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Consumers' willingness to pay for safer vegetables in Tamale, Ghana

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Consumers' concerns over misuse of agrochemicals and untreated wastewater for irrigation in vegetable production are increasing demand for safer vegetables in urban cities. Providing safer vegetables requires production methods that minimize or eliminate the associated risks. Nevertheless, these practices involve extra cost, which requires that consumers, at least, bear part of the cost. The main objective of this paper is to examine factors influencing consumers' willingness to pay price premiums for safer vegetables. We sampled a cross-section of 331 consumers in Tamale, and elicited their willingness to pay premium prices for safer vegetables. The results show that consumers are willing to pay average premiums of GH¢8.01 (US$1.90), GH¢3.27 (US$0.78) and GH¢2.89 (US$0.69) for standard quantities of safer cabbage, safer ayoyo and safer okra, respectively. These premium prices are equivalent to 128.6%, 197.3% and 189.0% of the current average market prices of same quantities of the conventional vegetables. Typically, consumers willing to pay premium prices are those with income generating employment, have trust in traders and care about the use of untreated wastewater for irrigation. These findings mean that consumers are generally willing to bear extra cost to secure consumption of safer vegetables, and avoid health-related risks associated with unsafe, conventional vegetables.

Keywords: ayoyo, ordered logit regression, food safety, Tamale metropolis, Ghana

Introduction

Food safety can be defined as the degree of consumer confidence in relation to the presence (or absence) of beneficial (or harmful) sensory and credence attributes. In a narrow sense, food is considered 'safer' when all disease-causing hazards are eliminated or reduced to a level that is acceptable and considered safe for consumption (Haghiri 2016). In this study, safer vegetables are those that are cultivated without the use of agrochemicals and wastewater for irrigation, or using permissible amounts of agrochemicals and treated water. Such vegetables are from the farm to the consumer through proper handling practices, so that there are no associated illnesses when such vegetables are consumed.

Demand for fresh and blemish-free vegetables is on the rise in Tamale like other cities in Ghana due to increasing urbanization and population growth (Owusu and Owusu 2010). Over 70% of this demand comes through urban and peri-urban vegetable farming (Gyasi et al. 2014). Vegetable production in and around Tamale serves as primary source of food, nutrition and income security for over 70% of the urban poor (Gyasi et al. 2014). However, some middle and high-income households lately adopt vegetable farming as a leisure activity, or as risk mitigating strategy (Nchanji et al. 2017).

In the Tamale metropolis, small-scale commercial (or subsistence) vegetable production is normally done in the rainy season due to limited irrigation facilities for dry season production (Gyasi et al. 2014). For this reason, many farmers resort to the use of wastewater for dry season vegetable production. Besides the issue of water scarcity, vegetables such as ayoyo (*Corchorus spp*), cabbage (*Brassica oleraceae* var. capitata) and okra (*Abelmochus spp*) suffer major pest and disease attacks, which make the use of crop protection inputs very important for farmers. To overcome these challenges and meet the rising demand for vegetables in the city, farmers tend to adopt intensification practices through heavy investments in in soil fertilization, crop protection and dry season irrigation (Nchanji et al. 2017). These practices often compromise the safety of the vegetables due to residues of the agro-inputs.

Vegetables are highly susceptible to contamination under poor practices by farmers, vendors, and even consumers. However, pre-harvest practices are critical because contaminations are often linked to excess levels of chemical and microbial residues (Amoah et al. 2006; Abass, Ganle, and Adaborna 2016), which arise from pesticides misuse and irrigation with untreated wastewater. Most farmers misuse agrochemicals due either to limited knowledge of how to use them or in the quest for supernormal profits. Also, farmers engaged in dry season irrigation farming tend to use raw (untreated) wastewater, either driven by limited funds to purchase clean water (Nchanji et al. 2017) or the perceived rich nutrient content of wastewaters. Of major concerns are pesticide residues in raw, unprocessed or untreated vegetables.

These practices have come to the attention of consumers, and in response consumers are now very conscious and demand safer vegetables (Gumber and Rana 2017) due to health hazards associated with consuming contaminated unsafe vegetables. Recent studies indicate that most consumers have high intentions to grow their own vegetables as a way of ensuring consumption of safer foods (Obuobie et al. 2014). However, it is not clear whether the rising consumer health consciousness matches their positive intentions to purchase safer vegetables on the market. For example, Obuobie et al. (2014) found that while most consumers were unwilling to buy vegetables produced using poor quality water if they knew about it, 40% or more also showed positive intentions to purchase those vegetables subject to thoroughly treating them before consumption. This implies the existence of both health risk averse and risk loving consumers, with mixed knowledge and perceptions about food safety.

Tamale metropolis is a major business hub in the three northern regions of Ghana, where local food markets play key roles in supplying fresh vegetables to consumers. Like any other typical traditional African market, several informal and unregistered mobile vendors who sell at traditional open-air markets, in kiosks, roadside shops and farmer markets dominate vegetable marketing in the Tamale metropolis. The market consists of middle-women called market queens, retailers and farmers who largely supply conventional vegetables to consumers.

Ensuring safer vegetable supply requires the appropriate use of agrochemicals and the use of treated water for irrigation, among other good handling practices (Whittington et al. 1990; Kutto et al. 2011; Vidogbéna et al. 2015; Yahaya, Yamoah, and Adams 2015). However, the cost of using these methods increases the cost of producing safer vegetables compared to conventionally produced vegetables. This requires that consumers bear at least part of the additional cost in a form of price premiums. However, there is limited understanding as to whether consumers in Tamale are willing to pay more for safer vegetables. Also, in the area of food safety in vegetables, while the concept of willingness-to-pay (WTP) has received lots of analysis from researchers in other countries (Whittington et al. 1990; Fu, Liu, and Hammitt 1999; Posri, Shankar, and Chadbunchachai 2006; Suresh et al. 2015), only few focus on Ghana (Yahaya, Yamoah, and Adams 2015). WTP analysis helps to understand the value consumers place on risk-free foods. Consumers' knowledge and perceptions about food safety, trust, choice of food safety market and risk preferences are important factors that could influence decisions and willingness to pay for safer vegetables. However, previous studies have not directly assessed these factors (Acheampong et al. 2012; Yahaya, Yamoah, and Adams 2015). This study digresses from others by including a wide range of food safety knowledge and perception elements in WTP models.

