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Rural Women's Participation in Managing Aflatoxin Contamination in the Groundnut Postharvest Value Chain in Chemba District, Tanzania

Robert Komba [a*], Dismas Mwaseba [a] and Respikius Martin [b]

[a] Department of Agricultural Extension and Community Development, Sokoine University of Agriculture, P.O. Box 3002, Morogoro, Tanzania.
[b] Department of Sociology and Anthropology, Sokoine University of Agriculture, P. O. Box 3035, Morogoro, Tanzania.

Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Aims: This study sought to determine the extent of rural women's participation in managing aflatoxin contamination in the groundnut postharvest value chain.
Study Design: The study employed a cross-sectional mixed-methods research design involving quantitative and qualitative methodologies.
Place and Duration of Study: The study was conducted in the Chemba District in Dodoma Region, Tanzania situated at the coordinates 05°14′ 34″ S latitude and 35°53′ 24″ E longitude, respectively.

**Corresponding author: Email: robertkomba2007@gmail.com;*

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Methodology: The primary data for the study were obtained from a random sample of 137 female groundnut farmers residing in twelve (12) villages from eight (08) wards in Chemba District. A questionnaire was used to collect quantitative data, while an FGD guide, checklist, and participant observation were employed to obtain qualitative data.
Results: The findings show that women groundnut farmers participate partly in various aflatoxins-related project activities in decision making (50.36%), implementation (44.52%), benefits (59.85%), and evaluation (51.09%). Moreover, the findings of the study show that women participate in groundnut postharvest activities involving cleaning, drying, grading, sorting, processing, packing, storage, and marketing. However, the study shows that women's participation in groundnut postharvest activities for managing aflatoxin is low. The findings also indicate that there is no statistically significant association between women's involvement in aflatoxin management and their age ($\chi2 = 7.800$, $P = 0.099$), years of engagement in agriculture ($\chi2 = 3.556$, $P = 0.469$), and farm size ($\chi2 = 2.004$, $P = 0.735$). Additionally, a statistically significant association was observed between women's participation in managing aflatoxin and their level of education ($\chi2 = 12.650$, $P = 0.013$*), as well as their marital status ($\chi2 = 27.550$, $P = 0.000$***).
Conclusion: The study found that rural women's participation in managing aflatoxin contamination in the groundnut postharvest value chain is critical. Hence, this study recommends developing strategies and initiatives targeting and supporting women's participation in managing aflatoxin contamination in the groundnut postharvest value chain.

Keywords: Women participation; groundnuts; aflatoxin; postharvest; value chain; project activities.

1. INTRODUCTION

On a global scale, the agricultural sector faces a notable challenge concerning the increasing value of groundnuts, primarily attributed to the demand for aflatoxin-free produce [1-4]. Women, who are predominantly involved in the groundnut postharvest value chain, play a crucial role in addressing this challenge [5-7]. In many developing countries, groundnuts are often referred to as the "women's crop" [8-12]. This is because groundnuts provide rural women with subsistence, nutrition, and food security through their active participation in the postharvest value chain [8,13]. The groundnut postharvest value chain involves a sequence of activities encompassing cleaning, drying, sorting, processing, grading, packing, storing, and marketing. Women's participation in these activities involves various practices and technologies to manage aflatoxin contamination.

Despite their awareness of aflatoxin and its consequences, women, especially in developing countries, face numerous challenges that hinder their effective participation in aflatoxin management practices in groundnuts (AMPGs). These challenges, including poverty, limited access to resources, and decision-making, paint a stark picture of their difficulties [14-16]. In a study conducted in the central region of Tanzania, Kimario *et al.* [17] as also reported in studies conducted in other developing countries [6,5,18-21] found that small-holder farmers, predominantly women, exhibit participation in suboptimal postharvest handling practices concerning aflatoxin contamination. Building on the available literature, this paper aims to shed light on the extent to which women in Chemba District in Tanzania participate in aflatoxin management, considering these challenges.

2. CONCEPTUAL FRAMEWORK

The conceptual framework for this study is built upon the understanding that participation lacks a universal definition and framework, originating from specific practices in particular contexts. In light of this, Cooke and Kothari [22] express concerns about participation being perceived as nebulous and difficult to quantify, particularly in a technologically driven world. To address this, our study adopts Cohen and Uphoff's [23] participation framework, which is known for its inclusivity and flexibility. This framework views participation as a descriptive concept encompassing a broad spectrum of activities and contexts. However, it is important to note that despite its inclusivity and flexibility, this framework may generate confusion due to the diverse range of activities and situations it considers.

Cohen and Uphoff [23] outline three dimensions clarifying the participation process in rural development interventions. These are the "what,"

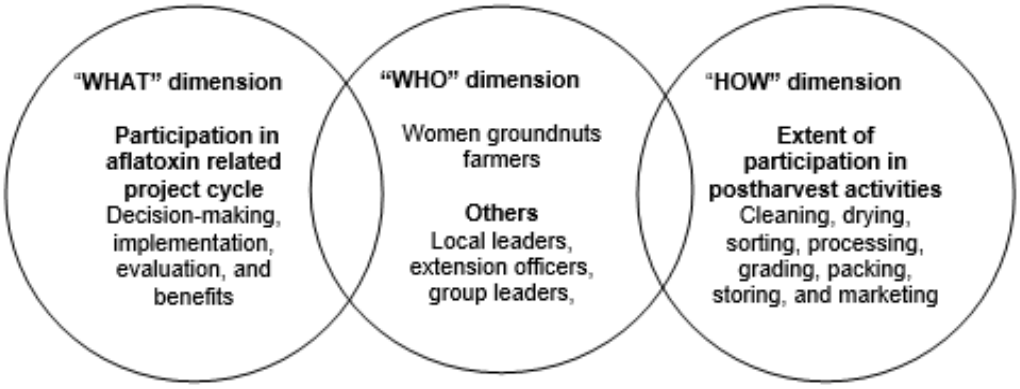

Fig. 1. The conceptual framework

"who," and "how" dimensions. The "what" dimension delineates participation in decision-making, implementation, evaluation, and benefits within the project cycle. The "who" dimension categorises the actors involved, including residents, leaders, government personnel, and foreign personnel. The "how" dimension details the mechanisms through which participation occurs, including its form, extent, and impact.

