Are U.S. consumers willing to pay a premium for bee-friendly beef?

Elizabeth Mubanga Chishimba-Musonda, Department of Agricultural and Applied Economics, Virginia Tech, emchishimba1@vt.edu

Catherine Larochelle, Department of Agricultural and Applied Economics, Virginia Tech, claroche@vt.edu

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ABSTRACT

The loss in biodiversity has resulted in a decline in bee populations which threatens our food production systems due to the reliance of wild plants and agricultural crops on bee pollination services. Thus, the restoration of pollinator habitats calls for concerted efforts from all actors, including producers, retailers and consumers. This study examines consumer willingness to pay for bee-friendly beef using data from a nationwide choice experiment survey of 2,162 U.S. beef consumers. Using a fully correlated mixed logit regression we show that U.S. beef consumers prefer bee-friendly ground beef compared to conventional ground beef and are willing to pay $1.06 - $2.36 more per pound for bee-friendly ground beef. The willingness to pay value varies depending on whether beef consumers donate or volunteer to an environmental organization, are knowledgeable about pollinator population decline, feel they have a role to play in restoring pollinator populations or if the beef consumer considers the environmental impact of food production when purchasing food. The analysis from this study identifies one incentive that can be used to encourage beef producers to contribute to the restoration of pollinator populations by adopting and maintaining wildflower-enhanced pastures on their ranches.

Keywords: Bee-friendly beef, willingness to pay, choice experiment

1 Introduction

Pollinators play a crucial role in agriculture. About 75 percent of food crops rely, to some extent, on animal pollination. Most of the wild plants and agricultural crops are primarily pollinated by wild and managed bees (Potts et al., 2010). Pollination services provide direct support to 5-8 percent of current global crop production with an annual market value of $235-$577 billion[1] (IPBES, 2016). In the U.S., more than 100 food crops grown, including fruits and grain crops, depend on pollinators and it is estimated that $18 billion of the added revenue to crop production is from pollinators (USDA, 2020). Furthermore, the economic dependence of U.S. crops on insect-mediated pollination services was estimated at 34 billion USD in 2012 (Jordan, Patch, Grozinger, & Khanna, 2021). Crop pollinators include honeybees, native bees, butterflies, beetles, moths, and more. Bees are the most efficient pollinators. In the U.S, there are about 3,600 native bee species.

However, insect pollinators, in particular bees, have been declining, threatening our food production systems (Klein et al., 2007; Potts et al., 2010). Between 1947 and 2005, the number of managed honeybee hives declined by approximately 59% in the U.S. (Goulson, Nicholls, Botías, & Rotheray, 2015; Kluser S. & Peduzzi P., 2007). Causes of pollinator decline include land use change, increasing agricultural intensification, climate change, alien plant species, pathogens, and pesticides (Vanbergen et al., 2013).

One approach to restore pollinators is by creating essential habitats that provide nesting, water, and food sources for pollinators. Landowners can create essential habitats by planting wildflowers in field borders or on fallow land. In beef production, creating essential habitats

[1] Adjusted to 2015 USD taking into account inflation only

could be achieved by integrating native wildflowers into traditional grazing systems. Grazing systems are currently dominated by non-native cool season grasses such as tall fescue. In the Southeastern United States, tall fescue forms the foundation for beef cattle production as the primary pasture and hay forage across the fescue belt which supports about 40 percent of the calf-cow operations in the U.S (USDA-NASS, 2018 as cited in Boyer et al. 2020). However, this type of grazing systems does not help conserve pollinators. Integrating wildflowers into grazing pastures increases the biodiversity of grazing systems (Chamberlain, Paine, Harrison, & Jackson, 2012) and improves the attractiveness of the pasture to pollinators, including bees. Pollinator populations rebound when provided with essential habitats and protected from threats such as pesticides.

Since establishing and maintaining wildflowers into pasture systems is costly and more management intensive, financial incentives must be created for beef cattle producers to adopt this practice (Tracy, Maughan, Post, & Faulkner, 2010). One incentive could be if beef consumers are willing to pay a higher price for beef products raised on wildflower-enhanced pasture. Through proper certification, labeling, education campaigns on pollinator decline, and willingness of consumers to pay a premium for bee-friendly beef products, cattle producers could recover some of the costs associated with creating essential pollinator habitats. This labeling program would make converting traditional pasture into wildflower-enhanced pasture more appealing to cattle producers and could have a significant impact on restoring pollinator populations.

While there is evidence that consumers are willing to pay a premium for pollinator-friendly ornamental plants (Khachatryan et al., 2017), it is not clear if it would be the case for bee-friendly beef products. Hence, this study contributes to the understanding of whether a new

certification and labelling program could be an effective approach to encourage cattle producers to convert part of their pasture into wildflowers-enhanced pasture. This study addresses the central research questions: Are consumers willing to pay a premium for bee-friendly beef? If so, what is the average willingness to pay? Is there heterogeneity in WTP for bee-friendly beef among consumers?

