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Food Values Applied to *Moringa oleifera*: A Case Study in Niger

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Abstract: The objective of this paper is to determine food values as applied to leafy vegetables such as *Moringa oleifera* and to specifically determine how climate change and food security information influence food values using recent advances in best worst scaling. Based on previous research related food values and focus group with consumers and resourceful persons, thirteen food values were identified and included in this study. Data were collected from 174 respondents randomly selected and interviewed in both rural and urban locations. Results suggest that food values such as veganism, nutrition, aesthetic object and social good when applied to *Moringa oleifera* are among the more important to consumers; while medicine, culture and object of hunger and desire were among the least important to consumers. Our findings further revealed that food values such nutrition is the most important when climate change information is provided to consumers, while technology and culture are the least important food values. Finally, food values such veganism, aesthetic object and nutrition are the most important, whereas food values such as culture is the least important when food security information is provided to consumers.

Keywords: Food Values, *Moringa oleifera*, Climate Change, Food Security, Information

1. Introduction

Measuring what matters in food is essential to developing action plans reflecting the concerns of a country. This implies that food can be viewed not simply as a commodity, but also a human right, a part of our culture and history and as well as a means of building community. Human welfare can be greatly improved when decision-making processes are based on historical, social, economic, political and cultural awareness. Thus, food activists, political leaders, researchers, food scientists and philosophers have recently mobilized by dedicating their effort, time and research programs to better design strategies aims at combating food insecurity and mitigating climate change that factors affecting producers and consumers decisions related to massive production and evaluating the value chain as known as miracle tree due its multiple uses. The benefits of Moringa to human, livestock, and environment can no longer be denied and the international community should take the leadership to organize globally and locally resources and to channel them towards tackling the battle against poverty, malnutrition, climate change and water-borne disease.

Firstly, food movement activists are acting locally and globally to fight hunger and malnutrition via food aid and donation and community based projects. Thus, in 2015, for the first time, the Food Movement decided to support both a local group (Chicago) and a group working globally to stop famine in Africa and other important locations using Moringa known as tree of life and because of its reputation as a high source of vitamins and minerals. Recent studies have indicated that Moringa can be considered a solution for fighting malnutrition and soil degradation, generating income, treating unclean water, and treating a variety of illnesses

[8]. Though Moringa production is limited in Tahoua State, the Faculty of Agricultural Sciences at Tahoua University has recently introduced Moringa seedling production, which will be largely propagated across the State and beyond. According to Tabbo and Amadou, the introduction of *Moringa oleifera* in semi-arid zone is not only an excellent climate change adaptation strategy, but also a means to generating income as well as to restoring

degraded ecosystems [17].

Secondly, political leaders are also concerned about food security by stating that food security is better than military security for a given nation. Thus, former Cuban leader, Fidel. Food scientists strongly believe that Moringa plant possessing unique nutritional qualities can hold promise to millions of food insecure communities being in need of dietary supplements like protein, minerals and vitamins. The development practitioner says that Moringa largely known as a poor man's crop and rich man's food is a better candidate not only to fight malnutrition under the threat of climate change, but also an excellent fortification agent are factors to be considered. He also added that the promotion of this important shrub must first be done through an assessment of consumer perceptions and preferences, levels of knowledge and information [5].

Thirdly, numerous scientific studies conducted by researchers have indicated that Moringa oleifera is not only a drought tolerant, fast growing and multiple purposes tree due to its nutritional and medicinal properties in the world, but it is also the most promising tree used for environmental conservation, water purification, human consumption, fuel, soil and water conservation, livestock forage, climate change mitigation strategies and fertilizer ([1, 2, 6]). Researchers in various countries across the world have unanimously concluded that all parts of *Moringa oleifera* ranging from leaves, fruits, immature pods, and flowers to seeds are combined into food for human consumption. They have further documented that nutritional and natural products characterization derived from Moringa's leaves can contribute significantly to daily food requirement needed for many vitamins and minerals needs as well as rich source of polyphenols (micronutrients with antioxidant properties), thereby confirming the important role that Moringa can play to improve health and nutrition specifically in malnourished population ([1, 2, 6]).

