

Access to and trust of information sources on Genetically Modified Organisms (GMOs) among extension workers in selected regions of Tanzania

Rebeca Y. Kachembeho¹

Philbert S. Nyinondi²

Ester E. Mnzava³

¹rebecakachembeho@gmail.com

^{1,2,3}Sokoine University of Agriculture (SUA), Tanzania

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ABSTRACT

Modern agricultural biotechnology, particularly genetically modified organisms (GMOs), presents both opportunities and ongoing debates within agricultural development, placing extension workers at the centre of information exchange. The Source Credibility Theory is primarily a theoretical framework to guide this study. This study examined how agricultural extension workers in Tanzania access and trust sources of information on genetically modified organisms, drawing on data from a cross-sectional survey conducted in Dodoma, Geita, and Mtwara regions. The study population comprised agricultural extension workers from the selected regions. Non-probability sampling was employed to purposively select three regions, which are Dodoma, Mtwara and Geita, based on their agricultural characteristics and potential relevance to GMO-related information needs. The list of all extension workers and their contacts was obtained from the regional extension officer from every region. Within the regions, simple random sampling was applied to select extension workers, ensuring representation across districts and extension service structures. A total of 172 agricultural extension workers participated in the study. Data were collected using questionnaire surveys. The data was coded and analysed using the IBM SPSS Version 25.0. Descriptive statistics, including frequencies and percentages, were used to summarise respondents' characteristics and patterns of information source use. Inferential analyses, including chi-square tests and Cramer's V, were conducted to examine relationships between socio-demographic variables, particularly age, education level and region and trust in information sources. The results show that extension workers rely on diverse sources of information, but their confidence is placed in sources perceived as scientifically credible, especially universities and research institutions. The most favoured methods of information dissemination are training programmes and seminars, reflecting the value of interactive and explanatory formats for complex technologies. Traditional media such as radio and television remain relevant but secondary. Socio-demographic influences are limited, with education level and regional context shaping some trust and preference patterns. The study critically suggests that reliance on credible institutions alone is insufficient unless structured training opportunities are made routine and regionally responsive, underscoring the need for sustained institutional collaboration to support informed agricultural biotechnology communication within extension systems.

Key words: Agricultural, Biotechnology, Extension, GMO, Information Sources, Tanzania

I. INTRODUCTION

Agricultural biotechnology is a central element of contemporary agricultural innovation and holds considerable potential for addressing the global challenges, including, environmental sustainability, the impacts of climate change and food insecurity. The application of biotechnology in agriculture has evolved over time, beginning with ancient practices such as selective breeding and domestication, succeeding through standard practises such as hybridisation, and advancing to modern approaches (Riaz et al., 2025; Wuest et al., 2021). The advanced approach of agricultural biotechnology often referred to as modern agricultural biotechnology, encompasses a range of technologies including genetic modification, gene editing, and gene drive systems (Bhattacharjee et al., 2024; Singh et al., 2018). Empirical studies have shown that early applications of modern agricultural biotechnology, which is genetic modification, have contributed to improved crop yields, increase tolerance to drought and salinity, enhanced resistance to pests and diseases, and reduced dependence on chemical inputs (Amri & Saraswati, 2025; Hanif et al., 2023).

Despite this body of scientific evidence, the introduction and adoption of Genetically Modified Organisms (GMOs) have remained contested in many parts of Africa. Government responses vary widely across the continent. While countries such as South Africa and Nigeria have approved the commercial cultivation of genetically modified crops, others, including Tanzania, continue to approach the technology with caution and regulatory uncertainty (Akinbo et al., 2021; Kedisso et al., 2022; Mmbando, 2023). In contrast, countries such as the United States of America, Brazil,

Argentina, and India have integrated GMOs into their agricultural systems, reporting economic gains alongside environmental and productivity benefits (Eckerstorfer et al., 2019; Ishii & Araki, 2017; Menz et al., 2020). These contrasting adoption paths suggest that scientific evidence alone does not determine acceptance of GMOs; rather, how information about GMOs is communicated, interpreted, and trusted plays a critical role in shaping policy decisions and public responses.

In this context, effective communication of agricultural innovations becomes essential to understand differences in acceptance and adoption. The dissemination of information on Genetically Modified Organisms to rural areas relies on a diverse range of information sources. Studies have often mentioned government reports, research institution publications, mass media such as television, radio, and newspapers, as well as training workshops, non-governmental organisations, and peer networks among extension staff (Anyanwu & Udoh, 2022; Essougong et al., 2019; Mwaniki et al., 2017; Wunderlich & Gatto, 2015). In current years, digital platforms including websites, social media, and mobile applications have become increasingly important because of their speed and accessibility (Bharti et al., 2024; Kandagor et al., 2018; Ramavhale, 2024)

Trust and access of GMO-based information are strongly shaped by the nature, quality, and credibility of information disseminated by different actors, including scientists, policymakers, extension workers, and the media. The ways in which GMO information is communicated, and the level of trust related with different sources, are further influenced by existing policy positions and regulatory frameworks (Mmbando, 2024). In contexts where regulatory uncertainty exists, trust in information sources becomes particularly important.

