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# Phases of Adoption of One Acre Fund Agricultural Innovation Among Smallholder Maize Farmers, Bungoma County, Kenya

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**Abstract:** This study examines the adoption of One Acre Fund (OAF) agricultural innovations in Bungoma South Sub-County, Kenya, in response to declining maise production. Despite agricultural development programs aiding Kenya's economic growth, research shows low technological acquisition. Qualitative and quantitative data were collected from 204 out of 9,924 OAF-registered farmers using descriptive research design. Inferential statistics were employed to analyse the different phases of adoption, with quantitative data presented in tables. The qualitative findings were analysed using thematic analysis and incorporated into the results of the inferential analysis as narratives. A situational analysis was performed to assess the status of various types of OAF agricultural innovation among smallholder farmers in the study area. Pairwise ranking was implemented to identify advanced acquisition strategies. The findings revealed that the socio-economic characteristics of farmers, such as age ($p = 0.002$), marital status ($p = 0.000$), level of education ($p = 0.001$), family size ($p = 0.047$), non-farm work ($p = 0.327$), and size of land ($p = 0.110$), significantly influenced the adoption of the OAF agricultural innovations. The study also indicated that the adoption phases were impacted by factors such as group memberships ($p = 0.047$), farm visits ($p = 0.012$), and training ($p = 0.000$). Based on the findings, the study recommends the implementation of awareness programs, crop insurance, the establishment of farm cooperatives, and the strengthening of farmers' knowledge systems to enhance OAF maise output and achieve food security.

***Keywords:*** Adoption, agricultural innovations, Bungoma County, One Acre fund, technological acquisition.

## 1. Introduction

Agriculture plays a pivotal role in the 2030 Food Agenda as it is essential for achieving global food security and serves as a primary source of income for a large portion of the world's low-income population (Omilola & Robele, 2017). Recent estimates project that the number of agricultural farms worldwide will decrease from 656 million in 2020 to 624 million by 2030 (Erenstein et al., 2021). Maise smallholder farming is the predominant form of agriculture in developing nations, with maise crops grown on approximately 197 million hectares. It is anticipated that by 2030, maise production will increase by 3%, with an output of 1.7 metric tons (Erenstein et al., 2021).

By 2050, the global population is expected to surpass 9.1 billion, necessitating the provision of food for an additional 2.4 billion individuals, out of which 0.9 billion will be in Africa (Islam & Karim, 2019). Smallholder maise farmers in developing countries are projected to contribute significantly to feeding this population, given the high demand for food (Shiferaw et al., 2011). Smallholder agriculture prevails in global agriculture, encompassing half of all small farms worldwide, with nearly 98% of Chinese households producing maise on less than 2 hectares of land (Lowder et al., 2014). In Eastern Africa, smallholder farming accounts for approximately 75% of the overall agricultural output (Salami et al., 2010). Tanzania leads in smallholder farming, with 19.2 million individuals owning 80% of the country's farms, with an average farm size of 0.9 hectares (FAO, 2021).

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The adoption of agricultural innovations has significant potential for increasing maise production (Ahmed, 2015). The development of agricultural techniques and the availability of improved seed varieties are crucial for enhancing the welfare of smallholder farmers whose livelihoods depend on agriculture (Sigigaba et al., 2021). The adoption of high-yielding maise varieties by farmers is expected to stimulate maise production, thereby reducing poverty and improving food security in rural areas (Chandio & Jiang, 2018). Likewise, Ali et al. (2020) highlight that the utilisation of improved varieties leads to increased yield, consumption, and food security.

Globally, investment in green revolution agricultural research has resulted in the development and dissemination of advanced varieties of crops to farmers worldwide (Danso-Abbeam et al., 2017). The adoption of these advanced varieties has contributed to increased grain yields, improved farm returns, and enhanced food security. For instance, in Mexico, the adoption of hybrid maise has significantly increased household income and provided social support to the poor (Lamichhane et al., 2018).

In Africa, the adoption of improved maise varieties plays a crucial role in supporting individuals who depend primarily on agriculture and reside in areas prone to drought (Sigigaba et al., 2021). This adoption has been shown to enhance food security and alleviate poverty among maise-dependent households (Lamichhane et al., 2018). In the case of Malawi, the introduction of improved maise varieties has resulted in increased yield, disease resistance, price stability, security, and market demand (Sigigaba et al., 2021). Notably, the Sub-Saharan Africa region has experienced consistent growth in maise production due to the adoption of agricultural technology (Epule et al., 2022).