In applying this framework to rural women's participation in managing aflatoxin in the groundnut postharvest value chain, the study focuses on first the "what" dimension, which focuses on women's participation in decision-making, implementation, evaluation, and benefits in various aflatoxin-related project cycle. Second the "how" dimension, emphasising that participation allows individuals to gain greater control over situations [24]. Specifically, it assesses the extent of women's participation in various stages of groundnut management. Third, the "who" dimension primarily focuses on women groundnut farmers while also involving other actors such as local leaders, extension officers, and project representatives [25-27]. The study posits that participation is a comprehensive framework encompassing diverse elements essential for understanding and addressing rural development challenges.

3. METHODOLOGY

3.1 Description of the Study Area

The study was conducted in the Chemba District in Dodoma Region, Tanzania. Administratively, Chemba District is composed of 4 divisions, 26 wards, and 114 villages. It is situated 140 kilometres north of the regional headquarters of Dodoma City and 40 kilometres south of the Kondoa District headquarters. Famously, the district is divided into the Irangi zone, where the study was conducted, and the Sandawe zone. The District is situated at the coordinates 05°14′ 34″ S latitude and 35°53′ 24″ E longitude, respectively, concerning the Equator and the Greenwich Meridian.

According to the National Bureau of Statistics [28], the current population of Chemba District is 339,333, of whom 170,837 are males and females are 168,496. The total annual rainfall varies between 500mm and 800mm, which are influenced by geographical, seasonal, and annual factors. The temperatures in the region are subject to variation based on altitude. Agriculture and livestock farming are the primary sources of income. The agricultural practices being employed are predominantly traditional, specifically shifting cultivation, resulting in low yields of subsistence crops per hectare. Individual farmers typically engage in small-scale farming, primarily focused on crop production. Groundnuts, sunflower, sesame, and finger millet are commonly grown for commercial purposes and generate significant revenue. The study area was chosen because of the high occurrence of aflatoxin contamination in maize and groundnuts, which has been reported to have adverse effects on the local population [29].

3.2 Research Design

The study adopted a cross-sectional mixed research design, incorporating qualitative and quantitative approaches. The design was deemed suitable to uncover the extent of women's participation in managing aflatoxin in the groundnut postharvest value. The two research approaches complemented each other in the data collection process. More specifically,

the study involved a combination of methods: household surveys, Focus Group Discussions (FGDs), key informant interviews, and participant observation.

3.3 Study Population

The study population consisted of women groundnut farmers from male-headed households in selected villages where incidences of aflatoxicosis were prevalent.

3.4 Sampling Procedure and Sample Size

The sampling frame comprised groundnut women farmers in agricultural households residing in twelve (12) villages from eight wards in Chemba District. The unit of analysis was women who cultivate groundnuts. The villages that were ultimately selected for inclusion in this study were Igunga, Mapango, Soya, Mwailanje, Mwaikisabe, Isusumya, Mondo, Daki, Mlongia, Itolwa, Churuku, and Kinkima. Then, 137 agricultural households were randomly selected from the sampling frame consisting of 12130 agricultural households. The sample size in Table 1 below was calculated using the formula by Kothari [30] as follows;

$$n = \frac{Z^2 \cdot p \cdot q \cdot N}{e^2 (N-1) + Z^2 \cdot p \cdot q}$$

Where: n is the sample size; N is the sampling frame/population size; Z is the standard value at a given confidence level, i.e., 1.96 (confidence interval at 95%); p is a sample proportion (0.1); q equals to 1-p and e is sampling acceptable error, i.e., 0.05

The proportional sample size for each village was calculated by using the formula proposed by Kothari [30] $n = \frac{n}{N} x\ S$ as shown in the Table 1.

