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Empowering rural smallholder farmers: access to maize postharvest handling information for sustainable food security in Uganda

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ABSTRACT

This paper presents a model for improving access to scientifically researched information on maize postharvest handling among rural smallholder farmers in Uganda. The model was developed from a study that examined the influence of evidence-based information practices (EBIPs) on farmers' ability to access and use such information effectively. A convergent mixed-methods design was employed, combining both qualitative and quantitative approaches. Data were collected through interviews with 22 agricultural extension officers, four information officers, and 312 rural smallholder farmers, as well as focus group discussions and analysis of relevant government documents. The study found that access to verified information was intermittent. There was no clear linkage among actors responsible disseminating evidence-based postharvest information. Challenges included, low digital literacy, inadequate funding, and limited availability of well-equipped information centers. As a result, postharvest losses remained a significant bottleneck to food security and rural household incomes. With these findings, the model developed defines roles for the Ministry of Agriculture, Animal Industry and Fisheries (MAAIF), Department of Extension Services, district production and information offices, and sub-county extension offices. Through coordinated action, stakeholders work together to share professional expertise, verify the information through evidence sourcing, repackaging, dissemination, and continuous feedback. This model informpolicy and decision-making for improving rural farmers' access to scientific postharvest information.

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SUBJECTS
Information Technology; Librarianship; Research Librarianship; Food Laws & Regulations; Nutrition

1. Introduction

Access to evidence-based information (EBI) by rural smallholder farmers for the right decisions and practices is important. Access to evidence-based information is a human right and a central activity in the field of library and information science. Omekwu et al. (2023) argues that access to information is the ability to identify, obtain, and use information effectively for a desired purpose. Improving access to information on postharvest handling of maize can contribute to long-term food security for rural farmers. Rural and urban populations in Sub-Saharan Africa depend on maize as an important food (Akumu et al., 2020; Manandhar et al., 2018; Mutambuki et al., 2019). Maize is a priority food crop grown by 55% of households in Uganda (Uganda Bureau of Statistics, 2020) feeding most families and providing income (Falconnier et al., 2023; Mwebaze & Mugisha, 2011). Globally, food loss is estimated at approximately 14%, USD 400 billion annually (Muwereza, 2024). Maize postharvest loss in Uganda from 2008 to 2016 was estimated at 320,000–465,000 tons in quantity and 50% in quality due to aflatoxin (Shee et al., 2019).

Maize postharvest loss in Uganda is attributed to poor harvesting and drying practices, inadequate storage, and limited access to appropriate technologies (Akumu et al., 2020). Farmers often harvest maize either too early or too late, which increases vulnerability to pests and spoilage (Focker et al., 2021;

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Gachara et al., 2024). Traditional storage methods are ineffective to prevent maize from weevils and larger grain borers (Fundikira et al., 2025; Kirui et al., 2024).

Unfavourable maize transport services and climate change spoil maize, leading to postharvest loss in quality and quantity. Insufficient drying, especially on bare ground, produces high moisture content, promoting fungus growth and aflatoxin contamination. Scholars report aflatoxins from the Aspergillus flavus fungus that grows from improperly dried or stored crops consumed can cause poisoning of human bodies, leading to liver damage, reduced immunity, cancer and stunting in growing children (Ezekiel et al., 2020; Kortei et al., 2022).

The aflatoxin exposure weakens the population's productivity, increases health care costs and strains food supplies (Boyd & Spencer, 2022; Muwereza, 2024; Sugri et al., 2021). Furthermore, chronic exposure strains the food supply when massive quantities of maize are unfit for human consumption, leading to food insecurity (Muwereza, 2024). A combination of improved practices, technology adoption, and institutional information support is necessary to address these difficulties. When there is linked access to evidence-based information on postharvest management, aflatoxin mitigation, and proper care for harvested crops using new best practice technologies, these efforts will improve food safety and reduce postharvest losses.

Agricultural extension officers serve as primary information providers for farmers in most African countries. For instance, in Uganda, the Ministry of Agriculture, Animal Industry, and Fisheries (MAAIF) is legally mandated to provide access to evidence-based maize postharvest handling information to rural smallholder farmers to improve their practices, reduce food loss, and improve household income (Balungi, 2016; Uganda Bureau of Statistics, 2020).

However, these efforts have been reported to be inadequate (Agwaru et al., 2004; Atube et al., 2021; Bisheko & Rejikumar, 2023; Boyd & Spencer, 2022; Bushman et al., 2021; FAO and Nuwagaba, 2019; Lowe & Sanyu, 2017; Teferra, 2022; Viola, 2017). Collaboration among stakeholders, including librarians, can provide adequate information and training to farmers to reduce postharvest loss.

The lack of collaboration between rural extension services and library services was reported in Nigeria (Sobalaje, 2020), contributing to the lack of sufficient information among rural smallholder farmers. Librarians are known for best practices in information repackaging and information literacy, and agricultural extension workers work individually. Therefore, there is a need to create formal linkages to ensure better services for rural smallholder farmers. Through the evidence-based information practices (EBIP) process, stakeholders work together to share their expertise in the information field to ensure that maize postharvest handling evidence is appraised, packaged, and translated to facilitate better use. A study focusing on indigenous agricultural knowledge (Okello-Obura, 2018) reported that despite scientific information being available to researchers in Uganda, such information was scarce among smallholder farmers. This study identified a gap in the literature where the application of evidence-based information practices in agricultural practices is rare, which is contributing.

The quest for credible, well-translated, and packaged EBI that is relevant and referable to support better maize postharvest handling practices, problem-solving, and decision-making by rural smallholder maize farmers in Uganda remains enormous. This study examined the influence of EBIP on access to and use of maize postharvest handling of EBI by rural smallholder farmers in Uganda. The goal was to propose a model to address the difficulties in improving access to and use of EBI for rural smallholder farmers in Uganda handling maize postharvest.

1.1. Study objectives

The study objectives were as follows.

1. Determine the status of maize postharvest handling EBIP by rural smallholder maize farmers in Uganda.
2. Identify the sources of access to and use of EBI on maize postharvest handling by rural smallholder farmers and extension workers.
3. Establish the EBIP needs of rural smallholder farmers concerning maize postharvest handling.

4. Assess difficulties experienced by smallholder farmers, agricultural extension officers and information officers with the available information services related to maize postharvest handling.
5. Propose an EBIP model for maize postharvest handling for rural smallholder farmers in Uganda.

1.2. The conceptual framework

The conceptual framework of the study was developed from Schatzki practice theory, as described by Lloyd (2010), and evidence-based theory (Hasanpoor et al., 2020; Koufogiannakis, 2013; Smith & Rennie, 2014; University of North Carolina (UNC) Health Science Library, 2024). Maize postharvest handling value chain practices (Shee et al., 2019), and information access and use derived from the laws of library science (Ranganathan, 1931). Practice theory suggests that several practices are required for EBIP to influence postharvest handling of maize. This study used the four concepts of practice theory: actions, sayings, goals, and social values context to signify that evidence shared with farmers should be demonstrated practically, considering the rural smallholder farmers' values and clear goals to be achieved. This study used the EBP theory component of evidence, professional expertise, users' needs (i.e. problems), and EBIP. Furthermore, six components are associated with the EBIP process: ask, acquire, appraise, aggregate, apply, and assess.

