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## **Need and Access to Genetically Modified Food Crops' Information among Maize Farmers in Western Kenya**

By

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### **Abstract**

This article aims to examine the dynamics of need and access to information about Genetically Modified Organisms among maize farmers in Western Kenya. The contention of this article is that despite Genetic Modification (GM) of food crops being around for more than two decades and championed as one of the possible solutions to global food insecurity, it has inspired a consistent polarized debate worldwide with a specific focus on the potential benefits and concerns over the safety to human health and the environment. We conducted a survey among 298 maize farmers in western Kenya and interviewed eight key informants from scientists researching GM food in Kenya to determine farmers' GM food information needs, examine farmers' access to GM food information, and assess the approaches used by scientists in communicating GM food information to farmers. Findings reveal that farmers accessed information mostly from sources that are unreliable and prone to misinformation. Approaches used by scientists in communicating GM food information to farmers were ineffective, rendering farmers dissatisfied with the amount of information they access. Findings further reveal that farmers required more precise and complete information from trustworthy sources, including scientists and the government. The study underscores the need for more involvement of farmers and the general public through constant engagement in GM food research and effective communication to enhance their knowledge about GM food. We recommend that scientists rethink their public engagement framework to ensure they reach farmers with more reliable information on GM food. The engagement framework should ensure coordinated messaging among the various stakeholders to avoid confusing farmers on the nature of GM food.

**Keywords:** Genetic modification, GM food, Western Kenya, farmers, science communication

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### **Introduction**

The importance of the accessibility of reliable information in making decisions about adopting new technologies, such as Genetic Modification (GM) of food crops, cannot be overemphasized. Despite Genetically Modified food crops being around for more than two decades and hailed as one of the possible solutions to global food insecurity (cf., Mbugua-<sup>1</sup>Gitonga et al., 2016; Zhang et al., 2016; Dadgarnejad et al., 2017; Gheysen et al., 2019; Siddiqui et al., 2022), it has continued to attract polarized debate globally with specific emphasis on the GM food crops safety concerns. What has become apparent in these debates is the lack of scientific evidence regarding GM technology and food and the availability of competing information from both scientific and non-scientific sources. Cook et al. (2004) pointed out that this debate involves various groups, including anti-globalization campaigners, environmentalists, doctors, farmers, food retailers, lawyers, religious leaders, and scientists. The authors observed that each of these groups brings into the debate their own genres and styles, notably: the scientific report, the food label, the marketing campaign, the legal text, the newspaper report, and many others (p. 434).

The composition of GM debate participants means the chances of the general public being confused by GM food information are high. Cook et al. (2004) acknowledge that in the GM debate, GM scientists have a privileged and influential contribution and that their voice is rightly regarded as having a particular kind of authority. However, reports indicate a lack of scientists willing to share their GM food crop research findings with the public. For example, Kosgey and Cyrus (2019) note that most scientists do not engage the public on GM affairs, leading to a public non-scientific debate that ultimately brings about misconceptions regarding GM crops.

The lack of scientific facts may leave the public feeding on misinformation and miscommunication partly spread by some anti-GMO groups. Such tend to stress immeasurable issues about GM that appeal to emotion instead of communicating scientific facts about GM technology and its products (Oloo et al., 2020a), especially in developing countries. For example, Gheysen et al. (2019) note some international NGOs headquartered outside Africa that are prominent for anti-GMO campaigns in Africa, including Friends of the Earth International and Greenpeace International. These GMO opponents constantly seek to explore the communication gaps left by scientists and other GMO proponents (Oloo et al., 2020b) and contradict scientific facts about GM. Ultimately, the public is left confused with these conflicting messages and unable to make informed decisions about GM technology and its products. This confusion is further intensified by the opinion leaders, including politicians, religious leaders, and government leaders' communication, which tends to base on their personal opinions about GM products. Such have the power to sway public opinion, but they tend to talk about GM without scientific evidence (Kosgey and Cyrus, 2019). It could be

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argued that the ability of opinion leaders and anti-GMO groups to influence public perception can be attributed to insufficient scientific information about GM food. This situation forces the public to welcome any information about GM food to quench their thirst. Clearly, the public needs precise, complete, and understandable information about GM technology and food to make informed decisions.

