Information and the trade-off between food safety and food security in rural markets: Experimental evidence from Malawi.

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Abstract

Unobservable food safety attributes can undermine demand for quality, leading to a lemons market where unsafe food is prevalent. Providing consumers with information about food safety and labels designating food quality can potentially reduce the problem. However, it is unclear how food scarcity changes the impact of information on demand for unobservable food quality. To inform this issue, we implemented a clustered randomized control trial (RCT) with 1,098 households in Malawi to evaluate whether providing food safety information can increase demand for food safety, and whether the demand for quality varies depending on food availability. We used Becker-DeGroote-Marshack auctions to elicit consumers' willingness to pay (WTP) for three quality grades of groundnuts: (1) unsorted and unlabeled grade; (2) visibly sorted and unlabeled grade; and (3) visibly sorted with a food safety label. Results indicate that at harvest, when grain is abundant, both informed and uninformed consumers were willing to pay statistically the same premium for unobservable quality (WTP for grade 3 – WTP for grade 2). However, in the lean season, when grain is scarce, uninformed consumers were not willing to pay any premium for unobservable quality, possibly reflecting a belief that food quality during scarce times is low.

Keywords: randomized controlled trial, experimental auction, product quality, food safety, aflatoxins, groundnuts, sub-Saharan Africa, Malawi.

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INTRODUCTION

Informal food markets in sub-Saharan Africa (SSA) are dominated by numerous small-scale producers and traders who typically operate without formal business registration. This makes enforcement and monitoring of quality standards in these markets difficult and expensive (Hoffmann, Moser and Saak 2019; Roesel and Grace 2014; Grace 2015). This lack of regulation and coordination can have important negative consequences on human health (WHO, 2015). Given the unobservability of many food quality attributes (for example, presence of chemical and biological contaminants), producers and traders in these informal markets have little or no incentive to invest in grain quality, giving rise to a "lemons markets" in which low quality dominates (Akerlof, 1970).

In this paper, we estimate the extent to which information about food safety and quality labels can increase consumers' willingness to pay (WTP) for higher quality (safe) grain in rural markets of sub-Saharan Africa (SSA). We also evaluate whether or not limited resource consumers value these remedies during harvest season when food is plentiful and six months later during lean season when food is scarce. To address these issues, we implemented a clustered randomized control trial (RCT) with 1,098 rural households in central Malawi to evaluate whether randomly providing information about food safety to half of the respondents increased their demand for safe groundnuts. Specifically, we used Becker-DeGroote-Marshack auctions to elicit consumers' willingness to pay (WTP) for three quality grades of groundnuts: (i) unsorted where damaged kernels were mixed with undamaged kernels, and without a food safety information label ("unsorted grade"); (ii) visibly sorted with only undamaged kernels, and without a food safety information label ("sorted grade"); and (iii) visibly sorted with only undamaged kernels, and with a food safety label ("labeled grade"). The auctions for groundnuts of the three different levels of quality were conducted in the harvest and six months later in the lean seasons with the same households. This allowed us to estimate the extent to which information affects the relative importance that the same consumers place on food safety (quality) vs. food security (availability) during times of plenty and during times of scarcity.

Our main research objective is to evaluate whether food quality labels that make food safety attributes observable increase consumers' demand for higher-quality/safe grain across the year. We seek to know if the label creates a separating equilibrium among consumers, where demand for safe food exceeds the cost of testing and labeling it as such. The food safety threat we test and provide information about in this study are aflatoxins, which are poisons produced by fungi present in the soil that affect staple and cash crops such as maize, rice, sorghum, cassava, groundnuts and millet. They thrive in the field, and in storage if grains are not dried and stored properly. These toxins pose a serious health risk globally, including liver and esophagus cancers, stunting, malnutrition and immunodeficiency (Khlangwiset, Shephard and Wu 2011). Furthermore, aflatoxins are unobservable to consumers in rural markets, because they are tasteless, colorless, and odorless, and testing does not exist in these markets. Therefore, if consumers learn about and value the unobservable attribute then providing information about aflatoxin food safety could make the issue more salient and create an incentive for producers and consumers to transact higher-quality grain at a premium price,

In the present study we specifically measure the premium that consumers place on the unobservable grain quality (the aflatoxins-safe label) beyond that on observable grain quality (the sorting of good grains from visibly broken grains and foreign materials). Information campaigns are also a key potential policy lever, so testing their effectiveness in redressing a market imperfection provides critical information to address both economic and health aspects of this food safety issue.

This paper contributes to the literature on product quality and rural market development in in four ways. First, to our knowledge we are the first study to experimentally disentangle observable and unobservable premiums in consumers' willingness to pay for food safety. Most previous studies of consumers' WTP for grain quality have measured demand for observable quality or unobservable quality, but not both. For example, studies have focused on WTP for observable attributes such as grain color and insect damage (De Groote & Kimenju, 2008; Kadjo, Ricker-Gilbert, & Alexander, 2016), or have estimated demand for unobservable attributes in grain like moisture content (Prieto, Ricker-Gilbert, Bauchet, & Sall, 2021) and on-farm production practices, which are unobservable to buyers in markets (Hoffmann & Gatobu, 2014). In a correlational analysis of maize samples from Kenyan mills, Hoffmann, Mutiga, Harvey, Nelson, and Milgroom (2021) find that only observable quality is priced at a premium, but that unobservable quality (safety from aflatoxins contamination) is not. The closest work to ours is De Groote et al. (2016), which compares maize of three quality grades: visibly moldy, visibly clean but unlabeled, and visibly clean and labeled "aflatoxin-safe." Our study adds to De Groote et al. (2016) in that we disentangle observable and unobservable quality premiums between "normal" grain (unsorted grain, rather than moldy maize used in De Groote et al.'s study) and aflatoxins-safe grain.

Second, we estimate the causal impact of providing information on aflatoxins and their dangers on farmers' valuation of various quality grades, using a randomized controlled trial. Providing information on aflatoxins has been shown to increase demand for maize flour in Kenya (Hoffmann, Moser, & Herrman, 2021), particularly when an aflatoxins-free certification is provided (Kariuki & Hoffmann, 2019). De Groote et al. (2016) also analyzed the impact of providing information about aflatoxins (where they come from, and what impacts they have on human health) on rural consumers' willingness to pay for maize of different quality grades. They found that providing aflatoxins information increased WTP for all quality grades of maize, but did not differentially influence WTP for higher or lower quality grades. Our study adds to De Groote et al. (2016) a rigorous randomization of participants into the information or no information groups, as opposed to their "every other participant" approach.

Third, we contribute to the literature by evaluating how rural consumers' demand for grain quality varies under different states of food availability: by measuring demand for groundnuts in the harvest season and in the lean season. This important aspect helps to highlight how conflicting food security objectives, that is, quality versus quantity concerns, affect households' food quality demand in the post-harvest period. To our knowledge the only study to consider demand for food quality in rural markets across seasons focused on observable attributes such as insect damage and mold (Kadjo et al., 2016). Our paper provides empirical evidence of the effect of scarcity on consumers' demand for quality, highlighting the need for policy that re-enforces aflatoxin testing and regulations in informal markets especially during the lean season.

Last, we focus on groundnuts rather than maize. Groundnut is both a cash and staple crop for many smallholder farmers in Malawi and elsewhere in SSA. Smallholder farmers' sale of groundnut can be limited by their inability to meet stringent aflatoxins limits on international markets. In turn, these constraints could influence their demand for groundnut quality and their response to information in different ways from a staple crop like maize.

Overall, our results indicate that the food safety information treatment helped to increase consumers' demand for both observable and unobservable grain quality attributes. For example, receiving information about food safety increased consumers' WTP for both the visibly sorted groundnuts and those with the visible sorting and food safety label during the harvest season when grain was plentiful. However, auctions conducted during the lean season showed that households treated with information placed a higher WTP premium on groundnuts with the food safety label, compared to both the uniformed households, and to their own valuation of the label during the harvest season. Conversely, the uninformed households in the control group had a lower WTP premium for the food safety label in the lean season than they did at harvest.

These results suggest that providing information may incentivize consumers to increase the relative importance they place on food safety during the lean season, compared to those without information who may be inclined to prioritize food security (availability) during times of scarcity. We also find evidence that the premium that informed consumers place on groundnuts that are tested and labelled as aflatoxin-safe is higher than the cost to test groundnuts. This suggests that government investment in aflatoxin awareness and training campaigns could facilitate a sustainable private-sector market for higher-quality safe groundnuts in Malawi.

