

Communication Channels and their Potential Applicability in Enhancing Agricultural Research Data Sharing among Agricultural Researchers in Tanzania

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Abstract

The goal of this research was to investigate the communication channels that enhance data sharing among agriculture researchers in Tanzania. Specifically, the study aimed to identify communication channels that are used by agricultural researchers in Tanzania, examine the extent to which such channels were used to enhance data sharing among agricultural researchers, and examine the factors that influence the choices of channels used in data sharing. A descriptive cross-sectional design, alongside

quantitative, and qualitative approaches, was employed to collect data from 204 respondents. The Concentric Layered Model for the channel choices was used to guide this study. Results indicate that both mediated, and non-mediated channels existed and were used as data-sharing avenues and channels. The majority of the researchers (77.9%) preferred to use non-mediated channels. Also, the findings indicate that more than 50% of respondents agreed that timely delivery, the cost of the channel, and convenience of a channel were among the factors influencing researchers in their channel selection. It can be concluded therefore that research institutions should invest in mediated channels that have been underutilized to strengthen data-sharing practices among researchers.

Key Words: Agricultural Research; Agricultural Research Data; Communication Channels; Data Sharing; Agricultural researchers

1. Introduction

Research data is the key to scientific agricultural research. Data use in research drives the discovery of new areas of research (Tenopir et al., 2018). Furthermore, data is important for future research and reproducibility analyses (Harper et al., 2018). Access to and use of agricultural research data can drive the development of agricultural science and technology (Zhao & Wang, 2015). Such data should therefore be shared through appropriate communication channels, which serve as pipelines through which messages are transported (Suthers, 2017). In this case, a communication channel links the sender and receiver of data.

Communication channels may be mediated or non-mediated. Mediated communication channels are channels that allow communication between individuals to occur via computer networks and other electronic media (Thompson, 2020; van Deventer & Snyman, 2004; Yao & Ling, 2020). For example, data sharing through mediated communication channels may be through publishing articles on electronic platforms such as AGRA, AGROVOC, and AIMS (Delserone and Dinkelman, 2016; Dodgson et al., 2021). By comparison, non-mediated communication channels include the use of interpersonal communication (Zhao & Wang, 2015). Examples of non-mediated channels are written correspondence and face-to-face dialogue (meetings, discussions). The use of appropriate communication channels guarantees that the data reaches the receiving audience.

The choice of appropriate communication channels is essential in data sharing. A better choice of suitable communication channels ensures the achievement of effective communication (Mtega, 2021). Some criteria are used to guide individuals in the choice of an appropriate channel. A good communication channel does not distort a message and should be fast, confidential, easy to use, accessible, and reachable by both the sender and receiver (Kok et al., 2016; Zizka, 2014).

Over the years, governments and organizations worldwide have made deliberate efforts to embrace data sharing. Funding agencies in the United States have developed policies to encourage research data sharing (Bates, 2017). For example, data sharing has become a criterion for supporting research projects (Bezuidenhout & Chakauya, 2018). Furthermore, the government of Tanzania has made several initiatives to foster data accessibility. The establishment of the Database on Food and Agriculture (Country STAT) aimed at ensuring timely, reliable, and affordable data (Dunmore & Di Cori, 2011; National Bureau of Statistics, n.d.). Moreover, the government of Tanzania implemented the Policy, Regulatory and Institutional Framework to ensure improved data quality and timeliness of access (United Republic of Tanzania, 2015). Likewise, the establishment of the National ICT (Information and Communication Technology) Policy, which focused on areas of ICT infrastructure and universal access to data (<https://www.nbs.go.tz/index.php/en/>), was among the efforts to make data accessible to the public. The establishment of an open data policy draft and an open data portal is among the initiatives intended to make data accessible to the public (Agrawal, 2017). But, until now, the efforts to implement open data in Tanzania has not achieved much success, although the remnants still exist. Until now, different types of data, including agricultural administrative data, and statistical data, are said to be accessible through web-based platforms, websites, and email in the National Bureau of Statistics (NBS) (Bhatia et al., 2016; United Republic of Tanzania, 2015). In addition, weather and climate data that are useful for agricultural research are shared and accessed by the Tanzania Meteorological Agency (TMA) via web-based platforms (Tanzania Meteorological Authority, 2020). Despite these initiatives in Tanzania, the channels for sharing agriculture research data among researchers from research institutions in Tanzania are unknown. There is, therefore, a need to find the channels used for sharing existing data from research institutions.

1.1. Statement of the Problem

Agricultural research is a data-intensive activity. Agricultural researchers use various channels to share their data. In Tanzania, much research has been conducted on communication channels used to share information, and knowledge with researchers, smallholder farmers, and other agricultural stakeholders (Barakabitze et al., 2015; Mtega, 2021; Mtega & Ngoepe, 2019; Ndimbwa et al., 2019, 2021). It can be noted, however, that most of these studies have focused on channels for sharing agricultural information, and knowledge, while none of them focuses on channels for sharing agricultural research data in particular, despite the large amount of research data that exists in agricultural research institutions (Tanzania Agriculture Research Institute, 2019). While there is consequently much knowledge on the effectiveness of channels of various forms in sharing agricultural information and knowledge, there is undoubtedly a lot of untapped potential in terms of how these channels can be equally used to enhance agricultural research data sharing among agricultural researchers. This study was, therefore, set up to fill this knowledge gap by investigating the existing channels in agricultural institutions, their potential applicability in enhancing agricultural research data sharing, and their extent of usage to gauge whether they may be effective and efficient in sharing agricultural research data, and factors that influence researchers in channel choice in Tanzania.