Agricultural extension workers serve as intermediaries between scientific researches and farming communities, they translate technical knowledge into practical guidance, especially in rural areas where there is low access to formal education and scientific information (Arowosegbe et al., 2024). Their effectiveness depends on access to timely, accurate, and comprehensible information. However, extension workers often rely on multiple information sources and may have limited opportunities for continuous professional development in agricultural biotechnology, which can affect both their understanding of GMOs and their confidence in communicating related information.

Understanding how agricultural extension workers access, evaluate, and trust information about GMOs is therefore essential for developing effective communication strategies, strengthening extension services, and informing policy and capacity-building initiatives. Such understanding is particularly relevant in Tanzania, where decisions regarding agricultural biotechnology adoption remain cautious and questioned.

The findings of this study contribute to this understanding by examining the access and trust of information sources that provide information on Genetically Modified Organisms to extension workers. The study provide information that may assist extension workers in recognizing the value of different information sources and using them more effectively to balance existing extension and knowledge services. In addition, the findings may inform researchers, extension education providers, and policymakers in designing targeted training programmes that utilize appropriate and trusted information channels. Strengthening the use of reliable information sources has the potential to improve extension service delivery and, support better farm productivity and decision-making among farmers.

This study aimed to assess the access and trust of information sources consulted by agricultural extension workers regarding Genetically Modified Organisms. Specifically, the study sought to identify information sources on Genetically Modified Organisms initially accessed by extension workers, examine the sources they trust most, determine their preferred information sources and examine the influence of socio-demographic variable on trust and preference of information sources on Genetically Modified Organisms.

1.1 Research Questions

- i. What are information sources on Genetically Modified Organisms do extension workers consult?
- ii. Which information sources are trusted most by extension workers regarding Genetically Modified Organisms?
- iii. How do extension workers prefer to receive information on Genetically Modified Organisms?
- iv. How socio-demographic variables influence trust in information resources regarding Genetically Modified Organisms?
- v. How socio-demographic variables influence preference on information resources regarding Genetically Modified Organisms?

II. THEORETICAL REVIEW

2.1 Theoretical Framework

The Source Credibility Theory is primarily as a theoretical framework to guide this study. The Theory suggests that information acceptance and use depend largely on the perceived credibility of the information source. However, the theory does not adequately explain how individuals search, select, and use information based on their needs. Therefore, Information Seeking and Use Model was adopted to complement Source Credibility theory.



2.1.1 Source Credibility Theory

Source Credibility Theory provides the primary theoretical lens for this study. The theory originates from the persuasion research of Hovland, Janis and Kelly (1953; 1963), who argued that message acceptance depends not only on message content but also on the perceived credibility of the source, as cited by (Koch, 2024). Their experimental work demonstrated that identical messages recognized to highly credible sources were more likely to produce opinion change than those attributed to less credible sources (Hovland & Weiss, 1951). These findings established credibility as a central mechanism through which information influences beliefs and attitudes. Later studies advanced the concept by emphasizing that credibility is a perception held by message receivers, rather than an objective property of the communicator (McCroskey et al., 1974; McCroskey & Young, 1981). Audiences evaluate credibility largely through valuations of a communicator's expertise and trustworthiness, and, in some contexts, perceptions of goodwill or concern for the audience's welfare (McCroskey & Teven, 1999). Across communication scholarship, there is broad agreement that credibility is closely tied to the communicator's ethos, encompassing knowledge, integrity, and perceived motivation.

In science and risk communication, source credibility assumes carried importance because audiences often lack the technical expertise required to independently evaluate complex information. Under such conditions, individuals rely on experiential signs, particularly the credibility of the information source to make judgements about scientific claims (Pornpitakpan, 2004; Vraga & Bode, 2018). This dynamic is especially noticeable in communication about genetically modified organisms (GMOs), where uncertainty, competing interests, and contested narratives are common. Empirical studies consistently show that trust in scientists, universities, and public research institutions is positively associated with acceptance of genetic Modification technologies, while skepticism toward commercial actors and politically motivated institutions is associated with greater concern and resistance (Hunt & Wald, 2020). Thus, Source Credibility Theory provides a strong explanatory basis for examining why agricultural extension workers trust certain GMO information sources more than others, and how such trust shapes their beliefs and preferences. While Source Credibility Theory explains how information sources are evaluated, it does not explain how individuals come to encounter, seek, or select those sources in the first place. To address this behavioural dimension, the study is supported by Wilson's Information Seeking and Use Model (Wilson, 1999), one of the most influential frameworks in information science.

2.2 Information Seeking and Use Model

Wilson first introduced his general model of information behaviour in 1981, with subsequent refinements in 1994, 1997, and 1999, and further conceptual clarification in later work (Potnis, 2015). Across these iterations, Wilson consistently defined information behaviour as the whole of human behaviour in relation to information sources and channels, including information need recognition, information seeking, information searching, and information use. According to Wilson, information behaviour is initiated when a person's work role or life context gives rise to a perceived information need. This need does not automatically result in information seeking; rather, a range of intervening variables, including demographic characteristics, role demands, environmental constraints, and characteristics of information sources themselves (Wilson, 1999), mediates it. These variables can either facilitate or inhibit engagement with particular sources. Crucially, Wilson's model recognises that individuals operate within institutional and social contexts that shape both accesses to information and preferences channels. Information seeking is therefore not a purely rational or linear process, but a contextual and adaptive one, in which individuals balance effort, accessibility, perceived usefulness, and anticipated outcomes (Wilson, 1999).