STUDY SETTING, SAMPLE, EXPERIMENTAL DESIGN AND AUCTION PROCEDURES

Sampling and Experimental design

Our sample included 1,098 farmers in total from Mchinji district in central Malawi, the major producer of groundnuts in the country (see Study area in Figure 1). They were randomly selected from a list of members of the National Smallholder Farmers' Association of Malawi (NASFAM), a farmer-based organization that has over 43 associations across the country. Each NASFAM Association has sub-units at the community level, called Group Action Centers (GACs). GACs are typically about 10 to 35 kilometers apart. A single NASFAM Association counts 21 GACs (or communities) on average, with each GAC having an average of about 15 farmer clubs. A club is made of 10 farmers who reside within the same village; village are typically 1-5 kilometers apart from each other. We targeted two Associations for the study, and we randomly selected 16 GACs from each Association to form the study sample. Within each of the 32 GACs, we randomly selected 25 farmers, subject to the condition that at least 2 (and at most 5) farmers were selected in each club. The resulting initial sample included 830 farmers, who participated in auctions twice: in the harvest and lean seasons. To these we added 268 randomly sampled new farmers in the lean season auction, to measure possible learning effects arising from the bulk of our sample bidding in the same auction twice.

The random assignment into treatment (receive information about aflatoxins) or control (do not receive information about aflatoxins) groups was done at the GAC level. We assigned treatment at the GAC level to avoid potential information spillover across clubs (or villages) within the same GAC. This arrangement also ensured cost-effective administration of the study activities (aflatoxins training and auction). Although GACs are far enough apart to limit possible information contamination, GACs that fall within the same Association are generally similar.

The information provided to treatment group participants included facts about aflatoxins, the crops they affect and the way they affect crops (in the field and during harvest, drying and storage), the health and economic effects of aflatoxins, and how to avoid or reduce aflatoxins contamination (practices available and appropriate for smallholder farmers). The information script is provided in Appendix A2). In the second round of auction, participants in the treatment group were not given the aflatoxin information again. However, new participants assigned to the treatment group in the second round (as described below) were given the same information. Participants in the control group were provided with the information at the end of the study.

Auction procedures

We elicit farmers' WTP for grain quality with incentive-compatible auctions using the Becker-Degroot-Marschak (BDM) mechanism, which is commonly applied in field experiments in developing countries (Becker, Degroot and Marschak 1964; Channa et al. 2019; Prieto et al. 2021). BDM auctions provide revealed preferences estimates based on bidding real money and actually purchasing the item at the bid price. In our setting, because participants bid on three quality grades of groundnut, one of their three bids was randomly selected as a binding bid.

Participants were first oriented about the BDM goals and procedures, then went through two practice rounds with sweets to ensure they understood the process as well as understood that strategic behavior was not beneficial. Once this was done, participants completed the real auction. All the three groundnut grades were auctioned in one-kilogram units, and participants were allowed to inspect the groundnuts before bidding. They then bid on the three grades of groundnuts that were presented in random order. Once they bid for all the grades, the enumerator rolled a die in the presence of the participant to determine which of the three grades of groundnuts was the binding bid. The participants then drew a paper from a bag that had uniformly distributed numbers, based on the median price of groundnut in each village as reported by NASFAM lead farmers. These were used as "offer prices" at which the binding bid was determined. Per standard BDM procedures, the participant bought the kilogram of groundnut of the selected grade if their bid was higher than the randomly drawn "offer price" from the bag, and they paid the "offer price" rather than the price they bid. Conversely, they did not buy the bag of groundnut if their bid was below the “offer price.” In all analyses, we use the amount that participants bid as our measure of WTP. Participants were given a fixed participation fee to eliminate liquidity constraints that would limit participation and bias their WTP.

The auction was implemented twice, first during the harvest season (June 2019) when farmers have abundant stocks of grains, and then again targeting the same participants during the lean season (January 2020). In the lean season we recruited an additional sample of 268 farmers (155 in the control group and 113 in the treatment group) during the second auction to tease out possible learning effects among the farmers in the original sample from the repeated auctions.

We purchased all groundnuts from a single farmer during the 2019 harvest in order to reduce heterogeneity in other grain attributes. The grain was then used to simulate the different grain quality grades prevalent in local markets (i.e. sorted and unsorted grain) for both auctions. For the auction implemented in the lean season, we used the same grain that was purchased during the harvest season and stored in hermetic bags to ensure minimal variation in grain quality (Baributsa et al. 2017). Aflatoxins testing of groundnut was done by a laboratory in Lilongwe, Malawi’s capital (Appendix A1). The aflatoxins-safe certificate was shown to participants when they were presented with the 1-kg sample of aflatoxins-safe groundnuts on which they bid. All groundnuts used in the auctions came from the same sample, in which the aflatoxins level was 2.1 ppb (below the 15 ppb limit in Malawi and the 4 ppb limit in the European Union); the aflatoxins level was not mentioned when presenting participants with the samples of unsorted and sorted grades. No participant asked about aflatoxins level in the samples of unsorted and sorted grades.

Power calculations

Since our outcome variable is WTP for groundnuts, we use baseline data from another study involving the same households, implemented in 2018, to get an estimate of mean and standard deviation of groundnuts purchase prices for the harvest and lean season. These data indicated an intra-cluster correlation coefficient within GAC of 0.02. Power calculations used 80 percent power and 95 percent confidence intervals. Calculations suggested that 32 total clusters (GACs) including 23 farmers per cluster (768 study participants in total) would ensure a minimum detectable effect (MDE) of 0.32 standard deviations between treated and control households. This is generally considered a small-to-medium effect size (Cohen, 1988; Duflo, Glennerster, and Kremer 2007). Our sample included 830 participants in the harvest season auction, and 1,013 participants in the lean season auction (1,098 unique participants in total).

RESEARCH QUESTIONS AND HYPOTHESES

This study answers three research questions. (1) Do rural consumers place premiums on observable and unobservable grain quality? This question aims to separately estimate the value of an aflatoxins-safe label, certifying quality along an unobservable characteristic of gain, and the value of simple grain sorting, which is a sign of observable grain quality. (2) What impact does the provision of information about aflatoxins and their dangers have on each premium – for observable and unobservable quality? (3) How do rural consumers approach the trade-off between grain quantity and quality? In other words, do their quality premiums and responsiveness to information differ when grain is abundant (harvests season) versus when it is scarce (lean season)?

To answer these questions, we test three hypotheses. First, we hypothesize that (uninformed) consumers' observable quality premium (willingness to pay for sorted groundnuts versus unsorted groundnuts) is not different from their unobservable quality premium (willingness to pay for aflatoxins safety labeling versus sorted groundnuts); H1. Limited awareness and/or understanding of aflatoxins and the health risk posed by aflatoxins may influence consumers to value the observable attribute more than the unobservable attribute. In addition, considering that consumers have established valuation processes and habits for valuing observable quality such as insect damaged kernels, it is possible that after receiving the information treatment, consumers' may overlook the labels (i.e. not read or care about labels) as they may be used to evaluating observables only due to habit persistence.

Our second set of hypotheses is: informed consumers' demand for the observable and unobservable attributes is not different from uninformed consumers' demand for these attributes (H2a: information does not change the observable quality premium; H2b: information does not change the unobservable quality premium). It is likely that consumers who are informed may have higher (lower) quality premiums for aflatoxins-safety labeling (sorting) in groundnuts than consumers that are uninformed. This is because when consumers are informed about the prevalence and health risks of aflatoxins, they are likely to place a lower (higher) probability of risk on groundnuts that has (does not have) aflatoxins-safety labeling compared to consumers who are uninformed about the potential risk.

Our last hypothesis is that demand for food quality and the impact of information decreases when food is scarcer, in the lean season; H3. We test this hypothesis by eliciting WTPs from the same participants during harvest and lean seasons. We hypothesize that both observable and unobservable premiums are higher in the harvest season than in the lean season (H3a), but we also hypothesize that this effect may be reduced by the information treatment (H4a).

ANALYTICAL APPROACH

Empirical models

We test our main hypotheses with the models estimated in this sub-section.

To estimate the observable and unobservable quality premiums, we analyze WTPs for the three quality grades of groundnuts among uninformed participants (control group) only, using the following regression equation:

$$WTP_{ijt} = \beta_0 + \beta_1 S_{ijt} + \beta_2 L_{ijt} + \beta_3 T_{it} + \beta_4 X_i + \varepsilon_{ijt} \qquad (1)$$

In equation (1), *i* indexes individual participants, *j* indexes groundnut quality grades, and *t* indexes the time when the bid was placed (harvest or lean season). WTP is the bid value in Malawi Kwacha per kilogram of groundnut (MK/kg). S_{it}, L_{it} are binary variables equal to one if the grade of groundnut on which individual *i* bid was sorted and labeled, respectively, and zero otherwise. The unsorted groundnut grade is the omitted quality grade. Coefficient $\widehat{\beta_1}$ measures the observable quality premium, and the difference $(\widehat{\beta_2} - \widehat{\beta_1})$ measures the unobservable quality premium. Variable T_{it} is a binary variable equal to one if the bid was recorded in the lean season, and equal to zero if the bid was recorded in the harvest season; average bids were higher in the lean season. Vector X_i is a vector of baseline participants characteristics, including the participants' baseline aflatoxins knowledge score (mean: 3.1, range: 0-10) and the number of years that the participant's household has been a member in NASFAM (mean: 4.1, range: 0-30). The former is included because the randomization is imbalanced with respect to baseline knowledge (p=0.030; Appendix A4), and the latter is included because it was correlated with the likelihood of attrition between the harvest and lean seasons (p=0.002; Appendix A5 and A6). We present all analyses with and without vector X; results are nearly identical. Last, ε_{ijt} is the error term. Standard errors were clustered at the GAC level, which is the level of randomization of the information treatment; results are similar when clustering at the household or individual bidder levels.