Several studies conducted in various countries in East Africa have aimed to identify the factors contributing to the increased adoption of Improved Maize Varieties (IMV) by smallholder maise farmers (Diiro et al., 2015). These studies have consistently shown that farmers who utilise improved maise varieties are able to benefit significantly in terms of financial returns through improved grain yields and reduced risk (Diiro et al., 2015). Despite these advantages, the uptake and adoption of IMV in the region have been slow (Khaemba et al., 2022). This can be attributed to the limited resources of farmers, which hinders their ability to acquire hybrid seeds of improved maise varieties (Lunduka et al., 2019).

Recognising the importance of IMV adoption, One Acre Fund (OAF), a non-governmental organisation founded by Andrew Young in Kenya in 2006, has implemented a program designed to assist maise farmers in increasing their yields in Bungoma County (Odaba & Otinga, 2021). OAF's primary objective is to help rural smallholder farmers overcome hunger, and poverty, and achieve self-sufficiency. This is achieved by providing high-quality farm inputs such as seeds and fertilisers, offering extension services and weekly training from OAF field officers, and facilitating access to markets. The program also includes a flexible loan repayment schedule linked to the farm's output (Odaba & Otinga, 2021). Collaboration with rural village groups is employed by OAF to ensure that the most vulnerable families, predominantly residing in rural areas, can benefit from the initiative. However, the number of smallholder farmers joining OAF village groups remains relatively low.

While existing studies have primarily focused on the socio-psychological characteristics of farmers relating to the adoption of improved technologies (Doolin & Eman, 2008) and the impact of off-farm income on agricultural innovation adoption (16) and decision-making, little attention has been given to scaling up the adoption of NGO innovation programs by smallholder farmers. Furthermore, no research has been conducted to assess the stages of OAF agricultural innovation adoption by maise-dependent households in Bungoma County.

## 1.1 Problem statement

One Acre Fund has implemented an innovation program tailored to the specific needs of Kenyan farmers. This program involves providing farmers with asset-based financing, which includes the provision of fertilisers, improved seeds, and regular training on maise cultivation, processing, and marketing (Harley, 2016). These loans are then repaid by the farmers using their farm produce. In Bungoma South Sub-county, 9,923 farmers have currently benefited from this asset-based financing. However, this number represents only a small proportion of the total number of smallholder farmers in the program, which stood at 98,743 in 2023 (KARI, 2023). Against this backdrop, this research aims to assess the factors that influence the adoption of the One Acre Fund agricultural innovation program among smallholder maise farmers in Bungoma County, with the objective of promoting wider adoption.

The population of the county by 2025 is estimated to be 2,740,342 (BCIDP, 2018). These population figures will lead to increased demand for maise within the county, emphasising the importance of expanding cereal production through the adoption of the OAF agricultural innovation program. The findings of this study contribute to the existing body of conceptual and empirical evidence on the factors that influence the adoption of such programs and their associated packages.

### 1.2 Research objective

The study explores the phases involved in the adoption of One Acre Fund program activities in Bungoma County, Kenya.

## 2. Literature Review

Doolin & Eman (2021) identified several factors as drivers of technology adoption, including training, platforms, market access, policies, and leadership. They emphasised the importance of Smallholder Farmers' Forums as a means of accessing markets and credit information, as well as receiving valuable farming information on new agricultural programs.

Farmer groups or platforms provide a space for like-minded community members to come together and collaborate on activities of common interest. Multiple studies in Sub-Saharan Africa have shown that advisory services are channeled through these farmers' group platforms (Wennink & Heemskerk, 2006). These associations establish stronger connections between the government and rural residents, offering forums for capacity building, information exchange, and innovation in rural settings. Furthermore, these groups provide opportunities for grassroots participation. When it comes to farmer training, extension officers play a crucial role. Onono (Onono et al., 2013) found a positive relationship between extension officers and technology adoption. While previous studies have focused on extension officers as institutional factors, this study examines the different stages of adoption status related to these factors.

Kralawi (Kralawi et al., 2016) conducted a study in West Java, Indonesia, by joining tea smallholder farmer organisations. The study discovered that members were able to address challenges faced by tea societies either individually or collectively as a group of tea farmers. This led to increased efficiency and served as a platform for learning and engagement. In South Africa, the Smallholder Development Working Group (SDWG) played a vital role in supporting and developing smallholder farmers. According to the Republic of South Africa (ROSA) (2013), SDWG was established to facilitate smallholder support and development, ensuring overall coordination, monitoring, evaluation, and reporting to relevant government structures.

