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Consumer Perceptions of Flatheaded Borer Control Methods

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To the Graduate Council:

I am submitting herewith a thesis written by Samuel Gerloff entitled "Consumer Perceptions of Flatheaded Borer Control Methods." I have examined the final electronic copy of this thesis for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Science, with a major in Agricultural and Resource Economics.

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Consumer Perceptions of Flatheaded Borer Control Methods

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Dedication

To my mother and father Gail and Delton Gerloff.

Abstract

Flatheaded borers are insect pests that cause damage to ornamental and fruit producing plants. This study examines consumers' willingness to pay for four alternative flatheaded borer control methods across four products. The four products tested included two plants (maple trees, blueberry bushes) and two fruits (apples (3 pounds), blueberries (1 pint)) to ascertain if differences were observed between product categories (plant verses food) and potential product uses for the plant categories (aesthetic vs food producing). The four control methods included a chemical drench, spray, cultivar selection, and cover crop. A no control option was also included. Survey data were collected by the online platform Qualtrics in April 2022 and a total of 1,597 people surveyed across the United States. The data was analyzed in two distinct ways and each analysis had a dedicated chapter. Chapter 1 used a conditional logit model to determine price premiums for blueberries, blueberry bushes, apples, and maple trees by control method. Chapter 2 used a Ward's Linkage Cluster analysis to identify consumer segments and determined price premiums for blueberries and blueberry bushes.

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CHAPTER 1:

CONSUMER'S FAMILIARTY WITH AND ATTIDUES TOWARD FLATHEADED BORER CONTROLS IN FRESH FRUIT AND GARDEN PLANTS

Abstract

In Chapter 1 a conditional logit model was used to analyze the data. When compared to the chemical drench method, cover crops increased consumers' willingness to pay by $3.01 for blueberries, $2.55 for apples, $5.06 for blueberry bushes, and $7.64 for maple trees. Pollinator friendly growing methods were significant and increased consumers' willingness to pay for all four products when compared to products that were designated as not being grown with pollinator friendly methods. Different retail outlets were also tested including farmers markets, specialty stores, big box stores, and grocery stores along with plant origin information such as grown in state, U.S. origin, or imported. The retail outlet type and plant origin's significance varied for each product.

Introduction

Flatheaded borers (Chrysobothris) are beetles whose larvae make tunnels within plant trunks, branches, and roots (K. Addesso and B. Klingeman, personal communications, 2022). Chrysobothris is a genus of metallic wood-boring beetles in the family Buprestidae and are native across the United States. Female flatheaded borers lay eggs in the stems of trees and shrubs and the larvae then feed on the vascular tissue (K. Addesso and B. Klingeman, personal communications, 2022). This disrupts water and nutrient movement, eventually causing trunk scars, bark shedding and splits, and potentially plant death. Flatheaded borer damage in plants can be seen by loose bark that has sawdust-filled tunnels (tamu.edu). An example of damage from a flatheaded borer can be seen in Figure 1 (All tables and figures are located in the appendix).

Flatheaded borer infestations create serious financial implications for nursery, tree nut and fruit crops growers. The damage from flatheaded borers can result in revenue losses to the nursery/greenhouse industry due to plant damage: hence, damaged plants hold less appeal to gardening shoppers. Specifically, trees or shrubs infested with flatheaded borers may have sparse foliage, dead branches, or damage on the trunk and stems (iastate.edu). Flatheaded borer damage can also result in the death or loss of productivity of fruit bearing plants. Consequently, flatheaded borer damage can diminish the revenues from production of tree nuts and fresh fruits, such as apples or blueberries (K. Addesso, personal communications, 2022).

A variety of methods to control flatheaded borers are currently used or are under development. Insecticidal controls include insecticide drenches. Drenches are applied as liquid in spring to the plant's root zone, with the insecticide being carried through the roots to the entire plant which provides systemic protection from insect pests. Two drench treatments are currently used by growers to control insect borers. First, is an Imidacloprid drench that provides 3 years of protection from insect borers. Second, is a Dinotefuran drench that provides 1 year of protection from insect borers. This method can be used as a part of a pollinator-friendly plant production program on plants with flowers that are wind pollinated or if applied after flowering when pollinators are not present (K. Addesso, personal communications, 2022).

Spray control methods involve spraying the insecticide onto the plant (or select parts of the plant such as the trunk or lower 24 inches of the plant) to provide protection from insects. Spray options are quicker to implement, use less labor, and require less product when compared to drench methods. However, they are susceptible to drift (via wind) and must be applied when the weather aligns with application requirements (i.e., no rain within a designated

period of time). The spray method may be used as a part of a pollinator-friendly plant production program if sprays are targeted to the trunk only, if applied after flowering, or are used on plants that do not require insect pollination (e.g., wind pollinated) (K. Addesso, personal communications, 2022).

Cover cropping has potential as a new control method for flatheaded borer management in nursery operations (tnstate.edu). Cover crops are grown at the base of the plants (trees, bushes) or in the rows between the plants. The cover crop changes the environment around the plants and provides habitat for predators insects and other natural enemies of the flatheaded borer. Cover crop benefits may also include soil improvements, secondary income from forage crop harvests, and mulch for weed suppression. This method can be used as part of a pollinator-friendly plant production program by increasing availability of food and habitat plant species for pollinators (K. Addesso, personal communications, 2022).

Some cultivars (plant varieties that have been produced for cultivation by selective breeding) may be better suited to specific climates (for example, the unique climate in a particular area) and exhibit greater resistance to flatheaded borers. Observational data from entomologists suggest that stressed plants are more susceptible to flatheaded borer attacks (K. Addesso and B. Klingeman, personal communications, 2022). Changing the cultivars grown to those more suited to the specific area could decrease borer incidence while being part of a pollinator-friendly plant production program.

Literature Review

The four products used in the study were identified through industry and Extension professionals' input to align with their needs and their clientele's needs. Each of the products

were identified as being susceptible to flatheaded borer and products in demand in their areas. Two types of products (plants, fruit) were selected to allow for differences based on product end-use.

The four flat headed borer control methods used in this project (i.e., drench, spray, cover crop, and cultivar) along with different plant attributes are anticipated to show an impact on consumer preferences and purchasing decisions for the products of interest. According to Rihn and Khachatryan (2016) consumers of ornamental plants most preferred labeling and growing practices that were pollinator friendly, followed by phrases such as “plants for pollinators”, “bee friendly”, and “pollinator safe”. Further research suggests consumers are opposed to the use of neonicotinoids (the pesticides currently used in drenches for flatheaded borers) on ornamental plants (Rihn & Khachatryn, 2016; Wei et al., 2020). Research addressing consumer acceptance of alternative control methods relative to neonicotinoids (i.e., drench controls) are lacking. Here, we combine pollinator friendly production methods with flatheaded borer control methods to address consumer behavior towards ornamental plants and fruits. This research looks to demonstrate that consumer behavior and opinions towards the plants and fruits that they purchase could be influenced by the pest control techniques and labeling of the product in the retail environment.

Study Objective and Conceptional Framework

The overall goal of this study is to provide the horticultural and nursery/greenhouse industries with information about consumers’ awareness of flatheaded borer damage and their perceptions of flatheaded borer control methods that may be helpful when determining the best control methods for their operations. While the cost of implementing flatheaded borer control

methods is a consideration in developing control strategies, the revenue effects are also a consideration. The purpose of this study is to build a better understanding of consumers awareness of flatheaded borer damage, attitudes toward control methods, and preferences for products produced using varying flatheaded borer control methods. In this study, four products are considered: fresh blueberries (1 pint), fresh apples (3 pounds), blueberry bushes (1 gallon), and maple trees (5 gallon). As part of the study results, estimates of consumers' willingness to pay for plants and fruits produced using the alternative flatheaded borer control methods are provided. The control methods include the drench, spray, cover crop, cultivar selection, and no controls. In addition, the results provide information about consumer familiarity with flatheaded borer damage, their attitudes toward pesticide use on fresh fruits, food producing and ornamental plants, consumer demographics, and their attitudes toward the environment.

It is hypothesized that nonchemical control methods such as the cover crop, cultivar, and no control method will bring a higher willingness to pay when compared to the chemical drench method across all four products (H1). Furthermore, it is hypothesized that pollinator friendly production practices will have a positive and significant influence on willingness to pay over non pollinator friendly production practices across all four products (H2). For the fruit products it is hypothesized that consumers will prefer in state and U.S. grown products over imported products and for the plant products (H3), it is hypothesized that having a 6-month guarantee program and no damage visible will have a higher willingness to pay when compared to no money back guarantee and damage visible (H4, H5).

Survey Methods, Data Collection, and Analysis

A survey of 1,597 U.S. adults aged 18 and over was conducted online through Qualtrics, an online survey platform. The panelists were recruited by Qualtrics. To qualify, the adults had to be responsible for food and/or gardening shopping for their household. The survey was conducted in spring 2022. Responses were collected until no less than 250 completes were obtained for each product (i.e., fresh blueberries, fresh apples, blueberry bush, maple tree). The study protocols were approved by the IRB.

The survey contained several sections. The first section consisted of screening questions. These questions included the year the respondent was born. Only those born in 2003 or earlier were included in the analysis to ensure the respondents were at least 18 years old. Respondents were also asked if they were the primary shopper or shared responsibility for household food and/or garden products shopping. Those who indicated neither to both product categories were excluded from the survey.