2 Background

Conserving the biodiversity of agricultural lands increasingly require consented efforts from producers and consumers in order to be sustainable. To this effect, consumers are increasingly showing support for such efforts by expressing their willingness to pay a premium for products that are produced using practices that encourage/contribute to the conservation of the environment and/or ecosystems. For instance, consumers in Vietnam are willing to pay a premium for rice that is environmentally certified -"crane-friendly farming"- which would result in an increase in the number of cranes, a reduction in the use of chemical levels in rice production, and conservation of biodiversity in the Mekong Delta in Vietnam (Khai & Yabe, 2015). In China consumers indicated that they would purchase carbon-labeled milk which would foster low-carbon emissions/development (Zhao, Geng, Liu, Tao, & Xue, 2018). Consumers in Italy are willing to pay for anchovy eco-labels to protect marine habitats (Vitale et al., 2020) while Belgium consumers value sustainably produced free range chicken (Van Loo, Caputo, Nayga, & Verbeke, 2014). In the U.S., consumers are WTP a premium for beer produced with carbon and landfill reduction practices, and water conservation technologies (Staples, Reeling, Widmar, & Lusk, 2020). U.S. consumers are also more likely to purchase and pay a premium for ornamental plants with a pollinator-friendly eco-label compared to plants without the pollinator attribute (Khachatryan et al., 2017).

Research has shown that there are several attributes that consumers consider important when purchasing beef products. Food safety certification is considered an important attribute for beef consumers (Angulo & Gil, 2007; Dickinson & Von Bailey, 2005; Loureiro & Umberger, 2007; Verbeke & Ward, 2006). U.S. consumers rank the USDA food safety inspection certification attribute higher than country of origin labelling, traceability, and tenderness attribute (Loureiro & Umberger, 2007). This result is echoed by Belgium consumers who showed similar preferences (Verbeke & Ward, 2006). Similarly, consumers in Spain are willing to pay a premium for food safety certified beef (Angulo & Gil, 2007). Furthermore, consumers in the U.S., Canada, United Kingdom and Japan are willing to pay a higher premium for traceability that guaranteed food safety and humane animal treatment, compared to traceability only (Dickinson & Von Bailey, 2005). Another important attribute to consumers is whether beef is locally produced or not. When asked if they would support a country-of-origin labeling program, U.S. consumers indicated that they would be willing to pay a premium for U.S certified steak and hamburgers (Loureiro & Umberger, 2003).

There is a growing body of evidence indicating that consumers are willing to pay a premium for beef products with environmental attributes (Aquino & Falk, 2001; Belcher, Germann, & Schmutz, 2007; Burnier, Spers, & Barcellos, 2021; Li, Jensen, Clark, & Lambert, 2016; Schulze, Spiller, & Risius, 2021). These include: conservation of wildlife habitats (Belcher et al., 2007), "wolf-friendly" beef hamburgers that support protection of riparian areas and predators (Aquino & Falk, 2001), sustainably produced beef (Burnier et al., 2021; Schulze et al., 2021), and Raised Carbon Friendly (RCF) certified beef products produced using grazing practices that mitigate GHG emissions and increase carbon sequestration (Li et al., 2016). This study extends the

literature by examining whether consumers would consider the bee-friendly beef label as an important attribute when making purchasing decisions of beef products and their willingness to pay a premium for beef raised on pastures that conserve pollinators.

3 Data and methods

3.1 Discrete choice experiment

A nationwide online choice experiment (CE) survey of U.S. beef consuming households was implemented between March 2022 and May 2022 to elicit consumer WTP for ground beef with bee-friendly beef attributes[2]. This method has been successfully implemented to elicit consumer preferences for similar products, beef, with environmental attributes (Burnier et al., 2021; Schulze et al., 2021) and can simulate consumer buying decisions for products with related attributes. We use ground beef to examine purchasing decisions and WTP for bee-friendly beef because it is the most popular beef cut consumed in the U.S. In 2020 ground beef accounted for about 40% of the total share of beef sales in the U.S. (Statista, 2020). Furthermore, this product has successfully been used to execute similar studies in the literature (Chang, Xu, Underwood, Mayen, & Langelett, 2013; Schulze et al., 2021).

The study proceeded in two stages: In the first stage, two Focus Group Discussions (FGDs) of 6 participants each were held. The purpose of the FGDs was to inform the design of the study. In addition, input from the FGDs was used to validate the choice of attributes and levels used in the choice experiment and final design of the questionnaire. After joining the FGDs, participants were given about 15 minutes to answer the questionnaire. After completing the questionnaire, we asked FGD participants about the attributes and levels in the choice experiment, level of

[2] The survey was implemented by a professional polling firm, Dynata

difficulty in answering questions, language/wording, their perceptions of the length and purpose of the study, and general questions about beef products. This is a common practice in the literature (Ando, Cadavid, Netusil, & Parthum, 2020). The FGDs lasted 90 minutes and participants received a $40 gift card for their time.

