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Role of collective action and handling practices on aflatoxin contamination of groundnuts: Evidence from Kenya

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Abstract: Groundnut is a major dietary component and a relatively cheap source of proteins for many people in western Kenya. In order to commercialize groundnut production, the government of Kenya, International Crops Research Institute for the Semi- Arid Tropics (ICRISAT) and Catholic Relief Services mobilized growers into producer marketing groups (PMGs). The PMGs are trained on practices that minimize groundnut contamination with aflatoxin. This paper examines the effectiveness of PMGs as avenues for promoting practices that reduce the risk of groundnut contamination with aflatoxin based on a household survey conducted in Homabay district, western Kenya. Aflatoxin content of groundnuts samples obtained during the survey was determined by indirect competitive ELISA. The results indicated a significant ($P<0.01$) level of awareness about aflatoxins among farmers belonging to PMGs (90.6%) than those who did not (58.1%). A significantly higher percentage of PMG farmers practiced sorting and grading. In addition, a significantly ($P<0.01$) higher percentage of PMG respondents (89.5%) employed cultural methods of pest control compared with the non PMG farmers (52.2%). However, levels of aflatoxins in groundnut samples taken from both categories of farmers did not differ, suggesting a lag between the time farmers receive a message and its implementation. These results indicate that PMGs have contributed substantially to increased awareness about aflatoxins and underscore the need for up-scaling training of farmers on specific measures that reduce the risk of exposure.
Key words: Groundnuts, aflatoxin contamination, production marketing groups, handling practices, Kenya

Introduction

In Kenya, groundnuts are mainly grown in parts of Nyanza, Western and Rift Valley provinces (Anon., 2004), and are considered a profitable and reliable crop suitable for planting during both the short and long rain seasons. Groundnuts are a rich source of energy because of their high oil (44-56%) and protein (25-34%) content (Desai *et al*., 1999). They also contain carbohydrates (18%) and are a good source of riboflavin, thiamine, nicotinic acid and iron (Burn and Huffmann, 1975). In Nyanza province, groundnuts serve as an important source of protein and oil, supplementing fish which is relatively expensive (Mayatepek *et al*., 1992). In this area therefore, groundnuts which are eaten as a sauce, blanched, roasted or fried, play an important role in terms of food security, especially with regard to nutritional quality.

Aflatoxins are a major threat to the safety, quality and marketability of groundnuts, especially in the developing world (Lubulwa and Davis, 1994). Although no quantitative data is available for western Kenya, consumption of contaminated groundnuts is suspected and supported by anecdotal evidence based on several indicators. For example, constant drought conditions during growth, erratic rainfall, high temperatures and humidity prevalent in the study region favour groundnut contamination and development of aflatoxin. Most groundnut in Kenya is cultivated under small holder conditions, characterized by mechanical damage to pods and poor harvesting, drying and storage methods. These practices have been linked to aflatoxin contamination of groundnuts elsewhere in sub-Saharan Africa (Waliyar *et al*, 2005[A]; Bilgrami and Choudhary, 1990; Jones and Duncan, 1981). In addition, groundnuts are processed at home and marketed through informal marketing systems where products are seldom tested for aflatoxin contamination (Felicia, 2004).

In order to support the production and marketing of groundnuts and to improve food security and income, the Kenyan government in collaboration with international research organizations such as ICRISAT has established producer marketing groups (PMGs). PMGs are groups of small scale local farmers. They are considered an efficient way to reach many people at minimal costs, an important factor given the constraints faced by the agricultural extension service. The primary role of these groups is to commercialize the production of groundnut by improving its marketability in order to improve incomes and food security. One of the goals of this intervention is to encourage use of good pre- and post-harvest practices that maximize yields and quality.