Next, the participants who indicated having primary or split responsibility for food were asked if they would purchase fresh blueberries or apples during their next food shopping trip. Conversely, those who answered that they were the person in their household with primary or split responsibility of gardening shopping were asked if they would purchase a blueberry bush or a maple tree within the next three years. The plant purchase window was extended to three years to allow for seasonality and greater longevity of the plants (i.e., people do not buy maple trees or blueberry bushes as often as annual plants). If a participant indicated they were both food and garden shoppers, they were randomly assigned to one of the product categories question blocks (fruit or plants). If participants indicated they would purchase neither item (e.g., apple or

blueberries, maple trees or blueberry bushes) they were sent to the end of the survey, and gardening shoppers who would purchase neither blueberry bushes nor maple trees were sent to the end of survey. If participants only chose one product, they would be assigned to the product they chose. A diagram of the survey flow is shown in Figure 2. Ultimately, each participant who qualified for the survey was randomly assigned to evaluate one product.

Prior to answering questions about product choices, respondents were presented with a brief summary of the product attributes for the specific products they would be evaluating. For the nursery plants (blueberry bush or maple tree), these included the flatheaded borer control method used, visible plant damage, whether pollinator friendly methods were used, retail location of purchase, money back guarantee (i.e., six months of protection from flatheaded borers), and plant price. For the food products (fresh blueberries or apples), these included flatheaded borer control method used, whether pollinator friendly methods were used, product origin, retail outlet, and price. Price points for all four products were determined based on similar products currently available in the U.S. market using online searches of garden centers, e-commerce sites, and on-site visits to local garden shops. To provide information about some of the attributes and gauge familiarity, information screens and questions regarding several topics were provided (pollinators, flatheaded borer damage, and flatheaded borer control methods). For instance, the pollinator information included:

> With respect to pollinators, respondents were provided the following description:
> *"Birds, bats, butterflies, moths, flies, beetles, wasps, small mammals, and bees are pollinators. They visit flowers to drink nectar or feed on the pollen and transport pollen grains as they move from spot to spot. Pollinator friendly plants*

and production methods are those that encourage the process of pollination. Pollinators are negatively impacted by loss of habitat."

The respondents were then asked how familiar they were with the term "pollinators". The responses could take on the values 1=not at all, …, 5=extremely familiar using a 5 point Likert scale.

For the flathead borer familiarity question respondents indicated whether they had seen flatheaded borer damage like that shown in Figure 1. Answer options included yes, no, or not sure. If they answered yes, respondents were then asked about where they had seen the damage and the level of damage. The places where damage was observed included: in their own landscaping, in their neighborhood, in their town or city, and outside their town or city. Regarding the level of damage, the respondents could answer that they had seen light damage, medium damage, heavy damage in the area, or that they had not seen any damage.

Survey participants were then provided information about each of the flatheaded borer control methods, including drench, spray, cover crops, or cultivar selection. A screen about each flatheaded borer control method with the information discussed in the introduction section of this paper was provided to the survey participants to aid them in making informed decisions.

Survey participants were then reminded about their budgets and to make realistic product choices (i.e., a cheap script, Cummings & Taylor, 1999; Blamey & Bennett, 1999). This information screen contained the following text:

"Now that we have told you about the potential control methods, we also want to remind you to keep your household budget in mind when making your selections. The experience from similar previous surveys is that people often say they will

pay a higher price for a product than they actually will pay for it when faced with the same decision in an actual store setting. Remember, it is possible to support an issue without being willing to pay more for it. It is important to remember that if you choose to pay more for a product, you will have less money in your household budget to spend on other items."

Following the budget reminder screen, participants were provided with 18 choice set scenarios where each had two product alternatives displaying varying attributes for the participants to choose from, or they could choose neither product. An example choice set is shown in Figure 3.

This method of presenting choice sets is called a discrete choice experiment, which allows the respondent to choose between two product alternatives with varying attributes. The reason this method of presenting product alternatives is used is that it enables the respondent to choose between product attribute bundles they might realistically see on a product. This simulates a real retail environment where they might choose different products rather than asking them about their preferences for each product attribute individually. A D-efficient design was used to construct the choice sets. Table 1 shows the products, their attributes, and the attribute levels used in the design and choice set questions. The neither, or opt-out option, enables measurement of the effects of factors beyond the attributes offered in determining the product choice.

Following the choice sets, the respondents were asked about expenditures, either their food expenditures and attitudes or gardening expenditures and attitudes depending upon the choice set they evaluated.

Econometric Analysis

A conditional logit model was used to analyze the data**.** This model was chosen because our survey used a discrete choice experiment, and the conditional logit model would complement this survey style (Jumamyradov, 2023). The conditional logit model calculates the likelihood of an individual choosing a product with the three choices of option 1, option 2, or nether being available to the individual. $V_{ij}= \beta_1 x_{1j} +\beta_2 X_{2j}+ \dots \beta_k X_{kj} + \varepsilon_{ij}$ is the formula for a conditional logit model with i= 1, …, i respondents, j = 1, …, j choices, V_{ij}= respondents i's utility from choice j, V_{ij}= respondents i's utility from choice j, Xj= characteristics of choice j (control methods, money back guaranteed, pollinator friendly or not, etc.), β= preferences for observed choice characteristics with k being the number of coefficients, ε_{ij}= idiosyncratic preferences for choice (McFadden, 1973). Random utility theory was implemented to demonstrate that respondents will make choices based on preferences (Azari, 2012). To calculate willingness to pay (WTP) we used a nonlinear combination of $-1(\beta_{attribute}/ \beta_{price})$ where β is the coefficient.

Results

Survey Sample Demographics

The data were summarized and analyzed using several statistical methods. Categorical data (for example, when answer options were: Yes or No) were summarized with percentages and can be seen in table 2. Continuous data (for example, age in years) were summarized using the medians. The median age for the survey was 47 with 69.57% of respondents being female and a median household income of $53,238. Of those that were surveyed 30.93% were college graduates, the median household size was 2.6 individuals and the percent of households with children under the age of 18 was 34.47%. Approximately, 36.1% lived in a rural or small town,

37.9% lived in the suburbs, and 25.96% lived in an urban area with 45.5% of respondents owning a single unit home. The survey demographics seemed to reflect the general U.S. Census data (Census.gov,2010, 2021,2022). The survey had a higher percentage of female and rural residents then the general U.S population but this can be explained by the generalization that females are the primary shoppers in the U.S (Schaefer, 2019). and that people in rural areas may take more interest in agriculture due to closer proximity.

Familiarity with Flatheaded Borer Damage

As seen in Figure 4 most respondents (60%) indicated they had seen flatheaded borer damage on plants. As seen in Figure 5, most of the damage was observed outside of their own town or city (24% heavy damage, 45% moderate damage) . Flatheaded borer damage was observed least within the participants' own landscapes or neighborhoods (22% had not observed damage; 25% observed light damage)

Blueberries

The conditional logit model estimates for blueberry fruit are presented in Table 3. Price negatively impacted participants' likelihood of selection the products. Blueberries grown using pollinator friendly production methods improved likelihood of selection. Compared to the drench control methods, cover crops, cultivar selection, spray, and no control methods were preferred. Retail outlet type also influenced preference with grocery stores, specialty store and farmers markets positively impacting choice relative to big box stores. Blueberries produced in the US or in-state were preferred to those from international origins.

The participants willingness to pay for products grown using different flatheaded borer control methods and other products attributes were derived from the conditional logit model

(Fig.6). The drench method was used as the control method baseline for comparison given its current popularity within the industry (Cranshaw, 2020). Regarding flatheaded borer control methods, the cover crop, cultivar selection, no control, and spray each increased willingness to pay by $3.01, $2.77, $2.16, and $0.67, respectively. Grocery stores, specialty stores, and farmers market retail outlets were compared to big box stores (e.g., WalMart and Target) and increased willingness to pay by $0.43, $0.67, and $0.45, respectively. Produced either in-state or in the U.S. increased consumers' willingness to pay by $0.80 and $1.27 relative to products from other countries. Pollinator friendly practices increased consumers' willingness to pay by $2.97 when compared to non-pollinator friendly production practices.

Apples

The conditional logit model estimates for a 3lb bag of apples are presented in Table 4. Price negatively impacted choice. The "none chosen" option also negatively impacted choice indicating that participants received more utility from selecting one of the products than selecting the neither option. Compared to non-pollinator friendly products, the pollinator friendly production method positively impacted choice. Regarding flatheaded control methods, cover crops, cultivar selection, spray, and no control were all preferred to the drench method. Relative to big box stores, grocery stores and farmers markets positively impacted choice; however, specialty stores were not significant. Both in-state and domestic production were preferred to imported apples.

Willingness to pay estimates were based on the conditional logit model results (Fig. 7). The drench method was used as the baseline for the flatheaded borer control methods. Cover crop, cultivar selection, no control, and the spray method were all significant at the five percent

level and increased consumers' willingness to pay by $2.55, $2.31, $1.75, and $0.92, respectively. Grocery stores and farmers markets were found to be significant when compared to big box stores and improved consumers' willingness to pay by $0.47, and $0.47. Specialty stores were found to be insignificant at the 5 percent level. In state and U.S. grown products were found to be significant at the 5 percent level when compared to foreign imported products and increased consumers' willingness to pay by $0.36 and $0.80 respectively. Pollinator friendly practices were significant at the 5 percent level when compared to non-pollinator friendly practices and increased consumers' willingness to pay by $2.39.

Blueberry Bushes

The conditional logit model results for the blueberry bush product category are presented in Table 5. Price and the presence of flatheaded borer damage both negatively impacted likelihood of selection. Blueberry bushes with the pollinator friendly attribute positively impacted selection relative to those without a pollinator label. Compared to drench control methods, cover crops and cultivar selection positively impacted choice. Neither the spray nor no control methods were significant. None of the retail locations were significant. The presence of a 6 month money back guarantee positively impacted selection relative to plants without a guarantee.

