

Review Article

Factors Influencing Data Sharing Practices, Perceptions and Motivations for Improved Accessibility of Agricultural Research Data in Tanzania

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Abstract

Accurate and reliable information on the data sharing practices and what motivates researchers to share their data is important in making data accessible for use/reuse. The purpose of this paper is to report a study that investigated factors influencing data-sharing practices, perceptions, and motivations for enhanced accessibility of agricultural research data among agricultural researchers in Tanzania. This research employed a cross-sectional survey method to examine data-sharing practices in agricultural research institutions and examined factors motivating researchers in their data-sharing. The sample size included 227 while from this sample size, some 204 respondents participated in the study. The findings have revealed that more than 80% of the researchers shared their data with project funders, research institutions, and with departmental colleagues. The findings also indicate that many researchers (60%) shared their data with the public through media, institutional libraries, and online publications. The findings reveal that both individual and institution-

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al factors influence researchers in data sharing. However, some of the factors were statistically significant at 5%; these are perceived community benefit, perceived ability to share, data sharing norms, perceived risk, and funding agency policies. In addition, the findings indicate that agricultural researchers face several challenges in their data sharing, including a lack of data sharing policy that could enhance data sharing in research institutions. This study has practical implications for promoting more reliable, and beneficial data sharing in the agricultural scientific community. The findings of this research can facilitate the establishment of a data-sharing policy and data repositories that could improve easy data sharing. The present study has significant theoretical contributions: the TPB model has been used in this study to explain the factors motivating researchers in their data-sharing behavior.

Keywords: Agricultural Research; Agriculture Research Data; Data Sharing; Research Data

Introduction

Agriculture research depends on scientific data. Scientific data are data generated through research activities [1]. Such data are needed to be shared to attain the benefits accrued. Scientific data sharing contributes to the improvement of scientific research. Thus, data sharing enhances the advances in agricultural research at the end leading to an increase in food production [2-5]. Also, data sharing increases research visibility, increases the pace of innovation, and facilitates collaborative problem-solving [6-8]. Additionally, through data sharing it is possible to verify the original analysis, compare results, and limit the unnecessary collection of existing scientific data [9-12]. Without proper allowing access to agricultural scientific data important issues such as climate and food security can be impaired [13]. This reminds the scientific community to continue strengthening data sharing. It is for this reason that this study was undertaken to enlighten researchers on the need to share their data.

To achieve effective data sharing there is a need to create a better data-sharing environment. Effective scientific agricultural data sharing is achieved when it is a trustful, transparent environment in data sharing, the presence of clear incentives for data sharing, and compliance with agreed legal terms, specifications, and standards for data sharing [14]. Data sharing can take place through some methods. Research data and other related material can be shared with fellow researchers and other research institutions by submitting to the one requesting data upon request [15-17]. Depositing data into databases and repositories is another method for data sharing [18]. The most important motivating factor for a scientist to share their data is the perceived benefits attained through data sharing.

As a result, in recent years there have been several initiatives that put more emphasis on scientific data sharing. For example, universities, research institutions, national governments, funding agencies, and journal publishers have been encouraging researchers to open and share their scientific data [6,19]. The funding agency, research funding institutions, and publisher's policies for PLoS ONE and data

sharing frameworks such as the ODIs Data Spectrum, the FAIR principles, Tim Berners-Lee 5 Star Scheme, and DATA-FAIR principles emphasize opening and sharing scientific data [14,20-22]. The availability of timely and reliable agricultural research data provides the base for agricultural research.

In Africa, there have been notable initiatives for data openness and sharing. The African Data Revolution Report of 2018 indicates that open data initiatives were inadequately embraced by most African countries including Tanzania [23]. In Tanzania like in any other developing country, agricultural research data sharing is not effectively established and implemented in agricultural research institutions despite the existence of initiatives to open up different types of data to the public [24]. Also, the absence of data-sharing repositories in Tanzania makes research institutions practice their data activities without any national coordination [25]. However, there are several efforts done in Tanzania to facilitate data sharing. There is a need for the implementation of policies for better timely dissemination of animal data on research projects based in Kenya and Tanzania [26]. The Government of Tanzania through its different agencies has done a lot to open and enable different types of data to be shared with the public. Furthermore, another initiative implemented by the Government to open data and make data discoverable is the establishment of an open data portal, an open Government initiative in 2011 [24,27-29]. These initiatives did not attain effective data-sharing practices in agricultural research institutions however, some remnants still exist.

In the health sector, the health research institutions in Tanzania managed to implement data-sharing policies to guide data management [30]. Along the same line, Ifakara Health Research Institution launched and developed a data repository to facilitate data management and sharing in the research institution hence benefiting researchers, the Government, and students [31]. Along the same line, the Government of Tanzania has successfully managed to implement health information systems for improved health data availability and sharing [32]. These health information systems facilitate management and enhance data sharing in the health sector.