To estimate the impact of providing information on the two quality premiums, we implement the following regression on our full sample:

$$WTP_{ijt} = \alpha_0 + \alpha_1 S_{ijt} + \alpha_2 L_{ijt} + \alpha_3 I_{it} + \alpha_4 I_{it} * S_{ijt} + \alpha_5 I_{it} * L_{ijt} + \alpha_6 T_{it} + \alpha_7 X_i + \mu_{ijt}. \quad (2)$$

The subscripts, variables WTP, S, L, T, X, and standard errors are as described for equation (1). I is a binary variable equal to one if the participant was provided information about aflatoxins and their dangers before bidding (treatment group), and equal to zero if the participant was not informed (control group). The error term is μ_{ijt}. The observable quality premium for uninformed participants is estimated by $\widehat{\alpha_1}$, and the unobservable quality premium for uninformed participants is $(\widehat{\alpha_2} - \widehat{\alpha_1})$. The observable quality premium for informed participants is $(\widehat{\alpha_1} + \widehat{\alpha_4})$, and the unobservable quality premium for informed participants is estimated by the expression $(\widehat{\alpha_2} + \widehat{\alpha_5} - \widehat{\alpha_1} - \widehat{\alpha_4})$.

Finally, to estimate the impact of food scarcity on the quality premiums and on the impact of information on these premiums, we estimate two versions of equation (2): one in which I_{it} is omitted and replaced by T_{it}, including its interaction with the two grade variables, and the second in which we estimate equation (2) without variable T_{it} but separately for bids in the harvest season and in the lean season.

Randomization balance checks

To estimate the balance of randomization, we used a probit estimator to model whether household characteristics were balanced across the treatment and control group. Appendix A4 presents the results. The Chi-squared test of joint significance of all the independent variables in the model suggests that the treatment assignment was not perfectly balanced (χ^2=31.8, p=0.046). However, only one variable showed a statistically significant imbalance: participants who had a higher previous knowledge of aflatoxins were 1.8 percentage points more likely to have been assigned to the treatment group (p=0.030). To control for the possible effect of this imbalance, we present all results with and without this covariate included in regressions models; results are unaffected.

[Insert Table 1 here]

Attrition

Willingness to pay for the three grades of groundnut quality was measured twice. In June 2019, during harvest, we surveyed and conducted the auction with 830 farmers. In January 2020, at the height of the lean season, we conducted a follow-up survey and a second auction with the same farmers. Of the 830 farmers surveyed at harvest, we could not locate 168 for the lean season survey and auctions. In such cases, we attempted to survey another member of the household, and measured the new member's willingness to pay for the three groundnut quality grades. This effort was successful for 83 households, from whom we were able to collect lean season data. As a result, 85 households truly attrited from harvest to lean seasons; 50 of them were in the treatment group and 35 in the control group.

In order to estimate the possibility of attrition bias, from attrition being correlated with the treatment assignment, we regressed a binary indicator of a farmer or household being an attriter (1=could not be found for the lean season survey; 0=completed the lean season survey) on the information treatment indicator and the set of baseline household characteristics included in the summary statistics table and the randomization balance test. Coefficient estimates show that neither farmer-level nor household-level attrition were correlated with the random assignment (Appendix A5 and A6). Only one household characteristic was statistically significantly correlated with household attrition: years as a NASFAM member (p=0.002). At the farmer level, years of schooling, gender, landholding, years as a NASFAM member, and members of the Chioshya NASFAM Association were statistically significantly associated with the likelihood that a specific farmer was not available to answer the survey and bid in the lean season.

We addressed attrition in three ways. First, we present all regressions with and without a control variable for years as a NASFAM member, the variable consistently associated with attrition. All results are robust to the inclusion of this variable. Second, we re-estimate our main table with years of schooling, gender, landholding, and members of the Chioshya NASFAM Association included in the regression and results are nearly identical to our main results. Last, we re-estimate our main table on the sub-sample of farmers who were included in both the harvest and lean seasons. Coefficient magnitudes and levels of statistical significance are similar to those in the main table. In summary, attrition – at the farmer and household levels – did not impact our estimates.

Learning effects

Because most farmers in our sample were surveyed twice and bid twice on the same quality grades of groundnuts, learning may have occurred between harvest and lean seasons activities – about both aflatoxins and auction procedures – and may bias our measures of impacts and our comparisons across seasons. We tested for possible learning effects by re-estimate our main model with a binary variable equal to one if the household who bid in the harvest season also bid in the lean season, and zero if the household attrited between waves or was added to the lean season survey. Results (not shown) are similar if we define the variable based on a farmer (rather than any household member) having participated in both waves.

Summary statistics

Table 1 presents mean values of WTP for various quality grades, in Malawi Kwacha per kg (MK/kg; US$1=MK750 at the time of the study). At baseline (harvest season), the average WTP was MK233/kg for unsorted groundnuts, MK313/kg for sorted groundnuts, and MK334/kg for labeled groundnuts grades. The average WTP for all quality grades was about 40 percent higher in the lean season than in the harvest season.

[Insert Table 1 here]

Table 2 shows characteristics of participants and their household at baseline (i.e. from the survey conducted during the harvest season). Before any aflatoxins information was shared with participants, participants knew the correct answer to 3.1 out of 10 questions about aflatoxins, on average. Only 39 percent of participants knew the answer to 5 or more questions. The aflatoxins awareness score was constructed based on participants' response to 10 key awareness questions, such as indicators that aflatoxins are present, crops affected, practices that proliferate aflatoxins in grain, aflatoxins' health effects and prevention.

On average, research participants were middle-aged (39 years), equally divided between men and women (54 percent women), had received a primary school education (5.8 years of schooling), and owned 3.5 acres of land. Participant were food insecure for 1.5 months in the previous 12 months; 75 percent of households reported being food insecure for at least one month (not shown).

[Insert Table 2 here]

RESULTS

Mean WTP for observable and unobservable quality attributes

Table 3 presents our base model, described in equation (1), for the sample of uniformed consumers. Results represent demand for quality in a "normal" setting, absent any information. They indicate that typical consumers value observable quality, but not unobservable quality. Auction participants were willing to pay MK82 more for the sorted grade of groundnuts on average than for the unsorted grade ($p<0.001$). However, they were only willing to pay MK7 more for the labeled grade than for the sorted grade, on average, than for the sorted grade (shown as the unobservable quality premium in Table 3; $p=0.109$).

[insert Table 3 here]

Impact of information on quality premiums

We estimate the impact of information in two steps. In the first step, we include in the regression equation a binary variable equal to one if a bidder was provided information about aflatoxins (treatment group), and zero if not (control group). Table 4 shows that, overall, providing information increases WTP by MK15/kg ($p<0.001$). Information also increases the size of both quality premiums: WTP for sorting was MK97/kg ($p<0.001$), and WTP for labeling – beyond sorting – was MK32/kg ($p<0.001$), in the full sample including both uninformed and informed participants. These observable and unobservable quality premiums were MK82/kg ($p<0.001$) and MK7/kg ($p=0.109$) in the sample of uninformed participants only.

[Insert Table 4 here]

In a later step, we exploit the random assignment of information to calculate the causal impact of providing aflatoxins information on consumers' demand for quality. We implement equation (2), interacting the information treatment indicator with the two quality grades variables.

Table 5 shows three key results. First, providing information lowered WTP for lower-quality groundnut (unsorted grade), by MK26/kg on average (p<0.001). Second, information increased consumers' quality premiums, for both observable and unobservable quality. The unobservable quality premium was MK82/kg for uninformed participants and Mk116/kg for informed participants; the difference is statistically significant (F=182, p<0.001). The observable quality premium was MK7/kg for uninformed participants and MK62/kg for informed participants (F=51, p<0.001). Finally, estimating quality premiums separately for informed and uninformed participants shows that the overall estimate of the quality premium described above (MK32/kg) needs to be nuanced. Uninformed consumers were not willing to pay a statistically significant premium for unobservable quality (regression coefficients estimate a MK7/kg labeling premium; p=0.093), but informed customers were willing to pay a MK62/kg unobservable quality premium (p<0.001).

