DOI: https://doi.org/10.59983/s2024020201
AgroEnvironmental Sustainability, 2024, 2(2), 62-73

RESEARCH

Access and Use of Information for Enhanced Adoption of Climate Smart Agricultural Practices among Smallholder Farmers in Lake Victoria Basin, Kenya

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ARTICLE HISTORY
Received: 12 May 2024
Revised: 24 May 2024
Accepted: 31 May 2024
Published: 26 June 2024

KEYWORDS
agronomic information
climate-smart agriculture
decision making
decision support

EDITOR
Pankaj Kumar

eISSN 2583-942X

Abstract

The value of information in agricultural production cannot be overemphasized given the challenges caused by the impact of climate change. This study evaluated the importance of accessing and using information for enhanced adoption of climate-smart agriculture (CSA) practices in sorghum production among smallholder farmers in Lake Victoria Basin, Kenya. The study used a quantitative research method with a correlation design, collecting data from 382 farmers through a questionnaire. A pilot study was conducted with a 10% sample size to assess reliability and validity achieving a CVI value of 0.877445696 and Cronbach's alpha (α) value of 0.809. Descriptive statistics were used to determine information access and use, while correlation analysis examined associations between age and education and information access and use. The findings showed that farmers obtained information primarily from television, radio, extension workers, and neighbors and friends. The accessibility and use of this information were influenced by age and level of education. The findings are significant since they can help agricultural stakeholders identify and use appropriate channel and context-specific information to disseminate information that would enhance the adoption of CSA practices for improved sorghum yield. This may increase farmers' resilience to climate variability and improve their farming knowledge and skills, potentially leading to better livelihoods for the farming communities in the region. By advocating the provision of easily accessible and relevant information in the appropriate format and media, the findings may aid in policy formulation by providing policymakers with insights when formulating agricultural policies and legislation.

Citation: Ajwang, S., Owoche, P., & Mutonyi, J. (2024). Access and Use of Information for Enhanced Adoption of Climate Smart Agricultural Practices among Smallholder Farmers in Lake Victoria Basin, Kenya. *AgroEnvironmental Sustainability*, 2(2), 62-73. https://doi.org/10.59983/s2024020201

Statement of Sustainability: The study acknowledges that effective utilization of natural resources is crucial in the attainment of sustainable development goals. Therefore, by championing access to adequate and relevant information, the study intends to promote data-driven agriculture leading to efficient use of natural resources, increased food production, and enhanced adaptive capacity of farmers while mitigating the negative impact of climate change.

1. Introduction

Access and utilization of relevant information have increasingly become important in modern agricultural practices particularly in managing climate-related risks and adopting climate-smart agriculture (CSA) technologies (Ngigi and Muange, 2022). This has been made possible through the use of Information and Communication Technology (ICT)-based tools such as radio, television, and mobile phones to disseminate real-time agronomic and climatic information, enabling data-driven decisions and effective crop planning for farmers (Kumar et al., 2023; Abdul-Salam and Phimister, 2017). This leads to improved agricultural practices due to the application of early warning systems in dealing with climate change-related occurrences (Zhang et al., 2016). In doing so, farmers are likely to utilize better production resources, resulting in improved output and revenue and thus better livelihood (Yegbemey et al., 2020). In recognition of this endeavor institutions such as Microsoft have developed a mobile platform to democratize access to information using either a feature or a smartphone (Fabiyi et al., 2022). This platform has helped farmers to access information on pest and soil diagnosis, market prices, agricultural news, success stories from neighboring farmers, weather, and personalized recommendations for maximizing yields based on soil tests.

Other agri-tech social entrepreneurs such as Twiga Foods have developed a mobile-based business-to-business food supply platform that has connected smallholder farmers in rural Kenya with urban informal retail merchants (GSMA, 2017). Also, N-Frnds has enabled smallholder farmers in Africa and other developing countries to build socially cohesive communities that interact using mobile phones without an internet connection or mobile data. It also delivers financial services to market groups that have traditionally been underserved by traditional banking and insurance systems (Amrote, 2020). It is on the realization of this disruptive potential that ICT technologies are gaining popularity in agriculture, partly supported by the explosion in data generation and availability of advanced technologies for data capture, processing, and use (Yegbemey et al., 2020). These technologies have become beneficial to various stakeholders who can make accurate decisions based on facts (Venkat, 2021), due to unparalleled access to real-time and synthesized location-based information (Byamukama et al., 2023). The information can also be utilized to model weather patterns, soil diagnostics, simulation of crop growth, yield, water and nutrient uptake, and pests and diseases with the necessary early warning capabilities for crop improvement (Nakasone et al., 2014).

