INVESTIGATION OF CONSUMERS' AND PROFESSIONALS' PERCEPTION, ATTITUDES AND BEHAVIORS ABOUT PURCHASING PLASTIC-ALTERNATIVES AND/OR RECYCLING PLASTIC HORTICULTURAL CONTAINERS
FY 2008

The Green Industry contributed nearly $150 billion to the nation's economy in 2002 and employed approximately two million people. Nearly every floral crop and many nursery crops are grown in plastic containers. Botts (2007) reported that making nursery pots, flats and cell packs uses 320 million pounds of plastic annually. Consumer demand for product-stewardship and environmentally-conscious products and business practices is rapidly rising. What alternatives do professional plant producers and consumers of nursery and floral products have? One alternative might be to recycle containers; another, to purchase plants grown in bio-degradable containers or containers made from recycled products. Since not all consumers are alike, some may prefer the alternative containers and some might prefer to recycle plastic containers. The goal of this project was to identify, profile, and quantify consumer market segments with regard to their preferences, and to identify attitudes and perceptions of nursery professionals that would facilitate their adoption of recycling and alternative containers.

FINAL REPORT

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Final Report of FSMIP Project entitled, "**Investigation of consumers' and professionals' perceptions, attitudes and behaviors about purchasing plastic-alternatives and/or recycling plastic horticultural containers**."

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Final Report

- Outline of the issue or problem.

The Green Industry contributed nearly $150 billion dollars to the nation's economy in 2002 and employed ~ two million people (Hall, Hodges, and Haydu, 2005). Nearly every floral crop and many nursery crops are grown in plastic containers. Botts (2007) reported that making nursery pots, flats and cell packs uses 320 million pounds of plastic annually. The consumer demand for product-stewardship or environmentally-conscious products and business practices is rapidly rising. What alternatives do professional plant producers and consumers of nursery and floral products have? One alternative might be to recycle containers and a second alternative might be to purchase plants grown in bio-degradable containers or containers made from recycled products. Since not all consumers are alike, there are potential market segments that would prefer the alternative containers and some that might prefer to recycle plastic containers. The goal of this project was to identify, profile, and quantify consumer market segments and to identify perceptions of nursery professionals that would facilitate their adoption of recycling and alternative containers. We also wanted to learn what consumers as well as professional plant growers were thinking and doing, to better meet their changing demands in the marketplace.

Our specific objectives were:

A. To determine the size and develop a profile of consumer segment(s) who would be more likely to recycle plastic containers.
B. To determine the size and develop a profile of commercial producer segment(s) who would be more likely to recycle plastic containers.
C. To determine the size and develop a profile of the consumer segment(s) that would be more likely to purchase a nursery or greenhouse plant containers made from non-plastic components.
D. To determine the size and develop a profile of the commercial producer segment(s) that would be more likely to purchase containers made from non-plastic components.
E. To determine the relative importance of container attributes to consumers and professionals.

- How the issue or problem was approached via the project.

Researchers from Michigan State University, The University of Minnesota, Purdue University, and Texas A&M University collaborated at least twice monthly with telephone or online conferences and utilized Google Docs to work collaboratively to review results and develop manuscripts. The team first developed two survey instruments: one for consumers (online) and one for commercial producers (mail). We collaborated in data analysis and interpretation as well as peer-reviewed manuscript preparation. As of the time of submitting this final report, two peer-reviewed publications have been accepted and three more are in various draft forms. The research team has submitted seminar topic suggestions based on the study findings were to the Southeast Greenhouse Conference, Ohio Florists Short Course, and New England Perennial Plant Symposium meetings. It is highly likely that multiple presentations to commercial plant producers will occur in 2010 and 2011 from the results of these studies.

Consumer Survey

Researchers developed a set of questions from prior survey instruments and discussion sessions among themselves. Questions about recycling other products (aluminum cans, glass containers, newspapers, etc.) as well as attitudes about recycling were developed. The survey also included a conjoint study. The conjoint portion of the survey was used to determine the relative importance of four product attributes (container material composition, percentage of material which was recycled, carbon footprint for making the container, and price). Conjoint output also was used to provide a basis for consumer segmentation. Containers made from plastic, straw, wheat starch or OP, rice hulls, peat, and cow manure were photographed and digitally manipulated to depict an identical yellow chrysanthemum growing them. They were displayed to consumers as pictures of a 4-inch potted chrysanthemum, shown only with the front-facing perspective, with text indicating price, carbon footprint, and waste composition level. Respondents were asked to evaluate each

product on a 9-point willingness-to-purchase scale with 9 = “very likely”, 5 = “somewhat likely”, and 1 = “very unlikely,” with 2-4 and 6-8 serving as intermediate levels.

After obtaining approval from the universities committees on the protection for human subjects, the data collection sub-contractor put the survey online and pre-tested questions on approximately 50 consumers. Knowledge Networks (California) was subcontracted to collect data from approximately 250 consumers in each of the four participating states in July, 2009. The company drew a sample of participants from the four states who were representative of that geography on multiple demographic characteristics, making the results representative of those areas.

Data entry was immediate as information was recorded as it was entered online. Different aspects of data analyses were conducted at all four institutions. An ordinary least squares regression was used to estimate the part-worth utility values for each individual respondent. After estimating the individual regressions, the relative importance values were calculated, market segments were developed, and the marginal effects associated with each segment were determined. After assigning respondents to a cluster, a multinomial logit model was used to identify any relationships between segment membership and demographic and socio-economic variables, store recycling behaviors, and respondent recycling behaviors and perceptions.

Producer Survey

Researchers adapted survey questions from a study conducted with Indiana producers in 2007. The survey included many questions from the Indiana study but others were added. After approval from the universities committees on the protection for human subjects, this survey instrument was mailed to a sample of 200 nursery producers in the four states in October, 2009. A second mailing was distributed to study participants who had not responded. Data entry was conducted at Texas A&M University and the data analysis was conducted at all four institutions.

- Contribution of public or private agency cooperators.

The American Floral Endowment funded a related study on consumer perceptions of alternative floral containers. Researchers leveraged dollars obtained from FSMIP funding with this funding to conduct separate but related consumer auctions of plants in alternative containers. The auctions provided a different perspective on the same containers, enabling researchers to create a comparison of hypothetical preferences (conjoint portion of the Internet survey) with stated preferences (from the auctions).

Input was sought from the American Nursery and Landscape Association. Their membership was interested in the consumer appeal of containers made from poultry feathers and wheat starch. Their input was helpful to create a broader palette of alternative containers, expanding the impact of the study results.

- Results, conclusions, and lessons learned.

Consumer Survey

Consumers were diverse in their perceptions of alternative containers and expressed different preferences. We learned there are opportunities for diverse container manufacturers, which will provide alternatives for landscape service providers and retail sellers of horticultural plants.

We had good distribution of respondents from all four participating states in the survey: Michigan (n=286), Minnesota (281), Indiana (272), and Texas (274). Of the 1113 total respondents, 49.6% were male and 50.4% were female. Respondent age ranged from 18 years to 92 years, with a median of 48 years, and mode of 43 years (3.4%). In terms of formal education, 9.8% had completed high school, 35.1% had some college education, 31.9% completed college, and 23.2% had some post-college education. In terms of ethnicity, 79.7% were Caucasian, 8.5% were African-American, 7.7% were Hispanic, and 4% were classified as having "other" ethnic heritage. In terms of home ownership (highly correlated with gardening and plant purchases), 81.4% owned their home, 16.7% rented their home, and 1.9% occupied a residence without paying rent. Slightly more than 20% of the respondents were from single-person households with 34.7% from dual person households, and 27.1% of the participants came from households with 3 or more persons. We had a diverse and representative sample of Americans included in the online consumer survey, which brings confidence in our ability to generalize this information to a larger population.

We showed consumers photographs of plants in containers (see figure right) and indicated to them what the price of the container was, how much of the material was recycled, and what the carbon footprint of the container was. For all the study participants, the relative importance of the plant container was the highest among the four product attributes and comprised 33.3% of the purchase decision. This means that a third of the stated choice of what consumers might buy was accounted for by the material from which the container was made. Plant price, carbon footprint, and waste composition were less important than container composition with relative importance values of 24.3%, 23.4%, and 19%, respectively. As expected, consumers preferred lower prices over higher prices; preference for plants costing $2.49 and $2.99 were almost identical whereas the $3.49 price received a large preference decrease. Examination of container type indicates that rice hull (shown in figure) and straw were preferred over plastic while the wheat starch or OP container (similar in appearance to plastic) had a negative preference rating of -0.23. Waste composition only resulted in a small change on the rating scale, however, greater than 49% waste resulted in a decreased rating of

-0.06. As expected, a carbon footprint label of “intense” resulted in a large rating decrease from the mean of -0.50, while “neutral” and “saving” were almost the same with a 0.26 and 0.24 rating increase, respectively. Surprisingly, carbon neutral was slightly, but not statistically higher, than carbon saving. Market segments included the “Rice Hull Likers,” “Straw Likers,” “Straw Dislikers,” “Price Conscious,” “Environmentally Conscious,” “Carbon Sensitive,” and “Non-Discriminating” segments. These segments are explained more fully in the peer-reviewed article in Appendix A.

With supplemental funding obtained from the American Floral Endowment, experimental auctions were conducted using identical plants and a similar survey. These two experimental auctions showed very similar results to the online consumer survey results. A peer-reviewed paper comparing the stated consumer preferences in the online survey with the actual preferences obtained through real plant auctions with consumers is presented in Appendix B.

We learned that consumer preferences and behavior was heterogeneous, as expected. Researchers were able to identify distinct market segments with regard to behavior, attitudes, and preferences. The information will help container manufacturers, distributors, plant producers and retailers better understand which consumers are more likely to value and purchase plants grown in containers made from alternative materials.

Producer Survey

Unlike consumers, growers were very similar in behavior and attitudes. They had little variation in their adoption of sustainability methods and in non-plastic container use. Surprisingly, nearly 70% were already recycling plastic containers. Researchers were delighted to learn that 12% planned to adopt biodegradable plant containers in the near future.

Among all respondents to the grower survey, Florida (16.8%) had the highest percentage of survey returns followed by California (10.4%), Pennsylvania (8.8%), North Carolina (8.9%), Texas (5.6%) and New York (5.6%). So, we did have appropriate representation from key production areas. Survey respondents’ average total square footage and covered production area were 515,822 and 120,536 sq. ft., respectively, with average uncovered production area of 474,673 sq. ft. or approximately 10.8 acres. Respondents reported 14.7 full time employees during the peak season and 14.5 part time employees. A third of businesses classified themselves as growing shrubs and woody ornamentals (36.8%) followed by container perennials (14.8%). Survey respondents were equally classified as retailers (22.4%), wholesalers (18.4%), growers (22.4%) or some combination (28.8%).