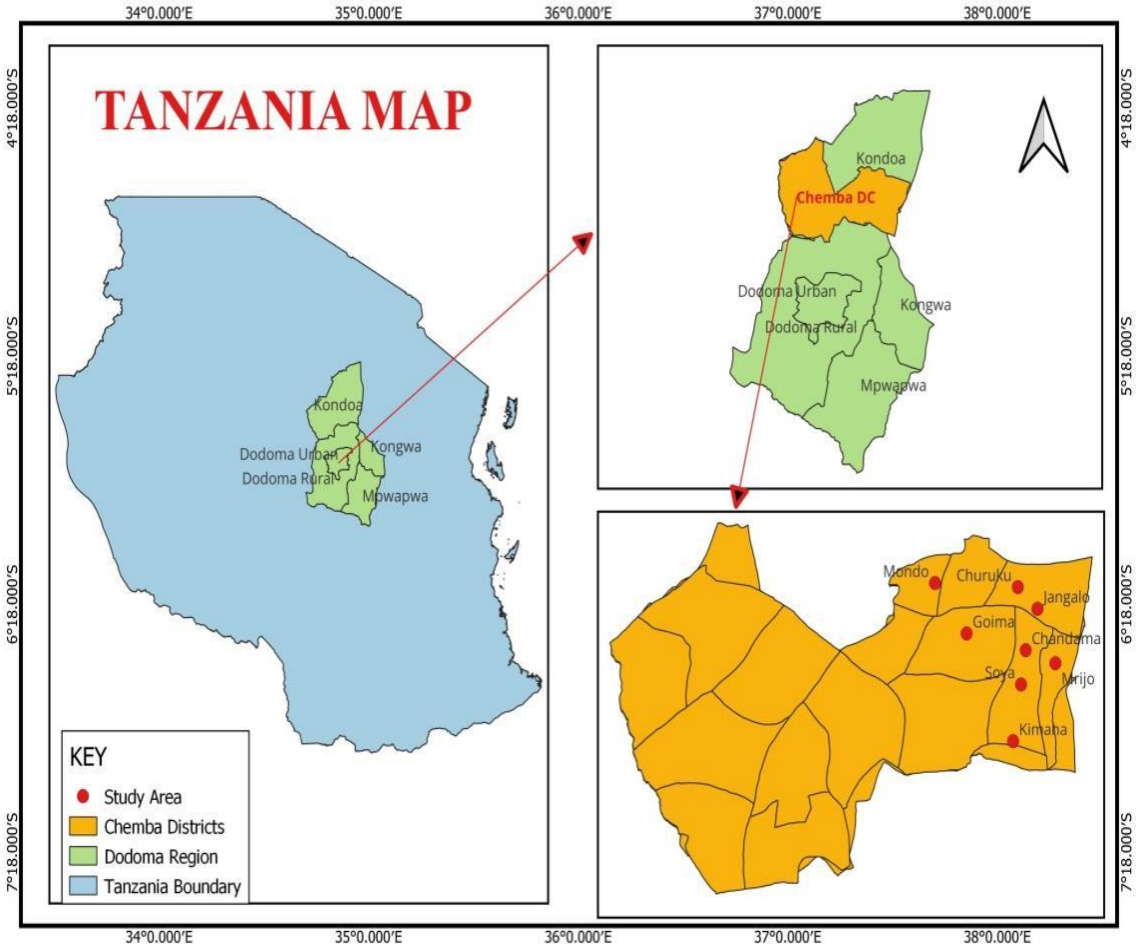

Fig. 2. Map of Chemba District council showing the location of the study area

Table 1. Proportionate sampling matrix

Wards	Village	Total Households	Agricultural Households	Sample Size
Goima	Igunga	1424	1210	14
Chandama	Mapango	806	685	8
Soya	Soya	1688	1435	16
Kimaha	Mwailanje	2414	2052	23
	Mwaikisabe	1798	1528	17
Mrijo	Isusumya	460	391	4
Mondo	Mondo	986	838	9
	Daki	214	182	2
Jangalo	Mlongia	2238	1902	21
	Itolwa	891	757	9
Churuku	Churuku	694	590	7
	Kinkima	657	558	6
		14270	12130	137

(Source: Chemba District 2022)

3.5 Data Collection Procedures

The primary data were collected using a semi-structured questionnaire using the KOBO Collect v2022.3.6 software. This tool was pre-tested on randomly selected respondents from Soya and Kimaha wards. The primary data were collected through 137 random scheduled interviews, eight (8) key informant interviews, five (5) focus group discussions (FGDs), and participant observation. Specifically, participant observation was used to complement the quantitative data by observing postharvest practices and technologies. The researcher procured secondary data from diverse sources, including online platforms, TANIPAC project reports, and official government publications. However, data regarding the perceived level of participation between men and women were obtained from women only.

3.6 Data Analysis Procedures

The primary data obtained using the KOBO Collect v2022.3.6 software were retrieved and imported into the IBM SPSS Statistics v20 software for analysis. Subsequently, a descriptive analysis was performed. The study utilised content analysis as a method for analysing qualitative data. This involved data collection, transcription, coding, and subsequent grouping of the data into themes. The field survey's quantitative data underwent processing and analysis to derive descriptive statistics, including means, standard deviations, frequencies, and percentages. The participation of women in various aflatoxin-related projects was analysed using descriptive statistics to obtain the frequencies and percentages. The perceived level of participation between men and women in the groundnut postharvest value chain was obtained from women groundnut farmers and analysed by descriptive statistics to obtain the frequencies and percentages. To assess the characteristics of the respondents, the Chi square test ($\chi 2$) was used to test whether there is a relationship between socio-economic characteristics and women's participation in aflatoxin management, where an individual participation index was used. The extent of women's participation in managing aflatoxin in the groundnut postharvest value chain was measured using the Participation Index (PI) based on a three-point continuum, namely frequently, occasionally, and seldom, which were assigned scores of 3, 2, and 1, respectively [31]. For the purpose of ranking different activities performed by rural women, the frequency of responses from each of the three columns of a specific activity under major activity was tabulated and multiplied by the concerned score. Then, they were added together to get the total score for each specific activity for the purpose of their ranking with an expected PI value of 411 (N1 x Sample size). Then, the Participation Index for each activity was computed by using the following formula used by Kifale *et al*. [31]:

$$PI = (N1 \times 3) + (N2 \times 2) + (N3 \times 1)$$

Where:

PI = Participation Index for different postharvest activities of participation

N1 = Number of members who participate frequently

N2 = Number of members who participate occasionally

N3 = Number of members who participate seldom

4. RESULTS

4.1 Socio-Economic Characteristics

The findings indicate that the proportion of individuals within the working-age population (15–64 years) exceeded 66%. This aligns with the data provided by the National Bureau of Statistics (2022), which shows that the working-age population of women surpasses that of men by 52% while constituting only 48% of the rural population. Additionally, young women accounted for only 25.5% of the sample. The findings in Table 2 indicate that a significant proportion of the participants (78.8%) were married, while a small percentage (1.5%) identified as single. Besides, 19.7% of the sample consisted of households with female heads, who were either widowed or separated households. A significant proportion (70.8%) of the participants received formal education, while the remaining 29.2% indicated a lack of attendance at any formal school.

The study revealed that a significant majority of respondents (72.9%) had previous experience exceeding a decade in the cultivation of groundnuts. Table 2 shows that the majority of farmers engaged in groundnut cultivation are small-scale farmers, with an average farm size of less than 2 acres. The cropping system practised by the majority of respondents (94.9%) is a mixed cropping system, wherein they cultivate groundnuts alongside other crops such as maize and sunflower.

4.2 Participation of Women in Aflatoxin Projects

Table 3 displays the participation of women groundnut farmers in various aflatoxin-related project activities. The findings reveal that approximately half of the participants are engaged in decision-making processes. Notably, a significant portion of women did not contribute resources to project activities, indicating potential barriers or constraints that may need to be addressed to enhance participation. However, the encouraging aspect is the relatively high

Table 2. Socio-economic characteristics (N= 137)

Variables	Categories variable	Frequency	Percent
Age of respondent	21-35	35	25.5
	36-50	63	46.0
	51-65	28	20.4
	66-85	11	8.0
Marital Status of Respondent	Married	108	78.8
	Single	2	1.5
	Widowed	14	10.2
	Separated	13	9.5
Education level of the respondent	No formal education	40	29.2
	Primary level	91	66.4
	Secondary level	6	4.4
Years engaged in agricultural activities	1-10	37	27.0
	11-20	43	31.4
	21-30	38	27.7
	31-40	14	10.2
	41-50	4	2.9
	51-60	1	0.7
Total farm size in acres	1-10	130	94.9
	11-20	3	2.2
	21-30	4	2.9
Cropping system	Mono-cropping	7	5.1
	Mixed-cropping	130	94.9

Table 3. Participation of women in aflatoxin projects

	Activities	response	n	%
Decision making	Did you participate in decision making?	No	68	49.64
		Yes	69	50.36
Implementation	Did you contribute any resources to project activities?	No	116	84.67
		Yes	21	15.33
	Have you recently attended training on aflatoxin?	No	61	44.53
		Yes	76	55.47
	Did you participate in group activities?	No	51	37.23
		Yes	86	62.77
Benefits	Did you get any benefit from project activities?	No	55	40.15
		Yes	82	59.85
Evaluation	Did you participate in the evaluation?	No	67	48.91
		Yes	70	51.09

percentage of women who attended training sessions on aflatoxin and participated in group activities, suggesting a willingness to engage and learn. Moreover, the fact that nearly 60% of the participants benefited from project activities underscores the importance and impact of these initiatives on the livelihoods of women groundnut farmers.