Participants' willingness to pay for blueberry bushes displaying different attributes are presented in Figure 8. The drench method was used as the baseline for the control methods. The cover crop and cultivar method were found to be significant at the 5 percent level and increase consumer willingness to pay by $5.06 and $6.81 respectively. The spray and no control method were not significant. If the blueberry bushes had damage from flatheaded borers it significantly

lowered consumers' willingness to pay by $10.22. Big box store was used as the baseline for the blueberry bush retailer type. None of the store outlets significantly affected price at the 5 percent level. A money back guarantee was found to be significant at the 5 percent level when compared to no money back guarantee and increased consumers' willingness to pay by $8.21. Pollinator friendly practices were significant at the 5 percent level when compared to plants without the label and increased consumers' willingness to pay by $13.04.

Maple Trees

The conditional logit model estimates for the maple trees are presented in Table 6. Price and the presence of flatheaded borer damage both decreased likelihood of selection. The presence of the pollinator friendly production label improved likelihood of selection relative to maple trees without the label. Relative to drench control methods, cover crops improved likelihood of selection. Conversely, spraying to control flatheaded borers decreased the likelihood of selection. If the maple trees were sold through home improvement stores, they were more likely to be chosen relative to those sold at big box stores. The presence of a guarantee improved likelihood of selection while cultivar selection, no control, online retailers, and garden retailers were insignificant.

Figure 9 shows the willingness to pay estimates for maple trees. Compared to the drench method, the cover crops and spray methods were significant at the 5 percent level. Cover crops positively influenced consumers' willingness to pay by $7.64, while sprays decreased willingness to pay by -$3.94. Relative to a big box store, the home improvement store was the only store outlet to be significant at the 5 percent level and increased consumer willingness to pay by $5.57. A money back guarantee was found to be significant at the 5 percent level when

compared to no money back guarantee and increased consumers' willingness to pay by $10.52. If damage from flat headed bores was visible, it was significant and decreased consumers' willingness to pay by -$13.56 compared to undamaged trees. Pollinator friendly practices were significant at the 5 percent level when compared to non-pollinator friendly practices and increased consumers' willingness to pay by $14.34 for maple trees.

Concerns About Personal & Environmental Safety of Pesticide Use on Fresh Fruits and Plants

Participants also indicated their level of concern about pesticide use on different types of plants and fresh fruit (Table 7). Pairwise t-tests were used to identify significance at the 5 percent level starting by comparing within the safety categories (i.e., personal, environmental) and then across the safety categories for each product category. In the personal safety category, product ratings were significant at the 5 percent level, meaning participants exhibited the strongest concern about pesticides being used on fresh fruits, followed by outdoor food producing plants, indoor food producing plants, outdoor ornamental plants, and indoor plants. In the environmental safety category, all 5 product ratings were significant at the 5 percent level. Interestingly, the products were rated in the same order as the personal safety category indicating a level of similarity in participants' perceptions of risk across product categories. However, when cross comparing between the personal and environmental safety categories, only outdoor ornamental plants and indoor food producing plants were significant at the 5 percent level. For both of these product categories, respondents had a higher concern for environmental safety than personal safety.

In general, respondents had a higher rate of concern for both personal and environmental safety for fresh fruits, outdoor food producing plants, and indoor food producing plants when compared to outdoor and indoor ornamental plants. This could be due to consumers being more concerned about pesticide residues on products they eat (or may potentially eat) over products used for decorative design purposes.

Environmental Attitudes and Organization Membership

Respondents were given six environmental statements and were asked to rate their level of agreement with the statement using a 5-point Likert scale where 1 was strongly disagree, 2 somewhat disagree, 3 neither agree nor disagree, 4 somewhat agree, and 5 strongly agree (Fig 10). The statements “in the future damage to the environment will impact my quality of life in the future”, “global climate change is occurring”, and “I have responsibility to protect the environment for future generations through my actions” had a rating of 3.87, 4.00, and 4.01, respectively. Showing respondents generally agree with the statements. The statements “there is no urgent need to prevent environmental damage”, “I don’t have enough knowledge to make well informed decisions on environmental issues”, and “my personal actions have little impact on the environment” had a rating of 2.32, 2.89, and 2.75 respectively, which demonstrates slight disagreement and some neutrality with these statements. Overall, these results suggest that respondents care for and are concerned about the environment. Supporting evidence found that 17.35% of respondents are members of or donated to an environmental organization.

Conclusion

Overall respondents were willing to pay more for plants and fruits that used alternative flatheaded borer control methods such as cover crops, cultivar selection, or no control methods

when compared to the drench method. When fruits were evaluated (apples, blueberries), participants' value for non-chemical flatheaded borer control methods (i.e., cover crops, cultivar selection) increased. Additionally, the no control used option was valued more than the drench method for these items. Conversely, when plants were evaluated, valuation varied by the end use of the product. For the blueberry bushes, which produce fruit that can be consumed, the non-chemical control options of cover crops and cultivar selection were valued more than the drench method. However, for the maple trees (which are primarily for ornamental use), participants' value did not change based on the provided flatheaded borer control methods. The implications of these findings are that consumers seem to favor alternative flatheaded control methods when selecting products that they consume or plants that produce fruit supporting hypothesis 1. These results add another layer to the discussion on pest control methods in the horticulture industry. Given the existing evidence of consumer concern related to neonicotinoid (drench) use on ornamental plants (Rihn & Khachatryan, 2016; Wei et al, 2020), the current study provides evidence that this preference includes a broader swath of products with diverse end-uses.

Regarding other product attributes, regardless of product (fruit or plants), the pollinator friendly production methods attribute generated a greater value than non-pollinator friendly practices, supporting hypothesis 2. This shows that participants of this survey are willing to pay a price premium for plants and fruits grown using pollinator friendly practices. Furthermore, this could show that consumers are concerned with how the plants and fruits they buy affect pollination and pollination practices. These results align with existing research on consumer preferences for pollinator friendly production methods on ornamental plants (Khachatryan and Rihn, 2020)

Participants also exhibited a great value for fruit from in-state or a U.S. origins, supporting hypothesis 3. This result supports Caprio and Isengildina-Massa 2009 study of consumers in South Carolina that consumers value locally grown over imported products and are willing to pay a price premium for the local products.

For the plants, participants exhibited low tolerance for visible damage indicating the need for control methods that eliminated the pest or minimize potential damage by the pest, supporting hypothesis 5. Plant aesthetics have been identified as a key quality indicator when purchasing plants (Kugler 2009). These results support this finding. Similarly, the moneyback guarantee generated value (supporting hypothesis 4) indicating that consumers prefer their products to be in good condition and want to have peace of mind (i.e., a refund) if the product were to be damaged shortly after purchase. Guarantees reduce risk when purchasing plants and can aid in generating consumer loyalty (Behe & Fry, 2020; Dennis et al., 2004).

Lastly, respondents' concern for their personal and environmental safety increased when pesticides were used on food producing plants. This information is of particular importance to growers who are growing food producing plants or fruits (apples and blueberries in particular). Growers should consider how consumers view their flatheaded borer control methods and how they align with their product offerings when deciding on the information to share and promote about their products. Using more environmentally friendly practices when controlling flatheaded borer is one means to satisfy the customer. In turn, informing customers about environmentally friendly production practices used to grow the plants may result in increased profits. Future research could expand the products investigated to identify the robustness of the results across different product categories and markets.

CHAPTER 2:

BLUEBERRY AND BLUEBERRY BUSH ENIVRONMENTAL TARGET MARKETING

Abstract

In Chapter 2, a Ward's Linkage Cluster analysis was introduced to effectively create three distinct groups or consumer clusters. The Ward's Linkage Cluster method has been an industry standard and is used as a classification tool in marketing (Stauss, 2017). The groups were created based on participants' environmental preferences to identify differences in preferred flatheaded borer control methods when considering blueberry fruit and bushes. Within the groups, preferences varied from being environmentally conscious to not being environmentally conscious. Participants' preferences for alternative flatheaded borer control methods were assessed using choice experiment scenarios and mixed logit models (similar to Chapter 1) but only for blueberries and blueberry bushes. All three groups seemed to value alternative control methods in blueberries more than blueberry bushes. Regardless of group membership, participants indicated they were willing to pay a premium for pollinator friendly practices. Information about these groups provide information on consumer preferences to consider when developing their marketing and production practices.

Introduction

For companies to compete in today's high demand market, producers need to create marketing strategies centered around homogenous groups (i.e., target marketing). These homogenous groups are known as market segments. By identifying specific segments, producers can tailor and concentrate most of their marketing efforts toward specific groups of individuals who are most likely to consume their goods or services. This helps producers reach their financial goals and establish a competitive edge on competitors (Goyat 2011).

This study uses cluster analysis to identify and focus on potential target markets for blueberries and blueberry bushes based on how consumer environmental preferences influence their willingness to pay for these items. This study provides producers with additional knowledge of consumer preferences and where in the market producers should focus their efforts. In turn, this will help producers identify a target market and gain a competitive advantage on competitors.

Econometric Analysis and Conceptual Framework and Literature Review

To address the research objective, a Wards linkage cluster analysis was used. The Ward's linkage measures the variance of the groups (i.e., clusters) relative to each other. According to Strauss and Maltitz (2017) the distance of the clusters or difference is based on the increase of the sum of the squares which can be expressed as $I_{AB} = SSE_{AB}-(SSE_A+SSE_B)$ where I_{AB}= minimization of sum of squares. Where A is cluster A and B is cluster B for the Sum of the Squares (SSE). The SSE are defined as: $SSE_A = \sum_{i=1}^{n_A}(a_i - \bar{a})'(a_i - \bar{a})$, $SSE_B = \sum_{i=1}^{n_B}(b_i - \bar{b})'(b_i - \bar{b})$, $SSE_{AB} = \sum_{i=1}^{n_{AB}}(y_i - \bar{y}_{AB})'(y_i - \bar{y}_{AB})$ where a_i represents the i^{th} observation vector in cluster A, and $\bar{a}$ the centroid of cluster A. b_i represents the i^{th} observation vector in cluster B, and $\bar{b}$ the centroid of cluster B. y_i represents the i^{th} observation vector in cluster AB, and $\bar{y}_{AB}$ the centroid of newly formed cluster AB. To calculate willingness to pay (WTP) we used the equation $-1(\beta_{attribute}/\beta_{price})$ where β is the coefficient. The coefficients were estimated using the mixed logit approach $P_{ni}=\int(\frac{e^{\beta' x_{ni}}}{\sum_j e^{\beta' x_{ni}}})\Theta(\beta|b,W,)d\beta$, where β are the coefficients, $\Theta(\beta|b,W,)$is the normal density and b is the mean, W is the covariance, P is the utility from n choice of i, n is the respondents, i is the choices (Train, 2003).