2.3 Theoretical Implications for the Study

In the context of this study, Wilson's Information Behaviour Model explains how and why agricultural extension workers in Tanzania seek information about GMOs, while Source Credibility Theory explains how they evaluate and trust the sources they consult. Agricultural extension workers occupy a professional role that requires them to interpret and communicate scientific and technological information to farming communities. This role creates recurring information needs related to Genetically Modified Organisms, food security, and climate resilience. In line with Wilson's model, these needs prompt extension workers to engage with multiple information sources, including universities, researchers, government agencies, mass media, social networks, and private sector actors. However, Wilson's framework also predicts that contextual and personal factors, such as education level, regional location, and institutional exposure, shape both access to and selection of information sources. This aligns closely with the study's empirical findings, which show that education level and region significantly influence preferred sources and trust patterns, while gender and age do not.

Source Credibility Theory then provides the evaluative mechanism through which these accessed sources are judged. Although extension workers may encounter information from a wide range of channels (as explained by Wilson's model), they do not assign equal trust to all sources. Instead, consistent with credibility theory, sources perceived as possessing higher scientific expertise and institutional legitimacy, particularly university scientists and

public research institutions, are trusted more than commercial or informal sources. Thus, Wilson's model explains exposure and use, while Source Credibility Theory explains trust and acceptance. Together, the two frameworks offer a coherent explanation for the study's key findings: extension workers draw on diverse information sources due to role-driven information needs, but they selectively trust sources perceived as credible when forming beliefs about GMOs.

The integration of Wilson's Information Behaviour Model with Source Credibility Theory, this study captures both the behavioural process of information seeking and the evaluative process of credibility assessment. This combined framework is particularly suited to the GMO context, where information is abundant but trust is unequally distributed across sources. The integration also provides a theoretical basis for the study's recommendation that stronger partnerships between universities, research institutions, and extension services are necessary. Such partnerships not only improve access to information (as emphasised by Wilson's model) but also strengthen the credibility of GMO communication (as emphasised by Source Credibility Theory), thereby supporting more informed and trusted knowledge transfer within the agricultural extension system.

III. METHODOLOGY

3.1 Study Design and Approach

This study employed a cross-sectional design to examine the access and trust of information sources on genetically modified organisms among agricultural extension workers in selected regions of Tanzania. A cross-sectional approach was suitable because the study required to capture existing patterns of information seeking, source and trust at a single point in time rather than to assess change over time (Tashakkori et al., 2020; Tobi & Kampen, 2018). A quantitative research approach was adopted. Quantitative data provided measurable forms of source, trust, and preference. This approach aligns with information behaviour research, which recognises that information seeking and evaluation are shaped by both observable actions and contextual factors (Pluye et al., 2022).

3.2 Study Area

The study was conducted in Tanzania, a country characterised by various agricultural zones that influence agricultural practices and the relevance of agricultural technologies. Tanzania comprises several agricultural zones, including arid and semi-arid zones, coastal, lake zones, plateau, southern and western highlands, and alluvial zones (Mkonda & He, 2018). These variations shape both agricultural production systems and information needs among extension workers. Purposively three regions, namely, Dodoma, Geita, and Mtwara were selected in this study. Dodoma represents arid and semi-arid conditions with low and variable rainfall, where drought-tolerant technologies are particularly relevant. Geita, located within the plateau and lake zone, supports crops such as cotton, maize, and cassava under moderate to high rainfall conditions. Mtwara represents the coastal zone, characterised by climatic and soil conditions suitable for crops such as maize, cassava, and soybean. These regional differences provided a relevant context for examining how location influences information access, source use, and trust.

3.3 Study Population and Sampling

The study population comprised agricultural extension workers from the selected regions. The extension workers were selected because of their professional role in accessing, communicating and interpreting, scientific and technological information to farming communities. Both non-probability and probability sampling techniques were used. Non-probability sampling was employed to purposively select three regions which are Dodoma, Mtwara and Geita based on their agricultural characteristics and potential relevance to GMO-related information needs. The list of all extension workers and their contacts were obtained from the Regional extension officer from every region, within the regions, simple random sampling was applied to select extension workers, ensuring representation across districts and extension service structures. A total of 172 agricultural extension workers participated in the study.

3.4 Data Collection Methods

Data were collected using questionnaire surveys. Structured questionnaires were used to collect quantitative data, both printed and online questionnaires were distributed to respondents. The respondents who were easily accessible were given printed questionnaires face to face while online structured questionnaires distributed to respondents who were difficult to reach.

3.5 Data Analysis

The data were coded and analysed using the IBM SPSS Version 25.0. Descriptive statistics, including frequencies and percentages, were used to summarise respondents' characteristics and patterns of information source use. Inferential analyses, including chi-square tests and Cramer's V, were conducted to examine relationships between socio-demographic variables, particularly age, education level and region and trust in information sources.

