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# Using Elicitation Mechanisms to Estimate the Demand for Nutritious Maize: Evidence from Experiments in Rural Ghana

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## ABSTRACT

In this paper we assess (a) consumers' willingness to pay (WTP) for a recently developed variety of maize that is high in provitamin A in the context of a public health intervention and (b) the performance of three elicitation mechanisms in estimating WTP in a field experiment in Ghana. The mechanisms that we used for elicitation are the Becker-DeGroot-Marschak (BDM) mechanism, kth price auction, and choice experiment. The basic design of the experiment involved random allocation of consumers to one of three elicitation methods. This was augmented to include treatment arms to address the effect of (1) participation fees and (2) nutrition information on WTP. Estimation of BDM and kth price auction models that account for censoring of bids at the market price for maize (*kenkey*) and estimation of a conditional logit (CLM) model for the choice experiment that accounts for lexicographic preferences yield estimates of average WTP that are similar in magnitude across the three elicitation mechanisms. Variation in participation fee has no effect on estimated WTP in the two mechanisms that varied participation fee, suggesting that people did not have a higher propensity to spend out of windfall income. In the absence of information on the nutrient density of the new maize variety, subjects are willing to pay less for it than the existing varieties; however, nutrition information transforms this discount into a substantial premium.

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# I. INTRODUCTION

This paper has the twin objectives of assessing consumers' willingness to pay (WTP) for a new, nutritious product and assessing the performance of alternative mechanisms that are used to elicit WTP. These questions are addressed in a framed field experiment in rural Ghana with non-standard subjects.[1] The product being considered is a new variety of maize that is high in provitamin A and is yet to be released. The maize represents a new public health intervention, biofortification, which increases the micronutrient content of staple grains using conventional plant breeding techniques. The intervention seeks to target maize-growing regions of Africa with high incidence of vitamin A deficiency. The provitamin A content of the maize renders it orange in color; therefore, the question of consumer acceptability must be addressed before this new maize variety can be expected to have a significant impact on public health.

This research attempts to elicit WTP using two auction and one discrete choice experiment mechanisms that are incentive compatible, with respondents randomly allocated to one of three elicitation mechanisms. The three mechanisms are: the Becker-DeGroot-Marschak (BDM) mechanism, kth price auction (with k-1 units for sale; in our experiment, k=4), and a choice experiment (CE).

The use of three preference elicitation mechanisms (with a between-subject design) is motivated by the following concerns. First, while there is a multiplicity of mechanisms that are incentive compatible[2] in the standard theory, experimental lab evidence on induced-value auctions suggests that in practice these mechanisms may not reveal demand accurately; there is no consensus on which mechanism does the best at eliciting subjects' bids uniformly closer to their induced values.[3] The experimental literature suggests various reasons for this failure of demand revelation.[4] On the other hand, we cannot directly observe homegrown values. However, if multiple elicitation mechanisms yield similar WTP estimates, we have some assurance that this could arise from participants bidding their true WTP in all of them (in accordance with theory). If the WTP estimates in the different mechanisms are at variance with each other, however, we can still hope to learn whether the differences are systematic, such as whether one elicitation mechanism systematically gives higher estimates than another.

We chose the BDM and kth price auctions over other auction-like mechanisms due to their suitability in rural settings. BDM elicitation can be conducted one-on-one and is therefore usable not just in central locations but also in household survey contexts. Previous experience in rural settings suggests that difficulties in training subjects on the BDM mechanism can be overcome as they are keen to learn if the new product in question interests them (e.g. De Groote, Kimenju, and Morawetz 2011). With a sufficient number of prizes, the kth price auction gives a reasonable probability of winning to subjects with low WTP, thereby keeping them engaged and reducing the possibility that their bids will have a lot of noise. This auction is also easier to explain to participants than the random kth price auction that is popular in urban, developed country settings. Having multiple prizes may also reduce the possibility that participants may value the act of winning per se; in contrast, in a second price auction, the single winner is more salient (Lusk and Shogren, 2007).

Along with the two auction mechanisms, we chose a very different (and increasingly popular) third mechanism—a real choice experiment (CE). In auctions, subjects provide bids for each one of the products offered to them; in a CE, they choose one product out of the several displayed, each tagged with a price. Thus, both the form in which the experiment is framed and the methods used to infer WTP are very different here (Louviere, Hensher, and Swait 2000). Only two previous papers compare results from CEs with incentive-compatible auctions. Lusk and Schroeder (2006) find that estimated WTP in their CE is more than twice as high as that in a BDM experiment. Gracia, Loureiro, and Nayga (2011) also find significant, though more nuanced, differences.[5] Lusk and Schroeder (2006) emphasize that the CE is similar to

1 The classification as a framed field experiment follows Harrison and List 2004.

2 That is, it is optimal to bid one's value or WTP for the object (see Lusk and Shogren 2007). The mechanisms include the following auctions: 2nd price, kth price (with (k-1) prizes), random kth price, and BDM.

3 Thus Lusk and Rousu (2006) suggest that the BDM is a less accurate reflection of induced values than 2nd price or random kth price auctions. Other contradictory findings include those by Kagel, Harstad, and Levin (1987) who find that people overbid in 2nd price auctions and by Noussair, Robin, and Ruffieux (2004), where bidding in 2nd price auctions is closer to the induced values than that in BDM. Yet other evidence suggests that in 2nd price auctions, bids are closer to induced values when those values are themselves relatively close to market price, but are "misbehaved" especially for low values and that bids in random kth price auctions have the reverse profile in terms of accuracy (Shogren et al. 2001).

4 These include: confusion or inadequate training (Plott and Zeiler 2007); subjects' payoffs being a function of the experiment environment, e.g., enumerator scrutiny (Levitt and List 2007); low stakes or high cognitive costs (Lusk et. al. 2006); and non-canonical preferences such as loss aversion (Lange and Ratan 2010; Banerji and Gupta 2013).

5 In contrast to Lusk and Schroeder (2006), Gracia, Loureiro, and Nayga (2011) have experienced shoppers as subjects and a good that is storable with variants of both private and public characteristics (cured ham with varying levels of animal welfare). Their results are more qualified (WTP and marginal WTP estimates are not always larger for CEs); however, in many cases WTP varies significantly across elicitation methods.

making choices in a market with posted, take-it-or-leave-it prices, and subjects are therefore more familiar with this system of valuing a product than with auctions. But other framing effects could exist as well. It is also possible that there is a closer analogy between CE frames, posted prices, and supermarket choices made in developed countries than with negotiable prices in developing country rural markets; thus, the context in which we are comparing elicitation methods is different than these papers.

Subjects in "real" experiments as this one are usually given a participation fee at the beginning of the experiment, sufficient for them to not be out of pocket in making purchases. Standard theory suggests that since such fees are small relative to the subjects' wealth, their effect on WTP should be negligible. However, it has been argued that subjects' propensity to consume out of such "windfall income" could be different than out of wealth and could bias WTP estimates. The literature on experimental evidence for this is still limited and mixed (see Clark 2002; Rutstrom and Williams 2000; Thaler and Johnson 1990; Cherry, Kroll, and Shogren 2005). As a final check on the robustness of WTP estimation procedures, we therefore include variation in participation fee as a cross-treatment.

