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Adoption and use of information and communication technologies (ICTs) by agricultural research institutions in information dissemination: A case study of Zimbabwe

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Abstract

The study sought to evaluate the adoption and usage of ICTs in agricultural research stations under the department of research and specialist services (DR&SS) in Zimbabwe. A questionnaire was administered to 37 employees who participated in the study. The results show that ICTs are adopted in the research institutions but most of the hardware and software used is not modern hence there is a gap in information access, generation and dissemination. Results also show that most of the employees in the research institutions have little ICT knowledge and aptitude while a few have taken short courses to augment their ICT use proficiency. However, factors such as low disposable income have contributed significantly to less priority on ICTs capacity self-building limiting its adoption. Nonetheless, employees reflected that they were willing and had time for ICTs. The study concluded that in order for effective information access, generation and dissemination, there is need to allocate enough budgets to ICTs and also upgrade on the ICT equipment that they use. For quick and effective information flow to the users, research stations have to frequently disseminate information through platforms that are more convenient to the users, specifically to resource-poor small-scale farmers who make up to 80% of farmers in Zimbabwe.

Keywords: Information and Communication Technologies; Agricultural Research Institutions; Information Dissemination; Emerging Technologies; Zimbabwe

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1. Introduction

1.1. Background of study

An increase in food production by about 70 % will be necessitated by the growing population which is expected to reach 9.1 billion by 2050 (FAO, 2009). This calls for more effective extension methods which will address the growing food demand especial for the poor smallholder farmers in developing countries. Agricultural extension experts are advocating for the use of Information and Communication Technologies (ICTs) in extension and education (FAO-ITUM, 2016). ICTs has the potential to accelerate the technology transfer from research institutions to farmers, resulting in adoption of new technologies and access to profitable markets (Tata et al., 2016).

Agriculture's full potential has been hampered by a number of factors, one of which is access to production and marketing information. Access to information would influence proper decision making on use of available technology packages. Although there has been growing interest to disseminate information to smallholder farmers through extension, private sector, research institutions, NGOs and traders (Nyongesa et al., 2008). Information and communication technologies play a crucial role in disseminating information to farmers enabling them to decide on the cropping pattern, use of high-yielding seeds, fertilizer application, pest management and marketing.

According to Sylvester et al. (2011), due to the demand for appropriate ICT-enabled technologies to support small-holder resource poor farmers there is the need for appropriate ICT-enabled applications for holistic farm productivity and economic simulations, knowledge-based decision support systems, the ability to access and use information for risk assessment and mitigation including that for climate change, the use of geographical information in planning and monitoring agricultural activities and market-related information, not only for prices but also for appropriate options for increasing productivity and profit and for ensuring food safety and appropriate information for consumers were identified as one priority areas in the efforts to achieve food security. The attainment and sustenance of high levels of agricultural production and income is not possible without an effective agricultural extension and appropriate tools that is relevant to farmers' needs. Therefore ICTs becomes an important aspect in agricultural production and also plays the role in the attainment of food security as information is spread quickly, stored and retrieved anytime it is required. In this view the role of Agricultural Research Institutes becomes very important in dissemination of information to its users such as farmers and other researchers, through the use of information and communication technologies which are believed to play a role in effective and quick dissemination of information.

Despite a lot of effort being made by the DR&SS to conduct relevant research for the changing environment and markets, very little or no effort has been made to share this information with the beneficiaries of such research outputs who are the small-holder farmers. Traditional extension approaches have been a success in the past years but due to the new type of farmers we are currently having who are always information seeking and most of them are not full-time farmers, new approaches for disseminating research outputs are critical. There is little and scattered research on the challenges of using ICT in the generation and dissemination of agricultural information to the farmers through the research-extension linkage. Therefore, there is need to

identify the level of ICT adoption, their utilization, ICT challenges and their relationships to information dissemination through the research-extension linkage to extend relevant, timely and easily accessible agricultural information to the farmers. The main objective of the study was to investigate on the adoption and use of the ICTs by Agricultural Research Institutions in Zimbabwe to ensure access and quick spread of information in the agricultural sector.

1.2. Application of information and communication technologies in agriculture

Developments in Information and Communication Technologies (ICTs) have impacted all sectors of society, including the agriculture sector. Levi et al. 2015 argue that ICT is a very important aspect in agriculture. According to FAO-ITU (2016) ICT assist can bridge the gap between agricultural researchers, extension agents and farmers, thereby enhancing agricultural production. Aker (2011) states that "by improving communication flows, mobile phones could potentially strengthen the link between farmers, extension agents and research centres" Smart phones support social media or sharing user-generated content through forums, blogs, bookmarking and sharing videos and photos. Greater efficiencies in terms of time, cost, quality of services and products can be attained in farming by using these technologies (FAO, 2013/14). Aker, (2011) further argued that "by reducing communication costs, mobile phones could assist risk-averse farmers in identifying potential buyers for their products over larger geographic areas and at crucial moments, thereby reducing price risk and potentially increasing the net benefits of the technology". Access to information is an essential component in strengthening agricultural practices and empowering farmers to find solutions to agricultural challenges. Information requirements of farmers should be analysed and documented and then adequate information systems (IS) should be developed.

Poor farmers have largely remained poor with 73 per cent of the people living in rural areas subsisting on less than a dollar a day (Zyl et al., 2014). Furthermore, information and communication technologies when embedded in broader stakeholder systems can bring economic development and growth as it can help bridge critical knowledge gaps (FAO, 2013/14).

New information and knowledge fuel innovation and increase productivity and competitiveness. The ability of farmers to participate in and benefit from growth in the sector is linked to their ability to adopt new practices, solve problems and be involved in agricultural value additions. Farmers currently access information through a complex web of social networks that include other farmers, family members, extension agents and input supply dealers. Yet for many farmers, these networks lack the type of information that can help them to move confidently into more productive and competitive strategies. (Kiptum, 2016).

1.3. Information needs by researchers

Information of adequate quality is a necessary condition for improvement of all areas of agriculture. According to Milovanovic (2014), in order to improve agricultural production, farmers should have following information backed by research:

- *Information on crops* – for example categories of seeded crops, size of land with specific crops, time of dropping seed, time of harvest, yields etc. The information is analysed to create statistical

reviews and tables that can be accessed by farmers through internet with ordinary web browser. Farmers can make their own production plans based on the information.

- *Information on production techniques* developed by experimental agricultural institutes and stations for agriculture improvement can be collected and integrated. The information is made available to farmers through internet and the other channels.
- *Information on production equipment and agricultural inputs* -The information is gathered from enterprises selling equipment for soil processing and other production equipment, seed and the other agricultural inputs. Information collected in such way is offered to farmers.
- *Market information* -In order to support farmers in gaining the best prices for their products, information on market of various agricultural products should be created. Aims of market information activities are to show review of prices on various markets and to facilitate reorientation of farmers' production to markets where better prices are expected. Farmers need overall reviews of food market information. The reviews present valuable information on some most important import and export markets.
- *The other information of interest for farmers* - Examples of such information includes weather forecast, availability of credit, and expert advice about maintaining crops in healthy state.