[Insert Table 5 here]

Food safety/security trade-off

To evaluate the presence of a trade-off between food safety and food security, we estimate the effect of food scarcity on consumers' observable and unobservable quality premiums. We do so by interacting the two grade variables in equation (2) with variable T_{it}, a binary variable equal to one for bids made in the lean season and zero for bids made in the harvest season. Results, shown in Table 6, shows that participants placed a premium on observable quality in both harvest and lean seasons (MK50/kg and MK107/kg, p<0.001 and p<0.001). The values of this premium was much higher in the lean season, when quantities are scarcer, than in the harvest season, even when measured in percentage of the unsorted groundnut grade to account for generally higher prices in the lean season: the observable quality premium was about 20 percent of the lower-quality grade in the harvest season, and 32 percent in the lean season.

Willingness to pay a premium for unobservable quality, however, changed between the harvest and the lean seasons. At harvest, participants as a whole exhibited a small but statistically significant willingness to pay a premium for unobservable quality: MK12/kg on average ($p<0.001$). During the lean season auction, however, this premium disappeared. Participant were not willing to pay a higher price for labeled groundnut above sorted groundnuts (coefficient estimate=MK2/kg, $p=0.507$).

[Insert Table 6 here]

Impact of information by level of food scarcity

The level of food abundance or scarcity could influence the impact of providing aflatoxins information on willingness to pay for grain quality, both observable and unobservable. We address this question by estimating equation (2) separately for the harvest and the lean seasons. Quality premiums in the harvest season generally mirrored the overall estimates of the impacts of information presented above, with one important difference. Compared to uninformed participants, informed participants discounted lower-quality groundnut and placed a premium on unobservable quality. The difference is that the unobservable quality premium was not statistically significantly different from zero in the harvest season (MK17/kg, $p=0.127$; Table 7, column 1), unlike in the analysis of data from both seasons together (MK55, $p<0.001$).

In the lean season, the impact of information on participants' willingness to pay and quality premiums differed noticeably from those in the harvest season. Informed participants placed a higher willingness to pay for observable quality than uninformed participants (MK116/kg versus

MK107/kg, F=327, p<0.001), but the value of the observable quality premium – MK9/kg – was smaller than that in the harvest season (MK66/kg). Estimates of the quality premium in percentage of the average willingness to pay for unsorted quality grade, which adjust for the mean difference in WTP across seasons, tell the same story (Table 7).

The impact of information on the unobservable quality premium differed in a large way in the harvest and lean seasons. Recall that the unobservable quality premium in the harvest season was not statistically significantly different for informed and uninformed participants (coefficient estimate of the difference in premiums=MK17/kg, p=0.127). In the lean season, the impact of informing participants was large and statistically significant: uninformed participants exhibited no premium for unobservable quality (MK=2/kg, p=0.494), but informed participants were willing to pay a premium of MK90/kg (p<0.001) for groundnuts of guaranteed unobservable quality. The difference was strongly statistically significant (p<0.001).

[Insert Table 7 here]

CONCLUSION

This paper contributes to the literature on information, product quality and market development in sub-Saharan Africa by evaluating how food safety information and food availability influence consumers' demand for observable and unobservable grain quality attributes. We use aflatoxins levels in groundnuts, an unobservable quality attribute that has important implications for food safety, to evaluate rural consumers' demand for sorting (the observable food quality attributes) and aflatoxins safety (the unobservable food quality attributes). We consider the difference between the unsorted grade and sorted grade a quality premium for sorting and the difference between the sorted grade and the labeled grade as a quality premium for aflatoxins safety. Although our results suggest that consumers had significant quality premium for both observable and unobservable quality attributes (MK96 and MK32 respectively), the estimated quality premium for the observable attribute (sorting) was significantly higher compared to the premium for the unobservable attribute (aflatoxins safety). This may have been due to limited awareness and /or understanding of the aflatoxin information and health risk posed by aflatoxins also likely influenced consumers' valuation processes. In addition, consumers who did not receive the foods safety information treatment seemed to be relatively more concerned with the observable attributes rather than the unobservable food safety attributes. This was likely due habit persistence and an inability to read or understand the food safety label. This finding supports what Hoffmann et al. (2021; 2013) found in Kenya where only observable maize attributes had a significant effect on price, but not unobservable attributes, such as aflatoxin contamination.

Our analysis of the impact of providing aflatoxins information on consumers' demand for quality suggested that giving consumers information about aflatoxins and its health risks significantly decreased their demand for quality especially aflatoxins safety, the unobservable grain quality attributes. We found that the treated group (informed households) had significant marginal quality premium for sorting and aflatoxins safety of about MK 34 ($p<0.001$) and MK55 ($p<0.001$) respectively. It was likely that the new information about health risk associated by aflatoxins may have influenced consumers' beliefs and increased their quality demand. Our results suggested that raising awareness about aflatoxins and the health risk posed by it may have helped to increase consumers' demand for grain quality especially for unobservable attributes like aflatoxins safety. Therefore, there is need to increase aflatoxins information campaigns for key food crops in Malawi including groundnuts. In addition, there is also need to increase aflatoxin testing and regulation in informal grain markets to deal create supply side incentives for aflatoxins control within these markets.

For our final hypothesis, we found that food scarcity significantly influenced uninformed consumers to compromise their quality demand as we observe that the quality premium for the unobservable attribute (aflatoxin safety) was lower in the lean season relative to the harvest season (i.e. 5% in harvest vs 1% in the lean season). We also observed a decline in demand for sorting in the lean season relative to harvest season amongst the informed consumers. Our results indicated that consumers' quality demand were more profound in the harvest season when grain is readily available compared to the lean season when they face scarcity. Conflicting food security objectives (i.e. to achieving both desired food quantities and quality) that households faced during the lean season may likely influence them to trade-off food quality for quantity. These results exposed the need for policy that would target increasing aflatoxin testing and enforcement in the informal grain market especially during the lean season when consumers' own quality demand are compromised. In addition, these results also highlighted the need for government to identify and support policy initiatives or interventions that could help rural households achieve food security while balancing their food quality and quantity needs.

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Table 1: Outcome descriptive statistics

	Count	Mean	Std. Dev.	Min	Max
Panel A: Overall					
WTP for unsorted groundnuts (MK/kg)	1,843	289	134	0	830
WTP for sorted groundnuts (MK/kg)	1,843	386	142	50	1,060
WTP for labeled groundnuts (MK/kg)	1,843	418	152	70	1,210
Panel B: Harvest season					
WTP for unsorted groundnuts (MK/kg)	830	233	104	0	760
WTP for sorted groundnuts (MK/kg)	830	313	104	50	870
WTP for labeled groundnuts (MK/kg)	830	334	103	70	740
Panel C: Lean season					
WTP for unsorted groundnuts (MK/kg)	1,013	334	139	90	830
WTP for sorted groundnuts (MK/kg)	1,013	445	140	60	1,060
WTP for labeled groundnuts (MK/kg)	1,013	487	152	70	1,210

Data are in Malawi Kwachas; US$1=MK750.

Table 2: Household descriptive statistics

	Count	Mean	Std. Dev.	Min	Max
Baseline aflatoxins knowledge score (0-10)	1,098	3.1	3.4	0	10
=1 if baseline aflatoxins awareness score > 5	1,098	0.39	0.5	0	1
Age of respondent (years)	1,081	39	12	17	76
Respondent's schooling (years)	1,098	5.8	3.7	0	38
=1 if respondent is male	1,098	0.46	0.5	0	1
Household size	1,098	5.3	1.8	1	12
Landholding (acres)	1,098	3.5	1.4	0.4	10
Number of years in NASFAM	1,098	4.1	3.3	0	30
Number of school goers in household	1,068	2.4	1.6	0	9
Number of females in household	1,068	2.7	1.3	0	9
Number of adults (age>18 years) in household	1,068	2.5	1.1	0	9
Distance from home to closest market (km)	1,098	12	15	0	300
Number of extension officer visits per year	1,098	5.6	10.2	0	90
=1 if household owns radio set	1,098	0.46	0.5	0	1
=1 had cash savings at the beginning harvest	1,068	0.25	0.4	0	1
Storage expenditure (MK)	1,068	2,015	5,051	0	91,000
Number of months food insecure (0 to 12)	1,098	1.5	1.5	0	10
=1 if respondent too ill to farm for >2 months in past 2 years	1,068	0.19	0.4	0	1
Respondents' anchor price (MK)	1,098	355	119	0	850
=1 if association is Chioshya	1,098	0.52	0.5	0	1

US$1=MK750 (Malawi Kwacha). The baseline aflatoxins knowledge score (0 to 10) is constructed based on participants' response to 10 aflatoxins awareness questions.