The rest of the paper falls under the following sections. The next section reviews the empirical literature on consumers' purchasing behavior concerning food safety and outlines the theoretical framework that underpins this study. In the section thereafter we present the data and methodology for addressing the objectives, followed by the section that presents and discusses the results from the data analysis. The last section concludes the paper with some policy implications.

Literature review

Empirical review of consumer behavior toward food safety

Major research areas regarding consumer behavior towards food safety and quality revolve around perceptions of food safety and demand for food safety. Consumer perceptions of food safety narrates their judgements toward quality, which guides purchasing and consumption decisions based on preferences (Verbeke et al. 2007). Grunert (2005) explains consumers' perceptions of food safety as mediating factors that lead to the actual and hypothetical purchase decisions. Perceptions are also correlated with knowledge which itself is a product of exposure to sources of information and personal willingness to obtain information (Wilcock et al. 2004). The human psyche is a very complex process because economic, emotional and social factors all influence consumer behavior. This makes the study of consumers' decision making very difficult. According to Grunert (2005), consumer demand for safety tends to explain the extent to which certain safety improvements correspond to consumer preferences and ultimately results in product acceptance (i.e., WTP). In assessing consumers' demand for food safety, researchers often use a stated preference (willingness to pay or WTP) approach. WTP for food safety is one of the inherent decisions that consumers make regarding hypothetical products and is studied as a function of several factors; however, findings are mixed and varying.

For instance, empirical studies find that male, older and educated consumers exhibit higher WTP for safer foods (Cranfield and Magnusson 2003; Posri, Shankar, and Chadbunchachai 2006; Yahaya, Yamoah, and Adams 2015). For income, most studies conclude that food safety is a normal good, because WTP increases as income increases (Boccaletti and Nardella 2000; Posri, Shankar, and Chadbunchachai 2006). Studies also show that consumers who strongly perceive safer foods to be associated with more health benefits, and those that have high concern for the environment, tend to have higher WTP (Cranfield and Magnusson 2003; Owusu and Anifori 2013; Gumber and Rana 2017). Similarly, consumer knowledge (awareness) regarding food safety issues have been found to relate positively with WTP (Gil and Soler 2006; Vidogbéna et al. 2015). Besides, product attributes such as nutritional values, freshness, being chemical-free, taste, availability and label, influence consumers' WTP (Makatouni 2002; Nouhoheflin et al. 2005; Acheampong et al. 2012). Finally, trust is found to relate positively to WTP (Nocella, Romano, and Stefani 2014; Roosen et al. 2015).

Theoretical framework

Individuals make decisions on alternative choices, each defined by several features (Payne, Bettman, and Johnson 1991; Smith and Brynjolfsson 2001). The decision-making process depends on several factors, which include: (1) the number of verifiable and non-verifiable attributes of the product (such as appearance, price, quality and safety); (2) difficulty in the evaluation of certain attributes; and (3) uncertainty regarding the value of attributes (Payne, Bettman, and Johnson 1991). This study adapts the cognitive decision-making process to explain consumers' WTP. Largely, cognitive processing occurs immediately before a consumer purchases a product or through repeated purchases (use or experience) over time.

Consider safer vegetables produced with or without permissible amounts of chemical pesticides and the use of treated (hygienic) water and packaged neatly. Consumers may have appetites for these attributes as a bundle. The attributes of the safer vegetables may not apply to conventional alternatives (Johnson 1984); hence, the choice between those two alternatives can be studied. While consumers may not usually know the consequences of their choices beforehand, they often make trade-offs between alternatives (Payne, Bettman, and Johnson 1991). The concept of trade-offs has often been studied in the domain of utility (Smith and Brynjolfsson 2001).

The appropriate framework for explaining consumers' preferences for alternatives with similar or unrelated attributes usually leans on the traditional random utility and the Lancaster demand theory. According to Lancaster (1966), a commodity per se does not give utility to the consumer but rather its attributes or characteristics do. In other words, the probability of a consumer choosing one alternative over another is equal to the sum of utilities the consumer derives from the individual attributes of the commodity. In this study, we consider safety as a composite commodity with several equally important attributes, so that the traditional random utility theory becomes appropriate to derive the empirical model. We hypothesize that the likelihood of consumers selecting either safer or conventional vegetables is based on the utility-maximization theory (Louviere et al. 2005).

Therefore, WTP for safer vegetables rests on the microeconomic theory of expected utility maximization, which specifies that consumers aim at maximizing utility under a fixed budget. The consumer chooses a commodity (bundle) that best offers the highest satisfaction. In principle, a rational consumer buys more of a normal good if her income increases or if the commodity price falls, and for which the utility is greatest. This trade-off the consumer makes is reflected in her WTP (Vidogbéna et al. 2015). WTP is the amount of money that an individual is willing to offer to obtain a product or service (Gumber and Rana 2017). The additional percentage price charged on a vegetable product when it transforms from its conventional state to a safer one is called the premium price (Fillion and Arazi 2002).

Analyzing the change in consumer utility (WTP) and the predictive factors influencing utility can be done using the econometric models of probabilistic choice (McFadden 1981). The utility function U_{ij} (in equation 1) consists of an observed deterministic component (V_{ij}), which is stated by a consumer or observed through a consumer's actions or choices, and unobservable random component (ε_{ij}), which arises from omitted attributes, discrimination errors and unmeasured preferences.

$$U_{ij} = V_{ij} + \varepsilon_{ij} = f(X_{ij}, \beta_{ik}) + \varepsilon_{ij} \quad (1)$$

The choice problem is utility maximization, and it implies an individual chooses good j as in expression 3 over good q I:

$$E[U_{ij}] \geq E[U_{iq}] \quad \forall j \neq q \quad (2)$$

whereas the probability of the consumer maximizing her utility for good j over good q is given by:

$$\text{Prob}\,(U_{ij} \geq U_{iq}) = f(X_{ij}, \beta_{ik}) + \varepsilon_{ij} \geq f(X_{iq}, \beta_{ik}) + \varepsilon_{iq} \quad \forall j \neq q \quad (3)$$

Data and empirical strategy

Data and study area

The research was based in Tamale, Ghana (see Figure 1) as part of a collaborative initiative by Urban FoodPlus, a German-African project to promote food safety among three (3) other West African countries, namely Burkina Faso, Cameroon and Mali. The Metropolis covers a land area of about 922 km^2 and is located approximately 180 meters above sea level. The city is the only Metropolitan Assembly in northern Ghana (which includes Northern, Upper East and Upper West regions). The choice of Tamale for this study was strategic for two reasons. First, Tamale is now the fastest growing city in Ghana and one of the few in West Africa. Second, the city remains the major business hub of northern Ghana, and the converging point of roads leading down from the southern regions and the Upper East and Upper West regions of Ghana. Tamale is the capital city, located right at the center of the Northern region. It had a 2013 projected population of 360,579 according to the 2010 census (GSS 2012), with a mean household size estimated at approximately 7 persons per household. Urban agriculture is a common activity in the area (Nchanji et al. 2017). Vegetable production however, occurs in and around its periphery. The use of agrochemicals, especially synthetic pesticides to control pests and diseases in vegetables cultivation, is a key feature of commercially-oriented farms. Lack of access to water, especially for dry season farming to ensure all year-round supply of vegetables in the city has also resulted in the use of untreated wastewater from residential and industrial fluids for irrigation.