Evidence-based information practice (EBIP) refers to a systematic process of promoting gathering, packaging, translating, and applying integrated research information while prioritizing user needs and expert knowledge to ensure user satisfaction (Lloyd, 2010; Reich & Hager, 2014; Rovio-Johansson, 2018; Steglitz et al., 2015). Hodges and Stathers (2012) highlighted that access to appropriately packaged, relevant, and credible evidence-based information (EBI) improved daily practices. The main goal of EBIP is to provide quality information that is appraised and appropriate to the farmers' needs for a satisfied service (Hasanpoor et al., 2020). The EBIP originated in evidence-based practice (EBP) in health sciences to repackage scientifically researched evidence for access at the point of healthcare to influence medical decisions (Koufogiannakis, 2013 and Marshall, 2014). EBP emerged in the 1980s when researchers began asking about the use of research findings in the real world (Polit & Beck, 2021).

This study used postharvest handling of maize value chain practices as one variable. Specifically, it examined smallholder farmers' access to and use of information on the significant postharvest practices of drying, storage, value addition, financial support, and continuous training (Shee et al., 2019). The variables of information access and use employed in this study were derived from the laws of library science (Ranganathan, 1931), which indicate that the scientific information generated cannot affect decisions and practices or achieve the aim of its generation unless it is accessed and used.

2. Materials and methods

2.1. Study area

The study was conducted in the districts of Adjumani, Iganga, Mubende, and Kabarole as highlighted in Figure 1. These districts were selected for this study because a 2019 report indicated they were the major maize producers in their respective regions (Uganda Bureau of Statistics, 2019).

Figure 1 shows the administrative districts of Uganda; those highlighted in grey show where the study was carried out. Uganda occupies an area of 241,551 km^2, of which 196,904.3 km^2 comprises land and 44,650.6 km^2 comprises water and swamps. In 2015, Uganda's agricultural land was estimated to encompass 43.6% of the total available land mass in 2015 (Uganda Bureau of Statistics, 2019). World Bank Group (2024) report released on 27th June 27, 2024, reported that Uganda, as a developing country, had a per capita income of $980 between August 2023 and May 2024 (Sebudde et al., 2024). Uganda is a predominantly agricultural country with many natural resources, including fertile soils, regular rainfall, and recently discovered deposits of minerals such as copper, gold, and petroleum. Uganda has a total population of 40.3 million people, with a growth rate of 3.0% per annum (Uganda Bureau of Statistics, 2019).

Figure 1. Administrative map of Uganda.
(Source: National Online Project, 2023).

2.2. Data collection and management

This study was grounded in the pragmatic paradigm, which prioritizes understanding research problems and questions from multiple perspectives (Creswell & Clark, 2018; Mavodza, 2020). It allows combining qualitative and quantitative elements, which provides flexibility to ensure balanced research and knowledge generation (Morgan, 2014). This study adopted a mixed methods approach that integrated qualitative and quantitative techniques (Granikov et al., 2020; Leavy, 2017; Morse & Linda, 2016; Ngulube, 2022; Saunders et al., 2019). Specifically, this study employed a parallel convergent mixed methods design. The data were collected from multiple sources (extension officers, information officers, and smallholder farmers) from November 2023 to May 2024. Personal interviews were conducted on 26 participants from five workstations: the four selected districts (Adjumani, Iganga, Kabarole, and Mubende) and the MAAIF Head Office, which is in Entebbe Municipality comprised of 22 agricultural extension officers and four information officers.

A mixed-methods approach was chosen to understand how evidence-based information practice (EBIP) was implemented among smallholder farmers, extension officers, and information officers. This approach allowed the study to combine the strengths of quantitative methods used to identify EBIP patterns and relationships with qualitative methods that explored the participants' more profound EBIP experiences and contextual realities. By integrating both forms of data, the study produced a more holistic and credible analysis, which was essential for capturing the complex and multidimensional nature of EBIP across diverse stakeholders and maize postharvest handling processes.

The study population was chosen because they were either from the significant maize producer districts or from the Ministry of Agriculture, Animal Industry, and Fisheries, which were directly involved in the access to and use of maize postharvest handling information or providers of such services. Quantitative data were collected through a questionnaire developed by the researchers. To ensure the questionnaire's validity, clarity, and relevance, researchers piloted it on 40 respondents. They employed expert reviews of the feedback using the Content Validity Index (CVI) to assess each item's validity, with experts rating items on a 1–5 scale. Scores of 4 or 5 indicated validity. The CVI formula, R/N, calculates the proportion of valid items, where R is the number of items rated as valid and N is the total number of items reviewed, as explained by Yusoff et al. (2019). This study targeted 1,930,019 individuals, comprising 1,926,034 rural smallholder maize farmers, 3,854 agricultural extension officers, and 131 information scientists. The sample size for the quantitative component was determined using a formula (Adam, 2020), as follows:

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

Where n represents the sample size, N denotes the target population, and e is the level of significance, set at 0.05 (5%), representing the accepted margin of error in social science research. Based on this formula, a sample size of 400 rural smallholder farmers was deemed appropriate for the quantitative strand, from which 312 valid responses (78% response rate) were obtained. For the qualitative component, purposive sampling was employed to select 48 participants, resulting in 26 participants participating in in-depth interviews and discussions.

Furthermore, two focus group discussions (FGDs) were conducted to represent the four districts included in the study, comprising 15 participants, nine in the first group and six in the second. The FGD participants consisted of agricultural extension workers and information officers who had also participated in in-depth interviews, providing further clarification and triangulation of emerging findings. Additionally, document analysis was conducted to examine relevant government policy documents on agricultural extension and information dissemination. The fieldwork was supported by five research assistants, each recruited from the respective localities to facilitate data collection and contextual understanding.

Quantitative and qualitative data were analysed independently and later integrated during interpretation using a convergent mixed methods design as explained by Hirose and Creswell (2023). Quantitative data were analysed using SPSS v29, employing descriptive statistics, cross-tabulations, and Pearson's chi-square tests to examine relationships at a 5% significance level. For qualitative data, thematic analysis following Braun and Clarke's six-phase framework was conducted using ATLAS.ti v24. The six phases are: knowing the data, coding the data, forming code groups or themes, reviewing the themes, deciding on the important themes and reporting the results (Braun & Clarke, 2006, 2022). Codes P1-P26 were developed from interviews, focus groups FGD1 (09.02.2024) and FGD2 (13.03.2024), and observations (PIGA), then organised into themes. The consistent themes formed the constructs for the model proposed in this study. The findings from both strands were merged using narrative weaving as suggested by Skamagki et al. (2024) to highlight convergence, complementarity, or divergence, thus enhancing interpretation, inference, and methodological transparency.