We asked respondents about their views of sustainability, practices used in their businesses, and practices they wanted to implement in the future. Most survey respondents stated the two most common definitions of sustainability were “minimal or no negative impact on the environment” as well as “going green” as it related to conservation of water, land and resources. Respondents were asked to check a list of sustainable production practices that

were already implemented in their operations. The highest sustainable categories were: recycling plastic pots (69.6%), use of controlled release fertilizer (66.4%), composting plant waste (64.0%), conservation/efficiency of energy (55.2%), use of biological pest controls (44.0%), water conservation measures (44.0%), and use of organic fertilizer (41.6%). Survey respondents were also asked which practices their companies planned to implement in one to three years. The highest sustainable categories for future practices were: biodegradable plant containers (12.0%), water conservation measures in applying irrigation (12.0%), wind as an alternative/supplemental energy source (9.6%), and sun as an alternative/supplemental energy source (9.6%). All respondents stated their operation was not certified sustainable however, at least one-quarter (25.8%) were interested in becoming certified.

We asked respondents to identify the type of containers used in their operations and majority (85.3%) reported virgin plastic followed by peat and recycled plastic at 12.8%, respectively. We also asked green industry businesses the percent of all containers used in 2009. Although less than one-quarter use recycled plastic, those that used it stated it accounted for just under half (49.8%) of all container types used. Virgin plastic had the second highest percentage at 25.5%. Peat containers accounted for 2.6% of container type used.

We also asked their biggest obstacles that would affect the adoption of sustainable production practices. On a scale of 1 = “small obstacle” to 10 = “biggest obstacle”, respondents rated other factors such as unavailability of biodegradable pots, lack of untreated water for irrigation, and the economy as the biggest obstacles (8.0) respectively followed by inadequate financing to change to sustainable practices (7.0), and little incentive to growers to convert to sustainable practices (6.8). The smallest obstacle was based on customers not valuing sustainability (4.6).

Producers are already making great strides in adopting more sustainable production practices. Among these are recycling plant containers and adopting alternative non-plastic containers. While they recognize their consumers value sustainable business practices, economic challenges are one of the greatest barriers to adopting more sustainable business practices.

- Current or future benefits to be derived from the project.

Visibility of containers made from non-virgin plastic continues to increase. At a minimum, the study helped to improve the awareness among consumers and industry professionals with regard to the number and type of alternative container materials available on the market today or coming to the market in the near future. With the publication of results and presentation at industry seminars, this visibility should continue to improve.

Additionally, container manufacturers and distributors, as well as plant producers and retailers have a better understanding of the diversity of consumers to which they market products. Most lack the resources and ability to conduct this type of research on their own, thus the study has provided the >10,000 U.S. plant producers with some consumer insight they most likely would not have otherwise. This funding enables them to have timely consumer perceptions and behavior on which to base near term business changes.

- Additional information available (e.g. publications, websites).

  Hall, Charles R., Benjamin L. Campbell, Bridget K. Behe, Chengyan Yue, Jennifer H. Dennis, and Roberto G. Lopez. 2010 (accepted). The Appeal of Biodegradable Packaging to Floral Consumers. HortScience (in press). Attached in Appendix A.

  Yue, C., Hall, C.R., B.K. Behe, B.L. Campbell, R.G. Lopez, J.H. Dennis. 2010 (accepted). Are Consumers Willing to Pay For Biodegradable Containers than for Plastic Ones? Evidence from Hypothetical Conjoint Analysis and Non-hypothetical Experimental Auctions. Attached in Appendix B.

  Dennis, Jennifer H., Roberto G. Lopez, Bridget K. Behe, Charles R. Hall, Chengyan Yue, and Benjamin Campbell. Greenhouse and Nursery Grower Percpetions of Sustainable Production Practices. HortTechnology (in manuscript).

  Campbell, Benjamin, Charles R. Hall, Chengyan Yue, Jennifer Dennis, Roberto Lopez, and Bridget Behe. Market Simulation Using Alternative Materials in Nursery Plant Containers. HortTechnology (in manuscript).

  Behe, Bridget K., Chengyan Yue, Benjamin Campbell, Jennifer H. Dennis, Roberto G. Lopez, and Charles R. Hall. Recycling and Other Eco-Friendly Behaviors of Five Consumer Segments. HortScience (in manuscript).

  Hall, Charles R., Benjamin L. Campbell, Bridget K. Behe, Chengyan Yue, Jennifer H. Dennis, and Roberto G. Lopez. Two Tiers of Alternative Materials Used in Nursery Plant Containers from the Consumer Perspective. HortScience (in maunscript).

  Campbell, Benjamin, Charles R. Hall, Chengyan Yue, Jennifer Dennis, Roberto Lopez, and Bridget Behe. Online Survey for Nursery Plant Containers: Does Time to Complete the Survey Impact Consumer Perceptions? HortScience (in manuscript).

- Recommendations for future research needed, if applicable.

  There is interest among the research group members to build upon these findings and conduct a study to identify, profile, and quantify consumer groups who may be likely to purchase plants grown not only in more sustainable containers but using more sustainable production methods. Similar methodologies (Internet study and auction) would be suggested in future studies to capture both hypothetical and stated preferences. Additional methods may include in-store displays of identify types of plants grown using conventional and sustainable methods.

  - A brief description of the project beneficiaries including the number, type and scale of producers.

  Who will benefit from this research? Plant container manufacturers are considering alternatives to virgin plastic, and have begun to recycle scrap as well as recycled plastic

containers. At least one of three major plastic plant tag manufacturers is now beginning an effort to recycle unused and returned from recycling plant tags. How many businesses could be affected? A recent online search of plastic container manufacturers yielded 1274 separate businesses that produce nursery, annual, or other plant containers from plastic. These businesses likely produce > 80% of all plant containers, plastic flat inserts, and other types of plastic production containers used in the Green industry.

Nearly all plants grown domestically are produced in a plastic container, so the commercial producers of nursery and garden plants, as well as indoor flowering and foliage plants, could benefit most immediately and directly from this study. Some newer businesses are being established as well as new business units within plastic container manufacturers to either produce alternative material containers and/or recapture some of the plastic before it enters a landfill. How many existing business might this research influence, in addition to container manufacturers? The most recent USDA National Agricultural Statistics Service Floriculture Crops Summary (USDA, 2009) reported there were 7189 commercial greenhouses in 15 surveyed U.S. states with total production area of 659 million sq. ft. The Economic Impact of the Green Industry (Hall, Hodges, and Haydu, 2005) reported there were 56,233 producers of nursery and greenhouse crops in all 50 U.S. states. In addition, recycling or preventing some plastic containers from entering landfills would benefit the more than 4800 wholesale businesses that supply retail and service businesses. The research could also benefit the more than 76,000 landscape service professionals and 21,000 lawn and garden retailers. It eventually, this research should improve the quality of life of all 307 million Americans because more plastic will find its way into U.S. landfills.

- Contact person for the project with telephone number and email address.

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Images with plants, shown to consumers in on-line study

Straw container

Plastic container

Rice hull container

PLA or wheat straw container

Images without plants, shown to consumers in on-line study

Cow manure container

Coconut coir container

Peat container

Chicken feather container

Rice hull container with vertical slots

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The Appeal of Biodegradable Packaging to Floral Consumers

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***Abstract*. Currently, one of the most widely discussed topics in the green industry, which is promulgated by consumers exhibiting greater degrees of environmental awareness, is the issue of environmental sustainability. This has led to a desire for products that not only solve the needs of consumers, but are also produced and marketed using sustainable production and business practices. Consumers increasingly place a greater emphasis on product packaging and this has carried over to the grower sector in the form of biodegradable pots. Although various forms of these eco-friendly pots have been available for several years, their marketing appeal was limited as a result of their less-than-satisfying appearance. With the recent availability of more attractive biodegradable plant containers, a renewed interest in their suitability in the green industry and their consumer acceptance has emerged. The objective of this study was to determine the characteristics of biodegradable pots that consumers deem most desirable and to identify distinct consumer segments, thus allowing producers/businesses to more efficiently use their resources to offer specific product attributes to those who value them the most. We conducted a conjoint analysis through Internet surveys with 535 valid observations from Texas, Michigan, Minnesota, and Indiana. Our results show that on average, consumers like rice hull pots the most followed by straw pots. Our analysis identified seven market segments and corresponding consumer profiles: "Rice Hull Likers," "Straw Likers," "Price Conscious," "Environmentally Conscious," "Carbon Sensitive," "Non-discriminating." Idiosyncratic marketing strategies should be implemented by industry firms to market biodegradable containers to the identified consumer segments.**

The commercial greenhouse and nursery industries often produce crops in plastic containers of varying sizes and shapes depending on the crop and target market (Evans and Hensley, 2004). Plastic containers serve the role of consumer packaging, transportation container, sometimes marketing vehicle as well as propagation and production receptacle and therefore must be strong, compatible with automation, horticultural uses, and able to be formed to essentially any size, shape, and color (Evans and Hensley, 2004; White, 2009). Containers, trays, cell packs, and flats are used for the propagation and production of annual and perennial bedding plants, in which relatively small plants are produced in large quantities (Evans and Hensley, 2004). Additional plastic use in the floriculture industry includes greenhouse films, pot tags, and packaging (Garthe and Kowal, 1993). In 1993, estimates showed that 408 million pounds of plastic were generated by the floriculture and nursery industries. Of that, 23 (5.6%), 90 (22%), 240 (58.8%), and 55 (13.5%) million pounds, respectively, were used for greenhouse films, mulch films, containers, and container trays, packs, and flats (Garthe and Kowal, 1993).

In 2003, the United States generated ≈11 million tons of plastic in the municipal solid waste stream as containers and packaging [Environmental Protection Agency (EPA), 2007], which comprised a third of all municipal solid waste (EPA, 2005). Nationwide, only 3.9% of the 26.7 million tons of plastic generated in the United States was recycled in 2003 according to the EPA (2007). Most of the recycled plastic was from beverage containers, including soda pop and milk. Agricultural plastics are challenging to recycle or reuse as a result of contamination problems or ultraviolet light degradation. Recycling facilities are often unwilling to accept plastics with soil or media residue. If recycling facilities clean and process the plastics, collection and shipment fees increase as a result of the heavier weight and increased transportation expenses (Garthe and Kowal, 1993). Two types of contamination unique to agriculture are ultraviolet light degradation and pesticide residue (Garthe and Kowal, 1993). Ultraviolet light and heat degradation are caused by exposure to extreme sunlight and heat, which lessens the value of the plastics resulting from loss of flexibility and recyclability (Garthe and Kowal, 1993). Typically, these non-reusable or non-recyclable plastic containers are disposed by consumers and landscapers, thus presenting a significant disposal issue for the horticulture industry (Evans and Hensley, 2004).

In recent years, the floriculture industry has seen a rise in biodegradable, compostable, or bioresin containers often called "green" products (Lubick, 2007). These "green" containers have emerged to take advantage of the green marketing and environmental awareness related to high fuel prices (Kale et al., 2007). Containers made of bioresins have the characteristics of plastics without the petroleum base. These containers are derived with renewable raw materials such as starch (e.g., corn, rice hulls, wheat, and so on), cellulose, soy protein, and lactic acid (White, 2009). Therefore, they are often labeled as compostable because they are broken down by naturally occurring microorganisms into carbon dioxide, water, and biomass when composted or discarded (White, 2009).

