JENER Journal of Empirical and Non-Empirical Research
Volume 2, Issue 3, Page 416-424 | Article No. 59
DOI: 10.4898/jener.v2i3.a59
ISSN: 7895-9216
Journal homepage: https://jenerjournal.com
Journal email: editor@jenerjournal.com

JENER Journal
JENER Journal of Empirical and Non-Empirical Research

Evaluating the Effectiveness of Handling Practices in Minimizing Afflation Contamination in Beans

Gideon Banda[1] & Mwenya Silombe[2]

[1,2]Department of Agriculture and Environmental sciences school of engineering information and Commutation University

ARTICLE INFORMATION

Article history:
Published: March 2026

Keywords:
Aflatoxing
Beans
Drying
Storage
Hermetic Technology

ABSTRACT

The purpose of this study is to empirically examine how informal transportation system affects urban criminal threats in Abuja, Nigeria. The research hinged on Routine Activity Theory to provide a comprehensive explanation of urban criminal threats. The study adopts a descriptive cross-sectional survey research design. Data are collected from civil servants, students, and private sector workers, residents of urban neighbourhoods, and registered traders and market women across Federal Capital Territory, using a structured questionnaire with a total sample size of 384 respondents involved in the study. The data are analysed using Partial Least Squares Structural Equation Modelling (PLS-SEM), which is suitable for predictive analysis and theory extension in emerging research contexts. The findings revealed that for the direct relationship, law enforcement threats, operator density and route coverage have positive and significant relationship with urban criminal threats. While law enforcement presence moderates the relationship between operator density and urban criminal threats, also, law enforcement presence moderates the relationship between route coverage and urban criminal threats. Therefore, it is recommended that Nigeria Police force should focus resources on areas with high operator density, as increased law enforcement presence in these zones can effectively reduce urban criminal threats.

1. Introduction

Afflation contamination remains one of the most persistent and harmful food safety concerns affecting agricultural value chains in Sub-Saharan Africa. Beans, a major staple and source of protein in Zambia, are particularly vulnerable due to post-harvest conditions that favor fungal growth. The warm and humid climate in many bean growing regions accelerates the proliferation of Aspergillus species, leading to contamination that threatens both human health and market access. Smallholder farmers, who constitute the backbone of Zambia's agricultural economy, rely heavily on traditional post-harvest practices. Such practices include drying beans on bare ground, storing them in woven polypropylene bags, and using rudimentary threshing techniques. These conditions increase moisture retention, physical damage to beans, and exposure to fungal spores, all of which create an ideal environment for afflation formation. The consequences of these contaminants are severe: aflatoxin B1 has been recognized as a potent hepatocarcinogen, contributing to chronic illnesses and reduced immune function. At the economic level, contamination restricts trade opportunities, as many export markets enforce strict maximum allowable limits for aflatoxins.

To address these challenges, recent years have seen a growing emphasis on improved post-harvest handling technologies designed to minimize contamination. These include solar drying systems, mechanical dryers, hermetic storage solutions, and structured sorting processes. Despite their proven effectiveness in controlled research environments, adoption among smallholder farmers remains limited. The constraints vary from technological and economic barriers to low awareness and limited access to training. Therefore, evaluating the real-world effectiveness of these interventions is critical. This study focuses specifically on bean production in Munyezi, a community within Mbala District, where beans represent both a food staple and a cash crop. By comparing traditional practices with improved handling methods, the study aims to quantify reductions in aflatoxin levels and identify the most impactful combination of interventions.

2. Literature Review

This chapter presents a comprehensive and critical analysis of the existing body of scholarly work relevant to the problem of aflatoxin contamination in beans, with a specific focus on post-harvest handling practices as the primary mitigation strategy. The purpose of this review is to situate the current study within the broader academic discourse, identify the theoretical and empirical foundations upon which it builds, and pinpoint the specific research gaps it aims to fill. The chapter is systematically organized to first establish a foundational understanding of aflatoxins, their global significance, and the agronomic conditions that foster their proliferation. It then delves into an in-depth empirical review, structured hierarchically from a global perspective to regional (African) and finally local (Zambian) contexts, examining the evidence related to drying, storage, and handling practices. This tripartite structure allows for a nuanced understanding of how the aflatoxin challenge manifests at different scales and how intervention strategies must be contextualized. The chapter further explores the socio-economic dimensions of aflatoxin management and the policy landscape, culminating in a critical synthesis that highlights the contradictions, consistencies, and overarching gaps in the literature. Finally, the chapter explicitly outlines the research gaps identified, thereby providing a clear and compelling justification for the present study on evaluating handling practices in Munyezi, Zambia