Table 3: Observable and unobservable quality premiums, uninformed participants only.

	(1)	(2)
Dependent variable:	Willingness to pay (MK/kg)	
=1 if sorted grade (β_1)	82***	82***
	(3)	(3)
=1 if labeled grade (β_2)	89***	89***
	(5)	(5)
=1 if lean season	119***	122***
	(13)	(13)
Baseline aflatoxins knowledge score (0 to 10)		2*
		(1)
Number of years in NASFAM		1
		(1)
Constant	235***	225***
	(6)	(7)
Observations	3,030	3,030
R-squared	0.25	0.25
Number of unique bidders	600	600
Observable quality premium (β_1)	82***	82***
Unobservable quality premium ($\beta_2 - \beta_1$)	7	7
F-test: Obs. quality premium = unobs. quality premium	F=176***	F=176***

The sample is limited to uninformed participants. Coefficient names refer to equation (1). Standard errors clustered by GAC in parentheses. *** p<0.01, ** p<0.05, * p<0.1. *** p<0.01, ** p<0.05, * p<0.1. US$1=MK750 (Malawi Kwacha). Group action centers (GAC) are community-level clusters; the assignment to treatment and control was done at the GAC level. Baseline control variables include the baseline aflatoxins knowledge score and the number years that the household has been a member of NASFAM.

Table 4: Impact of information on overall WTP.

	(1)	(2)
Dependent variable:	Willingness to pay (MK/kg)	
=1 if sorted grade (α_1)	97***	97***
	(5)	(5)
=1 if labeled grade (α_2)	129***	129***
	(11)	(11)
=1 if household informed about aflatoxins (α_3)	15**	15**
	(7)	(7)
=1 if lean season (α_6)	129***	130***
	(9)	(9)
Baseline aflatoxins knowledge score (0 to 10)		1
		(1)
Number of years in NASFAM		-0
		(1)
Constant	211***	208***
	(8)	(8)
Observations	5,529	5,529
R-squared	0.31	0.31
Number of unique bidders	1,098	1,098
Observable quality premium (α_1)	97***	97***
Unobservable quality premium ($\alpha_2 - \alpha_1$)	32***	32***
F-test: Obs. quality premium = unobs. quality premium	F=105***	F=105***

Coefficient names refer to Equation (2). Standard errors clustered by GAC in parentheses. *** p<0.01, ** p<0.05, * p<0.1. *** p<0.01, ** p<0.05, * p<0.1. US$1=MK750 (Malawi Kwacha). Group action centers (GAC) are community-level clusters; the assignment to treatment and control was done at the GAC level. Baseline control variables include the baseline aflatoxins knowledge score and the number years that the household has been a member of NASFAM.

Table 5: Impact of information on observable and unobservable quality premiums.

	(1)	(2)
Dependent variable:	Willingness to pay (MK/kg)	
=1 if sorted grade (α_1)	82***	82***
	(3)	(3)
=1 if labeled grade (α_2)	89***	89***
	(5)	(5)
=1 if household informed about aflatoxins (α_3)	-26***	-26***
	(7)	(7)
Sorted grade * Information (α_4)	34***	34***
	(6)	(6)
Labeled grade * Information (α_5)	89***	89***
	(7)	(7)
=1 if lean season (α_6)	129***	129***
	(9)	(9)
Constant	230***	227***
	(5)	(7)
Observations	5,529	5,529
R-squared	0.32	0.32
Number of unique bidders	1,098	1,098
Baseline control variables included	No	Yes
Uninformed participants (Control group):		
Observable quality premium (α_1)	82***	82***
Unobservable quality premium ($\alpha_2 - \alpha_1$)	7*	7*
Informed participants (Treatment group):		
Observable quality premium ($\alpha_1 + \alpha_4$)	116***	116***
Unobservable quality premium ($\alpha_2 + \alpha_5 - \alpha_1 - \alpha_4$)	62***	62***
F-test: Obs quality premium, uninformed = obs. quality premium, informed	F=182***	F=182***
F-test: Unobs quality premium, uninformed = unobs. quality premium, informed	F=51***	F=51***

Coefficient names refer to equation (2). Standard errors clustered by GAC in parentheses. *** p<0.01, ** p<0.05, * p<0.1. US$1=MK750 (Malawi Kwacha). Group action centers (GAC) are community-level clusters; the assignment to treatment and control was done at the GAC level. Baseline control variables include the baseline aflatoxins knowledge score and the number years that the household has been a member of NASFAM.

Table 6: Impact of seasonality on observable and unobservable quality premiums, uninformed participants only.

	(1)	(2)
Dependent variable:	Willingness to pay (MK/kg)	
=1 if sorted grade (α_1)	50***	50***
	(5)	(5)
=1 if labeled grade (α_2)	62***	62***
	(6)	(6)
=1 if lean season (α_6)	85***	87***
	(15)	(15)
Sorted grade * Lean season (α_4)	57***	57***
	(6)	(6)
Labeled grade * Lean season (α_5)	47***	47***
	(6)	(6)
Constant	254***	244***
	(7)	(7)
Observations	3,030	3,030
R-squared	0.31	0.31
Number of unique bidders	600	600
Baseline control variables included	No	Yes
Harvest season:		
Observable quality premium (α_1)	50***	50***
(In % of unsorted grade)	*19.7%*	*20.5%*
Unobservable quality premium ($\alpha_2 - \alpha_1$)	12***	12***
(In % of unsorted grade)	*4.7%*	*4.9%*
Lean season:		
Observable quality premium ($\alpha_1 + \alpha_4$)	107***	107***
(In % of unsorted grade)	*31.6%*	*32.3%*
Unobservable quality premium ($\alpha_2 + \alpha_5 - \alpha_1 - \alpha_4$)	2	2
(In % of unsorted grade)	*0.6%*	*0.6%*
F-test: Obs quality premium, harvest season = obs. quality premium, lean season	F=15**	F=15**
F-test: Unobs quality premium, harvest season = unobs. quality premium, lean season	F=2.6	F=2.6

Coefficient names refer to Equation (2). Standard errors clustered by GAC in parentheses. *** p<0.01, ** p<0.05, * p<0.1. US$1=MK750 (Malawi Kwacha). Group action centers (GAC) are community-level clusters; the assignment to treatment and control was done at the GAC level. Baseline control variables include the baseline aflatoxins knowledge score and the number years that the household has been a member of NASFAM.

Table 7: Impact of information on observable and unobservable quality premiums, in harvest and lean seasons.

	(1)	(2)	(3)	(4)
Dependent variable:	Willingness to pay (MK/kg)			
Season:	Harvest		Lean	
=1 if sorted grade (α_1)	50***	50***	107***	107***
	(5)	(5)	(3)	(3)
=1 if labeled grade (α_2)	62***	62***	109***	109***
	(6)	(6)	(5)	(5)
=1 if household informed about aflatoxins (α_3)	-46***	-45***	-11	-12
	(10)	(10)	(12)	(12)
Sorted grade * Information (α_4)	66***	66***	9	9
	(8)	(8)	(8)	(8)
Labeled grade * Information (α_5)	83***	83***	97***	97***
	(9)	(9)	(10)	(10)
Constant	254***	259***	339***	334***
	(6)	(7)	(10)	(13)
Observations	2,490	2,490	3,039	3,039
R-squared	0.18	0.18	0.19	0.19
Number of unique bidders	830	830	1,013	1,013
Baseline control variables included	No	Yes	No	Yes
Uninformed participants (Control group):				
Observable quality premium (α_1)	50***	50***	107***	107***
(In % of unsorted grade)	*19.7%*	*19.3%*	*31.6%*	*32.0%*
Unobservable quality premium ($\alpha_2 - \alpha_1$)	12**	12**	2	2
(In % of unsorted grade)	*4.7%*	*4.6%*	*0.6%*	*0.6%*
Informed participants (Treatment group):				
Observable quality premium ($\alpha_1 + \alpha_4$)	116***	116***	116***	116***
(In % of unsorted grade)	*55.8%*	*54.2%*	*35.4%*	*36.0%*
Unobs. quality premium ($\alpha_2 + \alpha_5 - \alpha_1 - \alpha_4$)	29***	29***	90***	90***
(In % of unsorted grade)	*13.9%*	*13.6%*	*27.4%*	*28.0%*
F-test: Obs quality premium, uninformed = obs. quality premium, informed	F=15***	F=15***	F=327***	F=327***
F-test: Unobs quality premium, uninformed = unobs. quality premium, informed	F=2.5	F=2.5	F=131***	F=131***

Coefficient names refer to equation (2). Standard errors clustered by GAC in parentheses. *** p<0.01, ** p<0.05, * p<0.1. US$1=MK750 (Malawi Kwacha). Group action centers (GAC) are community-level clusters; the assignment to treatment and control was done at the GAC level. Baseline control variables include the baseline aflatoxins knowledge score and the number years that the household has been a member of NASFAM.