4.3 Perceived Level of Participation between Men and Women

Table 4 shows respondents' perceived level of participation, as well as that of men, in various postharvest activities related to the groundnut value chain. The postharvest activities column lists different activities involved in the groundnut postharvest value chain, such as cleaning, drying, sorting, processing, grading, packing, storing, and marketing. The participation column indicates the level of participation for each activity, categorised as low, medium, or high. The men column represents the number and percentage of men participating in each activity as perceived by the respondents. The women column represents the number and percentage of women participating in each activity as perceived by the respondents as follows.

4.3.1 Cleaning

The results show that 48.1% of the men and 27.7% of the women participate at a low level; 31.4% of the men and 30.7% of the women participate at a medium level; and 20.4% of the men and 41.6% of the women participate at a high level. This suggests that individuals of both genders participate in cleaning tasks to a moderate extent. Indeed, during the scheduled interviews, a respondent disclosed that men typically assist with the labor-intensive tasks of cleaning and field drying through Mandela cock so that pods are primarily on top to permit better air circulation and exposure to sunlight for a shorter drying time after the harvest.

4.3.2 Drying, sorting, processing, and grading

In these activities, over 60% of the women participate at a high level. This indicates that men participate in drying, sorting, processing, and grading activities at a relatively lower level while women participate at a high level. The low level of men's participation in postharvest activities may be attributed to the local perception that these activities are primarily meant for women. This is supported by remarks given by a woman during the in-depth interview when she said:

> *"… Participating in postharvest activities is customary for women and is typically presumed to be a woman's duty. Women in our community over the years have become used to these activities without complaining…." (Woman groundnut farmer at Mlongia on April 11, 2023)*

4.3.3 Packing

The groundnuts are packed into bags after drying, sorting, and grading. The study shows that 36.5% of the men and 29.2% of the women participate at a high level. This indicates that men participate relatively higher than women. This is quite a fact, as the study found that men give a hand to those activities that require some physique, like packing and stalking the bags.

4.3.4 Storing

According to the study, 67.1% of the men participate at an almost similar level to women, at 68.6%, in the storage activities. This indicates that men exhibit a notable level of participation, ranging from moderate to high, as they primarily undertake tasks such as constructing elevated platforms using materials such as bricks and wood, as well as moving and assembling bags.

4.3.5 Marketing

Regarding marketing, over 75% of men participate actively compared to 60.6% of women. This suggests a notable disparity in the levels of participation between men and women in the area of marketing. Furthermore, the study found that the majority of women give consent to their husbands to market the produce. This is supported by remarks given by an extension officer during the in-depth interview when she said:

> *"….in Irangi zone, the majority of women are given control over groundnuts; however, before selling groundnuts, they are the ones giving consent to their husbands for transporting and selling the groundnuts to meet the household's needs..." (Extension officer at Mapango on April 10, 2023)*

In summary, Table 4 indicates that women's perceived participation dominates in activities like drying, sorting, processing, grading, packing, and storing. All women participate at a relatively medium level in these activities. On the other hand, men have a higher presence in marketing activities.

4.4 Extent of Women Participation in Managing Aflatoxin

4.4.1 Cleaning

The majority of women (67.9%) regularly remove adhered soil during the process of cleaning by shaking off attached soil after harvest. This practice exhibits a participation index (PI) of 355 and, hence, the highest frequency of engagement among women. From field observation, cleaning by shaking off attached soil by hand left the pods with attached soil.

Table 4. Perceived level of participation of men and women in groundnut postharvest value chain

Postharvest Activities	Level of participation	Men		Women	
		n	%	n	%
Cleaning	Low	66	48.1	38	27.7
	Medium	43	31.4	42	30.7
	High	28	20.4	57	41.6
Drying	Low	58	42.3	32	23.4
	Medium	43	31.4	40	29.2
	High	36	26.3	65	47.4
Sorting	Low	70	51.1	17	12.4
	Medium	45	32.8	49	35.8
	High	22	16.1	71	51.8
Processing	Low	55	40.1	23	16.8
	Medium	62	45.3	55	40.1
	High	20	14.6	59	43.1
Grading	Low	64	46.7	24	17.5
	Medium	54	39.4	51	37.2
	High	19	13.9	62	45.3
Packing	Low	25	18.2	53	38.7
	Medium	62	45.3	54	39.4
	High	50	36.5	40	29.2
Storing	Low	45	32.8	43	31.4
	Medium	45	32.8	57	41.6
	High	47	34.3	37	27.0
Marketing	Low	33	24.1	54	39.4
	Medium	43	31.4	46	33.6
	High	61	44.5	37	27.0

4.4.2 Drying

The most observed practice involved "drying on the bare ground" and “drying in the field using Mandela Cock”. The study shows a high frequency of participation among women, with approximately 67.2% and 55.5% of them reporting regular participation, respectively. These methods exhibit the PI of 362 and 325, respectively, making them the prevailing approaches employed for drying purposes. The survey indicated that a significant majority of 75% dried their groundnuts on the bare soil within their residences. Furthermore, the results show that 7.3% of the participants frequently use improved drying techniques, such as "drying on tarpaulin," which is the least used practice in drying.

4.4.3 Sorting and grading

The participation of women in sorting activities shows that 67.9% frequently partake in removing peanuts that undergo color alteration by hand. These practices recorded a performance index (PI) of 363, making it the most employed technique for sorting. The grading practice that is most employed is referred to as “winnowing," which is frequently practiced by all women, accounting for 65.0% of the participants, respectively. These grading practices have a PI (participation index) value of 351.

The sorting and grading process is done based on various attributes such as color, mold growth, size, and injury. However, according to a key informant, women exclusively sort and grade bags designated for personal use due to the laborious nature of the task and their constrained availability to address other domestic responsibilities. Her remarks:

> *“…the sorting and grading of harvested bags of groundnuts pose challenges due to concurrent household responsibilities. Consequently, it is customary for us to carefully sort and grade only one bag designated for domestic consumption…” (April 15, 2023, Mondo)*

The study additionally indicates that during the process of sorting and winnowing, the grade-out groundnuts are discarded as a precautionary measure, as a substantial amount of them may be susceptible to aflatoxicosis. This was contributed by the previous aflatoxicosis incidences, which resulted in fatalities among farmers, leading to heightened concerns and caution in handling these groundnuts.