Many argue that biofortification is more likely to succeed since it attempts to address micronutrient deficiencies without changing dietary habits. However, if biofortification results in a substantial change in some characteristics of the staple (such as color, taste, or texture), the question of whether the new variety is accepted by consumers becomes crucial. This becomes important as the biofortified maize in question is orange in color, owing to its high provitamin A content. Orange and yellow are close on the color spectrum, and yellow maize is considered inferior to white maize in many parts of Africa including Ghana.[6] Thus, any discount on yellow maize relative to white may also be transferred to orange maize. While there is evidence of yellow maize going at a discount in Southern and Eastern Africa, our study is the first to address this question in Western Africa.[7]

To study the question of a discount/premium for color, we elicit WTP across white, yellow, and orange maize varieties. For the experiment, we used a popular maize product, *kenkey*, made from these maize varieties. In order to assess the marginal WTP for the biofortified food, we also investigate how information on the high provitamin A content (henceforth, "nutrition information") of the orange maize affects such a discount. The basic design of the experiment involved randomly assigning consumers to one of the three elicitation methods and will be discussed further in a later section.

The data show that many bids in the auction mechanisms were censored at the market price for *kenkey* and that the choices of a large proportion of participants in the choice experiment suggest lexicographic preferences (Section III). Incorporating these features in our modeling leads to WTP estimates that are fairly similar across elicitation mechanisms (in striking contrast to Lusk and Schroeder, 2006, but in line with standard theory). We also find that in Ghana, there is little evidence that yellow maize products are uniformly discounted and that an information campaign would be necessary, and effective, in promoting the new orange provitamin A maize.

In what follows, Section II and the appendix give details on the study design, Section III describes and summarizes the data, Section IV describes the models estimated, and Section V contains a discussion of the estimation results. Section VI provides conclusions and policy implications.

6 A partial reason is the association of yellow maize with food aid (see Tschirley, Donovan, and Weber 1996).
7 On Zambia, see Meenakshi et. al. 2012; on Mozambique, see Tschirley and Santos 1995, Tschirley, Donovan, and Weber 1996; on Kenya, see de Groote, Kimenju, and Morawetz 2011; on Zimbabwe, see Rubey and Lupi 1997; on South Africa, see FAO and CIMMYT 1997.

# II. METHODOLOGY

## A. Study Sites and Sampling Design

The study was conducted in the three major maize-growing regions in Ghana, Ashanti, Central, and Eastern, which together with the Brong-Ahafo region produce most of the maize in the country. In each region, a set of "high-potential impact" districts with high consumption of maize and high levels of poverty was shortlisted.[8] From this set, one district was randomly selected. Within each of these, 10 enumeration areas (EA) were selected (an EA is a village or cluster of small villages as defined by the Ghana Statistical Service; we use the terms EA and village interchangeably). For logistical reasons, we carried out elicitation experiments in the first seven EAs in Ashanti and the first eight EAs in the Central and Eastern regions. To avoid possible confusion through subject word of mouth, the unit for randomly assigning elicitation methods was the EA. Three EAs in each region were assigned to the BDM method and three EAs to the CE. One EA in Ashanti and two each in Central and Eastern regions were assigned to the kth price auction. To avoid disparity between subjects at any location, participation fees were varied only across EAs. For the BDM and the CE groups in each region, the EAs were assigned participation fees of 40, 80, and 200 pesewas.[9] The kth price auction did not include a participation fee treatment. Finally, subjects in each EA were randomly assigned to treatments with or without nutrition information about the benefits of provitamin A orange maize. To prevent contamination from the nutrition information, the with-nutrition-information treatment was conducted in the afternoon. Each EA was covered in a single day.

For each EA, a census of households was obtained from the Ghana Statistical Service. From this census, we randomly selected 32 households for each EA in which BDM or CE were used and 24 households for the kth price auctions. From each household, the husband or the wife was alternately selected to participate. Table 1 summarizes the design of the treatments.

Three maize varieties (orange, white, and yellow) were used for the study. Orange maize with high provitamin A content was grown by the National Crop Research Institute, Kumasi, in fall 2008, while local varieties of white and yellow maize were purchased from the market. Field work was conducted November–December 2008. A popular maize product, *kenkey*, was used for the experiments. Fermented maize is made into dough, steamed, and cooked to make *kenkey*; it is normally purchased from the market, not prepared at home. The product for purchase in the experiments was thus regular-sized *kenkey*, similar to that sold in the market.

The elicitation treatments were conducted in a central location in each village, where the field team arrived in the morning with freshly-cooked *kenkey* made from the three maize varieties. The *kenkey* takes the color of the

**Table 1: Sampling Design, by Region, Elicitation Mechanism, and Participation Fee**

| | | Ashanti | | Central | | Eastern | | Total | |
|---|---|---|---|---|---|---|---|---|---|
| **Elicitation method** | **Participation fee (pesewas)** | Villages | People / village | Villages | People / village | Villages | People / village | Villages | People |
| **Kth price auction** | 80 | 1 | 32 | 2 | 24 | 2 | 24 | 5 | 128 |
| **BDM** | 40 | 1 | 32 | 1 | 32 | 1 | 32 | 3 | 96 |
| | 80 | 1 | 32 | 1 | 32 | 1 | 32 | 3 | 96 |
| | 200 | 1 | 33 | 1 | 32 | 1 | 32 | 3 | 97 |
| **Choice experiment** | 40 | 1 | 32 | 1 | 32 | 1 | 32 | 3 | 96 |
| | 80 | 1 | 32 | 1 | 32 | 1 | 32 | 3 | 96 |
| | 200 | 1 | 32 | 1 | 32 | 1 | 32 | 3 | 96 |
| **Total** | | **7** | **225** | **8** | **240** | **8** | **240** | **23** | **705** |

8 Although the selection of districts should have been based on high consumption of maize combined with high levels of vitamin A deficiency, the latter data were not available at the district level. We therefore used poverty levels as a proxy for the prevalence of vitamin A deficiency.
9 At the time of the study, 100 pesewas equaled approximately $US 0.9.

maize, so we call these white, yellow, and orange *kenkey*. In each experiment, subjects were given preliminary information about the study, signed a consent form, and received a participation fee. The subjects then responded to a short demographics questionnaire. Next, they tasted the three types of *kenkey* and evaluated each on a 5-point scale for appearance, taste, texture, aroma, and overall response. We randomized the order in which the three *kenkey* products were evaluated across participants. Following the sensory evaluations, subjects participated in the elicitation exercise assigned to that village.