Fourthly, food scientists have also highlighted that *Moringa oleifera* is of great important for human and livestock nutrition due its rich source of macro and micro nutrients. They have also concluded that seed powder, leaf powder and flower from *Moringa oleifera* can be applied in numerous food fortification such as amala (stiff dough), ogi (maize gruel), bread, biscuits, yoghurt, cheese and in making soups [17]. A team of researchers in India have also investigated the nutritive importance and medicinal application of Moringa. Hence, they have concluded that Moringa leaves containing minerals and vitamins can be used in treating malnutrition, increasing breast milk in lactating mothers and providing a potential candidate for antioxidant, anticancer, anti-inflammatory and antimicrobial agent; while Moringa seed is an excellent natural coagulant used for water purification as well as an excellent fortification agent for food used in commercial products [8]. According to Fahey, *Moringa oleifera* due to its nutrient-dense leaves with high quality protein, is increasingly used by doctors, healers, nutritionists and community leaders for nutritional supplement to treat under nutrition and a variety of diseases [7]. Another study by has investigated how Moringa can be used as natural food additives in the application and development of functional food products. They have suggested that Moringa is one of the most prominent candidates capable of improving quality and the safety of various livestock foods such as meat, milk, eggs and fish products in a world largely dominated by chemical additives which adversely affect human and animal health [7].

Fifthly, philosophers have also historically analyzed food by focusing on its metaphysic dimensions. Thus, Platon famously explained in his book II titled the Republic what an appropriate diet should be. Others philosophers such Epicurus and Seneca, as well as enlightenment philosophers such as Locke, Rousseau, Voltaire, Marx, and Nietzsche, all have discussed various aspects of food production and consumption. In the twentieth century, philosophers discussed on food issues such as vegetarianism, agricultural ethics, food rights, biotechnology, and gustatory aesthetics; while in the twenty century philosophers have addressed food issues as related to globalization, technology and consumers and producers' right and responsibility. Aristotle also pointed out that the link between food (animal and plants) and human is highly metaphysics. Aristotle further assumed that human having a rational soul, while animals and plants having respectively a sensitive and vegetative souls, have developed a ways of communicating via food. The role of philosophy is to ask some basic questions about food: what is food? How do we know it is food? What should we eat? How should food be distributed? What is good food? Are you what you eat? These questions are difficult to answer because they involve philosophical questions about metaphysics, epistemology, ethics, politics, aesthetics and identity. Food metaphysics is a vague concept to determine what food is. The answer to this question suggests that the nature of food is not clear and no consensus is found among philosophers about the nature of food. However, food such as nutrition, nature, culture, social good, spirituality, object of hunger and desire, aesthetic object, diet, fuel, commodity, veganism, technology and medicine have been unanimously proposed by philosophers to understand food metaphysics. We believe that above any philosophy of food, the welfare of people should be considered. Several studies have investigated the importance of food values as applied to animal food product such ground beef, beef steak, chicken breast, eggs and milk [3, 10], but little research is geared towards evaluating food values as applied to leafy vegetables such as *Moringa oleifera* and this research will contribute to fill this knowledge gap.

In Niger, previous research has indicated that *Moringa oleifera* is the most widely produced, harvested, consumed and commercialized leafy vegetables due to its multiple benefits for rural and urban households. Because of the presence of high amount vitamins and mineral elements, leafy vegetables are very important protective food and useful for the maintenance of health, the prevention and the stabilization of diseases. Determining and understanding values consumers place on food related to Moringa is

important to formulate and guide food consumption and marketing policy strategies, thereby to increase farmers' income, to help building resilience against negative externalities of climate change and to augment their food security as well as to enhance their welfare. However, there is no actualized data available on food values as related to Moringa so as to guide food policy makers on how to make informed decisions. Food values applied to livestock products have been well documented in the academic literature, but little is relatively known for food values applied to leafy vegetables such as Moringa. This study will contribute to enhance the literature related to food values in general and food values applied to leafy vegetables in particular.