1.4. Challenges of ICT use in information dissemination

There are some limitations that can make implementation and expansion of ICT in agricultural sector difficult. Rao, 2003 and Mittal, 2012 explain factors and limitations preventing effective implementation and use of ICTs in agricultural sector and rural areas. These limitations include:

- *Lack of awareness about benefits of ICTs:* **-** Many people in rural areas have no computer and internet access. This contributes to their lack of awareness of the benefits from using information and communication technologies.
- *Easiness of system use and language barriers:* **-** Success of strategy of information and communication technologies implementation in agriculture depends on easiness of system use by rural population. In addition, there is a language barrier for large segments of the rural population to use systems.
- *Connectivity:* **-** Cost of computers and fees for internet access are still high for the most rural population that is poor in developing countries. Availability of internet access is low in rural areas because Internet Service Providers (ISP) delivers services mainly in urban centres. Reliable network connection is prerequisite for successful implementation of information and communication technologies in rural areas and farms.
- *Bandwidth of network:* **-** Even where telephone and the other communication services exist, available bandwidth can be limitation for effective use of networks. Low bandwidth network can be main limitation for providing electronic services to farmers.
- *Lack of motivation to use computers and internet:* **-** Despite internet access, users in rural areas have to be motivated for internet use. In order to use internet, farmers and the other individuals in rural areas must have adequate level of competence and skills.
- *Lack of online government information:* **-** Much of potentially vital government information is not available online. Governments in many developing countries do not focus on the poor population in rural areas and do not give them appropriate information and services through internet that could be used for improvement and development of agriculture.

1.5. ICT Sector challenges in Zimbabwe

According to the Zimbabwe National Policy for Information and Communication (2015), the ICT sector has been faced with a number of challenges. Some of these include:

- *Inadequate communications infrastructure:* - Broadband coverage in rural and remote areas remains low. Coverage is mainly concentrated in affluent urban areas. This is widening the urban-rural digital divide against the principle of equitable access.
- *Inadequate Commercial Electricity*: - The national power grid does not cover the whole country which leaves a significant population dependent on alternative power sources which tend to be more expensive. Even those who are on the national grid experience erratic supply. This shortage has had adverse effects on the development and use of information and communication technologies.
- *Inadequate information and communication technologies skills:* - There is a shortage of ICT skilled manpower to roll out ICT programmes. This shortage has a knock-on digital literacy which drives uptake and usage of ICT services.
- *Low digital literacy level:* - The education curriculum does not include information and communication technologies; therefore, the level of digital literacy at grassroots level is very low to stimulate service uptake and usage, especially in rural areas.
- *High cost of data/ bandwidth* – The recent increase in tariffs by mobile subscribers will make data beyond the reach of many Zimbabweans (Herald, 2019)

Despite a lot of effort being made by the department of research and specialist services (DR&SS) to conduct relevant research for the changing environment and markets, very little or no effort has been made to share this information with the beneficiaries of such research outputs who are the small-holder farmers. Traditional extension approaches have been a success in the past years but due to the new type of farmers we are currently having who are always information seeking and most of them are not full-time farmers, new approaches for disseminating research outputs are critical. There is little and scattered research on the challenges of using ICT in the generation and dissemination of agricultural information to the farmers through the research-extension linkage. Therefore, there is need to identify the level of ICT adoption, their utilization, ICT challenges and their relationships to information dissemination through the research-extension linkage to extend relevant, timely and easily accessible agricultural information to the farmers. The main objective of the study was to investigate on the adoption and use of the ICTs by Agricultural Research Institutions in Zimbabwe to ensure access and quick spread of information in the agricultural sector.

2. Research methodology

In order to evaluate the types of ICTs used in research stations, skills possessed, the degree of adoption of these ICTs and how they are used to process, store and disseminate the research information to final users (farmers, other researchers, government etc.), a descriptive research design was implemented. A choice of the questionnaire as a data collection tool was done because it was very relevant to the survey research design. Stratified random sampling method was used in this research. Deliberate sampling or convenience sampling method was also very useful. The units selected constituted a sample which then represented the whole area.

This method allows one to select individuals or items which one considers as the representatives of the whole group. In this study both data types were used which are quantitative and qualitative. The sample size of the research study was 62 participants. Equation 1 was used in establishing the sample size (Saunders et al., 2016):

$$N = [n \times 100]/re\% \quad (1)$$

Where:

N - Actual sample size required

n - Minimum sample size which is 30 in this case.

re% - estimated response rate estimated at 80% which the researcher justifies it is because he self-administered the questionnaires therefore, he did follow-ups to make sure that all responses were done properly and everyone responded.

2.1. Data analysis and presentation

Data was entered and analyzed using Microsoft Excel as well as Statistical Package for Social Sciences (SPSS). Data collected was analyzed by the use of tables, graphs and pie charts. The data was presented using tables and graphs.

3. Results

3.1. Demographic characteristics, education and positions at work

The characteristics presented in this study were responses from research institutes workers who adopts uses ICT in information dissemination in Zimbabwe.

Majority of respondents were male who constituted 70% of the respondents (Table 1). This however does not imply that female does neither use ICTs in research stations nor a few of them works in the agricultural research stations.

Table 1. Gender of Respondents

	Frequency	Percent
Males	26	70.3
Females	11	29.7
Total	37	100.0

Ages of respondents ranged from 21-53 years with the mean age of 35 years and standard deviation of 6.29 (Figure 2). Also the age of the respondents was tri-modal with the modal ages of 31, 33 and 35 years.

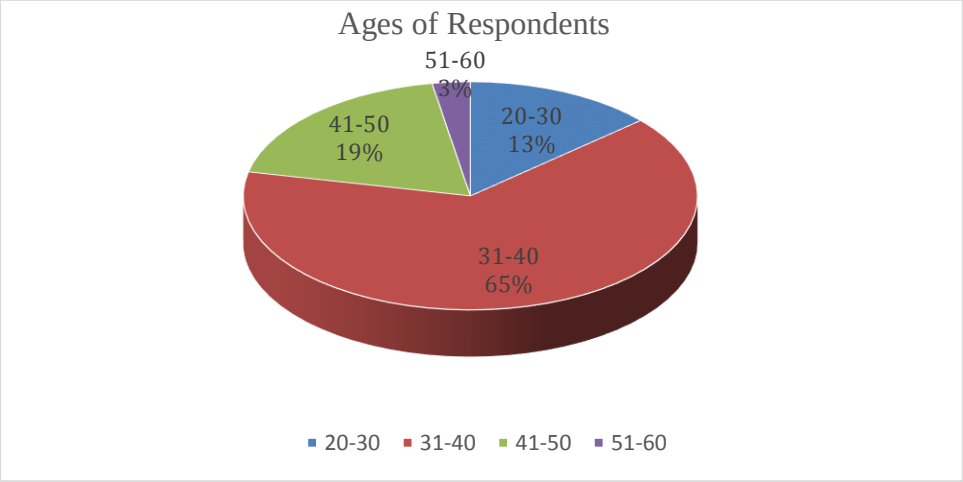

Figure 2. Age of Respondents

The majority of respondents possessed diplomas. However, there is no a big difference between frequencies of diploma holders and the ones who possesses degrees. The least educated among respondents were secondary education holders constituting 2.7% of the respondents (Figure 3).