4.4.4 Processing

The majority of women's participation in groundnut processing for preparing different meals exhibited frequent participation of women, reaching 58.4% with PI values of 341. This suggests that women's participation in the processing of groundnuts is limited, as they primarily roast and fry groundnuts to prepare meals within the household. The study found that none of the respondents participated in processing groundnuts into different products for retail business.

4.4.5 Packing

Among the most common packing practices is packing in woven polypropylene bags, with a frequent percentage of 78.1%, followed by packing in the jute sack with 37.2% and a PI of 362 and 268, respectively. The study found that women use these less expensive packing bags because they cannot afford improved ones, for example, PICS, and because groundnuts have hard shells, they possess less destruction from pests and insects; therefore, traditional packaging is enough.

4.4.6 Storage

The study findings indicate that a substantial majority of farmers (61.3%) employ a storage practice wherein bags of groundnuts are elevated on staged bricks and wooden platforms. This practice effectively mitigates the risk of aflatoxin contamination. In addition, it is worth noting that a significant proportion of women (54.7%) tend to store groundnut bags directly on bare ground. This practice can lead to increased moisture levels and contamination from the ground or floor, exacerbating aflatoxin contamination. Moreover, the study found that it is financially unfeasible for women to invest in upgraded storage technologies, such as SILO and moisture meters.

4.4.7 Marketing

Women are less involved in marketing groundnuts. "Retailing at the market" is a seldom-practiced marketing activity, with 83.7% seldom participating and a PI of 204. These include but are not limited to

boiled or roasted groundnuts, groundnut cake, flour, paste, oil, peanut butter, candies, snacks, and pressed cake for animal feed. "Wholesaling at the market" is another frequently practiced marketing method, with 67.9% frequently participating, and the PI for this practice is 356. However, most groundnuts at the household level are sold wholesale, and men are responsible for selling, with women participating by consenting to sell. The reason behind this practice was given by a village chairman during an in-depth interview. His remarks:

> *"……because of our inexperience in marketing and quality control, we cannot guarantee a secure market and a premium price for our aflatoxin-free groundnuts. Because of this, most groundnuts in households are sold in bulk by men at lower prices..." (April 4, 2023, Mrijo Village)*

In addition, the chairman was quoted saying,

> *"… if the newly built warehouse and aflatoxin testing laboratory guarantee aflatoxin-free groundnuts and attract an assured market, we anticipate that in the near future, most families, especially men, will shift to large-scale production of groundnuts." (April 4, 2023, Mrijo Village)*

Table 5. Extent of women participation in managing aflatoxin in the postharvest value chain

Postharvest Activities	Postharvest Practices	Extent of Participation						PI
		Seldom		Occasionally		Frequently		
		n	%	n	%	n	%	
Cleaning	Shaking off attached soil	12	8.8	32	23.4	93	67.9	355
Drying	Mandela cock	25	18.2	36	26.3	76	55.5	325
	Drying On the bare ground	4	2.9	41	29.9	92	67.2	362
	Drying On the raised platform	62	45.3	45	32.8	30	21.9	242
	Drying On hand made sack	59	43.1	67	48.9	11	8.0	226
	Drying On tarpaulin	61	44.5	63	46.0	10	7.3	217
Sorting	Manual sorting	34	24.8	29	21.2	74	54.0	314
	Removing groundnuts damaged by pests and moldy	19	13.9	50	36.5	68	49.6	323
	Separating the groundnuts that change color after blanching	4	2.9	40	29.2	93	67.9	363
Processing	Roasting groundnuts	17	12.4	48	35.0	72	52.6	329
	Making groundnuts butter	23	16.8	43	31.4	71	51.8	322
	Preparing groundnut oil	89	65.0	31	22.6	17	12.4	202
	Frying salted groundnut	31	22.6	41	29.9	65	47.4	308
	Cooking only in the meal	13	9.5	44	32.1	80	58.4	341
Grading	Picking by hand	24	17.5	37	27.0	76	55.5	326
	Winnowing	12	8.8	36	26.3	89	65.0	351
Packing	Packing in the jute sack	57	41.6	29	21.2	51	37.2	268
	Packing in woven polypropylene bags	19	13.9	11	8.0	107	78.1	362
Storing	Stacking bags on a raised platform	13	9.5	40	29.2	84	61.3	345
	Stacking bags on bare ground	17	12.4	45	32.8	75	54.7	332
	Spraying insecticides on stored bags	82	59.9	42	30.7	13	9.5	205
Marketing	Retailing at the market	91	66.4	25	18.2	21	15.3	204
	Wholesaling at the market	11	8.0	33	24.1	93	67.9	356

Table 6. Socio-economic characteristics and the women's participation in managing aflatoxin contamination

	Age		Marital status		Education level		Experience in agriculture		Farm Size in acre	
	X^2	P	X^2	P	X^2	P	X^2	P	X^2	P
Extent of participation (Individual PI)	7.800	.099^{NS}	27.550	.000***	12.650	.013*	3.556	.469^{NS}	2.004	.735^{NS}

*Statistically significant at * p=0.05, *** p<0.001, NS=not significant*

4.5 Socio-Economic Characteristics and Women's Participation in Managing Aflatoxin Contamination

Findings from Table 6 show that variables like experience in agriculture (χ2 = 3.556, P = 0.469) and farm size (χ2 = 2.004, P = 0.735) exhibited no statistically significant relationship and extent of women's participation in managing aflatoxin contamination in the groundnut postharvest value chain. Whereas variables like education level (χ2 = 12.650, P = 0.013*) and marital status (χ2 = 27.550, P = 0.000***) showed a statistically

significant relationship between socio-economic characteristics and the extent of women's participation in managing aflatoxin contamination in the groundnut postharvest value. On the other hand, age (χ2 = 7.800, P = 0.099) showed no statistically significant relationship with a significant linear-by-linear association between a statistically significant relationship between socio-economic characteristics and the extent of women's participation in managing aflatoxin contamination in the groundnut postharvest value. Respondents' experience growing and participating in the groundnut postharvest value chain could not relate to the extent of managing aflatoxin.

5. DISCUSSION

In the "what dimension," the findings show that women have participated, on average, in all activities of aflatoxin-related projects. This suggests not only a low level of participation by women in aflatoxin-related interventions [32,33] but also that when they are involved, their participation is only about half of what is required. In implementation activities, women expressed that they lack the resources to contribute due to their low income. More importantly, women were found to participate, on average, in attending training sessions, which is consistent with a study in Ethiopia by Cervini et al. [32], revealing that only 0.24% of interviewed women had previously attended aflatoxin-related training. Additionally, findings show average participation in benefits, suggesting that the impact of these projects is still moderate. For the benefits of aflatoxin-related interventions to be realized, women groundnut farmers need to adopt and employ practices and technologies for managing aflatoxin, which is mostly unaffordable for rural women [20,14].