The objective of the research reported in this paper is to evaluate consumers' preferences' for food values applied to Moringa oleifera. Specific objectives of this research include determine relative importance of food values as applied to Moringa, to examine food value policy for leafy vegetables such Moringa and to assess the influence of climate change and food security information on food values.

2. Background on Best Worst Scaling (BWS)

As suggested in the previous literature, the rating and the best worst scaling are the most popular used approaches to determine the importance of the thirteen food values. In the former, respondents would be asked to generally rate the thirteen food values on a scale from 1 to 5 (where 1=least preferred and 5=most preferred) or 1 to 7 or 1 to 11 depend on studies. According to Lee et al, the rating is simple to administer and easy to answer, but this approach has some weaknesses, namely respondents could rate all thirteen food values as most preferred (or least preferred); therefore no trade-offs can be made amongst food values [9]. Furthermore, there is no guarantee that scale will be uniformly interpreted by all respondents [12, 13]. The best-worst scaling (BWS) approach introduced by [14] has been proposed as an alternative to rating system. This approach also forces respondents to discriminate amongst food values.

BWS can be method of data collection as well as a theory of how respondents provide most and least ranked items from a set. Marley and Louvriere were first to show that BWS is a theory explaining the process individual follows in providing best worst data [13]. Marley and Flynn have introduced sequential and maximum difference models of best worst data. The former assumes that a particular order is maintained by the individual in providing best and worst in while the latter is a well-established model assuming a simultaneous choice of that pair of items maximizing the difference between them on a latent scale [14].

Louviere has developed three cases of BWS based on the nature and complexity of goods and services evaluated. The first case also called the object case is appropriate when the researcher is interested in the relative importance associated with each a list of objects. The second case called profile case is most familiar in health sector, while the third case called multiple profile case is the most accessible to discrete choice experiment. By following Louviere, stating that many models of choice particularly those involving BWS are based on extensions of the multinomial logit (MNL). We assume that a sample of N consumers with repeated BWS choices. The difference between best options and worst options also called maximum difference is consistent with the random utility theory.

The use of BWS procedure in agricultural economics field has been exploded. Thus, [12] have also developed a simple theoretical framework on how data from best worst scale can be modeled using random parameter model, while [3] and [10] have empirically employed BWS theory to investigate specific food values applied to animal food products. Similarly, the BWS was previously used to investigate what agricultural food policies US Consumer do prefer [4], determine which cultural ecosystem services is more important to japan consumers [8], to study chinese consumers' preferences for food traceability information [11], to evaluate improved cowpea variety attributes [16], to identify the fresh vegetables attribute preference among the quality conscious consumers in the selected areas of Bangladesh [18], to assess which sustainable development goals and eco-challenges matter most to Niger farmers and herdsmen [19] and to elicit the most important domains of health for health-related quality of life in Singapore [21].

3. Experimental Design

Based on previous studies related to food values, interviews with consumers and resourceful persons, 13 food values have been compiled and included in this study. The questionnaire used in the data collection was designed with R statistical package which helps to generate 13 blocks having each four food values randomly assigned, thereby maintaining the equal probability principle. For each block or question, respondents were asked to choose his/her best and worst food values. The survey was conducted in Tahoua city considered as urban area as well as in some selected rural villages as a way to increase the diversity of our sample size. The sample was further diversified by providing food security and climate change information to respondents. In total, 174 respondents were randomly selected and interviewed in person

To determine the relative importance that consumers place on these policies, a BWS experiment was designed [14]. A balanced incomplete block design (BIBD) developed by [13, 14] has been used to determine allocation of the 13 policies for each BW question. The resulted design contains 13 BWS questions, each having four policy options. The BIBD is the most widely used design in the BWS literature because it is not only a balanced design, but also an orthogonal design [14].

