Economics and Marketing

Nick Gawel

Section Editor

Engaging Elementary Students into Horticulture with Cooperation of Master Gardeners Through Multidisciplinary Approaches in Rural Kentucky

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Significance to the Industry In order to develop a scientifically trained workforce for the horticulture, nursery and landscape industry it is necessary to create an awareness in youth of what horticulture is and that it can be an exciting and worthwhile career. This projects goal was to foster scientific interest and curiosity in 4th and 5th grade students from Caldwell and Lyon Counties in Western Kentucky. Activities were planned for them to participate actively in field days and to grow vegetables in demonstration gardens at their schools.

According to the US Census Bureau, 87.6% of high school students in Lyon County School graduated for the 2011-2015 period, a similar record (86.8%) was reported for Caldwell County School. Even though these records seem high, the number of students that received a bachelor or higher degree reached 17.8% and 16.4 % for Lyon and Caldwell counties, respectively. Among these students there is the low population of students in agricultural careers. This program was seen as an opportunity to develop a connection between children in rural communities and the University of Kentucky; and to promote a four year education degree in agricultural related sciences. Previous studies have shown that participants in summer camp garden projects with hands-on horticulture activities increased science knowledge and confidence in gardening skills. Furthermore, it helped participants to consider engaging in higher agricultural education or working in an agricultural-based career (Gillett et al., 2017). Gardening promotes stronger student-institution and student-community relationship and stimulates physical activity and psychological stability (Hassenauer and Cobb, 2015). Direct experience in the garden contributed to participants' environmental awareness and appreciation. Social interaction, excitement and motivation are learning outcomes from a natural environment besides the scientific knowledge (Alon and Tal, 2017).

Hands-on activities for 900 students were delivered at the University of Kentucky Research and Education Center Botanical Garden, Princeton, KY. Topics included plant

morphology and diversity; insect pollinators and their importance in agriculture, insect diversity and behaviors; soil types and their interactions with plants, vermicomposting, plant diseases, and the importance of environmental conservation for a sustainable future. There were two visits to the Botanical Garden scheduled per grade for each school in March-May and one visit in August-October periods to coincide with the school year. An extension agent and master gardeners from Lyon County and eight teachers from both schools collaborated with the student group organization and helped to guide students around working stations during the students' visits. Four raised beds were built at each school to support outdoor education and make this project long lasting. Fifth graders evaluated seven different experiments. Lyon Co. 5th graders made competitive presentations based on these experiments at the school and were awarded prizes and certificates based on their inclusive presentations.

Nature of Work The UKREC Botanical Garden is a 5-acre setting located at the University of Kentucky-Research and Education Center, Princeton. It was created in 1980 to evaluate and select superior environmentally sustainable plants for enhancing Kentucky's environments and landscapes. Being an enclave in a rural region, with limited resources; the garden has a potential use for becoming a learning center to teach science based knowledge and outreach. Besides, it has been Spring Visits to the UKREC Botanical Garden shown that a garden is considered a powerful tool in promoting outdoor education, social interaction, community restauration, and sustainability. The Next Generation Science Standards guidelines were taken into account to accomplish the goals of this project. The main objective was to foster scientific interest and curiosity in 4th and 5th grade students from Caldwell and Lyon Counties in Western Kentucky.

Instructors and Master Gardeners, received students and their science teachers and divided each group of 75 students into five subgroups. Each subgroup was assigned to a working station and every 20 min, they rotated until finished visiting the five stations.

Hands-on activities were delivery on diverse agricultural topics. April: Soil types and conservation; soil biology: compost and vermicomposting, carbon footprint calculation; plant hunter (plant morphology); planting vegetable seeds and seedlings (Fig. 1). May: Plant diseases: pathogen and symptom description; flowers and pollinators; mimicry and camouflage; insects: pests vs natural enemies; raised bed vegetable garden (students observed crop development after the first month) (Fig. 2).

Caldwell and Lyon County Elementary schools were provided with four raised beds; 4 feet (1.22m) wide by 8 feet (2.44m) long by 12 inches high (30.48cm). Lyon County Elementary school added 8 raised beds to provide the gardening experience for all classes (Figs. 3 and 4).

Student spring visits to the UKREC Botanical Garden five working stations were set for every visit, students rotated every 20 min. Topics included: Soil types and conservation, soil biology: compost and vermicomposting, carbon footprint calculation, plant hunter

(plant morphology), and vegetable seed and seedling planting, plant diseases, flowers and pollinators, mimicry and camouflage, insects: pests vs natural enemies and vegetable harvest.

Seven different experiments were set up at the UKREC for fifth graders to evaluate. During a two-hour visit, the students worked as 5-7 student teams to learn about basic replicated studies, record scientific data, and to operate some lab equipment. One-page report and oral presentation of the projects were assigned. Students chose to prepare power-point presentation instead of posters. Three UK faculty and three staff judged the presentations and selected the best three project presentations.

Results and Discussion At the end of the second spring visit, teachers (17 CCES, 6 LCES) and students (300 CCES, 150 LCES) were surveyed to assess their experiences and receive their input to plan fall activities. Evaluation sheets were presented to students and teachers and the results are in Fig. 5. A majority of the students, up to 86.2%, have gardened. Plant hunter morphology was the least favorite among the science teachers. Fourth grade teachers from both schools considered that activities on pollinators and soil fit their curriculum in large extend. Carbon Foot Print calculator activity did not match CCES curricula for fourth and fifth grades, besides this session evidenced that a very low number of students recycle at home, and recycling is barely done at the schools. It might have been the reason for those students evaluated it as the least favorite of all the learning sessions except for the Lyon County 4th grade. The insect mimicry and camouflage was highly ranked by students and teachers. In general, students enjoyed learning most of the activities; particularly LCES 4th graders. LCES science teacher is very active and committed to use gardening as a tool to complement her lectures and teach students to work and maintain their garden.

The quality of the events varied according to the schools, all LCES teachers judged the events as excellent (Fig. 6). The majority of CCES fourth grade teachers considered that the activities were excellent. However, CCES fifth grade teachers thought that the activities were just good for their students. Students' evaluation was similar regardless the school, fourth graders rated the events as excellent. Based on this information, and considering that the fourth graders would be our fifth graders in the fall program, we planned totally different approach. The main goal of fall program was to provide students the opportunity to learn how to evaluate fair tests, use laboratory equipment, write a report and give a presentation. Different elements of their curriculum will be integrated, such math, analysis and writing.

Master Gardener Advanced Training

Lyon County Master Gardener Association has contributed to the field days of this program through helping instructors delivering information, keeping students in groups and helping them to move between working stations. This program is also aimed at increasing the scientific knowledge of master gardeners. Advanced Master Gardener Training included hands-on and interactive sessions on pruning techniques (Fig. 7), natural enemies of garden pests, plant disease identification, and UKREC Soil

Laboratory Tour. A total of 24 master gardeners from 5 counties attended the event that was classified as very good for most of them. Both sessions included hands-on and interactive activities. The second training (Fig. 8) for 32 master gardeners included a hands-on landscape design from a blueprint, a presentation on insect pests, cutting propagation of tropicals by Forsyth pot, a self-irrigated system, and a presentation with examples on the benefits of bats.