1.2. General Objective

The main goal of this research was to investigate the communication channels that enhance data sharing among agriculture researchers in Tanzania.

1.2.1. Specific Objectives

Specifically the study aimed to:

1. Determine the communication channels that are used by agricultural researchers in Tanzania.
2. Examine the extent to which such channels are used to enhance data sharing among agricultural researchers.
3. Examine the factors that influence the choices of channels used in data sharing.

1.2.2. Research Questions

1. Which communication channels are used by agricultural researchers in Tanzania?
2. To what extent are the channels used to enhance data sharing among agricultural researchers?
3. Which factors influence the choices of channels used in data sharing?

2. Literature Review

The literature review for this study covers themes that are in line with the objectives. It focuses on previous studies that dealt with channels used for sharing agricultural research data, the extent of the channel usage, and the criteria guiding channel selection. This rigorous review contextualized the current study within the wider area of the channel for sharing agricultural research data.

2.1. Communication Channels Used for Sharing Agriculture Research Data

Data is defined as a visual representation of something. Data encompasses observation or information that is obtained from a research project, including experimental samples, technologies, materials, products, and procedures (Kirub, 2016). In this current study, data can be raw or analyzed, quantitative or qualitative, and is collected by researchers and can be shared with other researchers for use or reuse. Research data are data generated through research activities; such data can be in the form of textual, quantitative, and qualitative (Tripathi et al., 2017), and may be in the form of images, recordings, musical compositions, verbal communications, simulations, experimental readings, and code. In agriculture, research data contain crop breeding data, baseline survey data, genomic data, remote sensing data, and geographical information systems (GIS) data (Kirub, 2016). Agricultural research data can be obtained through electronic objects and tools such as sensors, laboratory tools, voice interviews, and online surveys (Boté & Termens, 2019; Zhao & Wang, 2015). Such important data are required to be shared through appropriate channels simply because they are related to agricultural scientific research. Data sharing in this case is defined as a process of

making data available to others, although not necessarily by depositing it in repositories (Thoegersen & Borlund, 2021). Moreover, data sharing can take place in three methods; data is deposited in a repository, sent upon special request, and published as supplementary materials on the journal website (Gray et al., 2018; Williams, 2022). Likewise, data can be shared in the form of manuscripts, including pre-print products generated by researchers (Jeng et al., 2016).

Communication channels are media that facilitate the transfer of messages from sender to receiver (Mtega, 2021). In this case, therefore, communication channels are also data-sharing channels. However, not all channels work in all environments, and the proper selection of the channel is therefore important to attain effective data delivery. Previous studies have examined different communication channels used for sharing scientific data. In a study that investigated how communication channels are used to increase awareness among researchers, Zaira (2012) observes that the online channels preferred by researchers included blogs, Wiki, Facebook, LinkedIn, and Twitter. The study also reported that the offline channels preferred by researchers in creating awareness among them include printed materials, magazines, and frequent departmental meetings. Researchers from developed nations, in particular, have been sharing and accessing research data through channels that are web-based, such as data repositories. Several meta-analysis and survey studies have revealed that researchers have been sharing research data by depositing it into data repositories (Cooper et al., 2019; Feder et al., 2015; Drakos et al., 2015; Suhr et al., 2020; Thoegersen & Borlund, 2021).

When the data file is shared in repositories, they can be preserved for future use and reuse. The presence of metadata standards and agreements, among other things, facilitated researchers and research institutions in sharing and accessing data from data repositories. In line with this, through reviewing selected publications by Crop Sciences faculty, it was found that data sharing takes place in three methods, namely depositing data into repositories, sending data to researchers upon request, and supplementary materials on journal websites (Williams, 2022). Findings indicate that data sharing in articles appeared in 50 different journals. However, studies from low-income countries reveal that data sharing is not through data repositories; a majority share data through email on request, within published papers, collaborative initiatives, and through research unit servers (Bull et al., 2015;

Katabalwa et al., 2021; Koopman & de Jager, 2016). It is clear that the presence of a data-sharing channel is important to enhance data to be accessible for use by others. Most of the existing studies from developed nations have revealed the presence of formal data sharing channels such as data repositories as compared to most developing countries, where there are no existing data repositories to facilitate data sharing. This therefore called for a detailed study to investigate the current data-sharing channels existing and used by agricultural researchers in less developed countries like Tanzania.

2.2. Extent of Channel Usage and Criteria that Determine Choice of Channels

The selection of proper channels can ensure the message, or in this case, the data reaches the intended audience. The criteria to guide channel selection was studied in detail. In the study that focused on literature review of 36 papers to identify methodologies and knowledge gaps in channel choices by Madsen and Kraemmergaard (2015), the results revealed that the criteria that guide researchers on choices of communication channels include: channel characteristics (interactions, ease of use, usefulness), task characteristics (type of task, adequacy of information), personnel characteristics including social demographics (age, gender, race, education, and income), situational constraints (channel availability, price, and distance to channel) and satisfaction with services offered by the channel. All of these were said to motivate individuals in making their channel selections.