The amendment of Acts and the presence of data exchange and sharing guidelines are efforts done to guide the process of data sharing in Tanzania. The statistical Act CAP.351 R.E. of 2019 was established to facilitate the NBS in the collection, management, and dissemination [33]. In line with this, the e-Government Act of Tanzania sections 48, 58, and 59 put the need to create primary data once and share it with the public. While sharing an individual must adhere to the data sharing and exchange principles which ensure effective and efficient data sharing. Furthermore, the Government has established electronic data exchange and sharing guideline that manages data exchange and sharing to all public institutions in Tanzania [34].

The Tanzania Commission for Science and Technology (COSTECH) guideline for research registration in Tanzania stipulates clearly that researchers are required to share their raw data in soft copy with COSTECH and local collaborating institutions based on project agreement. The presence of this guideline to an institution coordinating research activities in Tanzania reveals the existence of data-sharing practices between researchers, COSTECH, and their research institutions. Also, the research guideline for SUA put the data sharing procedure, and methods throughout the project research lifecycle [15]. Despite all the efforts done in the implementation of data-sharing initiatives in Tanzania, there is a lack of a clear picture

that reveals the current data-sharing practices among researchers, and what motivates researchers to share their data. The current study provides additional insight and understanding of how individual and institutional factors drive researchers' scientific data-sharing practices. The study will add value to the scientific community as it sheds a light on the need to establish data-sharing and exchange policies in agricultural research institutions which will provide a formal mechanism for data management and sharing.

Statement of the Problem

Agricultural researchers are users and also producers of data. Agriculture researchers dedicate most of their time to generating data, and new innovative technologies that facilitate improving crop production [35,36]. Such data generated by researchers are needed to be shared with the scientific community. Prior research from different research disciplines including that of agriculture has already exposed the methods used in data sharing, and what motivates and hinders researchers to share the produced data [4,12,37-40], despite all previous literature and the existence of data exchange and sharing guideline in Tanzania [34], TARI ACT of 2016, COSTECH research registration guideline and SUA research guideline of 2019 [15].

What has been noted from the prior studies and other documented evidence from Tanzania, is that there was no comprehensive look at agricultural research data sharing practices among researchers, it is not clear about the stakeholders with whom agricultural researchers share their data, and the factors that motivate or hinder agricultural researchers in data sharing, particularly in agricultural research institutions in Tanzania. The internal data sharing of research data and some innovative technologies among agricultural researchers may not be similar as only a limited number of research institutions have or may not have an elaborate system for data sharing. With this then what has been observed is that there is a dearth of information on the agricultural research data sharing practices among agricultural researchers, and what motivates researchers in their data sharing in pursuit of improving agricultural research data accessibility.

General Objective

The main objective of this study was to investigate research data-sharing practices, and what motivates agricultural researchers to share their data in Tanzania.

Specific objectives

1. Examine the data sharing practices exhibited among agricultural researchers
2. Determine factors that influence agricultural researchers in their data-sharing practices
3. Find out the challenges facing agricultural researchers in their data sharing

Research questions

1. What are the data-sharing practices exhibited by agricultural researchers in Tanzania?
2. Which factors influence agricultural researchers in their data-sharing practices?
3. What hinders agricultural researchers in their data-sharing practices among researchers?

Significance of the study

The findings from this study will provide insights for researchers and top-level managers in agricultural research institutions. For researcher's findings will provide an assessment of their contribution to agricultural research data sharing. The knowledge of data sharing will help researchers to improve the data sharing practices in research institutions. The research institution's management will know the limitations researchers are facing in trying to share agricultural research data and may try to solve them. The finding will enlighten Government, and research institutions on the need to establish data sharing policy and develop technological infrastructure that could promote and strengthen centralized collaborative data sharing.

Literature Review

The literature review was conducted based on the study research questions; agricultural researchers' data sharing practices, factors influencing researchers in data sharing, and challenges facing researchers in their data sharing.

Data Sharing Practices by Agricultural Researchers

Data can be defined depending on the field of study. Data in agriculture include facts obtained through the research process including agronomic samples, satellite photographs, experimental samples, research materials, procedures, technologies, and products [37,41]. Agriculture sciences research data include data obtained from experiments, laboratory or surveys, collections of published peer-reviewed datasets, published research results, satellite photographs, agronomic samples, and digital images [13,41,42]. Such important data are required to be shared with the scientific community.

Data sharing is an activity carried out by scientists to release their data to other people to use for scientific research [43]. In agricultural sciences, data sharing takes place involving the scientific community to share their common research interests. In a study conducted by Kerby, [44] and Lodwick, [38] findings indicate that 20% of data produced were publicly made open through depositing to repositories such as Gene Bank or posting on the website as supplementary files. Furthermore, Williams reveals that agricultural scientists at the University of Illinois in the USA tended to share their data using three methods; 88% shared their data as supplementary materials on journal articles, 40% shared their data via repositories and 17% shared their data through sending upon request. In line with this, the study that examined the data sharing trends in the College of veterinary medicine faculty members at the University of Oxford in the UK by Lodwick, [38] revealed that 56% of veterinary researchers indicated they shared their data by sending it upon request to fellow researchers, and through publishing articles in journals. Likewise, agricultural researchers in Germany were found to make data available to support research and make data available through a personal request to colleagues in the context of research cooperation. In the absence of data-sharing infrastructure, data sharing can be hindered therefore, to strengthen effective scientific data sharing there is a need to establish data-sharing platforms. The presence of a data-sharing platform can allow navigation, searching, and downloading of data for use/reuse. Also, this argument has been supported by other prior studies which revealed that to archive effective data sharing there is a need to have data repositories that use common metadata standards as agreed among participating members and adhere to data sharing principles (use of the five-star development scheme, and the FAIR Guiding