## B. The Elicitation Method Treatments

**The BDM Elicitation**: In this treatment, each subject was asked to bid for white, yellow, and orange *kenkey*, and their bids were recorded. Then one of these three *kenkey* types was randomly selected, with the auction for that type regarded as binding. The subject then drew a slip of paper randomly from a box that had 40 price slips labeled 1–40 pesewas (the uniform distribution of potential sale prices that the subject was competing against).[10] If the random draw was less than the subject's bid for the binding *kenkey* type, s/he obtained the *kenkey* and paid the price on the slip of paper; if the draw was higher than the bid, s/he did not get the *kenkey*.

Prior to the actual elicitation of bids, the subject was given detailed instructions on how the auction would proceed and trained on the concept that the optimal choice of bid equaled the maximum that s/he would be willing to pay for the particular type of *kenkey*. Examples were given to show that bidding below or above this maximum that they were willing to pay would turn out worse than bidding their true WTP. Before the actual elicitation, the subject underwent a practice round, which was conducted with a packet of biscuits. The training also emphasized the point that since any of the three products could be selected, all three bids could result in a BDM auction with a "real" consequence (i.e., with an outcome—sale with payment or no sale—that would be implemented).

**kth Price Auction**: Each kth price auction was conducted with eight subjects as bidders. The top three bidders were awarded *kenkey* as prizes and had to pay a price equal to the fourth highest bid. Thus the 24 respondents in villages selected for this treatment were divided into three groups of eight. Auctions were conducted successively, with only the third group receiving nutrition information about the biofortified maize.

For each group of bidders, there were four rounds of auctions.[11] In each round, the eight bidders submitted bids for white, yellow, and orange *kenkey* on slips of paper. At the end of each round, the bids were collected. The top three bidders for each *kenkey* type were declared winners, and their bids (but not their identities), as well as the 4th highest bid, were displayed on a white board. At the end of the four rounds, one round was randomly selected from which one of the *kenkey* types was randomly selected. The three winners from this round paid the 4th highest bid as the price for obtaining the randomly selected *kenkey*.

As with the BDM elicitation, the subjects were given detailed instructions and training prior to conducting the auction. Illustrations were provided on the optimality of bidding one's true WTP, and a practice round was conducted with a packet of biscuits. To ensure that participants understood, each participant had one enumerator to assist him or her, in addition to the enumerator who conducted the auctions and the overall training.

**Choice Experiment**: For the CE, possible price ranges of *kenkey* were discussed with local key informants, and five price points (10, 20, 25, 30, and 40 pesewas) were chosen.[12] Since only relative prices matter in a CE, the price of white *kenkey* was fixed at the then prevailing market price of 20 pesewas, and the price for yellow and orange *kenkey* was varied between 10 pesewas and 40 pesewas, across the scenarios. An orthogonal choice set comprising 25 choice scenarios was prepared using a fractional factorial design. Table A1 in the Appendix gives the choice scenarios utilized in the study.

To reduce the complexity of the choices, and to avoid potential fatigue from viewing 25 sets of choices (see Chowdhury et al. 2011), the full set of 25 choice scenarios was divided into five sets of five choice scenarios each, and each subject was randomly allocated to one of these five sets (Table A1). To these choice scenarios, a 6th scenario with all three *kenkey* prices equal to 20 was included. Thus, a subject was given six choice scenarios, each in the form of a choice among the three types of *kenkey* at specified prices. A fourth choice of "none of the above" was always available.

The three *kenkey* varieties were displayed on plates in front of the subjects as they made their choices (recall that the subjects had previously tasted all three types). In this "real" choice experiment, one of the six scenarios shown to the subject was randomly drawn to be the

10 This distribution was symmetric around the mean market price of about 20 pesewas for white *kenkey*.
11 Earlier studies (e.g. Lusk, Feldkamp, and Schroeder 2004) suggest bids stabilize by the third or fourth round, justifying our choice of four rounds.
12 These represented prices around the mean market price of 20 pesewas for white kenkey, capturing premiums and discounts relative to this price.

"binding scenario" after the subject made his/her choice for each scenario. For instance, if this scenario had the choices white, orange, and yellow *kenkey* at 20, 25, and 30 pesewas, respectively, and if the respondent had chosen orange *kenkey*, s/he had to buy the orange *kenkey* and pay a price of 25 pesewas.

## C. Nutrition Information

It is important to assess the effect of information (and more generally of an information campaign) on WTP for orange maize, especially given the potential that orange maize could go at a discount in the absence of such information. To evaluate the importance of providing nutrition information about orange maize, the Ghana Broadcasting Corporation was tasked with producing a five-minute simulated radio program in the local language of each region. The simulated radio program included information on the properties of provitamin A orange maize, as well as the health benefits of vitamin A and vitamin A-rich foods for children and adults. Respondents in the with-nutrition-information treatments listened to the program on individually provided MP3 players.

## III. SUMMARY STATISTICS

In this section, we highlight key features of the data, especially those that guided our estimation strategy. A description of the dataset is presented in Appendix Table A2. Of the 705 participants in the study, 49 percent were women. The age of respondents ranged from 18 to 90 years, indicating the broad range of the population sampled for this study. Table 2 shows that subjects in the kth price auction were older, and those in the choice experiment were less educated and had more males (at 5% significance level, as indicated); however, key demographic characteristics were broadly in the same numerical ballpark.

Maize was the most important crop, grown by 93 percent of households, and the major staple food, with half of the respondents eating it every day and an additional 30 percent eating it a few times a week. As shown in Appendix Table A2, there appear to be significant regional differences in maize production patterns and consumption preferences. While Ashanti grows mostly white maize (or "improved" varieties), the other regions grow a lot of "local" varieties, including appreciable amounts of yellow maize. Results from the tasting and scoring of the three types of *kenkey* reveal that respondents from Ashanti gave white *kenkey* the highest score, which was significantly higher than their score for orange *kenkey* (scores for the three varieties can be found in Appendix Table A2). Consumers from the Central Region preferred yellow *kenkey*, while those from the Eastern Region scored yellow and orange *kenkey* about the same and significantly higher than white *kenkey*.

Table 3 provides a brief comparison of bids across the BDM and kth price auction mechanisms, aggregated over maize varieties and information treatments. Similar means (17.9 and 18.3, respectively) and variances (around 8) strongly suggest that both elicitation methods would result in similar estimates of WTP.

A noticeable feature of bids in both auction mechanisms is the large proportion of bids that equaled 20 pesewas (42 percent in BDM and 50 percent in kth price auctions); only 15–20 percent of bids exceeded 20 pesewas. Moreover, in both these mechanisms, over half the subjects had a maximum bid of 20 pesewas. Since the market price for the size of *kenkey* used in the experiment was about 20 pesewas, it is possible that a bid equal to 20 indicated censoring. The estimation discussed in the next section takes this censoring into account.