Chemical Nature and Producing Fungi

Aflatoxins are a group of structurally related difuranocoumarin compounds produced as secondary metabolites primarily by the filamentous fungi *Aspergillus flavus* and *Aspergillus parasitic us* (Kumar et al., 2021). The most prevalent and toxicologically significant aflatoxins are B1, B2, G1, and G2, designated based on their blue (B) or green (G) fluorescence under ultraviolet light and their chromatographic properties (IARC, 2012). Among these, Aflatoxin B1 (AFB1) is the most potent, classified as a Group 1 human carcinogen by the International Agency for Research on Cancer (IARC). These fungi are ubiquitous in nature, inhabiting soil, air, and decaying plant matter. They are opportunistic pathogens that can invade crops pre-harvest, particularly under stress conditions like drought, but the most significant proliferation and toxin production often occur post-harvest if the crop is not handled and stored properly.

Health Implications and Economic Consequences

The public health burden of aflatoxin exposure is staggering. Chronic dietary intake is unequivocally linked to hepatocellular carcinoma (HCC), with a synergistic effect observed in populations with high prevalence of Hepatitis B virus, leading to a multiplicative increase in liver cancer risk (Liu & Wu, 2010; WHO, 2018). Beyond carcinogenicity, aflatoxins are potent immunosuppressants, compromising both cell-mediated and humoral immunity, thereby increasing susceptibility to infectious diseases such as malaria, HIV/AIDS progression, and childhood diarrheal diseases (Jiang et al., 2005; Turner et al., 2003). Perhaps most insidiously, chronic exposure in children is strongly associated with growth faltering (stunting) and impaired cognitive development, effectively locking future generations into a cycle of poverty and underachievement (Khlangwiset et al., 2011). Gong et al. (2002) in a seminal study in Benin and Togo, found a significant inverse correlation between aflatoxin-albumin adduct levels in children's blood and their growth indices.

Economically, the impact is multi-faceted. Direct losses occur from condemned harvests, reduced livestock productivity and health from contaminated feed, and the costs of regulatory monitoring and control programs (Wu, 2004). Indirectly, international trade is severely hampered. Stringent aflatoxin regulations in developed markets, particularly the European Union, act as non-tariff barriers to trade. Otsuki et al. (2001) estimated that the implementation of the EU's aflatoxin standards could reduce African exports of cereals, dried fruits, and nuts by 64%, or US$670 million, underscoring the massive foregone revenue for agricultural-dependent economies.ldred, 2007).

The Agronomy and Susceptibility of Beans to Aflatoxin Contamination

Beans (*Phaseolus vulgaris* L.) are a vital source of plant-based protein, complex carbohydrates, and essential micronutrients for millions of people, particularly in Latin America and Sub-Saharan Africa (FAO, 2020). However, their physical and physiological characteristics make them susceptible to fungal invasion. The seed coat, while protective, can be compromised by mechanical damage during harvesting, threshing, or handling, creating direct pathways for fungal spores to reach the nutrient- rich cotyledons (López et al., 2015). Furthermore, beans are often grown and harvested in periods of high humidity, and if not dried promptly and adequately, the high initial moisture content provides an ideal substrate for *Aspergillus* growth.

The critical moisture content for safe storage of beans is generally considered to be below 13%, as levels above this threshold support fungal metabolism and aflatoxin production (Mutungi et al., 2008). Unlike field crops like maize, where contamination can initiate pre-harvest, the primary risk period for beans is post-harvest, making the focus on drying, storage, and handling not just important, but the central front in the battle against contamination (Kaaya & Kyamuhangire, 2010).

Global Perspective

Globally, a wide spectrum of drying technologies is employed, ranging from traditional methods to highly sophisticated industrial systems. In developed countries, mechanical drying is the norm, allowing for precise control over temperature and airflow to rapidly reduce moisture content to safe levels, effectively minimizing the window of opportunity for fungal growth (Mutegi et al., 2013).