By using this technique, participant clusters were estimated based on participants' environmental views and concerns. Environmental perceptions were used given that the type of flatheaded borer control method used could have an impact on the environment and people may perceive the different control methods as being better or worse for environment (e.g., chemical-based controls may be perceived negatively) (Wei, et al. 2020). To determine participants' environmental views, respondents answered six environment related questions which were then used in the cluster analysis. In these questions, respondents rated the statements using a 5-point Likert scale of strongly disagree (1) to strongly agree (5). The six statements, their means and standard deviations are shown in Table 8.

In the statements, participants agreed most with "Providing pollinator plants in my garden is important to me" followed by "Home gardeners can improve the environment with their gardening practices," and" Reducing pesticides or fertilizers used in my garden is important to me." The six statements were used in a Wards's linkage cluster analysis and three clusters were formed. The first cluster consisted of 18.3% of the sample and had the lowest level of agreement with the environmental statements (hereafter called "indifferent" group). The second cluster consisted of 54.3% of the sample and had an average level of agreement with the environmental statements (hereafter called "middle" group). The third cluster had 27.4% of the sample and had the highest level of agreement with the environmental statements (hereafter called "environmental" group). It is hypothesized that the environmental group for both blueberries and blueberry bushes will be willing to pay more for alternative growing methods such as the cover crop, cultivar, and no control methods when compared to the drench method (H1). Furthermore, it is hypothesized that pollinator friendly practices will bring a higher

willingness to pay across all three clusters when compared to no pollinator friendly production practices for both blueberries and blueberry bushes (H2).

Table 9 presents the environmental perceptions and summary socio-demographic variables by cluster. Regarding the first environmental statement "responses to this survey will influence the types of products offered by gardening products industry" all three clusters varied with the environmental cluster having the most agreement and the indifferent group having the least agreement. The statement "home gardeners can improve the environment with their gardening practices" varied across all three clusters with the environmental cluster having the highest agreement and the indifferent cluster having the least agreement. "Providing wildlife habitat in my garden is important to me" varied across all three clusters with the environmental group agreeing the most and the indifferent group agreeing the least to the statement. "Reducing pesticides or fertilizers used in my garden is important to me" varied across all three clusters with the environmental group agreeing the most and the indifferent group agreeing the least to the statement. "Using water conservation methods in my garden is important to me" varied across all three clusters with the environmental group agreeing the most and the indifferent group agreeing the least with the statement. "Providing pollinator plants in my garden is important to me" varied across all three clusters with the environmental group agreeing the most and the indifferent group agreeing to the statement the least.

For demographics, age varied across all three clusters with the environmental group being the oldest and the indifferent group being the youngest. For female representation the environmental group had the highest percent of female participants while the middle and indifferent group had a slightly lower percentage of female. College graduates varied across all

three clusters with the middle group having the most and the indifferent group having the least. Household income varied across all three clusters with the middle group having the highest income and the indifferent group having the lowest. White ethnicity varied across all three clusters with the environmental group having the most and the indifferent group having the least. Black ethnicity varied across all three clusters with the indifferent group having the most and the environmental group having the least. For all other ethnicities, the indifferent and middle groups had the largest percent while the environmental group had the lowest portion. Urban area respondents varied across all three clusters with the indifferent group having the most and the environmental group having the least. Suburb area respondents varied across all three clusters with the environmental group having the highest and the indifferent group having the least. For rural area respondents the middle and environmental groups had the highest and the indifferent group had the least. For the analysis, the sample was split by the product that was evaluated (i.e., blueberry fruit, blueberry bushes) and summary statistics were observed.

Results

Blueberries

Table 10 shows the demographic variables for all three clusters for subsample that evaluated the blueberry fruit. Significance across cluster was determined using ANOVA and Tukey's honest significance test. The age demographic varied across all three clusters with the environmental group being the oldest at (57.6) and the indifferent group being the youngest (47.3 years). For female representation the environmental group had the highest percent at nearly 70% and the middle and indifferent group had the lowest percent (~64%). For college graduates the middle group had the highest amount (40%) while the environmental and indifferent group had

the lowest (26-28%). Household income varied across all three clusters with the middle group making the most ($55,972) and the environmental group making the least ($46,727). White ethnicity varied across all three clusters with the environmental group having the largest proportion (84.8%) and the indifferent group having the least (75.4%). Black ethnicity was highest among the indifferent and middle groups (~12%) and lowest in the environmental group (7.5%). For all other ethnicities and race, the middle group had the most (7.4%) with the environmental and indifferent group having the least (~5%). Urban residents varied across all three clusters with the indifferent group having the most (29.8%) and the environmental group having the least (19%). For suburb residents, the middle and the environmental group have the most (38-39%) with the indifferent group having the least amount (14%). Rural residents varied across all three clusters with the environmental group having the most (29.1%) and the indifferent group having the least (29.1%).

To determine differences across clusters for flatheaded borer controls, participants' willingness to pay estimates were viewed across the clusters for blueberry bushes (Table 11). For the indifferent cluster, cover crop and no control methods were significant at 5 percent when compared to the drench method and carried price premiums of $1.46 and $1.23, respectively. Pollinator friendly production methods were significant when compared to non-pollinator friendly production methods and carried a price premium of $1.06. None of the origin or retail location attributes were significant.

When considering the flatheaded control methods for the middle cluster, the cultivar, cover crop, and no control methods were significant, and had price premiums of $1.82, $2.14, and $1.38 respectively when compared to the drench method (Table 11). Pollinator friendly

production methods were significant when compared to non-pollinator friendly production methods and carried a price premium of $2.69. U.S. and in-state origins were significant when compared to imported and carried price premiums of $1.41 and $0.92, respectively. Specialty and grocery stores were significant when compared to big box stores and carried a price premium of $0.82.

For the environmental cluster, the cultivar, cover crop, and no control methods were significant and positive when compared to the drench method and carried price premiums of $3.07, $2.93, and $1.65, respectively. The spray method was significant and negative with a discount of -$1.63 relative to the drench method. These results are partially in support of hypothesis 1(i.e., the environmental group will prefer and value alternative controls to the drench method). Pollinator friendly production methods were significant when compared to non-pollinator friendly production methods and carried a price premium of $5.30. U.S. and in state origins were significant when compared to imported and carried price premiums of $1.94 and $1.32, respectively (supporting hypothesis 2). Farmers markets, specialty stores, and grocery stores were significant and positive when compared to big box stores and carry a price premium of $1.98, $1.75, $1.89, respectively.

Blueberry Bushes

Table 12 describes the demographics of each cluster for the blueberry bush choice experiment. For the age demographic, the middle and environmental groups had the highest age (nearly 49 years) while the indifferent group had the lowest (37.8 years). For female representation, the environmental group had the highest (73%) and the middle and indifferent group had the lowest (70%). College graduates varied across all three clusters with the

environmental group having the most (36%) and the indifferent group having the least (27%). Household income varied across all three clusters with the environmental group making the most ($59,067) and the middle group making the least ($49,065). White ethnicity varied across all three clusters with the highest in the middle group (86.2%) and the lowest in the indifferent group (64.9%). Black ethnicity varied across all three clusters with the highest in the indifferent group (24.3%) and lowest in the environmental group (6.7%). All other ethnicities varied across all three clusters with the highest being in the indifferent group (10.8%) and the lowest being in the middle group (5.5%). Urban area respondents varied across all three clusters, the indifferent group had the highest (35.1%) and the middle group had the lowest (17.9%). For suburb area respondents the environmental group had the most (45.3%) with the indifferent and middle groups having the least (~40%). For rural area respondents, the middle group had the most (26.9%) with the indifferent group having the least (13.5%).

To determine differences across clusters for flatheaded borer controls, participants' willingness to pay estimates were viewed across the clusters for blueberry bushes (Table 13). For the indifferent cluster, cultivar and cover crop were the only significant control methods and they had a premium of $11.78 and $10.86 respectively when compared to the drench method. Pollinator friendly practices and a 6-month money back guarantee against flatheaded borer infestation resulted in premiums of $15.23 and $7.87, when compared to blueberry bushes without these attributes. Visible flatheaded borer damage was significant and required a discount of -$12.49 when compared to blueberry bushes without damage. None of the retail outlets were significant.

When considering the flatheaded control methods for the middle cluster, cultivar selection and cover crops were the only significant control methods and had a premium of $7.40 and $9.01 when compared to the drench method (Table 13). Pollinator friendly production methods and a 6-month guarantee against flatheaded borer infestation resulted on premiums of $11.60 and $7.60, respectively, when compared to blueberry bushes without these attributes. Visible flatheaded borer damage had a significant, negative impact on willingness to pay (-$12.14). None of the retail outlets were statistically significant for the middle group.

For the environmental cluster, cover crop was the only significant control method and had a premium of $6.45 when compared to the drench method. Pollinator friendly production methods and a 6-month guarantee against flatheaded borer infestation resulted on premiums of $6.60 and $6.65, respectively, when compared to blueberry bushes without these attributes. Visible flatheaded borer damage had a significant negative impact on willingness to pay requiring a discount of -$5.73. None of the retail outlets significantly impacted the environmental group's value of blueberry bushes.