Being part of social groups enables farmers to learn from each other about the benefits and uses of new agricultural inputs. The influence of social networks is significant in shaping individual actions and, specifically, the adoption of agricultural innovations. Muzari (Muzari et al., 2020) conducted a study on the impact of technology adoption on smallholder producer production in SSA and found that farmers who were part of social groups engaged in learning technology had higher chances of accepting or rejecting new innovations. Peer influence plays a crucial role in driving adoption of agricultural technology. According to research by Mimeo (Oster & Thornton, 2009), peer effects operate in three ways in the technology adoption process: (i) individuals benefit from their interactions with friends or neighbours, (ii) individuals learn about the benefits of technology from their peers, and (iii) individuals learn how to use new approaches from other group members.

Access to information allows farmers to learn about existing technology and how to effectively use innovations. Accessing information helps reduce uncertainty and clarifies issues related to innovation. According to a study conducted by Wole (2015) on the factors influencing the adoption of improved varieties in rural Nigeria, membership in farmer-based groups had a positive influence on adoption intensity.

## 2. Methodology

### 2.1 Study locale

Bungoma County is bordered by the Republic of Uganda to the northwest, Trans-Nzoia County to the northeast, Kakamega County to the east and southeast, and Busia County to the west and southwest. The county has a total land size of 3032.4 km2. Mt Elgon, Cheptais, Bungoma East, Bungoma West, Cheptais, Bungoma Central, Bungoma South, Bumula, Webuye West, Bungoma North, Kimilili, and Tongaren are the eleven sub-counties of Bungoma County (Figure 3.1). Bungoma South sub-county (formerly Kanduyi Division) is located at longitude 340 6'E. It has a total size of 663.3 km2 (29). Kanduyi is the only constituency in the sub-county. There are 98,743 agricultural households in the sub-county (30, 33).

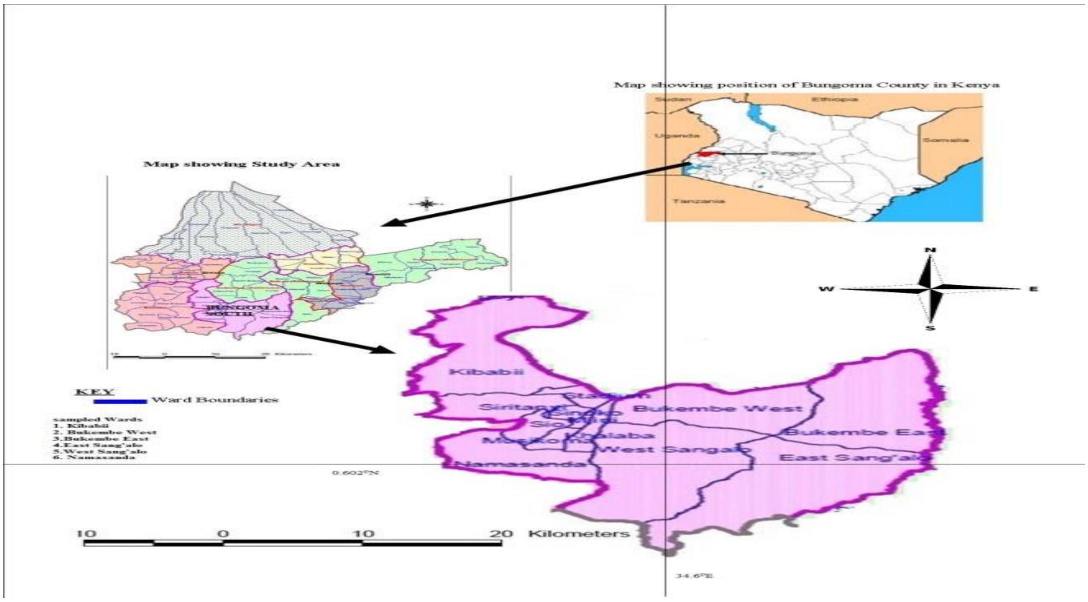


***Figure 1:*** *Map of study location.* Source: BCIDP (2020)

### 2.2 Research design

This study employed a descriptive study design to collect data from the population and assess the current status of the adoption of One Acre Fund (OAF) agricultural innovation. This design was chosen to enable a comprehensive investigation of the topic by exploring the factors that influence the adoption process, including the reasons, locations, and methods involved. The design incorporated various data collection methods such as questionnaires, checklists, interviews, and focus group discussions to gather both qualitative and quantitative data for analysis. In terms of sampling, purposive, stratified, simple random, and non-proportionate sampling techniques were utilised. Bungoma South Sub County was purposively selected as the study area due to the observed decline in maise production and the increased implementation of the OAF program in that sub-county. The study aimed to target 9923 OAF farmers, and a sample frame of 203 participants was drawn for the study.