Literature Cited

Alon, N.L. & Tal, T. (2017) Teachers as Secondary Players: Involvement in Field Trips to Natural Environments. Res Sci Educ 47: 869. https://doi.org/10.1007/s11165-016-9531-0

Anonymous. 2011. Next Generation Science Standards - Fourth Grade. Accessed November 11, 2018. https://www.nextgenscience.org/sites/default/files/4%20combined%20DCI%20standardsf.pdf

Anonymous. 2011. Next Generation Science Standards - Fifth Grade. Accessed November 11, 2018. https://www.nextgenscience.org/sites/default/files/5%20combined%20DCI%20standardsf.pdf

Gillett, C, K Fontenot, E Bush, M Walsh, C Johnson. 2017. Summer Camp Garden Project: An Opportunity to Grow the Next Generation of Horticulturists. HortTechnology 27(1):114-120.

Hasenauer, Madisen and Cobb, Hannah, "Benefits of Integrating Gardening into Outdoor Education for Elementary Students" (2015). Capstone Projects and Theses. Paper 519. Accessed November 11, 2018. https://digitalcommons.csumb.edu/cgi/viewcontent.cgi?article=1518&context=caps_thes

Fig. 1. Earthworms for vermicomposting.

Fig. 2. Pollinators are more than Monarch butterflies and honey bees

Fig 3. Students planting raised at beds LCES

Fig 4. Multiple raised beds at the LCES

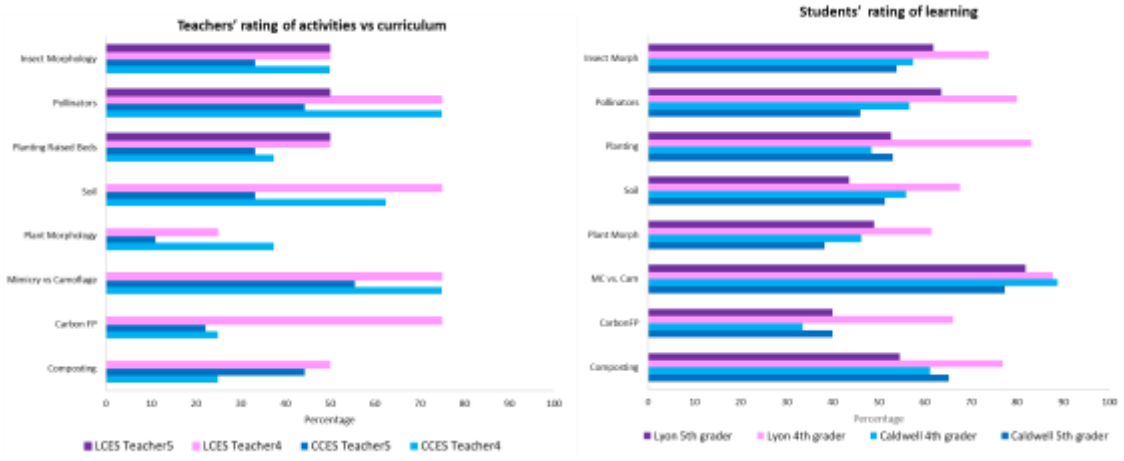

Fig. 5. Teacher's and students' evaluations of activities offered in 2018 spring.

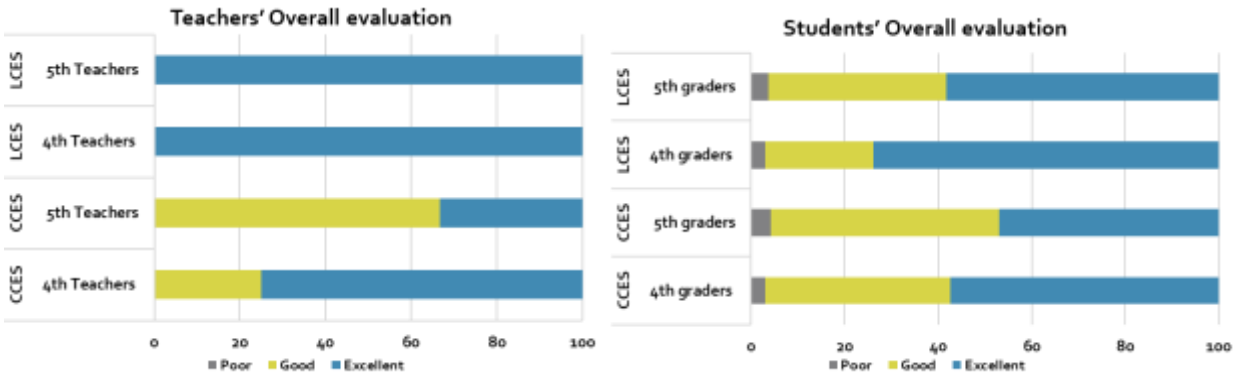

Fig. 6. Overall evaluation of the 2018 spring events at the UKREC Botanical garden.

Fig. 7. Master Gardeners Advanced Training pruning workshop.

Fig. 8. Master Gardeners Advance Training.

Consumer and Producer Preferences for Neonicotinoid Pesticide Labeling in the U.S. Green Industry

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Significance to the Industry Recent pollinator population declines have led to in-depth investigations of the cause behind weakened pollinator health and populations. Neonicotinoid pesticides have been identified as a potential contributing factor. As a result, neonicotinoids have been banned in several European countries. Additionally, large home and garden retailers in the U.S. now require plants produced using neonicotinoids to be labeled. To date, labeling of neonicotinoids is voluntary and consumer and producer reactions to these labels have not been explored. Research suggests low consumer awareness of neonicotinoids which implies labeling may have minimal effects on consumer preferences and demand. However, consumer interest in sustainable products suggests that labeling neonicotinoids may reduce demand for plants grown using neonicotinoids due to environmental concerns. On the production side, producers frequently use neonicotinoids to protect plants from insect predation. If neonicotinoid labeling influences consumer preferences, this will impact producers' production practices and potentially their profits. To date, producers' preferences for neonicotinoid usage and labeling practices have not been investigated. The current report summarizes the state of the industry focusing on consumer and producer preferences for neonicotinoid usage and labeling.

Nature of Work Parallel studies were conducted to measure consumer and producers' reactions to neonicotinoid use and neonicotinoid labeling practices. The main objective was to assess the current state of the industry and potential consumer perceptions with regards to neonicotinoid use, preferences, and related marketing strategies to determine the possible economic impacts of neonicotinoid labeling and alternative pest management strategies. The consumer study consisted of an in-person study and online survey to assess consumer preferences, knowledge, and perceptions about neonicotinoids. Estimates of consumer demand for neonicotinoid free products will be calculated. The producer study consists of national online (complete) and mail surveys (in progress). The surveys investigate current production practices, use of neonicotinoids and other pesticides in production practices, producer preferences and perceptions of neonicotinoids, and their marketing practices related to neonicotinoids (e.g. labeling practices). The benefits and costs of alternative pest management practices will be estimated.

Results and Discussion

Consumer Study Methodology: The research team administered two sets of experiments including an in-person experimental auction and an online discrete choice

experiment. The in-person experimental auction consisted of live product auctions and computer simulated auctions to examine if the experimental environment changed participants' choice decisions. The live product auction simulated a real purchasing environment and participants were able to closely examine the actual plants before submitting their bids. On the other hand, participants in the computer simulated auction were presented with on-screen images of the plants that were used in the live product auction.