Three hundred and fifty-two (352) questionnaires were administered in a survey undertaken on a population of consumers in Tamale from November to December 2016. A sample of 331 observations was used for the data analysis after deleting 21 observations with large missing observations. Target respondents were at least 15 years old and were selected through a multi-stage sampling technique. First, 1,200 satellite waypoints, initially presumed to be houses, were generated using the simple random sampling method. Second, systematic sampling was applied to select 352 consumers (based on equation 4) from the 1,200 randomly selected satellite waypoints.

The appropriate sample size was determined using Cochran's (1977) formula as follows:

$$n = \frac{z^2[p(1-p)]}{e^2} = \frac{1.96^2[(0.636)(0.364)]}{0.05^2} = 352 \quad (4)$$

where p is the proportion of targeted individuals from the population of consumers, z is the z-critical value and e is the margin of error. According to the 2014 reports from the Ghana Statistical Service, the adult population (individuals aged 15 years and above) in Tamale is about 63.7%. This percentage was used as the target or eligible population who are capable of cooking, purchasing or providing income for household food consumption.

The sample selection procedure for the respondents is outlined as follows. First, the 352 waypoints were planted

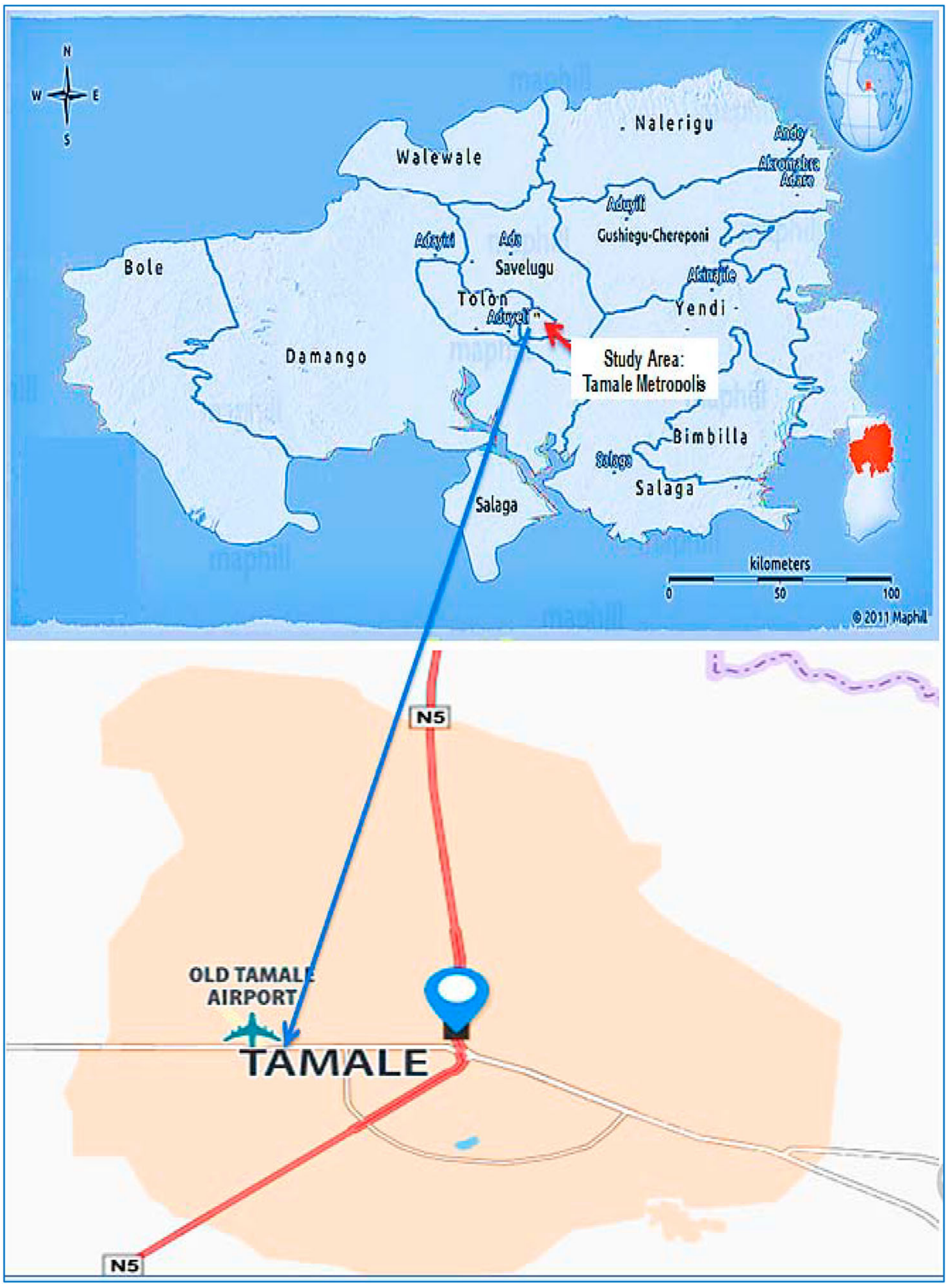

Figure 1: Map of Tamale metropolis, and the study site.

in the GPS route planner and set out on the route map, and then used to locate the houses where respondents lived. Field assistants followed the direction of a point until a house was found. A margin of error of about 10 meters away from a house was allowed when the point fell between two or more houses. However, any waypoint that fell on a non-household structure, for example public offices, churches, mosques, schools, roads or bushes was treated as a misplaced point, and additional waypoints were systematically planted thereafter until the 352 waypoints were exhausted.