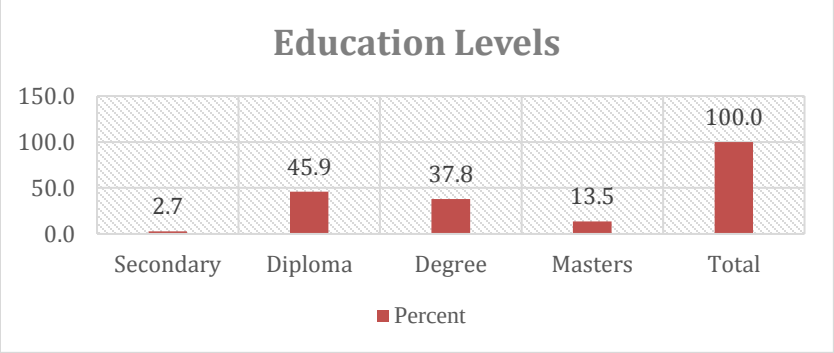

Figure 3. Levels of Education of Respondents

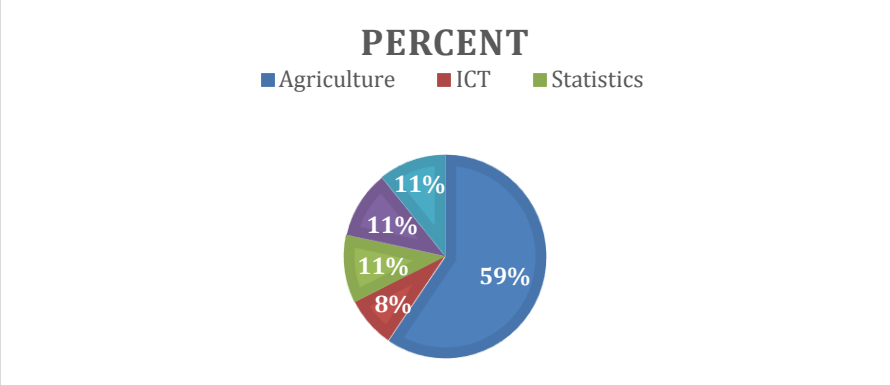

Figure 4. Areas of Specializations of Respondents

The majority of the respondents in the study were in the agriculture department with more research officers followed by technicians (Figure 4). The rest of the respondents who constituted less than 20% were student trainees, seed analysts, biometricians, HR, statisticians and ICT specialists.

Some of specializations in the other-category of specializations were media, chemistry and biotechnology.

3.2. Skills and trainings in ICT use

The proportion of respondents who received some formal training in ICT recorded a 54% (Figure 5). Most of the respondents acquired this formal training when it was conducted by the organization internally.

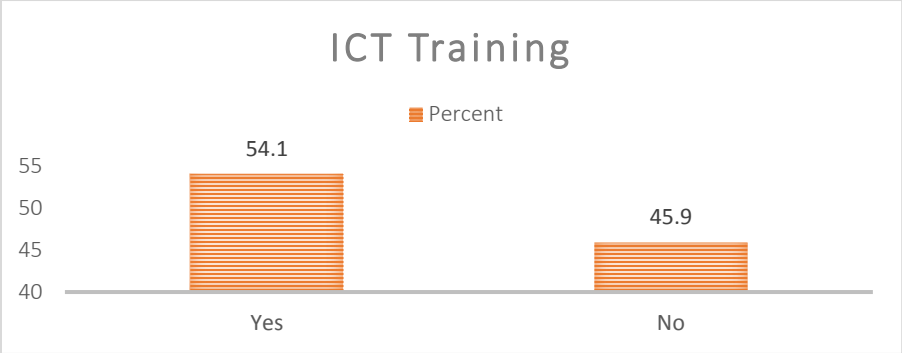

Figure 5. Formal ICT training

Also other formal training of ICT that was stated by the respondents is Introduction to Information technology done under degree programmes and also under diplomas.

Stated short courses mentioned by the respondents are computer course that were undertaken and an example of these is ICDL computer course. Only a few respondents did short ICT courses as shown in Table 2.

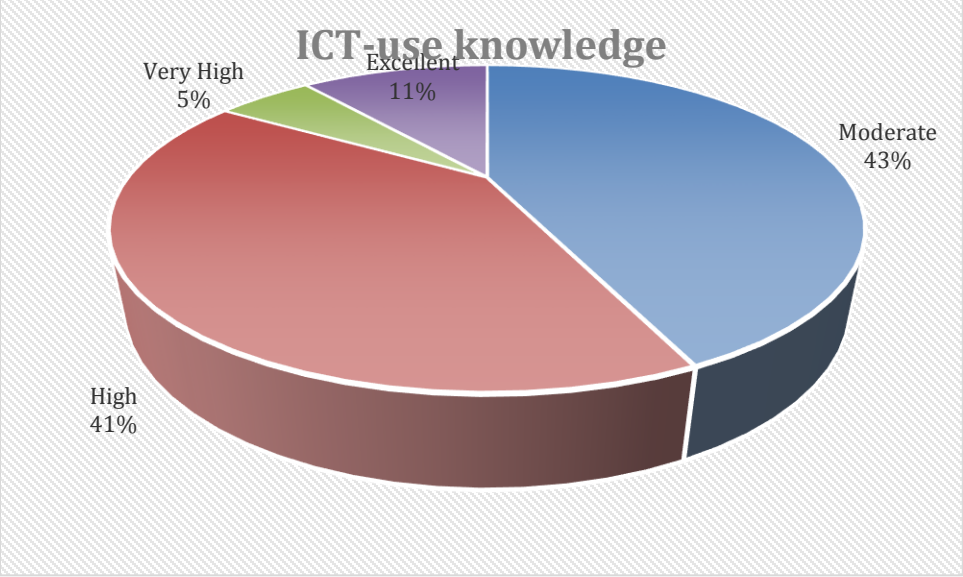

Figure 6. ICT-use Knowledge Ratings

Table 2. Short Courses Taken by the Respondents

	Percent (%)
Yes	27
No	73
Total	100

Most respondents mentioned that their knowledge on ICT-use is moderate and high. 11% of them claimed that their knowledge is excellent and the other 5% rated their knowledge to be very high (Figure 6).

3.3. ICT hardware and software used

In this category respondents were asked to tick the hardware that they use and it came to light that most of the workers use their personal laptops which had the highest percentage (Figure 7). The other category was provided in case of additional equipment used and only a few indicated that they have more equipment other than stated. Examples of other equipment were overhead projectors and landline phones.

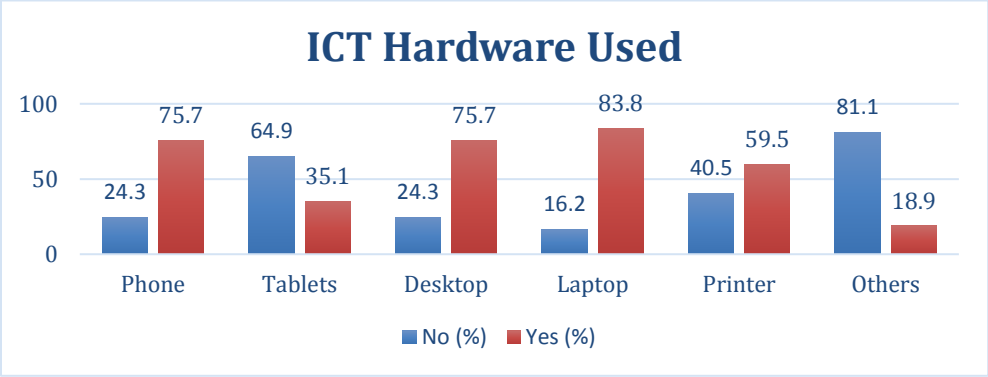

Figure 7. ICT Hardware Used

Mostly used software is Microsoft Office Word (94.6%) and GIS (13.5%) is the least used software (Figure 8). In the other-category, only a few individuals selected it and an example was GenStat.