Conclusion

The cluster analysis revealed three distinct clusters based on participants' existing environmental perceptions. The three clusters included indifferent (18.3%), middle (54.3%) and environmental (27.4%) clusters. The environmental cluster agreed with the environmental statements more so than the other two clusters. The middle cluster exhibited the next highest environmental ratings while the indifferent cluster had the lowest ratings.

The environmental and middle clusters selected and valued blueberries that were grown within their own state or within the U.S. over imported fruit. Furthermore, the location where

blueberries are sold (i.e., retail outlet) only affected consumers' willingness to pay for those who are in the middle group (cluster 2). However, the environmental cluster was the only cluster that had all three retail store outlets positively impacting likelihood of selection relative to big box stores. Each of these attributes may be related to product quality perceptions. Often fresh produce from closer origins are considered fresher and of higher quality than produce from further distances(Chambers, 2007). Additionally, research has demonstrated that retail outlet can influence quality perceptions where specialty stores are often considered to have higher quality products than more generalized outlets (Yue & Behe, 2008).

When considering blueberry fruit, the cover crop and no control methods were significant and had a positive impact on consumers' willingness to pay across all 3 clusters. This result implies that for blueberries (i.e., fruit for consumption) consumers are displaying a preference for chemical free flatheaded borer control methods. The most environmentally conscious cluster and the indifferent cluster had the spray method as having a significant negative impact on consumers' willingness to pay. These results partially support hypothesis 1 that the environmental group will prefer alternative control methods (relative to the drench method) for the products. Pollinator friendly practices were significant and positive across all three clusters, which is supported by previous literature (Rihn, 2016).

The majority of blueberry consumers would pay a premium for blueberries grown using pollinator friendly production practices, grown in-state, or grown domestically. If blueberry growers' operations fall within these categories, marketing messages could be used to communicate these attributes to customers. If the grower's primary customer is more

environmentally conscious, using alternative flatheaded borer control methods that do not rely upon chemicals may improve their value for those products.

For blueberry bushes, all clusters were negatively affected by flatheaded borer damage. All three clusters were willing to pay a price premium for a 6-month money back guarantee program when they purchased blueberry bushes. For all three clusters, retail outlet did not impact purchasing behavior nor valuation. This could show that consumers of blueberry bushes place a higher preference on the condition and guaranteed protection of the plant and less emphasis on where the bush is purchased. The middle and indifferent clusters viewed the cultivar method as significant relative to drench. All three clusters viewed the cover crop method as significant compared to drench. However, some caution should be used when interpreting the indifferent cluster given the smaller sample size relative to the middle and environmental clusters.

Overall, both blueberry and blueberry bush respondents in all three clusters valued pollinator friendly practices and were willing to pay a price premium for growing practices that support pollinator health (supporting hypothesis 2). From this observation one can conclude that pollinator health is considered important by most individuals regardless of their environmental attitudes. The control methods used seemed to have a larger impact on blueberries than blueberry bushes across all three clusters. One could speculate that consumers have a more vested interest and concern for products they consume such as blueberries over products they do not directly consume such as blueberries. Further research could clarify and investigate this hypothesis and confirm its validity.

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APPENDIX

Tables

Table 1. Product Attributes Offered in the Choice Sets for Fresh Blueberries, Fresh Apples, a Blueberry Bush, and a Maple Tree.

Attributes	Fresh Blueberries-1 pint	Fresh Apples-3 pound bag	Blueberry Bush-1 gallon	Maple Tree-5 gallon
Price	$2.00, $3.00, $4.00, $5.00	$2.49, $3.49, $4.49, $5.49	$22.00, $27.00, $32.00, $37.00	$30, $37.50, $45, $52.50
Pollinator Friendly Method Used	Yes, No	Yes, No	Yes, No	Yes, No
Flatheaded Borer Control Method	Drench, Spray, Cover Crop, Cultivar Selection, None	Drench, Spray, Cover Crop, Cultivar Selection, None	Drench, Spray, Cover Crop, Cultivar Selection, None	Drench, Spray, Cover Crop, Cultivar Selection, None
Money Back Guarantee	---	---	No, Yes-Up to 6 Months	No, Yes-Up to 6 Months
Visible Damage	---	---	Yes, No	Yes, No
Place Where Purchase	Grocery, Big Box, Specialty, Farmers Market	Grocery, Big Box, Specialty, Farmers Market	Local Garden Center, Home Improvement, Hardware Store, Online	Local Garden Center, Home Improvement, Hardware Store, Online
Product Origin	Own State, U.S., Imported	Own State, U.S., Imported	---	---

Table 2. Survey Sample Demographics and Census Estimates for the U.S. Population.

Respondent Demographic Measure	Median	N	U.S. Census Estimate[1]	Description
Age (years)	47	1,597	38.2	Median age of respondent
Female gender (%)	69.57%	1,597	50.80%	Percent of female participants
2021 Household income ($1,000 before taxes)	53.238	1,566	$64,994	Median household income of respondents
College graduate (%)	30.93%	1,597	32.90%	Parentage of college graduates
Household size (persons)	2.636	1,584	3.21	Total Household size
Children under 18 in household (%)	34.47%	1,590	22.40%	Percentage of households that have children
Urbanization (%)				Percentage breakdown of urbanization of respondents
Rural or small town	36.11%	576	19.30%	A breakdown of the living area of the respondent
Suburban	37.93%	605		
Urban	25.96%	414	80.70%	
Single unit owned house (%)	45.50%	1,597	64.40%	The percentage of respondents that live in a single unit home that they own

[1]All U.S. Census Estimates were taken from the 2020 Census data excluding Urbanization percentages which came from the 2010 Census data.

Table 3. Conditional Logit Model Estimates of U.S. Consumers Preferences for Blueberries Grown Using Different Flatheaded Borer Control Methods (n=287)

Blueberries		
Variable	Coef.	SE
Price	-0.286***	0.021
Pollinator Friendly[1]	0.849***	0.045
Cover Crop[2]	0.861***	0.068
Cultivar[2]	0.792***	0.083
Spray[2]	0.191**	0.07
No Control[2]	0.618***	0.067
Grocery[3]	0.124*	0.057
Specialty[3]	0.191**	0.063
Farmers Market[3]	0.129*	0.063
In State[4]	0.229***	0.058
Us Origin[4]	0.364***	0.058
None Chosen	-0.767***	0.134

***,**,* indicate significance at <0.1%,1%,and5%, respectively.
[1]Base attribute level for the pollinator friendly growing practices attribute was “Not pollinator friendly growing practices”.
[2]Base attribute level for the control method was “drench”.
[3]Base attribute level for the retail environment was “big box stores”.
[4]Base attribute level for origin was “imported”.

Table 4. Condition Logit Model Estimates of U.S. Consumers Preferences for Apples Grown Using Different Flatheaded Borer Control Methods (n=317)

Apples		
Variable	Coef.	SE
Price	-0.35***	0.02
Pollinator Friendly[1]	0.836***	0.043
Cover Crop[2]	0.892***	0.066
Cultivar[2]	0.808***	0.08
Spray[2]	0.322***	0.067
No Control[2]	0.614***	0.065
Grocery[3]	0.164**	0.055
Specialty[3]	0.086	0.061
Farmers Market[3]	0.165**	0.06
In state[4]	0.127*	0.055
U.S. Origin[4]	0.266***	0.056
None Chosen	-0.966***	0.12

***,**,* indicate significance at <0.1%,1%,and5%, respectively.
[1]Base attribute level for the pollinator friendly growing practices attribute was “Not pollinator friendly growing practices”.
[2]Base attribute level for the control method was “drench”.
[3]Base attribute level for the retail environment was “big box stores”.
[4]Base attribute level for origin was “imported”

Table 5. Conditional Logit Model Estimates of U.S. Consumers Preferences for Blueberry Bushes Grown Using Different Flatheaded Borer Control Methods (n=261)

Blueberry Bushes		
Variable	Coef.	SE
Price	-0.049***	0.004
Damage[1]	-0.498***	0.05
Pollinator[2]	0.636***	0.048
Cover Crop3	0.247***	0.06
Cultivar[3]	0.332***	0.077
Spray[3]	-0.001	0.069
No Control[3]	0.011	0.071
Home Improvement[4]	0.097	0.053
Online[4]	-0.052	0.068
Garden Center[4]	0.045	0.053
Guarantee[5]	0.4***	0.051

***,**,* indicate significance at <0.1%,1%,and5%, respectively.
[1]Base attribute level for the damage variable was “no damage”.
[2]Base attribute level for the pollinator friendly growing practices attribute was “Not pollinator friendly growing practices”.
[3]Base attribute level for the flatheaded borer control methods was “drench”.
[4]Base attribute level for the retail environment was “big box stores”.
[5]Base attribute level for guarantee was “no guarantee”.

Table 6. Conditional Logit Model Estimated of U.S. Consumer Preferences for Maple Trees Grown Using Different Flatheaded Borer Control Methods (n=268)

Maple Trees		
Variable	Coef.	SE
Price	-0.036***	0.003
Damage[1]	-.493***	0.046
Pollinator[2]	0.521***	0.048
Cover Crop[3]	0.277***	0.063
Cultivar[3]	0.116	0.076
Spray[3]	-0.143*	0.069
No Control[3]	-0.095	0.072
Home Improvement[4]	0.202***	0.055
Online[4]	0.093	0.069
Garden Center[4]	-0.024	0.057
Guarantee[5]	0.382***	0.057

[1]Base attribute level for the damage variable was “no damage”.
[2]Base attribute level for the pollinator friendly growing methods attribute was “not pollinator friendly growing methods”.
[3]Base attribute level for the flatheaded borer control methods was “drench”
[4]Base attribute level for the retail environment was “big box stores”.
[5]Base attribute level for guarantee was “no guarantee”.