Moreover, if a household was identified by the GPS device but members were unavailable for the interview, they were revisited at a later time or day. Once the household was tracked with members available, an adult member of the household was selected and interviewed face-to-face using a contingent valuation questionnaire. Duplicate interviews were avoided by deleting every used waypoint and allowing for selection without replacement. The questionnaire consisted of questions on socio-economic characteristics of consumers, purchase decisions regarding quality attributes and preferences safer vegetables. The final part of the questionnaire solicited information on consumers' food safety knowledge and perceptions. Six knowledge-based questions reflected food hazards, such as (1) bacterial infections, (2) agrochemical residues, (3) heavy metals and (4) physical materials. Also, health impacts of food hazards, such as (5) foodborne diseases and (6) premature deaths were classified together with 10 perception questions. These perception questions reflected quality, price, packaging, environment, health, taste, nutrition, risk, certification and labelling. A Likert-scale that assesses perceptions in terms of strongly agree (+1), agree (+0.5), or don't know (0), disagree (–0.5) strongly disagree (–1) was used.

Conceptual framework

Safer vegetables are largely hypothetical, private and credence commodities produced using safer practices and handled properly from the farm to the consumer without contamination. Safer vegetable production emphasizes methods such as prudent use of agrochemicals, treated water and soil testing. These attributes are not observable. However, all other sensory and nutritional attributes are maintained or enhanced (Aban, Concepcion, and Montiflor 2009). During the survey, safer vegetables were explained to consumers as those that are reliably unlikely to cause harm, while maintaining or enhancing beneficial attributes. In the absence of such explanations, consumers assumed that vegetables were safe unless proven otherwise, for instance, after food safety incidents, when they detected poor practices by suppliers or when they suffered illness after consuming the product (Aban, Concepcion, and Montiflor 2009). Consumers often face the problem of information asymmetry since food suppliers tend to provide little or no information to consumers despite being adequately knowledgeable of the product. Food certification could be a guarantee that assures consumers of food safety, but that was not the idea of this study (our focus is on safer vegetables with no certification).

We employed the contingent valuation method (CVM) to elicit consumers' WTP. In organizing this, we first defined the good of interest, the change in the product, the market structure under which the good is delivered and the method of payment for consumers. We asked this question:

> If vegetables are produced more wholesomely and safely but with higher prices compared to the conventional ones that may have high levels of pesticide residues and pathogens in them, would you be willing to pay more for that same quantity of vegetables you ever purchased if safer for you and your family considering your budget?

To conform to economic theory, we told the respondents to take into consideration that their budgets were constrained. We made respondents understand that if they paid higher prices for safer vegetables, they might have to reduce expenditure on other foods or needs.

The CVM by far is the most difficult method for eliciting WTP since the product and everything about its market are hypothetical (Cummings et al. 1986). It is prone to several biases such as strategic bias, information bias, starting point bias and hypothetical bias. For strategic bias, the respondent may intentionally hide under a free-riding umbrella or positive sentiments to influence the level of provision of the good by stating artificially higher or lower prices (Whittington et al. 1990; Mitchell and Carson 2013). In other words, strategic bias occurs from a deliberate attempt by the respondent to influence either their payment obligation or the level of the provision of the good through the stated valuations by hiding their true WTP. In our study, we reduced this bias by using cheap talk scripts to advise the respondent that her decision is not likely to influence policy directly if the product existed in the real world, so they must be sincere in their answers.

In the CVM, since both the product and the market are created in words by the researcher rather than being in existence, information and hypothetical biases can also happen if respondents do not have complete knowledge about the product (Loomis 2014). We reduced this bias by (1) only including people who had previously purchased vegetables, and (2) providing an adequate, clear and meaningful description of the good to the respondent. In addition, we consistently informed respondents about the budget constraint, the quantity of good valued for that price and the season of production to minimize information bias. Using the initial values by the respondents to make her decision can cause starting point bias. This may be a problem of the follow-up question where the respondent uses the initial price or the first bid to make her decision on the next question instead of the market price if the respondent is misled or fails to understand the concept. We reduced this bias by using random starting bids generated from average market prices. Morrison and Brown (2009) suggested the use of the cheap talk method as an important strategy to reduce hypothetical bias. We also linked respondents' own health and wellbeing to the status quo and the policy change to help reduce hypothetical bias. Little and Berrens (2004) argued that using the double-bounded dichotomous choice (DBDC) question format itself minimizes hypothetical bias.

In using the CVM, several elicitation methods are available but broadly grouped into two: open-ended and the discrete choice (single and double-bounded) elicitation formats. We elicited WTP specifically by using the DBDC format together with the open-ended question. In the open-ended technique, respondents were asked to state at what maximum price (GH¢X) they were willing to pay for safer vegetables. The estimates derived from the open-ended questions are continuous. Ready, Buzby, and Hu (1996) point out that the open-ended question generates a lower estimated WTP than a dichotomous choice format due to more 'yes' saying among dichotomous choices respondents. While Pearce, Pearce, and Palmer (2002) reported that the single-bounded dichotomous choice (SBDC) can simplify the reasoning task (that is, trying find at what price to pay) faced by respondents, Hanemann, Loomis, and Kanninen (1991) argued that the DBDC produces reliable and asymptotically more efficient estimates compared to the SBDC.

In the SBDC question, the respondents were asked whether they were willing to pay GH¢X price premium for safer vegetables. The response derived from the SBDC question was 'yes' or 'no', which induces a binary model. In the DBDC questions, we first asked the general question: '*Are you willing to pay more for safer vegetables?*' The response was 'yes' or 'no'. A 'yes' response was then followed by two questions: for example, if the respondent was willing to pay more for safer vegetables, then the consumer was allowed to state whether she was willing to pay a certain premium price based on the outcome from a tossed dice containing four (4) percentages (25%, 50%, 75% and 100%). The response was also 'yes' or 'no'. If she answered 'yes' to the first bid, a second higher bid was presented to her to decide on whether to pay or not. If the respondent answered 'no' to the first bid, a second lower bid was presented to her, which was based on certain percentages (10%, 20%, 30%, 40% and 50%). The possible combination of responses was no-no (*n/n* WTP), no-yes (*n/y* WTP), yes-no (*y/n* WTP) and yes-yes (*y/y* WTP). We also denoted the segment of consumers who were not willing to pay more for safer vegetables by zero WTP. These give rise to the framework in Figure 2.