Figure 1: Study Area

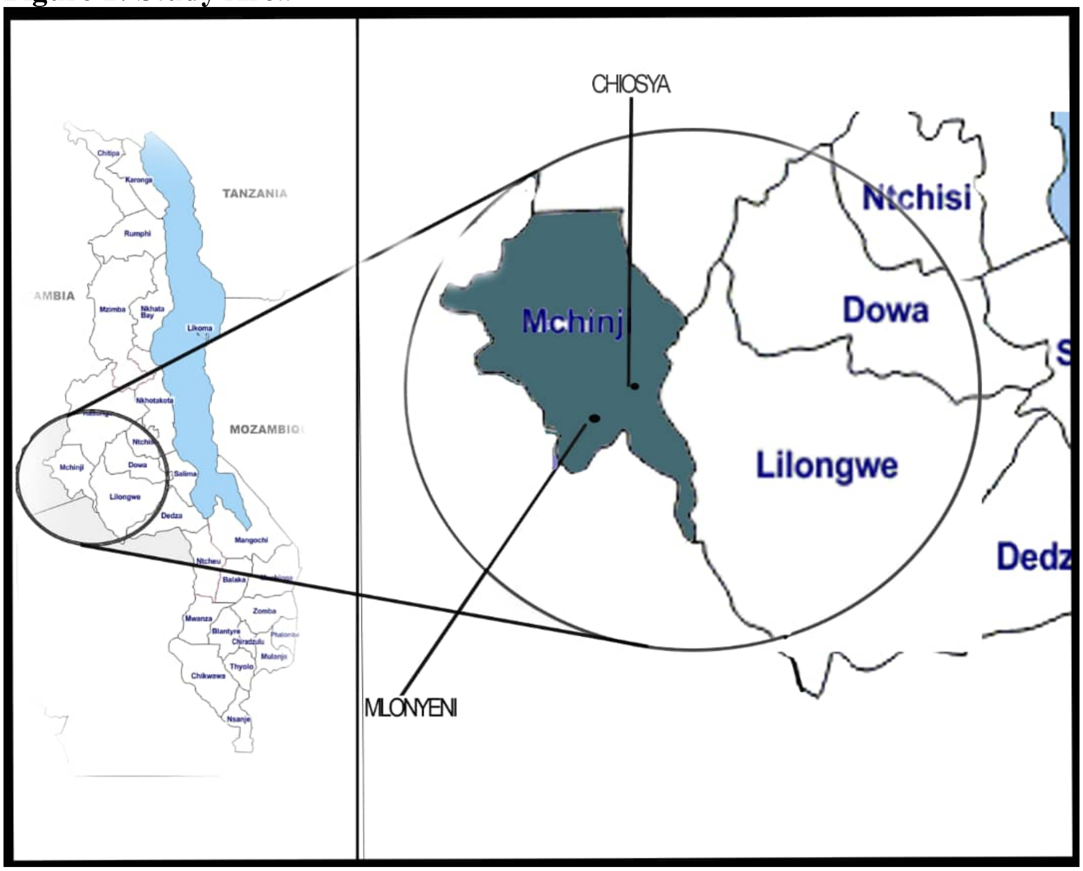


Figure 2: Study consort diagram and timeline

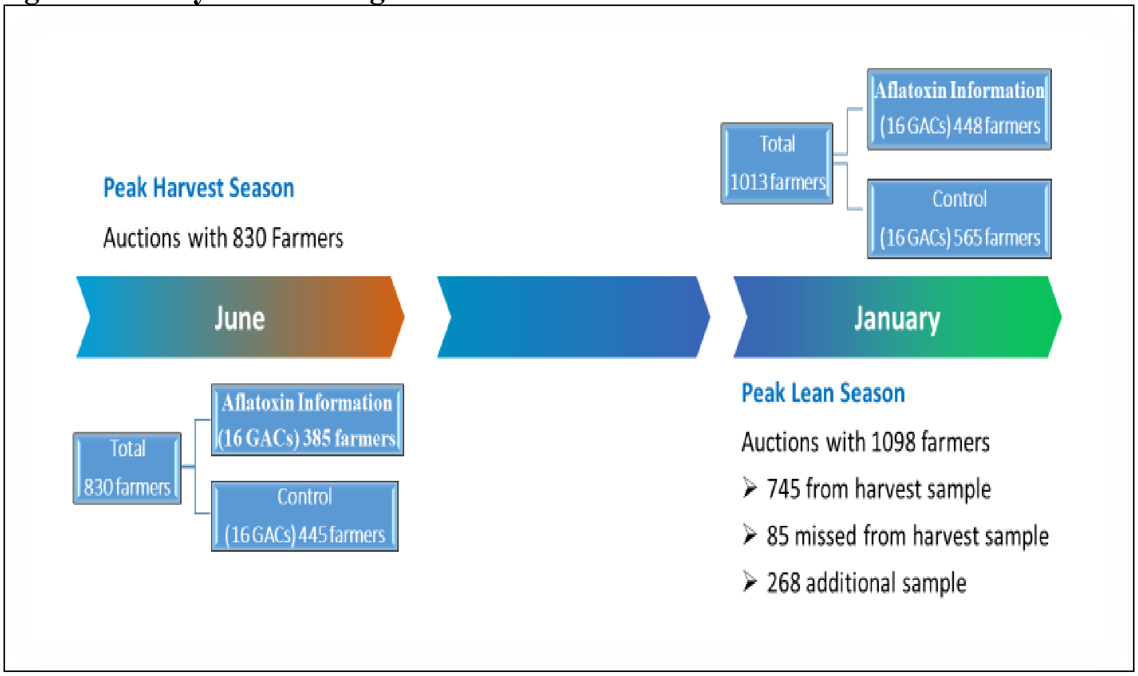


Figure 3: Auction Samples

Figure 4: Effect of Information Treatment on WTP for Different Groundnuts Quality Grades