Biodegradable containers are those that can be planted directly into the soil or composted and will eventually be broken down by microorganisms (Evans and Hensley, 2004; White, 2009). Most biodegradable containers are made of peat, paper, or coir fiber, with peat containers being the most prevalent (Evans and Hensley, 2004). Other examples of biodegradable container materials include spruce fibers; sphagnum peat; wood fiber and lime; grain husks, predominantly rice hulls; 100% recycled paper; nonwoven, degradable paper; dairy cow manure (GreenBeam Pro, 2008); corn; coconut; and straw (Biogro-pots: Eco Friendly, 2007; Van de Wetering, 2008). Some of the reported benefits of using biodegradable and compostable containers include an elimination of plastic waste, stronger and healthier plants,

less disturbance of roots during transplanting, and the "feel-good factor" of the grower (Martin, 2008).

Consumers are not all alike. They have different attitudes, preferences, and behavior and differ with regard to their acceptance and purchase of new products (Kotler and Keller, 2006). Groups of consumers create markets. Thus, market segments have characteristics that can be quantified and distinguishable. Consumers think and act differently in response to ideas and products; ornamental plant containers are no different. Consumers impart a different relative importance to products and even features within those products, assigning value and importance through past purchases and future purchase intentions. The presence of environmentally sensitive or "green" consumers has been acknowledged for some time and such consumers are more likely than the general population to take environmentalism into account when purchasing goods. The presence of such consumers has also been assumed to bring profits to companies with a record of environmentally friendly practices (Russo and Fouts, 1997). Most research has found that many consumers are willing to pay a premium price for green products and share attitudes that are favorable to the environment (Engel and Potschke, 1998; Guagnano et al., 1994; Laroche et al., 2001; Schegelmilch et al., 1996; Straugh and Roberts, 1999), yet not all consumer attitudes about the environment are the same (Gladwin et al., 1995; Purser et al., 1995).

Despite the introduction of green products as alternatives to already existing ordinary products, many customers still choose ordinary products with lower "environmental quality" because of price and performance considerations or ignorance and disbelief (Ottman, 1998). Like most innovation activities, green product development is a task characterized by high levels of risk and uncertainty and the introduction of biodegradable containers into the Green industry marketplace is no exception.

Unfortunately, the impact of differing consumer attitudes about the environment on their willingness to pay a premium price for those products has not been explored in the literature. That is, researchers have yet to "unpack" the notion of the green consumer. For example, considering green consumers in the aggregate may mask important distinctions within the group. Unfortunately, there is little work that explores segmentation within the consuming populace on this dimension.

The objective of this study was to determine the characteristics of biodegradable pots that consumers deem most desirable and solicit their preference for this type of sustainable product. Additionally, we wanted to determine the size and develop a profile of the consumer segment(s) that would be more likely to purchase a nursery or greenhouse plant produced and marketed in biodegradable containers made from non-plastic components. We hypothesized that consumers with certain demographic characteristics (age, income, gender) or attitudinal and behavioral (already recycling other materials) have a moderate to high level of interest and will more likely consider purchasing containers made from alternative (non-plastic) materials. This type of segmentation will greatly benefit the Green industry by ensuring that environmentally friendly products marketed to floral consumers in the future truly meet their "sustainability" needs and/or expectations.

Materials and Methods

Conjoint analysis is a key technique for evaluating consumer preferences for predetermined combinations of product attributes. Results of conjoint analysis studies have commonly allowed for not only the comparison of consumer preferences between products and attributes, but also both market segmentation and simulations. Numerous studies have examined preferences for a wide variety of horticultural issues using conjoint analysis. Hopman et al. (1996) used conjoint analysis to obtain grower preferences for horticultural locations, whereas Lin et al. (1996) evaluated professional buyer preferences for organic produce. More traditional studies have tended to try and better understand consumer preferences of consumer products. Horticultural products included asparagus (Behe, 2006), bell peppers (Frank et al., 1999), Christmas trees (Behe et al., 2005), satsuma mandarins (Campbell et al., 2004, 2006), and fresh-market tomatoes (Simonne et al., 2006). Research has also focused on horticultural products more notably identified with the green industry such as edible flowers (Kelley et al., 2002), landscapes (Behe et al., 2005), and geraniums (Behe et al., 1999).

Baker (1998) noted that a consumer's valuation of a product is directly related to the utility or satisfaction associated with each attribute that comprises the product. If we allow a consumer to evaluate enough combinations of attributes, then we can determine the utility (value) associated with each attribute and, thereby, the product as a whole. For instance, if a consumer evaluates two products with only one attribute varied, say price, between them, then we can determine how much value the consumer gives to the attribute in question.

Attributes. Establishing the key product attributes and attribute levels is essential for any conjoint study. For this study, we consulted with industry experts and retailers to identify container attributes and their corresponding levels that were considered to be environmentally important to consumers while directly controlling for other attributes considered to be of lesser importance. Product attributes (and levels) identified were container price ($2.49, $2.99, $3.49), material (plastic, wheat starch, rice hulls, straw), carbon footprint (neutral, saving, intense), and waste composition (0%, 1% to 49%, greater than 49%).

Price has been shown to be a critical factor in most consumers' buying decisions. Although our main objective was to compare consumer preferences for environmental versus traditional alternatives, price is an essential attribute given that some/many customers may select ordinary products with lower "environmental quality" because of price and performance considerations or ignorance and disbelief (Ottman, 1998). For this reason, price was incorporated as an attribute. Price levels were determined by taking the four-state (Indiana, Michigan, Minnesota, and Texas) average price, $2.99, for a 4-inch potted chrysanthemum. The low and high prices were then set at $0.50 above ($3.49) and below ($2.49) the average retail price. The four-state average price was used because the survey was administered in Indiana, Michigan, Minnesota, and Texas. Also, by incorporating price as a product attribute, we can estimate the relative increase or decrease in dollar value associated with varying attribute levels.

There is evidence in the literature that "green" consumers exist within the market. Their presence has also been assumed to bring profits to companies with a record of environmentally friendly practices (Russo and Fouts, 1997). However, there is considerable variation in consumers' attitudes about the environment (Gladwin et al., 1995; Purser et al., 1995). For this reason, we chose to incorporate several attributes that have environmental connotations: material type, carbon footprint, and waste composition of AU1 container. Other attributes that could be AU2 considered as important to the consumer's purchase decision were held constant, i.e., pot size, flower type and size, and pot color, to minimize variation not accounted for by the attributes identified as most important.

We wanted to evaluate consumer reactions to several biodegradable potting container materials compared with traditional plastic. Wheat starch, rice hulls, and straw were chosen given the interest of these particular containers to the green industry and also given they provided a general representation of what is available on the market. Plastic was used because it is the most accessible in the market and can thereby serve as a control for the biodegradable potting containers.

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Carbon footprint was included given the increased importance both at the producer and consumer end of the marketing channel. The increased importance of carbon footprint can be easily seen by the increasing amount of not only academic research, but also increased media coverage and marketing strategies of businesses attempting to capitalize on claims of carbon footprint savings. As noted by Philip (2008), there has been a shift by consumers to greener food products, which has led businesses to begin to establish measures of a product's carbon footprint so that they can gain a competitive advantage by offering products with lower carbon footprints. One such means of making carbon footprint information available to the consumer is through "carbon labels," as suggested by Pearson and Bailey (2009). To determine consumer preference for and the value of "carbon labels," we compare several different labels, namely "carbon-neutral," "carbon-saving," and "carbon-intense."

The fourth product attribute we included was percent waste composition. This was included to determine if the percentage of the pot made of waste products played any role in the consumer's decision to purchase. Waste composition levels included: "0% waste," "1–49% waste," and "> or = 50% waste."

Stimuli. After identifying both the most important attributes and attribute levels, a fractional–factorial design was used to limit the number of stimuli respondents needed to evaluate to improve response rate and reduce participant fatigue. The total number of possible attribute-level combinations was 108, whereby the fractional–factorial design allowed the actual number of stimuli to be evaluated to be 14. Products with various combinations of attribute levels were displayed as a picture depicting a 4-inch potted mum with text indicating price, carbon footprint, and waste composition level. Respondents were asked to evaluate each product on a 9-point willingness-to-purchase scale with 9 = "very likely," 5 = "somewhat likely," and 1 = "very unlikely" with 2 to 4 and 6 to 8 serving as intermediate levels. Also, within the directions, respondents were reminded that all the containers were the same size: 4 inches.

The survey was administered through the Internet accessing a sample of ≈300 consumers each from Indiana, Michigan, Minnesota, and Texas, whose average demographic characteristics were reflective of the population at large in those states. The Internet survey was developed by researchers and approved by the university committees involved with research on human subjects. The survey was then implemented by Knowledge Networks during July 2009. Advantages of web-based surveys according to McCullough (1998) are that they are potentially faster to conduct than telephone or face-to-face interviews and generate more accurate information with less human error. Although 74.2% of the U.S. population has Internet access at work or home (Internet World Stats, 2009), Knowledge Networks provides Internet access to potential respondents without it, thereby eliminating that potential bias.

To eliminate respondents who do not purchase outdoor plants, we asked potential respondents if they had purchased any plants for any type of outdoor use during the last year (since July 2008). If the respondent did not purchase any plants, then the survey ended and the respondent did not proceed to subsequent questions. An answer of "yes" allowed the respondent to finish the rest of the survey. The survey was made up of four parts: 1) types and amounts of plants purchased; 2) conjoint questions; 3) recycling programs offered by the businesses where they purchase the most plants; and 4) personal and household recycling behaviors.

Data analysis. An ordinary least squares regression was used to estimate the part-worth utility values for each individual respondent. Individual regression models were used instead of an aggregated model for two reasons. First, aggregating respondents into a single model produces the potential to lose individual effects, which can cause biased estimations and thereby incorrect inferences to be drawn. Fixed or random effects can be used to capture individual effects within an aggregate model, but the model becomes more complex. The second (and most severe) problem is that an aggregated model produces a single set of utility estimates, which makes clustering on preferences (utilities) impossible, which is discussed in detail later. Given the scope of this research, market segmentation through clustering is essential and thereby directly lends itself to individual regression models that take the following form:

$$Ri = B0 + B1(PR2) + B2(PR3) + B3(RH) + B4(OP) + B5(STW) + B6(CBSV) + B7(CBIN) + B8(WS2) + B9(WS3) + ei, \quad [1]$$

where R is the rating of the ith stimuli by the respondent; PR2 = $2.99/pot; PR3 = $3.49/pot; RH = rice hull pot; OP = wheat pot; STW = straw pot; CBSV = carbon-saving; CBIN = carbon-intense; WS2 = waste composition between 1% and 49%; and WS3 = waste composition greater or equal to 50%. Base attribute levels included $2.49/pot, plastic container, carbon-neutral footprint, and made of 0% waste. Before estimating the individual regressions, each independent variable was effects coded, which means the coefficients are transformed into deviations from the mean (Hair et al., 1998).