IV. FINDINGS & DISCUSSION

4.1 Socio-demographic Characteristics of Respondents

The study involved 172 agricultural extension workers from the selected regions. As presented in Table 1, males constituted 64.0% of the respondents, while females accounted for 36.0%. This indicates a male-dominated extension workforce in the study areas, a pattern that has been widely reported in agricultural extension services across many African contexts. While this imbalance reflects broader structural and occupational trends rather than sampling bias, it provides important background for interpreting information use and trust patterns observed later in the study.

With regard to age, almost half of the respondents (48.3%) were between 31 and 40 years, followed by those aged 21–30 years (22.7%). Respondents aged 41–50 years (15.1%) and 51–60 years (14.0%) were less represented. This age structure suggests that the extension staffs in the study regions are largely composed of young to middle-aged professionals. From an information behaviour perspective, this demographic profile is relevant because individuals in these age groups are typically active in seeking information and adapting to new knowledge demands associated with evolving agricultural technologies.

Table 1
Socio-Demographic Characteristics of Respondents

Demographic characteristics	Frequency (N)	Percentage (%)
Gender		
Male	110	64.0
Female	62	36.0
Total	172	100.0
Age		
21-30	39	22.7
31-40	83	48.3
41-50	26	15.1
51-60	24	14.0
Total	172	100.0
Education Level		
Diploma	62	36.0
Graduate	110	64.0
Total	172	100.0

In terms of educational attainment, the majority of respondents (64.0%) held a graduate degree, while 36.0% had a diploma. The relatively high level of formal education among extension workers suggests a workforce with the capacity to engage with technical and scientific information, including complex topics such as Genetically Modified Organisms. This educational background is particularly important in relation to trust in information sources, as higher levels of education may enhance the ability to assess expertise, credibility, and institutional authority when evaluating information.

4.2 Initial Information Sources on Genetically Modified Organisms

The ways through which agricultural extension workers first access information on Genetically Modified Organisms provide important insight into how its knowledge enters the extension system. As shown in Table 2, formal educational institutions were the most frequently reported initial source of information, cited by 15.1% of respondents. This was followed by researchers (14.0%), indicating that first exposure to GMOs-related information often occurs within structured learning and research environments.

Fewer respondents reported mass media sources, particularly television (9.9%) and radio (5.2%) as initial sources of information. Interpersonal sources, including friends (7.0%), colleagues (5.8%), and parents or guardians (2.9%), were also mentioned, although less frequently. Small portion of respondents cited other sources such as written materials, internet or websites, non-governmental organisations, government or community leaders, and agricultural officers. Particularly, a large proportion of respondents (25.0%) reported that they had not yet accessed information on GMOs at the time of the study.

The prominence of educational institutions and researchers as initial information sources suggests that knowledge on GMOs is primarily introduced in formal and professional channels. This finding is consistent with earlier studies showing that formal education plays a central role in equipping extension personnel with scientific and technical

knowledge (Karembu et al., 2011). Universities and research institutions often serve as entry points for exposure to new agricultural technologies, particularly during training, academic programmes, and professional development activities.

The relatively limited role of mass media as an initial source contrasts with findings from other contexts where radio and television are widely used for disseminating agricultural information due to their broad reach (Mubofu & Watson, 2020; Pius Mtega, 2018). The lower reliance on these channels in this study may reflect limited availability of biotechnology-focused programming or the technical nature of GMO-related information, which may require more detailed explanation than mass media formats typically provide.

Interpersonal sources, while present, played a modest role in initial exposure to biotechnology information. Although previous research has highlighted the importance of social networks in early-stage information diffusion (Miorner et al., 2025), the findings of this study suggest that extension workers may exercise caution when relying on informal sources for information on complex and potentially controversial technologies, such as GMOs.

Table 2
Initial Sources of Information on Genetically Modified Organisms

Information source	Frequency (N)	Percentage (%)
At school/university/learning/ center	26	15.1
From researchers	24	14.0
From Television	17	9.9
From a friend	12	7.0
From a colleague	10	5.8
From parents/guardian	5	2.9
From Radio	9	5.2
From Newspaper	3	1.7
From a written article/journal/book	10	5.8
From internet/website	5	2.9
From NGO (environmental activist)	3	1.7
From Community/Government leaders	1	0.6
From agricultural officer	4	2.3
Never heard of GMO	43	25.0
Total	172	100.0

The low reporting of internet-based sources and written materials may be linked to challenges such as limited digital access, digital literacy constraints, and language barriers, which have been identified as factors limiting the effective dissemination of agricultural innovations in rural settings (Ndimbwa et al., 2019). Together, these patterns indicate that while multiple information sources exist, initial exposure to GMOs among extension workers remains uneven and largely dependent on formal institutional channels.

4.3 Trusted Sources of Information on Genetically Modified Organisms

Trust in information sources plays a major role in how agricultural extension workers interpret, accept, and transmit knowledge on GMOs. University scientists appeared as the most trusted source of information among respondents, as presented in Table 3. A large proportion of extension workers expressed faith in university scientists, with 46.5% indicating a great deal of faith and a further 15.7% reporting some faith, while only a small proportion reported little faith or uncertainty. This strong faith in academic sources reflects perceptions of scientific expertise and neutrality, particularly in relation to complex technologies such as GMOs.