CSA is an integrated approach designed to address the interlinked challenges of climate change, food security, and sustainable agricultural development (Joshi et al., 2019; Van Asseldonk et al., 2023). It aims to transform and reorient agricultural systems to support development and ensure food security in a changing climate by focusing on sustainably increasing agricultural productivity and incomes, adapting and building resilience to climate change, and reducing and/or removing greenhouse gas (GHG) emissions where possible (Venkatramanan and Shah, 2019). CSA incorporates a variety of site-specific practices and technologies, such as integrated crop management, conservation agriculture, agroforestry, and digital agriculture, to enhance nutrient use efficiency, minimize the use of synthetic agrochemicals, and reduce environmental pollution (Balo and Mahata, 2022). Premised on enhanced access and use of agricultural information, the adoption of CSA practices can improve farm productivity, enhance adaptation and resilience, and reduce the agricultural share of GHG emissions (Gudeta, 2022; Revanth, 2019).

Ahmed et al. (2023) studied climate change adaptation practices and their impact on food and nutrition security and found that adopting low levels of CSA practices increased food and nutrition security by 28% and 4.3%, while medium-level practices increased food and nutrition security by 43% and 20%. The factors identified as influencing the adoption of technologies in agriculture included gender, education, and livestock-holding (Ahmed et al., 2023). Mthethwa et al. (2022) identified factors affecting CSA adoption among smallholder maize farmers in KwaZulu Natal and found that drought and socioeconomic factors positively influenced the intensity of CSA adoption, Also, a high level of knowledge about climate change adaptation practices among smallholder farmers, with intercropping and crop rotation being the most popular, influenced the adoption (Aturihaihi et al., 2023). However, it was noted that a lack of collaboration among agricultural stakeholders may lower adoption rates.

The communication revolution in India has shown that ICT tools can significantly raise the socio-economic status of farmers by providing relevant information, although challenges such as lack of funds and training persist (Singh, 2020). Socio-economic characteristics, such as age and education, also affect farmers' access to information, with fellow farmers and extension staff being major sources (Modirwa, 2019). Empirical evidence from Uganda indicates that access to information through low-power electrical items like radios and mobile phones positively impacts farm efficiency, especially among literate farmers (Abdul-Salam and Phimister, 2017). In Nigeria, significant relationships exist between marital status, education level, and access to agricultural information, with language and adult education being key factors for effective dissemination (Akani et al., 2019). Other studies have determined that farmers' attitudes, social pressure, attitudes, subjective norms, and perceived behavior control significantly impact their intention to adopt CSA practices (Sisay et al., 2023)

Developing countries are the most affected by climate change even though they are the least contributor to these changes (Biswas, 2018; Alamgir and Shan, 2023). This is attributed to underdeveloped ICT and agricultural infrastructure hindering access to information (Bregni, 2015). In India, low access to agricultural information has led to gaps in crop production practices, highlighting the need for effective information delivery systems (Krishna and Naik, 2020). In Africa, limited access to relevant, reliable, and up-to-date agricultural information has hindered agricultural advancement, emphasizing the need for improved dissemination channels (Kelil et al., 2020). Tailoring information delivery to farmers' search behaviors and preferences, such as interpersonal contacts and mobile phone-based services, is essential for successful extension programs (Babu and Glendenning, 2019). These studies clearly outline some factors influencing the access and use of information for the adoption of CSA. However, the studies were carried out in a different context and may not be generalized for effective application for sorghum farming in Lake Victoria Basin (LVB), Kenya. Therefore, this study provides a more focused approach in the target region to determine unique factors affecting access and use of information for enhanced adoption of CSA practices.

2. Material and Methods

2.1. Theoretical Underpinning

This study was anchored on the diffusion of innovations theory (Rogers, 1964) to explain how the access and adoption of CSA practices spread among smallholder farmers. The Technology Acceptance Model (Davis, 1989) was also applied to help understand the factors that influence the acceptance and use of CSA technologies. These theories provided the basis upon which data was collected and analyzed to tackle the challenges upon which the study was premised.

2.2. Research Design

The study used a quantitative research method to study sorghum farmers in five counties bordering Lake Victoria Basin in Kenya namely Migori, Homa Bay, Kisumu, Siaya, and Busia in Kenya, ensuring objectivity, generalizability, and reliability (Mugenda and Mugenda, 2003). Purposive sampling was used to select farmers who were registered in the county agricultural database and practiced sorghum farming. A simple random sampling method identified 385 respondents.

2.3. Data Collection

Questionnaires were created using data from farmer data types identified by the Technical Centre for Agricultural and Rural Cooperation. They were then evaluated for content validity by piloting to determine the clarity of the question items. The piloting occurred in all five counties, with 37 respondents representing 10% of the population participating. Questions that elicited ambiguous responses were modified. The study utilized Lawshe's equation to calculate Content Validity Ratio (CVR), (Lawshe, 1975). Thereafter, the content validity index (CVI) was computed whereby most items in the instrument were identified as essential with a CVI value of 0.87 which is above the recommended value of 0.80 (Shi et al., 2012). Data collected during the pilot test was also analyzed for reliability using Cronbach's alpha (α) coefficient method achieving a value of 0.809 which is above the recommended threshold of 0.70.