Regional Perspective (Africa)

Across Africa, the reliance on traditional sun-drying remains pervasive and its link to high aflatoxin levels is well-documented. A study in Nigeria by Adebayo et al. (2019) on maize and melon seeds found that sun-drying on bare ground led to aflatoxin levels that were frequently above the 10 ppb regulatory limit, whereas simple interventions like using black polypropylene sheets as a drying surface significantly reduced contamination. For beans specifically, a study in Tanzania by Mamiro et al. (2017) found that the duration of sun-drying was a critical factor; delays in achieving safe moisture content due to rainy weather were directly correlated with a spike in aflatoxin B1 levels.

The adoption of improved solar dryers, while promising, faces challenges. Mugisha et al. (2014) evaluated the use of low-cost solar dryers for groundnuts in Uganda and found them highly effective, reducing aflatoxin levels by over 70% compared to traditional methods. However, the study also highlighted barriers to adoption, including the initial cost of construction and the need for technical knowledge for proper operation and maintenance, pointing to a common theme across the region: the gap between technical efficacy and widespread adoption.

Local Perspective (Zambia)

Within Zambia, research on post-harvest drying has predominantly focused on maize, the national staple. Studies by Kachapulula et al. (2019) and Bumbangi et al. (2020) have consistently shown that improper drying of maize on bare ground and prolonged exposure to high humidity are major drivers of aflatoxin contamination in the country. While data specific to beans is scarcer, the principles are transferable. The climatic conditions in Zambia's Northern Province, including Munyezi, with their high humidity and unpredictable rainfall, create a high-risk environment where traditional sun-drying is particularly hazardoust effective single interventions for preventing aflatoxin accumulation.

Global Perspective

The primary goal of effective storage is to maintain the safe moisture content achieved during drying and to prevent re-infestation or fungal growth. Globally, hermetic (airtight) storage has emerged as a gold standard for smallholder farmers. The principle is based on creating an oxygen-depleted
environment through the respiration of the stored grain, insects, and microorganisms, which suppresses insect pests and halts the growth of aerobic fungi like *Aspergillus* (Villers et al., 2016). A global meta-analysis by Baributsa et al. (2020) confirmed that hermetic storage technologies (e.g., PICS bags, metal silos) consistently reduce aflatoxin accumulation and eliminate insect damage in a variety of grains and legumes without the use of pesticides.

Modified Atmosphere Storage (MAS), which involves actively altering the storage environment's gas composition (e.g., with high CO_2 or N_2), is another effective method used in commercial settings. Research in China and the USA has shown that storing grains in atmospheres with >60% CO_2 can completely inhibit aflatoxin production (Njoroge et al., 2019). However, the high cost and technical requirements of MAS make it less accessible for small-scale applications in developing countries. *Aspergillus* growth.

3. Methodology

The research employed a mixed-methods design combining laboratory testing, farmer surveys, and field-based observations. First, freshly harvested beans were collected directly from participating farmers. Samples were divided into treatment groups reflecting different handling practices: traditional sun drying on bare soil; solar drying on raised platforms using transparent sheeting; mechanical drying using low-heat forced-air systems; and combined drying and sorting interventions.

Sorting involved the manual removal of moldy, discolored, insect-damaged, or Evaluating the Effectiveness of Handling Practices in Minimizing Aflatoxin Contamination in Beans shriveled beans. Storage treatments included traditional woven polypropylene bags and hermetic storage bags designed to restrict airflow and limit oxygen availability. Each treatment group was monitored over a defined period, during which temperature and humidity conditions were recorded. Aflatoxin quantification was conducted using High-Performance Liquid Chromatography (HPLC), consistent with international food safety testing standards. HPLC provides highly sensitive and accurate readings, enabling clear differentiation between aflatoxin levels across treatments. Farmer surveys were conducted to understand awareness, attitudes, and adoption barriers related to improved handling practices. Participants were selected through stratified sampling to ensure representation across different production scales. Qualitative data from interviews were triangulated with quantitative results to provide a comprehensive analysis of the factors influencing aflatoxin contamination in Munyezi.