Principles) [13,4,43,44]. However, data sharing through depositing to data repositories is the best practice, yet it is not common to most of the agricultural research community, especially in developing countries including Tanzania. But the presence of data repositories is the best practice in data sharing simply because it ensures long-term data availability and accessibility [4]. In Tanzania for example, there are no national data repositories in place if researchers have their data there is no well-established infrastructure to share data to benefit the scientific community this is the challenge [28]. Therefore, it is not clear the best data-sharing practices exhibited by researchers in Tanzania.

Factors influencing data sharing behaviors among researchers

Some factors can motivate or hinder researchers to share their data. The perceived benefits of data sharing have a greater role in motivating researchers to share their data. Data sharing helps in answering research questions, testing new hypotheses, serves costs, and efforts to collect data that already exist [12,43,45-47]. Similarly, the study that investigated factors that drive or inhibit researchers from openly sharing their data [48] identified factors that influence a researcher's data sharing including researcher's background, intrinsic motivations, facilitating conditions, trust, expected performance, social influence, and affiliation, researchers' experience and skills, and data characteristics.

In addition, the perceived ability to easy-to-access data from a repository motivated researchers in Minnesota to share their data with repositories [49] as well as ensuring to get incentives and provide formal data citations to author's works [12,38-40,43,50]. However, it was also found that financial gain was not a factor to encourage researchers to share their data because an individual may be willing to share data without expecting any financial gain. Equally, an individual researcher's commitment is an important factor influencing researchers to willingly make their data visible [51,52]. Equally, funding agencies and journal publishers' roles may influence agricultural data-sharing practices. Earlier literature has indicated that conditions from funding agencies, organizations, and journal publisher policies for example PLOS One mandate researchers to open up their data from all publicly funded projects [8,16,38].

Despite the benefits of data sharing but there are observed reasons hindering researchers in their data sharing. The hypothesized reasons for researchers hesitating to make data available are the; lack of trust, and confidentiality, fear of being scooped, lack of privacy, lack of incentive, lack of money, lack of time, exposure of data to competitors, misuse, and misinterpretation, and lack of rewards [4,43,48,53-56].

Prior literature on data sharing has shown the following gaps: Data sharing is different across all research disciplines [43,55,57]. For example, researchers in a human subject such as Medicine/Health sciences were significantly lesser willing to share their data compared to hard sciences including Agriculture and Natural Resources for the reason that it is unethical to share some human-based data [43].

Most of the prior studies relied on the online survey or desktop research, reviewed several kinds of literature, or conducted a meta-analysis reviewing articles to find out data sharing, while other literature used mixed methods to investigate data sharing behavior on the individual level from different research disciplines [38,42,55,57-59]. However, few studies used the cross-sectional survey to investigate

data sharing among agricultural researchers [14]. What is noted there is a limited study that used the cross-sectional survey to investigate data sharing among agricultural researchers in Tanzania. Other prior work [48,57] developed the theoretical research model, to test hypotheses while there are limited previous studies that used TPB to test factors influencing data sharing among agricultural researchers in Tanzania. Based on these findings the current investigation sought to gain a better understanding of what motivates and hinders data sharing by examining both individual and institutional factors.

Theoretical Framework

This study adopted the Theory of Planned Behaviour (TPB) [60]. The Theory of Planned Behaviour (TPB) was observed to be a relevant theory to guide this study simply because the theory explains people's behaviors in terms of their attitudes, and resource-facilitating conditions [61]. The theory of Planned Behaviour (TPB) can guide us in understanding the personal and institutional factors that influence or hinder data sharing among researchers (Figures 1& 2) below. The Theory of Planned Behaviour (TPB) [60,62] has been used as a theoretical framework to explain how individual and institutional factors can influence data-sharing behavior. The theory of Planned Behaviour (TPB) has successfully been used to explain an individual's behavior based on several constructs such as subjective norms, perceived behavioral controls, and attitudes toward behavior [63].

The theory of Planned Behaviour (TPB) states that behavior is a result of a conscious decision to act in a certain way [57]. Behavior intentions are influenced by an individual's attitudes toward a given behavior, subjective norms regarding that behavior, and perceived behavior control [60]. Therefore, behavioral intention refers to a person's aim to perform a given behavior. While perceived behavioral control is an individual's opinions or perception that one is capable (the belief that one can perform a certain behavior) or has relevant skills and capabilities to perform a certain behavior [57]. Likewise, subjective norms can be broadly defined as the social pressure (social influence) that one perceives and is influenced by others to engage or not engage in a certain behavior [64]. The weakness of this theory is that it does not explain the influence of political factors in data-sharing practices.