A slightly different technique using information treatments was incorporated into the online choice experiment. Given the relatively limited public knowledge of neonicotinoids despite of increased media attention to neonicotinoids and pollinators (Wollaeger et al. 2015; Rihn & Khachatryan 2016), two information treatments were incorporated into the online choice experiment to test whether additional information affected participants' preferences toward labels disclosing the presence or absence of neonicotinoids. Participants randomly assigned to information treatment groups viewed a 3-miniute video with additional information about neonicotinoid prior to choice experiment while those assigned to the control group were directed straight to the choice experiment without any additional information.

Participants' demographics, knowledge and perceptions: 141 participants were recruited from central Florida for the experimental auction and 1,680 participants were recruited nationwide for the online choice experiment. Participants' demographic characteristics, purchasing behaviors, knowledge about neonicotinoid insecticides, as well as perceptions about labeling practices from both samples are summarized in Table 1. Even though participants were from two different population (Florida and national), we found that the two samples were very consistent in major demographics, knowledge about neonicotinoids, and perceptions about labeling neonicotinoids. In both samples, about 27% of the participants indicated that they have heard about neonicotinoid insecticides while the majority (more than 70%) have not. On a 7-point Likert scale, less than 20% of the participants perceived themselves as knowledgeable about neonicotinoids. Participants in both samples indicated that disclosure of "Pesticide Free" in a label is most important to them when make purchase decisions, followed by "Neonicotinoid Free" as in comparison with disclosure of other information such as Non-GMO, Organically produced, etc. Both auction and online participants agreed that the top three most attractive labeling phrases indicating pollinator friendly production were "Pollinator Friendly", "Plants for Pollinators", and "Pollinator Attractive" (Figure 1). Regarding perceptions about whether labeling neonicotinoids should be mandatory or voluntary, 75% of the auction participants and 87% of the online participants agreed that the labeling of neonicotinoids should be mandatory.

Consumer knowledge, information effect, and WTP: With experimental auction data, the estimated WTP for plants labeled as neonic-free (i.e., labeled as "Neonicotinoid Free" (text) or "Bee Better Certified" (logo)) was 3.21 dollars. Participants were willing to pay about 34 cents more for plants labeled as free of neonicotinoids. To account for the impact of heterogeneous individual knowledge on preferences for neonicotinoid

labeling, we divided participants into two dichotomy groups using their self-reported knowledge rating. We found participants in the not knowledgeable group were less impacted by whether the plant was labeled as neonicotinoid-free or not while participants in the knowledgeable group bid significantly lower for plants labeled with presence of neonicotinoids (Figure 1). Specifically, a person who was knowledgeable about neonicotinoids was willing to pay 53 cents less for a plant labeled with neonics. On the other hand, online experiment data showed participants were willing to pay about 6.00 dollars for a plant labeled as neonic-free. Higher WTP for online participants may be partially due to the hypothetical nature of online choice experiments. Further, we confirmed that negative information was more impactful and had a larger effect on individuals' choice. Participants' initial attitudes and knowledge toward neonicotinoids played an important role in how they responded to newly provided information.

Producer Study Methodology: The producer study uses both online and mail surveys to assess the current and projected use of neonicotinoid and non-neonicotinoid insecticides, to elicit producer perceptions on neonicotinoid labeling and anticipated changes in production practices due to regulation. While the mail survey is in process, 95 growers from 49 states have completed the online survey.

Operation characteristics: Among the 95 growers, 37(30%) were operating greenhouse only, 17 (18%) were operating open field or container only, while 41 (43%) had both types of operations. The average production area in 2017 was 553,761 square feet for greenhouse operations and 115 acres for open field or container operations.
Plant type categories: The top plant category reported by the surveyed firms were perennials (e.g., herbs, vines, ground covers, etc.). Seventy three of the surveyed firms indicated handling of perennials, followed by deciduous shrubs and trees (including shade, flowering, fruit producing trees), reported by 63% of the surveyed firms. The next two large plant categories were flowering potted plants (including hanging baskets) and annual bedding plants (e.g., flowers, veg., fruits, herbs).

Use of neonicotinoids and non-neonicotinoid: Foliar application was reported as the most commonly used pesticides application method in both greenhouse and open field or container production systems. 75% of the greenhouse growers and 56% of the open field or container growers reported using foliar applications. Liquid drench and soil/granular applications were the next two most widely used pesticides application methods. Based on self-reported information, Safari, Dinotefuran, Sagcity (Dinotefuran), Calypso (Thiacloprid) and Arena (Chlothianidin) were the three most widely used neonicotinoid brands by surveyed firms. Meanwhile, Acephate/Orthene (Acephate), BotaniGard ES (Beauveria bassiana Strain GHA), Konotos (Spirotetramat), Distance IGR and Fulcrum (Pyriproxifen), Endeavor (Pymetrozine), and Mainspring GNL (Cyantraniliprole) were indicated as the most widely used non-neonicotinoids brands.

Producer perceptions and predictions: Surveyed firms consistently predicted increases in input costs when the use of neonicotinoid pesticides were restricted (Figure 3). Sixty percent of the surveyed firm anticipated an increase in pesticides costs. More than half

of the surveyed firms indicated an increase in skilled/managerial labor costs and 30% indicated an increase in unskilled labor costs. In addition, surveyed firms also predicted an increase in both application frequency and man-hours after switching to non-neonicotinoid pesticides. Nonetheless, producers' projection about yield change was split. While half anticipated a decrease in yield due to potential switch of pest management practices, half of the surveyed firm anticipated a yield increase.

In terms of the most effective labeling phrases indicating pollinator friendly production, producers' perceptions were not completely in line with those of consumers (Figure 4). For example, one of the consumer's top-rated phrases "Pollinator attractive" was deemed as one of the least attractive labeling phrases to producers. In addition, producers and consumers seemed to have different perceptions regarding whether labeling of neonicotinoids should be mandatory or not. In contrast to consumers, only 25% of the surveyed firms agreed that labeling neonicotinoids should be mandatory while 59% were opposed to mandatory labeling of neonicotinoids.

Conclusions Results in this study suggested that participants had a strong preference for neonic-free products regardless of experimental method. Consumers were willing to pay a higher price for a neonicotinoid-free plants and neonicotinoid-free logo were more preferred. The producer study showed that producer preferences towards changing pest management practices were not homogeneous. Most producers anticipated an increase in production costs (increased labor input / application frequency and pesticide costs) if switching practices occurs. A cross comparison between producers' and consumers' perceptions revealed that producer and consumer preferences for neonicotinoid related labeling were somewhat different.

Literature Cited

Rihn, A. and H. Khachatryan. 2016. "Does Consumer Awareness of Neonicotinoids Influence Their Preferences for Plants?' HortScience 51: 388–393.

Wollaeger, H.M., K.L. Getter, and B.K. Behe. 2015. "Consumer Preferences for Traditional, Neonicotinoid-Free, Bee-Friendly, or Biological Control Pest Management Practices on Floriculture Crops. HortScience 50, (2015):721–732.