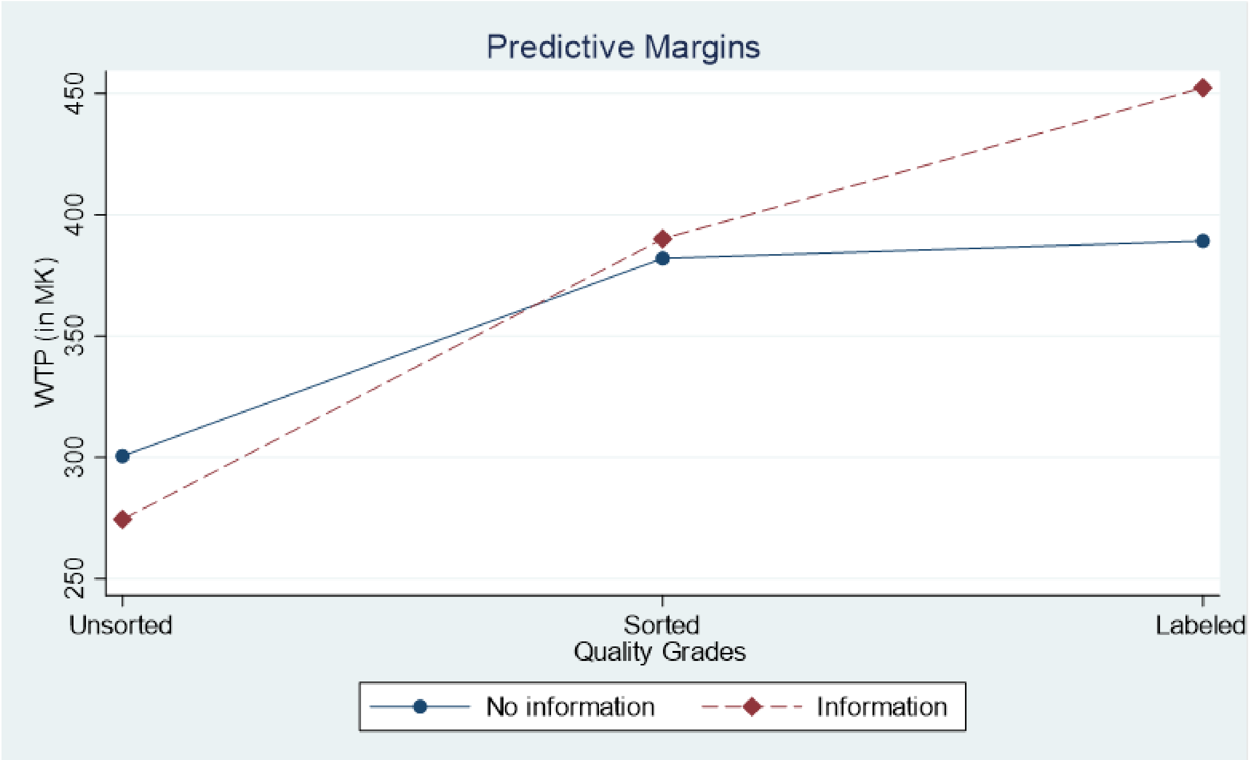
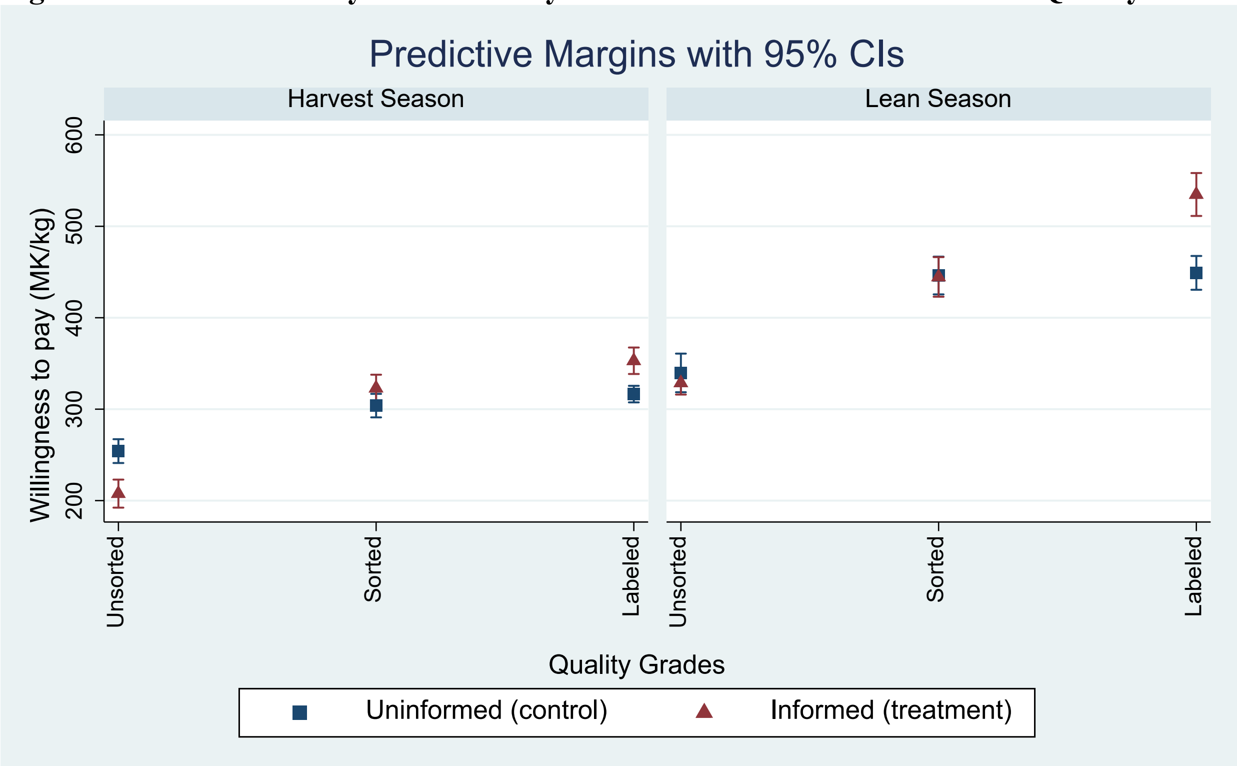


Figure 5: Effect of Scarcity or Seasonality on WTP for Different Groundnuts Quality Grades



Note: Figure that shows the results in Table 7:

APPENDIX A1: AFLATOXINS ANALYSIS AND CERTIFICATE

VALID NUTRITION

Valid Nutrition, Box 202, Lilongwe, Malawi
+265 (0)1 712 488 malawi@validnutrition.org www.validnutrition.org

DATE: 15/05/2019

Sample type: Raw nut and Maize
Sample ID: Grade A & B
Test required: Total aflatoxin
Date analysis started: 15/05/2019

CERTIFICATE OF ANALYSIS

1. Mycotoxin test

SAMPLE	TEST	RESULT	UNITS	METHOD	LAB REFERENCE NUMBER
Maize (A)	Total aflatoxin	1.7	ppb	Fluorometry	CHE/19/AO/17
Maize (B)	Total aflatoxin	0.71	ppb	Fluorometry	CHE/19/AO/17
Raw nut (A)	Total aflatoxin	2.1	ppb	Fluorometry	CHE/19/AO/17
Raw nut (B)	Total aflatoxin	41	ppb	Fluorometry	CHE/19/AO/17

Declaration

The undersigned hereby certify that the data is true to the specification of the obtained results of tests

Emmanuel Mawanga
Quality Assurance and Control Supervisor

Chikondi Matiki
Quality Assurance Manager

Note: We used groundnut sample A for all auctions. The aflatoxins limits in groundnut are 4 parts per billion (ppb) in the European Union, and 15 ppb in Malawi and the United States.

APPENDIX A2: AFLATOXINS TRAINING SCRIPT FOR THE MALAWI FOOD QUALITY AND SAFETY STUDY

We will now take you through a training session to inform you about Aflatoxins prevalence, its health effects as well as how to control or prevent contamination.

1. What are aflatoxins?

Aflatoxins are carcinogenic poisons produced by molds or fungus such as *Aspergillus flavus* and *Aspergillus parasiticus* which are usually found in improperly stored food. These toxins are invisible and tasteless such that it is hard for a consumer to detect them in their food without use of some lab equipment.

2. Which crops and foods are affected by Aflatoxins?

As pointed out earlier aflatoxins are found in improperly stored food including maize, rice, sorghum, cassava, groundnuts and millet amongst other staple foods. Molds are a key indicator of aflatoxins and these can also grow in flour or spices that are not stored properly and contaminate them with aflatoxins. Feeding animals grain contaminated with molds can also affect the products we get from them such as milk as these toxins can be carried over and are difficult to neutralize. Aflatoxins cannot be neutralized by cooking or processing. Some traditional food processing procedures especially those that increase moisture content can also increase aflatoxins infestation in food.

3. Health Effects and Economic Costs

Consumption of aflatoxins in large quantities can cause aflatoxicosis. This condition involves abdominal pain, vomiting, fever, diarrhea and convulsions. There has been several publicized epidemics in other countries like Kenya and Tanzania, but it is likely that people in Malawi experience this but few reports it.

Chronic consumption of aflatoxins in small quantities which is more prevalent in Malawi is also dangerous. This is because it can suppress the immune system, cause stunting, malnutrition, especially in children. There extensive research evidence that suggest a strong correlation between chronic aflatoxins exposure and liver diseases and cancers. Besides, because maize is a staple food crop in Malawi, taking up to about 60 percent of the daily caloric intake, it is likely that Malawians may be at high risk of chronic exposure to aflatoxins. For children who are mostly feed grain-processed products like porridges and puddings (*"Phala")* as weaning foods, this may also be a serious health threat.

Aflatoxins contamination in grain can also pose economic threat by limiting farmers access to high value markets. For example, for export markets and local processing sectors, there are limitation in terms of aflatoxins contents for grain, as such farmers that have contaminated grain with aflatoxins level beyond the allowable levels can fail to access such markets and this can have significant effects on the economy as well as reduce incomes for farmers. There has been limited awareness about aflatoxins in Malawi with the few initiatives focused on Groundnuts mostly because of the need to deal with such barrier to markets. However, not much has been done to raise consumer awareness about aflatoxins prevalence in different food crops especially those sold/purchased from informal grain markets such as groundnuts and maize. Our purpose is to raise awareness about aflatoxins prevalence and its health effects

4. How to Avoid Contaminations (Dealing with Practices that Proliferate aflatoxins)?

Aflatoxins contamination can be avoided in many ways in the different stages of production.

- ***During production***, farmers can use some bio pesticides like Afla-safe to control aflatoxins while the crops are still in the fields.

- ***During harvest***, farmers can avoid contamination by avoiding direct grain contact with soils i.e. not piling grain on the ground before and during harvesting.

- ***After harvest***, farmers can avoid aflatoxins contamination by ensuring that their grain is properly dried before packing as well as avoiding drying grain directly on the ground. This is because high moisture content promotes aflatoxins growth.

- ***During storage***, farmers can also further control aflatoxins by using effective storage technologies like hermetic bags (PICS bags) which have proven to be more effective at controlling molds.