Estimation procedure

To analyze the factors that influence consumers' WTP for price premiums, we used the ordered logit regression model. In this model, there is a continuous preference function for the individual that underlies the decision to pay and how much to pay, but is latent. What a researcher actually observes is a consumer's decision to pay certain premium prices, which puts her in a standard DBDC situation. The latent unobserved continuous variable is a linear combination of explanatory variables and an error term, logistically distributed as follows:

$$\lambda_i^* = \sum_{i=1}^{n} X_i\beta + \varepsilon_i \qquad (5)$$

The observed ordinal variable takes on values 0 through *m*-categories according to the following scheme:

$$\lambda_i = j \Leftrightarrow \gamma_{j-1} < \lambda_i^* < \gamma_j \qquad (6)$$

where:
λ_i = consumer WTP for safer vegetables, λ_i^* = the latent unobserved (continuous) variable, X_i = explanatory variables, β = unknown parameters to be estimated, ε_i = error term and γ = the threshold parameters or the cut-off points.

The DBDC questions produced five mutually exclusive outcomes, ranging from zero to four. If we assume that λ, γ_i, γ_L and γ_H denote the observed WTP, the first bid, the second lower bid and the second upper bid respectively, then we have the following consumers: those who were not willing to pay more for safer vegetables; these have zero WTP. Those who said 'no' to both bids (*n/n* WTP); those who said 'no' to the first bid but answered 'yes' to the second lower bid (*n/y* WTP); those who said 'yes' to the first bid but answered 'no' to the second lower bid (*y/n* WTP); and those who said 'yes' to both bids (*y/y* WTP). These are expressed as in (7) below.

$$\begin{array}{ll} \lambda_0 = 0 \;\; if \;\; \lambda_0^* \leq 0 & \text{stands for zero WTP} \\ \lambda_1 = 1 \;\; if \;\; 0 < \lambda_1^* \leq \gamma_1 & \text{stands for } n/n \text{ WTP} \\ \lambda_2 = 2 \;\; if \;\; \gamma_1 < \lambda_i^* \leq \gamma_2 & \text{stands for } n/y \text{ WTP} \\ \lambda_3 = 3 \;\; if \;\; \gamma_2 < \lambda_i^* \leq \gamma_3 & \text{stands for } y/n \text{ WTP} \\ \lambda_4 = 4 \;\; if \;\; \lambda_i^* \leq \gamma_3 & \text{stands for } y/y \text{ WTP} \end{array} \qquad (7)$$

Under the assumption of Gaussian errors, Maddala (1983) gives the ordered logit probabilities of *m*-categories as follows:

$$\pi(\lambda_i \leq \frac{j}{X_i}) = \Lambda(\gamma_j - X'_i\beta) - \Lambda(\gamma_{j-1} - X'_i\beta) \qquad (8)$$

Using the general logit framework;

$$\pi(\lambda_i \leq \frac{j}{\lambda_i}) = \Lambda(\lambda_i^*) = \frac{e^{\lambda_i^*}}{1 + e^{\lambda_i^*}} = \frac{1}{1 + e^{-\lambda_i^*}} \qquad (9)$$

and the probabilities of each ordered outcome is such that:

$$\begin{array}{l} \pi_0(\lambda_i = 0|X_i) = \Lambda(-X'_i\beta) \\ \pi_1(\lambda_i = 1|X_i) = \Lambda(\gamma_1 - X'_i\beta) - \Lambda(-X'_i\beta) \\ \pi_2(\lambda_i = 2|X_i) = \Lambda(\gamma_2 - X'_i\beta) - \Lambda(\gamma_1 - X'_i\beta) \\ \pi_3(\lambda_i = 3|X_i) = \Lambda(\gamma_3 - X'_i\beta) - \Lambda(\gamma_2 - X'_i\beta) \\ \pi_4(\lambda_i = 4|X_i) = 1 - \Lambda(\gamma_3 - X'_i\beta) \end{array} \qquad (10)$$

Combining the five outcomes, the parameters of the model can be estimated consistently and efficiently using the maximum likelihood (ML) criteria with the log-likelihood

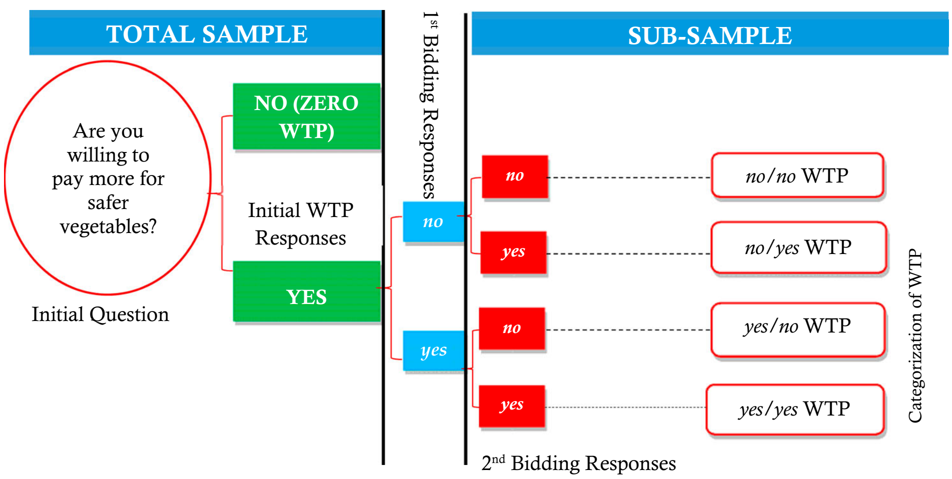

Figure 2: CVM elicitation approach for WTP for safer vegetables.

function given by:

$$\ln l = \sum_{i=1}^{N} \{d^{yy}\ln^{yy}(\gamma_i, \gamma_H) + d^{yn}\ln^{yn}(\gamma_i, \gamma_H) + d^{ny}\ln^{ny}(\gamma_i, \gamma_L) + d^{yy}\ln^{nn}(\gamma_i, \gamma_L) + d^{zero}\ln^{zero}(\gamma_i)\} \quad (11)$$

where d^{yy}, d^{yn}, d^{ny} and d^{nn} are binary variables denoting 1 in each case if the statement is true and 0 otherwise.