2.4. Data Analysis

The data was processed and analyzed using descriptive and inferential statistics provided by SPSS Version 22 developed by IBM headquartered in Armonk, New York, United States, and the results were presented in tables and figures showing frequencies and mean values. The results were used to derive broad generalizations in the form of research findings, then, conclusions were drawn as envisaged in Creswell (2014).

3. Results

The study examined farmers' access and use of climate and agricultural information by analyzing their information-seeking behavior, communication channels, ranking of information sources, reasons for using preferred sources, the impact of access, awareness, knowledge, and practice of CSA, and age and education-related information-seeking behavior. The findings from this analysis are presented in the sections below.

3.1. Information Seeking Habits

The study examined the information search and seeking behavior of farmers to determine the sources and types of information farmers relied on. The results of the findings are shown in Figure 1. Based on the weighted averages in Figure 1, it is evident that most respondents recognized the value of information in their agricultural practices. From the findings, it is evident that assistance with searching for information had the highest weighted average (4.07) which suggests that many farmers require assistance in searching for the information. This behavior could be attributed to limited access to information sources, lack of digital literacy, or inadequate infrastructure for the dissemination of information. Similarly, the high weighted average (3.99) for knowing the importance of access indicates that respondents understood the significance of access to relevant and reliable information for their farming activities. With a weighted average of 3.94, it appears that farmers were open to using information from different sources. This may include agricultural extension services, government publications, research institutions, or through other farmers' experiences. Also, 3.7 of respondents set aside time to search for information suggesting the possibility of time constraints in seeking and acquiring relevant information.

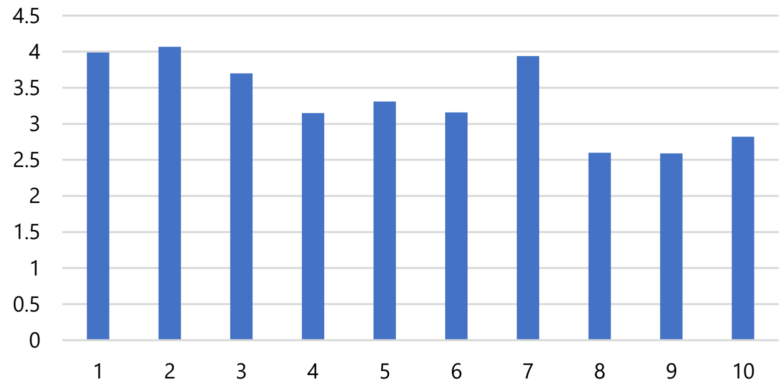

Figure 1. Information Seeking Habits (1-Farmers know the importance of farming information; 2-Assistance in searching for information; 3-Availing time to search for information; 4-Information is readily available and accessible; 5-Confusion caused by the volume of information; 6-Farmers don't know which information to rely on; 7-Comparative use of various information sources; 8-Inadequate knowledge of information required; 9-Availability of funds to acquire information resources; 10-Use modern technologies to acquire information).

3.2. Channels of Communication/Information Access

Data on the channels of communication that the respondents relied on to access agricultural and climatic information were collected, analyzed and results presented in Figure 2.

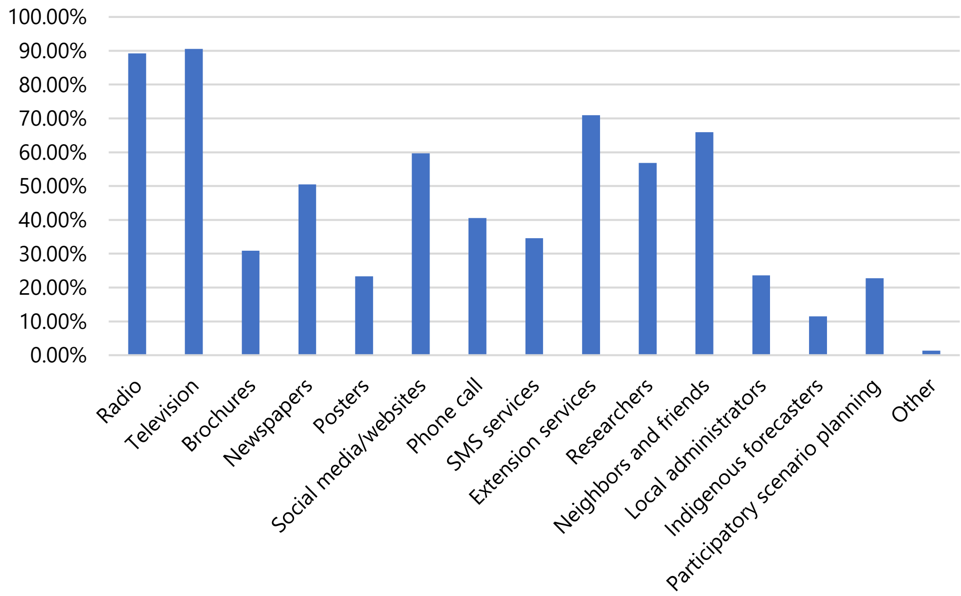

Figure 2: Channels of communication used to access agricultural and climate information