The researchers were granted ethical clearance and permission to conduct the study by the Uganda National Council of Science and Technology, registration number SS1435ES, and the accredited local Research Evaluation Committee, The AIDS Support Organization. The study was ethically evaluated and approved by the South African Ethical Clearance Body, University of South Africa (UNISA), registration number REC 240616 CREC_CHS_2022. Before obtaining participants' consent, the researchers supplied them with information sheets, including the translated version into the local languages for those who did not know English. The Information sheets described the study's goals, anticipated results, and how the findings will be disseminated. It also highlighted that participation was voluntary, with the option to withdraw at any point. To preserve anonymity, no personal identifiers or names of the participants were revealed. All participants provided written informed consent to participate in the study and consented

to publicly disseminating the findings through conferences, peer-reviewed journal articles, and other relevant scholarly outlets.

3. Findings

3.1. Demographic information

The study explored the demographic information of the respondents. The unique characteristics of the questionnaire respondents examined were gender, literacy, age bracket and Savings and Credit Cooperative Organization (SACCO) membership as presented in Table 1.

Table 1 presents a summary of these characteristics. In total, 57.1% of the respondents were men, and 42.9% were women. This indicated that the majority of maize smallholder farmers were male. Most respondents (75%) were literate, which means they could read and write; 25% could not read or write. The literacy rate among respondents was close to the national literacy level average (80.6%) (Uganda Bureau of Statistics, 2019). On the contrary, the qualitative data from personal interviews (P10-ADJ; P2-KAB) and observations (PIGA) showed that many rural smallholder farmers could not read independently.

Most respondents (76.9% ~ 77%) were 18–40 years, consistent with Uganda's largely youthful population composition (Uganda Bureau of Statistics, 2019). Only 23.1% of respondents were aged over 40 years, which suggested there were relatively few older farmers.

Nearly half of the respondents held SACCO membership, which was critical for financial support for farming enterprises and facilitating access to information. This finding reflected the recent government drive to set up SACCOs and Farmers' Cooperatives to support smallholder farmers and small and medium enterprises in Uganda. This implied that smallholder farmers had access to credit facilities offered through SACCO.

Table 2 presents the demographic information for those who participated in the personal interviews and focus group discussions.

As seen in Table 2, out of the 26 (100%) participants, 18 (69.3) were female, while eight (30.7%) were male. Two categories of participants were interviewed: the Agricultural extension officer (20, 77.0%) and Information service providers (6, 23.0%). Among those interviewed, there were three (11.4%) master's holders, 18 (69.3%) degree holders and five (19.2%) diploma holders in their respective qualifications. This means that the interviewees had training in what they were practising.

3.2. Status of maize postharvest handling information

The food produced should not be lost for food security and family income. To enable the understanding of the maize postharvest handling variables in this study, the respondents were asked to declare their maize farming activity in terms of land size, quantity of maize harvested, and postharvest loss experienced in bags or kilograms. To interpret the data and bring out more meaning, the descriptive analysis of range, mean, standard deviation, and skewness was done. The findings are presented in Tables 3 and 4.

Table 1. Demographics of questionnaire respondents (n = 312).

Demography	Number	%
Gender		
Male	178	57.1
Female	134	42.9
Literacy levels		
I can read and write	234	75.0
I cannot read and write	78	25.0
Age bracket, years		
18–40	240	76.9
41–60	67	21.5
≥61	5	1.6
SACCO		
Yes	154	49.4
No	158	50.6

Table 2. Demographics for the personal interviews (n = 26).

Demography	participants	%
Gender		
Female	8	30.7
Male	18	69.3
Category of the participants		
Agriculture extension officers	20	77.0
Information service providers	6	23.0
Age bracket		
18–40	18	69.3
41–60	8	30.7
Qualifications		
Master of Library and Information Science	1	3.8
Master of Science in Agriculture Crop	2	7.6
Bachelor Science in Agriculture	17	65.8
Bachelor of Arts Mass Communication	1	3.8
Diploma in Agriculture	4	15.3
Diploma in Library and Information Science	1	3.8

Table 3. Maize postharvest handling, land size, quantity of maize and literacy levels.

	N	Range	Mean	Std. Deviation	Skewness	
Variable	Statistic	Statistic	Statistic	Statistic	Statistic	Std. Error
Total acreage of land cultivated	312	1	1.52	.500	−.077	.138
Quantity of maize harvested	312	2	1.41	.518	.616	.138
The quantity of maize lost	312	3	1.76	1.246	1.177	.138
Literacy levels	312	1	1.25	.434	1.16	.138

The findings presented in Table 3 indicate that, on average, smallholder farmers in Uganda cultivate approximately 1.52 acres of land, with a low standard deviation of 0.50, suggesting minimal variability in land sizes among respondents. The negative skewness coefficient of −0.77 further implies that most farmers cultivated land slightly above the mean, with fewer cultivating smaller acreages, an observation supported by a standard error of 0.138. These results confirm that most smallholder farmers operated on small to moderately sized plots. The qualitative information collected from personal interviews confirmed that rural maize farmers grew maize on small farms using simple tools such as hand hoes and animals; few could afford tractors or other forms of mechanization (P1-IGA; P3-KAB).

In terms of yield, the average quantity of maize harvested is 1.41 (on a scaled measure), with a moderate variability of 0.518. The positive skewness value of 0.616 indicates that many farmers reported lower harvest quantities, which may indicate productivity constraints or inefficiencies in postharvest practices. Notably, the mean quantity of maize lost (1.76) exceeds the average quantity harvested, raising a critical concern. This is compounded by a high standard deviation of 1.246 and a strong positive skewness of 1.177, suggesting that while most farmers experience modest losses, a significant number face very high postharvest losses, likely due to poor storage conditions, pest infestation, or delays in harvesting.

Furthermore, low literacy levels are evident from a mean score of 1.25 and a skewness coefficient of 1.16, indicating that many farmers fall at the lower end of the literacy scale. This presents challenges in adopting improved postharvest handling practices such as record-keeping, use of technology, mechanization, and interpretation of agricultural guidelines. As a result, many farmers may still rely on rudimentary tools such as hand hoes, machetes, and ox ploughs. Overall, the findings underscore the urgent need for targeted interventions that address educational and infrastructural gaps to enhance postharvest management, improve productivity, and reduce crop losses among Uganda's smallholder maize farmers.

Table 4 shows the cross-tabulation between gender and quantity of maize lost postharvest findings, indicating that most male (125, 40.1%) and female (92, 29.5%) of 312 respondents lost less than 1,000 kg of maize. Only a small proportion of males (13, 4.2%) and females (11, 2.7%) experienced more considerable losses ranging from 1000 kilograms to 5,000 kilograms. Notably, each gender reported no maize losses (40) and (31) male and female respondents, respectively. These findings suggest that gender does not significantly influence the quantity of maize lost after harvest, pointing to the need for postharvest loss interventions that are broadly targeted rather than gender specific. In addition, the qualitative data suggested that the maize harvest returned low yields because of poor soils, fake seeds, high fertilizer costs, and a lack of EBI on scientific ways to improve soils for better crop yields (FGD1

Table 4. Quantity of maize lost by gender.

Quantity of maize lost	Male	Female	Total
Less than 1000kgs	125	92	217
1000-5000kgs	13	11	24
No maize post-harvest loss	40	31	71
Total	178	133	312

Table 5. Access to maize postharvest information on various topics.