Table 1. Summary statistics of consumer survey

	In-person Experimental Auction	Online Choice Experiment
No. of Participants	**141**	**1,680**
Demographic Characteristics		
Gender (Male)	26%	42%
Age (mean)	55	52
White/Caucasian	85%	87%
Household Size (mean)	3	3
Education		
High School +	100%	99%
Bachelor's degree +	51%	42%
Household Income (median)	$60,000-$79,999	$40,000-$59,999
Shopping Behavior		
No. of visits per year (mean)	8	6
Average amount spent per visit (mean)	$33	$68
Total amount (mean)	$100-$199	$100-$199
Knowledge and Perception		
Awareness of neonicotinoids	27%	27%
Knowledge of neonicotinoids[a]	14%	19%
Importance of disclosing "Pesticide Free" on labels (mean)[b]	5.8	5.6
Importance of disclosing "Neonicotinoid Free" on labels (mean)[b]	5.1	5.3
Importance of disclosing "Non-GMO/GMO free" on labels (mean)c	5.0	4.9
Importance of disclosing "Certified Organic"[b]	5.1	5.2
Importance of disclosing "Organically Produced" on labels (mean)[b]	5.2	5.1
Mandatory labeling of neonicotinoids[c]	75%	87%

[a] Participants were asked to indicate their knowledge about neonicotinoid pesticides on a 7-point Likert scale with 1 indicating not at all knowledgeable, 4 indicating neither knowledgeable nor not knowledgeable, and 7 indicating extremely knowledgeable. The percentage here summarizes participants who selected a 4 or higher on the knowledge scale.

[b] Participants were asked to indicate their level of importance on the disclosure of information on a label when they purchase a plant on a 7-point Likert scale with 1 indicating very unimportant, 4 indicating neither important nor unimportant, 7 indicating very important. The mean score across sample observations is reported here.

[c] Participants were asked to indicate whether they agree or disagree that labeling neonicotinoids should be mandatory as opposed to voluntary on a 7-point Likert scale with 1 indicating strongly disagree, 4 indicating neither agree nor disagree, 7 indicating strongly agree. The percentage here summarizes participants who selected 4 or higher on the scale.

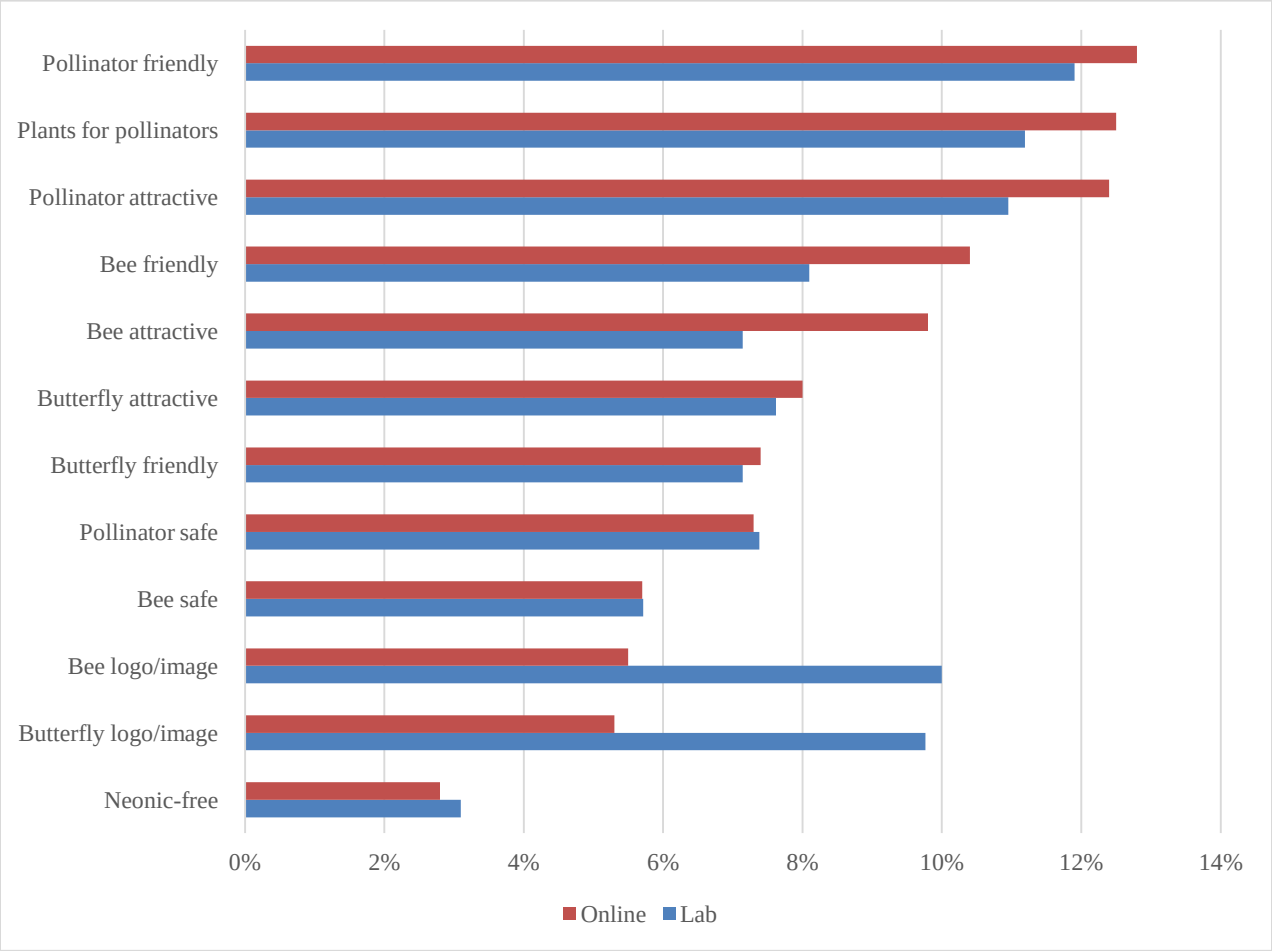
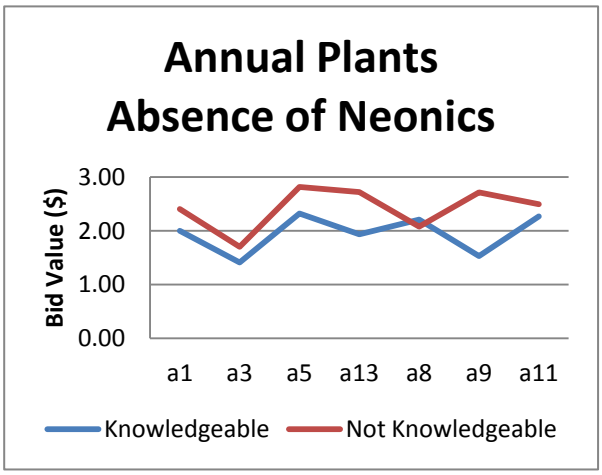


Figure 1. Consumer perceptions: most effective labeling phrases.