The findings revealed valuable insights into the channels of information among respondents. Figure 2 shows that television emerged as the most used communication channel, with a significant percentage of respondents (90.58%) relying on it. The appeal of television could be attributed to its ability to deliver multimedia messages, including audio and video content. This makes it an effective medium for disseminating agricultural information to farmers in an engaging and informative manner. Radio ranked second, with 89.27% of respondents using it as a source of information. Radio's popularity might be attributed to its high ownership among farmers and its reach, especially through community radio stations that broadcast in local languages. Radio's accessibility in rural areas makes it an effective tool for reaching a broad audience of farmers.

About 70.94% of respondents used extension services as a source of information. Extension services play a vital role in providing personalized and context-specific advice to farmers. The direct interaction with extension agents allows farmers to ask questions, seek clarification, and receive tailored guidance, which enhances their believability and effectiveness. 65.97% sought information from neighbors and friends. Information shared by trusted individuals within the farming community holds significant influence, as farmers often value advice from those with firsthand experience in similar agricultural activities. 59.69% of respondents used social media/websites as a source of information. This could be linked to the increasing number of young people getting involved in agriculture and adopting modern agricultural practices. The social media/websites' potential to provide a vast array of agricultural resources and real-time information is attractive to a tech-savvy generation. Approximately 56.81% of respondents sought information from researchers who play a critical role in developing and disseminating innovative agricultural practices. Their ability to provide on-farm demonstrations and training helps equip farmers with new techniques and knowledge. Newspapers were used by 50.52% of respondents. The appeal of newspapers might lie in providing pictorial and textual information on agriculture and climate, making them a valuable source of knowledge for certain farmers. The rest of the channels including brochures, posters, phone calls, SMS services, local administrators, indigenous forecasters, and participatory scenario selection, attracted less than 50% of responses.

3.3. Ranking of Sources of Information

The study evaluated the communication channels in terms of their effectiveness and trustworthiness in conveying agricultural and climatic information. The findings showed that television ranked first, followed by radio, field days, agricultural shows and exhibitions, refresher training, formal education, exposure visits, website, newspaper, phone calls, brochures, libraries and books, extension services, neighbors and friends, SMS, posters, researchers, local administrators, participatory scenario planning, indigenous forecasters and Kenya metrological department. The finding concurs with those in Figure 2 whereby television and radio were most used signifying their potential to effectively disseminate agriculture and climatic information that were relevant, accurate, useful, reliable, timely, and trusted. Field days, agricultural shows, and exhibitions also ranked high because they appeared to be significant in conveying credible information. On the other hand, some channels such as phone calls, SMS and brochures that were not highly used (Figure 2) seemed to have received relatively favorable ratings in terms of effectiveness. Surprisingly, some channels such as extension services, researchers, and neighbors that were widely used, had been ranked lower in terms of the evaluated attributes signifying the human influence on these channels.

3.4. Reasons for Using the Most Preferred Information Sources

Data was collected on the reasons for the choice of the most preferred information sources. The ranking was based on reasons that influenced the perception of farmers. The findings are presented in Figure 3. The findings revealed that the usefulness of information to farmers was the most highly ranked reason at 73.04% of the respondents. This suggests that farmers prioritize information that directly benefits their agricultural practices and decision-making. This was followed by the relevance of information to CSA practices (67.80%), implying that farmers were concerned about aligning their practices with climate-resilient and sustainable approaches. The accessibility and availability of the information source were important to 59.16% of respondents, showing that ease of access to information plays a crucial role in its perceived value. About 53.40% of respondents indicated that better facilitation and guidance on using the information is important, suggesting that farmers appreciate support in understanding and applying the information effectively. Affordability was considered a key factor by 45.81% of respondents implying that farmers were more likely to find value in information that doesn't impose significant financial constraints. Around 39.01% of respondents consider the reliability of information as a significant factor, timeliness was important to 37.17%, while accuracy of information shared was important to only 34.29% of respondents.