Variables	Sample	Mean	Std. dev.	Skewness
Storage information	312	1.76	.939	1.520
Drying information	312	1.85	.994	1.506
Value-added information	312	1.83	1.102	1.587
Financial information	312	1.87	1.002	1.430
Continuous training	312	1.79	1.106	1.523

09.02.2024). The findings from FGD2 (13.03.2024) estimated postharvest maize loss at 40% in Mubende District and 60% in Iganga District because of factors such as heavy rain, lack of dryers, and insect pests (e.g. weevils).

3.3. Access to maize post-harvest handling information

Respondents were asked to state the status of access to maize postharvest handling information in their community using closed-ended questions to determine what and how information influenced their post-harvest handling activities. Respondents were asked to rate their level of agreement with each statement using a Likert scale of 1–5 (strongly disagreed, disagreed, not sure, agreed and strongly agreed) concerning access to maize postharvest information. Responses were different for each of the major postharvest handling activities as seen in Table 5.

The findings reveal a substantial gap in smallholder farmers' access to critical postharvest information and training in Uganda. Mean scores across all indicator variables, ranging from 1.76 to 1.87, are consistently low, reflecting limited exposure to essential knowledge and support services, including evidence-based agricultural information. The high positive skewness values (ranging from 1.430 to 1.587) indicate that while a small fraction of farmers benefit from some level of access, the overwhelming majority remain largely excluded.

The high skewness values for value-added information (1.587 ~ 1.6) and continuous training (1.523) are of particular concern, vital for enhancing postharvest efficiency and improving farm-level incomes. The widespread lack of access across all areas highlights systemic weaknesses in agricultural extension and information dissemination systems. As a result, most farmers continue to rely on rudimentary, inefficient practices that contribute to high postharvest losses and limit their economic potential.

These findings underscore the urgent need for inclusive and well-targeted interventions to broaden access to practical postharvest information and sustained training. Addressing this critical knowledge gap is essential to strengthening food security, reducing crop losses, and building the resilience of smallholder farming systems. When these findings were compared across districts, the percentages were proportional to the sample size from those districts; therefore, there was no significant variation from Adjumani, Iganga, Kabarole and Mubende.

The qualitative dataset showed that a few rural smallholder farmers had accessed storage information and checked for quality through extension services (P6-IGA; P7-KAB–P15-KAB; FGD1 09.02.2024; PIGA). It was reported that the maize got rotten in the gardens last season because of the rain. One participant said, '*The government forgot about drying maize mechanisation and concentrated more on production. Why produce maize expensively, and it gets rotten? Rural smallholder farmers need drying information and dryers. The evidence-based information about dryers should be widely disseminated to rural farmers* (FGD2 13.03.2024). The qualitative dataset reported that smallholder rural maize farmers lacked financial information on insurance and loans (P18-KAB; P26-EBB).

Furthermore, the personal interviews showed that training for rural smallholder maize farmers on postharvest handling was seasonal or when funds allowed. Few farmers participated. Rural smallholder

farmers were also reported to have a negative attitude towards training. Dissemination of available evidence used a top-to-bottom approach, meaning that farmers were not involved in directing their learning or expressing an interest in what kind of training they wanted (P1–P26; FGD2 13.03.2024). Figure 2 summarises information access based on government policies and regulations analysed.

Access to information is a fundamental right for all Ugandans, including rural smallholder farmers. Government policies and regulations support this right, as shown by the findings of the document analysis (Figure 2), which mentions that all citizens are entitled to access information in Uganda (Uganda Parliament of Uganda, 1996; Uganda. Parliament of Uganda, 2005). This finding shows that rural smallholder farmers are empowered by the law to have a right to access information to support their daily decisions and practices.

3.4. Channels and types of maize postharvest handling information

Access to relevant information necessitated examining the maize postharvest handling information sources. The questionnaire respondents were asked to state how, where and what they accessed as maize postharvest handling information. This question allowed multiple responses. Table 6 reports where and how the farmers accessed information.

The results in Table 6 indicate that 'friends' were the most dominant channels of information for smallholder farmers (272, 87.1%), followed by village meetings (260, 83.3%), which included SACCOs and church meetings, and the Agricultural Extension Office (255, 81.7%). Community libraries were the least commonly used information source (35, 11.2%), and 4, 1.3% of respondents did not know any information source. Online means including mobile phones, and other Internet facilities, which provide access to databases, social media discussions and personal experiences 112(35.8%).

Participants further explained that extension workers did not work with the community libraries, librarians or district information officers. They cited not being aware of their ability to disseminate technical evidence to farmers. Some participants recommended that community libraries should be located nearer to rural smallholder farmers and that they should actively introduce themselves to the farmers. In contrast, participants from community libraries explained that they were disseminating information to rural smallholder farmers using Internet services via the community library reference services. One

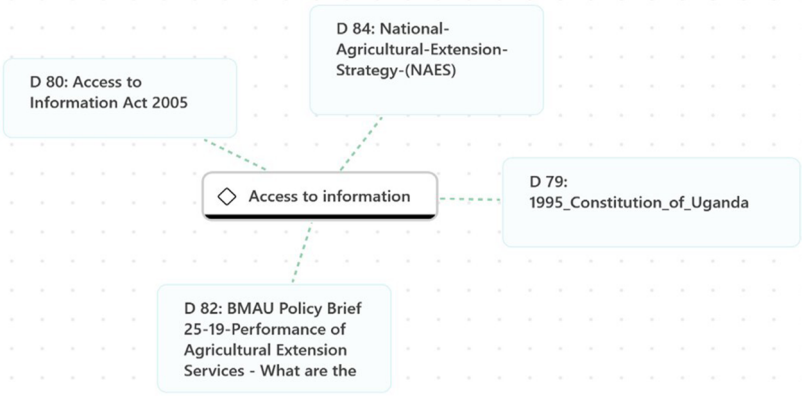

Figure 2. Information access according to government policies and regulations.

Table 6. Channels of maize postharvest information (N = 312).

Channels used by farmers to get information	Number	%
Village meetings	260	83.3
Agricultural Extension Office	255	81.7
Non-governmental organisations	220	70.5
Internet and other online means	112	35.8
District/village/sub-county information officers	135	43.3
Community libraries	35	11.2
Friends	272	87.1
Media (radio/TV/newspapers)	192	61.5
I do not know any source	4	1.3

participant said, '*Every time farmers come to the library and the Internet is available, I help them, but if not, I cannot help*' (P21-IGA). Participants cited the lack of postharvest handling evidence, equipped community libraries and skills to help farmers (P23-IGA). They suggested that extension workers should work with community libraries by equipping them with already packaged evidence to disseminate to the farmers who visited their libraries. However, the National Agricultural Extension Services Strategy 2016/17–2020/21 did not mention community libraries as partners in disseminating farmer information (Uganda Ministry of Agriculture Animal Industry & Fisheries, 2016).