APPENDIX A3: AFLATOXIN TESTING COST COMPARED TO WTP FOR AFLATOXIN SAFETY LABELING

	Aflatoxins safety or labelling premium per 100 kg bag	Testing cost per 100 kg bag	Cost of Information Treatment per household
Average for all households	$2.53 (Estimate is MK19/kg)	$3.65	$3.2
Informed households	$5.2 (Estimate is MK39/kg)	$3.65	$3.2

It costed MK16, 416 per sample for groundnuts from one trader (we had two samples one from each of the two 2 traders prior to purchase) for 1200 kgs of groundnuts. 27.36/kg=MK2736 per 100 bag. This is equivalent to about $3.65 (1US$=MK750)

APPENDIX A4: TEST OF RANDOMIZATION BALANCE

Dependent variable:	1 if household informed about aflatoxins (T), 0 if uninformed (C)
Baseline aflatoxins knowledge score (0 to 10)	0.018**
	(0.008)
Age of respondent (years)	0.002
	(0.002)
Respondent's schooling (years)	-0.002
	(0.005)
=1 if Respondent is male	-0.013
	(0.047)
Household size	-0.000
	(0.016)
Landholding (acres)	-0.019
	(0.039)
Number of years in NASFAM	-0.011
	(0.008)
Number of school goers in household	0.006
	(0.018)
Number of females in household	0.002
	(0.018)
Number of adults in household (age>18 years)	-0.018
	(0.015)
Distance from home to closest market (km)	-0.005
	(0.003)
No of extension officer visits per year	0.001
	(0.001)
=1 if household owns radio set	0.046
	(0.040)
=1 had cash savings at the beginning harvest	-0.043
	(0.041)
Storage expenditure (1000 MK)	-0.001
	(0.003)
Number of months food insecure (0 to 12)	-0.014
	(0.010)
=1 if member too ill to farm for >2 months in past 2 years	0.009
	(0.030)
Respondents' anchor price (1000 MK)	0.376
	(0.369)
=1 if repeated auction participant (learning effects)	0.026
	(0.083)
=1 if NASFAM association is Chioshya	0.084
	(0.202)
Observations	1,068
Chi^2-test of joint significance of all probit coefficients	$\chi^2 = 31.8$**

Coefficients are marginal effects after a probit regression. Standard errors clustered by group action center in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Group action centers (GAC) are community-level clusters; the assignment to treatment and control was done at the GAC level. 1 US$=750 Malawi Kwacha (MK). The baseline aflatoxins knowledge score (0 to 10) was constructed using participants' response to 10 aflatoxins awareness questions.

APPENDIX A5: TEST OF ATTRITION BIAS, HOUSEHOLD-LEVEL ATTRITION

Dependent variable:	Dummy=1 if household attrited between harvest and lean seasons; =0 if not		
Level of analysis:	Household	Bid	Bid
Standard errors clustered by:	GAC	GAC	Household
=1 if household received information (T group)	0.039	0.039	0.039*
	(0.031)	(0.031)	(0.021)
Baseline aflatoxins knowledge score (0 to 10)	0.001	0.001	0.001
	(0.002)	(0.002)	(0.003)
Age of respondent (years)	-0.001	-0.001	-0.001
	(0.001)	(0.001)	(0.001)
Years of schooling for respondent (years)	-0.001	-0.001	-0.001
	(0.003)	(0.003)	(0.003)
=1 if respondent is male	0.009	0.008	0.008
	(0.017)	(0.017)	(0.021)
Household size	0.011	0.011	0.011
	(0.008)	(0.008)	(0.010)
Landholding (acres)	-0.009	-0.009	-0.009
	(0.008)	(0.008)	(0.006)
Number of years in NASFAM	-0.015***	-0.015***	-0.015***
	(0.005)	(0.005)	(0.005)
Number of school goers in household	-0.004	-0.004	-0.004
	(0.010)	(0.010)	(0.010)
Number of females in household	-0.002	-0.001	-0.001
	(0.010)	(0.010)	(0.010)
Number of adults in household (age>18 years)	-0.009	-0.009	-0.009
	(0.011)	(0.011)	(0.011)
Distance from home to closest market (km)	-0.000	-0.000	-0.000
	(0.001)	(0.001)	(0.001)
No of extension officer visits per year	-0.002	-0.002	-0.002
	(0.002)	(0.002)	(0.002)
=1 if household owns radio set	-0.020	-0.020	-0.020
	(0.018)	(0.018)	(0.021)
=1 had cash savings at the beginning harvest	-0.039	-0.039	-0.039
	(0.031)	(0.031)	(0.028)
Storage expenditure (1000 MK)	-0.001	-0.002	-0.002
	(0.002)	(0.002)	(0.002)
Number of months food insecure (0 to 12)	-0.002	-0.002	-0.002
	(0.007)	(0.007)	(0.007)
=1 if member too ill to farm for >2 months in past 2 years	-0.006	-0.006	-0.006
	(0.020)	(0.020)	(0.027)
Respondents' anchor price (1000 MK)	-0.109	-0.065	-0.065
	(0.238)	(0.247)	(0.295)
=1 if NASFAM association is Chioshya	0.023	0.022	0.022
	(0.036)	(0.036)	(0.022)
Willingness to pay for grain grade (1000 MK/kg)		0.013	0.013
		(0.060)	(0.052)
Observations	830	2,490	2,490
Chi^2-test of joint significance of all coefficients	$\chi^2 = 103$***	$\chi^2 = 96$***	$\chi^2 = 34$**

Coefficients are marginal effects after probit regressions. Standard errors clustered as indicated in heading in parentheses. *** p<0.01, ** p<0.05, * p<0.1. US$1=MK750 (Malawi Kwacha). Group action centers (GAC) are community-level clusters; the assignment to treatment and control was done at the GAC level. Baseline aflatoxins knowledge score (0 to 10) is constructed based on participants' response to 10 aflatoxins awareness questions.

APPENDIX A6: TEST OF ATTRITION BIAS, FARMER-LEVEL ATTRITION

Dependent variable:	Dummy=1 if participant attrited between harvest and lean seasons; =0 if not		
Level of analysis:	Household	Bid	Bid
Standard errors clustered by:	GAC	GAC	Household
=1 if household received information (T group)	0.049	0.050	0.050
	(0.050)	(0.050)	(0.031)
Baseline aflatoxins knowledge score (0 to 10)	-0.006*	-0.006*	-0.006
	(0.003)	(0.003)	(0.005)
Age of respondent (years)	-0.002*	-0.002*	-0.002*
	(0.001)	(0.001)	(0.001)
Years of schooling for respondent (years)	-0.026***	-0.026***	-0.026***
	(0.007)	(0.007)	(0.005)
=1 if respondent is male	-0.052**	-0.052**	-0.052
	(0.025)	(0.025)	(0.033)
Household size	-0.002	-0.002	-0.002
	(0.015)	(0.015)	(0.015)
Landholding (acres)	-0.035**	-0.035**	-0.035***
	(0.014)	(0.014)	(0.010)
Number of years in NASFAM	-0.015***	-0.015***	-0.015***
	(0.005)	(0.005)	(0.005)
Number of school goers in household	-0.004	-0.005	-0.005
	(0.018)	(0.018)	(0.015)
Number of females in household	-0.028	-0.027	-0.027*
	(0.018)	(0.018)	(0.016)
Number of adults in household (age>18 years)	-0.015	-0.015	-0.015
	(0.013)	(0.013)	(0.017)
Distance from home to closest market (km)	-0.001	-0.001	-0.001
	(0.001)	(0.001)	(0.001)
No of extension officer visits per year	-0.001	-0.001	-0.001
	(0.001)	(0.001)	(0.002)
=1 if household owns radio set	-0.044	-0.044	-0.044
	(0.027)	(0.027)	(0.032)
=1 had cash savings at the beginning harvest	0.029	0.029	0.029
	(0.040)	(0.040)	(0.038)
Storage expenditure (1000 MK)	0.004	0.004	0.004
	(0.003)	(0.003)	(0.003)
Number of months food insecure (0 to 12)	0.004	0.004	0.004
	(0.010)	(0.010)	(0.010)
=1 if member too ill to farm for >2 months in past 2 years	0.002	0.002	0.002
	(0.029)	(0.029)	(0.039)
Respondents' anchor price (1000 MK)	-0.396	-0.292	-0.292
	(0.432)	(0.431)	(0.444)
=1 if NASFAM association is Chioshya	-0.198***	-0.198***	-0.198***
	(0.052)	(0.051)	(0.030)
Willingness to pay for grain grade (1000 MK/kg)		-0.041	-0.041
		(0.087)	(0.081)
Observations	830	2,490	2,490
Chi^2-test of joint significance of all coefficients	$\chi^2 = 300$***	$\chi^2 = 366$***	$\chi^2 = 108$***

Coefficients are marginal effects after probit regressions. Standard errors clustered as indicated in heading in parentheses. *** p<0.01, ** p<0.05, * p<0.1. US$1=MK750 (Malawi Kwacha). Group action centers (GAC) are community-level clusters; the assignment to treatment and control was done at the GAC level. Baseline aflatoxins knowledge score (0 to 10) is constructed based on participants' response to 10 aflatoxins awareness questions.