4. Findings

Findings from Other African Studies These findings are consistent with research from Kenya, Tanzania, and Ghana, which has repeatedly shown woven sacks to be ineffective at preventing aflatoxin accumulation. Ncube et al. (2011) found that aflatoxin levels increased significantly in maize stored in woven sacks compared to hermetic alternatives. Ng'ang'a et al. (2016) similarly reported that woven sacks allowed aflatoxin concentrations to rise rapidly during humid months. Implications for Smallholder Farmers although woven sacks remain popular due to their low cost and wide availability, they present substantial food safety risks. Their permeability creates a dynamic storage environment that
responds to external temperature and humidity changes—conditions over which farmers have no control. For this reason, woven sacks are ill-suited to safeguarding dried beans in regions prone to moisture fluctuations. 4. Survey Findings: Farmer Knowledge, Perceptions, and Adoption Barriers

Farmers Have Limited Awareness of Aflatoxin Risks Survey data revealed that although most farmers associate mold with spoilage, fewer than 20% understood its connection to aflatoxins. Many believed aflatoxin contamination is always visible, despite its known invisibility. The lack of awareness about the health implications aligns with prior findings that smallholder farmers in many African regions remain unfamiliar with aflatoxin toxicity and market consequences (Lewis et al., 2005; Mmongoyo et al., 2017). Knowledge gaps inhibit adoption because farmers do not perceive aflatoxin mitigation as an urgent priority.

Cost, Availability, and Labour Requirements Influence Adoption the primary barriers identified were:

• High cost of drying and storage technologies,
• Limited availability of hermetic bags or solar dryers in local markets,
• Labour demands associated with sorting,
• Insufficient training on equipment use.

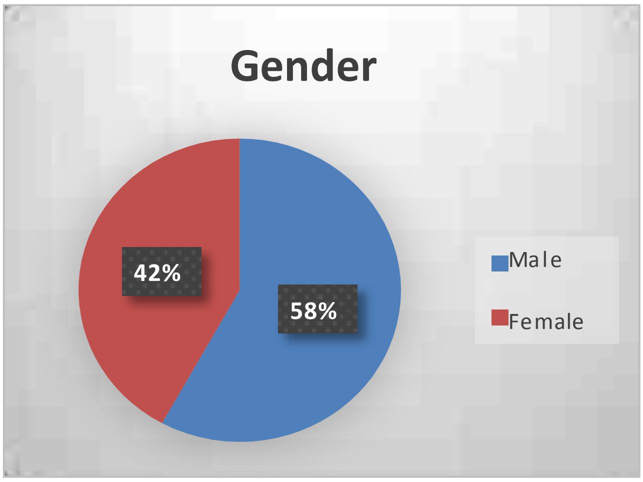
These results are consistent with evidence showing that affordability and convenience strongly influence farmers' willingness to adopt post-harvest innovations (Abebe et al., 2020; Grace et al., 2015). 4.3 Demonstration-Based Learning Increased Adoption Intentions Farmers who participated in demonstrations expressed strong willingness to adopt improved drying and storage

methods. Observing results firsthand increased trust, corrected misconceptions, and provided practical understanding. These findings echo those of Hoffmann et al. (2018), who found that experiential learning approaches significantly accelerate adoption of aflatoxin-control practices.
Efficient drying methods (solar or mechanical),
Systematic sorting,
Hermetic storage, and
Farmer-centered awareness initiatives.
By combining these practices, contamination levels can be reduced dramatically, contributing to safer food systems, Improved marketability, and enhanced public health.

Socio-Demographic Characteristics of Respondents
The study surveyed 150 smallholder bean farmers in Munyezi area. The demographic profile revealed a community predominantly comprised of experienced farmers with small land holdings.

Table 4.1.1: Gender Distribution of Respondents

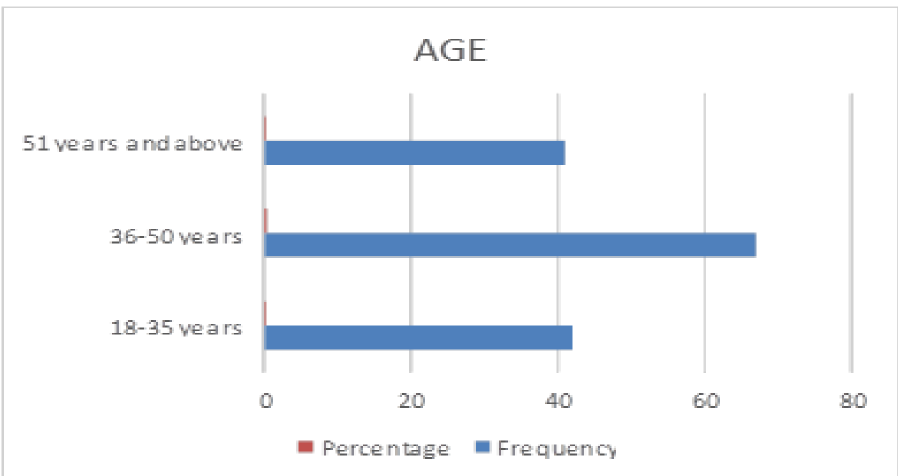
Gender	Frequency	Percentage
Male	87	58.0%
Female	63	42.0%
Total	150	100%



The majority of respondents were male, indicating their predominant role as bean farmers in the study area. This gender distribution suggests that interventions should be designed with consideration for male-dominated farming practices.