The qualitative dataset showed what information was accessed and disseminated to rural smallholder farmers. These findings report that rural smallholder farmers accessed traditional or local evidence through friends and village meetings. While agricultural officers (mostly extension officers and information officers) accessed scientific evidence, which is explicit knowledge from the MAAIF Manual, databases (e.g. AGORA), textbooks, NARO and the Internet, workshops, partners, and classroom knowledge, and tacit knowledge from their experiences, they then disseminated it to farmers. However, these participants felt they needed to widen and update their sources of evidence.

The extension officers and community librarians disseminated evidence-based information to farmers through training, farm demonstrations and trials, reference service in community libraries, radio and TV talk shows, WhatsApp, farmers' exploration and exhibitions, and hands-on farm practices. Though the dissemination process was minimal, most farmers reported lacking Internet connectivity and WhatsApp access.

Meanwhile, participants reported receiving support through materials such as PICS bags, hermetic bags, and threshing equipment made available through the WFP and the MAAIF.

3.5. Difficulties encountered by rural smallholder farmers, information officers and extension workers

When the respondents were asked about the challenges they encountered when accessing information, the findings suggested that various difficulties hindered rural smallholder farmers in the selected districts of Uganda's access to verified and harmonized maize postharvest handling EBI.

3.5.1. Inadequate information dissemination

Most respondents (268, 85.8% ~ 86%) felt that the currently available EBI was inadequate for their needs and could not empower small farmers to overcome postharvest difficulties (agreed: 64, 20.5%; strongly agreed: 204, 65.3%). The qualitative dataset revealed that the current information disseminated was inadequate regarding the frequency of dissemination, the top-to-bottom approach to providing evidence, the evidence itself and the personnel mandated to disseminate the evidence. Regarding the personnel, participants reiterated that the ratio of farmers to extension workers was high and that agricultural extension workers had not reached the farmers. The evidence was mostly traditional, rarely scientific, and unavailable in some sources such as information centres or libraries. For example, one participant said, *'As a community librarian, I am looking for that knowledge so that I can disseminate it to farmers who come'* (P21-IGA).

District information officers did not have evidence available for dissemination, and extension workers' knowledge and skills were limited. Amost half (48.6%) of respondents strongly agreed that the lack of a clear EBIP framework hindered stakeholder collaboration in supporting rural maize farmers' access to and use of EBI. While 97, 31% agreed that an unfavourable framework made access difficult, 44% disagreed. Some participants noted that reaching all farmers was challenging due to disorganisation, though farmer groups were helpful. Meanwhile, (225, 72.1%) of the respondents suggested that extension service providers implement the EBIP (ask, acquire, appraise, aggregate, apply and assess) framework for improved access to quality maize postharvest handling EBI. Furthermore, for postharvest handling to be effective, 304 (97.5%) of the respondents suggested the provision of specific EBIs that suit specific needs within the postharvest value chain. One participant added that '*Feedback and updates of the outcomes after dissemination and use of the information will be useful and help to identify areas of improvement*' (P26-EBB).

Participants suggested that to ensure the process of training and disseminating information to rural farmers was adequate, the government should coordinate all the stakeholders, including the private sector, civil societies, communities and local authorities.

3.5.2. Limited resources and funding to support information dissemination

Qualitative dataset, reported that limited resources, including personnel, materials, equipment, and funding, hampered EBI dissemination. Farmers highlighted gaps in information on loans, marketing, and transport. Limited resources and inadequate funding also hindered the dissemination of information to rural smallholder farmers. Reaching all farmers was challenging due to disorganization, lack of ICT distribution, and low literacy levels. Many farmers were unaware of available EBI for maize postharvest handling. The absence of direct accountability of district extension workers to the MAAIF hindered implementation.

Translating materials into local languages was difficult due to the large number of languages, while political interference and limited resources further obstructed effective dissemination. Farmers required consistent training, but conservative attitudes slowed the adoption of new practices. Unreliable weather and inadequate mechanization also posed significant challenges.

The document analysis supported the findings concerning the lack of a clear mechanism to bring stakeholders together, which resulted in ineffective EBIP. These documents revealed that Uganda experienced uncoordinated extension services, as evidenced in the following quotation. '*Agricultural Extension Services in Uganda are fragmented and uncoordinated due to the diverse players involved in their delivery. These operate largely independently of each other and in some cases, their operations are unknown*' (Uganda Ministry of Finance P and ED, 2019, p. 3). Furthermore, the participants suggested increasing the number of extension officers, as evidenced in one participant's comment: 'Recruit more extension officers. At least every parish should have one'(P1-IGA). This would improve dissemination and training efforts. 'Provide adequate facilitation for extension work' (P10-ADJ).

3.5.3. Inconvenient locations

The majority (221, 70.8%) of respondents indicated that they walked long distances to access information, which means the sources were inconvenient. However, 63 (20.2%) respondents stated that they found the sources of evidence convenient. The qualitative findings confirmed that rural smallholder farmers often lived far from sources of EBI, and the roads they needed to travel to access training or information from extension workers were poor. However, some personal interview participants said that farm demonstrations and visits could be offered conveniently at rural smallholders' farms (FDG1 09.02.2024; FGD2 13.03.2024; observations; qualitative findings from the questionnaire). This was described by one questionnaire respondent as '*I move long distances to get information*' (qualitative findings from the questionnaire). Furthermore, another participant said, '*Take the information centres nearer the farmers for ease of access*' (P26-EBB) as this would enhance EBI access and use among rural smallholder farmers. Meanwhile, adequate and convenient sources of information were preferred by (268, 85.9%) of the respondents. Improving road networks was also suggested to enable better movement for farmers to move to centres to access information.

3.5.4. Limited knowledge and skills

Furthermore, the qualitative findings revealed that limited knowledge and skills hindered access to EBI among rural smallholder farmers, extension workers and information officers. One participant said: '*Information is changing; we need to learn new ways and methods*' (P22-EBB). Four major areas of limited knowledge and skills were identified: using Information Communication Technologies (ICTs), new ways of packaging and disseminating information, implementation of EBIP, and information literacy. district information officers and extension workers faced lacked updates information to improve services. It was necessary to update and retool these workers to equip them with new technologies for improved services. Quantitative findings report that 179, 57.4%) felt that frequent training for smallholder farmers on maize postharvest handling would enhance their knowledge and skills.

4. Discussion and conclusions

This section discusses the findings, the recommendations, and the conclusions made in this study.

4.1. Status of maize postharvest information

Rural smallholder maize farmers cultivated an average of 1.52 acres with minimal variation across all four districts studied (Adjumani, Iganga, Kabarole and Mubende), indicating consistent land sizes, and most farmers manage slightly above-average plots. Maize yields 1.41 (scaled), but many report lower outputs, suggesting productivity challenges. Notably, the average maize loss (1.76) exceeds the harvest, with high variability and skewness, highlighting serious postharvest losses likely due to poor storage, pests, or delayed harvesting, pointing to a critical need for improved postharvest practices. The subsistence nature of farming in the districts studies and the postharvest loss were confirmed in other researchers' studies (Atube et al. (2021), Tibagonzeka et al. (2018), Uganda Bureau of Statistics (2019) and Shee et al. (2019) and Muwereza (2024) respectively. These findings implied the need for expert intervention, including EBI dissemination, to reduce these losses and improve yields.