It should be noted that because we used a hypothetical conjoint analysis format, there is a potential for bias associated the hypothetical nature of the response format (Murphy et al., 2005). In general non-hypothetical techniques (e.g., experimental auctions) have been used to offset any potential hypothetical biases; however, such surveys that are non-hypothetical may suffer from an additional problem of not being generalizable to the population given the small size of sample participating in the study. Large studies of this type are often infeasible given a large amount of product must be made available for purchase. Furthermore, small sample sizes have the potential to lead to misleading segments if segments can be delineated at all. Given the objective of our article, we believe a hypothetical bias, if present, will have a minimal impact on the overall message associated with the market segments presented with any biases affecting mostly those on the fringe of segments and not the hard-core segment members, which are the target customers for each segment.

After estimating the individual regressions, we proceeded to calculate relative importance values, market segments, and marginal effects associated with each segment. Relative importance values represent the amount of importance, represented as a percentage, an attribute contributes to the consumer's overall buying decision (Hair et al., 1998). For instance, a relative importance of 30% for the pot type can be interpreted because pot type makes up 30% of the consumer's buying decision. Relative importance values can be calculated as follows:

$$RI_j = (RG_j / \sum_{j=1}^{4} RG_j) * 100 \quad [2]$$

where RI is the relative importance of the jth attribute and RG is the range of the part-worth utilities (coefficients) for attribute j.

An important element of using conjoint analysis is the ability to both identify the number of and classify respondents into clusters or market segments. Using cluster analysis, respondents can be placed into clusters by grouping respondents with like part-worth utility (coefficient) estimates into clusters (Green and Helsen, 1989). Numerous criteria exist to identify the number of clusters present within the market, which taken alone may result in varying implications for the number of clusters identified. Therefore, we followed the methodology set forth in Campbell et al. (2004) and used several clustering algorithms, namely Ward, McQuitty, Equal Variance Maximum Likelihood, Flexible Beta, and Complete Linkage (SAS Institute Inc., 1987). The algorithms consistently indicated between five and seven clusters were present. The final determination of the number of segments is subjective; however, Kotler and Armstrong (2001) recommend choosing market segments that are measurable, accessible, substantial, differentiable, and actionable. After examining the segments recommended by the clustering algorithms in accordance with the Kotler and Armstrong guidelines, we chose a seven-segment model because the segments were distinct and allow for direct target marketing. After identifying the optimal number of segments, respondents were assigned to one of the seven clusters through SAS procedures addressed in Campbell et al. (2004).

Of interest was the process by which segments began to decompose as the number

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of segments increased to the optimally defined seven clusters. If a three-clustering solution was used, then the segments would have been straw liking, carbon dislikers, and price/container segment. As the number of clusters was increased, the container/price cluster began to split and fringe respondents were shuffled to other clusters. By five clusters, the environmentally conscious and carbon-sensitive groups were set and did not change with increased cluster levels. Also, the non-discriminating segment was also formed at Cluster 5. An interesting point regarding the non-discriminating segment was that we would suspect that as cluster number increased, the non-discriminating segment would have decreased in size given increased clusters would potentially result in fine tuning and fringe non-discriminators would find a new home in a cluster that more aligned with their preferences. However, this was not the case; as the number of clusters increased, the container groups began to splinter into finer segments. For instance, at eight clusters, the straw likers began to fragment into different levels of liking of straw, which produced clusters that were too small for any actionable marketing plan to be implemented.

After assigning respondents to a cluster, a multinomial logit model was used to identify any relationships between segment membership and the explanatory variables. Explanatory variables consisted of demographic and socioeconomic variables, store recycling behaviors, and respondent recycling behaviors and perceptions.

Results and Discussion

A total of 1113 respondents participated in the survey. However, 279 respondents were eliminated because they did not purchase any plants during year before the survey and another 299 respondents were eliminated as a result of missing responses or lack of variation among the conjoint ratings. The remaining 535 respondents were included in analyses. The 535 responses were collected from participants in four states: Indiana [n = 133 (24.9%)], Michigan [n = 141 (26.4%)], Minnesota [n = 126 (23.6%)], and Texas [n = 135 (25.2%)]. The sample was 54.4% female with respondent age ranging from 18 to 92 years with a mean of 47.7 years and a median of 48 years. Over half, 63.6%, were either married or living with a partner. Nine percent of respondents had less than a high school education with 38.3%, 21.7%, 24.5%, and 6.5% having a high school degree, some college, bachelor's/associate's degree, or post-bachelor's degree, respectively. A total of 78.7% were white, non-Hispanic; 9.0% were black; 8.6% Hispanic; 3.7% other, non-Hispanic.

Conjoint results. The part-worth utilities, relative importance values, R^2, and adjusted R^2 were calculated for all 535 respondents; however, only the average values are reported in Table 1 for the total and each market segment. Given effects coding was

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Table 1. Part-worth utility estimates, relative importance, and R^2 measures by market segments and the total sample.

Attributes and levels[z]	Rice Hull Likers		Straw Likers		Straw Dislikers		Price-conscious		Environmentally Conscious		Carbon-sensitive		Non-discriminating		Total
	Segment I	*P*	Segment II	*P*	Segment III	*P*	Segment IV	*P*	Segment V	*P*	Segment VI	*P*	Segment VII	*P*	
Number of observations	105		43		45		70		53		21		198		535
Market share (%)	19.6%		8.0%		8.4%		13.1%		9.9%		3.9%		37.0%		100.0%
Relative importance (%)															
Price	16.5	0.00	16.7	0.00	17.9	0.00	55.0	0.00	17.6	0.00	10.7	0.00	23.9	0.75	24.3
Container type	40.6	0.00	49.9	0.00	52.1	0.00	18.8	0.00	19.3	0.00	19.1	0.00	32.0	0.31	33.3
Waste composition	21.9	0.03	18.6	0.82	15.4	0.03	13.9	0.00	16.0	0.01	17.5	0.42	21.2	0.02	19.0
Carbon footprint	20.9	0.04	14.8	0.00	14.6	0.00	12.3	0.00	47.2	0.00	52.7	0.00	22.9	0.71	23.4
Part-worth utilities															
Intercept	4.69	0.61	5.02	0.30	4.49	0.23	5.47	0.00	5.13	0.07	5.34	0.00	4.45	0.03	4.78
Price															
$2.49/pot	0.05	0.00	0.11	0.27	0.22	0.92	1.15	0.00	0.06	0.08	–0.27	0.00	0.08	0.00	0.21
$2.99/pot	0.14	0.11	0.40	0.03	0.07	0.13	0.60	0.00	0.46	0.01	0.44	0.08	0.02	0.00	0.21
$3.49/pot	–0.19	0.00	–0.51	0.41	–0.29	0.13	–1.75	0.00	–0.53	0.28	–0.17	0.02	–0.10	0.00	–0.43
Container type															
Plastic	–0.31	0.16	–0.93	0.00	0.90	0.00	–0.15	0.49	–0.25	0.67	–0.87	0.00	–0.19	0.67	–0.21
Rice hull	0.73	0.00	0.18	0.69	0.71	0.01	0.17	0.22	0.19	0.55	0.68	0.02	–0.10	0.00	0.25
Straw	0.38	0.00	1.79	0.00	–1.68	0.00	0.16	0.65	0.19	0.98	0.27	0.66	0.17	0.69	0.19
OP (wheat starch)	–0.81	0.00	–1.04	0.00	0.07	0.11	–0.17	0.44	–0.13	0.25	–0.08	0.46	0.12	0.00	–0.23
Waste composition															
Waste: 0%	0.49	0.00	–0.38	0.00	0.21	0.01	0.06	0.54	0.03	0.99	–0.91	0.00	–0.09	0.00	0.03
Waste: 1% to 49%	–0.10	0.00	0.40	0.00	–0.09	0.09	0.19	0.00	0.06	0.77	0.23	0.10	–0.02	0.08	0.04
Waste: ≥50%	–0.39	0.00	–0.02	0.71	–0.12	0.50	–0.25	0.01	–0.09	0.81	0.68	0.00	0.11	0.00	–0.06
Carbon footprint															
Carbon neutral	0.27	0.87	0.37	0.15	0.07	0.01	0.19	0.19	0.69	0.00	1.80	0.00	0.03	0.00	0.26
Carbon saving	0.19	0.36	0.02	0.01	0.09	0.01	0.06	0.00	1.25	0.00	1.51	0.00	0.00	0.00	0.24
Carbon intense	–0.46	0.56	–0.39	0.28	–0.15	0.00	–0.25	0.00	–1.94	0.00	–3.31	0.00	–0.02	0.00	–0.50
R^2	0.76		0.85		0.81		0.85		0.84		0.88		0.71		0.78
Adjusted R^2	0.41		0.62		0.52		0.63		0.60		0.70		0.26		0.44

[z]Market segment part-worth utilities and relative importance values were compared against the total sample part-worth utilities and relative importance values using a two-tailed *t* test.

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used; the part-worth utilities are interpreted as a change in the mean rating on the 9-point rating scale. Relative importance values can be interpreted as how important each attribute is to the overall buying decision, in which a 100% relative importance implies that the attribute comprises 100% of the respondent's buying decision and all other attributes have no effect. Also, for each segment, the market share, number within the segment divided by the total sample, is presented.

For the total sample, relative importance values indicated that container type was the most important attribute comprising 33.3% of the purchase decision, whereas price, carbon footprint, and waste composition were less important with relative importance values of 24.3%, 23.4%, and 19%, respectively. Within the part-worth utilities associated with price, consumers preferred lower prices; $2.49 and $2.99 were almost identical, whereas the $3.49 price received a large preference decrease. Examination of container type indicates that rice hull and straw were preferred over plastic, whereas the OP container (similar in appearance to plastic) had a negative preference rating of –0.23. Waste composition only resulted in a small change on the rating scale; however, greater than 49% waste resulted in a decreased rating of –0.06. As expected, a carbon footprint label of "intense" resulted in a large rating decrease from the mean of –0.50, whereas "neutral" and "saving" were almost the same with a 0.26 and 0.24 rating increase, respectively. Surprisingly, carbon-neutral was slightly, but not statistically, higher than carbon-saving.

Although the total sample results provide some interesting results, Bretton-Clark (1992) noted that averaging across a market segments with different utility functions can provide biased results. Furthermore, targeting the whole market can result in businesses wasting valuable resources by marketing a product that might only appeal to a select group of consumers. The average results for each market segment are given in Table 1 with each market segment named according to observed preferences. Market segments included the "Rice Hull Likers," "Straw Likers," "Straw Dislikers," "Price Conscious," "Environmentally Conscious," "Carbon-sensitive," and "Non-discriminating" segments.