In the “who dimension” generally, women are highly perceived to participate in most agricultural activities [34], including postharvest activities. This also applies to their participation in the groundnut postharvest value chain in Chemba District. The study found that the perceived level of participation between men and women in the groundnut postharvest value chain reflects the substantial participation of women as a testament to their adeptness and resilience in agricultural-related activities [34]. The perceived level of participation in the groundnut postharvest value chain encompasses a spectrum of tasks ranging from harvesting and sorting to processing, packing, storing, and household responsibilities, each contributing to the overall enhancement of groundnut quality and accessibility. The findings also show that respondents perceived women as highly (75%) participating in this spectrum of tasks. The high perceived level of participation of women (75%) in the groundnut postharvest value chain is therefore reflected in the extent of their participation in managing aflatoxin in the postharvest value chain in the following discussion.

In the “how dimension,” the findings of this study, conducted among women groundnut farmers in Chemba Districts, serve as a microcosm of broader participation patterns in managing aflatoxin contamination within the groundnut post-harvest value chain observed across developing countries. The study found a similar trend to that of Kimario et al. [17], Waliyar et al. [35], and Kumar et al. [36], who consistently

highlight the prevalence of suboptimal postharvest practices in the groundnut value chain worldwide. These findings underscore the systemic nature of the issue, emphasizing its global scope rather than being limited to specific regions. Recent interventions highlighted in studies by Akullo et al. [1], Ajibade et al. [2], and Ansari et al. [3] aim to address these challenges and improve postharvest practices to enhance food security and agricultural sustainability on a global scale. Additionally, our study found financial constraints among women groundnut farmers as a barrier to employing improved practices, echoing similar findings reported by Posey *et al.* [37] and Martey [38] regarding constraints faced by farmers in the groundnut value chain.

The extent of women's participation in various postharvest value chain stages reveals more about suboptimal practices. For example, cleaning and drying were found to be poorly done, as significantly more than 75% cleaned by shaking off attached soil and drying their groundnuts on the bare soil within their households. Furthermore, the results show that 7.3% of the participants frequently use improved drying techniques by using tarpaulin. Similar findings by Jelliffe et al. [39] in Uganda on aflatoxin in groundnuts revealed that even though 61% of households indicated that they had indeed heard of aflatoxin, 75% of households dried groundnuts on the open earth at home, with only 3% using a tarpaulin. On the other hand, cleaning the attached soil in groundnut pods can lead to aflatoxin contamination, as reported by Vabi et al. [40] and Ehrlich [41], as fungi causing aflatoxin reside and spread in the soil.

During grading and sorting, the findings show that women precautionarily discard the grade-out groundnuts despite continuing to employ suboptimal practices. This is uncommon, as most respondents expressed that before the incidences of aflatoxicosis, they used to consume them, but after the aflatoxicosis incidents, everyone is careful and never intends to use them for animal or human consumption. This finding contrasts with a study conducted in the Mbeya region by Nyangi et al. [42], who found that farmers consume the grade-outs, as well as other findings [5,18,19,8,20,21].

Processing groundnuts into various products was found to be uncommon. The findings show that no practices were reported on processing groundnuts into various products for retail business because most women's participation in groundnut processing was only for preparing meals, accounting for over 80%. This contradicts Owusu-Adjei et al. [14] and Tyroler [8], who reported that the majority of rural women participate in processing groundnuts for retail businesses.

On the other hand, the packaging materials used by women groundnut farmers were limited, with 78.1% using woven polypropylene bags and 37.2% using jute sacks. Martey [38] also found that many farmers store their groundnut crops in polypropylene bags. The study reveals that women groundnut farmers opt to use commonly used packaging materials because they cannot afford improved ones, such as PICS [43]. This is widely reported in developing countries, where women opt for traditional or commonly used packing and storage materials that are readily available and inexpensive [44]. However, storage structures and the type of bag used play a vital role in mitigating the risks of mycotoxin contamination in the postharvest phase [38]. Another striking finding of our study is that no groundnut farmers use modern storage facilities. This pattern reflects a broader trend observed in developing countries, where women often opt for traditional or readily available packing and storage materials due to their affordability, as noted by Sugri [44]. However, it is crucial to acknowledge that storage structures and the choice of bags significantly influence the risk of mycotoxin contamination during the postharvest phase, as Martey [38] emphasized. Notably, the study revealed a lack of modern storage facilities among groundnut farmers, indicating a need for interventions to improve storage practices and mitigate contamination risks.

On the marketing side, the results above indicate that over 75% of men actively participate, compared to 60.6% of women. This suggests that men prefer to engage in aspects that benefit them more. More importantly, women profess that their spouses involve them in decision-making about marketing the groundnuts. This is supported by Daudi et al. [45] and Tyroler [8], who reported that men play roles in nodes that have high value in terms of income generation, such as distribution, including assembling and wholesaling groundnuts. Additionally, the findings show that women are not involved in the retail business of processed groundnut products. This finding differs from Owusu-Adjei et al. [14] and Tyroler [8], who reported that, in Africa,

groundnut retailing is typically done at the household level after processing groundnuts into various products. Though the study area shows women selling their groundnuts in bulk, they do not sell them in lump sums but in parts to meet their household needs.

6. CONCLUSION

Generally, the study found a relationship between their socio-economic characteristics (education and marital status) and the extent of women's participation in managing aflatoxin in the groundnut post-harvest value chain. The study also found that women groundnut farmers participate partly in various activities related to aflatoxin-related projects. However, despite the study showing a high perceived level of participation among women over men in the postharvest value chain, it suggests a low level of women's participation in the same regarding managing aflatoxin contamination in groundnuts. In particular, women are influenced by their inability to purchase and use improved post-harvest techniques in managing aflatoxin. Therefore, it is essential to promote gender-sensitive policies and programs to encourage and support women's participation in post-harvest management, ultimately benefiting the entire groundnut value chain against food poisoning in general.