Another study that indicates factors influencing choices of channels is the one by Fichman and Hara (2007), the findings show that channel choice is determined by six criteria: the task at hand, physical proximity, social proximity, sender and receiver accessibility to use the channel, individual preferences about the channel, and the initial channel used. Furthermore, the study that examined the knowledge sharing and channel choice in *The New Way of Working (NWOW)* by Kok et al. (2016), has reported that employees' choices of channels for knowledge sharing were based on factors such as usability, experience with the channel, effectiveness, and convenience. For example, some employees preferred to use multiple channels when sharing knowledge of sensitive information, while some other employees were still working in a more formal and traditional non-*New Way of Working (NWOW)* manner, using fewer channels such as face-to-face communication.

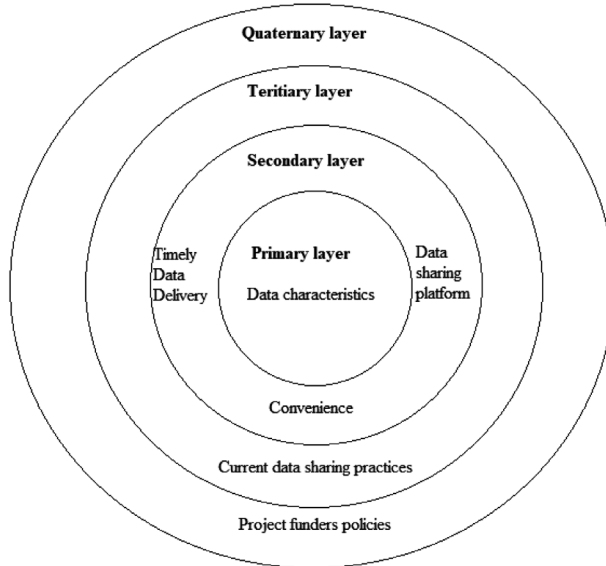
Most published literature on data-sharing channels focuses on research in high-income settings. Most existing studies have revealed that researchers are motivated to deposit their data due to the existing formal data repositories with well-defined metadata standards, file formats, policies, and other agreed arrangements (Cooper et al., 2019; Elsayed, 2018; Federer et al., 2015; Jeng et al., 2016; Thoegersen & Borhund, 2021; Zhao & Wang, 2015). However, although the literature is limited, literature concerning data-sharing channels from low and middle-income settings has exposed several aspects of data sharing (Bull et al., 2015; Katabalwa et al., 2021; Koopman & de Jager, 2016). Earlier literature reveals that the best data-sharing channels that have been operating include the sending of data upon request to researchers who trust each other and work collaboratively, publishing in the papers, and depositing data in repositories. It is interesting to see how Tanzania fits into the general landscape of data sharing in the contexts other developing countries.

2.3. Theoretical Framework

This study adopted the Concentric Layered Model. This model in prior studies was used to explain the factors influencing employees in channel choices when sharing knowledge in work teams and in a *New Way of Working* (NWOW) (Kok et al., 2016; Snyder & Lee-Partridge, 2013). The previous four-level model comprised four concentric circles, each consisting of a group of factors that influence the choice of a particular channel. The first or inner layer (primary layer) includes the type of information, sender efficacy level, and preferences. The secondary level includes richness, ability to keep records, reliability, conveyance of the message, feedback, trust, and preference. The third (tertiary) layer includes embedded practices, the degree of translation and transformation, and the key boundaries. The fourth (quaternary) layer includes the institutional culture, policies, and legal requirements (Snyder & Lee-Partridge, 2013).

In this study, the Concentric Layered Model was modified to take into account the factors influencing the choice of channels in the tertiary and quaternary layers. Based on the modified model (Figure 1 below), the factors that influence researchers' choice of channel for sharing data include the primary layer (data characteristics), secondary layer (timely delivery of data, convenience, and availability of data sharing platforms), tertiary layer – the current

Fig. 1: Adopted and modified model for data sharing channel selection (from Snyder & Lee-Partridge, 2013).

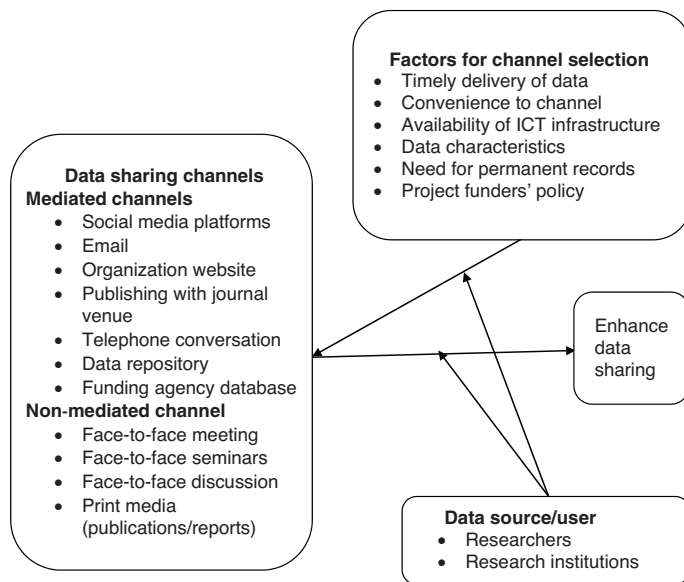


data sharing practice (submission of the data file to institutions or funders for permanent records) and quaternary layer (funding agency policies). Based on Figure 1, the current study findings indicate that some factors concur with the factors in the previous model and the model, therefore, explaining very well the factors influencing the choice of data-sharing channel and thus the model fits for this study.