Segment I, the "Rice Hull Likers," had a 19.6% market share. The highest relative importance value for this segment was 40.6% associated with the container type attribute, which implies that 40.6% of the respondent's buying decision came from the attribute level, whereas only 16.5% of the buying decision was dictated by price. So, the type of container was more than twice as important as other individual attributes. Furthermore, the "Rice Hull Likers" segment showed an average rating increase from the overall mean of 0.73 for the rice hull container compared with a –0.31 rating decrease for a plastic potting container, showing their profound preference for this container type. Furthermore, as can be seen in Table 2, 62.9% of Segment I chose rice hull as their first choice (attribute level with the highest utility, holding all other attribute levels constant). Given these data, a clear preference for this container type helped identify members of this segment.

Segment II, the "Straw Likers" segment, had a market share of 8%. The major distinguishing feature of this segment was the large rating increase associated with straw potting containers. A straw potting container resulted in a 1.79 rating point increase from the mean compared with only a 0.18 increase for the rice hull container. Also of note is that the OP pot resulted in a fairly large decrease of –1.04 from the mean. Interestingly, 95.3% of respondents chose straw as their first choice with 0% choosing plastic or OP as their first choice. This small group expressed a clear preference for the container made from straw.

The "Straw Dislikers," Segment III (also with a market share of 8%), expressed preferences that were the opposite of Segment II. Members of this segment highly discounted straw pots by –1.68 rating points. Also, 0% of the cluster members chose straw pots as their first choice. An interesting finding within this segment was that the first choice for almost half (48.9%) of the segment was the plastic pot. Clearly, they did not like the container made from straw and showed some indications of preferring the plastic container, although they were not strong indications.

Segment IV, "Price Conscious," represented 13.1% market share. As named, this segment was extremely sensitive to price with lower prices being preferred to higher prices. The $2.49 price resulted in a 1.15 rating increase compared with the $2.99 price, which only garnered a 0.60 rating increase. However, the $3.49 price resulted in a large rating decrease of –1.75 rating points. Correspondingly, 75.7% chose the $2.49 price as their first choice with 0% choosing the $3.49 price. So, although this group of consumers did not express a clear preference for any one type of container, their strong preference for lower-priced containers was readily observed. T2

Segment V was named the "Environmentally Conscious" segment given their dislike of a carbon-intense label. Containers labeled as carbon-intense incurred a –1.94 rating point deduction, whereas carbon-saving resulted in an increased rating of 1.25 points. This segment had a market share of 9.9% and 73.6% of segment members expressed carbon-saving as their first choice with 0% having carbon-intense as their first choice. Again, although no one container material emerged as their preference, they were seeking containers that had low impact (through a low carbon footprint or carbon savings) on the environment.

Segment VI was an interesting market segment. At first glance, this segment appeared to be a more extreme version of the "Environmentally Conscious" segment given their large disdain for a carbon-intense label with the carbon-intense label resulting in a –3.31

Table 2. Percentage of respondents choosing the attribute level as their first choice (highest part-worth utility) by consumer segment.[z]

Attribute and levels	Rice Hull Likers Segment I	Straw Likers Segment II	Straw Dislikers Segment III	Price-conscious Segment IV	Environmentally Conscious Segment V	Carbon-sensitive Segment VI	Non-discriminating Segment VII	Total
	105	43	45	70	53	21	198	535
Price								
$2.49/pot	36.2	34.9	35.6	75.7	28.3	9.5	39.9	40.7
$2.99/pot	50.5	55.8	40.0	27.1	66.0	81.0	36.4	44.5
$3.49/pot	13.3	11.6	24.4	0.0	5.7	9.5	25.3	15.9
Container type								
Plastic	10.5	0.0	48.9	18.6	13.2	0.0	16.2	15.9
Rice hull	62.9	4.7	37.8	34.3	43.4	42.9	22.2	34.6
Straw	32.4	95.3	0.0	32.9	24.5	38.1	44.4	38.7
OP (wheat starch)	1.9	0.0	22.2	18.6	20.8	28.6	28.8	18.5
Waste composition								
Waste: 0%	64.8	9.3	48.9	30.0	39.6	9.5	29.8	36.8
Waste: 1% to 49%	25.7	58.1	31.1	45.7	32.1	23.8	34.8	35.3
Waste: ≥50%	9.5	32.6	20.0	24.3	28.3	66.7	35.9	28.0
Carbon footprint								
Carbon-neutral	58.1	65.1	40.0	52.9	35.8	61.9	39.4	47.5
Carbon-saving	46.7	34.9	37.8	37.1	73.6	38.1	35.4	41.9
Carbon-intense	5.7	11.6	31.1	18.6	0.0	0.0	32.8	19.3

[z]Given consumer choice theory, consumers will choose the product with the highest utility given it is in their budget constraint.

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rating decrease. If this segment was more environmentally conscious than Segment V, then we would expect carbon-saving to be preferred to carbon-neutral. However, from the part-worth utilities, we saw that carbon-neutral actually incurred a higher rating compared with carbon-saving. We expected that carbon-intense containers were not chosen, which was confirmed given 0% chose carbon-intense containers as their first choice. However, 73.6% of Segment V members chose carbon-saving as their first choice compared with only 38.1% of Segment VI. After evaluating the choices associated with Segment VI and the marginal effects, discussed subsequently, we believe this segment is most likely a mixture of extreme environmentalists along with consumers that perceive carbon intensity to be bad and therefore represents a product attribute that is unwanted; therefore, we refer to them as "carbon-sensitive."

Marginal effects. A multinomial logit model was used after each respondent was placed into a segment. From the multinomial logit model, the marginal effects were calculated to develop consumer profiles. Consumer profiles associated with each market segment allow businesses to more efficiently target specific segments by allowing for direct marketing campaigns that emphasize specific characteristics that are preferred by the segment of interest. Marginal effects for the demographic and socioeconomic characteristics can be found in Table 3, whereas the marginal effects associated with recycling views and behaviors can be found in Table 4.

"Rice Hull Likers" who comprised Segment I were more likely to be younger consumers with higher incomes living in a non-metro area with fewer adults per household (18 years of age or older). Interpretation of the results varies depending on the type of variable of interest, e.g., continuous or dummy. For example, as age increases by one unit from the mean, there is a 0.07% decrease in the probability of a participant being a member of Segment I. This appears to be a small change; however, given a change of several years from the mean, the decrease in the probability of segment membership could be substantial. With regard to a dummy variable such as metro area, the interpretation is that living in a metro area, as compared with a non-metro area, results in a –14.6% decrease in the probability of a participant being a member of Segment I. Of note is that as income increases, the probability of being in Segment I increases at a higher rate. For instance, a household with income between $20,000 and $49,000 is 15.9% more likely to be in this segment compared with households with incomes below $20,000, whereas households with $50,000 to $74,000 and greater than or equal to $75,000 are 23.5% and 25.7% more likely to be in Segment I, respectively.

Examination of Table 4 shows that the "Rice Hull Likers" have a distinct consumer profile associated with purchasing and recycling behaviors and beliefs that can be used by the Green industry. For instance, respondents who purchased indoor flowering plants were 16.3% more likely to be members of this segment, whereas respondents who purchased flowering shrubs were –9.9% less likely to be a member. Also, members of this segment are less likely to have interest in purchasing sustainable bedding plants. However, they have an increased interest in plants grown in compostable pots. Also of note is that consumers display increased agreement that recycling pots are more important than biodegradable pots and are 10.6% less likely to be members of this segment. When shown a statement (see footnotes in Table 4) regarding a simple definition of what defines carbon-saving and carbon-intensive, consumers who agreed with the statements were 8.1% and 8.5% less likely to be in this segment, respectively.

Examination of the marginal effects associated with Segment II, "Straw Likers," indicates that blacks and Hispanics are less likely to be members of this group nor are consumers who are married or living with a partner. Furthermore, with an increased number of adults within a household or a participant living in a metro area resulted in an increased probability of being included in this segment. Also, consumers who

Table 3. Marginal probabilities for demographic and socioeconomic variables by consumer segment with respect to a vector of explanatory variables (computed at the mean).

	Marginal probabilities of membership in each segment													
Variable[z,y]	Probability Segment I Coefficient	*P*	Probability Segment II Coefficient	*P*	Probability Segment III Coefficient	*P*	Probability Segment IV Coefficient	*P*	Probability Segment V Coefficient	*P*	Probability Segment VI Coefficient	*P*	Probability Segment VII Coefficient	*P*
Gender (1 = male)	–0.031	0.51	0.003	0.91	0.011	0.53	0.011	0.72	–0.017	0.47	–0.001	0.60	0.023	0.69
Age (years)	**–0.007**	0.00	0.000	0.95	**–0.002**	0.05	**0.003**	0.07	**–0.001**	0.10	0.000	0.57	**0.007**	0.00
Education														
High school graduate	0.001	0.99	–0.004	0.89	–0.026	0.37	**0.221**	0.07	0.083	0.22	0.000	0.95	**–0.274**	0.01
Some college	0.011	0.91	–0.018	0.61	**–0.055**	0.01	0.139	0.33	0.037	0.60	–0.001	0.69	–0.113	0.42
College graduate	–0.119	0.12	–0.001	0.98	**–0.042**	0.10	**0.413**	0.03	0.008	0.90	–0.001	0.69	**–0.258**	0.07
Post-bachelor's	–0.029	0.81	0.001	0.99	**–0.054**	0.00	0.245	0.34	–0.032	0.42	–0.001	0.78	–0.130	0.52
Race														
White	0.111	0.32	–0.010	0.84	**0.069**	0.09	0.064	0.25	0.035	0.48	–0.001	0.76	**–0.268**	0.08
Black	0.193	0.48	**–0.055**	0.01	0.243	0.55	–0.059	0.31	0.100	0.57	–0.001	0.64	**–0.420**	0.00
Hispanic	0.038	0.83	**–0.062**	0.00	0.056	0.79	0.074	0.64	0.094	0.59	–0.001	0.66	–0.199	0.34
Household head (1 = yes)	–0.029	0.68	–0.012	0.74	**0.034**	0.07	–0.070	0.30	0.014	0.59	–0.013	0.43	0.076	0.41
Income														
$20,000–49,000	**0.159**	0.09	0.124	0.17	**–0.064**	0.02	0.007	0.88	0.085	0.13	–0.002	0.60	**–0.309**	0.00
$50,000–74,000	**0.235**	0.07	0.142	0.27	**–0.047**	0.01	0.000	0.99	0.053	0.34	–0.001	0.56	**–0.381**	0.00
≥$75,000	**0.257**	0.07	0.167	0.25	**–0.056**	0.02	–0.058	0.18	0.023	0.68	0.000	0.79	**–0.334**	0.00
Relationship status (1 = married)	–0.036	0.56	**–0.073**	0.09	–0.026	0.23	**0.062**	0.06	–0.052	0.21	–0.002	0.64	**0.127**	0.09
Housing (1 = detached structure)	–0.054	0.41	–0.058	0.30	0.026	0.18	–0.022	0.66	0.035	0.17	0.000	0.90	0.073	0.39
Household makeup														
Number ≤12 years	**0.059**	0.03	0.001	0.95	0.011	0.33	0.025	0.14	–0.015	0.38	–0.001	0.68	**–0.081**	0.04
Number 13–17 years	–0.056	0.24	0.019	0.28	0.016	0.24	**0.052**	0.06	**0.034**	0.09	0.001	0.47	–0.066	0.23
Number ≥18 years	**–0.067**	0.08	**0.037**	0.09	0.013	0.32	–0.004	0.84	–0.009	0.60	0.000	0.67	0.030	0.51
Employed (1 = yes)	–0.080	0.15	**–0.051**	0.06	–0.026	0.28	–0.025	0.51	–0.015	0.51	0.002	0.59	**0.196**	0.00
MSA (1 = metro)	**–0.148**	0.06	**0.044**	0.01	0.009	0.66	–0.026	0.54	–0.025	0.46	0.002	0.62	**0.145**	0.06
State														
Minnesota	–0.068	0.27	0.053	0.37	0.039	0.39	–0.045	0.24	**0.101**	0.10	0.000	0.86	–0.081	0.38
Indiana	–0.074	0.24	0.055	0.31	0.007	0.82	–0.025	0.50	–0.006	0.85	0.001	0.73	0.042	0.63
Michigan	**–0.137**	0.01	0.018	0.62	0.074	0.14	**–0.055**	0.10	0.050	0.30	0.000	0.84	0.050	0.57

[z]Base categories are: female, not a high school graduate, other race, not household head, income less than $20,000, not married or have partner, housing not detached, not employed, not MSA area, and Texas.
[y]Bold indicates significance at the 0.1 level, but *P* values are also given.