An important function of PMGs therefore includes training of farmers on groundnut management practices that can minimise aflatoxin contamination during pre-harvest, harvest and post-harvest stages. These practices include pest and disease management, timely harvesting, proper and timely drying, sorting, storage and grading techniques. Aside from ensuring food safety at household level, the need to prevent groundnut contamination is necessitated by the strict regulation on aflatoxin levels set by lucrative export markets. The aim of this study

therefore was to evaluate the impact of PMGs in reducing aflatoxin contamination by comparing differences in groundnut handling practices and levels awareness about aflatoxins, between PMG and non-PMG farmers.

Materials and Methods

This paper is based on a survey of 400 groundnut-growing households in Homabay District of Kenya. Information was collected through personal interviews using a pre-tested questionnaire. The questionnaire was developed after conducting a focused group discussion involving 50 participants drawn from farmers, village elders, some community leaders and provincial administration staff. The results of the discussion were used to formulate the survey questions. Pre-testing of the questionnaire was done in 20 randomly selected households in Asego division of Homabay district.

For the purposes of sampling, the district was stratified into Agro-ecological zones (AEZs), LM1, LM2 and LM3, where groundnut is commonly grown. The AEZs are determined based on altitude, mean annual rainfall, temperature, and evapotranspiration as well as the probability of successfully growing the main crops of that zone (Ngugi *et al*., 2002; Jaetzold and Schmidt, 1982). Sample size per AEZ was proportionate to acreage under groundnut production based on production statistics from the Ministry of Agriculture (MoA). Within the AEZ, farmers were randomly selected at village level from a list compiled by MoA staff. Issues addressed in the survey included types of storage facilities, pre-harvest crop management practices, methods of preparing groundnut-based foods, handling and disposal of sorted nuts, as well as awareness and source of information about aflatoxin contamination. Farmers were also asked whether or not they belonged to a PMG. A 1kg of groundnut sample was collected from each interviewed household. This sample was assayed for levels of aflatoxin as described below.

A 200g of sub-sample was drawn from each sample and ground to a fine powder using a dry mill kitchen grinder (Kanchan multipurpose kitchen machine, India). The ground sample was then sub-divided into two equal portions. The powder was triturated in 70% methanol (v/v 70ml absolute methanol in 30ml distilled water) containing 0.5% KCL in a blender, until the seed powder was thoroughly ground. The extract was transferred to a conical flask and shaken for 30 min at 300rpm. The extract was then filtered through Whatman No.41 filter paper and diluted 1:10 in PBS-Tween 20 and analyzed for aflatoxin with an indirect competitive ELISA (Waliyar *et al.*, 2005[B]).

Data on groundnut preparation, handling, storage and harvesting practices were analyzed by means of contingency tables using SPSS version 9 and SAS version 9.1. Correlation statistics were used to test for associations between variables and participation in PMGs.

Results

Effect of PMGs on handling practices

A significantly (P<0.01) higher level of awareness about aflatoxins was noted among farmers belonging to PMGs compared with those who were not members. Over 90% of PMG-members knew aflatoxin was a potential health risk compared with only 58.1% of non-PMG members (Table 1). This pattern of differences between the two groups was noted in other practices in the groundnut production chain.

Table 1. Percentage of respondents aware of the aflatoxin problem among PMG and non PMG interviewees (n=384; P< 0.0001)

Response category	PMG	Non PMG	Total respondents
Aware	90.6	58.1	73.4
Not aware	9.4	41.9	26.6

One factor that could influence groundnut aflatoxin contamination is damage from disease and insect pests (Lynch and Wilson, 1991). The survey grouped respondents into four categories based on whether they used organic or commercial pesticides, employed cultural controls such as rogueing of diseased plants, or used no pest management practices. Less than 1% of the respondents managed pests using commercial pesticides, while the majority (69.8%) used cultural methods. As shown in Fig. 1, a significantly (P<0.01) higher percentage of PMG respondents (89.5%) employed rogueing compared with the non PMG farmers (52.2%). Conversely, 46.8% of non PMG respondents did not employ any pest management procedures while only 7.7% of the PMG farmers were in this category (Fig.1).