The CE data show that almost half of respondents chose a specific *kenkey* variety over the other two regardless

**Table 2: Key Socioeconomic Characteristics of Respondents, by Treatment Group**

| | Choice Experiment | BDM Auction | kth price Auction |
|---|---|---|---|
| | Mean (Std.Error) | | |
| Age(in years) | 42.3 (0.77) | 42.4 (0.90) | 45.8 (1.07)** |
| Gender (male=1, 0 otherwise) | 0.53 (0.03)** | 0.47 (0.03) | 0.49 (0.04) |
| Schooling (in years) | 5.05 (0.26)** | 5.98 (0.26) | 5.6 (0.41) |
| Sample Size | 288 | 289 | 128 |

**Table 3: Summary of Bids in BDM and kth Price Auction (in pesewas/participant)**

| Elicitation Method | Mean | Std. Dev. | Min | Max |
|---|---|---|---|---|
| **BDM** | 17.9 | 8.2 | 0 | 50 |
| **kth Price Auction** | 18.3 | 7.7 | 0 | 60 |

of relative prices, since their choice of *kenkey* variety is the same in all the choice scenarios offered. Following Hensher, Rose, and Green (2005), we conclude that such choices exhibit lexicographic preferences. Table 4 shows that participants who displayed lexicographic preferences tended to be younger and wealthier than average, by small but statistically significant magnitudes, and more males than females have lexicographic preferences.[13] The proportion of participants with lexicographic preferences increased by participation fee and was highest in the Ashanti and Central regions.

The striking implication is that almost half of the participants were, therefore, not averse to paying more than 30 or 40 pesewas (this being the maximum price for some *kenkey* types in each choice frame); whereas in the auction treatments, only about 2.5 percent of participants had bids exceeding 30 pesewas.

**Table 4: Comparing Respondents with Lexicographic and Non-lexicographic Preferences, in the Choice Experiment**

| | Non-Lexicographic Individuals | Lexicographic Individuals |
|---|---|---|
| **Variable** | **Mean (Std. Error)** | |
| Age (in years) | 43.7 (1.16)** | 40.9 (1.02)** |
| Percentage of females | 0.58 (0.04)* | 0.48 (0.04)* |
| Asset (Index) | 13.6 (1.11) | 16.5 (1.66) |
| Schooling (in years) | 5.1 (0.38) | 5.0 (0.36) |
| **Region** | **Percentages** | |
| Ashanti | 45 | 55 |
| Central | 44 | 56 |
| Eastern | 61 | 39 |
| **Participation Fee** | **Percentages** | |
| 40 | 53 | 47 |
| 80 | 51 | 49 |
| 200 | 45 | 55 |
| Number of Observations | 144 | 143 |

** & * refers to statistical significance at 5 percent and 10 percent, respectively.

13 In this paper, we use the first principal component of the number of appliances and the number of livestock in the household as an index of wealth.

## IV. ESTIMATION OF WILLINGNESS TO PAY

### A. BDM and kth Price Auctions

We make the parametric assumption that WTP for *kenkey* is lognormally distributed in the population. This is reasonable as it gives non-negative WTP, and the density function can capture the observed skewness in bids adequately. Thus, for BDM and kth price auction data, we estimate regression equations of the form

$$\log(WTP_{ij}) = X_{ij}\,\beta+\varepsilon_i \qquad (1)$$

where $X_{ij}$ refers to a set of covariates for the ith individual for the jth maize (j= orange, yellow, and white), and $\varepsilon_i$ are iid normal errors with mean 0. The common set of covariates across both mechanisms on the right of Eq.(1) includes: district and maize variety dummies and their interactions; dummies for nutrition information interacted with the three maize varieties; the demographic variables of age, gender, years of schooling; and the first principal component from a vector of assets. In addition, the BDM analysis includes a participation fee variable, and the kth price auction equation includes dummies for rounds 2 to 4.

This model was modified to account for possible censoring of bids in both BDM and kth price auction data. White *kenkey* was widely available on the market, usually at a price of 20 pesewas. Thus, a bid equal to 20 pesewas could imply that the WTP was at least as large as 20 pesewas, but the person bid the price at which s/he could buy it in the market. The censored model, therefore, assumes that a bid of 20 for any variety of *kenkey* is an instance of censoring. About 15 percent of bids were higher than 20, and we did not treat these as being censored. Thus in the likelihood function for the censored model, a bid of 20 contributes the expression $1 - [F((\log(20) - X'\beta/\sigma)]$, while any other bid $b$ contributes the density $[f((\log(b) - X'\beta/\sigma)](1/\sigma)$. Let $uc_i$ and $c_i$ be dummy variables taking value 1 if observation $i$ is uncensored or censored respectively, and being equal to 0 otherwise. Then the likelihood function is given by (suppressing the jth subscript):

$$L = \Pi_{i\in N}((1/\sigma)f((\log(b_i) - X_i\beta)/\sigma)^{uc_i}\,(1-F((\log(20) - X_i\beta)/\sigma))^{c_i} \qquad (2)$$

Code for this somewhat nonstandard censoring was written and executed using the statistical language R.

### B. Choice Experiment

For the CE, we use the standard approach of specifying a random utility model

$$U_{ij} = V_{ij} + e_{ij}; \quad V_{ij} = X_{ij}\beta \qquad (3)$$

where the random utility that consumer $i$ gets from the *kenkey* variety $j$ depends on a systematic component $V_{ij}$ and a random component $e_{ij}$ (McFadden 1974). We estimate a conditional logit model (CLM) (i.e., assume that the random component follows an iid extreme value distribution; see Train 2009). The covariates that can potentially affect the systematic components are essentially the same as in the other elicitation methods, with two standard caveats (see Louviere, Hensher, and Swait 2000 and Train 2009): (1) the systematic component is viewed as indirect utility, with the price of alternative $j$ being a covariate (with an expected negative sign on the associated parameter $\beta_j$), and (2) demographic variables, which are constant for an individual, cannot be included as is because they get eliminated when utility differences across alternatives are specified for the given individual. They are, therefore, interacted with the alternatives.

The systematic component from not selecting any of the *kenkey* types is normalized to 0 (which is standard). Having estimated the parameters of the CLM, the ex-ante WTP for *kenkey* type j by consumer i is calculated as the price of *kenkey* that will equate the systematic component $V_{ij}$ to 0, the systematic utility from not purchasing the *kenkey* (i.e., Hicksian compensation). The average WTP of participants in each treatment is then computed from the individual-level WTP.

Apart from the basic CLM, we estimate another CLM accounting for the lexicographic individuals described in Section III. In this model, following Campbell, Hutchnison, and Scarpa (2006) and Hensher, Rose, and Green (2005), the systematic component of utility for a lexicographic individual is simply specified as an alternative specific constant (ASC).

# V. RESULTS

## A. WTP across Elicitation Methods

As explained, the parameter estimates of the models may be used to estimate WTP for individuals followed by average WTP. Table 5 summarizes the WTP estimates.

The first notable result is that in the without-nutrition-information treatment, the average WTP (and standard errors) is similar across elicitation methods. Aggregating all *kenkey* types, the average WTP is approximately 26 pesewas for all three elicitation methods. If we treat each *kenkey* type separately, the average WTP across elicitation methods are still within the range of about 5 pesewas (the de facto minimum unit of currency), and in fact mostly within 10 percent of each other. Although differences in average estimated WTP (by *kenkey* type) are statistically significant, one is led to interpret the magnitudes of WTP as being similar and therefore aligned with standard theory, which predicts that randomized allocation of subjects across elicitation methods would tend to yield similar average WTP estimates as these methods are incentive compatible.