The second part was an online choice experiment survey targeting respondents who are at least 18 years old, the primary person responsible for making food consumption and purchasing decisions in the household, and have purchased beef products for home consumption at least once in the period prior to the survey. The main survey was preceded by a pretest/initial "soft launch" involving 50 individuals to verify the correctness of the survey architecture, a common practice in the literature (Moeltner et al., 2021).

3.2 Experimental design

Table 1 shows the ground beef attributes and levels used in the CE. We describe ground beef using a combination of five attributes with a total of 12 levels. The attributes in the CE are production method, bee-friendly beef, grass-fed, origin, and price. The attributes and levels were selected based on characteristics shown in the literature to be important factors that consumers consider when making purchasing decisions for beef with environmental attributes (Risius & Hamm, 2017; Schulze et al., 2021; Syrengelas, DeLong, Grebitus, & Nayga, 2018; Torquati, Tempesta, Vecchiato, & Venanzi, 2018) as well as feedback from two focus group discussions of U.S. beef consumers.

The production attribute describes the agricultural production system used to produce the beef and has two levels, USDA organic and no label (conventional) (Khachatryan et al., 2017; Risius & Hamm, 2017; Schulze et al., 2021). We include these levels because they are common labels

observed on ground beef in the U.S. Type of feed and bee-friendly beef attributes describes the feed type (Syrengelas et al., 2018) and pasture used for grazing cattle, respectively. The feed type attribute has two levels: grass-fed, and no label. The bee-friendly beef attribute describes whether beef cattle were raised on pastures that support pollinators such as bees, the main focus of this study. This attribute has two levels: bee-friendly beef label and no label.

Origin is an attribute that describes where beef cattle were raised (Khachatryan et al., 2017; Schulze et al., 2021) and has two levels: Locally Raised (in-state) and Domestic (Raised in U.S.). The last attribute is price which has four levels ranging from $3.99/lb to $9.99/lb. The price ranges were set based on observing market prices and the average national retail price for 80% lean ground beef reported by USDA Agricultural Marketing Service National Retail Report for the week ending August 13, 2021 (AMS, 2021) which was 3.66 USD/lb for conventional ground beef. The highest price was set to be above the average national price for organic and grass-fed ground beef since we are introducing an attribute for bee-friendly beef that is not yet on the market. The price attribute is used to compute consumers' WTP for bee-friendly ground beef.

Given the attributes and levels in this study, a full factorial design results in a choice set of 96 profiles and each profile has a unique combination of attribute levels. However, the drawback of this design is that it generates a large number of alternatives (Holmes, Adamowicz, & Carlsson, 2017) and it is not efficient as it includes strictly dominated alternatives. Thus, this study follows a "D-optimality" criterion to reduce the initial choice sets to 40, each including two alternatives and a no-buy option[3]. The 40 choice sets were further grouped into ten blocks of four choice sets each. This means that each respondent was randomly assigned to one of the 10 blocks and only

[3] This is done using the "decreate" command in Stata

saw 4 choice sets. The advantage of blocking is that model parameter identification is assured, while reducing the cognitive burden on respondents. In environmental economics research, blocks of four sets are a common practice (Ferrini & Scarpa, 2007; Moeltner et al., 2021). We also added additional restrictions during the experimental design to ensure that the option pairs for each choice set were not dominated such that respondents would always make one ground beef purchasing decision over the other, i.e making sure that organic/grass-fed/bee-friendly ground beef had at least an equal or higher price tag than conventional ground beef. Figure 1 shows an example of a choice set for a ground beef purchasing decision.

3.3 Survey Instrument

The first part of the questionnaire has three screening questions which ensure that the respondents are at least 18 years old, the primary shopper or participates in shopping for food in the household, and purchased beef products at least once in the month proceeding the survey. The rest of the questionnaire is divided into 6 sections: The first section collects information about food and beef purchases as well as consumption patterns of respondents. The second section describes the benefits of wildflower-enhanced grazing pasture and the potential for a new product certified as bee-friendly beef. A description of the labels used in the choice sets is then presented. The third section presents four choice sets which are randomly presented to respondents. A set of standard validity checks questions are asked after the choice sets to respondents who choose at least one ground beef product from the four purchasing decisions. These follow-up questions are aimed at identifying “protest responses” which indicate that the respondents did not believe the factual information that was provided or did not make the ground beef purchasing decisions as they would in the store. If included, protest responses would bias the estimates (Moeltner et al., 2021). Section 4 of the questionnaire collects information on

pollinators followed by consumer food purchase preferences and concerns in section 5. Section 6 collects information on environmental organizations. The last section collects respondents' demographic information.