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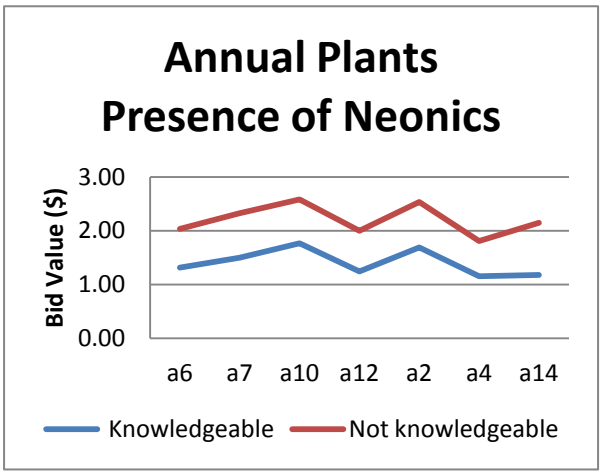

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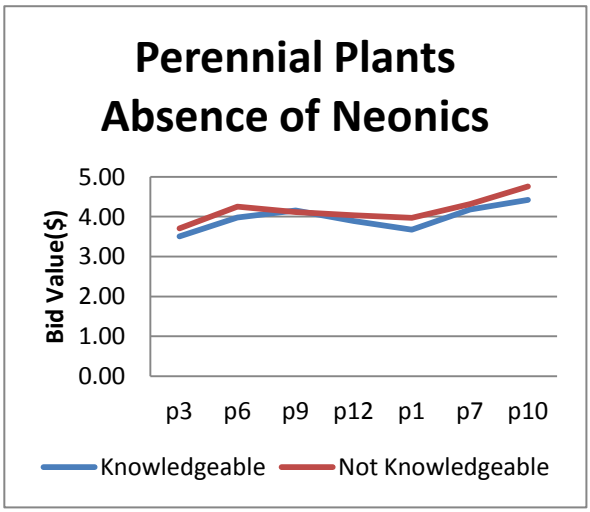

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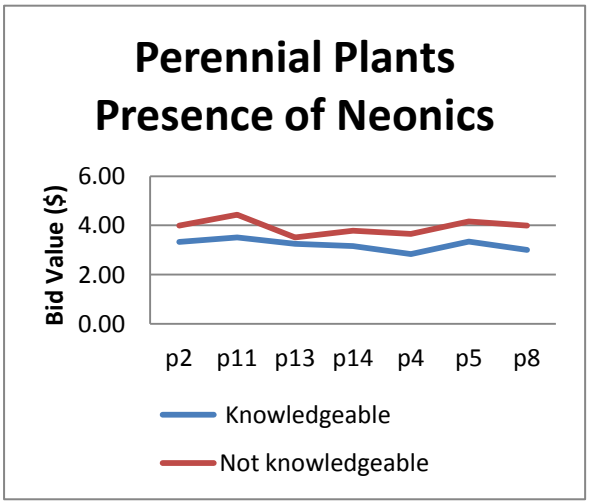