Second, in the absence of nutrition information, WTP for orange *kenkey* is significantly lower than for white and yellow *kenkey* in the BDM and kth price auction. For the CE, WTP for orange *kenkey* is significantly lower than that of yellow *kenkey* and comparable to that of white *kenkey*. Thus, orange *kenkey* suffered from a significant color discount, in the order of 15–20 percent of the highest-valued *kenkey*. This is despite the fact that in two of the elicitation methods, WTP for yellow maize is not assessed at a discount relative to white maize. This implies that yellow maize is perceived to be distinct from the orange, but the latter sells at a discount in the absence of nutrition information.[14]

**Table 5: WTP With and Without Nutrition Information (in pesewas/participant)**

**Choice Experiment**

| WTP | Without Information | | With Information | |
|---|---|---|---|---|
| | Mean | Std. Error | Mean | Std. Error |
| White | 24 | 0.707 | 18 | 0.707 |
| Yellow | 30 | 0.471 | 26 | 0.471 |
| Orange | 25 | 0.354 | 29 | 0.354 |

**BDM Auction**

| WTP | Without Information | | With Information | |
|---|---|---|---|---|
| | Mean | Std. Error | Mean | Std. Error |
| White | 26.8 | 0.038 | 21.2 | 0.029 |
| Yellow | 27.4 | 0.038 | 21.2 | 0.031 |
| Orange | 22.2 | 0.038 | 23.0 | 0.040 |

**kth Price Auction**

| WTP | Without Information | | With Information | |
|---|---|---|---|---|
| | Mean | Std. Error | Mean | Std. Error |
| White | 28.9 | 0.567 | 26.4 | 0.520 |
| Yellow | 25.1 | 0.517 | 32.8 | 0.676 |
| Orange | 21.0 | 0.545 | 33.9 | 0.877 |

Note: These estimates are derived from a CLM that accounts for lexicographic individuals (CE) and censored regression models (BDM and kth price auctions). All WTP are evaluated at a participation fee of 80 pesewas.

14 In contrast, research in Zambia found that yellow maize sold at a discount, but the orange maize could compete with the favored white varieties even in the absence of a nutrition campaign (Meenakshi et. al. 2012).

## B. The Impact of Nutrition Information

The nutrition information treatment shows the significant effect of information. The ranking of the three *kenkey* types in this treatment is orange-yellow-white, from high to low. When nutrition information is provided, the discount on orange shifts to a premium. The premium relative to white *kenkey* is small in the BDM mechanism but about 25 percent in the kth price auction and 50 percent in the CE. Thus, it appears that the discount on orange maize in the absence of information can be countered since people react positively to information about the high provitamin A content of the orange maize.

Table 5 shows that nutrition information about orange maize had a negative impact on the WTP for white and yellow *kenkey* (except for yellow *kenkey* in the kth price auction). There are two possible ways to interpret this. First, the three *kenkey* types are substitutes; therefore, positive information about one of these may lead to a readjustment of preferences based on this information. In the BDM and kth price auctions, bids are elicited separately for the three types, but it is conceivable that with readjusted preferences, and given that the bids are made with all three maize varieties present, there is a mental discounting of the white and yellow *kenkey* types. The other possibility is a potential time-of-day effect since nutrition information was given to participants in the second half of the day to avoid spillover effects. There is some anecdotal evidence that *kenkey* prices at the market decline in the afternoon and evening, explaining the lower estimates for white and yellow *kenkey* WTP. Across the BDM and CE treatments, this decline in WTP is about 5 pesewas for both yellow and white *kenkey*; in the kth price auction, the decline is about 2.5 pesewas for white *kenkey*.[15] Note also that if a time-of-day effect is present, then the effect of nutrition information on the WTP for orange maize is underestimated.

Across elicitation methods, differences in the average WTP aggregated over the *kenkey* types are higher in the with-nutrition-information treatments than in the without-nutrition-information treatments. However, these differences are small in magnitude.

Since every subject who participated in the CE was only exposed to a random subset of all the potential choice frames, we exploit the variability in the range of prices for orange *kenkey* to examine if framing effects (defined in a limited sense) may influence the estimated WTP. We, therefore, separately estimated the choice model and the WTP for subsets of respondents who saw prices of orange maize range from 10–40 pesewas, in contrast to those who faced a price of orange *kenkey* that ranged from 10–25 or 20–40 pesewas. These results, shown in Table 6, suggest that the WTP estimates are close and that respondents who faced higher prices did not display behavior that translated into a higher WTP as compared to those with lower prices.

## C. The Role of the Participation Fee

In both BDM and CE treatments, the participation fee does not affect the estimated WTP. The coefficients associated with this variable are all insignificant (Tables 7 and 8). Thus in our experiments, respondents did not appear to spend more out of the windfall participation fee income; this gives our results a classical flavor.

**Table 6: Impact of Varying Ranges in the Prices Faced in Choice Sets on WTP (pesewas/participant)**

| Variety | Range: 10–40 pesewas | | Range: 10–25 pesewas | | Range: 20–40 pesewas | |
|---|---|---|---|---|---|---|
| | Mean | Std. Dev. | Mean | Std. Dev. | Mean | Std. Dev. |
| White | 21 | 8 | 21 | 6 | 21 | 7 |
| Yellow | 29 | 5 | 28 | 4 | 29 | 5 |
| Orange | 30 | 6 | 27 | 4 | 27 | 3 |

Note: All differences in WTP are insignificant, except WTP for orange in the 10–40p range.

15 The WTP for yellow *kenkey*, however, shows an anomalous increase. A time-of-day effect has been found in several preference elicitation studies conducted in Africa, see e.g., Demont et. al. 2012.

## D. Other Correlates of WTP

The WTP comparisons in previous sections arise from model choices and regression results that we now discuss. For both the BDM and the kth price auction data, the models with censoring at a bid of 20 pesewas do better than the models without censoring. For BDM, the log-likelihoods for the censored and non-censored models are -1059.7 and -1122.0, respectively. The Vuong statistic (Vuong 1989) equals 2.18, decisively rejecting the non-censored model in favor of the censored model. Similarly, for the kth price auction, the log-likelihoods for the censored and non-censored models are -1543.2 and -1643.7; the Vuong statistic equals 1.74 and favors the censored model at the 10 percent level for a two-tailed test. For the CE, the CLM model accounting for lexicographic subjects has a log-likelihood value of -1717.6, compared to that of -1876.9 for the standard CLM model; the Vuong statistic of 6.75 again rejects the standard CLM model outright in favor of the model accounting for lexicographic preferences.