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Table 4. Marginal probabilities for purchasing and recycling behaviors and beliefs by consumer segment with respect to a vector of explanatory variables (computed at the mean).

	probabilities of membership in each segment													
	Probability Segment I		Probability Segment II		Probability Segment III		Probability Segment IV		Probability Segment V		Probability Segment VI		Probability Segment VII	
Variable[z,y,x]	Coefficient	*P*	Coefficient	*P*	Coefficient	*P*	Coefficient	*P*	Coefficient	*P*	Coefficient	*P*	Coefficient	*P*
Expenditures of lawn/garden products?														
Dollars: 1–25	–0.029	0.74	0.149	0.26	0.062	0.39	–0.021	0.66	0.035	0.56	0.000	0.97	**–0.195**	0.08
Dollars: 26–50	0.087	0.45	0.114	0.36	0.065	0.36	0.001	0.99	0.070	0.42	–0.001	0.61	**–0.335**	0.00
Dollars: 51–100	0.046	0.66	0.084	0.42	0.037	0.53	–0.064	0.11	0.026	0.64	0.000	0.90	–0.130	0.28
Dollars: 101–150	–0.004	0.97	0.106	0.38	0.032	0.61	**–0.075**	0.07	–0.011	0.78	–0.001	0.62	–0.048	0.72
Dollars: 151–200	–0.029	0.80	0.063	0.55	0.017	0.79	**–0.078**	0.03	–0.001	0.99	–0.001	0.64	0.029	0.85
Dollars: 201–250	–0.016	0.89	0.129	0.47	0.068	0.44	**–0.064**	0.10	0.015	0.84	0.000	0.92	–0.133	0.43
Dollars: ≥250	–0.001	0.99	0.059	0.55	0.013	0.80	–0.059	0.25	–0.043	0.27	0.003	0.77	0.027	0.85
Types of plants purchased?[y]														
Flowering annuals	0.079	0.15	0.006	0.78	**–0.076**	0.02	0.023	0.56	–0.001	0.98	0.002	0.56	–0.033	0.65
Flowering perennials	0.046	0.42	–0.007	0.80	0.012	0.55	–0.042	0.25	–0.024	0.44	0.001	0.67	0.013	0.86
Herbs/vegetables	0.026	0.61	0.018	0.43	–0.031	0.13	–0.009	0.80	–0.023	0.32	0.000	0.99	0.019	0.77
Flowering shrubs	**–0.099**	0.09	**0.088**	0.04	0.016	0.61	–0.003	0.95	0.031	0.43	0.001	0.52	–0.035	0.67
Trees	–0.083	0.18	0.011	0.72	0.002	0.94	–0.010	0.83	**–0.046**	0.03	–0.001	0.61	0.126	0.11
Indoor flowering plants	**0.163**	0.01	–0.020	0.33	**0.083**	0.01	–0.008	0.83	0.029	0.30	0.000	0.79	**–0.247**	0.00
Where are plants purchased?														
Mass merchandiser	0.079	0.25	0.041	0.26	0.024	0.35	0.029	0.53	0.000	1.00	0.005	0.55	**–0.178**	0.02
Home improvement center	0.026	0.64	0.010	0.72	0.026	0.38	0.012	0.76	0.018	0.55	0.002	0.71	–0.093	0.16
Number of trips made?	0.003	0.73	0.005	0.12	–0.002	0.44	0.006	0.25	**0.009**	0.02	0.000	0.57	**–0.020**	0.06
Heard of term sustainability?														
Yes	0.049	0.36	–0.016	0.53	**0.060**	0.03	**–0.065**	0.09	**–0.082**	0.01	0.001	0.69	0.053	0.45
No	–0.061	0.28	0.005	0.88	0.057	0.27	–0.048	0.13	**–0.044**	0.04	–0.002	0.44	0.094	0.23
Interest in purchasing following plant types?[w]														
Conventional bedding plants	0.031	0.16	–0.014	0.15	–0.005	0.51	**0.027**	0.06	–0.008	0.40	–0.001	0.59	–0.031	0.23
Organic bedding plants	–0.005	0.86	–0.005	0.64	–0.012	0.23	0.016	0.32	0.012	0.36	0.000	0.85	–0.005	0.87
Sustainable bedding plants	**—0.067**	0.01	–0.003	0.80	0.000	0.96	**0.031**	0.04	0.000	1.00	0.000	0.82	0.038	0.22
Locally produced bedding plants	–0.040	0.14	0.010	0.36	**0.018**	0.03	**0.031**	0.08	0.002	0.92	0.000	0.90	–0.020	0.53
Grown in organic fertilizer	0.012	0.69	0.018	0.14	–0.001	0.92	–0.010	0.58	**—0.023**	0.09	0.001	0.68	0.004	0.92
From energy-efficient greenhouse	0.024	0.32	–0.010	0.26	0.002	0.83	–0.005	0.69	0.010	0.38	0.000	0.70	–0.020	0.49
Grown in biodegradable pots	0.011	0.71	–0.002	0.91	–0.013	0.23	–0.018	0.21	0.018	0.19	0.000	0.73	0.005	0.89
Grown in compostable pots	**0.056**	0.04	0.007	0.45	–0.013	0.11	–0.005	0.74	0.006	0.62	0.000	0.84	**—0.052**	0.10
Grown in recyclable pots	–0.032	0.15	0.009	0.28	**0.027**	0.00	–0.012	0.41	0.004	0.73	0.000	0.95	0.005	0.87
Reason to purchase environmentally friendly plants?														
Feel good about helping environment	–0.085	0.12	0.000	1.00	–0.005	0.83	**–0.052**	0.09	–0.013	0.67	0.001	0.53	**0.155**	0.06
These plants are environmentally friendly	**–0.095**	0.07	0.022	0.42	–0.012	0.59	**–0.061**	0.06	–0.021	0.47	0.000	0.99	**0.168**	0.02
Control if package can be recycled[v]	0.000	0.74	0.000	0.99	–0.010	0.39	**–0.042**	0.06	–0.022	0.17	0.001	0.55	0.063	0.15
Sorting household waste is too inconvenient[v]	**–0.040**	0.09	0.000	1.00	**0.019**	0.05	–0.005	0.76	**–0.028**	0.02	–0.001	0.66	**0.056**	0.08
Recycling pots more important[v]	**–0.106**	0.00	**0.045**	0.00	0.015	0.23	0.004	0.85	0.012	0.51	0.000	0.63	0.030	0.46
Control if package is from recycled material[v]	–0.021	0.50	–0.028	0.12	0.010	0.48	–0.006	0.79	**–0.035**	0.05	–0.001	0.61	**0.081**	0.06
How often do you recycle containers?														
Sometimes	–0.024	0.68	–0.015	0.58	–0.010	0.68	0.003	0.95	0.000	0.99	–0.001	0.57	0.048	0.55
Usual/always	–0.073	0.29	**–0.060**	0.02	0.032	0.39	0.044	0.39	0.004	0.89	–0.001	0.57	0.053	0.56
How often do you recycle plastic tags?														
Sometimes	0.028	0.71	–0.033	0.19	0.052	0.23	**–0.053**	0.09	0.055	0.28	0.000	0.90	–0.049	0.58
Usual/always	0.046	0.61	0.013	0.75	–0.003	0.92	**–0.062**	0.08	0.014	0.74	0.000	0.82	–0.009	0.94
Agree with carbon-saving definition?[v,u]	**–0.081**	0.02	–0.003	0.85	–0.005	0.67	0.039	0.15	**0.053**	0.02	0.000	0.85	–0.003	0.95
Agree with carbon-intensive definition?[v,t]	**–0.085**	0.01	–0.015	0.40	**0.022**	0.10	0.008	0.74	0.018	0.26	0.000	0.67	0.050	0.20

[z]Base categories not yes/no answer include: dollar expenditures = 0, in which purchase = other store type, heard of sustainability = not sure, reason to purchase environmentally friendly plants = other, how often buy plastic containers = never, how often buy recycled plastic tags = never.
[y]Bold indicates significance at the 0.1 level, but *P* values are also given.
[x]Survey question regarding expenditures and purchases were for the last year (July 2008 to July 2009).
[w]The interest in purchasing question was on a 1–7 scale in which 1 = "low interest" and 5 = "high interest."
[v]A 1–5 scale was used in which 1 = "strongly disagree" and 5 = "strongly agree."
[u]The survey asked for agreement with the following statement: A carbon-saving footprint for a product means it takes less energy to make or ship the product to where I buy it.
[t]The survey asked for agreement with the following statement: A carbon-intensive footprint for a product means it takes a lot of energy to make or ship the product to where I buy it.

purchased flowering shrubs and usually or always recycle their plastic containers are 8.8% and 6% more likely to be in this segment, respectively.

Taking a more in-depth look at Segment III, "Straw Dislikers," tended to be less educated as demonstrated by the negative signs (and significance levels) associated with the education levels above "no high school degree." Increased incomes also resulted in a lower probability of segment membership. In regard to recycling views and behaviors in Table 4, we see that this segment is most likely made up of persons who do not purchase flowering annuals but do purchase indoor flowering plants. This segment is also more likely to agree that sorting household waste is too inconvenient, which implies they are less likely to be active in recycling efforts. They do, however, have an interest in locally produced bedding plants and plants grown in recyclable pots.