Specialists were consulted to ensure content validity was validated for the research instruments. To establish reliability, a triangulation approach was employed, which involved administering the same set of questions to respondents three times during the experimental study. This approach enhanced the credibility of the research. The reliability of the study was assessed through a pilot survey using the test-retest method, which yielded a reliability coefficient of 0.78 after inputting the data into SPSS version 252. For quantitative analysis, the diffusion of innovation model was employed using regression analysis. Additionally, the pairwise ranking method was utilised to identify the most effective strategy to enhance the adoption of the One Acre Fund. This method involved creating a square matrix of criteria, comparing pairs in each row, assigning ranks, and determining weights.

### 2.3 Ethical consideration

Ethical considerations were taken into account to protect the participants and those who may be affected by the research findings. Research authorisation was sought from NACOSTI. The participants were assured of confidentiality by guaranteeing their anonymity. The information obtained would be used for its intended purpose. The participants were asked to sign a Consent form in order to participate in the study. They were given the freedom to withdraw from the exercise at any stage during the field survey process.

## 3. Research Findings and Discussion

The findings on the uptake of the One Acre Fund (OAF) program activities in Bungoma South Sub-County were based on regression analysis of the phases of adoption (Table 1).

***Table 1:*** *Regression analysis on phases of adoption*

| | | Coefficients | | | | |
|---|---|---|---|---|---|---|
| Model | | Unstandardised coefficients | | Standardised coefficients | T | Sig |
| | | B | Std Error | Beta | | |
| 1 | Constant | 2.275 | .8 | | 4.865 | .027 |
| | Membership to a group | .7 | .365 | .487 | 3.789 | .047 |
| | Farm visits | .381 | .352 | .327 | 5.031 | .0 |
| | Training | .475 | .561 | .521 | 4.8 | .000 |
| | Management support | -.049 | .089 | -.263 | -1.0 | .608 |
| * | Dependent variable: Adoption | | | | | |

Source: Fieldwork (2020)

A regression analysis (Table 5) performed on phases of adoption of OAF agricultural innovation showed that membership to a group influenced the adoption of OAF agricultural innovation (P=0.47). This means that field visits with p-values=0.047 positively influenced adoption of OAF agricultural innovation. This was revealed through focus group responses, in which the majority of the farmers preferred to be visited by OAF field officers.

It was revealed that OAF training influenced the adoption of OAF agricultural innovation with a p-value=0.000 at a 0.05 significance level.

Therefore, the null hypothesis that Ho2: There is no relationship between phases involved in the adoption and adoption of OAF program among smallholder maise farmers was rejected as their p-values were less than 0.05.

Lastly, management support had a negative influence on the adoption of OAF agricultural innovation. This was anticipated as the majority of the respondents preferred to identify their markets.

## 3.1 Field visits phase

Field visits are an important factor for farmers to access agricultural extension resources (31). Respondents stated the number of OAF official visits per season, and the majority of them (49.2%) admitted to having been visited by the field office more than three times per season (Khaemba et al., 2021). 40.8% said that they were visited three times per season, 6.1% were visited twice a season, and 3.9% were visited once per season, as shown in Table 4.6. However, no matter how often the field officials visited the farmers, most of the farmers were sure that when they were visited by OAF officials, they received professional advice (OAF, 2018). Respondents noted that they could not be visited more often because they had not joined active OAF teams. These results confirm that the field visit of OAF regional staff helps to improve the acceptance of new inventions. The findings of this study are consistent with those of Emmanuel (Khaemba et al., 2021), who found that farm visits contributed to the adoption of technology.