In total, we have 13 BWS questions having each four food value policies and each respondent was asked to choose his

best and his worst food value policies, thereby maintaining equal probability principal. Figure 1 listed below presents an example of the best-worst questions used in the study.

Which of the following items are the best and the worst to you when you purchase moringa?

Best	Items	Worst
✓	**Moringa as Nutrition** (Any substance or material originating in the environment (plants, animals, or water) providing nourishment via nutrients such as carbohydrates, fats, fibers, protein, vitamins, and minerals to an organism)	
	Moringa as Nature (Perceived to have intrinsic value distinct from its instrumental value satisfying human ends. In this sense, food not only comes from nature but it is good when it does and bad when it does not)	✓
	Moringa as Diet (How food connects with a lifestyle and often a tradition)	
	Moringa as Medicine (The extent to which food can treat or correct certain diseases)	

Figure 1. *Best-worst scaling question sample used in the survey.*

4. Data Analysis

The BWS approach assumes that respondents simultaneously make repeated choices by choosing the best and worst items in a given set and thereby maximizing the difference [13]. By denoting J as number of items in each BWS question (4 food value policies), then J (J-1) best-worst pairs of best worst choices are possible.

By following this approach, our data were analyzed using random utility framework which is well-rooted in microeconomics theory [17], whereby a given respondent n derives from the selected best-worst pairs in each BWS question t is the difference in utility between the j best and k worst policies.

This can be mathematically written as follows:

$$U_{njt} = \beta_{jt} - \beta_{kt} + \varepsilon_{njt} \quad (1)$$

Where μ is the vector of estimated importance parameters of the best and worst food value policies (j and k respectively) relative to some policy normalized to zero for identification purpose.

The probability that respondents choose item j as best and k as worst out of J items in BWS question t is the probability that the difference in utility of the chosen items (β_{njt} and β_{nkt}) is greater than all other J (J-1)-1 possible differences within each BWS question [12]. While several econometric methods can be used to model this behavior, mixed logit is the most widely used estimation procedure because it is flexible and can approximate any random utility model [20].

The mixed logit model and the probability that an individual n chooses j as best and k as worst can be mathematically expressed as follows:

$$P_{nj} = \int \beta \prod_{t=1}^{T} \frac{e^{[\beta_{njt} - \beta_{nkt}]}}{\sum_{l=1}^{J} \sum_{m=1}^{J} e^{[\beta_{nlt} - \beta_{nmt}]-J}} f(\beta_n | \Omega) d\beta_n \quad (2)$$

Where $f(\beta_n|\Omega)$ is the density of the importance parameters β_n and Ω is the variance-covariance matrix of the vector of random parameters.

Furthermore, the variance-covariance matrix can be specified as follows:

$$\Omega_{ij} = \overline{\delta_j} + \sigma_j \beta_{ij} \quad (3)$$

Where Ω_{ij} is the importance parameter for consumer i and food values j, $\overline{\delta_j}$ and σ_j are mean and standard deviation for δ_j in the population, and β_i is random term randomly distributed with mean zero and unit standard deviation. It is important to highlight that results obtained from mixed logit generally report mean and scale parameters and the following formula was used to calculate the standard deviation:

$$\sigma_j^2 = \frac{\pi^2}{6\lambda_j^2} \quad (4)$$

Where σ_j and λ_j are the standard deviation and the scale factor respectively. The standard deviation and the scale factor are inversely related.

Finally, by following [12], we calculated share of preference of each value for estimated models.

The preference share is the estimated probability that each value is picked as most important: Share of Preference for value j can be mathematically expressed as follows:

$$\varphi_j = \frac{e^{\beta_j}}{\sum_{k=1}^{j} e^{\beta_k}} \quad (5)$$

Where φ_j is the share of preference for a given food value policy

The shares of preference must sum to one across all thirteen values in our application. Equation (5) calculates the importance of value j on a ratio scale, indicating that if one value has a share twice that of another value, the former value is twice as preferred as the latter. The share of preference conveys the probability that a value is picked as more important than another. Thus, the calculated share of preference for a value reflects both the importance and relative un-certainty of importance respondents place on the value.