4.2. Access to maize post-harvest handling information

This study explored whether these farmers accessed and used information to improve their mindsets and maize postharvest handling practices. The findings of this study highlight a significant gap in smallholder farmers' access to postharvest information and training in Uganda, with consistently low mean scores (1.76–1.87) across key indicators. High positive skewness values (1.43–1.587) suggest that only a minority benefit from available resources, while most remain unaware and excluded. These findings align with Atube et al. (2021), showing that while some farmers with resources accessed information, many still lacked access to EBI. Adequate access to evidence-based information and continuous training are crucial for improving postharvest practices and incomes. Hence, limited access reflects broader systemic shortcomings in agricultural extension services. This widespread knowledge gap contributes to persistent inefficiencies and losses, emphasising the urgent need for inclusive, targeted interventions to improve information access, enhance food security, and strengthen smallholder resilience.

Ranganathan's (1931) library and information science laws emphasise that information is for use, and both the Uganda Information Access Act 2005 and the Constitution of Uganda (1995) grant citizens the right to access information for personal growth. The Uganda Extension Services Guidelines and the Uganda National Extension Services Strategy (2016–2021) also stress the importance of information access for better farming practices among rural smallholder farmers.

4.3. Difficulties rural farmers experienced while accessing EBI

This study examined the difficulties rural smallholder farmers were experiencing when accessing evidence-based information. The findings demonstrate that rural smallholder maize farmers in the study area have limited engagement with evidence-based information and the information accessed was not supporting decision-making across key postharvest handling stages. Other scholars support these findings; Ariong et al. (2023) noted that the information farmers received was often impractical for postharvest handling.

EBP theory emphasizes that evidence should be assessed for quality and relevance to achieve desired outcomes through its implementation. This idea is encapsulated in the '6As' framework (ask, acquire, appraise, aggregate, apply, and assess) proposed by EBP scholars (Eldredge, 2016; Koufogiannakis, 2013; Smith & Rennie, 2014; UNC Health Science Library, 2024). To explore the impact of Evidence-Based Information Practice (EBIP) on the access of maize postharvest handling information, respondents were asked about the EBIP components involved in their practices. Most (85.9%) respondents and qualitative participants indicated that EBIP significantly influenced their access to and use of maize postharvest handling EBI, though it was not fully implemented. These results suggest that EBIP plays a role in farmers

accessing and using quality, credible, and relevant EBI. If fully implemented, quality EBI could help address the issue of ineffective postharvest practices, as noted by Ariong et al. (2023).

EBP theory emphasizes that knowledge (sayings) is implemented through actions within a social context to achieve goals (Lloyd, 2010; Mahon et al., 2017). In this study, rural smallholder farmers, information officers, and extension officers lived in communities with values, cultures, socio-political and economic factors, and experiences that should be reflected in EBIP. Lloyd (2010) explained that information practices must enable the achievement of their purpose, particularly in the context of maize postharvest handling. This EBI, which is technical and often in English, needs to be translated and repackaged in accessible forms for farmers who vary in language, understanding, economic status, technology access, and culture. Notably, some respondents provided actionable suggestions to bridge these gaps. Many suggested that agricultural training be brought directly to communities, preferably aligned with harvest schedules, and emphasised the need for improved access to drying and storage technologies. These suggestions align with evidence from participatory development models, emphasising community engagement and ownership as essential for effective agricultural interventions.

Participants explained that agricultural extension officers felt information officers couldn't effectively disseminate such technical information. Translation and repackaging occurred mainly at the Ministry (Uganda. Ministry of Agriculture, Fisheries and Animal Husbandry 2019), and partner levels, not at the district level. Repackaged information included training manuals (Uganda. Ministry of Agriculture, Fisheries and Animal Husbandry 2019), leaflets, materials, technological equipment, tacit knowledge, and experiments, often shared through farm demonstrations and visits. The weekly *Harvest Money Expo Guide* provided useful EBI on seeds, farm mechanization, and postharvest techniques, demonstrating that translation and dissemination to farmers is possible. However, this reached only a few farmers who could read English and had the means to access it, leaving the majority without access to repackaged, usable information (Atube et al., 2021).

Kumar and Kalita (2017) emphasized the importance of blending indigenous and scientific knowledge sources for sustainable agricultural growth. EBI sources, such as journals, textbooks, databases, blogs, websites, and newspapers, contain scientific knowledge, but people often prefer sources they trust and are familiar with. For instance, a study in Spain found that 85% of farmers relied on personal experience, with low levels of education and agriculture training, and viewed information-seeking as a private matter (Cruz et al., 2022). This suggests that access and use of information depend on users' education, literacy levels, and exposure to different sources. These results align with previous studies showing rural farmers prefer informal over formal sources (Essougong et al., 2019; Mwantima, 2018; Phiri et al., 2019; Sam et al., 2017).

Qualitative data confirmed that community libraries and district information offices could be valuable sources but lacked maize postharvest handling EBI. Farmers preferred informal sources such as friends, meetings, extension workers, and media, while online/Internet and libraries were less favored. This mirrored the Spanish study, where farmers primarily relied on personal experience and had low education levels (Cruz et al., 2022). Since most farmers accessed information from unofficial sources, the quality of the information was difficult to verify, raising concerns about its effectiveness in shaping the right mindset, decisions, and postharvest handling practices. Few farmers accessed EBI through official channels like extension services, libraries, and information centers.

4.4. The model for improved access to evidence-based information

Therefore, the study proposed a model to address the difficulties that hinder the effective implementation of EBIP for access to and use of maize postharvest handling information in Uganda. The model highlights the important stakeholders and how they will work together to ensure the effective implementation of EBIP for access to and use of maize postharvest handling information by rural smallholder farmers in Uganda.

The maize postharvest handling evidence-based information practice (MPHHEBIP) model, as seen in Figure 3, comprises the stakeholders who implement the relevant EBIP, evidence source, and EBIP process. This model was developed based on the difficulties identified in this study, theories employed in executing this study, conceptual framework, and reviewed literature, as described in the following steps.