Table 7. Reported of Concern for Personal and Environmental Safety of Pesticide Use on Fresh Fruits and Plants (n=1,597)

	Personal Safety	Environmental Safety
Concerns About Pesticide Use on	Mean Rating of Concern[1]	
Fresh Fruit	3.48	3.48
Outdoor Food producing Plants	3.41	3.44
Indoor Food Producing Plants	3.26	3.32
Outdoor Ornamental Plants	2.95	3.00
Indoor Ornamental Plants	2.91	2.95

[1] Level of concern was measured using a 5-point Likert scale (1= Not at all, … 5= Extremely).

Table 8. Environmental Perception Questions (n=541)

Question	Total (1=strongly disagree, 5=strongly agree) Mean	Std. err
Responses to this survey will influence the types of products offered by the gardening products industry.[1]	3.673	0.989
Home gardeners can improve the environment with their gardening practices.[1]	4.026	0.967
Providing wildlife habitat in my garden is important to me.[1]	3.908	1.042
Reducing pesticides or fertilizers used in my garden is important to me.[1]	4.022	0.996
Using water conservation methods in my garden is important to me.[1]	3.863	0.997
Providing pollinator plants in my garden is important to me.[1]	4.039	1.021

[1]Environmental perceptions variables.

Table 9. Environmental Perception Questions Responses and Demographics, by Cluster

	Indifferent (n=99)			Middle (294)			Environmental (148)		
Question	Mean	SE		Mean	SE		Mean	SE	
Responses to this survey will influence the types of products offered by the gardening products industry.[1]	2.566	0.835	a	3.789	0.786	b	4.189	0.883	c
Home gardeners can improve the environment with their gardening practices.[1]	3.04	0.968	a	3.967	0.817	b	4.818	0.404	c
Providing wildlife habitat in my garden is important to me.[1]	2.869	0.954	a	3.78	0.896	b	4.818	0.452	c
Reducing pesticides or fertilizers used in my garden is important to me.[1]	3.04	1.049	a	3.98	0.866	b	4.764	0.457	c
Using water conservation methods in my garden is important to me.[1]	2.717	0.937	a	3.762	0.719	b	4.838	0.421	c
Providing pollinator plants in my garden is important to me.[1]	2.717	0.969	a	4.109	0.789	b	4.798	0.42	c
Demographics									
Age	44.909	17.965	a	50.745	17.402	b	53.203	16.298	c
Female	0.657	0.477	a	0.656	0.476	a	0.75	0.434	b
College Graduate	0.283	0.453	a	0.361	0.481	b	0.311	0.464	c
Household Income	49.691	39.117	a	53.31	37.787	b	52.671	41.328	b
White	0.737	0.442	a	0.82	0.385	b	0.838	0.37	c
Black	0.152	0.36	a	0.105	0.308	b	0.074	0.37	c
Other ethnicity/race	.071	0.258	a	0.071	0.258	a	0.047	0.214	b
Urban	0.323	0.47	a	0.211	0.409	b	0.196	0.398	c
Suburb	0.354	0.481	a	0.395	0.49	b	0.419	0.495	c
Rural	0.152	0.36	a	0.235	0.425	b	0.243	0.43	b

[1]Environmental perceptions variables. (1=strongly disagree; 5=strongly agree)
[3]Different letters indicate significance at the 5% level. Significance was determined using ANOVA and Tukey's honest significance test.

Table 10. Summary Statistics for Three Clusters of Participants Evaluating Purchase Preferences for Blueberries Produced Using Different Production Methods.

Blueberries											
	Total (n=284)		Indifferent (n=57)			Middle (n=148)			Environmental (n=79)		
Variable	Mean	SD	Mean	SD		Mean	SD		Mean	SD	
Age	53.155	17.221	47.316	18.36	a	53.48	17.485	b	57.59	14.8	c
Female	0.655	0.476	0.638	0.487	a	0.642	0.481	a	0.696	0.463	b
College Graduate	0.338	0.474	0.263	0.444	a	0.399	0.491	b	0.278	0.451	a
Household Income	52.174	39.113	46.727	31.45	a	55.972	40.819	b	48.961	40.477	c
White	0.803	0.399	0.754	0.434	a	0.797	0.403	b	0.848	0.361	c
Black	0.109	0.312	0.123	0.331	a	0.122	0.323	a	0.075	0.267	b
Other ethnicity/race	0.063	0.244	0.053	0.225	a	0.074	0.263	b	0.051	0.221	a
Urban	0.232	0.423	0.298	0.462	a	0.23	0.422	b	0.19	0.395	c
Suburb	0.377	0.485	0.351	0.481	a	0.378	0.487	b	0.392	0.491	b
Rural	0.225	0.419	0.14	0.35	a	0.223	0.418	b	0.291	0.457	c

[a] Different letters indicate significance at the 5% level. Significance was calculated using ANOVA and Tukey's honest test.

Table 11. Willingness to Pay Estimates Addressing Consumers Value of Alternative Flatheaded Borer Control Methods on Blueberries.

Blueberries Willingness to Pay						
	Indifferent (n=57)		Middle (n=148)		Environmental (n=79)	
Variable	Coef.	SE	Coef.	SE	Coef.	SD
Cultivar[1]	0.874	0.618	1.822***	0.388	3.07***	0.74
Covercrop[1]	1.464**	0.537	2.142***	0.334	2.927***	0.614
Spray[1]	-1.053	0.601	-0.424	0.326	**	0.604
No control[1]	1.275*	0.532	1.382***	0.314	1.648**	0.537
Pollinator[2]	1.056**	0.367	2.694***	0.302	5.295***	0.835
In state[3]	0.018	0.443	0.922**	0.275	1.319**	0.477
U.S.[3]	0.294	0.453	1.408***	0.289	1.938***	0.515
Farmers market[4]	-0.703	0.462	0.399	0.273	1.978***	0.562
Specialty[4]	-0.296	0.476	0.824**	0.283	1.753**	0.52
Grocery[4]	-0.354	0.472	0.819**	0.279	1.893***	0.522

***,**,* indicate significance at <0.1%,1%,and5%, respectively.

[1]Base attribute level for the control method was “drench”.

[2]Base attribute level for the pollinator friendly growing practices attribute was “Not pollinator friendly growing practices”

[3]Base attribute level for origin was “imported”.

[4]Base attribute level for the retail environment was “big box stores”.

Table 12. Summary Statistics for the Three Clusters of Participants Evaluating Purchase Preferences for Blueberry Bushes Produced Using Different Production Methods.

	Blueberry Bush									
	Total (n=257)		Indifferent (n=37)			Middle (n=145)			Environmental (n=75)		
Variable	Mean	SD	Mean	SD		Mean	SD		Mean	SD	
Age	47.178	17.116	37.811	15.28	a	48.834	16.605	b	48.84	17.63	b
Female	0.713	0.453	0.703	0.463	a	0.703	0.458	a	0.733	0.445	b
College Graduate	0.329	0.471	0.27	0.45	a	0.324	0.47	b	0.36	0.483	c
Household income in thousands	52.937	38.921	54.054	49.072	a	49.065	32.657	b	59.067	43.501	c
White	0.814	0.39	0.649	0.484	a	0.862	0.346	b	0.813	0.392	c
Black	0.101	0.302	0.243	0.435	a	0.083	0.276	b	0.067	0.251	c
Other	0.066	0.249	0.108	0.315	a	0.055	0.229	b	0.067	0.251	c
Urban	0.221	0.416	0.351	0.484	a	0.179	0.385	b	0.24	0.43	c
Suburb	0.415	0.494	0.405	0.498	a	0.393	0.49	a	0.453	0.501	b
Rural	0.217	0.412	0.135	0.347	a	0.269	0.445	b	0.16	0.369	a

[a] Different letters indicate significance at the 5% level. Significance was calculated using ANOVA and Tukey's honest test

Table 13. Willingness to Pay Estimates Addressing Consumers Value of Alternative Flatheaded Borer Control Methods on Blueberry Bushes.

Blueberry Bush Willingness to Pay						
	Indifferent (n=37)		Middle (n=145)		Environmental (n=75)	
Variable	Coef.	SE	Coef.	SE	Coef.	SE
Cultivar[1]	11.775***	3.134	7.398***	2.169	3.526	3.822
Cover Crop[1]	10.863***	2.623	9.011***	1.892	6.446**	2.978
Spray[1]	-0.35	2.2	0.033	1.694	2	2.978
No Control[1]	-0.212	2.304	-0.181	1.775	3.095	3.14
Damage[2]	-12.493***	1.945	-12.140***	1.481	-5.731**	1.958
Pollinator[3]	15.234***	2.624	11.603***	1.719	6.600**	2.321
Guarantee[4]	7.865***	1.657	7.601***	1.268	6.654***	2.064
HomeImprove[5]	-0.582	1.812	2.624*	1.376	0.171	2.32
Online[5]	-1.487	2.174	1.091	1.638	-1.474	2.742
Gardencenter[5]	-0.719	1.796	1.747	1.459	-4.264	2.343

***,**,* indicate significance at <0.1%,1%, and 5%, respectively.
[1]Base attribute level for the flatheaded borer control methods was “drench”.
[2]Base attribute level for the damage variable was “no damage”.
[3]Base attribute level for the pollinator friendly growing practices attribute was “Not pollinator friendly growing practices”.
[4]Base attribute level for guarantee was “no money back guarantee”.
[5]Base attribute level for the retail environment was “big box stores”.