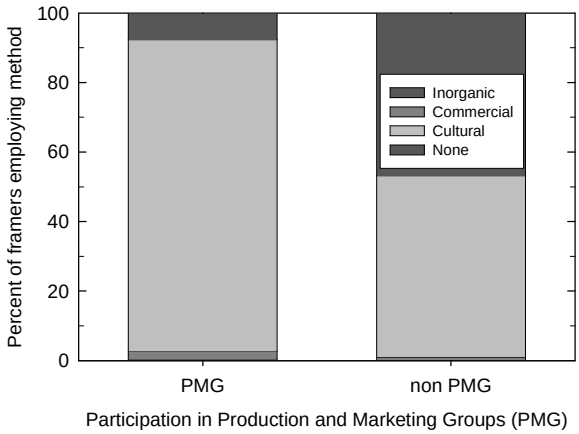

Fig 1: Percentage of PMG and non PMG farmers employing different types of pest control

Groundnuts were either dried in the field or in homesteads on reed mats, polythene sheets, bare ground or roof tops. Overall, 10.9% of all respondents left groundnuts to dry in the field. However, there was no significant difference in the number of PMG and non PMG respondents that dried their nuts in the field. There were more respondents (21.9%) drying groundnuts on reed mats in the homesteads compared with those drying in the field, but again no difference was found between PMG and non-PMG respondents. The number of respondents using roof drying was negligible. Overall, 42.4% of respondents dried produce directly on the ground while 57.8% dried produce on polythene sheets. Of those drying produce on the ground, a significantly (P<0.01) lower percentage (34.3%) were PMG respondents compared with 49.8% of non-PMG respondents. By contrast, a significantly (P<0.01) higher proportion of PMG respondents (65.7%) used polythene mats than did non PMG respondents (50.7%). More PMG

than non PMG farmers practiced sorting and grading, practices that significantly reduce aflatoxin contamination in groundnuts. A significantly higher (P<0.01) percentage of PMG respondents (86.2%) also graded produce for marketing compared with non PMG farmers (49.3%).

In general, most farmers interviewed stored groundnuts in one of five types of containers: sisal bags, propylene bags, metal tins, and woven baskets made of papyrus or clay pots (Table 2). The majority of respondents use propylene bags to store produce (Table 2). Significantly more (8.8%; P<0.05) respondents belonging to PMGs used sisal bags compared to those respondents who do not, even though use of sisal bags was generally low (6.3%).

Table 2. Percentage of respondents using different materials for storage of groundnuts (n=384; P = 0.032) [x]

Respondent category	Sisal bag	Propylene bag	Metal tin	Basket	Clay pot
PMG	8.8	86.7	3.9	0.0	0.6
Non-PMG	3.9	94.1	1.0	1.0	0.0

[x]One farmer often used more than one type of storage material

Sorting was done to separate sound kernels from bad ones. Kernels classified as 'bad' were grouped into four categories comprising of rotten, broken, discoloured, and shrivelled kernels. Bad kernels were consumed after preparation, fed to chickens, used as seed or discarded, based on level of damage. There were no differences in the utilization of sorted nuts between PMG and non PMG respondents (0.057≤P≤0.719), except for the proportions consuming discoloured groundnuts whereby a significantly (P<0.01) higher number of PMG respondents (88.4%) consumed discoloured nuts compared with 67% of the non-PMG respondents. Over 80% of respondents fed rotten produce to chickens, while discoloured produce was saved as seed by one out of every five households. In addition, shrivelled kernels were consumed by >90% of all households.