2.4. Conceptual Framework

The conceptual framework in Figure 2 was developed to explain the linkages between independent, intervening, and dependent variables. The intervening variables include researchers or research institutions that generate, and use research data. When researchers want to share their data, they are guided by some factors in the selection of the channels (independent variables). Data sharing will take place when data files are shared through the selected channels.

Fig. 2: Conceptual framework showing the relationship exist between the variables for this study.

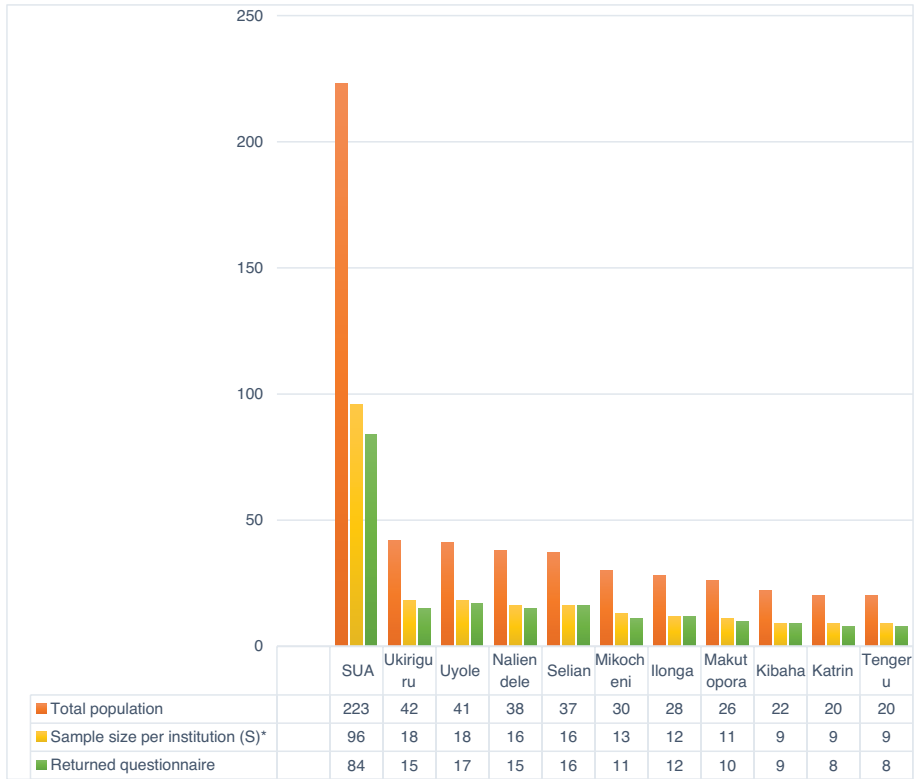


3. Methodology

The study employed a descriptive and cross-sectional research design to investigate communication channels for sharing agricultural research data among agricultural researchers in Tanzania. After receiving research clearance letter from SUA Postgraduate Studies Office, and TARI Headquarter Office the survey was conducted from March 2021 to March 2022. The study employed both qualitative and quantitative approaches in data collection and analysis. The qualitative approach was used to determine opinions, and views about data sharing channels used by researchers, while the quantitative approach was used to examine the existing data sharing and the extent of channel use in data sharing. A combination of the two approaches helped in getting relevant data for the study (Mwinami et al., in press).

The study was conducted in eleven agricultural research institutions in Tanzania. The agricultural research institutions were selected based on the need to have more than twenty (20) researchers at the institution (Figure 3).

Fig. 3: Sampling distribution. Sample size per institution* = study sample size (n) (227) times population per institution over Total population (N).



This number of researchers enabled us to get the intended sample size per institution. The Tanzania Agriculture Research Institution (TARI) centres and Sokoine University of Agriculture (SUA), specifically the Colleges of Agriculture and Veterinary Medicine and Biomedical Sciences, were purposely selected to be included in the study. Key informant interviews were purposively selected to include 10 TARI centre’s Directors/Managers and 1 Director of Postgraduate Studies, Research, Technology Transfer & Consultancy for SUA. They were selected because they were thought to be experienced and knowledgeable, and would therefore provide in-depth insights about the topic. The total population of researchers in the study area was 527. The sample size of 227 was obtained using Yamane’s (1967) formula for sample size calculation. After obtaining the sample size, a

representative sample per institution was calculated (Figure 3) (Mwinami et al., in press).

$$n = \frac{N}{1 + N(e)^2}$$

where:

n = Sample size (227)

N = Total study population (527)

e = Level of significance (5% or 0.05)

The data collection used multiple data-gathering techniques to investigate the channels used in sharing data among the researchers. The cross-sectional survey method (questionnaire and interview) and focus group discussions (FGDs) were employed in the study. The questionnaire with closed-ended questions was distributed to 227 agricultural researchers from SUA and ten selected TARI centres. A total number of 204 questionnaires from SUA and ten selected TARI centres were correctly filled, returned, and used in this study. By comparison, qualitative data were collected through interviews with key informants each of which lasted between 15 to 20 minutes (Mwinami et al., in press). A total of two focus group discussions, with each group containing six agricultural researchers, were conducted at Ilonga and Mikochoeni TARI centres. These research institutions were selected randomly from among several agricultural research institutions. The main purpose was to understand the types of channels used in sharing agricultural research data. During the discussion, respondents were free to express their views, and their opinions were recorded by the researcher. In addition, a document review was made: some of the documents reviewed include the SUA Research Guidelines and Regulations of 2019, the TARI communication strategy of 2019, and the TARI Act of 2016 (Mwinami et al., in press).