This is consistent with previous studies showing that scientists are often regarded as highly trusted sources of GMOs information because they are closely linked with research and knowledge production rather than commercial interests (Adisa et al., 2011). Similar patterns have been reported in other contexts, where academic researchers are viewed as knowledgeable and objective when communicating scientific innovations. In the United States, for example, university scientists are consistently ranked among the most reliable authorities on biotechnology (Riaz et al., 2025).

Government institutes were also broadly trusted, although responses showed greater variation compared to university scientists. While 36.6% of respondents reported a great deal of faith and 14.5% reported some faith in government sources, others expressed little faith (19.8%) or uncertainty (16.9%). These results suggest that government is an important source of information towards GMOs, but trust is shaped by perceptions of regulatory effectiveness and transparency. Hallerman et al., (2022) reported that government agencies tend to be trusted in environment where regulatory frameworks are seemed as clear and credible, while doubt may arise where political influence or weak enforcement is suspected.

Trust in extension workers as information sources was moderate. A quarter of respondents articulated a great deal of faith in fellow extension workers, others reported some faith, little faith or uncertainty. This finding aligns with evidence from Nigeria, where extension workers were found to place high trust in their fellows due to shared professional experiences and awareness with local farming environments (Sobalaje et al., 2019). However, the difference observed in this study suggests that trust among peers may depend on individual levels of exposure to biotechnology training and experience.

Table 3
Trusted Sources of Information on Genetically Modified Organisms

Information source	Level of trust	Frequency (N)	Percentage (%)
Government	No response	21	12.2
	Don't know	29	16.9
	Little faith	34	19.8
	Some faith	25	14.5
	A great deal of faith	63	36.6
Local leaders	No response	25	15.5
	Don't know	44	25.6
	Little faith	36	20.9
	Some faith	27	15.7
	A great deal of faith	40	23.3
Extension workers	No response	23	13.4
	Don't know	41	23.8
	Little faith	33	19.2
	Some faith	32	18.6
	A great deal of faith	43	25.0
University scientists	No response	18	10.5
	Don't know	24	14.0
	Little faith	23	13.4
	Some faith	27	15.7
	A great deal of faith	80	46.5
Local farmers	No response	23	13.4
	Don't know	54	31.4
	Little faith	38	22.1
	Some faith	24	14.0
	A great deal of faith	33	19.2
Seed companies	No response	16	9.3
	Don't know	39	22.7
	Little faith	28	16.3
	Some faith	33	19.2
	A great deal of faith	56	32.6
Environmental groups	No response	37	21.5
	Don't know	36	20.9
	Little faith	32	18.6
	Some faith	30	17.4
	A great deal of faith	37	21.5

Local leaders attracted comparatively lower levels of trust. Although some respondents expressed a great deal of faith, a large proportion reported uncertainty or little faith in local leaders as sources of GMOs-related information. Ezezika et al., (2012), who found that local leaders are often perceived as lacking technical expertise in GMOs, limiting their influence in shaping beliefs on scientific agricultural innovations, reported similar observations. This pattern may indicate low engagement of local leadership in communicating knowledge about GMOs.

The respondents trusted seed companies, with 32.6% expressing a great deal of faith and 19.2% reporting some faith. This finding echoes studies by (Ricroch & Hénard-Damave, 2016; Rukanda, 2018) which noted that seed companies play a significant role through investments in crop varieties with improved tolerance to drought, heat, cold, and salinity. Trust in these companies may mirror extension workers' recognition of their technical capacity and practical involvement in technology development. However, the presence of doubt and low trust among some respondents suggests continuing anxieties about commercial motives.

Concerning environmental groups, some respondents expressed a great deal of faith, others reported uncertainty or little faith. This variation mirrors findings from studies in Kenya and Nigeria, where trust in environmental groups

was found to depend on perceptions of transparency, scientific basis, and community engagement (Adenle *et al.*, 2015). In some cases, environmental organisations are viewed as advocates rather than neutral providers of technical information, particularly in debates surrounding GMOs.

Local farmers were among the least trusted sources, with many respondents expressing little faith. Although farmers' experience is valued in making decisions on agriculture, they are not regarded as primary sources of technical information on GMOs. Similar observations have been reported in other African countries, where farmers are respected for practical experience but are not seen as authoritative sources on scientific innovations (Adenle *et al.*, 2015)

In Tanzania, trust of extension workers on agricultural innovations depends on the present institutional arrangements. The Ministry of Agriculture plays an essential role in providing trainings on new technologies and innovations to extension workers (Rodriguez *et al.*, 2019), while university scientists, researchers and fellow extension officers remain important sources of technical knowledge (Oladipo *et al.*, 2020). Trust in seed companies and environmental groups are shaped by concerns about interests and advocacy positions. Although local leaders influence community perceptions, they are less central in shaping extension workers' trust in biotechnology information.

The above findings show that trust on GMOs information sources is strongly associated with perceptions of scientific expertise, institutional validity, and role in knowledge production. The Government institutions and university scientists are in central positions in the trust landscape. These trust frameworks help to understand how extension workers access information and decide which sources to use when communicating GMOs information to farmers.

4.4 Preferred Sources of Information on Genetically Modified Organisms

Preferences for information sources help to know how agricultural extension workers wish to receive GMOs-related knowledge and the formats they find most effective. The most preferred source of GMOs information was special programmes such as training and seminars (52.3%), as shown in Table 4. This shows a strong preference toward interactive learning environments when engaging with complex scientific topics such as GMOs.