The literature in Kenya has focused on determining the public's awareness, knowledge, concerns, and perception/attitude toward GM technology and food (Kimenju et al., 2005; Kagai, 2011; Karua et al., 2020; Mbugua-Gitonga et al., 2016; Anunda et al., 2010). Most studies report the public is aware of GMOs and that their awareness comes from the information accessible to them, mainly through the media. They also note that socioeconomic factors influence the public's awareness and perception/attitude toward GMOs. Most previous studies call for increasing public awareness by providing factual information about GM food; indeed, Gheysen et al. (2019) observed that when the benefits of GM crops are communicated or experienced, the support for it appears to be higher. Generally, the literature seems to agree with the importance of GM food information on the public knowledge and attitude/perception of GM food; nevertheless, matters related to the public's GM food information needs and access remain unexplored. Considering the current status of the debate on GM food, one wonders what kind of GM food information is accessible to the public and how much of this information has a scientific basis.

Unlike most available studies that featured the potential consumers of GM food, in the current study, we targeted farmers (who are the potential producers and consumers) and scientists researching GM food crops. Understanding the farmers' needs and access to information on GM food crops is essential. As De Steur et al. (2019) noted, farmers are the ones who will eventually need to decide whether to adopt the cultivation of GM food crops; thus, they play a significant role. Their decision on whether to adopt GM food crops will depend on the nature, quality, and amount of information accessible to them. They can make an informed decision only if they clearly understand GM technology and food, their potential benefits, and the perceived risks. Therefore, this study explored the maize farmers' needs and access to GM food information. It sought to investigate the approaches used by scientists to communicate GM food crops information to farmers and assess the information accessible to maize farmers on GM food by examining their information sources. It also sought to determine the information farmers need about GM food crops.

## **Material and Methods**

### **Study Participants**

This study targeted maize farmers from western Kenya and scientists researching GM food crops in Kenya. Our decision to target maize farmers was influenced by the fact that maize is among the staple food crops in Kenya. Still, reports indicate that the production does not meet the country's demands (see, for example, Mbugua-Gitonga et al., 2016). This owes to factors like poor farming methods, crop pests and diseases, and droughts, all leading to poor yield. On the other hand, Genetic Modification of food crops is said to partly provide the solution to these challenges, especially in Africa, where about 70% of the population engages in agriculture mainly as smallholder farmers. Yet, agriculture in Africa is not as productive as in other continents (Gheysen et al., 2019). Undeniably, the question of information needs and access by maize farmers is vital if the farmers are to reap the prospective benefits of genetic modification of food crops. Therefore, we wanted to examine the approaches used by

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scientists to communicate GM food information, assess the farmers' access to this information, and determine their GM food information needs.

A representative sample of maize farmers was drawn from two counties of western Kenya: Uasin Gishu and Trans-Nzoia. These counties are labelled the country's food basket in maize production. Specifically, we systematically sampled 298 farmers from Moiben, Ziwa, and Soy in Uasin Gishu, Cherangany, Saboti, and Kwanza in Trans-Nzoia. Additionally, eight key informants from scientists researching GM food crops in Kenya were selected for the study using snowball sampling.

### **Data Collection Methods**

Between April and July 2022, we collected quantitative and qualitative data from maize farmers in western Kenya and scientists researching GM food crops in Kenya through a questionnaire and an interview guide. We designed and administered a semi-structured questionnaire to 298 maize farmers to examine their needs and access to GM food information. Specifically, we wanted to know the information accessible to them about GM food and the sources of this information. We asked the farmers if they had heard or read about GMOs/GM food. Awareness of GMOs was a prerequisite for participating in the study; thus, the whole questionnaire was only administered if the farmer's response regarding hearing or reading about GM food was affirmative. We also asked the farmers to indicate the sources from which they heard or read about GM food and explain if they shared the information they received with others. We asked them whether they were satisfied with the amount of accessible information and to indicate how often they received information. The last part of the questionnaire allowed farmers to provide their opinion regarding what other information they needed regarding GM food.