Based on the Theory of Planned Behaviour (TPB) the data sharing conceptual model was developed in Figure 1 above to explain the relationship between independent variables (individual factors and institutional factors), and dependent variables (data sharing). Independent variables from TPB comprise individual factors (perceived community benefits, perceived career benefits, perceived ability to share, perceived data sharing risk, scholarly altruism, and data-sharing norms). The institutional factors include funding agency policies, journal publisher's policies, and facilitating conditions (data sharing infrastructures). The individual and institutional factors were found to influence agricultural researchers to share their data.

Based on the conceptual framework in Figure 2 above show that intervening variable comprise researchers and agricultural research institutions. Researchers and research institutions are the one who generate agricultural research data through different research activities. Also, researchers use/reuse data in research process, preserve and share their data. Researchers are influenced by individual and institutional factors to share their data. Once data is shared they became accessible for use/reuse in future research activities.

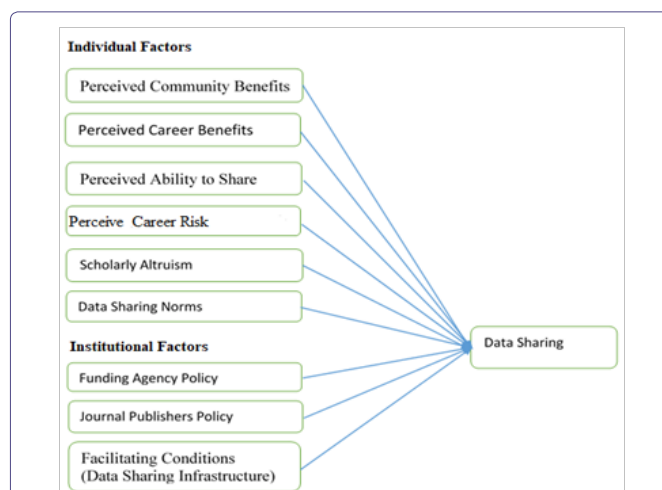


Figure 1: Research Data Sharing Conceptual Model.

Source: Adapted and Modified from [61] and [63]

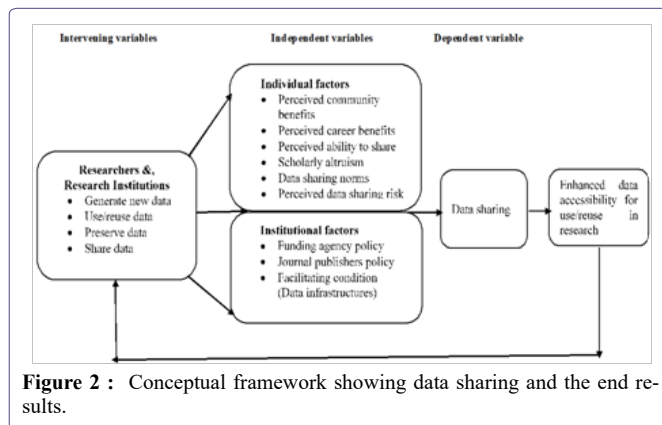


Figure 2 : Conceptual framework showing data sharing and the end results.

Research Methods

The study employed a cross-sectional research design where a researcher surveyed observed representative subjects at a specific point in time to examine the data-sharing practices and the factors that influence researchers in data sharing. The study applied both qualitative and quantitative approaches to data gathering and analysis. The qualitative approach was used to find out the views and insights about data-sharing practices. The quantitative approach was used to investigate the effectiveness of data-sharing practices and factors influencing researchers in data-sharing [65].

Population and Sampling

The target population of this research included agricultural researchers from different agricultural research fields belonging to Tanzania Agriculture Research Institution (TARI) centres and Sokoine University of Agriculture (SUA) specifically the College of Agriculture, and College of Veterinary Medicine and Biomedical Sciences. The total population of researchers in the study areas was 527. From this study population, the sample size of 227 was obtained using the formula for sample size calculation [66].

To obtain the number of respondents to be involved in this study in each research institution a representative sample per institution was calculated by taking the sample size divided by the total population

of the study area and multiplied by the population of a particular research institution. The key informant interview was selected purposively including 11 Directors from TARI centers and 1 Director from SUA Post Graduate Studies. Key informants were purposively selected because they were thought to be experienced and knowledgeable and would therefore provide in-depth insights about the study topic [65].

Data Collection

The data collection involved the use of multiple data-gathering techniques to examine the data-sharing practice and factors influencing researchers in their data-sharing. The cross-section survey method (questionnaire and interview) and focus group discussions (FGDs) were employed in the study. Quantitative data were collected through questionnaires. The questionnaire in hard copies with both open and closed-ended questions was distributed and administered to 227 agricultural researchers from ten selected TARI centers, and SUA. Out of 227 distributed questionnaires about 204 questionnaires were correctly filled and returned and used in this study. While qualitative data were collected through interviews with key informants and focus group discussions. A total of two focus group discussions with agricultural researchers were conducted at Mikocheni and Ilonga TARI Centres. Each focus group discussion had six participants who were selected from among the survey respondents. These research institutions were selected randomly from among several agricultural research institutions. In addition, secondary data were collected from different sources, including the TARI communication strategy of 2019, the TARI Act of 2016, the SUA Research Guideline and Regulation of 2019, and the national electronic data exchange and sharing guideline [65].