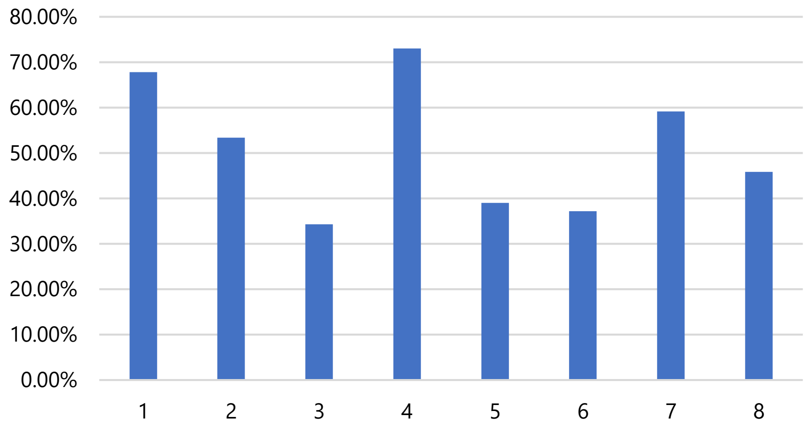

Figure 3. Reason for using the most preferred information sources (1-Relevance of information to CSA; 2-Better facilitation and guidance on the use of information; 3-Accuracy of information shared; 4-Usefulness of information to farming; 5-Very reliable information; 6-Information is delivered on time; 7-Source is very accessible and readily available 8-Source is affordable).

3.5. Impact on Farm Productivity

The study evaluated the impact of access and use of information on CSA practices on farm productivity. The findings reveal the significant impact of accessing and utilizing relevant CSA information on sorghum production as shown in Figure 4.

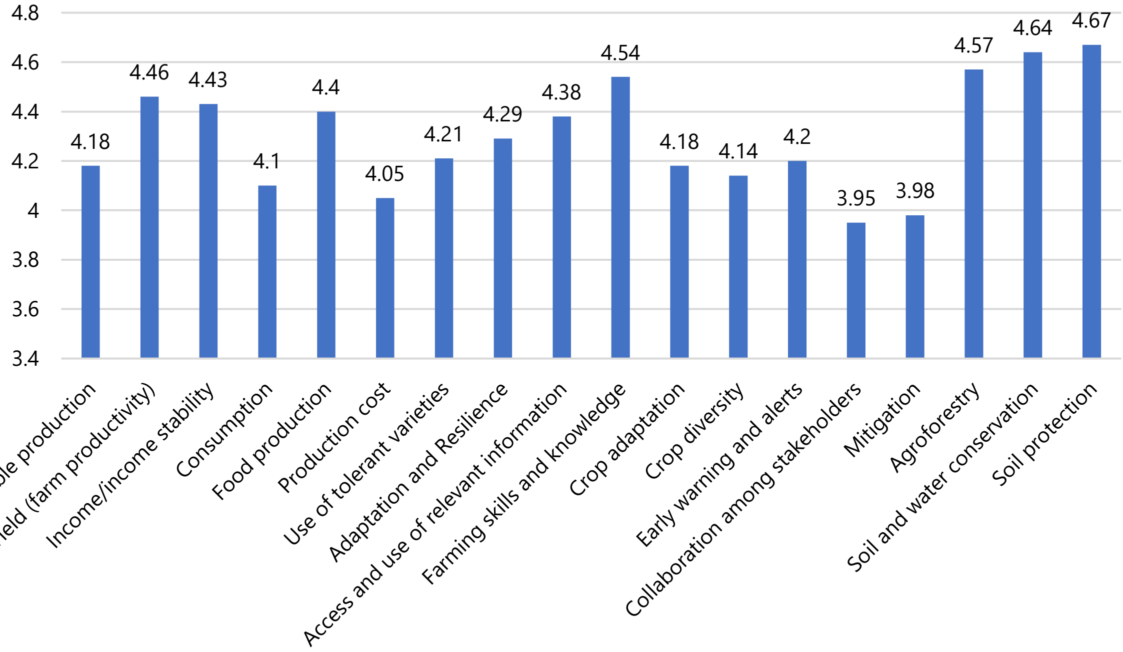

Figure 4. Impact of access and use of information on CSA practices on farm productivity.

Access and use of relevant CSA information were found to have a very impactful effect on better soil protection, with a weighted average score of 4.67 as shown in Figure 4. This indicates that farmers who had access to this information were able to implement practices that helped protect and improve the quality of their soil. Similarly, water conservation was impactful with a score of 4.64 suggesting that the information accessed by farmers contributed to more efficient water usage in sorghum cultivation. Also, the practice of agroforestry, combining agriculture and forestry techniques, received a score of 4.57 implying that farmers who had access to relevant information implemented some of these CSA practices effectively, which are likely to contribute to enhanced sorghum production. Accessing and using CSA information led to improved farming skills and knowledge, as indicated by a score of 4.54 suggesting that farmers were able to enhance their expertise in sorghum cultivation through the application of valuable information. The impact on yields, a critical factor in sorghum production, received a very impactful score of 4.46 indicating that the information accessed by farmers had a positive effect on increasing their sorghum yields.