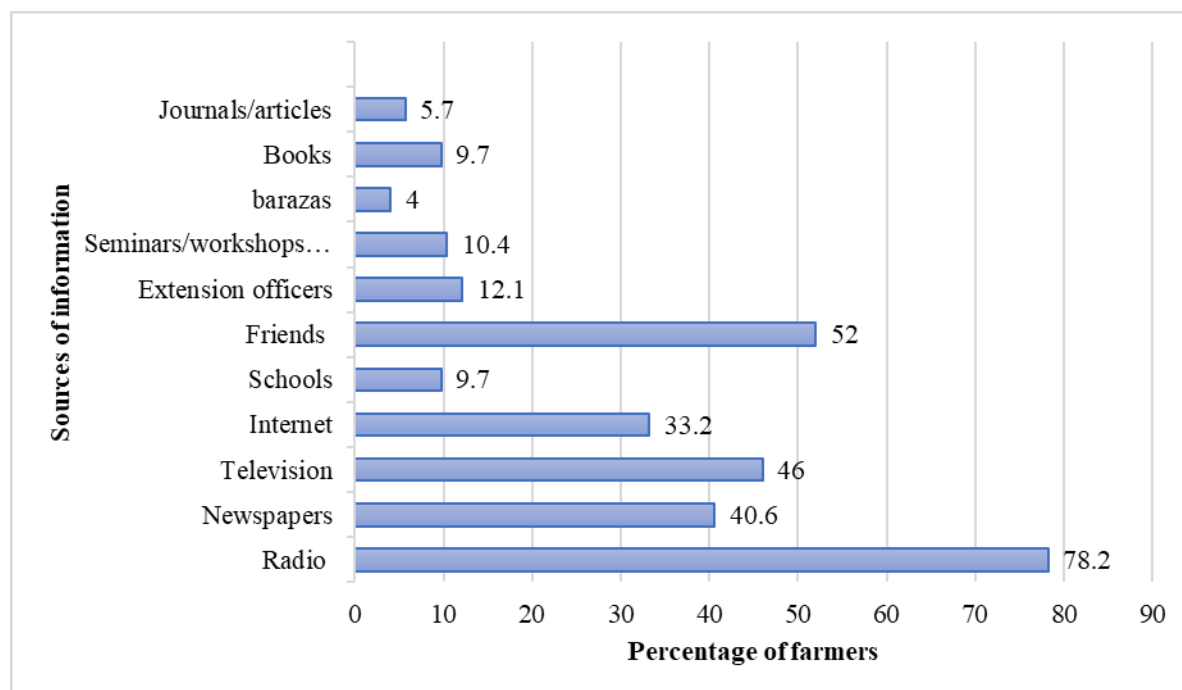
As for the data generated from the scientist participants, we interviewed key informants from scientists researching GM food crops in Kenya. These scientists were interviewed to help shed light on the approaches to communicating their research findings about GM to the farmers. We interviewed eight scientists through google meet and audio-recorded the interviews using a digital voice recorder.

### **Results**

#### **Farmers' Access to Genetically Modified Food Information**

As a basis for farmers' access to GM food information, we designed the questionnaire to determine whether farmers had read or heard anything regarding GMOs/GM food. Regarding this, the results indicated that all 298 farmers reported hearing or reading about GM technology or food, which means they all had access to some information about GM food. We then wanted to investigate this access further by asking farmers to explain the sources of information available to them on the one hand. On the other hand, we asked scientists during interviews to explain how farmers accessed the knowledge generated from their GM food research in terms of the approaches to their communication. In the next section, we present the results of scientists' approaches to communicating GM food information to farmers. Figure 1 below summarises the results of the questionnaire on farmers' GM food information sources.

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**Figure 1. Farmers' Sources of Genetically Modified Food Information**

When identifying the sources of GM food information, farmers stated that they read or heard about GM food from various sources of information such as radio, television, newspapers, schools, friends, extension officers, workshops/seminars/training, barazas, and the internet. The study revealed that most farmers relied on radio (78.2%) and friends (52%) as their main sources of GM food information. Farmers also identified television and newspapers, whereby 46% and 40.6% of the farmers said they received GM food information from tv and Newspapers, respectively.

It was also revealed that 33.2% of farmers received the information from the internet, making the media an overall most used source by the farmers. The study further revealed that very few farmers indicated accessing information through schools or books (9.7%), extension officers (12.1%), and seminars/training/conferences/workshops (10.4%). Barazas and journals/articles were reported as the least used means of accessing GM food information by farmers, with only 4% and 5.7% of the farmers reporting to have accessed information from these sources, respectively.

### **Scientists' Approaches to Communicating GM Food information to Farmers**

Apart from the various sources through which farmers accessed GM food information, we interviewed scientists researching GM food crops in Kenya to explore their communication of GM food information to farmers. We asked them to explain how the farmers accessed their GM food research findings. We first asked the scientists what they did with the knowledge generated from their research. After explaining that they shared this knowledge with several groups of people, including other scientists, the government, and the farmers, we asked them to describe their communication with the farmers. In our discussion, scientists explained the various approaches they employ to relay the GM food information from their research to the farmers. The results revealed that these approaches ranged from using barazas, agricultural

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shows, media, using partners, including the farmers, to direct communication by scientists, including field visits. We summarise the approaches below as explained by the scientists.