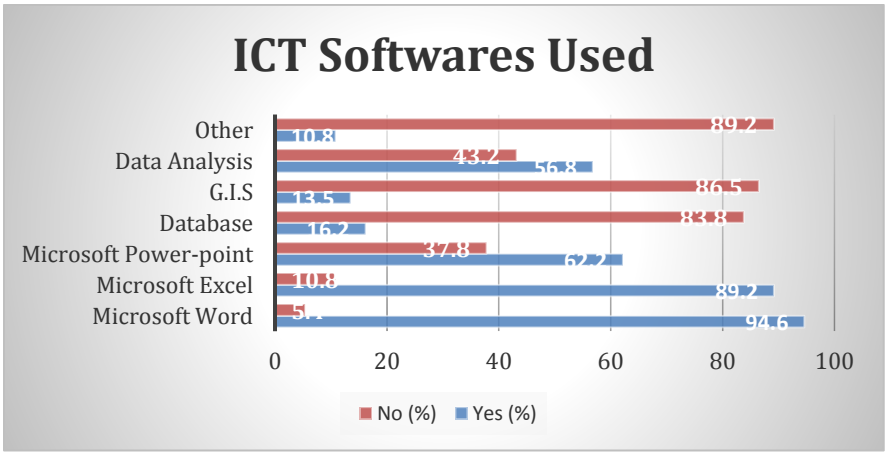

Figure 8. ICT Software Used

3.4. Information accessed, generated and disseminated

Three categories of type of information that he respondents accesses using ICTs was also required in the questionnaire where there results were that more information is accessed for the educational purposes as shown in Figure 9.

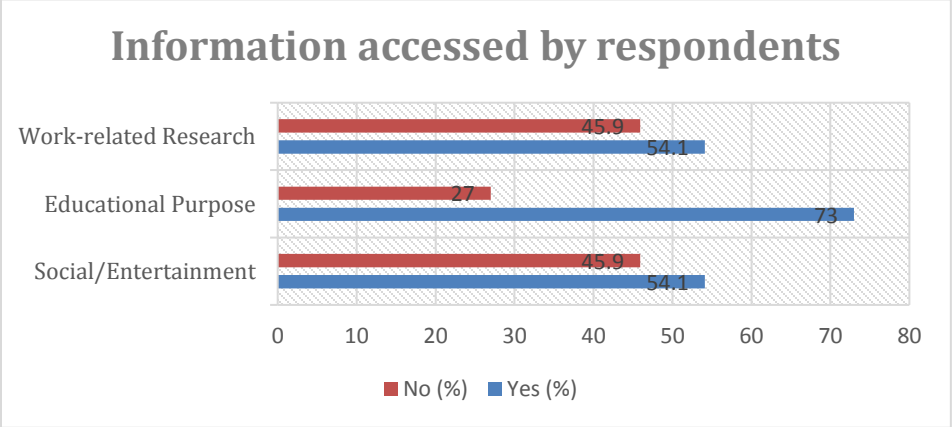

Figure 9. Type of Information Accessed Using ICTs

The responses were that information is being acquired from several sources with research sites (67.6%) providing more information. Farmers (62.3%) also provide more relevant information to the research stations. Laboratories and other researchers are at par, providing 40.5% of information (Table 3). Only 16.2% information is acquired from other sources which some of them are seed houses.

Table 3. Sources of Information Used in Research Stations

	Yes (%)	No (%)
Research Sites	67.6	32.4
Farmers	62.2	37.8
Laboratories	40.5	59.5
Other Researchers	40.5	59.5
Other	16.2	83.8

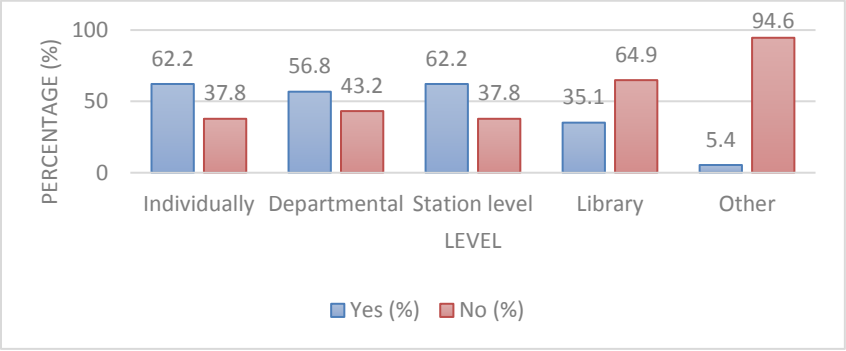

Figure 10. Information Storage

According to the responses, information is not only stored in one place. Same information can be stored individually, in libraries, departmentally and also at station level. However, only a few stated libraries (35.1%) (Figure 10).

Most information in research stations is stored in soft copies (91.9%). Libraries constitute the least percentage (27%) which implies that in the research stations there are few/no libraries where information is stored (Figure 4).

Table 4. Form of Information Storage

Category	Yes (%)	No (%)
Print form	56.8	43.2
Soft Copy	91.9	8.1
Library	27	73
Files	59.5	40.5

In the study, researchers also wanted to know how accessible the research information is to the workers of the research stations.

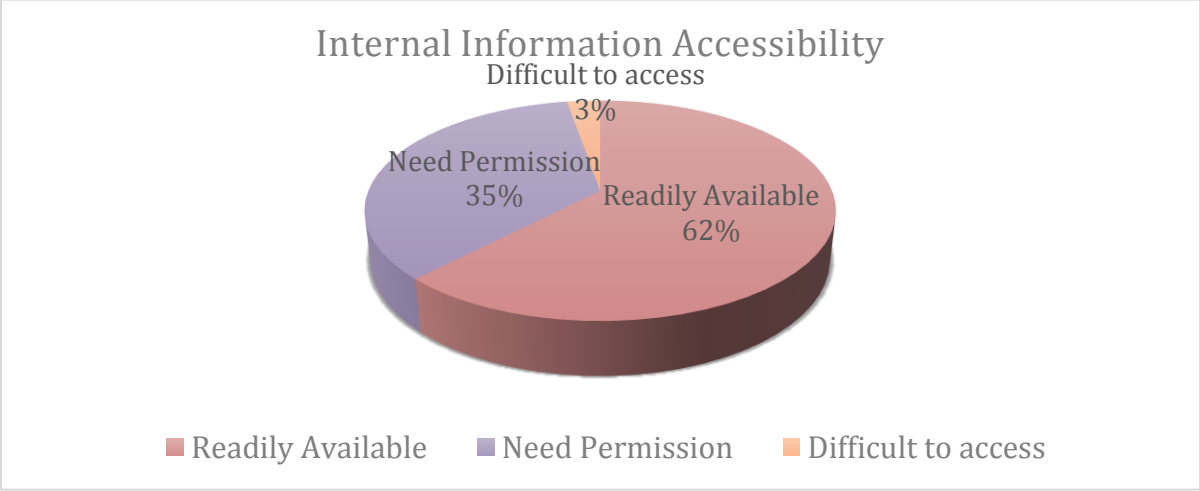

Figure 11. Internal Information Accessibility

Most responses (68%) show that in order for external users to access the research information, they must be given permission by the respective research stations. Only 27% of the respondents said that information is readily available and 5% for difficult to access (Figure 12).

The most used form of communication at work was email (91.9%). The least used form of communication was Fax (5.4%). Whatsapp (62.2%) and phone calls (83.8%) however had more use in the research institutions.

Most used platform to disseminate research outputs were journals (78.4%). Least used is media (35.1%) and above averagely used is field days, workshops and website is slightly above average (Figure 13).