Table 4

Preferred Sources of Information on Genetically Modified Organisms

Information Source	Frequency (N)	Percentage (%)
Through radio	82	47.7
Special programs(Training and seminars)	90	52.3
Through TVs	75	43.6
Magazines	75	43.6
News papers	62	36
Mobile phones	47	27.3
Extension Officers	55	32

Training and seminars enable face to face interaction and direct engagement with experts; this can facilitate explanation of difficult concepts and easily deliverance of message. It has been recognised as particularly effective for communicating technologies including genetic engineering (Food and Agricultural Organization [FAO], 2011). The observation from the study implies that extension workers value environment that allows dialogue, questioning, and practical illustration.

The respondents show preference on Radio by Radio 47.7%, television and magazines followed closely, each preferred by 43.6% of respondents. This aligns with findings from Sobalaje *et al.* (2019), who reported that extension workers preferred receiving agricultural information through colleagues, radio, and television programmes. The continued relevance of radio and television suggests that traditional broadcast media remain important in rural communication due to their accessibility, affordability, and wide reach, despite the growing availability of digital platforms. Magazines were also moderately preferred, reflecting their role in providing written content that can be read and revisited at the reader's convenience. Mwangi and Kariuki (2015) informed that printed materials allow readers to absorb technical details at their own pace, which can support understanding of complex information. However, newspapers were less preferred (36.0%), a finding is consistent with (Wulandari, 2015), who found that agricultural extension workers tend to rely less on newspapers due to inadequate coverage of specialised agricultural topics and sometimes cannot be available in rural areas.

Also, the 27.3% of respondents preferred mobile phones, the increase in mobile technologies made the mobile phones remain underutilised as primary channels for GMO information. Although mobile platforms have considerable potential for delivering timely and location-specific agricultural information, lower preference may be linked to challenges such as data costs, limited content in local languages, and inadequate familiarity with advanced mobile functions (Wasan & Jain, 2017). This finding suggests that the potential of mobile-based communication has not yet been fully realised within the extension system. Extension officers as information source were preferred by 32.0% of

respondents. While this proportion is relatively modest, this suggests that peer interaction remains relevant, particularly for practical problem-solving. However, the lower preference compared to formal training and media channels may indicate that extension workers prioritise science facts and institutional sources over knowledge exchanges among themselves when dealing with GMOs-related information.

The preferences observed in the study involve both access considerations and learning styles. For complex scientific content, participatory and interactive formats such as field demonstrations, training workshops and seminars are generally favoured over passive media formats (FAO, 2022). The similar results have been reported in other countries; for example, extension workers in Ghana and Uganda have been found to prefer training seminars, radio broadcasts, and mobile phone-based alerts (Ishii & Araki, 2017). However in Nigeria, Oladipo et al., (2020) reported a stronger preference for internet-based sources when accessing information on GMOs, suggesting contextual differences in digital access and capacity. Previous studies in Tanzania have also reported a preference for special programmes such as training and seminars, followed by radio, mobile phones, and television (Rodriguez & Lee, 2016). Although printed materials such as magazines and newspapers are infrequently used, they are often perceived as out-dated or difficult to access in rural settings. Face-to-face interaction with fellow extension officers is valued for its practicality and relevance, particularly when information is grounded in field experience.

In contrast, findings from Lee and Kim (2020) indicate that respondents in more digitally enabled environment tend to prefer the internet, television, academic papers, and technical books. The difference between these findings and those of the present study highlights the influence of infrastructural capacity, digital literacy, and contextual relevance in shaping information preferences. Globally the findings specify that extension workers prefer information sources that are interactive, accessible, and aligned with their professional responsibilities. Trainings and seminars supported by media and digital tools appear most suitable for communicating GMOs information. These preferences emphasize the importance of designing communication strategies that combine scientific credibility with practical delivery formats suited to rural and extension environment.

4.5 Relationship between Socio-demographic Variables and Trust in Information Sources

Understanding how socio-demographic characteristics relate to trust in information sources provides awareness into whether confidence in GMOs information is shaped by personal attributes or broader contextual factors. The relationship between trust and selected demographic variables which are region, gender, age, and education level were examined in different sources of GMOs information (Table 5).

The findings found that only a few socio-demographic variables influence trust in information sources. For several information sources, including government institutions, extension officers, and seed companies, no statistically significant relationships were observed with any of the demographic factors considered. In these cases, all p-values exceeded the 0.05 threshold, and Cramer's V values ranged from weak to modest (0.088–0.226), suggesting that trust in these sources is relatively stable across demographic groups.

Trust in government sources showed no significant association with region, gender, age, or education level. This finding suggests that extension workers' confidence in government as a source of GMOs information is not strongly differentiated by demographic characteristics. Similar observations have been reported by the Ndimbwa et al. (2019), which found that trust in government on science-related issues is often shaped more by institutional performance, policy transparency, and governance credibility than by individual demographic attributes. This highlights the importance of regulatory transparency and institutional effectiveness in shaping trust.