Statistical Data Analysis

Quantitative data were analyzed using Statistical Product and Service Solution (SPSS) software version 22. The quantitative analysis allowed a researcher to obtain the frequency of the responses. The descriptive analysis allowed a researcher to describe data-sharing practices, and influencing factors for data sharing. While qualitative information collected through interviews, and focus groups were recorded, coded, and categorized into similar themes explaining data-sharing practices among agricultural researchers, and were used in the discussion of findings. The inferential statistics were obtained by using the Binary Logistic Regression technique. This was performed to determine the presence or absence of statistically significant differences between the independent variable with a dependent variable [65].

Measurement of Construct

In testing the existence of relationship or nonexistence of a relationship between the dependent variable (data sharing) and independent variables (set of predictors) (factors influencing data sharing) Logistic regression techniques were used. The results reveal that both individual and institutional factors influence researchers in data sharing. The individual factors that were found to have a statistically significant relationship with data sharing were perceived community benefit ($\beta=1.385, p=0.012$), perceived ability to share ($\beta=1.338, p=0.042$), data sharing norms ($\beta=-500, p=0.050$) and perceived data sharing risk ($\beta=1.625, p=0.015$). While other individual factors including perceived career benefit ($\beta=.274, p=.0607$) and scholarly altruism ($\beta=-0.186, p=0.675$) were found to have no statistically significant relationship with data sharing. At the institutional level,

only funding agency policy ($\beta=0.969, p=0.023$) was found to have a significant relationship with data sharing. Other institutional factors such as journal publishers' policy ($\beta=0.089, p=0.836$) and technical infrastructure ($\beta=0.495, p=0.465$) were found to have no statistically significant influence on data sharing.

In testing the fitness of the model the Hosmer and Lemeshow Test was found to have a p-value greater than 0.05 ($p=0.131$), indicating that the model was fit for the test. The test Cox & Snell R² was found to have a value of 0.145 and a Nagelkerke value of 0.196 meaning that independent variables in the model contributed between 14.5% to 19.6% of the variation on the dependent variable. Thus, the remaining percent was contributed by other factors other than those included in the model. This research demonstrates that agricultural researchers are influenced by both individual and institutional factors in their data sharing. The study, therefore, proposes this model to be used in guiding researchers in data-sharing practices.

Findings and Discussion

Demographic Characteristics of Respondents

The survey participants' demographic characteristics were recorded for age, gender, level of education, and work experience. The findings in Figure 3 below indicate the majority are male (67%) and female (33%). These findings imply that the majority of agricultural researchers who participated in this study were male. Most of the researchers in this study had an age range from 31 to 50 years of age (69%). This indicates that most researchers were of active age for conducting research in the field. The academic levels for the survey indicated that the majority (82%) of researchers have attained a Master's and PhD level. This implies that most of the researchers in the study area had enough education for conducting research activities. The majority (95.3%) had a work experience of more than (6) years and a few (11.8%) had work experience between 1 to 5 years. This implied that the majority of researchers were experienced in conducting research from different agricultural fields [65].

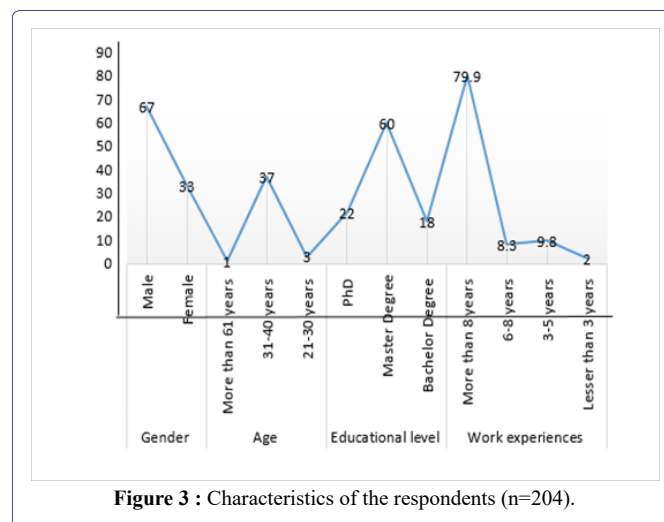


Figure 3 : Characteristics of the respondents (n=204).

Data Sharing among Agricultural Researchers

Findings in Figure 4 below show the responses on data sharing. The question intended to know if respondents share their data. Findings revealed that 74% of respondents indicated they share their data and 25.5% indicated they do not share their data. This finding

indicates that the majority of respondents share their data with fellow researchers.