3.1. Data Collection and Analysis

Both qualitative and quantitative data were collected and analysed. The present study used content analysis to analyse qualitative data obtained from open-ended questions in the questionnaire, key informant interviews,

and FGDs. The quantitative analysis was accomplished by using Statistical Package for the Social Sciences (SPSS) version 22. In the present study, the descriptive variables for the channels and factors were summarized using a table with the frequencies and percentages. Regarding ethical considerations, the researcher avoided any risk of harm during data collection and ensured the right to privacy and informed consent before engaging any respondent in the study (Mwinami et al., in press).

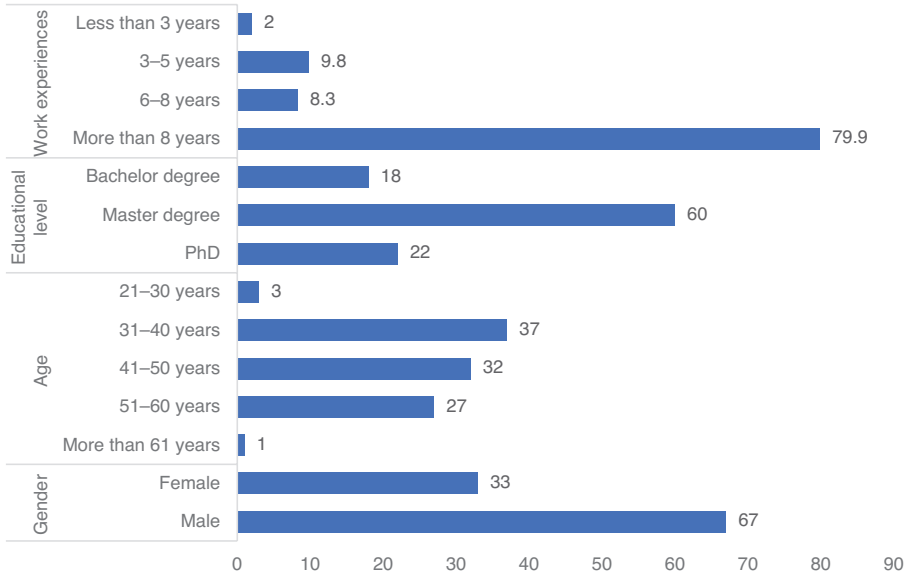
4. Results and Discussion

This section presents the findings based on study objectives, channels for data sharing, and the factors influencing agricultural researchers' choices of data sharing channels.

4.1. Demographic Characteristics of Respondents

The demographic characteristics of respondents are presented in Figure 4. Results indicate that a significant percentage (67%) of the researchers who participated in this study were male. This implies that the majority of researchers in the surveyed research institutions were male. This trend suggests that females were in a small proportion (33%) of those employed and therefore participating in agricultural research in the surveyed institutions. The findings further show that most (69%) of the respondents were aged between 31 to 50; the remainder (27%) was aged 50 and above. This implies that significant proportions of researchers were at an active age and engaged in agricultural research. Furthermore, the results also indicate that a large percentage of the respondent (82%) are researchers who had already received their Master's degree and above, while a few (18%) had only completed a Bachelor's degree. This implies that most of the researchers in the surveyed area had a higher level of education that enabled them to conduct research. The results further indicate that a large percentage of researchers (95.3%) had work experience of more than (6) years, while only 10% had work experience of between 1 and 5 years. This implies that the majority of the researchers had a reasonable amount of work experience in conducting research activities and the junior researchers would be gaining experience from seniors (Mwinami et al., in press).

Fig. 4: Characteristics of the respondents (n=204).



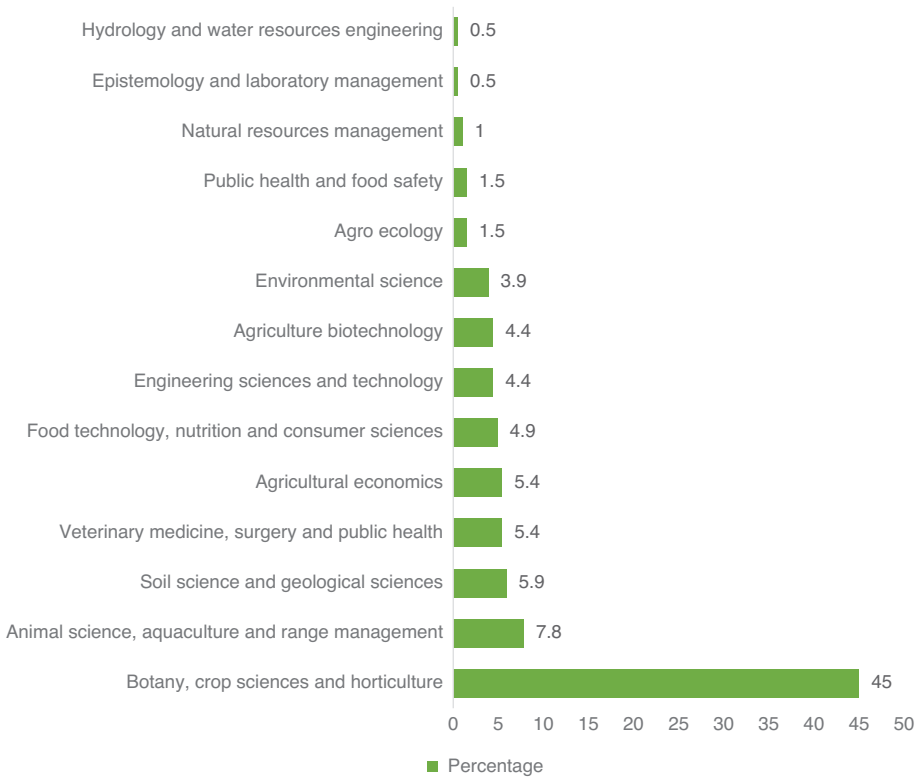
4.2. Researchers’ Academic Field of Specialization