Table 5*Relationship between Socio-Demographic Variables and Trusted Information Sources*

Trust source	Demographic Factor	χ^2 (df)	p-value	Cramer's V	Significant (p < .05)
Government	Region	8.103	0.423	0.153	No
	Gender	1.321	0.858	0.088	No
	Age	9.510	0.659	0.136	No
	Education level	3.490	0.479	0.142	No
	Region	13.227	0.104	0.196	No
Local leaders	Gender	4.843	0.304	0.168	No
	Age	16.768	0.159	0.180	No
	Education level	12.319	0.015	0.268	Yes
	Region	19.011	0.015	0.235	Yes
Extension officers	Gender	4.191	0.381	0.156	No
	Age	4.191	0.381	0.156	No
	Education level	1.790	0.774	0.102	No
	Region	9.187	0.327	0.163	No
University scientists	Gender	2.393	0.664	0.118	No
	Age	10.227	0.596	0.141	No
	Education level	0.664	0.956	0.062	No
	Region	18.438	0.018	0.232	Yes
Local farmers	Gender	3.223	0.521	0.137	No
	Age	12.896	0.377	0.158	No
	Education level	10.074	0.039	0.242	Yes
	Region	3.661	0.886	0.146	No
Seed companies	Gender	3.836	0.429	0.149	No
	Age	13.404	0.340	0.161	No
	Education level	8.803	0.066	0.226	No
	Region	8.456	0.390	0.222	No
Environmental groups	Gender	4.008	0.405	0.153	No
	Age	16.992	0.150	0.314	No
	Education level	10.399	0.034	0.246	Yes
	Region	8.456	0.390	0.157	No

In contrast, trust in local leaders was significantly associated with both education level ($p = 0.015$, Cramer's $V = .268$) and region ($p = .015$, Cramer's $V = .235$), indicating moderate associations. These results suggest that perceptions of local leaders as credible sources of information on GMOs vary depending on respondents' educational background and geographical context. Extension workers with higher levels of education may assess local leaders more critically in terms of technical expertise, while regional differences may reflect variations in leadership engagement with agricultural innovation. This pattern differs from the study done by Tanny and Al-Hossienie (2019), reported that trust in local leader was also influenced by gender and age, highlighting contextual differences across settings.

Trust in university scientists was significantly related only to region ($p = 0.018$, Cramer's $V = 0.232$). This suggests that geographical location influences trust in scientific sources, possibly due to being far away from research centres, universities, or the visibility of scientific outreach activities across regions. While education level did not show a significant relationship in this study, earlier work has shown that trust in university scientists can be linked to attitudes toward agricultural biotechnology Wingenbach and Rutherford (2005), suggesting that appropriate exposure may matter more than formal qualifications in shaping trust.

For local farmers, education level was the only demographic factor that associates with trust ($p = 0.039$, Cramer's $V = 0.242$). This finding indicates that educational background shapes how extension workers evaluate farmers as sources of biotechnology-related information. Respondents with higher education may place greater emphasis on evidence generated through formal research, whereas those with lower levels of formal education may value experiential knowledge and observed farming outcomes more strongly. This interpretation is consistent with earlier research showing that evaluations of knowledge sources vary according to educational orientation (Singh et al., 2018).

Education level was also significantly associated with trust in environmental groups ($p = 0.034$, Cramer's $V = 0.246$), while age, gender, and region showed no significant association. This implies that perceptions of environmental

organisations are influenced by respondents' educational background, potentially reflecting different clarifications of advocacy roles, scientific evidence, and perceived neutrality in biotechnology debates.

No significant relationships were found between any demographic variables and trust in seed companies or extension officers. This indicates that trust in these sources may be shaped more by perceived competence, experience, and past interactions than by respondents' demographic characteristics. For extension officers in particular, trust is likely influenced by professional credibility and familiarity within the extension system rather than by age, gender, or educational differences.

4.6 Relationship between Socio-demographic Variables and Preferred Information Sources

Examining the relationship between socio-demographic characteristics and preferred information sources provides information into whether communication channel preferences are shaped by personal attributes or broader contextual factors. As presented in Table 6, the analysis shows that most preferred communication channels, which are radio, special programmes such as training and seminars, television, magazines, and extension officers, do not vary significantly across region, gender, age, or education level. This suggests a general consistency in how extension workers prefer to receive GMOs information, regardless of their socio-demographic characteristics. In the earlier findings radio emerged as one of the most preferred sources, it does not show statistically significant association with any demographic variable, including region ($p = 0.192$), gender ($p = 0.274$), age ($p = 0.853$), or education level ($p = 0.258$). Also, preference on television was not significantly influenced by region ($p = 0.740$), gender ($p = 0.529$), age ($p = 0.620$), or education level ($p = 0.515$), and the same results were observed for magazines. These findings suggest that broadcast and print media remain broadly accessible and acceptable channels across different demographic groups within the extension workforce.