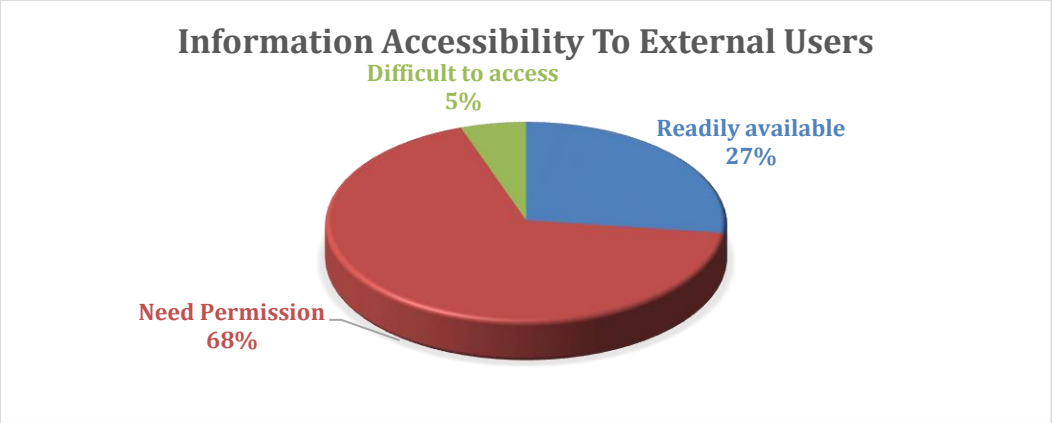

Figure 12. Information Accessibility to External Users

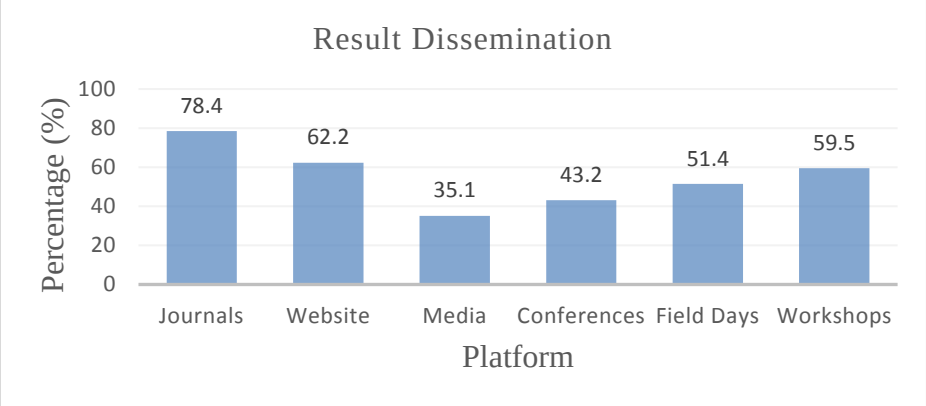

Figure 13. Result Dissemination Platforms

Most of the information is published yearly (46%) in most research institutions whereas some mentioned that it is published quarterly (30%). For weekly, only 13% of respondents confirmed, with 11% on monthly basis (Figure 14).

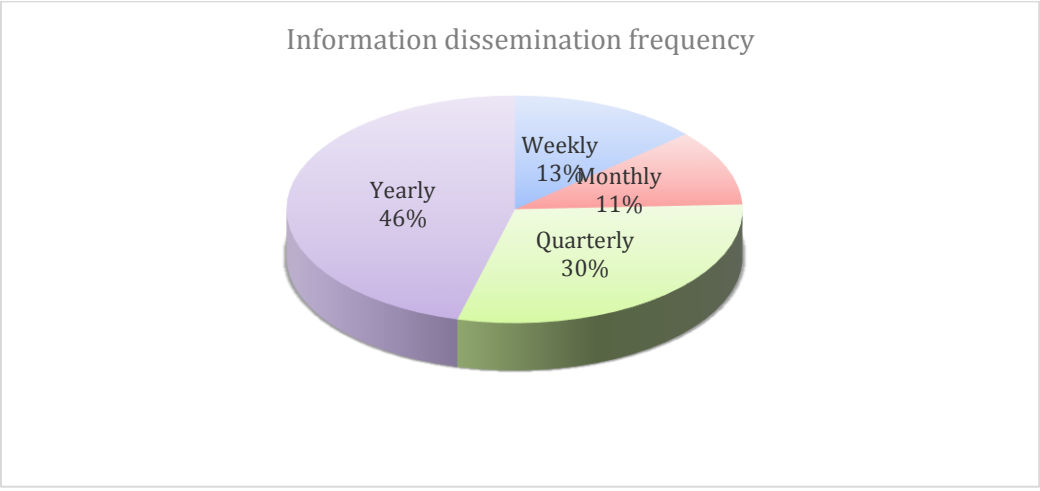

Figure 14. Information Dissemination Frequency

3.5. Factors influencing ICT adoption

Figure 15 shows the all the categories of information users who participated in this study. On charges for the information researched, 100% of the respondents in the study stated that there was no charge for the information. The information was for free.

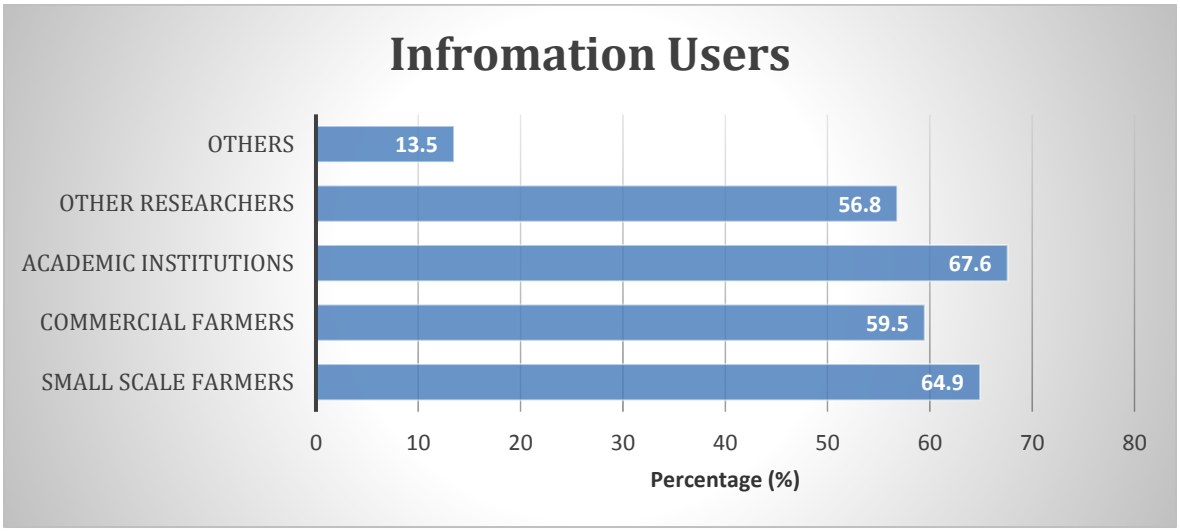

Figure15. Research Information Users

Responses from the respondents indicated that Email (78.4%), which is at par with users coming physically is the mostly used form of communication to make enquiries (Figure16).