5. Results and Discussions

This section summarizes in Tables forms results obtained from data analysis. Tables 2 through 4 respectively report socioeconomic statistics of surveyed respondents, the food value utility estimates based on mixed logit or random parameter model, influence of food security and climate change information on food value estimates and the influence of food security and climate change combined information on food value estimates.

Table 2 reports the socioeconomic statistics of surveyed respondents. As can be seen in Table 2, most of the respondents were male (82.2%) and were married (92.5%) and were uneducated (85.1%). They had an average age of 40 years and with average monthly income 49 000 FCFA. Most of the respondents also reported they had food security information (70.1%) and climate change information (58.6%) with 55.7% having a family size less or than equal to 7.

Table 1. *Food Values Applied to Leafy Vegetables.*

No	Food Values Applied to Moringa	Characteristics/Descriptions
1	Moringa as nutrition	Any substance or material originating in the environment (plants, animals, or water) providing nourishment via nutrients such as carbohydrates, fats, fibers, protein, vitamins, and minerals to an organism.
2	Moringa as nature	Perceived to have intrinsic value distinct from its instrumental value satisfying human ends. In this sense, food not only comes from nature but it is good when it does and bad when it does not.
3	Moringa as culture	Each society determines what food is, what is permissible to eat, and how and when particular things are consumed.
4	Moringa as social good	Goods can be used, allocated, and exchanged in a way that is consistent with the meanings societies give to it
5	Moringa as spirituality	Religion prescribing which foods should be eaten and which should be avoided. This spiritual dimension of food connects us to religious communities and to the supernatural when consumed appropriately.
6	Moringa as object of hunger and desire	A "food craving" is a desire to eat a specific food generated by something other than hunger, such as a memory, psychological motivation, or pregnancy
7	Moringa as aesthetic object	How food appeals to the senses as well as its visual presentation and sensual composition.
8	Moringa as diet	How food connects with a lifestyle and often a tradition.
9	Moringa as fuel	The extent to which food can be used in energy-production
10	Moringa as commodity	An economic good with value relative to the market
11	Moringa as veganism	No animal flesh or animal products
12	Moringa as technology	The extent to which food can be manufactured and processed in social reality, more akin to a drug than to nature
13	Moringa as medicine	The extent to which food can treat or correct certain diseases

Source: Adopted from the philosophy food by David M. Kaplan (Berkeley: University of California Press, 2012).

Table 2. *Socioeconomics characteristics of surveyed respondents.*

Variables	Definition	Mean	Standard deviation
Age	Age in years	40	15
Gender	1 if male, 0 if female	0.822	0.384
Marital status	1 if married, 0 otherwise	0.925	0.797
Education	1 if uneducated, 0 otherwise	0.851	0.580
Income	Monthly income in 1000	49.000	39.300
Food security information	1 if yes, 0 if no	0.701	0.459
Climate change information	1 if yes, 0 if no	0.586	0.494
Family Size	1 if size <= 7, 0 if otherwise	0.557	0.498

Table 3 reports food value utility estimates based on multinomial mixed logit across rural and urban areas. Results from likelihood ratio indicated that parameters were not homogeneous across location, indicating that food values are differently evaluated based on consumer's location. Therefore, results from both locations were reported. As shown in Table 3, coefficients with positive signs are more important, while coefficients with negative signs are discounted. Regardless of location, veganism followed by nutrition, aesthetic object and social good were positive and significant, implying that these food values are the most appreciated. However, food values such as medicine, culture and object of hunger and desire were negative and significant, indicating they are less appreciated in the study area. Table 3 also reports standard deviations of food values. As revealed in Table 3 and regardless of location, standard deviations for veganism, nutrition, aesthetic object, nature, spirituality, technology, culture and object of hunger and desire are significant, revealing that these food values do vary in the surveyed population. The mean and standard deviation can also be used to estimate market share for each food value related to Moringa. For instance, the mean and standard deviation for veganism are 0.938 and 0.977 respectively. The ratio of the mean by standard deviation is assumed to follow normal distribution. Results show that veganism is preferred by 83% of consumers, while veganism is avoided by 17% of consumers. These results are consistent with studies conducted by and Lister et al and Lusk and Briggeman [10, 12].