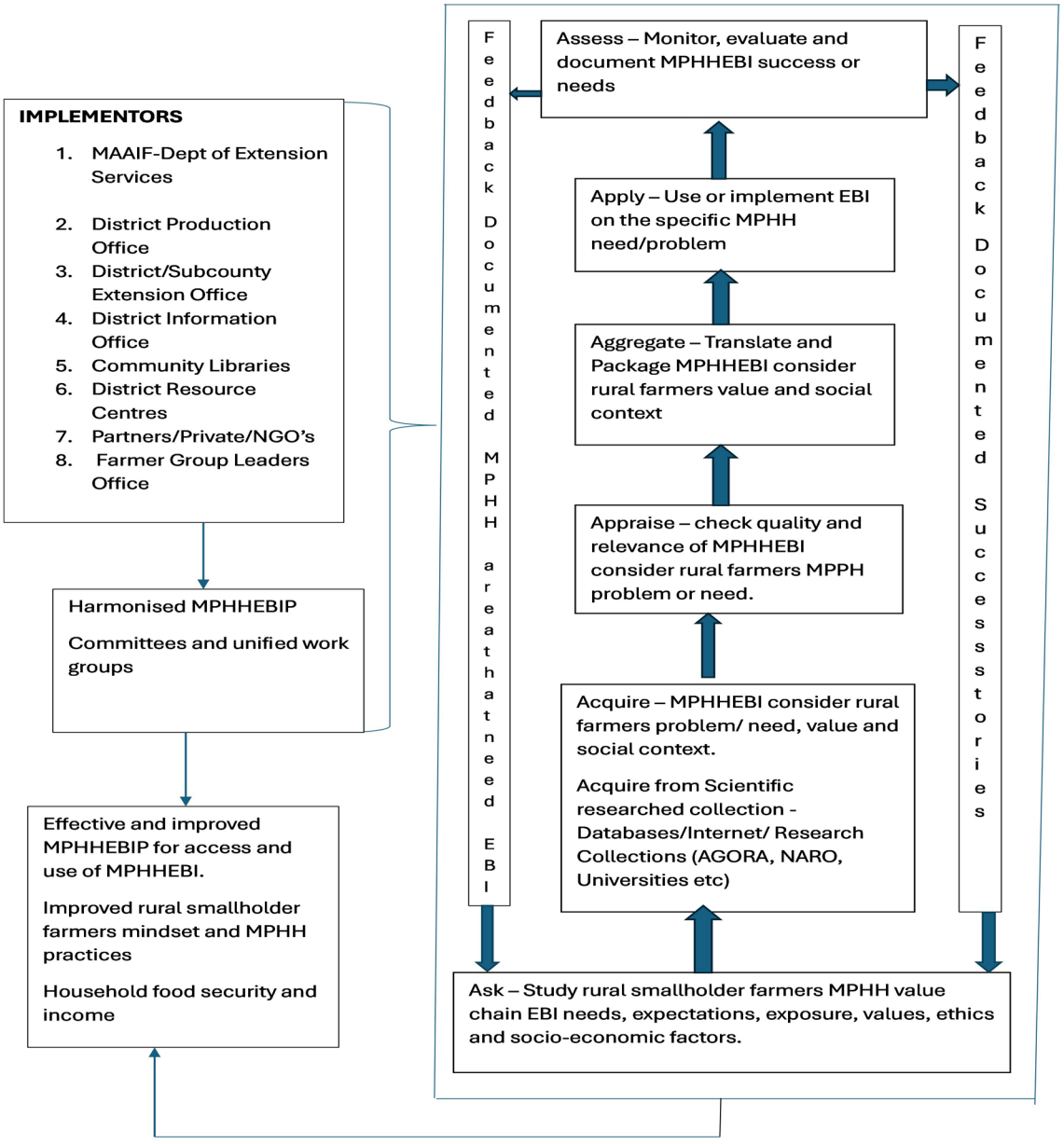

Figure 3. Model for access to and use of evidence-based maize postharvest handling information by rural smallholder farmers.

The Evidence-Based Information Practice (EBIP) model facilitates structured collaboration among key stakeholders: Librarians, extension officers, smallholder farmers, and other relevant actors who are working toward the goal of improving maize postharvest handling. The model promotes this collaboration through established committees and workgroups, guided by a systematic EBIP process that includes sourcing evidence, repackaging into accessible formats, targeted dissemination, and a monitoring and evaluation framework.

In the collaboration, agriculture extension workers and librarians in the EBIP process can work hand in hand to ensure farmers adopt the best maize postharvest handling practices by combining technical expertise with effective evidence-based information packaging. Extension workers provide practical, field-tested guidance on proper harvesting, drying, shelling, storage, pest control, and quality maintenance. Librarians provide access to the evidence-based information, organise the evidence into it, repackage it into farmer-friendly formats, and disseminate it to farmers. The two professions can also jointly deliver information through multiple outreach channels to maximise impact. Extension workers lead field demonstrations and hands-on training in villages, while librarians make resources available through community libraries, mobile library services, and information corners at local gathering points. They can

organise joint events like 'Postharvest Field Days' or 'Library-Farm Clinics' to engage farmers, share resources, and connect them with other stakeholders.

This process ensures continuous feedback, learning, and adaptation, enabling stakeholders to contribute their professional expertise jointly. By working together across disciplines with their expertise, they ensure that accurate, timely, and context-appropriate information reaches farmers, thereby enhancing the adoption of best practices in maize postharvest handling.

4.4.1. Step 1: Ask

The first step of the EBP theory suggests that the EBI need, query, or problem should be studied well, using the population, Intervention, Comparative, Outcome (PICO) framework, if possible. The EBI need should be well-interpreted to indicate the population where the needs will be applied, the intervention itself, an alternative intervention, and the outcome or goal. This EBIP step involves asking rural smallholder farmers for their specific EBI needs in relation to the maize postharvest handling value chain. This study identified various EBI needs in the rural smallholder farmer maize postharvest handling value chain, such as technologies for storage information, threshing, drying, marketing, value addition, marketing, pricing, and transportation. This specific information needs lead to a specific goal to be achieved by the application of EBI. The practice theory states that actions and goals are implemented in a social context. This means that rural smallholders' EBI needs related to maize postharvest handling should be studied in the context of rural communities where farmers live and act, and consider their values, norms, education level, and culture so that the remaining EBIP steps can be effectively guided.

4.4.2. Step 2: Acquire

This study highlighted a significant relationship between access to the EBI and the source from which the EBI was acquired. This means that the quality of the EBI depends on the source from which it is acquired. Therefore, this EBIP step concerns being aware of the available scientific research sources that hold maize postharvest handling EBI, identifying the right sources, and then searching, retrieving, and making the EBI available for access and use. This EBI can be drawn from research and manufacturing institution collections, databases such as Access to Global Online Research on Agriculture (AGORA) and Online Access to Research in the Environment (OARE) and the National Agricultural Research Organization (NARO) in Uganda, university websites, the Internet, the Directory of Open Access Books (DOAB), and the Directory of Open Access Journals (DOAJ). The process of EBI acquisition is guided by the specific needs identified and users' social context. On open-access sites, search and retrieval can be performed to gather information in the form of journal articles, e-books, print books, and case studies.

4.4.3. Step 3: Appraise

The EBP theory emphasizes the importance of appraising evidence to establish its suitability. In the medical field, evidence has been appraised using established checklists. Some of these checklists may be adopted in maize postharvest handling EBI appraisals. This is the process of checking the acquired EBI and ascertaining its relevance, quality, and suitability for the specific needs or problems identified in the local or social context. Exploiting emerging Artificial Intelligence (AI) technologies will enhance the implementation of EBIP among extension workers, information workers, and rural smallholder farmers.

4.4.4. Step 4: Aggregate

EBP theory and the Ranganathan laws of librarianship suggest that information should be aggregated for a specific user to save time for that user. This means that every rural smallholder farmer or farmer group has specific norms or social contexts that should be considered, and the information should be translated and repackaged for ease of use by that specific user. The appraisal of maize postharvest handling EBI in step three is then aggregated through a process of translating it from a technical language to a more suitable language for the rural smallholder farmers' social context. It can also be translated into the local language used by a specific target community. AI can be manipulated to facilitate translation After translation, the EBI was repackaged to be suitable and easy to use for rural smallholder farmers.