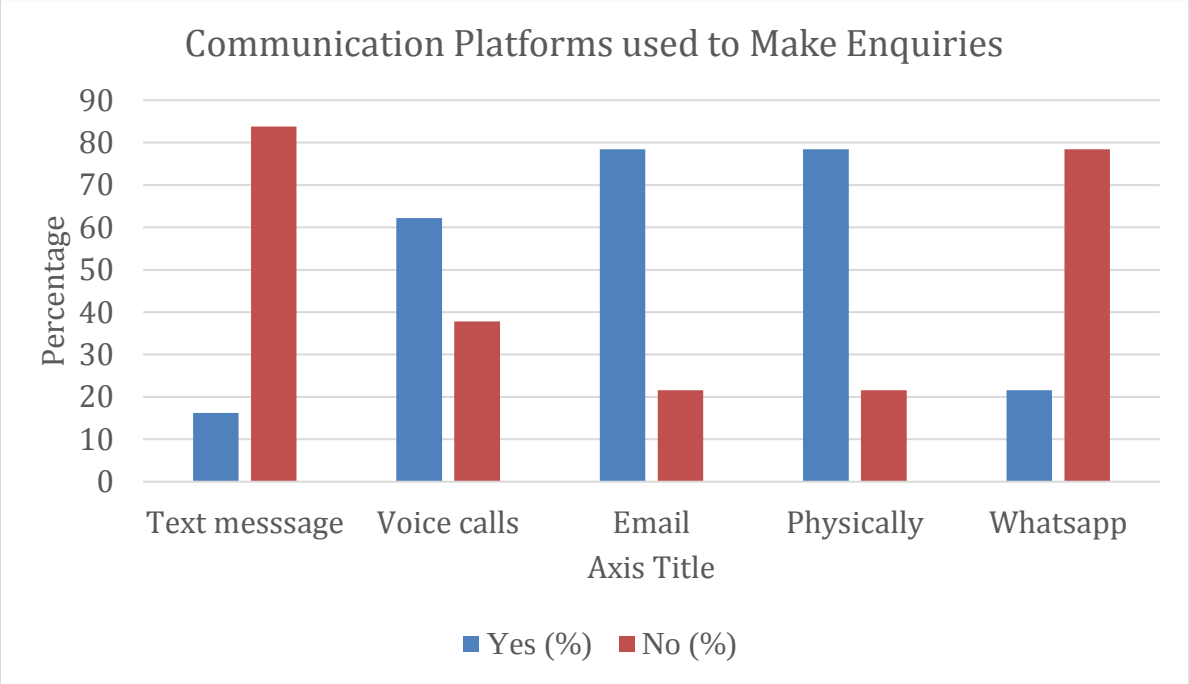

Figure 16. Communication used by external users for enquiries

Widely used platform as indicated by the respondents was Whatsapp groups (54.1%) followed by other-category where the mostly indicated platform within the category was email (Table 5).

Table 5. ICT platforms used to interact with external information users

	Yes (%)	*No (%)*
Facebook	18.9	81.1
WhatsApp Groups	54.1	45.9
Blog	24.3	75.7
Twitter	8.1	91.9
Other (E.g. email)	51.4	48.6

As indicated by the respondents, the major challenge that limits their use and adoption of ICTs was lack of relevant ICT equipment with 64.9%. They also indicated that they are willing to use the ICTs and have enough time for that by the result that they gave of a small value 18.9% on the factor of not enough time to use ICTs

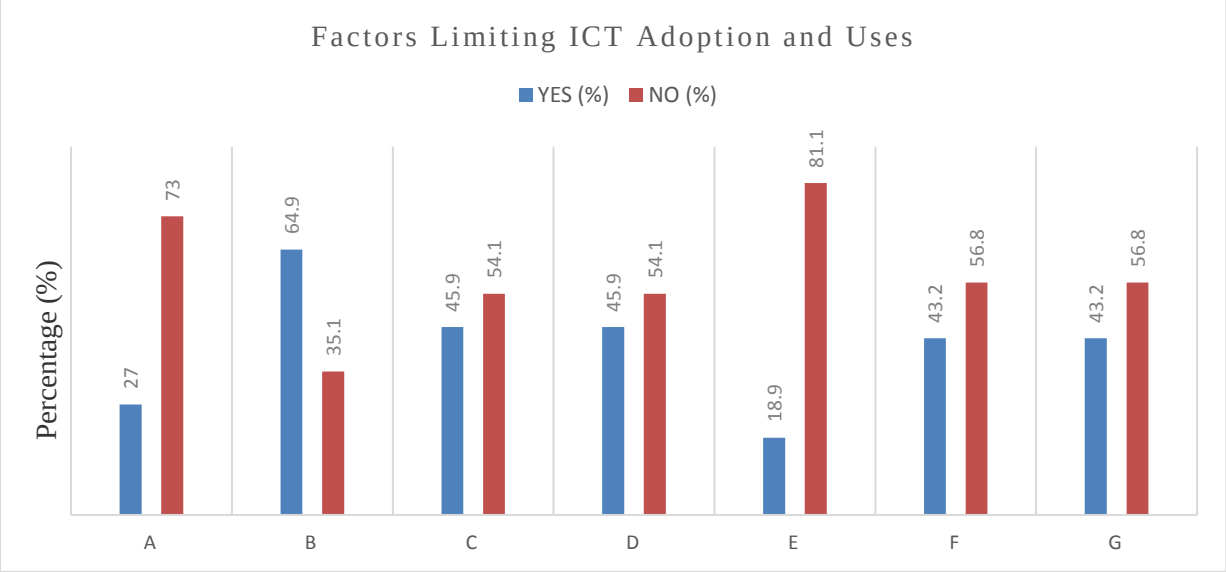

Figure 17. Factors Limiting the Adoption and Use of ICTs in Agricultural Research Institutions *(Key:* **A**–Limited knowledge of ICTs; **B**– Lack of relevant ICT equipment and software; **C**– Institution cannot afford to pay for internet subscriptions; **D**– Inconsistence in subscribing for the internet; **E**– No enough time to spent on technology; **F**– Budget allocated to ICT is not enough; **G**– Limited access/subscription to e-content e.g. journals)

4. DISCUSSION

4.1. Demographic characteristics, levels of education and positions at work

As evidenced by the results from the respondents' responses, the males dominate the research stations as their proportion is 70%. Also, the use of technology is also mainly dominated by men as few female counterparts

adopt ICT usage slowly and lacks zeal in usage of ICTs. This is also evidenced by Orji (2010) who found that the differences between men and women have been studied in various areas such as electronic mail, information retrieval, e-learning, communication technologies and online purchasing behaviour, the studies revealed more favourably towards men as compared to women.

Ages of the respondents reflected that there is a correlation between ICT use and age. The mean age was 35 years with the modal ages also in the thirties. The middle age range of 31-40 years dominated the sample with 65%. This brings to light that the technological era became more popular around the 1980s when these individuals were born. Prensky (2001) mentioned that one of the prevailing myths of our age is that there is a generational gap related to ICT such that the rising generations are 'digital natives' in contrast to their elders who are 'digital immigrants'. That statement in itself brings to light why the sample was dominated by the middle-aged people and not old people who were born before ICT use was popular.

Most of the respondents (97%) had acquired at least a diploma as their minimum qualification. This is expected to give the respondents an added advantage in ICT usage.

4.2. ICT equipment used in research institutes (Hardware and Software)

In the study, it was found that a variety of ICT hardware is adopted and used in agricultural research stations. Highest adoption and use were dominated by laptops. These days, due to the flexibility of many jobs, most individuals are adopting the use of laptops due to their portability; hence they can even work from home. Also the other reason why laptops have more use is that in most governments institutions, including agricultural research stations, there are outdated desktop computers which some of them can no longer support some new computer software required. The age generation of the dominating respondents in the study also is the one that grew in the technological revolution hence laptops are more preferable than desktops to them.

Desktops and mobile phones also had a higher percentage of 75.7% each. Governmental institutions are loaded with desktop computers. These are used to generate and store institutional information, including research information. Some simple software is installed in them and they are also used in the process of information generation. They are mainly found in the offices of the workers who have higher positions. These are very important especially for information storage, hence they are very necessary. Mobile phone usage in Zimbabwe is around 90%. Most of the phones used are smartphones. These phones can also perform other important tasks because they can install different useful software such as Microsoft Office and other statistical software. Besides, phones are used mainly for communication. Phone calls, text message, WhatsApp messaging, skype, twitter etc. is done on mobile phones. Notices and other urgent posts are done using mobile phones. Therefore the adoption and use of phones is high in agricultural research institutions. The smaller numbers of individuals who do not own phones are mainly the elderly.