The price-conscious segment fits many a priori notions. For instance, members of this segment tended to have a higher education level and be married. Furthermore, higher expenditures on outdoor lawn/garden products results in a lower probability of being in this segment for consumers spending $101 to $250. We also see that having heard of sustainability results in a 7.2% decrease compared with those who are not sure about the term. Consumers within this segment are

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also less likely to purchase environmentally plants as a result of feeling good about helping the environment or because the plants are environmentally friendly. Furthermore, this segment is more likely to have interest in conventional, sustainable, and locally produced bedding plants.

The "Environmentally Conscious" segment exhibited concern about the environment. They do not have a concise demographic profile other than being more likely to be younger consumers, but they do have a specific set of recycling views that set them apart. For instance, they are more likely to disagree that sorting household waste is too inconvenient; however, they generally do not control if a package is made of recycled material. This segment is a viable market segment given less of a carbon footprint will result in higher product liking, and thereby purchases, for these consumers. Direct marketing strategies to target this group of consumers is quite simple offer products that have a small carbon footprint.

A consumer profile for the "Carbon-sensitive" segment could not be well defined because no statistically significant difference was found within the marginal effects. This is most likely a direct effect of the small size of the market segment, but a mixture of varying beliefs and/or knowledge regarding carbon-intensive footprints could also play a role. Members of this segment did not converge with the previous segment until a four-cluster solution, which means that they are not as similar to environmentally conscious as one might expect. Again, like with the previous segment, a means by which to target this group is to offer a non-carbon-intense labeled product. Future research should take a more in-depth look at this segment to better understand the makeup of this segment.

The final segment is the "Non-discriminating" segment given this group does not have any distinguishable preferences that can be easily targeted by a marketing campaign. In general, this segment was made up of older consumers of lower education and incomes that live in a metro area. They are 24.7% less likely to purchase indoor flowering plants and 17.8% less likely to list "mass merchandiser" as the place where a majority of their outdoor plants were purchased. Of note is that for each increased trip to their "favorite" horticultural store, they are 2% less likely to be in this segment. They are also more likely to agree that sorting household waste is too inconvenient.

Conclusions

Over the last decade, the Green industry has made significant strides to offer more environmentally beneficial alternatives, whether it is a biodegradable potting container, increased waste composition, or even a reduction in the carbon footprint associated with old or new products. However, little is known about how traditional product attributes compare with newer attributes that may be more environmentally friendly. Our study bridges this gap by allowing for not only a better understanding of consumer preferences, but we also identify several distinct consumer segments that can allow producers/businesses to more efficiently use their resources to offer specific product attributes to those that value them the most.

Our analysis identified seven market segments and corresponding consumer profiles. The "Rice Hull Likers" liked the rice hull pots and tended to be younger, higher-income consumers with fewer adults in the household that live in a non-metro area. They also tend to purchase indoor flowering plants and have less interest in sustainable bedding plants. As the name suggests, this consumer segment will be more willing to purchase the rice hull pot compared with the other pots holding everything else constant. To capitalize on this segment, businesses should associate rice hull pots, perhaps mainly for flowering indoor potted plants, with a younger, higher-income customer image in non-metro outlets.

To target "Straw Likers," straw pots should be marketed in metro areas in stores that have fewer black and Hispanic shoppers. However, straw pots should not be targeted at younger, less educated consumers given this demographic is more likely to be in the "Straw Dislikers" segment.

Direct marketing potting containers toward the "Price-conscious" segment is highly dependent on the cost of production of the pot. To achieve the all important first sell, a potting container is going to have to be the cheapest on the market given there are not huge rating premiums or discounts associated with the various potting containers holding all other attributes constant. Unless potting containers can compete on price, they should be marketed in areas with more single and less educated consumers that spend more on outdoor lawn/garden products.

The "Environmentally Conscious" segment tends to be those most likely to recycle household waste. The means to target the "Environmentally Conscious" as well as the "Carbon-sensitive" is by offering non-carbon-intense products, which results in increased product liking holding all else constant. However, the "Environmentally Conscious" group will perceive a greater benefit to the carbon-saving compared with the carbon-neutral label. On the other hand, the "Carbon-sensitive" will not reward the carbon-saving label, which is one of the reasons why we perceive these groups as different segments. Furthermore, targeting of the "Environmentally Conscious" segment are less concerned with pot type and waste level, whereas the "Carbon-sensitive" segment can find increased liking through rice hull and higher waste composition products.

The "Non-discriminating" segment does not have any product attributes that will allow for easy target marketing, thereby implementing the strategies for the other six segments will bring in sales from this segment.

As a secondary benefit of this research, container manufacturers and distributors (as well as plant producers and retailers) now have a better understanding of the diversity of consumers to which they market products. Most lack the resources and ability to conduct this type of research on their own; thus, the study has provided them with some consumer insight they would not have otherwise.

Additionally, visibility of containers made from non-virgin plastic continues to increase. At a minimum, the study helped to improve the awareness among consumers and industry professionals with regard to the number and type of alternative container materials available on the market today or coming to the market in the near future.

In terms of merchandising strategies for biodegradable containers, industry firms need to be consistent with their message, communicating information about biodegradable containers across all media, including web sites, catalogs, consumer advertising, and store shelves. Additionally, the value proposition of these products has to be clear and devoid of greenwashing (the misrepresentation of product attributes). Consumers have demonstrated a reluctance to purchase low-quality products, even if they do have green attributes. They must perform as well or better than non-green competing products. Lastly, understanding why customers are buying green products and the premiums they are willing to pay for more sustainable options will influence pricing strategies for industry firms. If the point of differentiation of biodegradable containers can be successfully communicated to end users (making the demand for these products more inelastic), total revenue for industry firms will increase through any price premiums, even if total units sold decreases.

The need for future research regarding consumer preferences for many aspects about ornamental plants that relate to the environment is high. Future research is needed to determine monetary willingness to pay for various potting containers and carbon footprint levels to determine if it is feasible to produce/market them. Additional research may link consumer preferences for different types of production systems (e.g., conventional, sustainable, and organic) to container preferences. Market simulations are also needed to better understand how new product introductions will affect current market conditions.

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Running head: WTP for biodegradable containers

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Are consumers willing to pay more for biodegradable containers than for plastic ones? Evidence from hypothetical conjoint analysis and non-hypothetical experimental auctions

Abstract

This study utilized and compared hypothetical conjoint analysis and non-hypothetical experimental auctions to elicit floral customers' WTP for biodegradable plant containers. The results of the study show that participants were willing to pay a price premium for biodegradable containers but the premium is not the same for different types of containers. This paper also shows the mixed ordered probit model generates more accurate results when analyzing the conjoint analysis internet survey data than the ordered probit model.

JEL Classifications: D12, Q13

Keywords: biodegradable, willingness to pay, marketing, carbon footprint, waste composition, green industry, nursery crops, floriculture crops

Introduction

The environmental horticultural industry (often referred to as the Green Industry) contributed $147.8 billion (2004 dollars) to the nation's economy in 2002 and employed approximately two million people (Hall, Hodges, and Haydu, 2005). Participants engaged in producing Green Industry products include growers of floriculture crops, nursery crops, and turf grass sod. Floriculture crops include bedding plants, potted flowering plants, foliage plants, cut cultivated greens, and cut flowers. Nursery crops are woody perennial plants that are usually grown in containers or in-ground. The Census of Agriculture defines nursery crops as ornamental trees and shrubs, fruit and nut trees (for noncommercial use), vines, and ground covers.

Nearly every floral crop and many nursery crops are grown in plastic containers. Botts (2007) reported that making nursery pots, flats and cell packs uses approximately 320 million pounds of plastic annually. The floral industry adopted plastic containers during the 1950's to replace expensive and breakable clay terra cotta containers. Nursery production evolved from in-ground, field-grown growing of plants to above-ground container-growing systems about the same time. There is still a significant portion of in-ground production, but a majority of nursery plants are grown in plastic containers since they can be harvested during most times of the year and are much easier to handle and ship.

In 2003, the U.S. generated approximately 11 million tons of plastic in the municipal solid waste stream as containers and packaging (EPA, 2007) which comprised a third of all municipal solid waste (EPA, 2005). Nationwide, only 3.9 percent of the 26.7 million tons of plastic generated in the U.S. was recycled in 2003, according to the EPA (2007). Most of the

recycled plastic was from beverage containers, including soda pop and milk. It is often challenging to recycle or reuse agricultural plastics because of contamination problems or UV degradation. In the case of plant production, recycling facilities are often unwilling to accept plastics with soil or rooting media residue. Additionally, some professional plant growers have concerns about reusing plastic containers for fear that plant disease outbreaks will increase, and worry that existing sanitation practices may not be enough to render them sanitary for production. Typically, these non-reusable or non-recyclable plastic containers are disposed by consumers and landscapers, thus presenting a significant disposal issue for the horticulture industry (Evans and Hensley, 2004). What alternatives do professional plant producers and consumers of nursery and floral products have? One alternative might be to purchase biodegradable containers.

In recent years, the floriculture industry has seen a rise in biodegradable, compostable or bioresin containers often called "green" or "sustainable" products (Lubick, 2007). These containers are derived with renewable raw materials (e.g. corn or wheat starch, rice hulls, etc.), cellulose, soy protein, and lactic acid (White, 2009). Therefore, they are often labeled as compostable as they are broken down by naturally occurring microorganisms into carbon dioxide, water, and biomass when composted or discarded (White, 2009). Biodegradable containers are those that can be planted directly into the soil or composted and will eventually be broken down by microorganisms (Evans and Hensley, 2004; White, 2009). Most biodegradable containers are made of peat, paper, or coir fiber, with peat containers being the most prevalent (Evans and Hensley, 2004). Other examples of biodegradable container materials include spruce fibers; sphagnum peat; wood fiber and lime; grain husks, predominately rice hulls; 100% recycled paper; non-woven, degradable paper; dairy cow manure; (GreenBeam Pro, 2008) corn;

coconut; and straw (Van de Wetering, 2008; Biogro-pots, 2007). Containers are sold to consumers with plants. Consumers can recycle or trash the plastic containers; for biodegradable containers, consumers also have the opportunity and are advised to plant the plants together with containers in the soil.

Despite the introduction of "green" products as alternatives to already existing ordinary products, many customers still choose ordinary products with lower environmental quality because of price and performance considerations or ignorance and disbelief (Ottman, 1998). Like most innovation activities, green product development is a task characterized by high levels of risk and uncertainty and the introduction of biodegradable containers into the Green Industry marketplace is no exception.

Most research has found that consumers willing to pay a price premium share attitudes that are favorable to the environment (Laroche, Bergeron, and Barbaro-Forleo, 2001; Schegelmilch, Bohlen, and Diamantopoulos, 1996; Straughan and Roberts, 1999; Engel and Potschke, 1998; Guagnano, Dietz, and Stern, 1994). Yet not all consumer attitudes about the environment are the same (Gladwin, Kennelly, and Krause, 1995; Purser, Park, and Montuori, 1995). Consumers think and act differently in response to ideas and products; ornamental plant containers are no different. Some questions that arise naturally are: will consumers be willing to pay a premium for biodegradable containers in comparison to the traditional plastic containers? If they do, what are the premiums? Will the premium they are willing to pay be the same for biodegradable containers that are made of different materials such as wheat starch, straw, and rice hulls? If not, which types of biodegradable containers glean higher premiums?