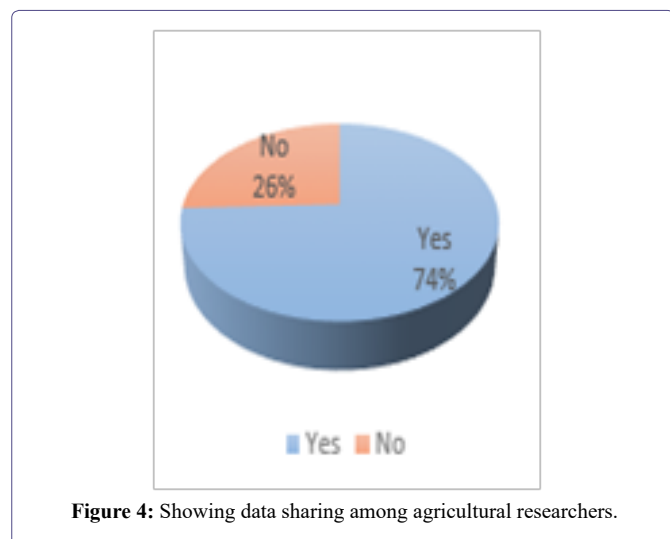


Figure 4: Showing data sharing among agricultural researchers.

Data sharing stakeholders exhibited by agricultural researchers in the study area

Findings in Table 1 indicate that the majority of respondents (more than 90%) indicated they shared data with their sponsor of the research project. This means that agricultural researchers preferred to share their data with the project sponsor during and at the end of the research project. This finding is similar to that reported by Shen [67], who revealed that academic faculty researchers shared their data with funding partners. Also, findings show that more than 80% of respondents indicated that they share their data with members of the research group, shared with the department members, and with their research institution. These findings imply that agricultural researchers work in teams and therefore share their data with members with whom they work closely in their research activities. Therefore, in this way data sharing enhances a collaborative way of working in research. These findings corroborate to findings of prior studies. Findings from agricultural researchers at the University of Nebraska indicated that they had a tradition of sharing their data with trusted colleagues, a faculty member in another college, other academic institutions, international organizations, and research collaborators [68; 69]. Furthermore, these findings are related to the previous study that revealed researchers were ready to collaborate and share their data with others. 73% of researchers shared with fellow researchers in the same team, 42% revealed to share their data within the same university, and 55% collaborated with researchers in other institutions. In line with this, data sharing enhances interdisciplinary and collaborative research [70]. Zhao and Wang [1] revealed that agricultural researchers were willing to use other researchers' data and are unwilling to provide their data. Through key informants interview one respondent at Ukiriguru TARI center revealed the following with whom data are shared.

I am willing to share my data with farmers, project funders, and fellow researchers working on the same project. This is because I have a close connection in research activities with these groups.

Factors influencing data sharing practice among researchers

Table 2 shows Inferential Statistics Analysis from Binary Logistic Regression model results. Based on the construct borrowed from TPB in Table 2 below findings indicate that both individual and institutional factors motivate researchers in data-sharing practices. From TPB theory, individual factors included perceived community benefits, perceived career benefits, perceived ability to share, scholarly altruism, data sharing norms, and perceived data sharing risk. Institutional factors included funding agency policy, journal publishers' policy, and facilitating conditions (technical infrastructures). From these findings in Table 3 the proposed research model is validated to be adopted in data sharing.

Results from inferential statistical analysis indicate that perceived community benefits ($\beta=1.385$, $p=0.012$) were found to have a statistically significant positive influence on scientist data-sharing behavior. These findings imply that researchers who perceive that agricultural research data sharing can be beneficial to the community will likely share their data with others. Similar sentiments have been reported by Williams et al. [8], an agricultural researcher from Minnesota revealed share their data by depositing data into repositories they believe that sharing data through repositories is beneficial to the scientific community whereby researchers can access, browse and download data for future use/reuse in research. Researchers who through data sharing is beneficial to the scientific community as it increases the expectation to collaborate and create a network with fellow researchers on future projects they shared their data with [48].

| With whom researchers share their data | Yes | |
|--|-----------|------------|
| | Frequency | Percentage |
| Sponsor of research project | 196 | 96.1 |
| Members of my research group | 182 | 89.2 |
| With my department | 168 | 82.4 |
| With my research institution | 168 | 82.4 |
| Journal publishers | 154 | 75.5 |
| With researchers whom we work on similar topic | 152 | 74.5 |
| With researchers whom I know personally | 149 | 73.0 |
| Everyone by publishing online | 142 | 69.6 |
| Institutional library | 130 | 64.0 |
| General public through media | 127 | 62.3 |

Table 1. Data sharing stakeholders exhibited by agricultural researchers (n=204).