Figures

Figure 1. Example of Damage from Flatheaded Borers

(Photo provided by Dr. Karla Addesso, Tennessee State University)

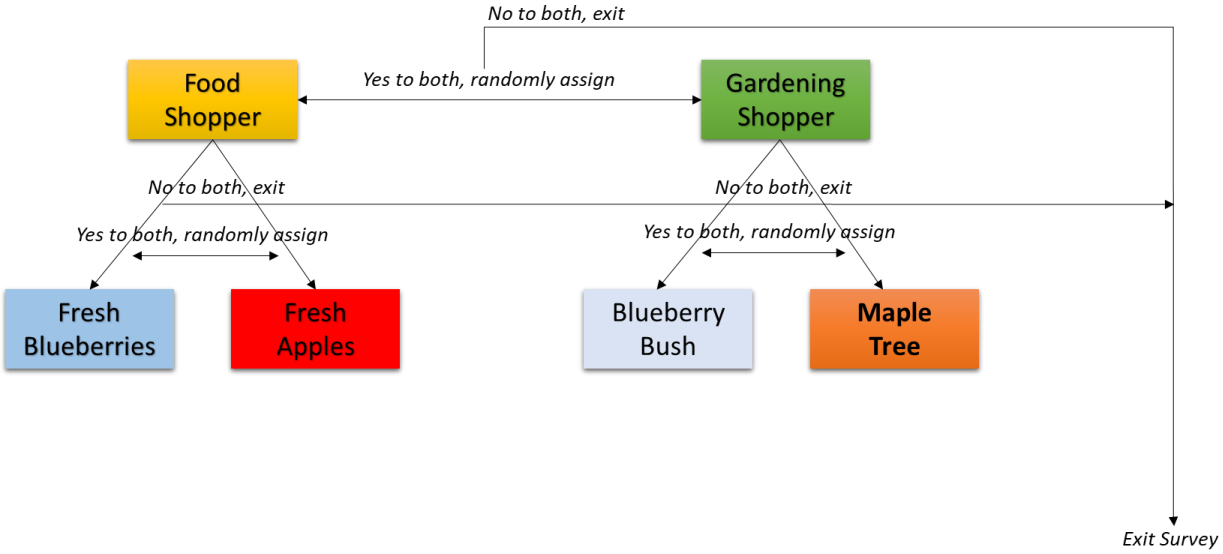

Figure 2. Diagram of Survey Flow to Product Choice Sets or Survey Exit

Please read the description for each **3-pound bag of fresh apples (about 10 apples).** All other apple attributes (such as variety, taste, shape, color, blemishes) are the same except for those listed below. **Select the bag of apples you prefer most** and would likely consider purchasing. If you would **not choose either bag of apples, please select neither bag**. FB=Flatheaded Borer.

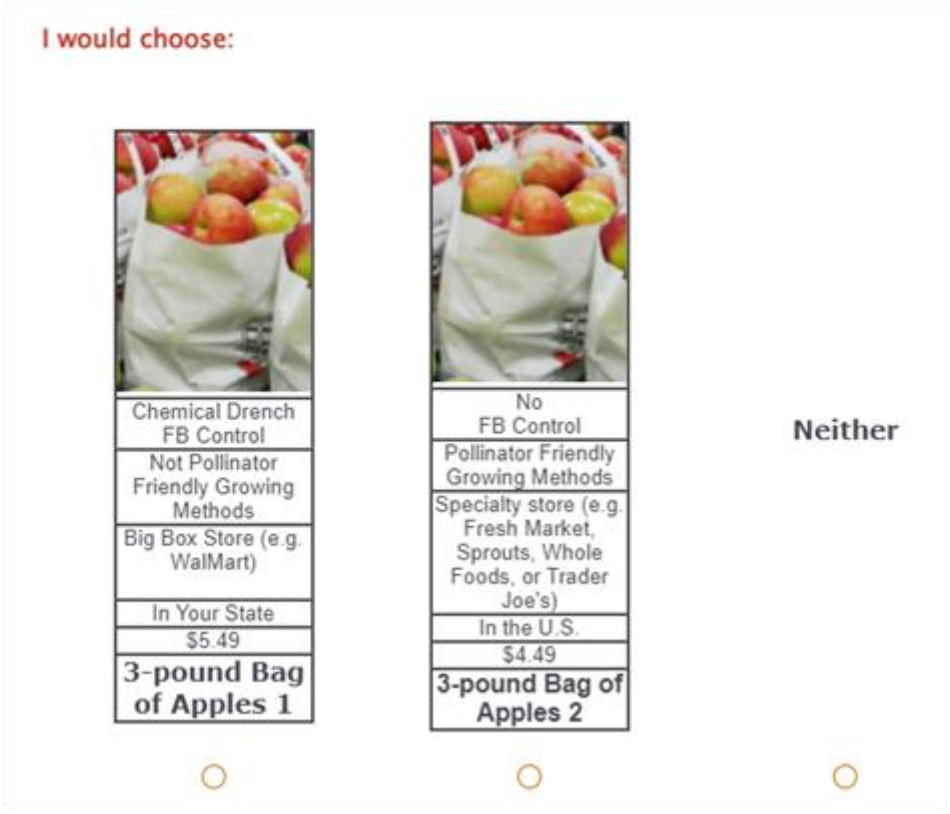

Figure 3. Example Choice Set Scenario for Fresh Apples

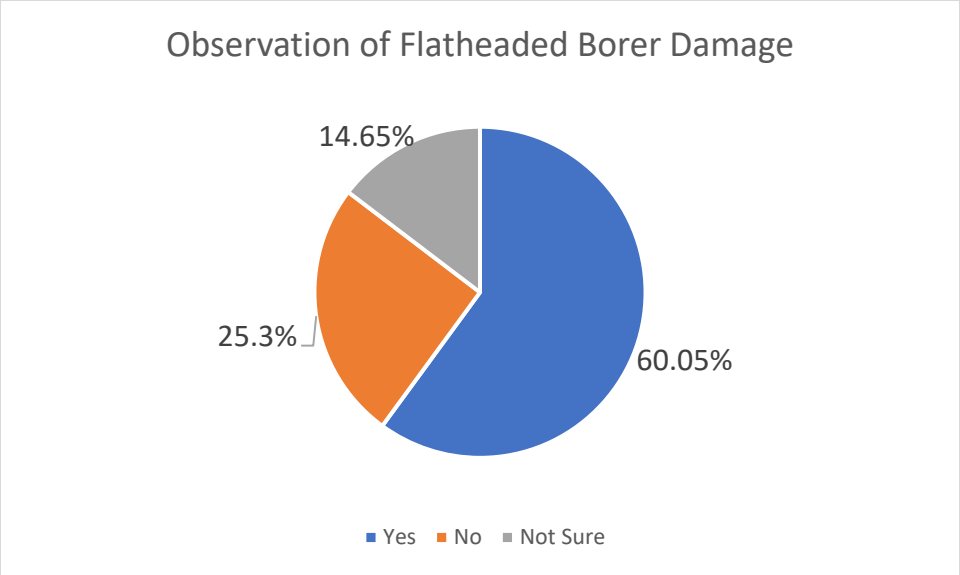

Figure 4. Percent of Sample Who Indicated Observing Flatheaded Borer Damage (n=1,597)

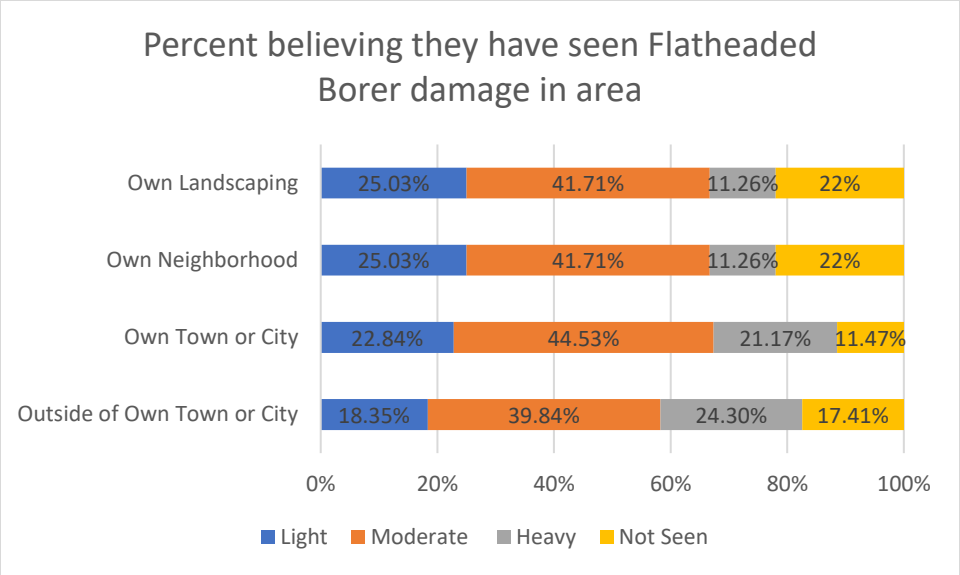

Figure 5. Locations and Levels of Flatheaded Borer Damage Observed by Participants (n=959)