Table 4.1.2: Age Profile of Respondents

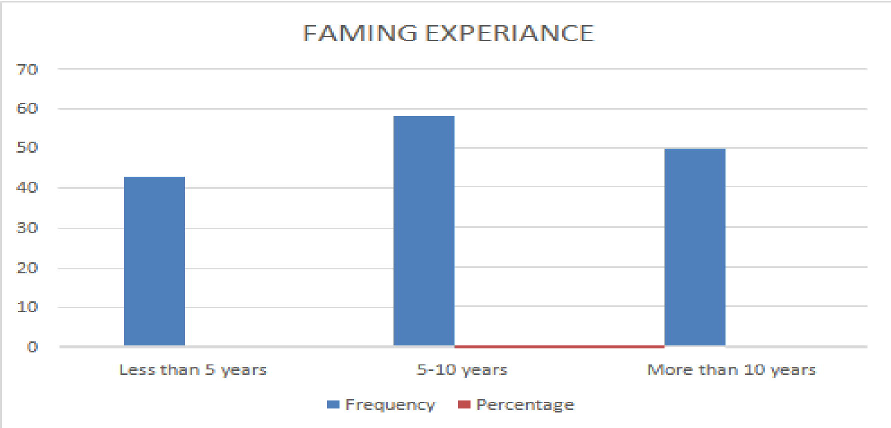
Age Group	Frequency	Percentage
18-35 years	42	28.0%
36-50 years	67	44.7%
51 years and above	41	27.3%
Total	150	100%



Most farmers fell within the middle-aged bracket of 36-50 years, representing a mature and potentially experienced farming population. This age profile suggests that farmers have substantial practical experience but may also be more accustomed to traditional practices.

Table 4.1.3: Farming Experience of Respondents

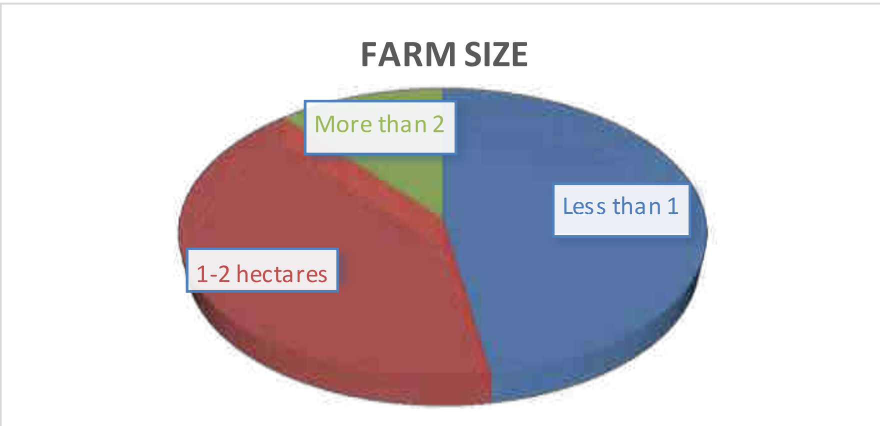
Farming Experience	Frequency	Percentage
Less than 5 years	43	28.7%
5-10 years	58	38.7%
More than 10 years	49	32.6%
Total	150	100%



The largest group of farmers had 5-10 years of experience, indicating a substantial level of practical knowledge in bean cultivation. Combined with those having over a decade of experience, this shows that most respondents are not newcomers to farming.