Equation 12 specifies the empirical model for analyzing the factors affecting consumers' WTP price premiums for safer vegetable, while Table 1 describes the variables and expected signs of the coefficients.

$$\ln\left(\frac{\pi_i}{1-\pi_i}\right) = \beta_1 X_{1i} + \beta_2 X_{2i} + \beta_3 X_{3i} + \beta_4 X_{4i} + \beta_5 X_{5i} + \beta_6 X_{6i} + \beta_7 X_{7i} + \beta_8 X_{8i} + \beta_9 X_{9i} + \beta_{10} X_{10i} + \beta_{11} X_{11i} + \beta_{12} X_{12i} + \beta_{13} X_{13i} + \beta_{14} X_{14i} + \beta_{15} X_{15i} + \beta_{16} X_{16i} + \beta_{17} X_{17i} + \varepsilon_i \quad (12)$$

Results and discussions

Summary statistics of sample characteristics

Most (72%) consumers were females. In typical Ghanaian homes, females take charge of food purchases and cooking. Men often provide money for food purchases while women decide on the type of food to purchase and consume in the household. The average respondent was 38 years old, implying that consumers surveyed were within the economic and active age group. Most (65%) consumers were educated to the primary level. Of those educated, 29% had schooled up to the tertiary level. Such a distribution could mean high consumer knowledge on food safety that helped them to understand better the WTP scenario. The majority of consumers were also married, since marriage is an important cultural orientation of the Tamale people. The majority (88%) of the respondents were fully engaged in some form of employment to generate income. This is probably because Tamale is a fast-urbanizing commercial business hub in Northern Ghana and the West African sub-region. The mean household monthly income was GH¢1,060.14 (US$252.41), out of which an average of only GH¢22.01 (US$5.24) is spent weekly on vegetables. Most (70%) consumers buy conventional vegetables daily, probably due to highly perishable nature of vegetables and the limited preservation mechanisms.

In addition, the majority of consumers consider sensory attributes when buying vegetables. Consumers find it easy to evaluate sensory attributes before purchase, through view and smell, and may not necessarily depend on whether or not farmers/traders provide information labels on the product. Most consumers consider nutritional values (such as level of vitamins), use of polluted wastewater (70%) and agrochemical misuse (66%) by farmers when buying vegetables at the market. It is almost impossible for consumers to evaluate these latter attributes because they lack explicit credence. However, some consumers can use their smell and visual inspection of insect bites to determine whether farmers used untreated wastewater and pesticides in the production process. Most consumers opted to purchase safer vegetables from the open-air markets if they were available while slightly more than a third and slightly more than half opted to do so at the supermarket and farm-gate, respectively, if they were available. We could explain the high intention of consumers to buy safer vegetables from the open-air market from the standpoint that most households in Ghana are already used to buying their vegetables from the open-air market (Acheampong et al. 2012). In addition, some have the perception that products sold at the supermarket are expensive and reserved for the highly educated or rich consumers.

Further, most consumers showed strong agreement that agrochemical residues and microbial pathogens are mostly associated with vegetable contamination compared to heavy metals and physical materials. This could arise

Table 1: Descriptions of the model variables.

Variable	Description	Measure	Mean (std. dev.)
X_1	Gender	Dummy, 1 if male	0.28 (0.45)
X_2	Age	Number of years	38.4 (12.5)
X_3	Education	Dummy, 1 if respondent formal education	0.09 (0.29)
X_4	Employment	Dummy, 1 if respondent does work for income	0.88 (0.33)
X_5	Income of household	Total amount earn/month (in Ghana cedi)	0.29 (0.46)
X_6	Vegetable shopping	Dummy, 1 if respondent buys vegetables daily	1060.1 (1355.3)
X_7	Vegetable expenditure	Total amount spent on vegetables/week (Gh₵)	22.0 (19.7)
X_8	Untreated wastewater use	Dummy, 1 if respondent considers use of untreated wastewater in vegetable purchase	0.70 (0.56)
X_9	Agrochemical misuse	Dummy, 1 if respondent considers agrochemical use in vegetable purchase	0.66 (0.47)
X_{10}	Trust in farmers	Dummy, 1 if respondent has high trust	−0.002 (0.62)
X_{11}	Trust in traders	Dummy, 1 if respondent has high trust	0.38 (0.61)
X_{12}	Price perception	Score	0.01 (0.66)
X_{13}	Environment perception	Score	0.32 (0.54)
X_{14}	Health perception	Score	0.83 (0.27)
X_{15}	Taste perception	Score	0.60 (0.47)
X_{16}	Risk perception	Score	0.61 (0.47)
X_{17}	Labeling perception	Score	0.10 (0.66)

from increased concerns in pesticide residues and microbial pathogens among the Ghanaian public (Amoah et al. 2006). Additionally, most consumers agreed strongly that food hazards could cause foodborne diseases and deaths. Recently, the media in Ghana reported incidences of foodborne diseases and attendant deaths. Further, most consumers perceived health, nutrition, taste, risk and quality as important food safety attributes, which shows that most consumers have key interest in credible health-related attributes. The word 'safer' and 'health' were common synonyms among the consumers interviewed. In contrast, most consumers perceived environment, certification, labelling, packaging and price as less important food safety attributes. This study corroborates that of Aban, Concepcion, and Montiflor (2009) among Philippine consumers.

Mean WTP for safer vegetables

Based on the elicitation method, the computed mean WTP for 1.5 kg of safer cabbage was GH¢ 8.01 (US$1.90), equivalent to an increase of 128.6% over the average price of GH¢3.50 for that same quantity of conventionally produced cabbage. Those of a bundle of safer ayoyo and 0.5 kg of safer okra were GH¢3.27 (US$0.78) and GH¢ 2.89 (US$0.69), equivalent to an increase of 128.90%, 197.3% and 189.0% over the average price of GH¢1.10 and GH¢1.00 for the same quantities of normal ayoyo and okra, respectively. The mean WTP estimates in this study are much higher than previous studies in most developing countries (Nouhoheflin et al. 2005; Mergenthaler, Weinberger, and Qaim 2009).

Determinants of WTP for safer vegetables

Tables 2 and 3 respectively report the coefficients and marginal effects of factors that influence WTP for safer cabbage, ayoyo and okra. The Wald chi^2 tests indicate that each of the three models is appropriate, and the selected explanatory variables contribute to building the models used.