*Use of barazas.* The results show that scientists used barazas as one of the approaches to communicating scientific information on GM food crops to the farmers. The scientists said they organized barazas to disseminate their research findings about GM food to the farmers and the wider public. They clarified that the organized barazas were open to the public and, therefore, brought together various stakeholders, including policymakers, farmers, and other members of the general public. Scientists hinted that since these barazas brought various members of the public together, it gave their GM food research a much-needed sense of public engagement. One scientist (Scientists 2) provided the following description:

[...] we try to organize public engagement, especially through barazas, to get to meet different stakeholders there from the government, that is, policymakers; students from universities; and also, farmers. So, through such programs, we are able to communicate what we have from the labs by presenting progress reports regarding the project. So, while presenting, we give them our expectations, and we also try to get expectations from their side. [...] barazas are open to the public because we try to bring in community ownership according to the Kenyan constitution (Scientist 2).

The scientist said they use this approach to update the public on the progress of their GM food crops research and collect the public's expectations about GM food to give GM food matters a sense of community ownership.

However, as explained above in the questionnaire results, when identifying the sources of GM food information, only 4% (12 out of 298) of the farmers reported accessing information from barazas. The results indicate that the scientists' assumption that barazas were open to the public and had farmers in attendance seems questionable. They imply that scientists need to rethink the operationalization of barazas to ensure that they achieve the intended purpose of public engagement in GM food matters.

*The agricultural shows.* The results also revealed that agricultural shows were another avenue used by the scientists to share GM food information with the farmers. Scientists explained that they presented their research findings regarding GM food in the agricultural shows, which they said were open to the public. Like the barazas, these shows were expected to have farmers in attendance. During the show, the scientists said they used various means of sharing scientific information on GM food with the farmers, such as poster presentations, brochures, leaflets, videos of scientists explaining their findings, and exhibitions. One scientist (Scientist 8) stated the following during the interview:

[.....] We have these agricultural shows, that is where we communicate to the farmers. The public can just come, and we do poster presentations telling them these are the crops we are working on, and these are the reasons why we are working on these crops based on their economic importance [.....] (Scientist 8).

As presented in the previous section (cf. Figure 1), farmers, on the other hand, were silent on accessing GM food information through agricultural shows. Farmers seem to rely

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more on indirect sources of information, such as the media and friends, where interaction with scientists is scarce. Nonetheless, as discussed later, farmers longed for direct communication from scientists or other parties involved with GM food to help them understand the GM process and GM food. Again, these results imply that scientists' approaches did not seem effective since farmers, who may be essential stakeholders in GM food, do not seem to benefit from the approaches.

*The use of media.* The scientists also identified using the media as one of their approaches to communicating GM food crops information emanating from research to the farmers. Scientists said they communicated to farmers through radio, Newspapers, television, and social media. Describing how farmers accessed GM food information through the media, one scientist (Scientist 3) used the following words:

[.....] We normally do public participation and majorly involving, maybe publishing the information [...] I'm working with a government institution, so we normally publish the information in the Kenya gazette, even in mainstream media such as newspapers and television (Scientist 3).

This description is consistent with the farmers' sources of GM food information explained earlier. In terms of the mainstream media, farmers indicated relying more on the radio (78.2%), newspapers (40.6%), and television (46%). Internet was used to access GM food information by 33.2% of the farmers, making it a less favourable type of media. Previous studies have also reported media as the dominant public source of GM food information (e.g., Kimenju et al., 2005; Karau et al., 2020). Generally, as elaborated more later, media could be ineffective in that some, like newspapers and social media, may be less favourable to some farmers and the general public, for example, those in rural areas where there could be low readership and limited internet connection. Media can also be biased in communicating GM food information (cf., Lore et al., 2013), leaving the public not knowing what information on which to rely. This situation is especially so when the scientist is not present in the media, for example, the radio or television, to explain their findings directly to the public.

*Field visits.* The study's findings also indicated that scientists shared GM food information directly with the farmers during one-on-one interactions during field visits. Scientists said that this approach worked in two ways. The first one involved the scientists visiting the farmers in the fields (their farms) and engaging with them by sharing their research findings on GM food crops. In contrast, the second one involved the scientists' inviting farmers to their research institutions for seminars or workshops where they presented the information they intended to share with farmers. Scientists further revealed that besides sharing their research findings with the farmers during these visits, they used these interactions to respond to farmers' questions and concerns regarding GM food crops. This approach seems to encourage more public participation in GM food crops matters, as explained during the interview by one scientist (Scientist 5) using the following words:

Actually, we only have like one-on-one with them, either at the field or we bring them over at the organization where we have like a whole day like seminar or a workshop, and we have lunch with them and just harvest their concerns and tell them this is what we are doing aaam...this is what we expect to do to perform better than this...what is the importance,.....and then we just

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listen to them, we just give them an opportunity,.....actually when we have them over, it's more of us hearing from them, then responding to their questions and concerns. Yeah, but we meet once in a while in the field or bring them over to our institution (Scientist 5).