Scholarly altruism ($\beta=-0.186$, $p=0.675$) was found to have no statistical significance differences between scholarly altruism and data sharing. The Wald value for scholarly altruism was a non-zero value indicating there was a small relationship between scholarly altruism and data sharing but the relationship was not statistically significant. This is contrary to what was found by [8,16], who found that scholarly altruism had a significant relationship with scientific data sharing. This means that researchers with feelings of scholarly altruism are more likely to share their data than those who did not. Furthermore, perceived behavioural control/perceived efforts ($\beta=1.338$, $p=0.012$) was found to have a statistically significant relationship with scientist data sharing. This means that scientists who have skills, and

knowledge and perceive able to share data are likely to share their data. This result supports many prior studies' arguments. Researchers perceived efforts and expected performance was realized to be among the intrinsic and personal factors influencing researchers to openly share data [48]. Also, Kim and Stanton [16] found that perceived effort had a significant negative effect on scientist data sharing behaviour. This means that scientists who perceive that they require a lot of time in data sharing are less likely to share data with others.

Likewise, data sharing norms ($\beta=0.500$, $p=0.050$) were found to have a statistically significant difference in scientist data sharing behaviour. This means that scientists who perceived that there are data-sharing norms that influence data sharing are likely to share their data. In agricultural research institutions, researchers are influenced to share their data by fellow researchers, collaborators, and funding agencies. The TARI Act of 2016 stipulates that all research data and other technology innovated belong to research institutions at the end of the project researchers are required to submit it to the research institutions [71]. The SUA research guideline also states clearly that all research data and specimens generated by researchers and students at SUA belong to the institution. The guideline further states sharing of data and research materials is upon request by other researchers and universities and research institutions based upon the spirit of collegiality in science and the applicable institutional and national policies and guidelines [15]. The institutional data exchange and sharing in Tanzania is mediated by electronic data exchange and sharing guidelines [33]. All these data-sharing norms in research institutions influence researchers to share their data with the research project funders and institutions. This finding agrees with the prior studies finding argued that data sharing is driven by a peer, the researcher's attitudes, social norms, self-efficient, social, organizational, cultural factors, and disciplinary practices [48,54,57].

Another individual factor was the perceived risk ($\beta=1.625$, $p=0.015$), which was found to have a statistically significant positive relationship with scientific data-sharing behaviour. This means that scientists who viewed data sharing as a potential risk were lesser likely to share their data and if they thought it was not a risk they could share their data. Similarly, funding agencies' pressure ($\beta=0.969$, $p=0.023$) was found to have a statistically significant relationship to scientist data sharing. Thus, funding agencies' policies influence researchers in their data-sharing practice. These findings relate to other prior studies that revealed that funding agency policy and mandates, government agencies, and the existence of Government directives was observed to influence researchers in their data sharing [11,37,48,57,59,72]. However, Kim and Stanton (2016) revealed that funding agency policies were not found to have a significant influence on data-sharing behaviour across diverse STEM disciplines. Also, Lodwick (2019) insists on the role of funding agency policies in influencing data sharing; findings showed that journals with no data sharing policy for example Antiquity had a lower level of data sharing.

Equally, journal publishers' policies ($\beta=0.089$, $p=0.856$) were found to have no statistically significant difference in data sharing. However, there was some relationship between journal publishers' policies and data sharing because its Wald value was found to be a non-zero value indicating the existence of the relationship. Prior study findings are contrary to these findings by Kim and Stanton [16] who found that regulative journal pressure positively increased scientist data sharing behaviour.

In the same way, perceived career benefits ($\beta=0.274$, $p=0.607$) were found to have no statistically significant differences in scientist data-sharing behaviour. Although there was no statistically significant relationship the relationship exists to a small extent because the Wald value was larger than the zero value implying the existence of a minor relationship between perceived career benefits and data-sharing behaviour. These results are related to the previous study [16] which found that perceived career benefits were not significantly related to scientist data sharing.

Additionally, facilitating condition (technical infrastructure) ($\beta=0.495$, $p=0.467$) was found to have no statistically significant relationship with scientist data sharing behaviour. The findings reveal there was no statistically significant relationship however, there was the existence of a small relationship between the availability of data infrastructures and data sharing because the Wald value was non-zero indicating the existence of a relationship among the variables. The results support the finding of a prior study that found that the availability of data repositories in a discipline was not found to have a significant relationship with data-sharing behaviour [16]. Other prior studies revealed that the presence of facilitating conditions (data repositories) can both drive and inhibit researchers from openly sharing their data [48,54,73]. Researchers from different research disciplines indicated that they would be willing to share at least some of their data in a central repository if the datasets are easily accessible [43]. In line with these researchers, prior studies found that building a data-sharing infrastructure can promote data sharing [10,43]. However, these studies reveal that the availability of data repositories is not the only motivator for researchers to share their data, other factors need to be considered.