3.4 Econometrics Approach

We develop our empirical model based on the random utility framework which posits that on any given choice situation, an individual will choose the alternative that yields the highest expected utility among a number of alternatives (McFadden, 1974). We describe consumer *i*'s utility, U_{ijt} from ground beef alternative *j* in choice situation *t* as:

$$U_{ijt} = \beta_{0i} Nobuy_{ijt} + \beta_{1i} Prod_{ijt} + \beta_{2i} BFB_{ijt} + \beta_{3i} Grass_{ijt} + \beta_{4i} Origin_{ijt} + \exp(\delta_i) Price_{ijt} + \varepsilon_{ijt} \quad (1)$$

Where *i*=1,…,I is the number of respondents, *t* is the number of choice occasions (i.e ground beef purchasing decision 1- ground beef purchasing decision 4), *j* is option A, B, or C (in the choice experiment, A and B represent the two buying alternatives and the no-buy alternative is represented by C); *Prod* is a dummy variable that equals 1 when the production method employed is organic, and 0 when conventional production method is used; *BFB* is a dummy equal to 1 when the ground beef is Bee-friendly and 0 when it is not bee-friendly; *Grass* is a dummy variable that equals 1 when cattle is 100% grass-fed and 0 otherwise; and *Origin* is a dummy that equals 1 when beef is locally raised from within the state and 0 when it is domestically raised from within the U.S. but outside the state where it is sold; *Nobuy* is a dummy variable that is alternative specific and equals 1 for the no-buy alternative, and 0 for all other alternatives, and β_0 is a constant representing the no-buy option. The coefficient of the price attribute only has support with respect to positive values which assures well-defined moments of the ratio distribution representing the empirical distribution of willingness to pay (WTP) (Carson

& Czajkowski, 2019). ε_{ijt} is the error term and it is assumed to be independently and identically drawn (IID) from a type I extreme value distribution. Equation 1 is estimated using a mixed logit model with full covariance among all coefficients (MXL CC). This model relaxes the Independence of Irrelevant Alternatives (IIA) assumption by allowing correlation over alternatives in the stochastic portion of the utility to induce variance in the unobserved consumer-specific parameters. The model also allows parameters to vary randomly across consumers. The MXL CC allows for all sources of correlation among coefficients, including scale heterogeneity induced correlation (Hess & Train, 2017).

We investigate whether there is heterogeneity in the willingness to pay value for bee friendly ground beef across different beef consumers by including interaction terms between the bee-friendly beef attribute and income; volunteering/donating to an environmental organization; working/living on a farm; knowledge about pollinator decline; and the attitude of beef consumers on their role in pollinator population restoration. Thus, we modify Equation 1 and specify a fully correlated mixed logit model with interaction terms:

$$\begin{aligned} U_{ijt} = {} & \beta_{0i} Nobuy_{ijt} + \beta_{1i} Prod_{ijt} + \beta_{2i} BFB_{ijt} + \beta_{3i} Grass_{ijt} + \beta_{4i} Origin_{ijt} \\ & + \beta_{5i} BFB * Income\_Mid_{ijt} + \beta_{6i} BFB * Income\_High_{ijt} \\ & + \beta_{7i} BFB * Farm_{ijt} + \beta_{8i} BFB * Env\_Food\_Impact_{ijt} \\ & + \beta_{9i} BFB * Env\_Donate_{ijt} + \beta_{10i} BFB * Polli\_Know_{ijt} \\ & + \beta_{11i} BFB * Polli\_Role_{ijt} + \exp(\delta_i) Price_{ijt} + \varepsilon_{ijt} \end{aligned} \quad (2)$$

Where *BFB*Income_Mid* is an interaction term between bee-friendly beef attribute and medium income which is defined as total yearly household income of $50K to $79,999; *BFB*Income_High* is an interaction term between bee-friendly beef attribute and high income which is defined as total yearly household income of $80K and above; *BFB*Farm* is an interaction term between bee-friendly beef attribute and living or working on a farm;

*BFB*Env_Food_Impact* is an interaction term between bee-friendly beef attribute and whether consumers consider the environmental impact of food production as an important factor when purchasing food; *BFB*Env_Donate* is an interaction term between bee-friendly beef attribute and volunteering or donating to an environmental organization; *BFB*Polli_Know* is an interaction term between bee-friendly beef attribute and consumer knowledge about pollinator decline; *BFB*Polli_Role* is an interaction term between bee-friendly beef attribute and consumers having a role to play in restoring pollinator populations; and all other variables are as defined in Equation 1.

All the parameters in Equations 1 and 2, except the cost-related parameter are specified to be random and normally distributed. We multiply the cost related parameter in the regression by negative one and it is specified as random and log-normally distributed with a standard deviation constrained to 0[4]. We estimate Equations 1 and 2 via maximum simulated likelihood with 1000 Halton draws using starting values from a MXL with uncorrelated coefficients[5].