Contrary to the scientists' claim of using a one-on-one approach, when explaining their information needs during the questionnaire, as we elaborate on later, farmers lamented the lack of parties concerned with GM food visiting them to explain what GM food plainly means. This kept them relying on unverified claims about GM food crops. Additionally, none of the farmers we selected systematically indicated having been invited by scientists for seminars or workshops on GM food.

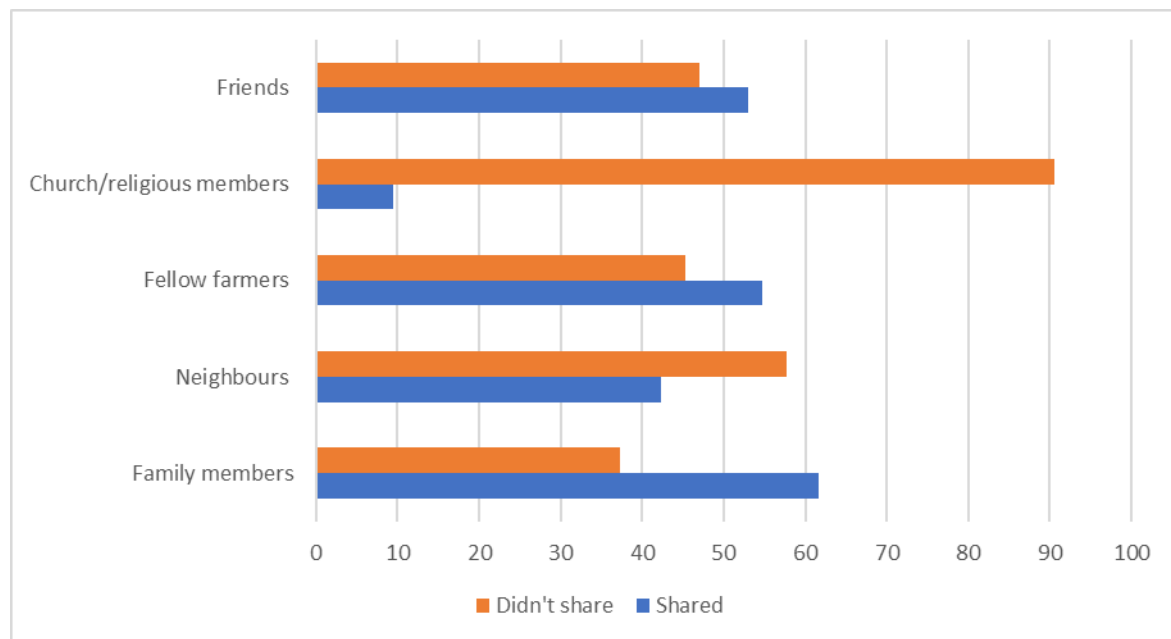
*Peer-to-peer communication.* The study further revealed that scientists partnered with other people or groups who helped them disseminate their research findings to the farmers. Scientists said they sometimes selected a few farmer representatives who, after training them, shared GM food information with them and sent them out to disseminate to other farmers. According to the scientists, these farmers acted as advocates of scientists to other farmers. Whenever needed, they were advised to refer farmers to the scientists for more clarification on any questions or concerns they had. The scientists called this peer-to-peer communication approach, such that farmers were expected to share GM food information with a few other farmers (say two), who were also expected to share with a few others (say two), and on it went, in that order. Farmers did indicate accessing information from their friends (52%), consistent with the scientists' peer-to-peer approach. They also revealed sharing the information they received with others, including friends, family members, and fellow farmers. More about farmers' sharing of GM food crops information is presented next.

### **Farmers' sharing of genetically modified food information**

The use of farmers as communicators and, therefore, sources of information to other farmers became much more apparent in this study when we asked farmers to indicate whether they shared information they accessed with others. As discussed below, 80.2% of the farmers shared the information they received from various sources with several others, including family members, friends, and fellow farmers (Figure 2 below), thus, acting as a source of information to those with whom they share the information.



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**Figure 2: Percentages on the Farmers' Sharing of GM Food Information**

The results revealed that 61.7% of the farmers shared the GM food information they accessed with their family members, whereas 54.7% and 53% reported sharing it with their fellow farmers and friends, respectively. 42.3% of the farmers indicated sharing the information with their neighbours, while 9.4% said they shared it with their church/religious members. These results imply a high chance for the farmers to feed on unreliable information on GM food crops, mainly because the farmers seem to rely mainly on the media and friends for information. Very little information seemed to come directly from the interaction with scientists, which means chances for misinformation and miscommunication could also be high.