Challenges Hindering Data Sharing among Agricultural Researchers

Although researchers indicated willingly sharing their data with fellow researchers, and other colleagues, findings in Table 3 show that 102 (50%) of respondents indicated a lack of data sharing policy for guiding data sharing to local and international context was among the factors that hinder researchers in data sharing. The presence of a data-sharing policy could stipulate all important aspects of data sharing including the procedure, methods, and agreements to be considered while sharing data. The presence of policy could influence the development of data repositories to facilitate data-sharing practices. Therefore, the absence of data sharing policy in agricultural research institutions makes it difficult for researchers to recognize a well-elaborated data-sharing scheme. These findings are in line with the study by Katabalwa et al. [24], who revealed that the absence of data sharing policy in Tanzania hampers data sharing. The absence of a data-sharing policy makes it difficult for researchers to be able to share their data with the scientific community. In addition, another prior study revealed that what hinders data sharing includes a lack of data sharing policies, standards, and technical infrastructures such as data repositories [28; 67]. Furthermore, findings indicate that insufficient research funds 43.6% were observed to be a factor that hinder researchers in their data sharing. The fund's availability allows researchers to conduct research easily thus it could be easy for them to share the data that has been obtained through funded projects [74-76].

| Factors influencing Data Sharing | B | S.E. | Wald | Df | Sig. | Exp(B) | 95.0% C.I.for EXP(B) | |
|--|--------|------|-------|----|-------|--------|----------------------|--------|
| | | | | | | | Lower | Upper |
| Individual factors | | | | | | | | |
| Perceived community benefit | 1.385 | .554 | 6.253 | 1 | .012* | 3.994 | 1.349 | 11.823 |
| Perceived career benefits | .274 | .532 | .264 | 1 | .607 | 1.315 | .463 | 3.732 |
| Scholarly altruism | -.186 | .444 | .176 | 1 | .675 | .830 | .348 | 1.982 |
| Perceived ability to share | -1.338 | .657 | 4.149 | 1 | .042* | .262 | .072 | .951 |
| Data sharing norms (subjective norms) | -.500 | .258 | 3.745 | 1 | .050* | .606 | .365 | 1.006 |
| Perceived data sharing risk | 1.625 | .667 | 5.936 | 1 | .015* | .5078 | 1.374 | 18.764 |
| Institutional factors | | | | | | | | |
| Funding agency policy | .969 | .782 | 1.535 | 1 | .023* | 2.635 | .569 | 12.201 |
| Journal publishers policy | .089 | .488 | .033 | 1 | .856 | 1.093 | .420 | 2.842 |
| Availability of technical infrastructure | .495 | .681 | .529 | 1 | .467 | 1.641 | .432 | 6.230 |
| Constant | -.237 | .979 | .059 | 1 | .808 | .789 | | |

Table 2: Factors influencing data sharing practice among researchers (n=204).

Note: * significant at 5% level

Conclusion

The findings reveal that despite the absence of a well elaborate agricultural research data-sharing policy agricultural researchers share their data with different research groups including project sponsors, members of the research group, departmental members, and research institutions. The methods that are used in data sharing include sending raw data and other research materials to fellow researchers upon request in both hardcopies and electronic means. Findings show that data sharing with research institutions and funding agencies is mandatory. Research institutions and research funding agencies for example COSTECH, and SUA stipulate sharing raw data for all funded projects is mandatory. Researchers are required to submit their raw data and other research materials at the end of the project in both hard copies and soft copies. Findings reveal that both individual and institutional factors motivate agricultural researchers to share their data. For example, for institutional factors funding agency policies and research institutional guidelines requires researchers to share their data and other research materials at the end of the research project. Individual factors also were found to influence researchers in data sharing. It can be concluded that factors that influence data sharing in TARIs and SUA include perceived community benefits, perceived ability to share, and existing data sharing norms such as submitting raw data to institutions, and funding agencies. These would be the factors that respective institutions should promote to improve accessibility to agricultural research data in Tanzania. Although this survey was conducted on a national level in Tanzania, the results of this study can help to address overarching challenges of data sharing at the

| Statement | Frequency | Percentage |
|------------------------------------|-----------|------------|
| Lack of data sharing policy | 102 | 50 |
| Insufficient research funds | 89 | 43.6 |
| Lack of reward | 74 | 36.6 |
| Difficult to prepare data to share | 73 | 35.8 |

Table 3 : Challenges hindering data sharing among agricultural researchers.

international level as well. Data sharing is not a national concern, the challenge of data sharing can only be solved in a participatory and cooperative way.

Recommendations

Based on the study findings it can be recommended that:

1. To strengthen data-sharing using modern ways there is a need to establish better data-sharing infrastructures such as databases or data banks in agricultural research institutions. Research institutions' authorities should establish a data repository for data management that also would enhance data sharing among researchers at local and international levels.
2. Research institutions should create awareness among researchers about the existence of online data-sharing platforms which can provide room for researchers to able to share their data with the scientific community. . Researchers should be informed that it is important to share data to benefit the scientific community rather than thinking first about their gain.
3. Research institutions authorities should establish a data-sharing policy to guide data-sharing practices in agricultural research institutions. The policy should incorporate the existing informal data-sharing practices. This is because the absence of a well elaborate data sharing policy in agricultural research institutions was found to hinder the data sharing practices.
4. To enhance data sharing among researchers in agricultural research institutions there is a need to address the challenges facing agricultural researchers in their data-sharing practices especially the provision of enough funds for research activities conducted in agricultural research institutions.

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