Tablets were also seen to be another type of ICT hardware used in the research institutions. A tablet performs similar tasks as phones. They are mainly used for tasks that require internet connections; therefore for information dissemination they can also be used. Important information can be sent to information users through different platforms such as WhatsApp groups, emails and Facebook. The reason why tablets are used for these tasks more than mobile phones is that some institutions purchases tablets for such tasks especially

for the heads of departments, unlike mobile phones which are mainly personal gadgets of employees. Mwalukasa (2013) state that ICTs such as Internet, e-mail and cell-phones can be used to share and distribute knowledge among farming communities to supplement what was gained verbally to the farmers". Consequently, the adoption and use of mobile phones is high in agricultural research institutions in Zimbabwe. According to the World Bank (2017) mobile phone airtime is available in prepaid bundles, allowing poor customers to avoid lengthy contracts and manage their expenditure in a discrete granular manner. This model is a key driver of access and use". Further, the World Bank (2017) state that "mobile phone lower information costs, reduce transportation costs, provide a platform to deliver services and innovate". Aker (2011) point out that "the rapid spread of mobile phone coverage in developing countries provides a unique opportunity to facilitate technological adoption via information and communication technology (ICT)-based extension programs.

Other ICT hardware used in the agricultural research institutions are overhead projectors which are used when holding meetings, either at some meetings with information users as well as internal meetings. Also printers were mentioned and these are found at every institution whereby they will be used to print some information that will be stored in files.

On software used, Microsoft Office package is used more than any other software. This consists of Microsoft Office Word (94.6%), Microsoft Office Excel (89.2%) and Microsoft Office Power-Point (62.2%). The reason why this package is widely adopted is because information can be generated and stored as word documents; excel book sheets and when holding meetings with information users, power-point presentations can also be used. Statistical data can also be processed using office excel. In research stations, statistical information can then be processed using Microsoft Excel depending on the data and favourable results will be achieved. Also the reason why Microsoft package is used is because of its simplicity to use; even the ones who did not do ICTs in detail can manage to use it after a few demonstrations. Hence adoption of Microsoft Offices software package is inevitable.

Data analysis software is also used in research stations. Examples such as GenStat and Statistical Package of Social Sciences (SPSS) are widely used. Usage of these data analysis software is above average. This then shows that it is not widely used due to some complications using it. Also for many organisations, such software requires product licenses. Due to economic constraints faced in the country, subscribing for such software renewal by the government is not done. Therefore usage of this software becomes low. Their importance should however not be taken for granted because they are the pillars of data capturing and processing. Since most of the information generated by agricultural research stations is quantitative, data analysis software are very important. Geographical Information System (GIS) software is less used in the research stations. When measuring size of the land as well as height above sea level of land a GIS is a very important tool. Most installations of such systems are expensive and also use of GIS requires expert knowledge. Due to that, the agricultural research stations cannot afford them, hence little adoption. This system is very important in these stations because it reduces the amount of work to the individuals for the tasks that it can be used for.

4.3. ICT skills possessed by respondents

Formal training of information and communication technologies was taken by 54% person of the respondents in the study. This training is very important because it will help the employees to undertake their tasks, be it data capturing, processing or even publishing it. That training is very important hence there is need for improvement in undertaking such trainings and as the technological world expands, the trainings need to be done frequently so that these employees will be able to use them. Most formal training was mainly done under degree and diploma programmes where introduction to Information Technology courses are done. Also a few employees in the research institutions mentioned that they did ICT short courses. These courses are important as they focus more on frequently used information and communication technologies and they also involve the latest information and communication technologies. About 73% of the employees did not take any short courses for information and communication technologies. International Computer Driving License (ICDL) is an example of a short course that was mentioned by some respondents who did short ICT courses. Information and Communication Technologies use proficiency is determined by ICT training that was done by the individuals as well as ICT short courses done. Some respondents stated that their rating on ICT use as high 41% and some rated themselves moderate (43%). Only 11% rated themselves excellent with 5% very high. The ratings are not bad since with moderate skills most workers can be able to handle ICT well. However at every station there is need of some individuals who will be responsible for more complicated tasks that requires more ICT knowledge.

4.4. Information accessed, generated and disseminated

Most of the information accessed by the workers of agricultural research stations is educational (73%). This implies that most of these individuals are furthering their education. Work related information is accessed as well and it is at par with social/entertainment information which is 54.1%. Since educational and social/entertainment information is more beneficial to the individual than the institutes, it shows that if internet charges are covered by the institution (Wi-Fi), it is losing to the individuals. More information accessed at workplace should be work-related. Work-related information is acquired from farmers (62.2%), Research Sites (67.6%), Laboratories (40.5%), Other Researchers (40.5%) and other sources (16.2%) Table 3. Most information is accessed from research sites because most of the information is generated from trials. Also some trials and other agricultural issues under researches are done through farmers. Information from farmers may also be feedback to the research institutes on some solutions suggested on different problems faced by farmers. There are also some researches that are specifically done in the laboratories for example soil tests. Not all agricultural researches are done under laboratories hence a relatively low value of 40.5%. Other researchers (40.5%) also provide some information that can be used to make comparisons and adjustments as well. This information is very important because it adds up on information researched internally. Information from other researchers is below average but it is high enough to top up the information generated internally in research institutions. Information is also accessed from other sources (16.2%). Seed houses are one of the other sources mentioned by some respondents from Seed Services Institute. Agricultural research institutions in Zimbabwe need to invest in agricultural information infrastructure so that they enhance

knowledge creation, transformation and innovation. "Agricultural research is a key knowledge and information-intensive activity for improving the productivity and sustainability of the agricultural sector" (World Bank, 2017).

Information is stored in different forms with soft copy (91.9%) as the prominent form used (Figure 10). Due to more use of computer and internet technologies (iCloud and google drives etc.) to store information, print form (56.8%), libraries (27%) and files (59.5%) usage is slowly decreasing. It costs less to store information in soft copy than in paper form. It is quick to retrieve information in e-format. Further, the e-copy is very easy to use. Given the transition from print to digital information, one of the most useful investments that an agricultural research institution can make is to invest in organising and providing access to its digital information and data resources according to the World Bank (2017:137). Furthermore, as the World Bank (2017:137) put it "new storage technology, particularly cloud storage, is making it far less expensive to store and share data and other information". Agricultural research institutions in Zimbabwe need to set up open repositories to archive research outputs. Agricultural research institutions can set up institutional repositories for their documents and research outputs and these repositories allow content to be uploaded and made accessible in full-text and allow metadata to be harvested and shared using open standards. In addition, the World Bank (2017:138) state that "as the collections grow, they become permanently accessible indices of an institution's research and nodes in a globally searchable knowledge base for agriculture".

Research information accessibility is in two ways which is internal (workers) and external (users). Externally, (Figure 10 and 11) the information is readily available at 62%. Some information that is crucial and needs permission (35%) and some data that is difficult to access (3%). This is usually done, depending on the importance of the information. Also some information under investigations and not proven tends to be not easy to access as compared to proven information. Externally, information is readily available (27%), difficult to access (5%) and need permission (68%). Most of the information usually requires permission so that when a request is made, the institutes will do record keeping which will help them in knowing who uses their information and also know where to expect feedback from. At work the workers uses different communication forms to communicate (Table 5). Mainly used platform is the email which constitutes of 91.9%. However, WhatsApp is also used highly (62.2%) and phone calls (83.8%). Electronic mail is a formal way to communicate at work that is why it is widely used and mainly the institutes creates email addresses for everyone to ease communication. Phone calls are also more formal and are mainly done using personal mobile phones which ends up posing some controversy on who recharges the airtime since it is for the benefit of the organization. WhatsApp due to convenience and less costly is widely used in institutions as well. It is more of a non-formal communication tool but if used properly and ethically, it can fit into formal where important work information is shared through it.