Special programmes such as training and seminars also showed no significant association with any socio-demographic variable. This uniform preference aligns with evidence that participatory and face-to-face learning formats are widely valued across professional groups, particularly when dealing with complex agricultural technologies. Magsi et al. (2024) reported that participation in extension training is strongly linked to perceived relevance and prior exposure rather than demographic characteristics, which may explain the broad appeal of training and seminar-based communication observed in this study. Two information sources, revealed statistically significant associations. Preference for newspapers was significantly related to region ($\chi^2 = 6.653$, $p = 0.036$, Cramer's $V = 0.197$), indicating that regional setting influences the extent to which newspapers are used as a source of information towards GMOs. This finding is consistent with observations by Rodriguez and Lee (2016), who reported variation in GMOs information coverage across newspapers in countries such as the Philippines, Vietnam, China, and Thailand. Such differences in content availability and emphasis suggest that newspapers may be a more effective communication channel in some regions than others, depending on editorial priorities and access.

Mobile phones also showed a significant association with region ($\chi^2 = 7.647$, $p = 0.022$, Cramer's $V = 0.211$), indicating a moderate relationship. This suggests that while mobile phones are increasingly recognised as a potential communication tool, their use as a preferred channel for GMOs information is influenced by regional factors such as network coverage, digital infrastructure, and local practices. The study done by Gupta et al., (2020) found that increased use of mobile phones among extension workers was associated with greater interaction with farmers on modern agricultural technologies, claiming the potential use of mobile platforms when environmental conditions are favourable. The lack of significant associations between demographic variables and most preferred information sources contrasts with some earlier studies. For example, Mtega (2012) reported gender-based differences in access to television, noting that men were more likely to access TV-based agricultural information due to greater availability of free time compared to women. The absence of such differences in the present study may reflect changes in work patterns among extension workers or greater professional equality in access to information resources within the extension system.

Table 6*Relationship between Socio-Demographic Variables and Preferred Information Sources*

Communication Channel	Demographic Factor	χ^2	p-value	Cramer's V	Significant (p < .05)
Through Radio	Region	3.297	0.192	0.138	No
	Gender	1.198	0.274	0.083	No
	Age	0.785	0.853	0.068	No
	Education level	1.280	0.258	0.086	No
Special Programs	Region	4.083	0.130	0.154	No
	Gender	0.020	0.888	0.011	No
	Age	6.280	0.099	0.191	No
	Education level	0.210	0.647	0.035	No
Through TVs	Region	0.603	0.740	0.059	No
	Gender	0.396	0.529	0.048	No
	Age	1.775	0.620	0.102	No
	Education level	0.425	0.515	0.050	No
Magazines	Region	1.935	0.380	0.106	No
	Gender	0.945	0.331	0.074	No
	Age	0.646	0.886	0.061	No
	Education level	2.528	0.112	0.121	No
Newspapers	Region	6.653	0.036	0.197	Yes
	Gender	1.227	0.268	0.084	No
	Age	4.399	0.221	0.160	No
	Education level	1.458	0.227	0.092	No
Mobile Phones	Region	7.647	0.022	0.211	Yes
	Gender	0.479	0.489	0.053	No
	Age	1.848	0.605	0.104	No
	Education level	2.091	0.148	0.110	No
Extension Officers	Region	1.556	0.459	0.095	No
	Gender	0.386	0.534	0.047	No
	Age	5.038	0.169	0.171	No
	Education level	0.004	0.953	0.005	No

Findings related to media preferences also resonate with evidence from Kenya, where Karembu et al. (2011) reported that mass media coverage of GMOs was often inadequate for informed public debate and policy engagement. Limited or uneven coverage of GMO-related issues may reduce the perceived usefulness of certain media channels, contributing to uniform preferences across demographic groups.

Furthermore, the absence of significant variation in preference for extension officers across region, gender, age, or education level suggests that this channel is consistently regarded as accessible and relevant within the extension system. This uniformity indicates that professional peer networks continue to play a stable role in agricultural communication, even if they are not the most preferred source for biotechnology-specific information.

V. CONCLUSION & RECOMMENDATIONS

5.1 Conclusion

This study demonstrates that trust and access of information on GMOs among extension workers are shaped primarily by perceptions of credibility and usefulness rather than by demographic characteristics. Extension workers gravitate toward sources they regard as scientifically grounded, institutionally legitimate, and capable of supporting professional learning. Interactive and participatory communication formats are particularly valued when dealing with complex and contested technologies such as genetically modified organisms.

The findings further suggest that information behaviour in the extension system is driven more by professional role and contextual exposure than by individual attributes such as age or gender. Regional context and educational background matter in selective cases, but overall trust and preference patterns reflect broader institutional and communication dynamics. These conclusions underscore the central role of credible institutions and appropriate communication formats in shaping how biotechnology knowledge is interpreted and conveyed within the extension system.

5.2 Recommendation

The study recommends that stronger partnerships should be established between universities, research institutions, and extension workers to ensure a continuous flow of reliable information on GMOs. Interactive platforms such as special programs, training sessions, and seminars should be expanded, incorporating demonstrations and participatory approaches. Communication strategies should also be region-sensitive, utilizing the most accessible channels such as newspapers and mobile phones where adoption is high, and exploring alternative outreach methods in areas with limited access to these tools.

Given that trust in information sources varies by education level and region, tailored trust-building initiatives should be implemented to make messages credible and relevant. Continuous capacity-building programs for extension officers are essential, as they are themselves trusted sources of information. Finally, an integrated communication strategy combining mass media, print media, digital platforms, and interpersonal approaches will ensure wide coverage and effective dissemination of information regarding Genetically Modified Organisms.

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