Table 4.1.4: Farm Size Distribution

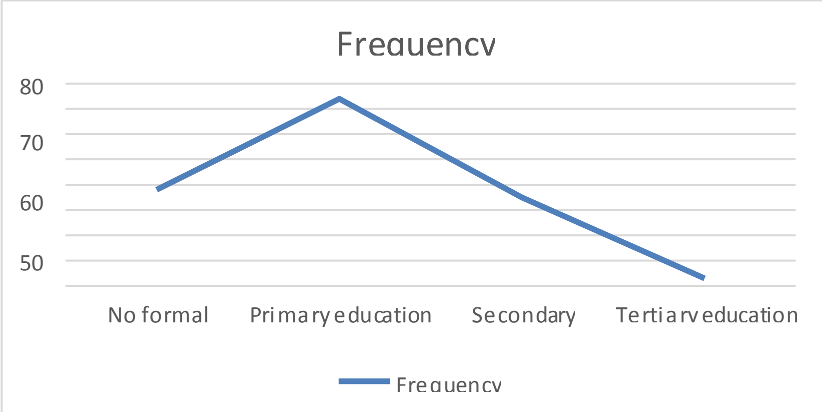
Farm Size	Frequency	Percentage
Less than 1 hectare	71	47.3%
1-2 hectares	62	41.3%
More than 2 hectares	17	11.4%
Total	150	100%



Nearly half of all farmers operated on very small plots of less than one hectare, confirming the smallholder nature of bean production in Munyezi. This prevalence of small land holdings has significant implications for the economic feasibility of adopting new technologies.

Table 4.1.5: Education Levels of Respondents

Education Level	Frequency	Percentage
No formal education	38	25.3%
Primary education	74	49.3%
Secondary education	35	23.3%
Tertiary education	3	2.0%
Total	150	100%



The majority of farmers had only primary-level education, which may limit their access to technical information about aflatoxin management. This educational profile underscores the need for practical, hands-on training approaches rather than written materials.

Awareness and Knowledge of Aflatoxin Contamination
The study investigated farmers' understanding of aflatoxins and their implications.

Table 4.2.1: General Awareness of Aflatoxins

Heard about Aflatoxins	Frequency	Percentage
Yes	53	35.3%
No	97	64.7%
Total	150	100%

A significant majority of farmers had never heard of aflatoxins, revealing a critical knowledge gap at the most fundamental level. This lack of basic awareness suggests that farmers cannot be expected to mitigate a risk they do not know exists.

Table 4.2.2: Sources of Aflatoxin Knowledge (n=53)

Source of Knowledge	Frequency	Percentage
Extension officers	28	52.8%
Radio programs	15	28.3%
Fellow farmers	7	13.2%
NGOs	3	5.7%
Total	53	100%

For the minority who were aware, extension officers served as the primary source of information, highlighting their crucial role in agricultural knowledge dissemination. This finding underscores the importance of strengthening extension services as a key channel for aflatoxin awareness campaigns.

Table 4.2.3: Understanding of Health Effects (n=53)

Understanding of Health Effects	Frequency	Percentage
Can cause sickness	31	58.5%
Linked to long-term health problems	12	22.6%
No specific knowledge	10	18.9%
Total	53	100%

Most aware farmers understood aflatoxins only in terms of causing general sickness rather than specific chronic diseases like liver cancer. This superficial understanding indicates that even among the informed, comprehension of the severe health risks remains limited.

Table 4.2.4: Knowledge of Economic Impacts (n=53)

Knowledge of Economic Impacts	Frequency	Percentage
Reduces market value	25	47.2%
Causes rejection by buyers	18	34.0%
No knowledge of economic impacts	10	18.9%
Total	53	100%

Nearly half of the aware farmers recognized that aflatoxins reduce market value, showing some understanding of the economic consequences. However, the fact that most farmers overall are unaware suggests this economic incentive is not driving changes in practice.

Current Post-Harvest Handling Practices

Drying Methods and Challenges

Table 4.3.1: Primary Drying Methods Used

Primary Drying Method	Frequency	Percentage
Direct ground drying	114	76.0%
On tarpaulins/mats	27	18.0%
Raised platforms	9	6.0%
Total	150	100%

An overwhelming majority of farmers dried their beans directly on the ground, a high-risk practice that exposes crops to soil-borne fungi and contaminants. This prevalent method represents a major contamination point in the post-harvest value chain. Despite the identified barriers, farmers expressed strong interest in adopting improved practices if supported.

Table 4.10.1: Willingness to Adopt Improved Methods

Willingness to Try Improved Methods	Frequency	Percentage
Yes, if support provided	138	92.0%
Not interested	12	8.0%
Total	150	100%

An overwhelming majority expressed willingness to adopt improved practices if adequate support is provided, indicating strong potential for intervention success. This high level of interest suggests farmers are not resistant to change but constrained by circumstances.