1-D

Figure 2. Distribution of bids by knowledge about neonicotinoids and plant types

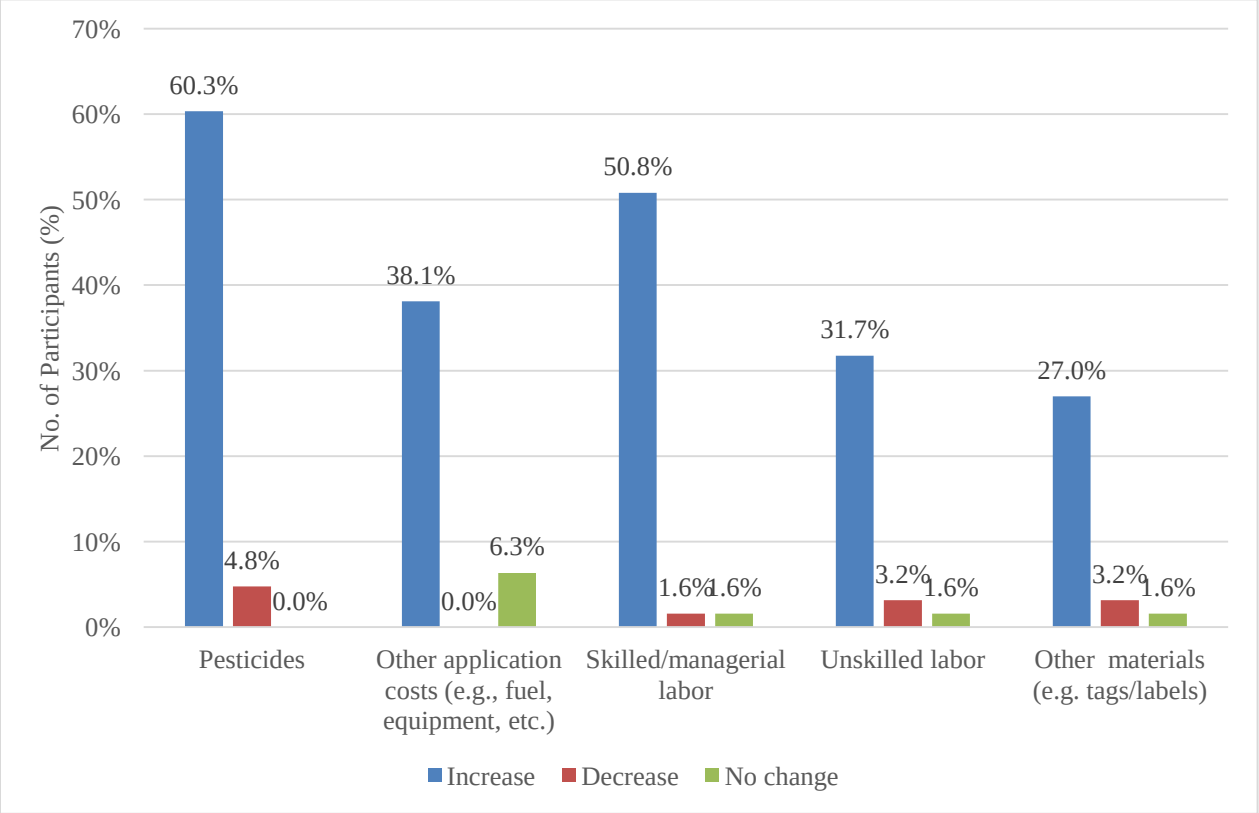

Figure 3. Producers' predicted change in input costs

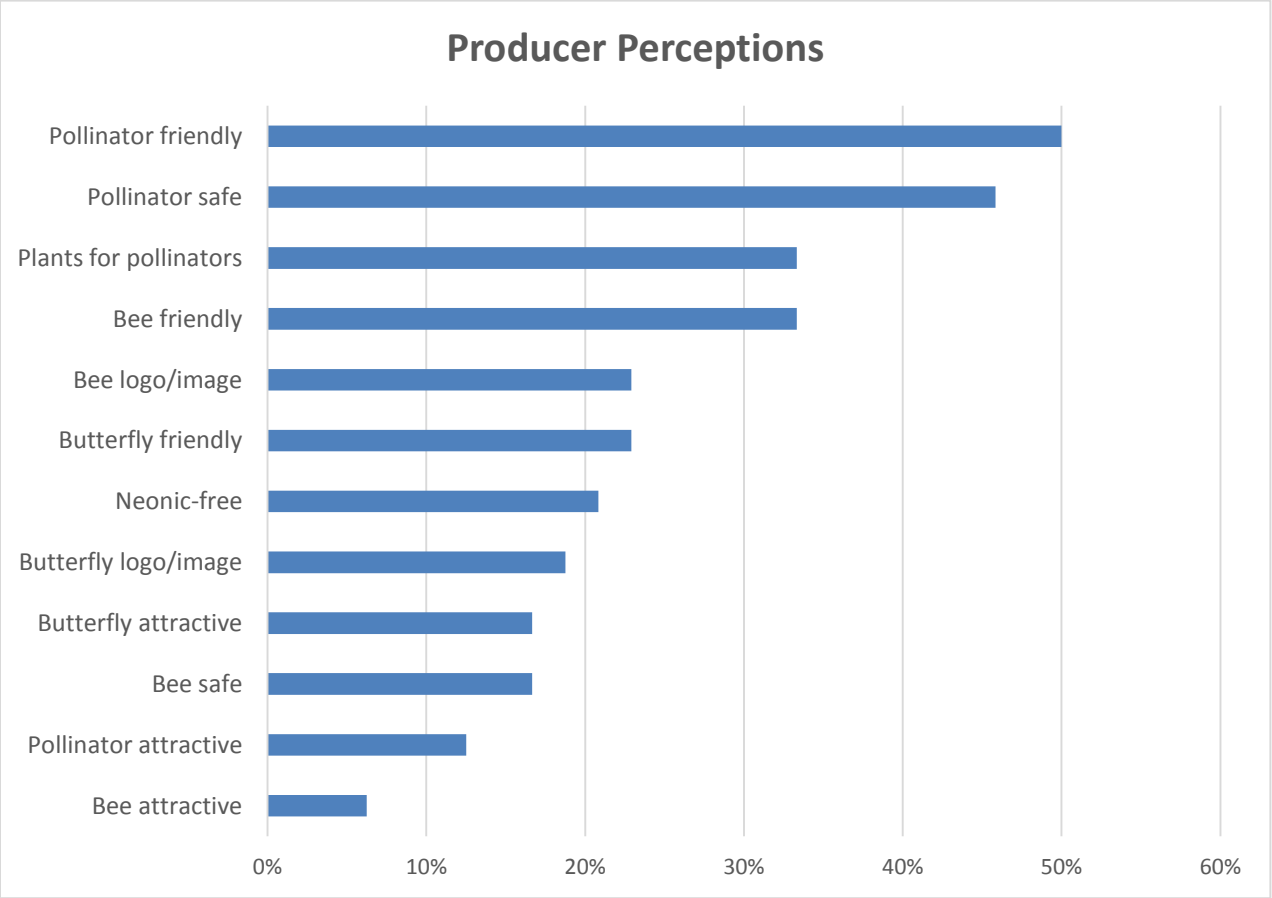

Figure 4. Producer perceptions about most effective labeling phrases

Tennessee Home Gardener Preferences for Environmental Attributes in Gardening Supplies: A Multiple Indicators Multiple Causation Analysis

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Index Words Consumers, Gardening Supplies, Environmental

Significance to Industry According to a 2015 Home Depot survey of 1,735 gardeners [1], low-maintenance plants and organics were among the top gardening trends. More than one quarter of gardeners over 35 years old stated they used rain barrels and other similar rainfall collection systems. Over 40% of millennials (persons age 35 and under) in the Northeast, South, and Midwest expressed interest in learning how to grow food using organic methods. This study hypothesizes that a segment of home gardeners, identifiable by demographic attributes, attitudes, and shopping patterns exhibit preferences for ecofriendly gardening products. The analysis developed market profiles of home gardeners who would prefer to use ecofriendly garden products. Our findings will supplement efforts to develop gardening products that embody ecofriendly attributes with the intent to market these products to specific group(s) of consumers.

Nature of Work Studies find that gardeners exhibit preferences toward ecofriendly gardening products and packaging [2,3,4]. Khatchatryan, et al, [2] found that attributes generally thought to be more environmentally friendly had a positive effect on the likelihood of purchasing florals possessing those attributes. Similarly, utilizing hypothetical and non-hypothetical auction analysis methods, Yue, et al. [3] found that consumers were willing to pay premiums for biodegradable packaging in relation to conventional plastic packaging. They found that as the percentage of waste material contained in the packaging increased, so too did the premium attributed by consumers, suggesting that consumers value waste reduction. Behe et al. [4] found similar results in their regional survey comparing ecofriendly practices among different gardening segment clusters. Rihn, et al. [5] found that fruit-producing plants and indoor foliage products grown using organic methods were associated with higher consumer willingness to pay and greater likelihood the products were purchased. Hugie, Yue and Watkins [6] use conjoint analysis to show that consumers value turfgrass that requires less irrigation. All of these studies indicate a growing consumer preference for greenhouse or nursery products with reduced environmental footprints.

The purpose of this study is to understand the factors influencing home gardener preferences for six ecofriendly attributes associated with gardening products. The attributes considered include a) decreased need for fertilizer, b) decreased need for pesticides, c) decreased need for water, d) native species, e) organic and f) the use of recyclable packaging or containers. The effects of home gardener demographics, attitudes, and shopping patterns on their preferences are measured. These measurements support the identification and definition of market segments more likely to purchase ecofriendly garden products.

A survey of home gardeners was conducted using the Qualtrics online survey platform. The list frame was comprised of Tennessee residents aged 18 years or older who self-identified as gardeners (either indoor, outdoor, or both). The sample frame was provided by Qualtrics. A pre-test survey of 108 respondents was fielded in June 2018. The survey was modified based on the pre-test results, with a full version of the survey fielded in July 2018 (n = 771 responses).

A Multiple Indicator Multiple Causation (MIMIC) Model was used to analyze which demographic factors influence consumer preferences for ecofriendly products. The MIMIC model is a multi-factor latent variable model that enables simultaneous modeling of discrete variables in a general linear model framework [7]. MIMIC models consist of two components: i) a measurement model defining the relationships between an unobservable latent variable and its indicators, and ii) a structural model capturing the effects of causal variables on the unobservable latent variable. This approach is useful when jointly modeling many indicators (in this case, preferences for each of the six environmental attributes) that are influenced by multiple factors. Consumer attributes included as factors determining the propensity to purchase ecofriendly garden products are demographic variables, spending patterns, and sentiments towards social, environmental, or political issues. The indicators and causal variables are linked by a latent, unobservable variable. In this case, the latent variable is the propensity of consumers to prefer environmentally friendly gardening products (ENVIR). Figure 1 illustrates the linkages between the indicators and the causal variables.

The probabilities of preferring each of the gardening products with environmental attributes (Decreased Fertilizer Needed, Decreased Pesticide Needed, Decreased Water Needed, Native Plant Species, Organically Produced, and Recyclable Packaging) are calculated using the estimated coefficients of the MIMIC model and the predicted values for ENVIR (using the regression and the demographic, spending patterns, and other causal variables). To illustrate potential market segments and their demographics/characteristics, three segments were developed, one with low propensity to prefer environmentally gardening products (lowest third of ENVIR), medium propensity (middle third of ENVIR), and high propensity (highest third of ENVIR). For the three segments, means of the respondent demographics, spending patterns, and attitudes reflect differences across the three market segments.