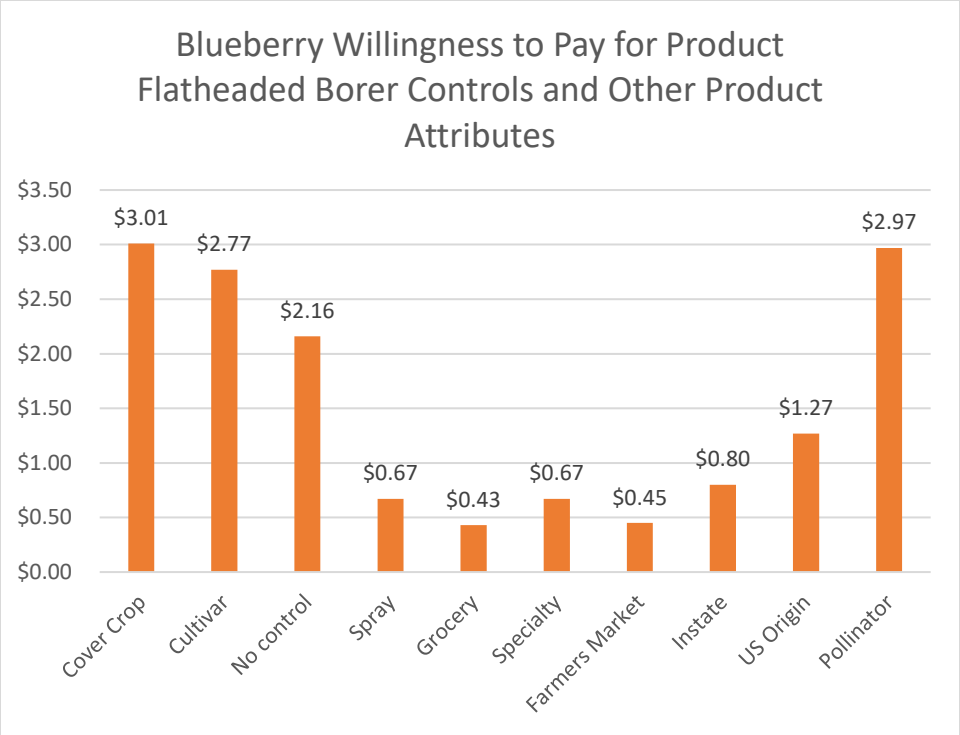

Figure 6. Participants' Willingness to Pay for Blueberries Frown Using Alternative Flatheaded Borer Control Methods and Other Product Attributes(n=287)

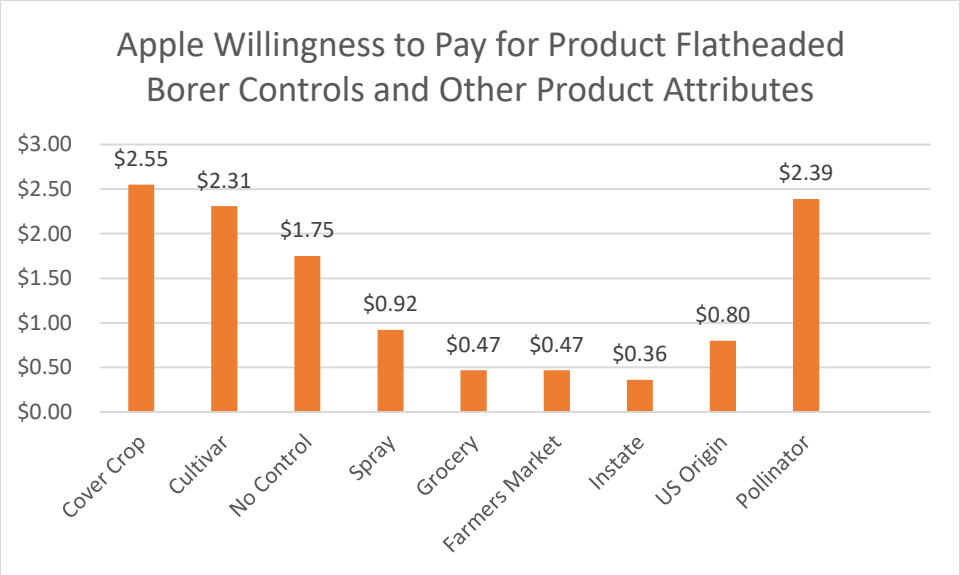

Figure 7. Participants' Willingness to Pay for Apples Grown Using Alternative Flatheaded Borer Control Methods and Other Product Attributes (n=317)

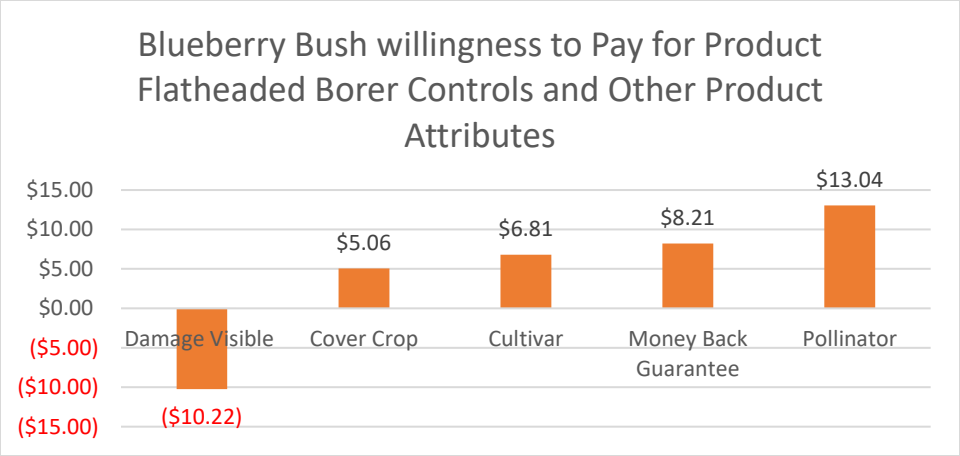

Figure 8. Participants' Willingness to Pay for Blueberry Bushes Grown Using Alternative Flatheaded Borer Control Methods and Other Product Attributes (n=261)

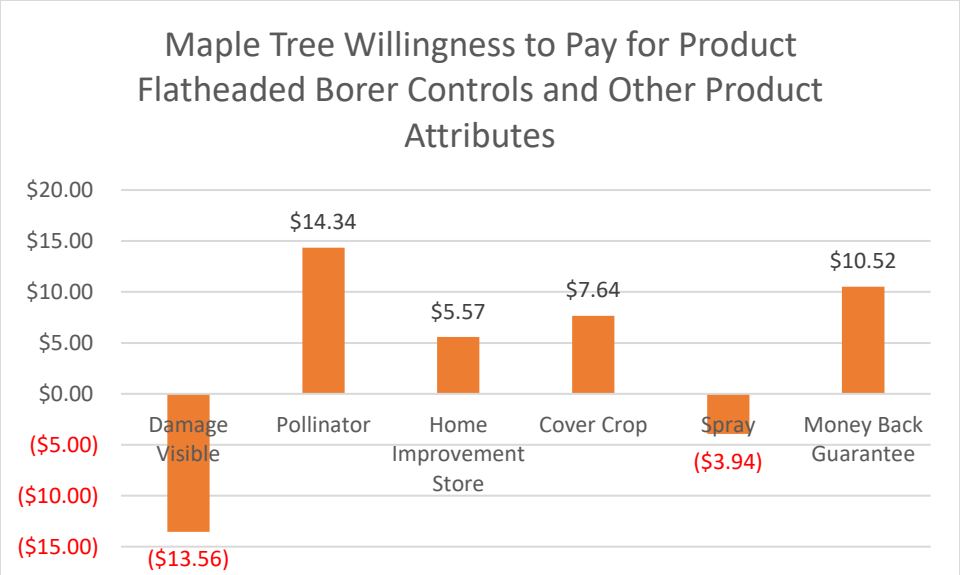

Figure 9. Participants' Willingness to Pay for Maple Trees Grown Using Alternative Flatheaded Borer Control Methods and Other Product Attributes (n=268)

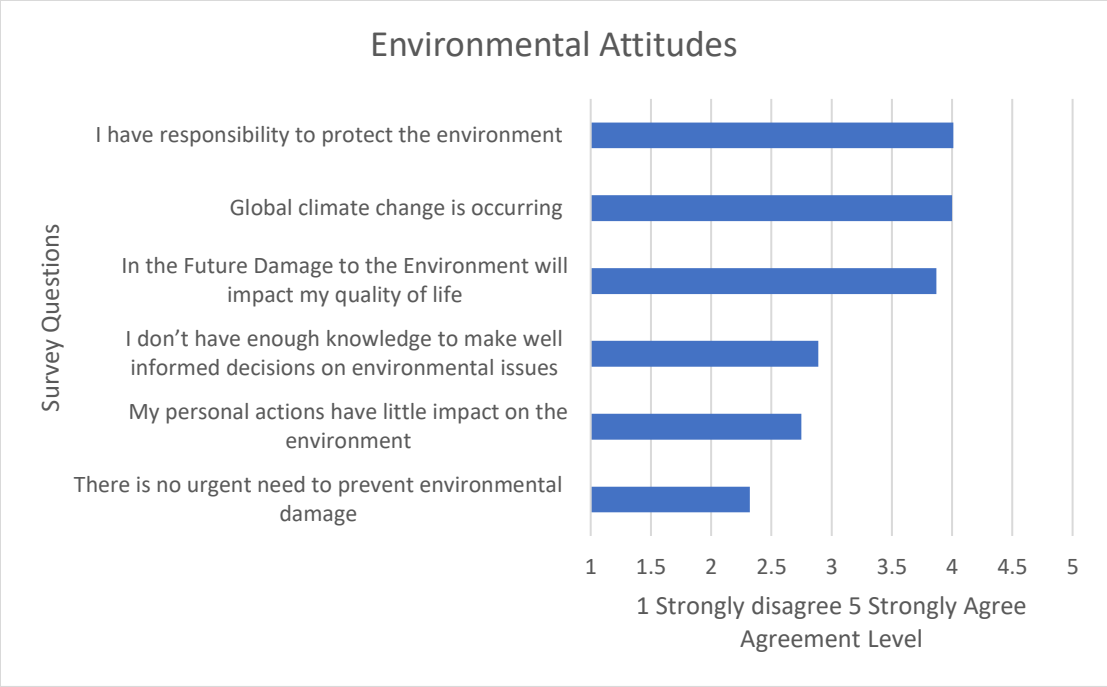

Figure 10. Participants Level of Agreement with Environmental Attitudes Statements

VITA

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