3.6. Awareness, Knowledge, and Practice of CSA

Despite 340 respondents being aware of CSA practices, only 286 were knowledgeable about application and use, and only 254 practiced CSA, indicating slow adoption due to inadequate information. This meant that the awareness had not been fully translated into knowledge to facilitate decision-making and eventually practice for enhanced sorghum production. Surprisingly, over 70% of the respondents have practiced these technologies for less than five years even though the effects of climate change had been felt longer than five years. The study also found that most farmers (91.88%) became aware of CSA activities through mass media including radio, television, social media/websites, and newspapers. This was closely followed by extension services visits which were polled by 69.90% of the respondents, framer field days at 67.80%, farmer groups at 65.97%, neighbors and friends at 58.90%, and on-farm trials at 44.76%. On the other hand, respondents who indicated that they were knowledgeable about CSA practices indicated that their sources of knowledge were those provided in Figure 2.

3.7. Age and Choice of Information Source

The study used cross-tabulation analysis to compare the selection of farming information sources among different generational cohorts of farmers (Table 1). Based on the data shown in Table 1, it can be observed that radio (90.9%), extension services (75.2%), neighbors and friends (67.4%), and local administration (26.5%) were identified as significant sources of information among respondents belonging to the generational X cohort, in comparison to respondents from the Generation Z and Millennial cohorts. Furthermore, the sources of agricultural information that garnered popularity among millennials included television (96.8%), newspapers (65.6%), posters (31.2%), phone calls (50.5%), researchers (68.8%), and interactive scenario planning (24.7%). In contrast, brochures (37.3%), social media/websites (74.6%), SMS (45.8%), and indigenous forecasters (11.9%) were popular among Generation Z farmers.

Table 1. Cross-tabulation of choice of source of farming information and generational cohorts of farmers.

Choice of source of farming information	**Generational Cohorts**							
	Generation Z (11-26 years)		**Millennials (27-42 years)**		**Generation X (43 years and above)**		**Overall**	
	n	**% (n=59)**	**n**	**% (n=93)**	**n**	**% (n=230)**	**n**	**% (n=382)**
Radio	50	84.7%	82	88.2%	209	**90.9%**	341	89.3%
Television	54	91.5%	90	**96.8%**	202	87.8%	346	90.6%
Brochures	22	**37.3%**	32	34.4%	64	27.8%	118	30.9%
Newspapers	33	55.9%	61	**65.6%**	99	43.0%	193	50.5%
Posters	18	30.5%	29	**31.2%**	42	18.3%	89	23.3%
Social media/websites	44	**74.6%**	66	71.0%	118	51.3%	228	59.7%
Phone call	26	44.1%	47	**50.5%**	82	35.7%	155	40.6%
SMS services	27	**45.8%**	40	43.0%	65	28.3%	132	34.6%
Extension services	32	54.2%	66	71.0%	173	**75.2%**	271	70.9%
Researchers	31	52.5%	64	**68.8%**	122	53.0%	217	56.8%
Neighbors and friends	38	64.4%	59	53.4%	155	**67.4%**	252	66.0%
Local administrators	9	15.3%	20	21.5%	61	**26.5%**	90	23.6%
Indigenous forecasters	7	**11.9%**	10	10.8%	27	11.7%	44	11.5%
Participatory scenario planning	12	20.3%	23	**24.7%**	52	22.6%	87	22.8%

Notes. % and totals are based on respondents. Bold-faced percentages indicate the popularity of the choice of source of farming information.

3.8. Education and Information Seeking Behaviour

This study employed an independent samples t-test to examine potential variations in information-seeking behavior among different groups of farmers, characterized based on educational cohorts. The education variable was transformed into two cohorts: without tertiary education (i.e., comprising farmers with KCPE and KCSE qualifications) and with tertiary education (involving farmers with diploma and degree qualifications). The descriptive results are summarised in Table 2. As shown by the data presented in Table 2, the mean of information-seeking behavior for the respondents belonging to the cohort with no tertiary education (*M*=2.67, *SD*=0.66) was lower than the mean of those with tertiary education (*M*=3.53, *SD*=0.47). Additionally, an independent samples t-test was performed to examine the differences in means regarding information-seeking behavior among respondents categorized by educational cohorts. The initial step in conducting the independent samples t-test consisted of assessing the homogeneity of variances assumption. The results of *Levene's* test were nonsignificant (F=0.068, p=0.794), meaning that the assumption of homogeneity of variances was met. According to the findings presented in Table 3, the results of the independent samples t-test were significant (t=4.62, p=0.000), demonstrating the mean of the cohort with tertiary education was significantly higher than that of the cohort with no tertiary education.

Table 2. Descriptives of information-seeking behavior among educational groups.

Educational Cohort	*n*	Mean	Std. Deviation
Without tertiary education	295	2.67	0.66
With tertiary education	87	3.05	0.67

Notes. N = 382. Scale (Interpretation Range): 1 = Strongly Disagree (1.00 – 1.79), 2 = Disagree (1.80 – 2.59), 3 = Neutral (2.60 – 3.39), 4 = Agree (3.40 – 4.19), 5 = Strongly Agree (4.20 – 5.00).