Tables 7, 8, and 9 present parameter estimates from the preferred models. There are several consistencies across the elicitation methods. First, the demographic variables generally have the same sign, but they are by and large insignificant. For the few significant estimates, the magnitudes are too small to be worthy of note (age is negative and significant in BDM; years of schooling is positive and significant in kth price auction; and

**Table 7: Parameter Estimates from the Conditional Logit Model for Choice Experiment Accounting for Lexicographic Individuals**

| Variable | Coefficient | Standard Error | P-value |
|---|---|---|---|
| White-ASC | 5.243 | 0.384 | 0.000*** |
| Yellow-ASC | 4.886 | 0.384 | 0.000*** |
| Orange-ASC | 4.292 | 0.386 | 0.000*** |
| Price | -0.121 | 0.017 | 0.000*** |
| Age*Price | -0.0005 | 0.000 | 0.125 |
| Asset*Price | -0.0003 | 0.000 | 0.290 |
| White*Gender | -0.155 | 0.273 | 0.572 |
| Yellow*Gender | 0.387 | 0.259 | 0.136 |
| Orange*Gender | -0.094 | 0.262 | 0.718 |
| White*Education | -0.113 | 0.028 | 0.000*** |
| Yellow*Education | -0.017 | 0.027 | 0.524 |
| Orange*Education | 0.011 | 0.027 | 0.694 |
| White*Information | -0.915 | 0.249 | 0.000*** |
| Yellow*Information | -0.630 | 0.234 | 0.007*** |
| Orange*Information | 0.522 | 0.241 | 0.030** |
| White*Fees | -0.001 | 0.002 | 0.508 |
| Yellow*Fees | -0.0003 | 0.002 | 0.843 |
| Orange*Fees | -0.002 | 0.002 | 0.270 |
| White*Central | -0.993 | 0.322 | 0.002*** |
| Yellow*Central | -0.417 | 0.318 | 0.190 |
| Orange*Central | -0.854 | 0.333 | 0.010*** |
| White*Eastern | -1.634 | 0.304 | 0.000*** |
| Yellow*Eastern | -1.022 | 0.289 | 0.000*** |
| Orange*Eastern | -0.460 | 0.290 | 0.112 |
| Log Likelihood | -1717.6 | | |
| Pseudo R2 | 0.18 | | |
| Number of Observations | 287 | | |

***, **, & * refers to statistical significance at 1%, 5%, and 10%, respectively, in Tables 7–9. The asset variable in Tables 7–9 is the first principal component of two vectors that record, for each subject, the number of household appliances and the number of livestock.

schooling interacted with white *kenkey* is negative and significant in the CE,). Second, there is some evidence of color preferences, but these have small magnitudes (e.g., in the kth price auction regression, orange *kenkey* goes at a significant discount in Ashanti; in the BDM regression, yellow *kenkey* has a premium in Central; in the CE regression, white and orange *kenkey* go at a discount in Central. Third, the effect of nutrition information on WTP for orange *kenkey* is positive for all elicitation methods. It is significant and of large magnitude in the CE and kth price auction regressions but insignificant for BDM. Interestingly, and as discussed previously, providing nutrition information for the orange maize has a negative effect on the WTP for white and yellow *kenkey* in two of the three elicitation methods. Finally, the 2nd to 4th auction rounds in the kth price auction did not yield significantly different WTP. This suggests two things: (1) people's WTP for the *kenkey* reflected homegrown values, which were not affected by information on the top four bids at the end of each round, and (2) optimal bidding strategy was understood by participants, so their bids did not fluctuate significantly after the first round.

**Table 8: Parameter Estimates from Becker-DeGroot-Marschak Auction (Censored MLE)**

| DepVar log(WTP); n=867 | Coefficient | Standard Error | P-value |
|---|---|---|---|
| Constant | 3.810 | 0.296 | 0.000*** |
| Central | -0.181 | 0.199 | 0.364 |
| Eastern | -0.101 | 0.198 | 0.609 |
| Yellow | -0.232 | 0.223 | 0.297 |
| Orange | -0.2560 | 0.225 | 0.255 |
| Central*Yellow | 0.4690 | 0.275 | 0.087* |
| Central*Orange | -0.054 | 0.274 | 0.844 |
| Eastern*Yellow | 0.316 | 0.272 | 0.246 |
| Eastern*Orange | 0.226 | 0.277 | 0.415 |
| Info*White | -0.246 | 0.165 | 0.136 |
| Info*Yellow | -0.283 | 0.161 | 0.079* |
| Info*Orange | 0.020 | 0.163 | 0.902 |
| Age | -0.011 | 0.003 | 0.001*** |
| Gender | -0.079 | 0.106 | 0.458 |
| Schooling | 0.010 | 0.013 | 0.405 |
| Asset | 0.001 | 0.003 | 0.830 |
| Participation Fee | 0.0001 | 0.001 | 0.936 |
| sigma | 1.246 | 0.041 | 0.000*** |
| Log Likelihood | -1059.700 | | |

**Table 9: Parameter Estimates from kth Price Auction Model (Censored MLE)**

| | Model with Censoring | | |
|---|---|---|---|
| **DepVar log(WTP); n=1524** | **Coefficient** | **Standard Error** | **P-value** |
| Constant | 3.171 | 0.181 | 0.000*** |
| Central | -0.231 | 0.133 | 0.082* |
| Eastern | 0.371 | 0.139 | 0.008*** |
| Yellow | -0.141 | 0.162 | 0.384 |
| Orange | -0.3930 | 0.159 | 0.014** |
| Central*Yellow | -0.0280 | 0.186 | 0.882 |
| Central*Orange | -0.052 | 0.184 | 0.778 |
| Eastern*Yellow | 0.014 | 0.195 | 0.942 |
| Eastern*Orange | 0.176 | 0.195 | 0.367 |
| Info*White | -0.083 | 0.106 | 0.432 |
| Info*Yellow | 0.272 | 0.107 | 0.011** |
| Info*Orange | 0.474 | 0.105 | 0.000*** |
| Round 2 | 0.088 | 0.085 | 0.299 |
| Round 3 | 0.095 | 0.085 | 0.266 |
| Round 4 | 0.115 | 0.085 | 0.178 |
| Age | -0.002 | 0.002 | 0.449 |
| Gender | -0.039 | 0.065 | 0.548 |
| Schooling | 0.022 | 0.007 | 0.002*** |
| Asset | 0.0001 | 0.001 | 0.839 |
| Sigma | 1.037 | 0.028 | 0.000*** |
| Log Likelihood | -1543.200 | | |

## VI. CONCLUSIONS AND POLICY IMPLICATIONS

This paper considers the question of eliciting WTP for a maize product (*kenkey*) in rural Ghana, using three real incentive-compatible experiments: Becker-DeGroot-Marschak (BDM) auction, kth price auction, and choice experiment. In contrast to Lusk and Schroeder (2006) who found that WTP estimated using a real CE exceeded WTP estimates from auction mechanisms by a factor of more than two, our results are far closer to standard theoretical predictions. We find that WTP estimates across elicitation mechanisms are of comparable magnitude from an economic point of view. To arrive at this conclusion, however, we have to take into account (i) the large proportion of respondents in the CE who exhibit lexicographic preferences and (ii) the censoring of bids for BDM and kth price auctions. The lexicographic behavior of a subset of our sample in the econometric specification is key to the classical nature of our findings. For models without these features (models rejected by the data), WTP estimates from the choice experiment are two and a half times those from the auction mechanisms.