The findings in Figure 5 indicate the researchers’ academic field of specialization. From the findings, the largest group (45%) of researchers specialized in botany, crop sciences, and horticulture. An additional 7.8% of the respondents specialized in Animal Science, Aquaculture, and Range Management. This implies that researchers who participated in this study specialized in various research fields (Figure 5).

4.3. Channels Existing and Used in Sharing Agricultural Research Data

These findings in Table 1 below reveal that respondents made the heaviest use (77.9% and above) of non-mediated channels, including face-to-face dialogue (meetings, discussions, and seminars) and print media, such as technical reports, etc. These results imply that researchers preferred to use channels that give the chance for face-to-face dialogue, and interaction, and provide timely feedback among researchers. In addition to that, the study established

Fig. 5: Researchers' Academic Field of Specialization (n=204).



that researchers mostly preferred channels that could deliver data promptly. These findings, concurring with the study by Shen (2017), show clearly that interpersonal discussion was used to help in providing data context, declaring assumptions, clarifying jargon, elaborating data structures, and identifying points of interest for effective data sharing. Similarly, findings are related to previous studies which reveal that face-to-face meetings and conversations are the best for research data sharing among researchers (Howland et al., 2015; Shen, 2017). It has also been reported that researchers in universities and research institutions have used formal seminars, workshops, mobile phones, and open discussions as the most preferred and available channels to exchange knowledge and ideas with colleagues (Delserone & Dinkelman, 2016; Kigatiira et al., 2018).

Table 1: Channels existing and used in agriculture research institutions (n=204).

Data sharing channel	Frequency	Percentage
Mediated channels		
Email	152	74.5
Publishing in online journal platforms	148	72.5
Organization website	130	63.7
Telephone (interpersonal mediated conversation)	107	52.5
Social media platforms	105	51.5
Funding agency database/repositories	84	41.4
Institutional repository	74	36.3
Non-mediated channels		
Face-to-face meeting	182	89.2
Print media publication (technical reports)	178	87.3
Face-to-face seminars	169	82.8
Face-to-face discussions	159	77.9

The findings in Table 1 show that respondents indicated the strongest preferences for mediated channels such as email, and publication on online journal platforms (74.5% and 72.5%, respectively). These findings imply that preference for such channels is a result of the timely delivery of data due to the available data in electronic format. Researchers had the habit of sharing their data files with fellow researchers through their emails. Researchers' preference to share data files through online journal platforms was motivated by the opportunity they got to increase their data visibility. Moreover, in agriculture research institutions/universities (in this case, at SUA), publishing articles with data in the journal avenue allows for advancement and promotions in the academic ranks. These findings are in line with a previous study by Zhang et al. (2016), which informed that emails were among the best channels used by researchers in sharing data. Concerning online journal publications, other previous studies have also reported the use of this channel (Shen, 2017; Tedersoo et al., 2021).

The study results show that some mediated channels were least used by researchers. These included websites, social media platforms, institutional repositories, and funding agency databases. This underutilization of mediated data sharing channels might have been caused by the absence of data

repositories among research institutions, and a lack of awareness among researchers of using such channels. Most of the research institutions in Tanzania do not have well-developed ICT infrastructures, especially data repositories; this might have hindered researchers sharing their agriculture research data through data repositories.

Findings in Table 1, showing multiple responses, indicate that both mediated and non-mediated channels were used in data sharing at varying levels. In support of this argument, one of the key interviewees at the TARI Selian centre commented:

“I share my research data through the print media (for example technical reports) by submitting it to TARI headquarters. I have usually attempted to share my data file with my fellow researchers through our WhatsApp group. The WhatsApp group enables us to share any fact or data files based on challenges on emerging issues in crops under mandate such as wheat, barley, and maize etc.”

Another key interviewee at TARI Katrin centre commented that:

“The project funders, collaborators and partners usually establish electronic platforms for communication throughout the whole period of the project. You are given a password and username for logging into the platform. Throughout the project, you will share data, information, and knowledge via this platform. At the end of the project, sometimes you are required to submit all the data files via this platform and sometimes data analysis is done by the project funder.”

Furthermore, another key interviewee on channels for data sharing at SUA commented that:

“Currently, in Tanzania, there are no generalist or domain data repositories or platforms maintained by agricultural research institutions. The SUA research regulation and guidelines spell out that data and other research materials generated by researchers belong to the institutions. If one needs to share data at individual, national and international levels are required to follow institutional and national guidelines. There are observed formal and informal data sharing within department and institutional levels. Some data embedded in research outputs are shared

by depositing through SUA institutional repository as channels that host content from different agriculture research fields. However, agricultural researchers share and access their data from other local and international research institutions, research partners, research collaborators, and agriculture-affiliated agencies. Also, some agriculture researchers access and share their agriculture data through generalist databases hosted by the National Bureau of Statistics (NBS). Another domain database that stores climatic data is hosted by the Tanzania Meteorological Agency (TMA)."