Table 4.10.2: Preferred Support Mechanisms

Preferred Support Mechanism	Frequency	Percentage
Subsidies on technologies	135	90.0%
Practical training	120	80.0%
Better market prices	105	70.0%
Access to credit	98	65.3%
Demonstration plots	87	58.0%

Nearly all farmers requested subsidies to lower the cost barrier, making this the most demanded form of support. Practical training was also highly prioritized, indicating recognition of the need for skill development.

Table 4.10.3: Social Influence on Practices

Social Influence on Practices	Frequency	Percentage
Learn from other farmers	105	70.0%
Follow family traditions	93	62.0%
Independent decision makers	42	28.0%

This chapter provides the concluding synthesis of the study, analyzing the key findings from the research that evaluated the effectiveness of handling practices in minimizing aflatoxin contamination in beans in Munyezi, Mbala District. It reflects on the extent to which the research objectives were achieved and summarises the major outcomes, grounded in the empirical evidence presented. Building directly upon the interpreted data and the identified challenges, this chapter presents a set of actionable, evidence-based recommendations. These recommendations are specifically tailored to address the study's objectives and are aimed at farmers, extension services, policymakers, and development partners to facilitate the widespread adoption of improved practices, thereby enhancing food safety, public health, and livelihood security in the community.

5. Conclusion

The study successfully achieved its general objective of evaluating the effectiveness of handling practices in minimizing aflatoxin contamination in beans within the Munyezi area. The findings paint a clear and concerning picture of a community grappling with a significant but largely unperceived threat to both health and economic stability. The research conclusively demonstrates that the current post-harvest handling paradigm is fundamentally high-risk. The widespread reliance on traditional sun-drying on bare ground (76.0%) and storage in permeable sacks (92.6%), creates ideal conditions for the proliferation of *Aspergillus* fungi and the subsequent production of aflatoxins. This risk is exacerbated by handling techniques that cause mechanical damage, such as beating with sticks (62.0%), and inadequate transport packaging.

A critical barrier identified is the profound lack of awareness, with 64.7% of farmers having no knowledge of aflatoxins. This knowledge gap eliminates the primary incentive for behavioral change. The adoption of proven, improved technologies is severely hampered by economic constraints; high cost was the predominant barrier for 85.3% of farmers, compounded by a crippling lack of local availability (94.7%) and access to training (76.0% had received none). Despite these challenges, a key positive finding is the overwhelming willingness of farmers (92.0%) to adopt new practices if provided with the necessary support, indicating a clear pathway for intervention and a rejection of the notion of farmer indifference.

6. Recommendations

Based on the findings of this study, the following actionable recommendations are proposed, each directly aligned with the specific objectives of the research and tailored for key stakeholders.

a. To Address Specific Objective 1 (Impact of Drying Methods): For the Ministry of Agriculture, NGOs, and Extension Services:

Promote Affordable Solar Drying Solutions: Government agencies and development partners should initiate programs to promote the adoption of low-cost solar drying technologies. This should be operationalized through the establishment of community demonstration plots to showcase the construction and use of simple, cost-effective solar dryers, coupled with targeted subsidies or microcredit schemes to enable farmers to acquire tarpaulins and materials for constructing raised drying racks. This directly addresses the high contamination rates from ground drying.

Intensify Education on Moisture Management: Extension services should intensify farmer education campaigns focusing on the critical link between prolonged drying times, moisture content, and aflatoxin growth. Messages should emphasise the economic and health benefits of achieving safe moisture levels (<13%) rapidly, leveraging the finding that 89.3% of farmers face dust contamination, which improved drying mitigates.

b. To Address Specific Objective 2 (Effectiveness of Storage Methods): For the Ministry of Agriculture, Agro-dealers, and Financial Institutions:

Scale Up Hermetic Storage Access: A concerted effort should be made to scale up the use of hermetic storage solutions. The Ministry of Agriculture, in partnership with cooperatives and NGOs, should develop and implement a smart subsidy program or voucher system to lower the entry cost of hermetic bags for smallholder farmers. Parallel to this, local agro-dealers should be supported through business development services to ensure consistent local availability, addressing the 94.7% reported lack of access.