Levels of aflatoxin among PMG and non PMG respondents

Based on the levels of aflatoxin, the groundnut samples analyzed were grouped into three categories: samples containing 0-to-<4ppb, samples with 4-20ppb, and samples with >20ppb. The upper limit of aflatoxin content for groundnuts destined for the EU market is 4ppb, while 20ppb is the maximum permissible level set by the Kenya Bureau of Standards (KEBS) and the WHO. Ninety two percent of samples contained less than 4ppb (Fig. 2). However, high levels of aflatoxin were noted with a few samples from both PMG (1.16%) and non PMG (1.03) farmers containing more than 1000ppb.

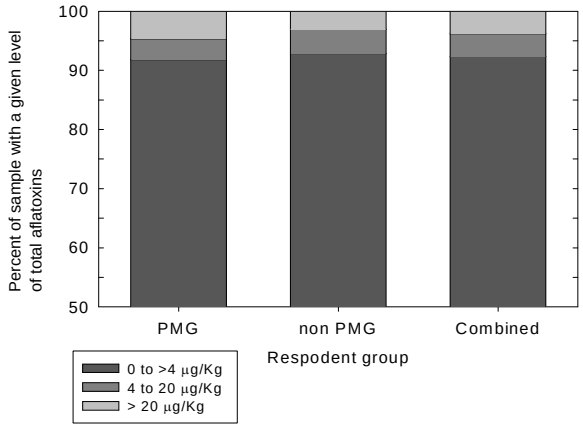

Fig 2: Percentage of PMG and non-PMG respondents with a given level of aflatoxin

Discussion

This study assessed the degree of awareness of farmers in western Kenya about the risks of exposure to aflatoxin through consumption of contaminated groundnuts and evaluated the effectiveness of PMGs as avenues for disseminating the knowledge essential to mitigating the risks. Our results indicate that more than 75% of sampled farmers are aware of aflatoxin problems and that PMGs have contributed substantially to raising this awareness. We also find that increased awareness about aflatoxins is positively associated with handling practices that minimize groundnut contamination with aflatoxin.

In all but three criteria assessing practices that might reduce the risk of groundnut contamination (e.g. sorting and grading, drying, pest and disease control), the percentage of PMG respondents employing the appropriate strategy was higher than that of non-PMG interviewees. Many of these practices have been associated with reduced levels of aflatoxin in groundnuts in rural farming communities (Turner *et al.*, 2005). For example, hand sorting which is practiced by more than 90% of respondents, but with a higher rate among farmers belonging to PMGs, has been shown to substantially reduce aflatoxin contamination in groundnuts (Galvez *et al*., 2003, Pelletier and Relzner, 1992; Kirksey e*t al*., 1989; Dickens and Whitaker, 1975). Conversely, practices that increase the risk of aflatoxin contamination such as drying produce directly on the ground (Moreau, 1977) were more prevalent among non-PMG respondents. It is thought that drying groundnuts in the field establishes contact between the pods and the soil, the primary source of *A. flavus* inoculum (Hell, *et al.* 2003; Diener *et al*., 1987).

Many studies have also documented a direct relationship between pest and diseases in groundnuts and aflatoxin contamination (e.g. Lynch and Wilson, 1991). Less than one percent of those interviewed used commercial pesticides, but PMG respondents were more likely to use cultural methods of pest control. The low use of pesticides is characteristic of the non-commercial nature of groundnut production in the region and the high costs of these inputs.

In spite of the apparent differences in the level of awareness about aflatoxin risks among the PMG and non PMG respondents, a large percentage of farmers from both groups consumed discoloured and shrivelled nuts, fed rotten nuts to chicken, or used such spoilt nuts for seed. The fact that PMG respondents, in spite of their

increased awareness about aflatoxin risks, were just as likely to feed rotten nuts to poultry and consume or plant shrivelled nuts suggests a need for clarity of the message being delivered through the PMGs. Alternatively, this observation may imply a lag between the time farmers learn about a message and when they assimilate and implement it. These reasons may also explain the equitable levels of aflatoxin recovered from samples obtained from both PMG and non PMG members and underscore the need for a more specific and clear-cut message that is easy to convey and explain to farmers.

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