7. RESEARCH CLEARANCE

The participants were guaranteed confidentiality and consented. They were also given an orientation regarding the rationale behind the study and the significance of their candid feedback. The research was conducted in compliance with all the requirements, which included obtaining a research clearance letter from Sokoine University of Agriculture and ultimately securing a research permit from various governmental offices, including the President's Office, Regional Administration and Local Government Tanzania (PO-RALG), Dodoma Regional Office, Chemba District Council Office, and village offices, respectively.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Akullo JO, Amayo R, Okello DK, Mohammed A, Muyinda R, Magumba D, Gidoi R, Mweetwa AM. Aflatoxin contamination in groundnut and maize food products in eastern and Northern Uganda. Cogent Food Agric. 2023;9(1). Available:https://doi.org/10.1080/23311932.2023.2221015.
2. Ajibade TB, Ajibade ET, Salami MF, Balogun AM. Groundnut value chain in Nigeria: Positioning to alleviate supply chain crisis in global edible oil markets. In Agricultural and Applied Economics Association Annual Meeting, Washington, DC; Washington DC; 2023.
3. Ansari MA, Prakash N, Punitha P, Baishya LK. Post-harvest management and value addition of groundnut. ICAR Res. Complex NEH Reg. Manipur Centre, Lamphelpat, Imphal-795004. 2015;6–36. Available:https://doi.org/10.13140/RG.2.2.22053.91365
4. Okoh ME, Kukwa RE, Nyinoh IW, Ityo IT. Evaluation of raw groundnuts from makurdi markets in Nigeria for Aflatoxin B1." European Journal of Nutrition and Food Safety. 2021;13(3):102-112. DOI: 10.9734/ejnfs/2021/v13i330395
5. Kostandini G, Rhoads J, MacDonald GE, Tanellari E, Johnson R, Carroll E, Pressoir G. Production, post-harvest management and gender dynamics among smallholder peanut farmers in Haiti. Agric. Food Secur. 2021;10(1):1–12. Available:https://doi.org/10.1186/s40066-021-00311-y.
6. Okiror JJ, Twanza B, Orum B, Ebanyat P, Kule EB, Tegbaru A, Ayesiga C. Journal of agricultural extension and rural development for whom will the crop be promoted? A Search for Gender Equity along the Grain-Legume Value Chains in Uganda. 2021;13(4):252–264. Available:https://doi.org/10.5897/JAERD2017.0872.
7. Christie ME, Kyamureku P, Kaaya A. Devenport, a. farmers, peanuts, and

aflatoxins in uganda: A gendered approach. Dev. Pract. 2015;25(1):4–18. Available:https://doi.org/10.1080/09614524.2015.983459.

8. Tyroler, C. Gender Considerations for Researchers Working; 2018. Available:https://ftfpeanutlab.caes.uga.edu/content/dam/caes-subsite/ftf-peanut-lab/documents/peanut-lab/Gender Considerations.pdf.
9. Orr A, Tsusaka TW, Kee-Tui SH, Msere H. What Do We Mean by 'Women's Crops'? A Mixed Methods Approach. ICRISAT Socioecon. Discuss. Pap. Ser. 2014(23):1–48.
10. Yalala M, Tshilenge-Lukanda L, Yandju DL, Kalonji-Mbuyi A. Control of aflatoxin production in cassava produced by dry fermentation in North Kivu, Democratic Republic of Congo. Asian Food Science Journal. 2019;13(1):1–7. Available:https://doi.org/10.9734/afsj/2019/v13i130097
11. Charity NC, Christian EO. Occurrence of aflatoxin in ready-to-eat roasted snacks obtained from port Harcourt and Owerri, Nigeria. European Journal of Nutrition and Food Safety. 2023;15(10):85–94. Available:https://doi.org/10.9734/ejnfs/2023/v15i101348
12. Fakruddin MD, Chowdhury A, Hossain MN, Ahmed MM. Characterization of aflatoxin producing Aspergillus flavus from food and feed samples. SpringerPlus. 2015;4:1-6.
13. Amin H, Ali T, Ahmad M, Iqbal Zafar M. Participation level of rural women regarding post harvesting activities in Pakistan. Pak. j. life soc. Sci. 2009;7(2):136–139.
14. Owusu-Adjei E, Baah-Mintah R, Salifu B. Analysis of the groundnut value chain in Ghana. World J. Agric. Res. 2017;5(3):177–188. Available:https://doi.org/10.12691/wjar-5-3-8.
15. Daniel IM, Elizabeth S. Challenges in groundnut production and adoption of groundnut production technology information packages among women farmers. J. Agric. Environ. Sci. 2014;3(4):252–258. Available:https://doi.org/10.15640/jaes.v3n4a8.
16. Nyombi A, Muwesa R, Sengendo M. Role of women in the management of aflatoxins in mayuge district , Uganda. African J. Soc. Sci. Humanit. Res. 2020;3(6):136–147.
17. Kimario ME, Moshi AP, Ndossi HP, Kiwango PA, Shirima GG, Kussaga JB. Smallholder farmers' storage practices and awareness on aflatoxin contamination of cereals and oilseeds in Chamwino, Dodoma, Tanzania. J. Cereal. Oilseeds. 2022;13(1):13–23. Available:https://doi.org/10.5897/JCO2020.0220.
18. Tsusaka TW, Msere HW, Gondwe L, Madzonga O, Clarke S, Siambi M, Okori P. Assessing the post-harvest constraints in smallholders' groundnut production: A survey in Central Malawi. Agric. Sci. Res. J. 2016;6(9):213–226.
19. Matumba L, Monjerezi M, Kankwamba H, Njoroge SMC, Ndilowe P, Kabuli H, Kambewa D, Njapau H. Knowledge, attitude, and practices concerning presence of molds in foods among members of the general public in Malawi. Mycotoxin Res. 2016;32(1):27–36. Available:https://doi.org/10.1007/s12550-015-0237-3.
20. Anitha S, Tsusaka TW, Njoroge SMC, Kumwenda N, Kachulu L, Maruwo J, MacHinjiri N, Botha R, Msere HW, Masumba J, Tavares A, Heinrich GM, Siambi M, Okori P. Knowledge, attitude and practice ofmalawian farmers on pre- and post-harvest cropmanagement tomitigate aflatoxin contamination in groundnut,maize and sorghum-implication for behavioral change. Toxins (Basel). 2019;11(12). Available:https://doi.org/10.3390/toxins11120716.
21. Seetha A, Munthali W, Msere HW, Swai E, Muzanila Y, Sichone E, Tsusaka TW, Rathore A, Okori P. Occurrence of aflatoxins and its management in diverse cropping systems of central Tanzania. Mycotoxin Res. 2017;33(4):323–331. Available:https://doi.org/10.1007/s12550-017-0286-x.
22. Cooke B, Kothari U. Particpation: The New Tyranny?; ZED BOOKS Development Studies, London; 2001.
23. Cohen JM, Uphoff NT. Participation's place in rural development: Seeking clarity through specificity. World Dev. 1980;8(3):213–235. Available:https://doi.org/10.1016/0305-750X(80)90011-X.
24. Burkey S. People First: A Guide to Self-Reliant Participatory Rural Development.;

Zed Books Ltd., 165 First Avenue, Atlantic Highlands; 1993.