Disseminate Integrated Storage Messages: Extension messages should be refined to clearly articulate the dual economic benefit of hermetic storage in simultaneously controlling both insect infestation (a problem for 90.0% of farmers) and fungal growth. For farmers unable to immediately access hermetic bags, training on the use of effective local desiccants like clean, dry wood ash as an interim improvement in traditional sacks should be provided.

c. To Address Specific Objective 3 (Combined Effect of Handling Practices): For Extension Services, Farmer Cooperatives, and Training Institutions:

Develop and Deliver Integrated Post-Harvest Training: Integrated, practical training programs that treat drying, storage, and handling as interconnected practices must be developed and delivered. These programs should include hands-on modules on careful harvesting techniques to minimise pod damage (addressing the 62.0% using damaging methods), proper sorting and cleaning to remove defective kernels and the use of better packaging during transport to prevent physical damage and moisture uptake.

Leverage Social Learning for Dissemination: To enhance adoption, these programs should actively leverage the finding that 70.0% of farmers learn from their peers. This can be achieved by establishing and supporting Farmer Field Schools (FFS) and identifying and training "Champion Farmers" within Munyezi to facilitate community-based learning and the dissemination of best practices, creating a self-sustaining model for knowledge transfer.

d. Overarching Cross-Cutting Recommendations: For Policymakers, Researchers, and Development Partners:

Create Market-Led Incentives: Policymakers and private sector actors should explore and develop market structures that provide a price premium for aflatoxin-safe beans. This creates a powerful economic incentive that can drive the sustained adoption of improved practices, directly addressing the economic constraints highlighted by farmers.

Mainstream Aflatoxin Awareness in Public Health Campaigns: Given the profound lack of awareness (64.7%), public health authorities should integrate messages about the health risks of aflatoxins (linking to liver cancer and child stunting) into existing community health outreach programs, moving beyond the agricultural sector to create broader societal demand for safer food.

References

[1] Abass, A. B., Ndunguru, G., Mamiro, P., Alenkhe, B., Mlingi, N., & Bekunda, M. (2018). Post-harvest food losses in Africa: Analytical review and synthesis. Food Security, 10(1), 1–22. Abebe, G., et al. (2020). Adoption of post-harvest technologies among smallholder farmers: Determinants and implications. Agricultural Systems, 178, 102735. Ayalew, A., et al. (2016). Reduction of aflatoxin contamination through improved grain sorting and handling practices. Journal of Stored Products Research, 67, 53–59.

[2] Baoua, I. B., et al. (2014). Performance of hermetic bags in preventing insect infestation and fungal growth. Journal of Stored Products Research, 58, 48–52.

[3] De Groote, H., et al. (2013). Evaluating hermetic storage technologies for smallholder farmers. Food Security, 5(3), 397–409.

[4] Grace, D. et al. (2015). The role of food safety in agricultural value chains. Food Policy, 55, 1–11.

[5] Hoffmann, V., et al. (2018). Training and trust: Improving aflatoxin-control practice adoption. World Development, 105, 262–273.

[6] Houssou, P., et al. (2019). Mechanical drying technologies and their role in aflatoxin mitigation. African Journal of Food Science, 13(5), 88–98.

[7] Kabak, B., Dobson, A. D., & Var, I. (2006). Strategies to prevent mycotoxin contamination. Critical Reviews in Food Science and Nutrition, 46(8), 593–619.

[8] Lewis, L., et al. (2005). Aflatoxin contamination and associated disease outbreaks in Kenya. Environmental Health Perspectives, 113(12), 1763–1767.

[9] Mmongoyo, J. A., et al. (2017). Aflatoxin contamination and knowledge among smallholder farmers. Food Control, 72, 265–273.

[10] Mutegi, C., et al. (2013). Factors associated with aflatoxin contamination in maize. Journal of Stored Products Research, 53, 88–96.

[11] Ncube, E., et al. (2011). Assessment of postharvest storage technologies on aflatoxin accumulation. Food Additives & Contaminants, 28(12), 1682–1688.

[12] Ng'ang'a, J., et al. (2016). Post-harvest storage methods and their effect on aflatoxin levels. Toxins, 8(6), 180. Ochieng, R., et al. (2020). Effectiveness of solar drying technologies in grain preservation. Renewable Energy, 152, 1–10.

[13] P. Kumar et al., Aflatoxins: A global concern for food safety, Food Chemistry, 2021. R. Bandyopadhyay et al., Integrated aflatoxin management strategies in Africa, Food Control, 2021.

[14] Turner, P. C., et al. (2005). Reducing exposure to aflatoxins: The role of food sorting and handling. Environmental Health Perspectives, 113(12), 1769–1773. WHO, Aflatoxins: Health impacts and control strategies, 2018

.
.