Results and Discussion Each of the estimated coefficients on ENVIR in logits for the probability of preferring each of the gardening supplies was significant (Table 1). A total of 725 responded to all questions needed for the analysis. The percent correctly classified for each dummy variable representing preferences for environmental attributes in gardening products ranges from 91.59% for decreased need for pesticide (Decreased Pesticides Needed) to 68.28% for native plants (Native Plant Species). Respondents who are older (AGE), female (FEMALE), members of environmental organizations (ENVIRORG) and garden clubs (GARDENCL), along with those who like to garden to grow their own food (GROWFOOD) and consider themselves more knowledgeable about the environment (LENVKNOW) are more likely to prefer environmentally friendly gardening products (ENVIR). Similarly, gardeners who feel a greater responsibility to care for the environment for future generations (RESPFUTGEN) and believe that home gardeners impact the environment (HGARDENVIR) have a higher propensity to prefer environmentally-friendly gardening products.

In Figure 2, the probability of preferring the gardening product attributes is plotted against ENVIR – the propensity to prefer gardening products with environmental attributes. The scale of the propensity score ENVIR indicates the degree of indifference a consumer has for garden products labeled as ecofriendly. Consumers who are relatively indifferent to ecofriendly garden products (lowest ENVIR levels) are less likely to prefer these goods. For example, complete indifference corresponds with an ENVIR of 0. The relationship is positive between preferences for ecofriendly garden products and the likelihood an individual would purchase a product with a specific attribute.

The probability of preferring products with decreased need for pesticide emerges first, followed by organically produced and native plant species (Figure 2). The relationship between preferences for ENVIR garden products and the likelihood of purchasing products marketed as “Deceased Pesticides Needed” is strongest across all consumers. However, the rankings cross for “Decreased Fertilizer Needed” and “Decreased Water Needed” products, and “Native Plant Species”, “Recyclable Packaging”, and “Organically Produced” as preferences for ENVIR garden products increase.

At the bottom of Figure 2, to illustrate market segments, the respondents were grouped into Low (lowest third), Medium (middle third), and High (highest third) groups that prefer gardening products with environmental attributes (ENVIR). The mean demographic attributes, expenditure patterns, and attitudes are calculated to illustrate characteristics of market segments for gardening products with environmental benefits. Compared with the Low Propensity group, the High Propensity group members are more likely to be female and older. These group members also tend to be members of environmental organizations and garden clubs and like to garden to grow their own food. Respondents in this group consider themselves more environmentally knowledgeable and feel more strongly about a responsibility to future generations to protect the environment and that home gardeners can impact the environment with their actions.

Results suggest that gardening products requiring less pesticides are adopted at lower levels of propensity to prefer gardening products with ecofriendly attributes, followed by produced organically, and native plant species. However, as the propensity increases, the probability of preferring products that require less fertilizer also increases rapidly. These results could indicate decreased need for pesticide has broader appeal, while only the most committed have preferences for products with decreased fertilizer needs (may rely on compost and/or natural fertilizers). Thus, investing the resources necessary to identify and target consumer segments would seem more justified for products that decrease fertilizer use than for those that decrease pesticide use. Conversely, untargeted approaches would be more likely to motivate a diverse set of consumers for products that reduce need for pesticide use than those that reduce need for fertilizer use. The results from this study help identify characteristics of market segments that have low, medium, and high propensity to prefer gardening products with environmental benefits. While products with decreased need for fertilizer and pesticides have a broader appeal across market segments, other gardening product attributes, such as organically produced and native plant species, have more narrow appeal to groups with medium and high propensity to purchase ecofriendly gardening products.

Literature Cited

1. S. Kellner. Low Maintenance and Organics Top Trends in Gardening Survey. http://gardenclub.homedepot.com/low-maintenance-gardening-survey/
2. H. Khachatryan *et al.* Visual Attention, Buying Impulsiveness, and Consumer Behavior. *Marketing Letters*, 2018 p. 23-35.
3. C. Yue *et al.* Comparing Willingness to Pay Estimation Models for Conjoint Analysis: A Case Study of Willingness to Pay for Biodegradable Containers for Plants. Acta Horticulturae. ISHS Acta Horticulture 930: XXVIII International Horticultural Congress on Science and Horticulture for People (IHC2010): International Symposium on Integrating Consumers and Economic Systems. 31 Mar. 2012 DOI:10.17660/ActaHortic.2012.930.28
4. B.K. Behe *et al.* Gardening Consumer Segments Vary in Ecopractices. *HortScience*, 2010, **45**, p.1475-1479.
5. A. Rihn *et al.* Consumer Preferences for Organic Production Methods and Origin Promotions on Ornamental Plants: Evidence from Eye-Tracking Experiments. *Agricultural Economics*, 2016, **47**, p. 599-608.
6. K. Hugie, C. Yue, and E. Watkins. Consumer Preference for Low-input Turfgrasses: A Conjoint Analysis. *HortScience*, 2012, **47** (8), p. 1096-1101
7. A. Skrondal and S. Rabe-Hesketh. 2004. *Generalized Latent Variable Modeling: Multilevel, Longitudinal, and Structural Equation Models*. Boca Raton, FL: Chapman & Hall/CRC.
8. *White, J. Home Gardening Statistics. The Masters of Horticulture. March 18, 2014.* http://masterofhort.com/2014/03/home-gardening-statistics/

Table 1. Sample Means and MIMIC Model of Tennessee Home Gardeners' Probability of Preferring Gardening Supplies with Environmental Attributes[a]

		Estimated Coefficients				
Logit Models of Prob. of Preferring Attribute of	Sample Means	Intercept		β_{ENVIR}		% Correctly Classif.
Decreased Fertilizer Needed	0.75	-6.329	***	1.961	***	89.24%
Decreased Pesticide Needed	0.87	-4.427	***	1.774	***	91.59%
Decreased Water Needed	0.67	-4.737	***	1.374	***	81.79%
Native Plant Species	0.57	-3.045	***	0.807	***	68.28%
Organically Produced	0.60	-3.382	***	0.921	***	70.48%
Recyclable Packaging	0.62	-4.139	***	1.142	***	72.00%
Regression on Latent Variable (ENVIR)	Means[b]	γ				
AGE (years)	44.00	0.011	***			
FEMALE (1 if female, 0 else)	0.79	0.265	***			
COLLGRAD (1 if college grad, 0 else)	0.40	-0.006				
RURAL (1 if rural, 0 else)	0.33	-0.115				
HHINC (2017 household income, in $1,000)	73.03	-0.001				
SHRGARDEN (shr income on garden supplies)	0.49	0.037				
OUTDOOR (1 if primarily outdoor garden, 0 else)	0.71	0.111				
ENVIRORG (1 if envir organiz member, 0 else)	0.16	0.342	***			
GARDENCL (1 if garden club member, 0 else)	0.08	0.374	*			
INFOEXT (1 if use info from Extension, 0 else)	0.24	-0.081				
INFOOG ("…" other gardeners, 0 else)	0.50	0.081				
INFOTVMAG ("…" TV/mag, 0 else)	0.38	0.074				
INFOSOCINT ("…" social media/Internet, 0 else)	0.56	0.096				
RESPFUTGEN (responsible for envir to future gen, 1=strongly disagree, …, 5=strongly agree)	4.51	0.372	***			
LENVKNOW (lack environ knowledge, "…")	2.80	-0.103	**			
Regression on Latent Variable (ENVIR)	Means[b]	γ				
SACRIFICENV (people will sacrifice for environ "…")	3.82	0.008				
HGARDENV (home gardeners impact environ "…")	4.27	0.343	***			
GROWFOOD (like to grow my own food "…")	3.87	0.109	**			
LLR Test (18 df)		-426.4	***			
N=725						

[a]***=significant at α=.01, **=significant at α=.05, and *=significant at α=.10.