The mixed logit model allows us to compute the consumer's WTP for the different attributes. The marginal willingness to pay (MWTP) for attribute *k* is computed as:

$$MWTP_k = -\frac{\beta_k}{\exp(\delta)} \tag{3}$$

Equation (3) computes the MWTP for an attribute without any interaction term. For attribute *k* which has an interaction term, the MWTP is computed as:

$$MWTP_k = -\frac{\beta_k + \boldsymbol{\beta}_{kD} * \mathbf{D}}{\exp(\delta)} \tag{4}$$

[4] For a detailed description of the approach, check Carson & Czajkowski (2019)
[5] The MXL estimation is done in Stata 16 using mixlogit command (Hole, 2007b).

Where **D** are covariates entered as interactions with the bee-friendly beef attribute in Equation (2), and $\boldsymbol{\beta}_{kD}$ are coefficients associated with the interaction effects. The MWTP is calculated using the Krinsky Robb (parametric bootstrap) method with 2,000 bootstrap repetitions[6].

4 Results and Discussion

This section presents the descriptive and econometric results. First, we present the socio-demographic characteristics of beef consumers, and their beef purchasing and consumption patterns. Second, we discuss the econometric results from the MXL CC and the fully correlated mixed logit model with interaction terms, and the estimated consumer willingness to pay for bee-friendly beef.

4.1 Descriptive Statistics of Beef Consumers

The survey generated 2,162 valid responses that are used in this study. Table 2 shows the socio-demographic characteristics of U.S. beef consumers. The sample is comparable to the 2020 U.S. census statistics in terms of the income distribution of households and age of the respondents, with few exceptions. The percentage of households earning $200,000 and more account for about 7 percent of the respondents in our sample compared to about 10 percent of U.S. population in 2020. These means are statistically significantly different at the 1% level. Furthermore, respondents falling in the 18-24 age group account for 9% in our sample compared to the U.S. census (12%), and these means are statistically significantly different at the 1% level.

About 55% of the respondents are female, while 45% of the respondents are male. About 22% of the respondents have some college education and 11% and 25% of the respondents have completed a two-year and four-year college degree, respectively. Most households have 2

[6] The approach used to calculate MWTP is described by Hole (2007).

members (41%). About 20% of the households have a child under 6 years old, while 29% of the households have a child between the age of 6 and 18 years.

Table 3 summarizes the beef purchases and consumption patterns. On average, consumers spend $44 on beef per week and paid $5.62/lb for ground beef. About 28% of the households have 3 meals that included beef in a typical week. Ground beef is the most frequently bought beef product (71%), followed by beef for stew which is bought most frequently by 9% of beef consumers. Most of households buy beef products from supermarkets, which accounts for 89% of the beef purchases made.

To understand beef consumption patterns, the survey asked respondents to indicate how often they buy organic, grass-fed, and locally sourced beef using a 5-point Likert-style question. The original 5 response categories of “never” and “rarely” were combined into one category “never/rarely”, while “often”, and “always” were combined into the “often/always" category. This information is summarized in Table 4. The majority of the households (61%) never/rarely purchase organic beef while 19% of respondents reported buying organic beef often or always. Furthermore, 28% and 32% of the households often or always buy grass-fed beef and locally sourced beef, respectively. In contrast, 38% and 32% of the households never/rarely buy grass-fed beef and locally sourced beef, respectively.

Using a 5-point Likert style question, respondents were also asked to indicate the importance of different characteristics such as taste, convenience, nutrition, price etc. when purchasing food. The original answer categories of “not at all important” and “slightly important” were combined into one category “somewhat less important”. On the other hand, answer categories “very important” and “extremely important” were combined into one category “very important” and

this information is summarized in Figure 2. About 86%, 80%, and 67% of the respondents consider taste, price, and nutrition content of the food, respectively, to be very important factors when purchasing food. More than half of the respondents (54%) consider fairness to farmers, retailers, and consumers as a very important factor when making food purchases, while 49% of the respondents consider the environmental impact of food production and the origin of food very important factor when purchasing food. Consumers were asked to indicate how likely they are to purchase a beef product with a bee-friendly beef label on a 5-point Likert scale and the results are summarized in Figure 3. The results show that 20% and 28% of consumers are very likely and likely, to purchase beef products with a bee-friendly beef label, respectively.

All four purchasing decisions were completed by all the 2,162 respondents. Among these, 58 respondents chose the no-buy option on all four purchasing decisions that they made. These respondents were asked follow-up questions in order to understand why they chose the no-buy option on all four choice occasions. Responses such as "my household does not consume ground beef" (9), "my household consume different ground beef products than those presented in the survey" (12), "the labels on the ground beef were not clearly explained"(5), and other specified reasons such as "I do not care about labels, I buy leaner ground beef, etc" (8) were flagged as "protest responses" and were not included for the econometrics analysis. Thus, the econometric results are based on a sample of 2,128 respondents.