From the results, education significantly and positively influences the WTP price premium for only safer cabbage but not ayoyo and okra. In Ghana, educated folks normally patronize exotic vegetables like cabbage while both the educated and non-educated patronize traditional vegetables like ayoyo and okra. It is therefore not surprising that only cabbage shows significant differences with education. Educated consumers are about 11% more likely to pay premium prices for safer cabbage than consumers who had no formal education, all other things remaining equal. Moreover, one could argue that education enhances knowledge, access to information and the ability to understand the risks associated with unsafe food consumption.

Among factors relating to purchasing behavior, the frequency of vegetable shopping has only a marginally significant effect on WTP premium price for safer ayoyo but not cabbage or okra. Consumers who purchase conventional ayoyo frequently are also willing to pay more for safer ayoyo. The reason for this result is not immediately apparent from the data, but one could think of the health benefits that consumers stand to gain if they switch to the safer version of the vegetable.

Consistent with prior expectations, the marginal effects of consumers' concerns on the use of untreated wastewater by farmers when buying vegetables was significant, with expected positive effects on WTP the premium prices for all three vegetables. The literature argues that wastewater pathogens are common worries of consumers (Nouhoheflin et al. 2005; Amoah et al. 2006; Keraita and Drechsel 2015). Therefore, our finding may suggest that consumers have basic knowledge that microbial contamination could arise from the use of untreated wastewater. The marginal effect of the willingness of consumers who care about the use of wastewater for vegetable irrigation to pay price premium for safer vegetables is non-ignorable. On the other hand, consumers

Table 2: Estimated coefficients from ordered logit regression.

	Safer cabbage model			Safer ayoyo model			Safer okra model		
Variable	Coef.	Std. Err.	$P>z$	Coef.	Std. Err.	$P>z$	Coef.	Std. Err.	$P>z$
X_1	0.006	0.274	0.982	−0.039	0.290	0.894	0.006	0.311	0.985
X_2	−0.011	0.009	0.231	−0.014	0.010	0.150	−0.017	0.011	0.111
X_3	0.480	0.274	0.080	0.061	0.290	0.834	−0.271	0.312	0.386
X_4	0.194	0.114	0.089	0.078	0.115	0.498	0.176	0.136	0.195
X_5	0.193	0.331	0.559	0.031	0.345	0.929	−0.549	0.398	0.168
X_6	−0.373	0.273	0.172	−1.143	0.304	0.000	−1.209	0.330	0.000
X_7	0.007	0.008	0.338	0.016	0.009	0.062	0.013	0.009	0.170
X_8	1.366	0.288	0.000	0.945	0.295	0.001	0.715	0.305	0.019
X_9	0.024	0.281	0.931	0.362	0.296	0.221	0.776	0.309	0.012
X_{10}	−0.709	0.294	0.016	−1.072	0.340	0.002	−1.161	0.366	0.002
X_{11}	0.684	0.298	0.022	0.765	0.342	0.025	0.969	0.371	0.009
X_{12}	−0.120	0.171	0.482	−0.174	0.185	0.347	−0.106	0.201	0.597
X_{13}	0.415	0.222	0.062	−0.203	0.240	0.398	−0.083	0.255	0.745
X_{14}	0.518	0.445	0.244	0.668	0.489	0.172	1.309	0.512	0.011
X_{15}	0.306	0.267	0.252	0.161	0.284	0.569	0.225	0.301	0.456
X_{16}	0.908	0.287	0.002	0.595	0.297	0.045	0.510	0.312	0.102
X_{17}	−0.317	0.173	0.067	−0.134	0.183	0.464	−0.095	0.197	0.628
/cut1	*0.867*	*0.658*		*−0.420*	*0.717*		*−0.616*	*0.766*	
/cut2	*1.215*	*0.658*		*−0.300*	*0.716*		*−0.574*	*0.765*	
/cut3	*2.188*	*0.667*		*0.405*	*0.716*		*−0.075*	*0.765*	
/cut4	*3.034*	*0.677*		*0.746*	*0.716*		*0.241*	*0.765*	

Table 3: Marginal effect estimates (in %) from the ordered logit regression model of factors influencing WTP for safer vegetables.

	Safer cabbage model					Safer ayoyo model					Safer okra model				
	Zero WTP	*n/n* WTP	*n/y* WTP	*y/n* WTP	*y/y* WTP	Zero WTP	*n/n* WTP	*n/y* WTP	*y/n* WTP	*y/y* WTP	Zero WTP	*n/n* WTP	*n/y* WTP	*y/n* WTP	*y/y* WTP
X_1	−0.09	−0.02	−0.04	0.01	0.14	0.61	0.04	0.23	0.06	−0.95	−0.09	0	−0.03	−0.01	0.14
X_2	0.15	0.04	0.08	−0.02	−0.25	0.22	0.02	0.09	0.02	−0.35	0.26	0.01	0.08	0.04	−0.39
X_3	−7.14	−1.58	−3.12	1.1	10.74*	−0.96	−0.07	−0.37	−0.1	1.5	4	0.11	1.27	0.69	−6.08
X_4	−2.75	−0.64	−1.37	0.32	4.45*	−1.22	−0.09	−0.47	−0.13	1.92	−2.67	−0.07	−0.83	−0.44	4.01
X_5	−2.87	−0.64	−1.27	0.45	4.33	−0.48	−0.04	−0.19	−0.05	0.75	7.28	0.21	2.58	1.53	−11.6
X_6	5.03	1.22	2.79	−0.33	−8.71	15.53	1.23	7.04	2.53	−26.33***	15.76	0.45	5.42	3.2	−24.83***
X_7	−0.1	−0.02	−0.05	0.01	0.17	−0.25	−0.02	−0.1	−0.03	0.39*	−0.19	−0.01	−0.06	−0.03	0.29
X_8	−22.86	−4.07	−5.97	4.9	27.99***	−16.45	−1.03	−4.8	−0.88	23.17***	−11.82	−0.29	−3.16	−1.5	16.77**
X_9	−0.34	−0.08	−0.17	0.04	0.56	−5.87	−0.42	−2.12	−0.54	8.94	−12.69	−0.31	−3.43	−1.65	18.08**
X_{10}	10.05	2.36	5.03	−1.16	−16.27**	16.78	1.24	6.53	1.82	−26.37***	17.6	0.48	5.45	2.9	−26.43***
X_{11}	−9.69	−2.27	−4.85	1.12	15.69**	−11.97	−0.88	−4.65	−1.3	18.8**	−14.69	−0.4	−4.55	−2.42	22.05***
X_{12}	1.71	0.4	0.85	−0.2	−2.76	2.72	0.2	1.06	0.3	−4.27	1.61	0.04	0.5	0.26	−2.42
X_{13}	−5.89	−1.38	−2.94	0.68	9.53*	3.18	0.23	1.24	0.35	−4.99	1.25	0.03	0.39	0.21	−1.88
X_{14}	−7.35	−1.72	−3.68	0.85	11.9	−10.45	−0.77	−4.06	−1.13	16.42	−19.85	−0.54	−6.15	−3.27	29.81**
X_{15}	−4.34	−1.02	-2.17	0.5	7.03	−2.52	−0.19	−0.98	−0.27	3.97	−3.41	−0.09	−1.06	−0.56	5.12
X_{16}	−12.87	−3.02	−6.44	1.49	20.83***	−9.31	−0.69	−3.62	−1.01	14.63*	−7.73	−0.21	−2.4	−1.27	11.61
X_{17}	4.49	1.05	2.25	−0.52	−7.27*	2.1	0.15	0.82	0.23	−3.29	1.45	0.04	0.45	0.24	−2.17

