and organization-based methods like publications (pamphlets and posters) were listed as highly prioritized methods of disseminating agricultural information to farmers. Internally generated information sources like circulars were also found to provide alternative information services to libraries. Due to their usefulness to the research and extension processes, it is imperative for these information sources to be properly documented for posterity.

The paper has shown how the DoI model was applied in the study through the various acceptance levels and levels of utilization of ICTs for research and extension purposes, beginning with utilizing ICTs as a method of transfer of new farming innovations. Various communication channels have also been demonstrated, such as use of newspapers, radio, and television, and the utilization of hybrid media (technologies that facilitate communication) such as the Internet and other web-based services. Third, innovations are not adopted by everyone at the same time, hence variations in their perceived usefulness as demonstrated in Tables 2 and 3. The responses also highlighted some contradictions, particularly with what ICT resources were available in organizations and their perceived usefulness for work and other purposes. Finally, the study has shown the use and complementary application of various ICTs (triangulation) in order to achieve the specific goals of research and extension.

7. Conclusion

Information generated by the researchers and extension workers is based on their work, and includes reports and other publications. The study found that while information is generated electronically, it is often distributed and circulated in print format. The challenges of print resources restricted the amount of documents that could be reproduced. This was particularly evident during Zimbabwe's economic meltdown (2005–2008), with the situation improving as resources gradually became available.

The results of the study contribute to literature on ICTs for agricultural research and extension and its adoption in a developing country environment. The study has demonstrated factors which may impede adoption and the challenges that are to be expected. The study recommends

that attention be drawn to the improvement of information management and ICT services. Adequate funds should be availed for the provision and maintenance of resources. An audit should also be carried out to ascertain the current state of ICTs within the Ministry of Agriculture in order to enable it to budget for the upgrade of infrastructure. There is also a need to develop the ministry' website and Internet bandwidth in order to encourage downloads and remote access to information and databases like AGORA, which has password access, as opposed to TEEAL which can only be accessed in one location. The study also recommends that training be provided to both researchers and extension workers on the use of various ICTs and databases in order to maximize the utilization of available resources.

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