4.2 Econometric Results

The econometrics results provide insights into the research question: Are consumers willing to pay a premium for bee-friendly beef? If so, what is the average willingness to pay? Is there heterogeneity in WTP for bee-friendly beef among consumers? Table 5 presents results from

Equations 1 (Model 1) and Equation 2 (model 2). Results show that the mean coefficient on bee-friendly beef, 100% grass-fed, and locally raised beef are positive and statistically significant, indicating that these attributes are important to consumers when making ground beef purchasing decisions. As expected, price has a negative and significant mean coefficient. The mean coefficient on bee-friendly beef is positive which means that some consumers will purchase bee-friendly ground beef if such a labeling approach were to be implemented. Consumers prefer beef that is locally raised in in-state compared to beef raised in the U.S. and grass-fed ground beef over conventional feeding methods. The mean coefficient on nobuy is negative and statistically significant which indicates that consumers, on average prefer to buy ground beef products featured in the choice experiment, rather than choosing the no-buy option.

Respondents indicated that they are willing to pay an additional $1.06 per pound for bee-friendly ground beef (Table 6) and $2.36 per pound for bee-friendly ground beef (Table 7). The willingness to pay for bee-friendly ground beef varies among different types of consumers in our sample: consumers that consider the environmental impact of food production as an important factor when purchasing food are willing to pay an additional $1.19 per pound for bee-friendly ground beef; consumers that volunteer or donate to environmental organizations are willing to pay an additional $0.64 per pound of bee-friendly ground beef; while those that are knowledgeable about pollinator decline and consumers that consider themselves as having a role to play in pollinator population restoration are willing to pay an additional $0.82 and $1.24 per pound of bee-friendly ground beef, respectively. In addition, respondents prefer grass-fed ground beef and are willing to pay $0.36 per pound for grass-fed ground beef (Table 6). This result is concordant with conclusions in previous studies (e.g Syrengelas et al., 2018) who found a preference among consumers for grass-fed beef compared to conventional beef.

The heterogeneity in the MWTP for bee-friendly ground beef among different respondents implies that the restoration of pollinator populations should include a mix of strategies in order to optimize these efforts. For instance, consumers can be educated about the decline in pollinator populations and bee-friendly beef products can be marketed to consumers that volunteer/donate to an environmental organization, consider the environmental impact of food production when purchasing food, are knowledgeable about pollinator decline and those who consider themselves as having a role to play in pollinator restoration.

5 Conclusions

Results show that some U.S. beef consumers would purchase bee-friendly beef if that labeling approach was implemented. This suggests that a market-based third-party voluntary labelling program of bee-friendly beef could be a potential solution to address pollinator decline. Our findings indicated that U.S consumers are willing to pay an additional $1.06 - $2.36 per pound for bee-friendly ground beef. There is heterogeneity in the MWTP for bee-friendly ground beef among respondents who volunteer/donate to an environmental organization, consider the environmental impact of food production when purchasing food, are knowledgeable about pollinator decline and consider themselves as having a role to play in pollinator population restoration. This premium would allow beef cattle producers to recover some of the cost of integrating wildflowers into their grazing systems. Research is being conducted to estimate the added costs of establishing and maintaining wildflower enhanced pasture compared to business as usual. These extra costs will be compared with potential additional revenues from consumers who are willing to pay a premium for bee-friendly beef. This will help determine whether additional incentives might be needed for producers to integrate wildflowers into their grazing systems such that pollinator population can rebound.

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Table 1: Choice Experiment Attributes and levels

Attribute	**Attribute levels**
Production method	USDA organic label
	No label (conventional)
Grass-fed	Grass-fed label
	No label
Bee-friendly beef	Bee-friendly beef label
	No label
Origin	Locally Raised (in-state) label
	Domestic (Raised in US) label
Price ($/lb.)	3.99
	5.99
	7.99
	9.99

Table 2: Socio-demographic characteristics of beef consumers

	% Sample	% 2020 US Census[7]
Age group (years)		
18–24	8.6	11.51
25–34	16.65	18.11
35–44	16.98	16.30
45–54	16.23	16.30
55–64	17.99	16.56
65–74	14.11	12.68
75 or order	9.44	8.54
Gender		
Female	54.76	
Male	44.63	
Non-binary / third gender	0.42	
Prefer not to answer	0.19	
Highest level of education		
Less than High School	2.54	
High School/GED	22.85	
Some College	21.83	
2-Year College Degree (Associates)	11.29	
4-Year College Degree (BA, BS)	25.25	
Master's Degree	12.16	
Professional Degree (Ph.D., J.D., M.D.)	4.07	
Household size		
1	17.07	
2	41.21	
3	17.02	
4	15.03	
5 or more	6.15	
HH with children under 6 years	20.21	
HH with children under 6-18 years	28.63	
Income		
Under $20,000	14.06	13.79
$20,000–$49,999	25.16	24.01
$50,000–$79,999	20.49	19.32
$80,000–$109,999	14.75	13.58
$110,000–$139,999	8.09	8.89
$140,000–$169,999	6.43	6.07
$170,000-$199,999	4.21	4.10
$200, 000 and over	6.8	10.25