Generally, the findings revealed some similarities and significant differences between the scientists' approaches to communicating GM food information to the farmers and the sources of GM food information reported by farmers. Interestingly, we noted the absence of agricultural shows and scientists' field visits on the sources of information reported by farmers. Similarly, barazas and seminars/workshops, which scientists highlighted in their approaches, were ranked very low by the farmers as sources of information (4%) and (10.4%), respectively. The analysis of the results further revealed that farmers acted as a source of information regarding GM food. Both scientists and farmers hinted at the possibility of farmers becoming the source of GM food information other farmers accessed. Whereas during the interview, the scientists said they trained a few selected farmers to assist in disseminating the information to other farmers, during the questionnaire, 52% of the farmers identified "friends" as one of their sources of GM food information. Only the radio, at 78.2%, outranked "friends" out of all the sources of GM food information identified by farmers. Besides, farmers also revealed in the questionnaire responses that they shared the information they received with others (80.2%), including their friends and fellow farmers. These findings seem to imply that scientists need to rethink their communication strategies to ensure they can reach farmers with scientific facts about GM food, especially during this era of infodemic.

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### **Farmers' genetically modified food information needs**

Apart from examining the farmers' access to GM food information, as presented above, we also explored farmers' GM food information needs. First, we designed the questionnaire to allow the farmers to offer their opinion regarding whether they were satisfied with the amount of information they received. We followed this up with a question on how often farmers received GM food information before asking them to indicate other information they would like to access regarding GM food.

Regarding farmers' satisfaction with GM food information, the results revealed (see Table 1) that most farmers were not satisfied with the amount of information they received on GM food. Only 25.8% (77 out of 298) of the farmers said they were satisfied with the amount of information they received regarding GM food, whereas 74.2% (221 out of 298) said they were not.

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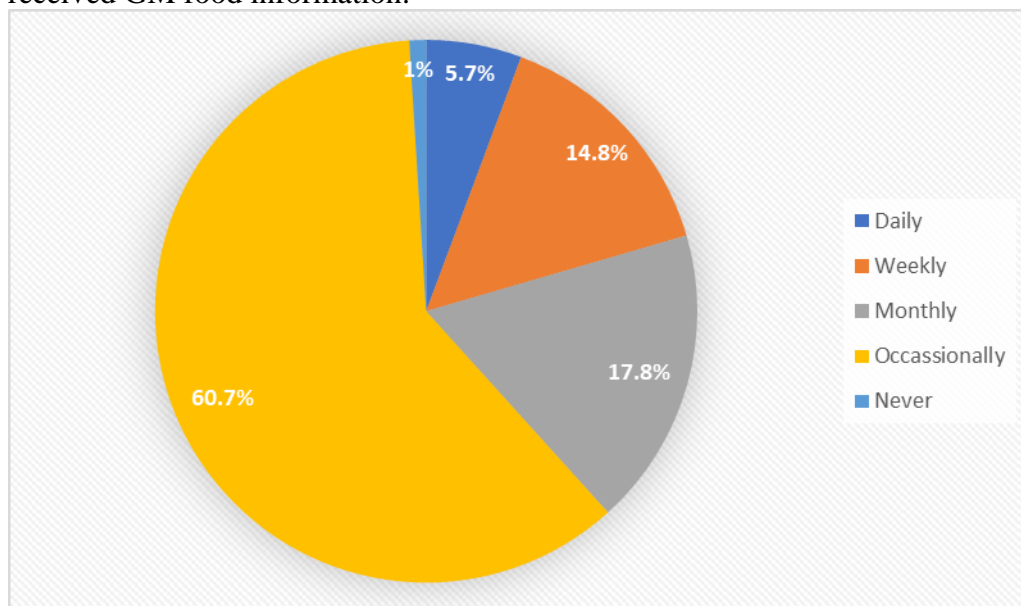
**Table 1: Percentages of Farmers Satisfied with the Amount of GM Food Information Received**

		<b>N</b>	<b>Percent</b>
Are you satisfied with the amount of information received about GM food?	Yes	77	25.8
	No	221	74.2
<b>Total</b>		<b>298</b>	<b>100.0</b>

Source: Field Survey 2022

As for the farmers' frequency of receiving GM food information, we asked them to choose between *daily*, *weekly*, *monthly*, and *occasionally* to reflect on how often each farmer received the information. Farmers could also choose *never* to indicate that they did not receive any information about GM food if that was the case. It is important to note that all the farmers reported hearing or reading something about GM food, meaning they had all accessed some information on GM food.

We found that (see Figure 3 below) more than half of the farmers (60.7%) indicated that they received GM food information only occasionally. The results showed that 17.8% of the farmers said they receive information monthly, while 14.8% of the farmers in the study reported receiving it weekly. Only 5.7% (17 out of 298) of the farmers said they received GM food information daily, whereas 1% (3 out of 298) of the farmers indicated that they never received GM food information.