25. Yalala M, Tshilenge-Lukanda L, Yandju DL, Kalonji-Mbuyi A. Control of aflatoxin production in cassava produced by dry fermentation in north kivu, democratic republic of congo. Asian Food Science Journal. 2019;13(1):1–7.
Available:https://doi.org/10.9734/afsj/2019/v13i130097
26. Charity NC, Christian EO. Occurrence of aflatoxin in ready-to-eat roasted snacks obtained from port harcourt and Owerri, Nigeria . European Journal of Nutrition and Food Safety. 2023;15 (10):85–94.
Available:https://doi.org/10.9734/ejnfs/2023/v15i101348
27. Fakruddin MD, Chowdhury A, Hossain MN, Ahmed MM. Characterization of aflatoxin producing Aspergillus flavus from food and feed samples. SpringerPlus. 2015;4:1-6.
28. The United Republic of Tanzania (URT). Administrative Units Population Distribution Report. Natl. Popul. House Census Tanzania. Natl. Bur. Stat. Dar es Salaam, Tanzania 2022;3A:290.
29. Kamala A, Shirima C, Jani B, Bakari M, Sillo H, Rusibamayila N, De Saeger S, Kimanya M, Gong YY, Simba A, Wigenge R, Justin I, Kyombo F, Tarimo V, Hipolite D, Mziray R, Kaiz K, Mutabuzi C, Muita M, Mghamba J, Mohamed MA, Kitambi M, Nyanga A, De Boevre M, Xu Y, Routledge MN, Mtui N, Mosha F, Charles J, Manase G, Lyamuya F, Ngass OP, Ikaji Z, Lyimo C, Mchwampaka W, Masumbuko E, Magodi R, Abade A, Josephat C, Omolo J, Ruheta M, Mengele I. Outbreak of an acute aflatoxicosis in tanzania during 2016. World Mycotoxin J. 2018;11(3):311–320.
Available:https://doi.org/10.3920/WMJ2018.2344.
30. Kothari CR. Research Methodology, Methods and Techniques, Second rev.; New Age International (P) Ltd., Publishers 4835/24, Ansari Road, Daryaganj, New Delhi – 110002; 2004.
31. Kifale M, Deselagne T, Yimam A, Tsegaye D. The status of member's participation in seed producer and marketing cooperatives in amhara region, Ethiopia. Glob. Adv. Res. J. Econ. Account. Financ. 2012;1:009–014.
32. Cervini C, Abegaz B, Mohammed A, Elias R, Medina A, Gebre K, Verheecke-Vaessen C. Assessment of agricultural practices by ethiopian women farmers: Existence of gender disparities in access to mycotoxins training. World Mycotoxin J. 2023;16(3):1–12.
Available:https://doi.org/https://doi.org/10.3920/WMJ2022.2827.
33. Xu Y, Doel A, Watson S, Routledge MN, Elliott CT, Moore SE, Gong YY. Study of an educational hand sorting intervention for reducing aflatoxin B1 in Groundnuts in Rural Gambia. J. Food Prot. 2017;80(1):44–49.
Available:https://doi.org/10.4315/0362-028X.JFP-16-152.
34. Adebayo JA, Worth SH. Profile of women in african agriculture and access to extension services. Social Sciences and Humanities Open. Elsevier Ltd; 2024.
Available:https://doi.org/10.1016/j.ssaho.2023.100790
35. Waliyar F, Osiru M, Ntare BR, Vijay Krishna Kumar K, Sudini H, Traore A, Diarra B. Post-harvest management of aflatoxin contamination in groundnut. World Mycotoxin J. 2015;8(2):245–252.
Available:https://doi.org/10.3920/WMJ2014.1766.
36. Kumar GDS, Popat MN. Factors influencing the adoption of aflatoxin management practices in groundnut (*Arachis Hypogaea L*.). Int. J. Pest Manag. 2010;56(2):165–171.
Available:https://doi.org/10.1080/09670870903268346.
37. Posey S, Magnan N, McCullough EB, Hoffmann V, Opoku N, Alidu AH. Challenges to groundnut value chain development: Lessons from an (Attempted) Experiment in Ghana. J. Dev. Eff. 2024;00(00):1–17.
Available:https://doi.org/10.1080/19439342.2024.2319657.
38. Martey E, Etwire PM, Denwar N. Improved storage technique and management of aflatoxin in peanut production: Evidence from Ghana. Sci. African. 2020;8:e00381.
Available:https://doi.org/10.1016/j.sciaf.2020.e00381.
39. Jelliffe JL, Bravo-Ureta B, Deom CM, Okello DK. The sustainability of farmer-led multiplication and dissemination of high-yield and disease resistant groundnut varieties. AgEcon Search. 2015;4:1–81.
40. Vabi MB, Eche CO, Mukhtar AA, Kunihya A, Alabi O. Understanding and Managing

Aflatoxin Contamination in the Groundnut Value Chain in Nigeria; 2016.

41. Ehrlich KC. Non-aflatoxigenic aspergillus flavus to prevent aflatoxin contamination in crops: Advantages and limitations. Front. Microbiol. 2014;5(FEB):1–9. Available:https://doi.org/10.3389/fmicb.2014.00050.
42. Nyangi C, Siyame P, Hussein Z. Assessment of knowledge, attitudes, and practices in relation to mycotoxin contamination in Tanzania. East African J. Heal. Sci. 2024;7(1):205–220. Available:https://doi.org/10.37284/eajhs.7.1.1828.
43. Jyothi I, Chowdary KR, Panduranga GS. Assessment of purdue improved crop storage bags for hermetic storage technology on groundnut pods. J. Krishi Vigyan. 2024;12(1):15–20. Available:https://doi.org/10.5958/2349-4433.2024.00003.5.
44. Sugri I. Prevalence, perception and participatory management of aflatoxins in groundnut with emphasis on Northern Ghana. Acta Sci. Nutr. Heal. 2020;4(2):01–10. Available:https://doi.org/10.31080/asnh.2020.04.
45. Daudi H, Shimelis H, Laing M, Okori P, Mponda O. Groundnut production constraints, farming systems, and farmer-preferred traits in Tanzania. J. Crop Improv. 2018;32(6):812–828. Available:https://doi.org/10.1080/15427528.2018.1531801

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