[7] Source (U.S. Census Bureau, 2021) and (U.S. Census Bureau, 2019)

Observations	2,162

Table 3: Beef purchases and consumption patterns

	Mean	Std. Dev.
HH weekly expense on beef	43.82	65.39
Typical price paid for a lb of ground beef	5.62	3.05
Meals that include beef in a week (%)		
1 or fewer	12	
2	25	
3	28	
4	18	
5	8	
6	4	
7 or more	6	
Beef product frequently bought (%)		
Ground beef	71	
Ribeye steak	7	
Roast beef	6	
Beef for stew	9	
Tenderloin/Filet mignon	4	
Other, specify	2	
Beef purchase locations (%)		
Supermarket	89	
Meat market/butcher shop	8	
Directly from the beef producer	1	
Farmers market/CSA	2	

Observations=2,162

Table 4: Household frequency of purchase of organic, grass-fed, and locally sourced beef

	Never/rarely	Sometimes	Often/always	Observations
		% of respondents		
Organic	60.59	20.86	18.55	2162
Grass-fed	38.02	33.63	28.36	2162
Locally sourced beef	32.38	36.03	31.59	2162

Table 5: Regression Results

	MXL CC (Model 1)		MXL CC interactions (Model 2)	
Attribute	Mean	SD	Mean	SD
No buy	-7.040***	2.480***	-6.996***	2.432***
	(0.314)	(0.159)	(0.314)	(0.169)
Production Method (base=no label)				
Organic	0.097	1.992***	0.098	-1.985***
	(0.123)	(0.121)	(0.122)	(0.121)
Bee-friendly beef (base=no label)				
BFB	0.723***	1.939***	-0.799***	0.805**
	(0.114)	(0.118)	(0.193)	(0.367)
Grass-fed (base= no label)				
100% grass-fed	0.245**	2.159***	0.228*	-2.129***
	(0.124)	(0.130)	(0.123)	(0.131)
Origin (base=Domestic)				
Locally Raised	0.192*	1.746***	0.185*	-1.691***
	(0.109)	(0.123)	(0.108)	(0.120)
BFB*Income_mid			-0.164	-0.058
			(0.143)	(0.133)
BFB*Income_High			-0.171	1.336***
			(0.173)	(0.309)
BFB*Farm			0.098	-0.430
			(0.139)	(0.413)
BFB*Env_Food_Impact			0.808***	1.536***
			(0.155)	(0.271)
BFB*Env_Donate			0.436***	0.660
			(0.168)	(0.593)
BFB*Polli_Know			0.554***	-0.371*
			(0.138)	(0.222)
BFB*Polli_Role			0.843***	-0.023
			(0.141)	(0.666)
Price	-0.382***	0.000	-0.386***	0.000
	(0.092)	(0.000)	(0.092)	(0.000)
Observations [a]	25,536		25,536	
Log-likelihood	-6859.85		-6771.518	
AIC	13741.71		13593.04	
BIC	13831.33		13796.73	

Standard errors in parentheses. Clustered at the individual (respondent) level.
* p<0.05, ** p<0.01, *** p<0.001
[a] Observations are the number of individuals *I* times choice occasions *T* times alternative *J*: *I***T**J

Table 6: Willingness to Pay (WTP) for attributes

MWTP ($/lb)	
Production Method (base=no label)	
Organic	0.14
	[-0.22, 1.44]
Bee-friendly beef label (base=no label)	
BFB	1.06
	[0.84, 1.28]
Grass-fed label (base= no label)	
100% grass-fed	0.36
	[0.02, 0.65]
Origin (base=Domestic)	
Locally Raised	0.28
	[-0.02, 0.52]

95% confidence intervals in brackets
MWTP estimated from the MXL CC (Model 1)

Table 7: MWTP for beef-friendly ground beef among different categories of consumers

	All	Env. Impact of food production	Donate or volunteer to env. organization	Knowledge of pollinator decline	Role in pollinator restoration
MWTP($/lb)					
BFB	2.36	1.19	0.64	0.82	1.24
	[1.68 - 3.07]	[0.76 – 1.76]	[0.15 – 1.18]	[0.41 – 1.26]	[0.81 – 1.75]

95% confidence intervals in brackets
MWTP estimated from the MXL CC with interactions model (Model 2)

Purchasing decision 1: Imagine you are in the grocery store, and you wish to purchase one pound of 85% lean ground beef. Assume the ground beef products are the same and only differ with respect to the labels and price. Which of the following ground beef products would you pick?