**Figure 3 Percentages on how often Farmers Received Information about GM Food**  
 Source: Field Survey 2022

These findings are similar to previous studies; for example, Karau et al. (2020) reported that 58.1% of the participants received GM information monthly. They imply that the scientists and other parties responsible for GM food crops have not done enough to reach farmers with complete GM food information. The farmers demand more information (as discussed below) than is being communicated to them. This could explain the farmers' limited understanding of GM technology and GM food, as implied in their information needs below. Such a

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situation could also render the farmers helpless when required to decide on GM food or lead them to make an uninformed decision.

Concerning what other information they would like to access regarding GM food, the result revealed that farmers would like to receive information about several issues, some of which reflected that the information accessible to them is unclear and unreliable. The study showed that common issues in the farmers' GM food information needs are connected to the effects of GM food on the human body/health, environment, and ecosystem. Other issues are related to procedures used in genetic modification, the composition of the resulting GM food, and the purpose of GM food. Table 2 below summarises some common issues on farmers' GM food information needs.

**Table 2: Common Issues on Farmers' GM Food Information Needs**

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Does it really have negative effects on the human body? I want to know more about the demerits and merits of GMOs.
Can it be dangerous to other insects and humans due to the use of chemicals?
I want to know the origin of GMOs and places that have practiced them well.
Does GMO have long-term effects or short-term effects, or chemicals?
The real and factual side effects on human health. What generally contributes to the fast growth of GMOs?
I wish the extension officer could teach me so that I understand and make better decisions.
Where are GMO products tested and proven safe for human consumption?
I want to know what chemicals are used to make plants and animals mature faster.
I wish seed companies involve farmers in the process they take to manufacture GM seeds.

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Source: Field Survey 2022

Farmers also indicated that they need information about whether GM foods have been tested by the responsible authorities to ensure their safety. Connected to this, farmers said they need information about whether GM foods have the potential to cause diseases such as cancer and ulcers or to reduce life span. These farmers' information needs may imply that the issues of GM food safety are unclear to the farmers, perhaps because the information available does not address this or intentionally misleads them. This lack of clarity increases fears among farmers regarding adopting GM food crops. Farmers seem to hunger for assurance that responsible authorities have tested GM foods to ensure their safety for human health; they need responsible parties to talk about the safety of GM food and the benefits and potential long-term effects.

The results also indicated that farmers need information about where to get GM crop seeds and how to use them. This could imply that despite having doubts about GM food's safety, they are optimistic about it and want to know how to grow GM food crops. In addition, farmers need simplified information on the science behind GM technology as well as the negative and positive effects of GM food. All these speak to a lack of complete, reliable, and understandable information about GM technology and GM food, especially on the potential benefits and risks associated with adopting GM technology.

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## **Discussion**

### **Scientists' Approaches to Communicating GM Food Information Are Ineffective**

The findings of this study have demonstrated evidence for scientists' use of both direct and indirect approaches when communicating GM food information to farmers. The direct approaches included scientists visiting farmers in the fields or scientists inviting farmers to the research institutions as well as seminars, workshops, and barazas. On the other hand, indirect approaches included media use and stakeholders such as a few selected farmers. However, of interest in this study, as we have noted earlier, is the finding that very few farmers received information through direct approaches. Specifically, only 10.4% (31 out of 298) and 4% (12 out of 298) of the farmers received information from seminars/workshops and barazas, respectively, whereas none of the 298 farmers reported receiving information through scientists visiting fields or farmers visiting the GM food research institution. These findings imply that most of the scientists' approaches to communicating GM food information to the farmers were inadequate and that farmers access very little information from direct interaction with scientists researching GM food in Kenya. They further imply that farmers depended on information mainly from the media and fellow farmers/friends, which is unreliable and may warrant misinformation and miscommunication about GM food.

It seems evident that most of the communication farmers received was linear, involving the scientists disseminating the information generated from GM food research to the farmers indirectly. This indirect dissemination of information was primarily through the mainstream media: radio, newspapers, and television, as discussed earlier (also note that media dominated the farmers' sources). The obvious implication here is that this communication approach denied farmers the much-needed interaction with the scientists. Through such interactions, farmers could air their doubts and fears about GM food for the scientists to clear them and improve their understanding of GM technology and food. It should also be noted that the use of social media (as reported by scientists), which could allow for some sort of interaction with farmers, does not seem to be a reliable approach since not many farmers accessed information from this source. Notably, the internet was identified by 33.2% of farmers as one of the sources of GM food information.