Results are disseminated on different platforms to the users (Figure 13). Journals (78.4%) are widely used. Website (62.2%) and Workshops (59.5%) follows. The least used platform to disseminate results is Media (35.1%). Journals and websites are not within the reach of many information users especially small scale information users. Workshops with users are good to use for information dissemination because there is direct conveyance of information to the users and the channel is rather short as compared to other platforms. The frequency of information dissemination is also a very important aspect (Figure 14). Most of the information is

disseminated yearly (46%), followed by quarterly (30%). Monthly and weekly is 11% and 13% respectively. Frequency of information should be shorter, usually monthly and weekly. This will keep the users up to date and also for some critical information, the users of information have to take action quickly for example an outbreak of dangerous disease in plants. Hence the frequency of dissemination of information relates to the form in which the information is published as well as the platforms used. Zendera et al. (2011) also highlight the importance of quick dissemination of information for critical decision making in weather forecasts.

4.5. Factors influencing adoption of ICTs

Users of information are commercial farmers, small scales farmers, other researchers as well as academic institutions. The type of user determines also the way in which the information is going to be disseminated. An example is of small-scale farmers who can afford less costly platforms to communicate, hence adoption of less costly and convenient ICTs by the research institutions. Also, for effective communication and information sharing, the research institutions should pay attention to their audience (users) so that they upgrade or adjust on their ICTs adoption and use. To make enquiries, users of information mainly use email which is at par with physically going to the research stations (78.4%). All these have an influence on the type of ICTs to use for interaction with users.

There are several factors that limit the adoption of ICTs. These limitations are limited knowledge of ICTs, lack of relevant ICT equipment and software, institution cannot afford to pay for internet subscriptions, inconsistence in subscribing for the internet, no enough time to spent on technology, budget allocated to ICT is not enough and limited access/subscription to e-content e.g. journals. These problems exist in most organizations other than research institutions. The problem that was highlighted by the respondents to be limiting their adoption of ICTs is lack of relevant ICT equipment and software (64.9%). The respondents also indirectly mentioned that they are willing to spent time and use ICTs by the no response (81%) to the problem of them having no enough time to spend on technology (Figure 17).

5. Conclusion

This study concludes that adoption of information and communication technologies in most agricultural research stations in Zimbabwe was minimal. Research stations had no ICT Departments and ICT Specialists. Further, some mostly used ICT equipment/hardware (mobile phones, laptops, tablets and iPads) were personally owned by the workers and not by the institutions. Most platforms through which information is disseminated are not easily accessible to the majority of the information users especially the small-scale farmers who currently constitutes 70% of the farmers in Zimbabwe. Information disseminated do not reach the farmers on time, meaning that it would have also lost its validity. Most of the research stations disseminates their information yearly, hence for some critical information researched on, the farmers will not get it as soon as they should so that they will solve the urgently arising problems.

6. Recommendations

1- Government need to develop policies and legislative frameworks that allow the use of information and communication technologies in agricultural research stations in Zimbabwe. Government need to craft and implement policies and regulations that create an enabling institutional environment for the adoption and use of ICTs in agricultural stations in Zimbabwe. Furthermore, without policies, ICTs can be used at research stations, often in fragmented and isolated efforts.

2- Agricultural Research Institutions need to invest in libraries and institutional repositories (IRs) to enhance information dissemination. Institutional Repositories are important platforms to disseminate research-based agricultural information and knowledge to farmers. Data and research findings can be shared across agricultural research institutions, systems and farmers. This improves the flow of information to its users. Along with the provision of adequate and consistent resources, both human and physical, the funding regime for agricultural research stations has to drastically improve to enhance the research enterprise of these strategic institutions in Zimbabwe. Government has to pay attention to both human capital development and institutional capacity in Agricultural Research Stations to enhance their efficiency and effectiveness.

3- Researchers in agricultural research institutions should be provided with specialised information and communication technologies. Provision of specialised information and communication technologies enhances information generation, processing and dissemination to targeted users. Agricultural research stations should invest in greater connectivity, information handling capacity (hardware and software) and improved human-computer interfaces to serve all aspects of the agricultural research in Zimbabwe.

References

Nyongesa, J.M., Lagat, J.K. and Mutai, B.K. (2008), "Determinant factors influencing farmers' use of Agricultural Information and the Impact on Improved Maize Production and Marketing in Vihiga District, Kenya", *Journal of Education and Human Resources*, Vol. 5, pp. 83-93.

Orji, R. (2010), "Impact of Gender and Nationality on Acceptance of a Digital Library: An Empirical Validation of Nationality Based UTAUT Using SEM", *Journal of Emerging Trends in Computing and Information Sciences*, Vol. 1, pp. 68-79.

Rao, S.S. (2003), "Information Systems in Indian Rural Communities", *Journal of Computer Information Systems*, Vol. 44 No. 1, pp. 48-56.

Tata, J.S. and Paul, E.M. (2016), "Social Factors that Influence use of ICT in Agricultural Extension in Southern Africa", *Journal of Agriculture*, Vol. 6 No 2, pp.15-25.

Milovanovic, S. (2014), "The role and potential of information technology in Agricultural Improvement", *Economics of Agriculture*, Vol 61 No. 2, pp. 471-485.

Kiptum, J.C. (2016). "ICT Framework for Adoption in The Dissemination of Agricultural Information in Kenya: (Case Study of Agricultural Development Corporation)", MSc. Thesis University of Nairobi, Kenya.

Zendera, W, Obwoyere, G.O. and Maranga, E.K. (2011), "Application of Weather Forecasts in Agriculture: Communicating Agro meteorological information to Smallholder Farmers in Kenya", Lambert Academic Publishing.

Levi, C., Kyazze, B.F. and Sseguya, H. (2015), "Effectiveness of ICT in dissemination of Agricultural Information to smallholder farmers in Kilosa District", Tanzania. MSc. Thesis Makerere University,Uganda.

Saunders, M., Lewis, P. and Thornhill, A. (2016). Reseach Methods for Business Students. Pearson, Italy.

FAO (2009), *How to Feed the World in 2050*; Food and Agricultural Organization of the United Nations, Rome, Italy, 2009.

Zyl, O.V., Alexander, T., Graaf, L.D. and Mukherjee, K. (2014), "*ICTs for Agriculture in Africa*" World Bank: Washington, DC, USA, 2014.

Latchem, C. and Walker, D. (2001), "Telecentres: Case studies and key issues", Vancouver: Commonwealth of Learning.

FAO-ITU, (2016). E-agriculture Strategy Guide. Bangkok, Thailand.

APAARI, (2004), "Information and Communication Technologies in Agricultural Research for development in the Asia-Pacific Region: A status Report". Asia-Pacific Association of Agricultural Research Institutions. Bangkok, Thailand.

Prensky, M. (2001) "Digital Natives, Digital Immigrants Part 1", On the Horizon, Vol. 9 No. 5, pp. 1-6, http://dx.doi.org/10.1108/10748120110424816. (Accessed on 29 March 2017)

Sylvester, A.G., Attaluri, S. and Maru, A. (2011), "ICT/ICM for Agricultural Research for Development in the Asia-Pacific Region" Bangkok, Thailand. http://www.fao.org/docs/eims/upload/315977/ICT_ICM%20for%20agricultural%20research%20for%20development%20in%20the%20Asia-Pacific%20region.pdf. (Accessed 5 May 2019).

Herald. (2019), "Potraz Adopts New Tariffs". https://www.herald.co.zw/potraz-adopts-new-tariff-model. (Accessed 14 May 2019).

FAO. (2013/14), Information and communication technologies for sustainable agriculture. Indicators from Asia and the Pacific. Bangkok, Thailand.

Mittal, S.C. (2012), "Role of Information Technology in Agriculture and its Scope in India", Available at: http://125.19.12.220/applications/Brihaspat.nsf/6dca49b7264f71ce 65256a81003ad1cb/82f2c15ccd4dd9a065256b37001af3fe/$FILE/it_fai.pdf. (Accessed 14 May 2019).