Figure 1: Example of a choice set

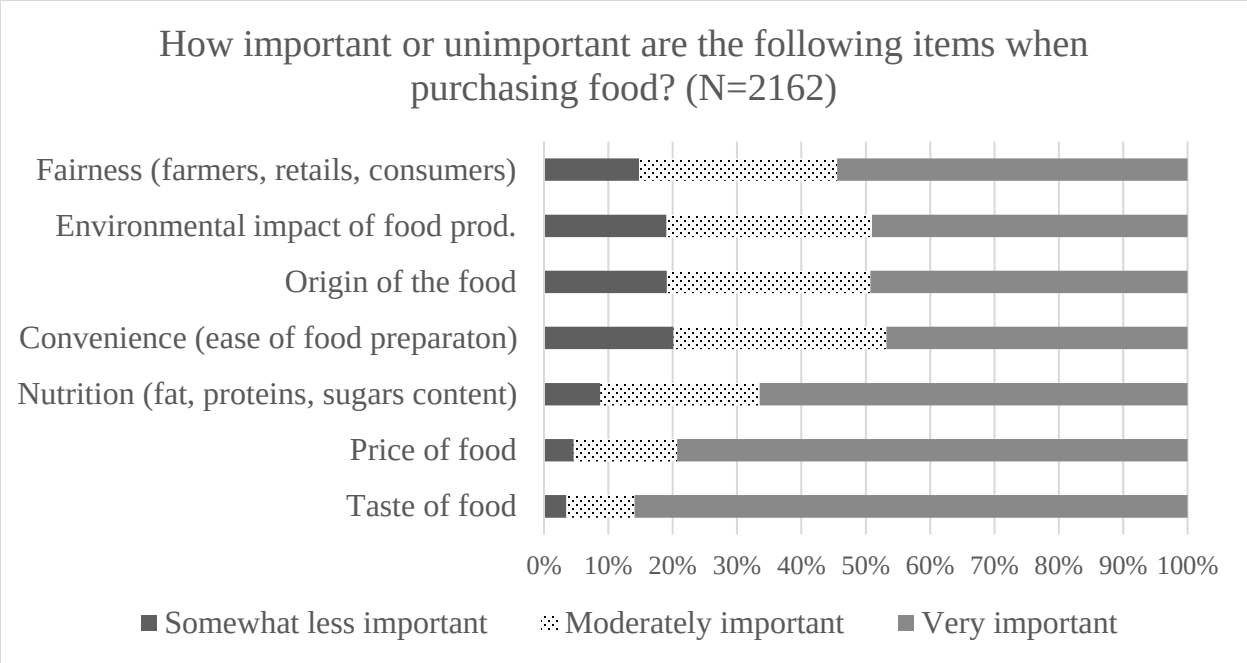

Figure 2: Food purchase preference

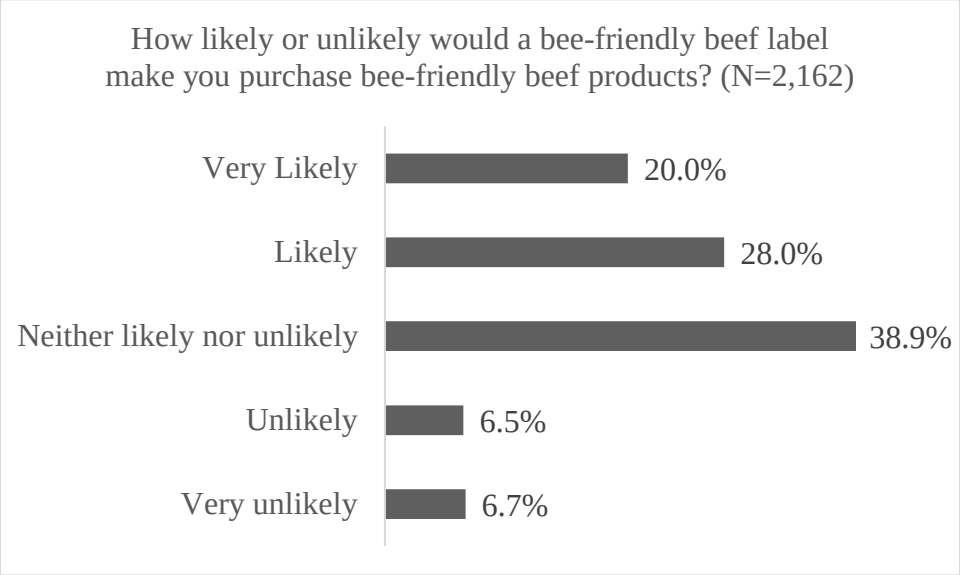

Figure 3: Consumer likelihood to purchase beef with a bee-friendly beef