Table 3. Independent samples t-test for equality of means.

	Statistic	*df*	Sig.
t-test	4.62	380	0.000

3.9. Education and Choice of Information Source

This study sought to examine the role of formal education on the choice of source of agricultural information preferred by the respondents. As shown in Table 4, radio (92.5%), extension services (71.2%), neighbors and friends (66.4%), and Indigenous forecasters (11.9%) were popular among respondents possessing no tertiary education. However, respondents with tertiary education preferred television (95.4%), brochures (50.6%), newspapers (72.4%), posters (31.0%), website (85.1%), phone calls (57.5%), SMS services (57.5%), researchers (66.7%), local administrators (28.7%), and participatory scenario planning (43.7%).

Table 4. Crosstabulation of formal education and choice of source of information.

Choice of Source of Agricultural Information		Formal Education Completed		Total
		With No Tertiary Education (KCPE & KCSE)	With Tertiary Education (Diploma & Degree)	
Radio	*n*	273	68	341
	%	92.5%	78.2%	89.3%
Television	*n*	263	83	346
	%	89.2%	95.4%	90.6%
Brochures	*n*	74	44	118
	%	25.1%	50.6%	30.9%
Newspapers	*n*	130	63	193
	%	44.1%	72.4%	50.5%
Posters	*n*	62	27	89
	%	21.0%	31.0%	23.3%
Social media/websites	*n*	154	74	228
	%	52.2%	85.1%	59.7%
Phone call	*n*	105	50	155
	%	35.6%	57.5%	40.6%
SMS services (*Dedicated and General*)	*n*	82	50	132
	%	27.8%	57.5%	34.6%
Extension services	*n*	210	61	271
	%	71.2%	70.1%	70.9%
Researchers	*n*	159	58	217
	%	53.9%	66.7%	56.8%
Neighbors and friends	*n*	196	56	252
	%	66.4%	64.4%	66.0%
Local administrators	*n*	65	25	90
	%	22.0%	28.7%	23.6%
Indigenous forecasters	*n*	35	9	44
	%	11.9%	10.3%	11.5%
Participatory scenario planning	*n*	49	38	87
	%	16.6%	43.7%	22.8%
Total	*n*	295	87	382
	%	77.2%	22.8%	100.0%

Notes. % represents proportions within formal education completed. Percentages and totals are based on respondents. Boldfaced values indicate the prominence of the choice of source of agricultural information.

4. Discussion

The objective of this study was to evaluate the importance of access and use of information on the adoption of CSA practices for enhancing sorghum production among smallholder farmers in the Lake Victoria Basin. The findings revealed that most farmers required assistance in searching for information with a weighted average of 4.07. A weighted average of over 2.5 was also achieved across all factors implying that farmers acknowledge the value of information in making informed decisions for their agricultural practices. Similar results were achieved in GSMA (2017) where ease of access to information was found crucial to farmers for adopting new farming techniques, best practices, and decision-making. Enhancing information dissemination channels, providing better resource access, and offering training to farmers can lead to more efficient and sustainable practices, benefiting both farmers and the agricultural sector. Television, radio, extension services, neighbors, and friends were the most popular sources of climatic and agricultural information used by farmers while indigenous forecasters, local administration, and posters were the least used. Television and radio were also the most trusted sources as compared to SMS, brochures, and phone calls since they delivered useful, relevant information that was accessible and readily available (Abdul-Salam and Phimister, 2017). The study emphasizes the need for tailored information dissemination strategies to meet the diverse needs of different farming communities, thereby improving knowledge transfer and enhancing agricultural productivity and sustainability similar to the findings of Babu and Glendenning (2019).

Some of the top-ranking reasons for the choice of a particular source of information included usefulness, relevance, accessibility and availability, and better facilitation and guidance respectively (Das and Jha, 2022). However, less than 50% of respondents agreed that affordability, reliability, timeliness, and accuracy of information were important. While not identified by many respondents, these attributes are crucial for farmers' normal activities, but not a major concern in the target region. These findings emphasize that farmers highly value information that is relevant, useful, accessible, and aligned with sustainable agricultural practices. They also seek guidance on effectively using this information (Phiri et al., 2019). Addressing these factors can enhance the adoption of information and its positive impact on agricultural productivity and sustainability. The findings showed that farmers who used climatic and agronomic information effectively implemented CSA practices, improving soil quality, water conservation, agroforestry, and farming methods due to improved farming skills and knowledge (Hossain et al., 2022). The findings underscore the significance of access and use of relevant and timely CSA information for positively influencing various aspects of sorghum production. The weighted average scores exceeding 3.98 for all factors evaluated further emphasized the substantial impact of this information across different dimensions of farming. These findings concur with the findings of Michael et al. (2022), Kalita and Kumar Das (2022), Mthethwa et al. (2022), and Atsiaya et al. (2023) studies.