In the same context, through focus group discussions held at Ilonga and Mikocheni, respondents reported the following:

"After the discussion in all the two sessions, researchers revealed the channel they use in sharing their research data, including field days at research institutes. The use of technical reports that contain some agriculture research data in the form of data files are shared via emails and in hard copies also submitted to the TARI headquarters. The annual meetings held in the zonal selected research institutions have been useful in sharing raw data, processed data, and other technologies innovated on the basis of crop specialization, for example maize, grain legumes, sunflower, sorghum and millets."

The second objective of this study was to determine the extent of channel usage to gauge whether they may be effective and efficient in sharing agricultural research data. Through cross-tabulation, the usage of each channel is shown for each of the research institutions. The findings in Table 2 below show that SUA had reported the use of all the existing data-sharing channels, and the extent of usage is higher than at the other research institutions investigated. Of all the data sharing channels that exist within the studied institutions, meetings, conferences, and the organizations' accessible website had a high statistical significance difference at a 1% level of significance ($p=0.005$ and 0.001 , respectively). Moreover, workshops, telephone-mediated conversations, and print media such as institutional publications, including technical reports that carry data had a statistically significant difference at a 5% level of significance ($p=0.049$, 0.045 , 0.045 , and 0.025 respectively). These findings imply that these channels or avenues were preferred over other channels in the studied area. Agricultural researchers at SUA and TARI centres always work in teams; this explains the role of meetings, conferences, telephone conversations, project reports, and workshops for data sharing. Findings show

Table 2: Extent of channel usage across research institutions as segregated by institution (n=204).

Data sharing channel	SUA		Ilonga		Naliendele		Selian		Uyole		Tengeru		Katrin		Ukiriguru		Makutopora		Mikocheni		Kibaha		P-value
	F	%	F	%	F	%	F	%	F	%	F	%	F	%	F	%	F	%	F	%	F	%	
Face-to-face conversation	48	35.6	8	5.9	7	5.2	12	8.9	13	9.6	8	5.9	5	3.7	13	9.6	8	5.9	7	5.2	6	4.4	0.066
Discussions	48	39	6	4.9	13	10.6	8	6.5	8	6.5	6	4.9	4	3.3	10	8.1	5	4.1	10	8.1	5	4.1	0.358
Meetings and conferences	52	35.9	11	7.6	15	10.3	12	8.3	8	5.5	7	4.8	3	2.1	14	9.7	7	4.8	10	6.9	6	4.1	0.005**
Seminars	49	38.3	8	6.2	6	4.7	12	9.4	9	7	7	5.5	3	2.3	11	8.6	9	7	8	6.2	6	4.7	0.098
Workshops	67	36.6	11	6	16	8.7	14	7.7	16	8.7	8	4.4	8	4.4	13	7.1	10	5.5	11	6	9	4.9	0.049*
Email	45	37.5	8	6.7	7	5.8	7	5.8	7	5.8	5	4.2	5	4.2	12	10	9	7.5	10	8.3	5	4.2	0.008
Telephone conversations	44	41.5	8	7.5	6	5.7	5	4.7	12	11.3	2	1.9	4	3.8	7	6.6	8	7.5	8	7.5	2	1.9	0.045*
Social media platforms	43	43	7	7	8	8	5	5	5	5	3	3	4	4	8	8	6	6	4	4	7	7	0.555
Organization website	38	32.5	5	4.3	12	10.3	10	8.5	13	11.1	5	4.3	2	1.7	15	12.8	8	6.8	3	2.6	6	5.1	0.001**
Institutional repository	38	52.8	0	0	5	6.9	3	4.2	5	6.9	4	5.6	3	4.2	6	8.3	2	2.8	4	5.6	2	2.8	0.154
Funding agency database	23	41.8	3	5.5	5	9.1	3	5.5	3	5.5	0	0	1	1.8	6	10.9	3	5.5	4	7.3	4	7.3	0.619
Publishing with journal venues	60	40.5	10	6.8	11	7.4	11	7.4	13	8.8	8	5.4	5	3.4	11	7.4	6	4.1	7	4.7	6	4.1	0.789
Institutional publications	63	37.7	10	6	16	6.9	11	6.6	16	9.6	8	4.8	7	4.2	9	5.4	9	5.4	10	6	8	4.8	0.045*
Project technical reports	61	35.3	10	5.8	16	9.2	14	8.1	16	9.2	8	4.6	8	4.6	14	8.1	8	4.6	10	5.8	8	4.6	0.024*

Note: *Significant at 5% level, **Significant at 1% level, F= Frequency and %= Percentage.

that there were variations in the existence of channels and the extent to which such channels were used, with SUA showing the primacy in all the channels used for sharing agricultural research data. This might be due to SUA having better ICT infrastructure compared to the other research institutions. SUA also has a large number of researchers from different research fields that would use a multiplicity of channels in sharing data files.