Table 3. *Food value utility estimates based on multinomial mixed logit across rural and urban areas.*

Food Values	Pooled		Rural		Urban	
	Mean	PS	Mean	PS	Mean	PS
Veganism	0.938* (0.141)	16.46%	1.076* (0.271)	17.39%	0.986* (0.216)	17.00%
Nutrition	0.711* (0.142)	13.12%	0.889* (0.264)	14.43%	0.736* (0.213)	13.24%
Aesthetic object	0.671* (0.150)	12.60%	0.765* (0.253)	12.74%	0.725* (0.232)	13.09%
Social good	0.554* (0.124)	11.21%	0.532* (0.206)	10.10%	0.676* (0.194)	12.47%
Nature	0.091 (0.127)	7.06%	0.179 (0.224)	7.09%	0.219 (0.189)	7.89%
Fuel	0.087 (0.128)	7.03%	0.158 (0.205)	6.95%	0.073 (0.185)	6.82%
Commodity	0.031 (0.128)	6.65%	0.114 (0.208)	6.65%	-0.038 (0.186)	6.10%
Diet	-0.011 (0.128)	6.37%	0.105 (0.207)	6.59%	-0.111 (0.186)	5.68%
Spirituality	-0.068 (0.133)	6.02%	-0.039 (0.198)	5.70%	-0.280 (0.191)	4.79%
Technology	-0.224 (0.161)	5.15%	-0.088 (0.250)	5.43%	-0.333 (0.238)	4.55%
Medicine	-0.464* (0.167)	4.05%	-0.599* (0.269)	3.26%	-0.394* (0.254)	4.28%
Culture	-0.918* (0.132)	2.57%	-1.111* (0.242)	1.95%	-0.863* (0.198)	2.68%
Object of hunger and desire	-1.325* (0.224)	1.71%	-1.235* (0.390)	1.72%	-1.496* (0.349)	1.42%
Standard deviation estimates (SD)						
Veganism	0.977* (0.233)		0.028* (0.419)		1.206* (0.353)	
Nutrition	1.028* (0.231)		2.978* (0.423)		1.007* (0.401)	
Aesthetic object	2.524* (0.221)		1.789* (0.480)		2.887* (0.415)	
Social good	0.940* (0.228)		1.105 (0.421)		1.379* (0.344)	
Nature	1.105* (0.201)		1.104* (0.42)		1.469* (0.328)	
Fuel	0.067 (0.608)		0.940 (0.456)		0.395 (0.545)	
Commodity	0.055 (0.544)		3.079 (0.469)		0.702 (0.405)	
Diet	0.427 (0.372)		2.489 (0.532)		0.802 (0.410	
Spirituality	1.789* (0.195)		0.172* (0.403)		1.854* (0.345)	
Technology	2.978* (0.232)		0.021* (0.481)		3.385* (0.435)	
Medicine	2.465* (0.242)		0.352* (0.490)		2.896* (0.429)	
Culture	1.104* (0.223)		0.888* (0.430)		1.339* (0.337)	
Object of hunger and desire	2.530* (0.309)		2.343* (0.653)		2.290* (0.478)	
N	174		87		92	
Log-likelihood at convergence	-5254		-2629		-2774	

One asterisk signifies statistical significance at 0.05 level or lower. Numbers in parentheses are standard errors, while SD stands for standard deviations. PS stands for preference shares.