***Table 2:*** *Farm visits and adoption of OAF programme*

| No. of visits per season | Frequency (N) | Valid Percentage |
|---|---|---|
| 1 | 7 | 3.9 |
| 2 | 11 | 6.1 |
| 3 | 73 | 40.8 |
| More than 3 | 88 | 49.2 |
| Total | 179 | 100 |

Source: Fieldwork (2019)

## 3.2 Training phase

Acquiring knowledge is the initial and fundamental step in the adoption of an innovation program. The respondents were asked to identify the training methods utilised by field officers, as well as the frequency of the training sessions. This aspect is crucial as the organisation, OAF, places great emphasis on field-based training opportunities, making maximum use of this approach (refer to Table 3).

Prior research has highlighted the positive impact of effective extension services and training on the adoption of technology (Abdulahi and Huffman, 2015). In this particular study, it was found that 60.8% and 34.1% of the respondents had received training through demonstrations and oral explanations. The respondents further emphasised that these demonstrations were conducted in the field.

***Table 3:*** *Training/demonstration*

| **Characteristics** | **Frequency** | **Valid Percentage** |
|---|---|---|
| *Methods of training farmers* | | |
| Oral information | 61 | 34.1 |
| Demonstration | 109 | 60.8 |
| Use of charts | 5 | 2.8 |

| | | |
|---|---|---|
| Videos | 1 | 0.6 |
| Others | 3 | 1.7 |
| *Frequency of OAF training* | | |
| Once per season (twice per year) | 33 | 18.4 |
| Once per year | 3 | 1.7 |
| Not at all | 1 | 0.6 |
| Several times | 142 | 79.3 |

Use of charts, videos, and other recorded materials accounted for 2.8%, 0.6%, and 1.7%, respectively. The respondents reported that training took place in the homesteads of OAF members during field visits by OAF field officers.

Regarding the frequency of OAF training, 79.3% of the respondents were trained multiple times by the field officers, 18.4% were trained once per season, and 1.7% were trained once per year. However, a small proportion of 0.6% of respondents revealed that they had never been trained. This could be attributed to their failure to follow OAF training timelines. These findings are consistent with previous studies (KARI, 2013 & Khaemba et al., 2021), which found that farmers need to be trained on the technologies in order to fully understand their benefits and be able to adopt them.

As reported during interviews, most of the OAF smallholder respondents noted that the demonstrations and training mainly focused on spacing, fertiliser application, weeding periods, insecticide application, harvesting time, storage, and other agronomic practices. The regional coordinator argued that OAF provides field-based training and demonstrations to clients on carbon-building soil management techniques, such as composting, residue retention, legume intercropping, crop rotation, and erosion control (OAF, 2018). OAF field officers revealed that field-based training provided farmers with an opportunity to seek clarifications when they didn't understand something. To demonstrate whether farmers were trained, Plates 1 and 2 were taken to show OAF field officers demonstrating how to apply fertilisers to farmers.

***Plate 1:*** *OAF field officer demonstrating how to measure and apply fertiliser.* Source: Fieldwork (2020).

***Plate 2:*** *OAF field officer showing how to apply fertiliser along a knotted rope*
Source: Fieldwork (2019).

Plates 3 and 4 reveal that field officers are tasked with training farmers on maise agronomic and management practices. Farmers are trained on the appropriate time for land preparation, which occurs between February and March. After land preparation, farmers are shown how to prepare holes with the assistance of a uniformly spaced knotted rope (75cm×35cm). A demonstration on how to plant maise is then conducted. One seed is planted per hole, and fertiliser is applied using a standardised measuring aid, such as a spoon or small measuring cylinder, as shown in plate 4 above.

## 2.3 Group membership formation phase

The study also evaluated group participation in order to determine whether farmers engage in collective work as mandated by the program (Table 3). Group members establish social networks that encourage one another to adopt technological components. According to the data presented in Table 5, a significant majority of respondents, amounting to 98.8%, appear to belong to groups.

This suggests that group membership is closely linked to technology adoption, as groups serve as platforms for farmers to exchange farming experiences. Through interviews, farmers expressed that these groups facilitate networking for market opportunities and provide supplementary knowledge on best farming practices, which complements the support provided by OAF.

***Table 5:*** *Membership to a group*

| Membership | Frequency (N) | Valid Percent |
|---|---|---|
| Yes | 175 | 97.8 |
| No | 4 | 2.2 |
| Total | 179 | 100 |

Source: Fieldwork (2019).

Field officers also indicated that farming groups allow farmers to pool their labour for farming activities, such as planting, applying fertiliser, weeding, and harvesting.