[b] From the National Gardening Association, in 2014, the average U.S. gardener was female, over 45 years old, and held a college degree or has some college education. Hence, our sample is similar to these statistics from the national survey [8].

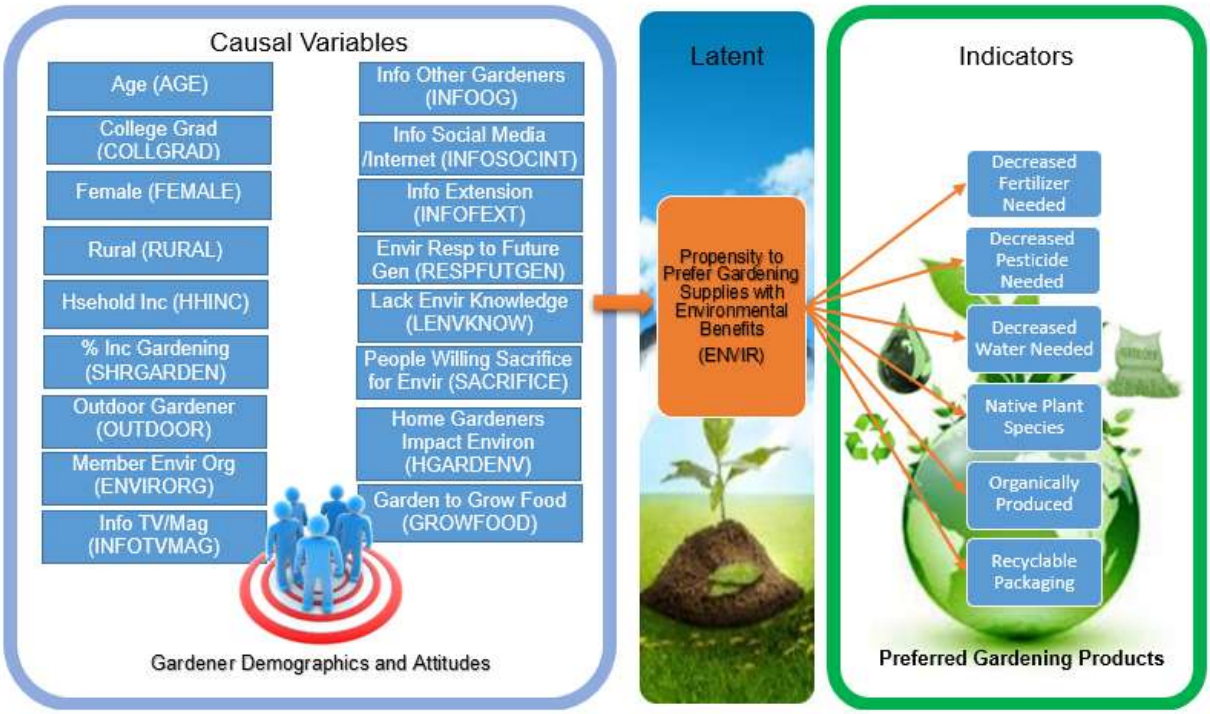
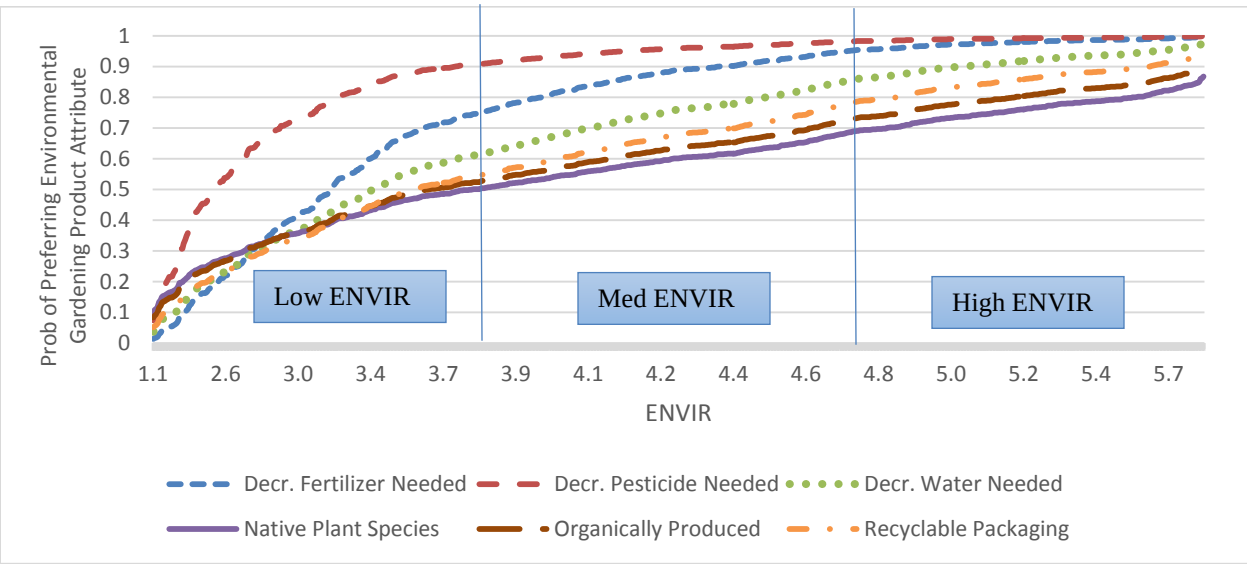


Figure 1. The MIMIC Model of Consumer Preferences for Gardening Supplies with Environmental Benefits.



Variable	Low ENVIR	Med ENVIR	High ENVIR
AGE	**42.54**	**43.81**	**45.64**
FEMALE	**0.75**	**0.79**	**0.85**
COLLGRAD	0.41	0.39	0.41
RURAL	0.37	0.33	0.31
HHINC	73.24	72.15	73.72
SHRGARDEN	0.46	0.46	0.54
OUTDOOR	0.66	0.72	0.76
ENVIRORG	**0.08**	**0.14**	**0.25**
GARDENCL	**0.07**	**0.06**	**0.11**
INFOEXT	0.21	0.20	0.30
INFOOG	0.46	0.47	0.57
INFOTVMAG	0.28	0.40	0.45
INFOSOCINT	0.54	0.57	0.57
RESPFUTGEN	**4.09**	**4.58**	**4.86**
LENVKNOW	**3.05**	**2.94**	**2.40**
SACRIFICENV	3.71	3.86	3.89
HGARDENV	**3.85**	**4.29**	**4.67**
GROWFOOD	**3.62**	**3.94**	**4.05**

[a]Groups were formed across the respondents across their level of ENVIR. The lowest third of ENVIR fell below 3.845. The middle third was 3.845≤ENVIR<4.757, and the top third was ENVIR≥4.757.

Figure 2. Probabilities of Preferring Gardening Supplies/Products with Environmental Benefits Across ENVIR and Demographics of Three Market Profiles (Low, Medium, and High ENVIR).