4.4. Factors Influencing Researchers in their Channel Selection

The third objective of this study was to examine factors influencing the choices of data-sharing channels as reflected in the Concentric Layered Model in Figure 1. Findings in Table 3 indicate that more than 50% of respondents shown strongly agree that timely delivery, the cost of the channel, and the convenience of the channel were among the factors influencing researchers’ choice of channels for data sharing. Timely delivery of data is among the motivating factors for researchers to use avenues such as face-to-face dialogue that provide timely delivery of data. For example, researchers preferred to use face-to-face dialogue (meetings, seminars, and discussions) because they were among the avenues which provide a chance for the timely exchange of data files, technologies, and innovations. With the advancement of technology, the weather forecast has been improved through the use of the mobile phone in data sharing. The use of CAMALIOT Android apps that uses a cell phone to support scientific research has been used in weather data collection

Table 3: Factors that influenced researchers in channel selection (n=204).

Factors that influence channel selection	Strongly Agree		Agree		Undecided		Disagree		Strongly Disagree	
	F	%	F	%	F	%	F	%	F	%
Timely delivery of data	154	75.5	-	-	36	17.6	14	6.9	-	-
Convenience to channel	101	49.5	77	37.7	20	9.8	6	2.9	-	-
ICT infrastructure	93	46.6	59	28.9	28	13.7	20	8.5	4	1.7
Need for permanent records	75	36.8	80	39.2	40	19.6	9	4.4	-	-
Funders policies	66	32.4	98	48	32	15.7	7	3.4	1	0.5
Data characteristics	43	21.1	94	46.1	39	19.1	27	13.2	1	0.5

and exchange. The app facilitates citizen and researchers to access and collect raw GPS satellite data from individuals with cell phones thus a cell phone act as a channel for transferring data to servers for permanent preservation for future use (See et al., 2022).

The convenience of the channel was observed to encourage researchers to choose a channel. The meetings convened in agricultural research institutions are convenient for researchers. Regular technical meetings for project evaluation (seminars and discussions held in research institutions) are convenient to most researchers to the extent that they motivate researchers in sharing data related to technologies or innovations. Likewise, almost every researcher owns a cell phone which makes it easy to call fellow researchers participating on the same project team or collaborators who are found in another institution just for sharing experiences in particular research projects. It is during such conversations that research data files are shared and hence exchanged using such channels. Elia (2018) recommended the use of mobile phone devices in meteorological stations to facilitate the timely collection and recording of weather raw data. The phone is a channel that can help to make data to be timely shared. In line with this, a study by Msemo et al. (2021) reveals that cell phone has been very useful to disseminate and receive weather data and warning information from weather stations located in different regions in Tanzania.

Data is characterised by its need for permanent records, availability of ICT infrastructures, and project funders' policies; yet these are also among the factors indicating less than 50% slightly in motivating researchers in their choice of channel. The availability of ICT infrastructure such as databases, and repositories that are connected by the internet motivates researchers to share their data by depositing their data files in funders' databases at the end of the project. Other data files have been published as supplementary materials in journal e-platforms. The need for permanent records for data obtained from research activities is among the factors that motivate researchers to choose a channel or avenue to share data. For example, by sending their data files to the funder's databases and research institutions, the researchers' main intention is to have permanent records for the data obtained during research projects. Therefore, the possession of data repositories or databases by the project funder motivates researchers to share their data through the available avenue. These findings are in line with the prior studies which have revealed that the availability of funding agencies' databases was observed to facilitate

researchers to select funder's databases as their channel to share their data (Bezuidenhout & Chakauya, 2018; Dodgson et al., 2021; Suhr et al., 2020).

5. Conclusion

Access to agricultural research data is essential for effective agricultural research. Our study findings reveal that agricultural researchers use both mediated and non-mediated channels for sharing their data. The non-mediated channels, such as meetings, seminars, and print media (institutional publications or technical reports), were mostly preferred by researchers. This implies that data sharing in research institutions is still happening via direct contact and face-to-face dialogue rather than via electronic platforms. Our findings indicate that timely delivery, the cost of the channel, and the convenience of the channel were among the factors influencing researchers to choose the channels for data sharing. From the findings, it is implied that data sharing would improve if research institutions could improve the use of digital technological channels in data sharing. This study contributes to the body of knowledge through the proposed conceptual framework for data-sharing channels because it can be used to explain existing data-sharing channels and the criteria for their selection.

6. Recommendations

Based on the study objectives and conclusion, the following are our recommendations.

1. The study recommends that, research institutions should devote themselves to preparing adequate funds for investing in mediated data-sharing channels such as generalised and specialised agriculture data repositories. Such investments could strengthen data practice sharing among researchers at local and international levels.
2. Research institutions should strengthen the non-mediated data-sharing channels that are currently used by researchers so that they continue to facilitate data sharing among researchers. The study recommends that research institutions should recognise the role of libraries in facilitating data management and sharing. A library is a

place where some of the mediated and non-mediated data-sharing channels are hosted. The data repositories and other print research outputs and other resources embedded with research data can be stored in a library. Therefore, strengthening the existing library infrastructures and building new libraries in agricultural research institutions can have a greater impact on data management sharing and use/reuse practices. The improvement of libraries should go hand in hand with recruiting librarians and ICT technicians who would play a greater role in data management and facilitate data sharing among researchers.

3. Research institutions should work closely with other international research institutions or partnerships so that researchers are given the opportunity to access and share their data with fellow researchers through international web-based channels.
4. Research guidelines, and regulations in agricultural research institutions should incorporate, and declare the formal channels for sharing research data.
5. This study further recommends that a data sharing policy framework should be amended to guide both the formal and informal data sharing procedures, and state clearly proper use of the mediated and non-mediated channels in data sharing among agricultural researchers.

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