## 2.4. OAF loaned inputs (OAF support) phase

Most respondents, at 98.9%, reported receiving loaned inputs from OAF, and only 1.1% reported not having received input loans (Table 4.9). Provision of farm inputs, at 94.6%, was the most common type of loan input advanced by OAF. The assistance included IMV, fertiliser, storage sacks, and pesticides. Of the respondents, 5.6% reported market facilitation assistance, where they sold their produce.

***Table 6:*** *OAF loaned inputs and adoption of OAF innovation programme*

| Characteristics | Frequency | Valid Percent |
|---|---|---|
| *OAF loan* | | |
| Yes | 171 | 95.5 |
| No | 2 | 1.1 |
| Sometimes | 6 | 3.4 |
| *OAF Support* | | |
| Farm inputs | 169 | 94.4 |
| Market | 10 | 5.6 |
| Financial inputs | 0 | 0.0 |

Source: Field Data (2019)

Plates 3 and 4 below were further taken to show the kind of assistance given by OAF


***Plate 3:*** *OAF farmer receiving farm inputs.* Source: Fieldwork (2019).

Plate 3 shows OAF adopters at a collection centre receiving farm inputs from field officers. It was revealed that maise seeds, fertilisers, bean seeds, and acetylic powder were given as inputs. Respondents also indicated that some farm inputs such as improved maise seeds (WH505), bean seeds, and planting fertilisers (DAP, 80kg/acre) were given to farmers at the onset of the planting season (March), while top dressing fertiliser (CAN) was issued when the maise crop is at its knee-high height. Respondents also reported that farm inputs were advanced to them as loans, with repayment expected from the output.


***Plate 4:*** *OAF maise preservation bags.* Source: Fieldwork (2019).

Plate 4 shows a farmer displaying maise preservation sacks. During interviews, it was reported that maise drying bags and storage sacks/preservation bags are given in July when maise is ready for harvest. In an interview, a 45-year-old male key informant who is also a primary school teacher commented on the reasons for the popularity of OAF among farmers in Bungoma County. He mentioned that OAF provides inputs such as maise seeds, fertiliser, storage sacks, and Super acetylic powder on credit and on time. Additionally, OAF offers good and regular training in crop management, which leads to high yields.

The above sentiment is very vital in achieving the third study objective as it informs the study on factors influencing the adoption of OAF. The information given indicates that OAF has effectively managed to recruit farmers because of its overwhelming support, such as good training and demonstration in farming, provision of inputs on credit, forming farmer's groups, and ensuring good harvest. This portrayal highlights the relative advantage of OAF, as its benefits supersede those of previous farming systems.

## 4. Conclusions and Recommendations

OAF management should consider the development of farmer cooperative societies that can provide farmers with inputs at a lower cost. This approach will address challenges identified by farmers, such as high input costs and high interest rates on loans. Cooperatives offer a range of maise breeds for farmers to choose from, which can have a positive impact on adoption rates. To facilitate greater contact with farmers and promote the spread of the benefits of adopting OAF agricultural innovation, it is important to strengthen the farmer-to-farmer information pathways. This can be achieved by training a select group of farmers on OAF agricultural innovations, who can then disseminate this knowledge to their colleagues in the study area. Based on these findings, the following recommendations were made:

- Farm visits have been shown to contribute to the adoption of technology. However, the study recommends increasing the frequency of these visits from quarterly to monthly in the study area.
- The study revealed that field officers are responsible for training farmers on maise agronomic and management practices. However, it is recommended that farmers also receive training on crop diversification and marketing in order to empower them with additional income streams and reduce their reliance on OAF for input loans.
- While most respondents reported receiving loaned inputs from OAF, such as IMV, fertiliser, storage sacks, and pesticides, only a small percentage of farmers (5.6%) reported receiving market facilitation assistance, where they were supported in selling their produce. There is a need to raise awareness and provide information on market access to farmers.

## 5. Declarations

**Authors contributions:** Conceptualisation (P.F.K. & M.S.); Literature review (P.F.K. & M.S.); methodology (P.F.K. & M.S.); software (P.F.K.); validation (M.S.); formal analysis (P.F.K. & M.S.); investigation (P.F.K. & M.S.); data curation (P.F.K.) drafting and preparation (P.F.K. & M.S.); review and editing (P.F.K. & M.S.); supervision (M.S.); project administration (P.F.K. & M.S.); funding acquisition (N/A). All authors have read and approved the published version of the article.

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**Data availability:** The data for the study can be found in the body of the work. However, more information is available from the corresponding author on request.

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