Table 4 reports food value utility estimates and share of preferences based on mixed logit model on food values when food security and climate change information were provided to farmers. Results from likelihood ration tests indicate that parameters are heterogeneous with information, implying that food values are differently valued in the presence and the absence of information. As shown in Table 4, for respondents provided with food security information positively and significantly valued nutrition, while they negatively and significantly valued technology and culture as food values as applied to leafy vegetable. Similarly, respondents provided with climate change information significantly and positively valued veganism, aesthetic object and nutrition. Table 4 also reports standard deviations for each food values after climate change and food security were considered as treatments. Results showed that standard deviations of nutrition, spirituality, nature, technology and culture are significant when food security information is provided, while veganism, aesthetic object, social good, nature, spirituality, technology and object of hunger and desire vary randomly among consumers provided with climate change information. Standard deviations for social good, medicine and fuel do not vary in the population when respondents are provided with climate change information; however, standard deviations of aesthetic object, social good, spirituality, diet, technology and object of hunger and desire for consumers without climate information vary in the population. These results are in line with and [10] who investigated specific food values as applied to livestock [12] who studied general food values and they found that food values such nutrition was the most important.

Table 4. *Influence of Climate Change and Food Security Information on Food Values.*

Food Values	Climate change Information		Food security information	
	Mean	PS	Mean	PS
Veganism	0.801 (0.167)	17.53%	1.073* (0.231)	17.83%
Aesthetic object	0.643 (0.190)	14.97%	0.873* (0.253)	14.60%
Nutrition	0.477* (0.170)	12.68%	0.821* (0.224	13.86%

Food Values	Climate change Information		Food security information	
	Mean	PS	Mean	PS
Social good	0.381 (0.151)	11.52%	0.743 (0.199)	12.82%
Spirituality	-0.082 (0.166)	7.25%	0.085 (0.195)	6.64%
Nature	-0.116 (0.157)	7.01%	0.037 (0.198)	6.33%
Diet	-0.261 (0.156)	6.06%	0.001 (0.194)	6.10%
Commodity	-0.264 (0.157)	6.04%	-0.074 (0.199)	5.66%
Fuel	-0.375 (0.160)	5.41%	-0.111 (0.217)	5.46%
Technology	-0.427* (0.213)	5.13%	-0.223 (0.246)	4.88%
Medicine	-1.002 (0.236)	2.89%	-0.784 (0.271)	2.78%
Culture	-1.238* (0.181)	2.28%	-1.176* (0.215)	1.88%
Object of hunger and desire	-1.844 (0.299)	1.24%	-1.655 (0.381)	1.17%
Standard deviation estimates (SD)				
Veganism	0.932 (0.293)		1.337* (0.328)	
Aesthetic object	2.929 (0.312)		0.215* (0.413)	
Nutrition	0.993* (0.298)		1.523* (0.344)	
Social good	0.743 (0.338)		1.848 (0.330)	
Spirituality	1.864* (0.259)		1.424* (0.303)	
Nature	1.292* (0.255)		2.565* (0.365)	
Diet	0.275 (0.564)		0.351* (0.916)	
Commodity	0.435 (0.411)		3.223* (0.350)	
Fuel	0.200 (0.647)		0.395 (0.347)	
Technology	3.495* (0.338)		0.216* (0.409)	
Medicine	3.065 (0.355)		0.268 (0.419)	
Culture	1.299* (0.282)		1.167* (0.328)	
Object of hunger and desire	2.509 (0.392)		0.223* (0.533)	
N	121		102	
Log-likelihood at convergence	-3645		-3047	

One asterisk signifies statistical significance at 0.05 level or lower. Numbers in parentheses are standard errors, while SD stands for standard deviations. PS stands for preference shares.