We also find that the variation in participation fee has no effect on estimated WTP in BDM and CE, the two mechanisms that varied the participation fee. Again, this result conforms to standard theory. Similarly, framing effects (as determined by variation in the range of prices that consumers face) also appear to not matter for estimated WTP in the CE.

Our results suggest that, unlike in Zambia where yellow maize sells at a discount, there is no clear evidence of a discount in the WTP for yellow *kenkey*, as compared to white *kenkey*, possibly due to Ghana's large yellow maize-growing regions. We also found in Ghana that the average WTP for orange *kenkey* is less than that for either white or yellow *kenkey* across mechanisms, although nutrition information reverses this ranking comprehensively. Thus an information campaign will be key to driving consumer acceptance, and this campaign must take into account the substantial differences in preferences for yellow, white, and orange maize varieties across regions within Ghana.

## APPENDIX: Detailed Description of the Dataset

### Respondents' Characteristics

In total, 705 people were interviewed, 49 percent of which were women (Appendix Table A2). A broad range of the population was reached, with an age ranging from 18 to 90, and an average of 43 years. About two-thirds of the respondents had gone to school, on average 8 years. The majority of participating households stated farming as their main activity and their main source of income. One-third of households engage in other commercial activities, such as small business, carpentry, or brick laying. Most households (84 percent) own a radio. Half of households in the Eastern region own a phone, but less than 30 percent in the other regions. Very few households own any transport vehicle such as a motorcycle, bicycle, or car.

### Agriculture and Maize

The average farm size of the interviewed households is 2.7 hectares (ha), with a large majority of farms (90 percent) smaller than 6 ha (15 acres). About half of the farm area (1.3 ha on average) is used for producing food crops. Livestock owned includes chicken (81 percent of households), goats (48 percent), and sheep (27 percent).

Maize is the most important crop grown by the majority of farmers (93 percent). The other two food crops of major importance are cassava and plantain. The most important cash crop is cocoa, grown by all farmers in Eastern, a majority in Ashanti, but relatively few in Central region. The farmers interviewed would not be considered subsistence farmers as they sell more than half of their agricultural production.

The average maize production is 259 kilograms (kg) per household. In Ashanti, only one-quarter of farmers grow local maize varieties (with the rest growing "improved" varieties), compared to three-quarters in Central and two-thirds in Eastern. Few farmers could specify the name of the local variety, but many were yellow in color.

### Consumption Patterns of Maize

Maize is the major staple food mentioned by almost all households. Others mentioned were starchy staples like cassava, plantain, and yam. The only other cereal mentioned, at the fifth place, was rice. Food staples important in the children's diet followed the same pattern, except that rice and beans were also included.

Half of respondents eat maize every day, and another 30 percent a few times a week. Five maize preparations are mentioned as important by more than 10 percent of respondents. The most important are fermented products banku (85 percent) and *kenkey* (65 percent), followed by porridge (50 percent).

There are major regional differences in consumption preferences for varieties. Most respondents from Ashanti prefer improved varieties (67 percent), while respondents in the other two regions prefer the local variety. Similarly, the majority of Ashanti respondents (98 percent) prefer to eat white varieties. Only one-quarter of respondents in Central and Eastern regions prefer to eat white varieties and two-thirds prefer yellow varieties.

Based on data collected using the 24-hour recall method, the diversity of respondents' diets is estimated to be 60 percent. On average, respondents ate 60 percent of the 17 food groups distinguished in the survey during the last 24 hours. In particular, the majority of respondents (90 percent) had consumed cereals, vegetables, and fruits with vitamin A content. Vegetables rich in vitamin A scored a bit lower in Central (70 percent) than in Ashanti and Eastern were 90 percent respondents ate vegetables rich in vitamin A in the past 24 hours (90 percent). Even though legumes were not mentioned by households as a major staple, most respondents (60 percent) had consumed some in the last 24 hours. In addition, many respondents reported consuming animal products, in particular fish (by more than half of respondents), eggs, or meat (both by one third).

### Sources and Levels of Information

Radio is the main source of information and was mentioned as a major source of agricultural information by three-quarters of respondents and information on vitamin A by half. Respondents' knowledge of vitamin-A rich foods and the health benefits of consuming vitamin A, however, was low. Only one-third of respondents (from those who did not receive nutrition information) mention fruit as a source of vitamin A, and one-quarter mentioned leafy green vegetables. Similarly, knowledge of the role vitamin A plays in improving immunity against diseases and maintaining good eyesight was low (33 percent and 20 percent, respectively).

### Sensory Evaluation

All participants were offered three samples of fresh *kenkey*, made the same morning, from white, yellow, or orange maize. They were invited to look at them, smell them, feel them, and taste them. They were then asked to evaluate them, on a scale from 1 (very poor) to 5 (very good), based on these traits, as well as to provide an overall evaluation.

No participants gave an overall score lower than three for any *kenkey* sample, but strong regional differences still emerged. The Ashanti consumers gave higher overall scores to white *kenkey*, followed by yellow and then orange *kenkey*. Only the difference between white and orange *kenkey* was significant ($p<0.01$, pair-wise t-test). The Central consumers preferred yellow over either orange or white, and both were significant ($p<0.001$). The consumers in Eastern preferred both yellow and orange over white, and both are significant ($p<0.001$).

**Table A1: The Choice Frames**

| | Choice Scenario | *Kenkey* | | |
|---|---|---|---|---|
| | | White Maize | Yellow Maize | Orange Maize |
| Choice Set 1 | 1 | 20 | 25 | 25 |
| | 2 | 20 | 25 | 10 |
| | 3 | 20 | 10 | 20 |
| | 4 | 20 | 25 | 25 |
| | 5 | 20 | 40 | 10 |
| | 6 | 20 | 20 | 20 |
| Choice Set 2 | 7 | 20 | 25 | 30 |
| | 8 | 20 | 30 | 25 |
| | 9 | 20 | 30 | 10 |
| | 10 | 20 | 30 | 20 |
| | 11 | 20 | 30 | 40 |
| | 12 | 20 | 20 | 20 |
| Choice Set 3 | 13 | 20 | 10 | 40 |
| | 14 | 20 | 20 | 30 |
| | 15 | 20 | 25 | 40 |
| | 16 | 20 | 40 | 25 |
| | 17 | 20 | 40 | 20 |
| | 18 | 20 | 20 | 20 |
| Choice Set 4 | 19 | 20 | 30 | 30 |
| | 20 | 20 | 40 | 40 |
| | 21 | 20 | 10 | 10 |
| | 22 | 20 | 40 | 30 |
| | 23 | 20 | 10 | 25 |
| | 24 | 20 | 20 | 20 |
| Choice Set 5 | 25 | 20 | 20 | 40 |
| | 26 | 20 | 20 | 25 |
| | 27 | 20 | 20 | 10 |
| | 28 | 20 | 10 | 30 |
| | 29 | 20 | 20 | 20 |

Respondents were randomly assigned to any one of the above choice sets.