This repackaging can be in the form of audio-visual materials, handbooks or manual step-by-step practices, talk shows, AI chatbots, leaflets, or brochures. The format should be guided by ideas from practice theory of knowledge, which can be practically demonstrated and implemented. The Uganda Extension Services Regulations and Strategic Plans should also be consulted for guidance. For example, if rural smallholder farmers do not have ICT facilities and skills but do have power, they may not be able to use computers or smartphones but could use a TV. Therefore, this type of detail should be considered. This study found that the MAAIF Extension Services Manual was the most used source by extension workers to identify relevant information for farmers; therefore, this manual should be enhanced and updated frequently with relevant information and shared widely.

4.4.5. Step 5: Apply

This is the process of connecting the maize postharvest handling EBI with the specific problems or needs identified in the rural smallholder value chain, implementing the EBI, and using it to solve problems. The application can be related to the expert's knowledge or the rural smallholder's preferences or experience to ensure its effectiveness. For example, if the needs or problems related to drying maize on the ground and the EBI acquired concerned drying maize on tarpaulins, then a demonstration could be given and tarpaulins made available free or at a small, subsidized fee. This should also include sufficient information on where rural smallholder farmers can continue purchasing tarpaulins.

4.4.6. Step 6: Assess

The EBP model suggests that it is necessary to monitor and evaluate the effectiveness of applied evidence. This study also found that no clear assessment could be performed in this regard. Assessment helps to identify what worked and what did not work. This is the process of monitoring the implementation of the applied maize postharvest handling EBI, identifying success stories, areas of improvement, or further problems, and documenting these factors for feedback to the implementers and rural smallholder farmers. This feedback should guide the next cause of action for the EBIP.

4.4.7. Feedback

The findings from both the quantitative and qualitative datasets showed that no feedback was documented or shared with implementers or rural smallholder farmers. The model proposed in this study includes a method to address this feedback issue. This model shows that there should be a connection from the start, based on asking farmers to assess where EBI implementation or use is monitored, evaluated, and documented. Success stories should be documented and shared with farmers to offer encouragement and support for further implementation. The areas of improvement or documented problems and needs should also be discussed, as well as the process of acquisition, appraisal, aggregation, application, and assessment. Therefore, this model exhibits a continuous process.

4.4.8. Implementers

The findings of this study suggest that there is no connection between stakeholders mandated to disseminate EBI concerning the maize postharvest handling value chain to rural smallholder farmers. The proposed model demonstrates how this challenge can be addressed. To ensure the effectiveness of the EBIP for postharvest handling of maize, the MAAIF, Department of Extension Services, District Production Office, sub-country extension offices, district or sub-county information/communication offices, community libraries, resource centers, and partners in the community interested in disseminating information to rural smallholder farmers should work together. These stakeholders have various expertise, connections, capabilities, and facilities that can contribute to implementing EBIP and ensure farmers' EBI access, use, and success stories are realised. These stakeholders can work together in committees and workgroups to ensure a harmonized way of improving evidence and practices.

For example, farmer groups have a duty to share the problems farmers are experiencing; they can also mobilize and encourage farmers to turn up for training. District information officers have a communication platform that can be used to disseminate information to farmers. Community librarians have the

knowledge and skills to search for and retrieve relevant information; they also have libraries where the EBI can be housed, and training is carried out. Private and public partners have various specialized connections and equipment (e.g. the WFP and FAO), which they can bring to the working group and mobilize funding through private-public partnerships. The Ministry can supervise this process, and district production officers, information officers, and extension workers have the expertise to disseminate the relevant EBI. In the long term, there will be improved maize postharvest handling EBIP for rural smallholder farmers to support improved practices, as well as improved food security and household income among rural smallholder farmers.

For Evidence-Based Information Practices (EBIP) to be effective in the maize postharvest value chain for rural smallholder farmers, this study proposed the Maize Postharvest Handling Evidence-Based Information Practice (MPHHEBIP) model. The model addresses the key challenges limiting EBIP implementation and delineates the roles of critical stakeholders, including the Ministry of Agriculture, Animal Industry and Fisheries (MAAIF), Department of Extension Services, District Production Offices, sub-county extension offices, information and communication offices, community libraries, resource centres, and community-based partners. These actors bring diverse expertise, networks, and infrastructure for facilitating farmers' access to and use of evidence-based information. The model promotes structured collaboration through committees and workgroups, supported by a systematic EBIP process encompassing evidence sourcing, repackaging, dissemination, and a robust monitoring and evaluation framework to ensure continuous feedback, learning, and adaptation.

The model is expected to inform policy and decision-making regarding access to and use of maize postharvest handling EBI by rural smallholder farmers. This model can be used as a reference point. The MAAIF, Department of Extension Services, District Production Office, sub-country extension offices, district or sub-county information/communication offices, community libraries, resource centers, and partners in the community plan to disseminate information to rural smallholder farmers.

The Department of Extension Services should implement existing extension services policies, such as the National Extension Services Regulations and Standards, and other programs to promote EBIP and theory-practice approaches in agricultural extension services.

This study is not without limitations. The self-reported data may introduce response bias, as recall challenges or social desirability could influence participants' answers. Additionally, since the study was conducted within selected communities, the findings may not be fully generalisable to all farming populations in Uganda. Future research may consider employing experimental or observational methods to validate these findings.

This study examined the influence of EBIP on access to and use of EBI for postharvest handling of maize by rural smallholder farmers in selected districts in Uganda. It did not look at other groups of farmers, such as large-scale, medium-scale, and urban farmers. Further studies should focus on this population.

The study did not consider how extension workers and other experts synchronized EBI and Indigenous knowledge among rural smallholder farmers. Further studies could investigate whether EBIP can influence access to and use of indigenous knowledge for postharvest handling of maize.

A study can be carried out to explore specific artificial intelligence capabilities that can support the translation and repackaging of evidence-based information to local farmers in less technological communities in Africa.

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Author contributions

CRediT: **Jackline Estomihi Mayende Kiwelu**: Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Methodology, Project administration, Resources, Software, Supervision, Validation, Visualization, Writing – original draft; **Patrick Ngulube**: Conceptualization, Supervision, Writing – review & editing.

Ethical approval

The study underwent two ethical evaluations and received the low-risk ethical clearance approval on 24/04/2022 by the College of Human Sciences Research Ethics Review Committee, University of South Africa (UNISA), with registration number REC 240616 CREC_CHS_2022. Additionally, the same low-risk clearance approval for Uganda was granted accreditation and registration number SS1435ES was granted on 15/02/2023 by the Uganda National Council of Science and Technology. All participants provided written informed consent to participate in the study and consented to the public dissemination of the findings through conferences, peer-reviewed journal articles, and other relevant scholarly outlets. The researchers confirm that the study adheres to the Helsinki Declaration about research ethics involving human subjects.

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Data availability statement

The data that supported the findings of this study are available from the corresponding author, J.E.M.K, upon reasonable request at kiwelu1999@gmail.com or jackline.kiwelu@aku.edu

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