Nevertheless, the unreliability of social media (and the internet in general, as identified by 33.2% of the farmers) could also be attributed to the fact that both proponents and opponents of GM food can post/share information and their perceptions through the internet. Therefore, social media could stand a high chance of misinformation and miscommunication. Even still, the media (generally) can be used by scientists and anti-GMO groups alike to disseminate different kinds of information about GM technology and food, which means the reliability of information from the media can generally be questionable. Additionally, previous studies (e.g., Lore et al., 2013) have reported unbalanced media coverage of GMOs, which is biased toward negative than positive aspects of GMOs. Nonetheless, since the media dominated the farmers' sources of information, scientists should seize this opportunity and ensure they use the media to reach as many farmers as possible through constant and proactive communication of scientific information about GM food crops.

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### **Farmers Need Complete Information on Gm Food from Credible Sources**

Although farmers reported receiving GM food information (scientists also reported communicating their GM food research findings to the farmers), the findings of this study have shown that the information farmers received could be incomplete and unreliable. Indeed, farmers expressed doubts and lack of clear understanding of some aspects of GM food when discussing their information needs. The findings have also shown that farmers need more information about GM food because they are unsatisfied with the amount of information accessible. Farmers need this information from sources they can trust. They demand information that can help them clearly understand several issues concerning the GM process and GM food in terms of what it is, what the benefits are, and the potential risks to human health and the environment if the technology is adopted. The findings of this study have further demonstrated that credible information regarding these aspects is either not adequately communicated or is lacking, which may confuse farmers and increase their scepticism. It also seems likely that credible information about GM food (if accessible to farmers) may be diluted by misinformation surrounding GM food since farmers reported receiving information from sources prone to misinformation and miscommunication, such as friends. All these add to the farmers' need for reliable information about GM technology and resulting food crops to understand it better and make informed decisions when required.

These findings imply, consistently with the findings of several previous studies, that there is a need to provide the public with complete GM food information to improve their understanding of it (e.g., Anunda et al., 2010; Kagai, 2011; Deffor, 2014; Changwena et al., 2019; Oladipo et al., 2020). It is important to reiterate that the findings of this study have demonstrated that farmers demand reliable and understandable information because they are not satisfied with the amount of information they receive (74.2%). Indeed, the information is communicated mostly occasionally to most farmers. The persistent implication of the findings of this study is that if the information accessible from reliable sources is insufficient, farmers will look for more information elsewhere to satisfy their needs. This situation may intensify misconceptions about GM food among farmers and the general public. It may also give room to misleading information primarily from the opponents of GM technology, who are said to be constantly looking to explore the communication gaps left by scientists' communication of GM information (cf., Oloo et al., 2020b).

Therefore, scientists need to engage the farmers more with their GM food crops research. Undeniably, accurate information could positively influence the farmers' attitude/perception toward GM food; thus, it is essential for the parties involved to ensure that the public gets appropriate and understandable information.

Along the same vein, Anunda et al. (2010) insisted on the need to communicate with the public with complete information about GM in a proactive way, whereas Chengwena et al. (2019) call for a need to engage the public in GM issues by consulting consumers during policy formulation about GM food. Oloo et al. (2020b) call for constant communication; for the scientists to be the sources of reliable, valuable, and authentic information and to be the ones the public turns to in moments of doubt or information overload. Clearly, farmers and the public, in general, need clear and complete information regarding what is involved in the GM process. As Anunda et al. put it, there is a need for well-designed and effective programmes to educate the public about genetic modification in agriculture and food production. These programmes should be coupled with increased public engagement in GM

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food issues. It seems evident that if the parties involved do not communicate effectively, it leaves room for misinformation and miscommunication, resulting in public confusion.

### **Conclusion and Recommendations**

The findings of this study have a special implication on the importance of communicating scientific information on GM food crops to farmers and the general public through reliable sources. It has presented evidence for ineffective communication of scientific information regarding GM food crops to the farmers and farmers' demand for accurate and reliable information about GM technology and food. This scarcity of reliable information leaves farmers confused by information from unreliable sources, which does not help improve their knowledge or attitude toward GM food crops. Scientists need to be on the front line in communicating scientific research finding about GM food crops to the farmers to address their concerns, improve their knowledge and ultimately help debunk the misinformation surrounding GM food crops. The farmers need complete, precise, and understandable information regarding the GM process as well as the benefits and risks of adopting the crops to inform their decision about GM food. This need could be achieved by the scientists and other parties involved in GM investing more in public engagement programmes to ensure there are enough forums to allow scientific public debate on GM technology and food. Such debates would help address farmers' fears and concerns and minimize the dependence on intentionally misleading information.

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