Safer cabbage: No. of Obs. = 331, Wald $Chi^2 = 108.39$; Prob > $Chi^2 = 0.0000$; Pseudo $R^2 = 0.11.30$;
Safer ayoyo: No. of Obs. = 331, Wald $Chi^2 = 67.12$; Prob > $Chi^2 = 0.0000$; Pseudo $R^2 = 0.086$;
Safer okra: No. of Obs. = 331, Wald $Chi^2 = 71.07$; Prob > $Chi^2 = 0.0000$; Pseudo $R^2 = 0.104$;
n/n WTP, *n/y* WTP, *y/n* WTP and *y/y* WTP stand for no-no, no-yes, yes-no and yes-yes willingness to pay bidders;
***; ** and* indicate significance levels at 1% 5% and 10%.

who care about the misuse of agrochemicals for pest control in vegetable production are likely to pay premium price for only safer okra but not cabbage and ayoyo. This result is quite unexpected but not impossible. Under normal circumstances, pesticides are used less in okra, compared to ayoyo and cabbage, since insects do not attack the fruits of okra but the leaves. However, with cabbage and ayoyo, the leaves are the edible parts; hence, consumers will be concerned if farmers tend to use more agrochemicals for cultivating okra.

Farmers and traders are key actors in relation to the production and distribution of safer vegetables. Therefore, it was important to understand how trust in these actors could affect consumers' WTP. The results reveal that trust is indeed a key determinant of WTP premium prices for safer cabbage, ayoyo and okra. Contrastingly, trust in farmers was significant with negative effect while trust in retailers had significant positive effects on WTP price premiums for all three vegetables. Thus, higher consumer trust in farmers reduces the probability of willingness to pay for safer vegetables, while higher trust in traders increases the probability. It is possible that consumers with high trust in retailers have more confidence in traders and expect them to provide credible information as opposed to information provided by farmers. Such confidence may translate into higher WTP than if farmers supplied the vegetable, all other things being equal. Certainly, confident consumers may turn to invest less effort to protect themselves against risks (Roosen et al. 2015) because of their positive perceptions about the vegetable chain actors. On the contrary, Chen (2013) found that trust in retailers is positively related to food safety perceptions, which, in turn, is negatively related to WTP.

We were also interested in perception factors, because perceptions play important roles in preferences. Consumers who perceived that safer vegetables are environmentally friendly were marginally willing to pay premium price for only cabbage but not ayoyo and okra. Those who perceived safer vegetables to be good for human health were only willing to pay premium price for safer okra. Consumers who perceived that safer vegetables are associated with lower health risks were more likely to pay premium prices for safer cabbage and ayoyo but not okra.

The above results present some interesting discussion points. First, many of the sampled consumers appear to be familiar with food safety in general. Due to this, they tend to consider possible sources of vegetable contamination, such as use of agrochemicals and untreated wastewater in vegetable production. Consumers who care about these vegetable safety parameters are ready to bear extra costs to obtain safer products. Furthermore, consumers tend to trust traders more than farmers to provide reliable information on safer vegetables. Due to this, as trust in traders increases, consumers are willing to pay premium prices for safer vegetables. Thus, if safer vegetable markets were to be established, it would require traders to be trustworthy with information provision.

Second, whether perceptions would affect consumers' WTP pay premium prices or not depend on the product under elicitation. Different products have different credence and sensory attributes. Therefore, if consumers perceive that they can easily detect the safety attributes of the vegetable, WTP premium prices seem to be low, but if consumers perceive that credence and sensory attributes of the vegetable are quite difficult to detect, they are willing to pay premium prices for safer vegetables. So, comparing the exotic vegetable (cabbage) to the local ones (ayoyo and okra), consumers might perceive that in terms of risk, local vegetables pose less health risks to because they are more adapted to the environment and might not involve heavy use of agrochemicals and irrigation wastewater, other things being equal. On the other hand, cabbage is very susceptible to insect attacks, and requires intensive production practices to generate optimum yields. Therefore, consumers perceive that safer cabbage will be associated with lower health risks than the conventional vegetables. This might explain their differentiated WTP premium prices for cabbage compared with ayoyo and okra.

Conclusion

In this paper, the objective was to understand whether consumers in Tamale are willing to pay premium prices for safer vegetables and to identify the corresponding factors that influence WTP. We first calculated mean WTP for three different vegetables (cabbage, ayoyo and okra), and found that the premiums are high enough (more than 120%) to cover the additional costs of implementing safer methods (for instance, wastewater treatment measures) of vegetable cultivation. Consumers perceive that safer vegetables are less risky, healthier, tastier, and environmentally friendlier than conventionally produced vegetables. These perceptions influence their preferences and actual purchasing decisions on safer vegetables. In addition, having a source of income through employment, caring about the use of untreated wastewater and agrochemicals misuse have significant effects on WTP for safer vegetables. The findings show that WTP premium prices depend on factors that are specific to perceptions about the vegetable under consideration. For vegetables of an exotic nature (e.g., cabbage), risk perceptions matter a lot, but is not important for local traditional vegetables. The significance of these findings is that consumers care about their health and are ready to part ways with extra money in order to secure their health by paying premium prices. Investors could benefit if they should start businesses that aim to provide safer vegetables in the Tamale metropolis. Policymakers and development partners could also assist vegetable farmers in the provision of adequate, constant flow of treated water and good knowledge in the use of agrochemicals to reduce health risks.

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