Table 5 reports the intention to vote for or against for each food value policy implementation. The estimated mean and standard deviations of these coefficients provide information on the share of the respondent placing a positive value on food value attribute and the share placing a negative value. Results indicate that 90% of respondents would vote for the implementation of policies such fuel, veganism (83%), nutrition (76%), social good (72%), commodity (71%), aesthetic object (60%) and nature (53%). Results also reveal that 100% of rural farmers would vote in favor for the implementation of policies such as veganism, social good (68%), aesthetic object (67%), nutrition (62%), fuel (57%), diet (52%) and commodity (51%). Similarly, 79% of urban respondents would vote for the implementation of policies such as veganism, nutrition (77%), social good (69%), aesthetic object (60%), fuel (57%) and nature (56%). Technology (0%) and Medicine (4%) had the lowest share amongst rural respondents, while culture (26%) and object of hunger and desire (26%) had the lowest share amongst urban respondents. This implies that rural consumers valued significantly food values such veganism, aesthetic object, nature and diet, while urban consumers valued significantly food values such as nutrition and nature. Food value policy voting implementation results reveal that rural and urban respondent's estimates greatly vary

Table 5. *Consumers' Vote for Food Value Policy Implementation across Location.*

Food Value Policy	Aggregate		Rural		Urban	
	Vote for implementation	Vote against Implementation	Vote for implementation	Vote against implementation	Vote for implementation	Vote against Implementation
Veganism	83%	17%	100%	0%	79%	21%
Nutrition	76%	24%	62%	38%	77%	23%
Aesthetic object	60%	40%	67%	33%	60%	40%
Social good	72%	28%	68%	32%	69%	31%
Nature	53%	47%	56%	44%	56%	44%
Fuel	90%	10%	57%	43%	57%	43%
Commodity	71%	29%	51%	49%	48%	52%
Diet	49%	51%	52%	48%	44%	56%
Spirituality	48%	52%	41%	59%	44%	56%
Technology	47%	53%	0%	100%	46%	54%

Food Value Policy	Aggregate		Rural		Urban	
	Vote for implementation	Vote against Implementation	Vote for implementation	Vote against implementation	Vote for implementation	Vote against Implementation
Medicine	43%	57%	4%	96%	45%	55%
Culture	20%	80%	11%	89%	26%	74%
Object of hunger and desire	30%	70%	30%	70%	26%	74%

6. Conclusion and Policy Implications

The objective of this research is to determine food values as applied to leafy vegetables and the influence of food security and climate change information on food values. Based on previous research related to food, a list of thirteen food values was compiled and included in this research. While data were collected via a questionnaire generated by a balanced incomplete block design, mixed logit was used in the modeling. The model estimates were used to estimate food values across location, influence of food security and climate change information and their respective shares of preferences as well as food value policy implementation.

Results suggested that food values such as veganism, nutrition, aesthetic object and social good were the most important to consumers on average; however results show a significant heterogeneity across location and food security and climate change information. Results also indicate that nutrition is the most important food values, while veganism, social good, nature, commodity and fuel were the most preferred food values. Results indicate that food values such as nutrition is the most important, while technology and culture were the least important food values when food security information was provided to consumers. Results also show that veganism, aesthetic object and nutrition were the most important food values for consumers when they are provided with climate change information; while culture is the least appreciated food values. We also found that rural consumers voting behavior for food values such as veganism, aesthetic object and nature were the most important, while for urban consumers voting behavior for food values such as nutrition and nature were the most appreciated.

This study summarizes the importance of food values as applied to leafy vegetables such *Moringa oleifera.* These findings provide useful information to implement strategies aims at increasing rural households' resilience against food insecurity and climate change challenges and thereby ensuring sustainable development by restoring degraded ecosystems. These findings will also provide a marketing strategy guide for farmers, processors and marketers to increase their market share and thereby increase their income and welfare. Limitations of this research include considering only consumers in semi-arid zone and focusing in a single leafy vegetable, which might limit our generalization. Another limitation is that food values as applied to livestock products are quite different to food values applied to leafy vegetable, making the comparison across products a challenge. Future direction of research is to study food values applied to Moringa overtime as well as the value chain of Moringa. Another direction of study is to compare food values applied to leafy vegetable with food values applied to livestock products by using a robust meta-analysis.

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