**Table A2: Summary Statistics of the Sample**

| Type | Variable/group | Ashanti (n=225) | Central (n=240) | Eastern (n=240) | All (n=705) |
|---|---|---|---|---|---|
| Respondent | Female (%) | 53.33 | 51.25 | 43.51 | 49.29 |
| Age | Age (years) | 41.56 | 45.67 | 41.54 | 42.96 |
| | (st. dev.) | (14.03) | (14.28) | (13.25) | (13.98) |
| Relationship with head | Head | 57.78 | 63.33 | 65.27 | 62.22 |
| | Spouse | 34.67 | 32.92 | 26.78 | 31.39 |
| | Parent, brother or sister | 4.00 | 0.83 | 2.93 | 2.55 |
| | Other | 3.55 | 2.92 | 5.02 | 3.84 |
| Marital status | Married monogamous | 70.67 | 77.08 | 76.15 | 74.72 |
| | Married polygamous | 4.44 | 3.75 | 2.09 | 3.41 |
| | Widowed, separated, divorced | 18.22 | 17.09 | 17.58 | 17.61 |
| | Single | 6.67 | 2.08 | 4.18 | 4.26 |
| Schooling | No formal schooling (%) | 29.33 | 44.17 | 20.92 | 31.53 |
| | Mean (years), of those who had education | 8.02 | 7.53 | 8.51 | 8.08 |
| | (st. dev.) | (2.60) | (3.29) | (2.90) | (2.94) |
| Household composition | Number of wives | 0.47 | 0.49 | 0.52 | 0.49 |
| | (st. dev.) | (0.84) | (0.63) | (0.55) | (0.68) |
| | Children 0–4 | 0.75 | 0.52 | 0.59 | 0.62 |
| | (st. dev.) | (0.95) | (0.78) | (0.88) | (0.88) |
| | Children 5–15 | 2.59 | 2.13 | 1.85 | 2.18 |
| | (st. dev.) | (2.29) | (2.16) | (1.98) | (2.16) |
| | Other dependants | 1.05 | 1.29 | 1.54 | 1.30 |
| | (st. dev.) | (1.72) | (1.94) | (1.99) | (1.90) |
| | Children and other dependents | 4.39 | 3.94 | 3.97 | 4.09 |
| | (st. dev.) | (2.61) | (2.74) | (2.54) | (2.64) |
| Main occupation of household head | Farmer (%) | 91.56 | 87.03 | 87.03 | 88.48 |
| Main source of income of household head | Farmer (%) | 90.67 | 85.00 | 87.45 | 87.64 |
| Assets owned | Radio (%) | 85.33 | 78.66 | 89.12 | 84.35 |
| | Telephone (%) | 30.22 | 29.29 | 49.79 | 36.56 |
| | Vehicle (%) | 6.22 | 2.93 | 2.09 | 3.70 |
| | Television (%) | 29.33 | 21.34 | 23.85 | 24.75 |
| Land Holding | Farm Area in hectares (mean) | 3.16 | 2.41 | 2.61 | 2.69 |
| | (st. dev.) | (3.76) | (2.57) | (2.63) | (2.98) |
| | | (n=165) | (n=214) | (n=210) | (n=589) |
| Size of land holding | 0-1 hectares | 20.61 | 24.77 | 21.43 | 22.45 |
| | 1-2.5 hectares | 37.58 | 50.00 | 46.67 | 45.41 |

| | | | | | |
|---|---|---|---|---|---|
| | 2.5–5 hectares | 23.03 | 14.02 | 21.43 | 19.22 |
| | 5 hectares & above | 18.79 | 11.21 | 10.48 | 12.93 |
| Livestock | Chicken | 71.11 | 69.46 | 81.17 | 73.97 |
| | Goats | 41.33 | 46.44 | 54.81 | 47.65 |
| | Sheep | 26.67 | 24.27 | 29.71 | 26.88 |
| | Cattle | 2.22 | 0.00 | 0.42 | 0.85 |
| Production | Area under food crop production (%) | 62.21 | 56.81 | 55.49 | 55.75 |
| | Average area under food crop production (hectares) | 3.44 | 2.93 | 3.12 | 3.08 |
| | (st. dev.) | (3.42) | (3.12) | (3.00) | (2.99) |
| Crop Grown | Maize (%) | 99.12 | 89.16 | 95.11 | 93.63 |
| | Cassava (%) | 78.66 | 75.83 | 81.59 | 78.70 |
| | Plantain (%) | 82.22 | 67.92 | 82.85 | 77.56 |
| | Cocoyam (%) | 55.55 | 24.17 | 41.84 | 40.20 |
| | Cocoa (%) | 42.67 | 21.67 | 43.51 | 35.79 |
| Consumption | Percentage of household reporting maize as staple | 85.33 | 79.58 | 86.61 | 83.81 |
| | Percentage of children reporting maize as staple | 51.11 | 37.50 | 39.75 | 42.61 |
| Frequency of maize consumption | Every day | 31.56 | 30.00 | 33.89 | 31.82 |
| | Two or more times a week | 53.33 | 60.42 | 60.25 | 58.10 |
| | Once a week | 8.44 | 4.58 | 2.93 | 5.26 |
| | Less than once a week | 6.67 | 5.00 | 2.93 | 4.82 |
| Sources of agricultural information | Radio as one of the top three sources (%) | 75.56 | 77.82 | 77.73 | 77.07 |
| | TV as one of the top three sources (%) | 8.00 | 7.95 | 3.77 | 6.54 |
| | Newspaper as one of the top three sources (%) | 2.22 | 0.00 | 2.51 | 1.56 |
| | Neighbor as one of the top three sources (%) | 54.67 | 43.51 | 46.86 | 48.22 |
| | Extension as one of the top three sources (%) | 46.22 | 31.80 | 28.45 | 35.28 |
| Source of vitamin A information | Percentage reporting radio as one of the top three sources | 52.00 | 52.08 | 63.18 | 56.25 |
| Overall Acceptability | Percentage scoring white as very poor and poor | 4.00 | 18.33 | 10.04 | 10.94 |
| | Percentage scoring white as neither poor nor good | 2.22 | 7.92 | 8.37 | 6.25 |
| | Percentage scoring white as good and very good | 93.78 | 73.75 | 81.59 | 82.81 |
| | Percentage scoring yellow as very poor and poor | 6.67 | 5.41 | 4.18 | 5.40 |
| | Percentage scoring yellow as neither poor nor good | 1.78 | 3.75 | 3.35 | 2.98 |
| | Percentage scoring yellow as good and very good | 91.55 | 90.84 | 92.47 | 91.62 |
| | Percentage scoring orange as very poor and poor | 8.44 | 13.33 | 4.18 | 8.66 |
| | Percentage scoring orange as neither poor nor good | 6.67 | 6.67 | 4.18 | 5.82 |
| | Percentage scoring orange as good and very good | 84.89 | 80.00 | 91.64 | 85.52 |

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