Results of inferential statistics showed that farmers in the Generation Z category agreed with the items used to assess their information-seeking behavior with a mean of 3.53 which was higher than the cut-off mean value of 3.40 followed by the millennials with a mean value of 3.41 and Generation X with 2.30. This was further confirmed by *Welch's* F Test (2,129.676=417.868, p=0.000) and *Tamhane's* post hoc criterion which showed that group means were not equal. The findings also showed that age was a significant predictor of information sources with the Generation X cohort mainly seeking information from radio (90.9%), extension services (75.2%), neighbors and friends (67.4%), Millennials sought information from television (96.8%), newspapers (65.6%), and generation Z from brochures (37.3%), social media/websites (74.6%), SMS (45.8%).

Further, the study found out that the level of education also influenced information seeking behavior of farmers with respondents belonging to the cohort with no tertiary education (M=2.67, SD=0.66) having lower mean than those with tertiary education (M=3.53, SD=0.47). This was further confirmed by an independent sample t-test which showed significance (t=4.62, p=0.000), in the mean of the cohort with tertiary education being higher than that of the cohort with no tertiary education. The study also showed that those with no tertiary education preferred radio (92.5%), extension services (71.2%), neighbors and friends (66.4%) as sources of agricultural information as compared with those with tertiary education who preferred television (95.4%), brochures (50.6%), newspapers (72.4%), social media/websites (85.1%), phone call (57.5%), SMS services (57.5%), researchers (66.7%). These findings concur with the findings in (Widiyanti et al., 2021, Michael et al., 2022, Kalita and Kumar Das, 2022, Mthethwa et al., 2022; Atsiaya et al., 2023) studies.

This diverse set of sources and information-seeking behavior based on age and level of education reflects the farmers' willingness to seek information from multiple channels (Drafor, 2016). In terms of relevance, accuracy, usefulness, reliability, timeline, level of detail, and confidence in the source, the study found television was the most preferred source, followed by radio, field days, agricultural shows and exhibitions, refresher training, formal education, exposure visits, and social media/websites. The study also found that smallholder farmers in the Lake Victoria Basin demonstrated some level of adoption of CSA practices as climate change adaptation measures. Farmers incorporated knowledge acquired from mass media sources, such as radio, television, social media/websites, and newspapers, into their farming practices implying that access to information has a direct impact on farmers' ability to adopt and implement climate-smart practices, promoting more sustainable and resilient agricultural production (Odini, 2014).

These findings emphasize the significance of effective information dissemination channels and strategies in promoting CSA practices among smallholder farmers. Ensuring that information is not only accessible but also reliable and relevant can empower farmers to make informed decisions and adapt to changing environmental conditions. This study aligns with the findings of a study by Apriyana et al. (2021) which concluded that more accurate information and more intensive dissemination can enrich farmers' knowledge, allowing for a better understanding of climate hazards and maintaining agricultural production.

5. Conclusion

The study has determined the information requirements of smallholder farmers in LVB for optimal sorghum production. The results provided insights into how effectively smallholder farmers access and apply CSA information. It suggests targeted dissemination of CSA information through appropriate channels to improve information flow and enhance sorghum production, contributing to climate change resilience and ensuring sorghum sustainability in LVB. While focusing on farmers' age and education levels for effective communication the study recommends: utilizing channels like television and radio for agricultural and climatic information to improve relevance and accessibility; and personalizing information delivery to boost farmers' engagement and motivation to adopt sustainable agriculture practices. These recommendations align with best practices in agricultural development and climate adaptation, helping smallholder farmers in LVB improve sorghum production, adapt to environmental changes, and achieve food security.

Author Contributions: Conceptualization: Stephen Ajwang; Data curation: Stephen Ajwang; Funding acquisition: not applicable; Investigation: Stephen Ajwang; Methodology: Stephen Ajwang; Resources: Stephen Ajwang; Software: Stephen Ajwang; Supervision: Patrick Owoche, Jonathan Mutonyi; Validation: Stephen Ajwang, Patrick Owoche, Jonathan Mutonyi; Visualization: Stephen Ajwang, Patrick Owoche, Jonathan Mutonyi; Writing - original draft: Stephen Ajwang; Writing - review & editing: Stephen Ajwang, Patrick Owoche, Jonathan Mutonyi. All authors have read and agreed to the published version of the manuscript.

Funding: The authors did not receive any funding during and after the completion of the study.

Acknowledgment: The study acknowledges the support of the Department of Information Technology at Kibabii University.

Conflicts of Interest: The authors declare no conflict of interest.

Institutional/Ethical Approval: The study was approved by the National Commission for Science, Technology, and Innovation and the School Graduate Studies of Kibabii University, Kenya.

Data/Supplementary Information Availability: Not applicable.

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