The objective of this study was to investigate consumer preferences for and willingness to pay (WTP) for biodegradable containers in comparison to traditional plastic containers. In

addition to container type, we also included other important attributes that are related to the environment such as carbon footprint and percentage of waste materials used in making the containers. We investigated how consumer WTP changes when the environmental attributes change in a container. The results from this study are not only important for the Green Industry but also provide important implications and insights about the market potential of alternative packaging materials for other industries such as shopping bags and food packages.

In this paper, we used a combination of a hypothetical conjoint analysis using pictures of products and a second-price sealed-bid auction using real products to elicit consumer WTP for biodegradable containers. The hypothetical conjoint analysis and non-hypothetical auction have their own advantages and disadvantages. The advantages of hypothetical conjoint analysis include: the hypothetical conjoint analysis can virtually be applied to any new product without actually having to develop or deliver the good, whereas non-hypothetical real auction can only be applied to existing product because subjects will buy the products if they win (Lusk, 2003); in the hypothetical conjoint analysis subjects can be asked how they would behave in a real store whereas values elicited in a non-hypothetical auction may change based on tastes and preferences at the time and location of the experiment (Lusk, 2003); the hypothetical conjoint analysis elicits responses in a manner that closely mimic actual shopping behavior by posting prices whereas non-hypothetical auction requires subjects to formulate bids in a manner that is unfamiliar to most subjects (Lusk, 2003); it's less costly in terms of money and time to conduct enough hypothetical conjoint analysis that can be generalized to a larger population compared to the non-hypothetical auction (Lusk, 2003). The advantages of non-hypothetical auction include: non-hypothetical auction is incentive compatible and is conducted in a non-hypothetical context that involves the exchange of real money and good, whereas the hypothetical conjoint analysis

can lead to hypothetical bias because no actual payment is required (Cummings, et al., 1995; Fox et al., 1998; List and Shogren, 1998); non-hypothetical auction can also put subjects in an active market environment where they can incorporate market feedback; non-hypothetical auction elicits WTP values for each individual, whereas WTP values must be indirectly inferred in hypothetical conjoint analysis from utility estimation (Lusk, 2003).

Additionally, the hypothetical conjoint analysis, which uses pictures, has its strength in the internal validity of the experiment. For example, using the same pictures for containers made from the same material but labeled with different levels of carbon footprint and waste material composition, we know that the differences in WTP that we find in this part of the study are due to the variation in these two attributes alone. The real auction using real products instead of pictures has its strength in its external validity. With real economic incentives, the participants face a real trade-off between money and goods and, as in real-world markets, thus it is in consumers' own interest to act so that they maximize their own utility. Through combining the data from the hypothetical conjoint analysis and non-hypothetical auctions, we utilize the strengths and alleviate the weaknesses of the two methods.

In the literature, there are several studies that elicit consumer WTP using both conjoint analysis and non-hypothetical auction . Lusk and Schroeder (2006) compared results from different experimental auction with those from a conjoint analysis and found bids from the experimental auction were significantly lower than those derived from conjoint analysis. Silva *et al*. (2007) investigated consumers' willingness to pay for novel products using the Becker-DeGroot-Marshak (BDM) auction mechanism and conjoint analysis. Grunert et al. (2009) studied consumer WTP for basic and improved soup products and compared experimental auction and conjoint analysis and the use of real vs. game money. In addition to the contribution

to the empirical WTP literature by estimating consumer WTP for biodegradable containers for plants by combining the hypothetical conjoint analysis and non-hypothetical experimental auction we employed and compared different estimation methods such as mixed ordered probit model and ordered probit model to estimate the conjoint analysis data and investigate which estimation method generates the most accurate and efficient WTP estimates.

Material and Methods

Experimental Methods

Conjoint analysis is a survey-based approach that has been widely used to evaluate consumer preference and willingness to pay for various products. Conjoint analysis decomposes a product with multiple attributes, all of which have associated utility, into individual attributes and asks respondents for an overall evaluation of the product. Using conjoint analysis, a researcher can determine a part-worth utility for each product attribute and the sum of the attributes allows for determination of total utility for any combination of attributes. Conjoint analysis is commonly used to evaluate product acceptance among consumers and consumer WTP for different attributes of a product (see e.g. Yue and Tong, 2009; Fields and Gillespie, 2008; Bernard et al., 2007; Harrison et al., 2005; Manalo et al., 1997). Most conjoint analysis studies conducted by previous researchers have been hypothetical using pictures without the real exchange of money and goods, which might lead to bias in the estimation in consumer WTP. Yue et al. (2009) showed that because the participants did not need to buy the product when presented with pictures, they tended to overstate their WTP for product in pictures compared to the cases where they were presented with real products and faced the chance they would need to pay out-of-pocket for the real product. There are numerous studies related to hypothetical bias in the

literature (see e.g. Cummings et al., 1995; Fox, et al., 1998; List, 2003; List and Gallet, 2001; List and Shogren, 1998; McKenzie, 1993; Poe, et al., 2002).

One way to overcome the aforementioned bias is to use experimental auctions, which is an incentive compatible experimental method since it involves the real exchange of money and goods. In the last 15 years, experimental auctions have been used to elicit WTP for a wide variety of food quality attributes (see, e.g., Olesen et al., 2009; Alfnes, 2009; Yue, et al., 2009; Hobbs et al. 2005; Brown, Cranfield and Henson 2005; Lusk, Feldkamp and Schroeder 2004; Lusk et al. 2004; Rozan, Stenger and Willinger 2004; Umberger and Feuz 2004; Alfnes and Rickertsen 2003; Roosen et al. 1998; Melton et al. 1996).

A (real) second-price sealed-bid auction is an auction in which the bidders submit sealed bids and the price is set equal to the 2nd-highest bid; the winners are those who have bid more than the price. Vickrey (1961) showed that in such an auction in which the price equals the first-rejected bid and each consumer is allowed to buy only one unit, it is a weakly dominant strategy for people to bid so that if the price equals their bid and they are indifferent to whether they receive the product or not. As a consequence, people not knowing the values of other participants have an incentive to truthfully reveal their private preferences. If they bid lower than their true WTP, they risk forgoing a profitable purchase. If they bid higher, they risk buying a product at a price that is above what they perceive the product to be worth given the available alternatives.

Product

The products we used were mature, yellow blooming chrysanthemums in four-inch containers. The flowers in the containers were identical to each other in appearance, while the container attributes changed among the alternatives. The container attributes and the attribute levels tested

are shown in Table 1. The attributes include material type, carbon footprint, and waste composition of a container (price was also an attribute for conjoint analysis).

Other attributes that could be considered as important to the consumer's purchase decision (such as container size and color and flower attributes such as flower type, color and size) were held constant. There were four types of containers: wheat starch, rice hull, straw and plastic. We choose these three types of biodegradable containers because they are currently available on the market. Participants were made aware about the biodegradable nature of the containers; that is, they can plant the flowers together with biodegradable containers in the soil. The plastic container was also included in our study since it is widely used by many producers and consumers and can thereby serve as control for the biodegradable containers.

The second attribute was carbon footprint. Carbon footprint was included given its increased importance both at the producer and consumer end of the marketing channel. This increased importance can be easily seen by the increasing amount of not only academic research, but also increased media coverage and marketing strategies of businesses attempting to capitalize on claims of carbon footprint savings (Philip, 2008; Pearson and Bailey, 2009). In order to determine consumer preference for and the value of "carbon labels" we compare several different labels, namely "carbon neutral," "carbon saving," and "carbon intensive."

The third attribute was percentage of waste composition (the amount of waste materials used in making the product), which was included to determine if the percentage of the pot made of waste products played any role in the consumer's purchasing decision. Waste composition levels included: "0% waste," "1-49% waste," and "> or = 50% waste."

For the conjoint analysis, we had three price levels. Price levels were determined by taking the 4-state (Indiana, Michigan, Minnesota, and Texas) average market price, $2.99, for a 4-inch potted chrysanthemum. The low and high prices were then set at $0.50 above ($3.49) and below ($2.49) the average retail price, which was determined by market observation of the price variation of a 4-inch potted chrysanthemum in the four studied states. The 4-state average price was used since the conjoint survey was administered in Indiana, Michigan, Minnesota, and Texas. Price was not an attribute for the experimental auction since participants were asked to name their own prices they were willing to pay for the containers.

Since it was not practical to ask each participant to evaluate all possible combinations of the attributes, a fractional factorial design was developed to minimize alternative number and maximize profile variation. The design was developed based on four principles: (1) level balance (levels of an attribute occurred with equal frequency), (2) orthogonality (the occurrences of any two levels of different attributes were uncorrelated), (3) minimal overlap (cases where attribute levels did not vary within a scenario were minimized), and (4) utility balance (the probabilities of choosing alternatives within a scenario were kept as similar as possible) (Louviere et al., 2000). The fractional factorial design generated by software SPSS yielded 16 alternatives to evaluate in the conjoint internet survey and 14 alternatives in the experimental auction. We did not manually eliminate any alternatives after the computer design. For a further discussion of factorial design, see Louviere et al. (2000). The alternatives used in the conjoint internet survey were product pictures and the alternatives used in the experimental auction were real products.

Experimental procedure

Hypothetical conjoint internet survey

The Internet survey was developed by researchers and approved by the university committees involved with research on human subjects. It was then implemented by Knowledge Networks during July 2009. Advantages of Web-based surveys according to McCullough (1998) are that they are potentially faster to conduct than telephone or face-to-face interviews, generate more accurate information with less human error. Even though 69.6% of the U.S. population has internet at work or home (Internet World Stats, 2006), Knowledge Networks provides Internet access to potential respondents without it, thereby, eliminating that potential bias.

The survey was made up of four parts: 1) types and amounts of plants purchased, 2) conjoint questions, 3) recycling behaviors of retailers where consumers purchase most plants, and 4) consumers' own personal and household recycling behaviors. The conjoint questions included the 16 alternatives in pictures with different product attribute combinations clearly labeled. Each survey question stated: "Please take a look at the following photographs and tell me how likely you would be to purchase the plant for your own home as shown. Keep in mind that all of the containers are four inches tall and the same size." Survey participants were then asked to indicate how likely they would be to purchase the plants on a 9-point Likert rating scale with 1 meaning "extremely unlikely" and 9 meaning "extremely likely." Conjoint analysis using ratings has its merits: it allows subjects to express order, indifference and intensity across product choice (Field and Gillespie, 2005); there is no information loss if subjects wish to express cardinal properties in their preference ordering (Harrison and Sambidi, 2004); and it's easier for subjects to use since they do not require a unique ordering (Harrison and Sambidi, 2004).

The biodegradable containers we examined in our study were meant to be planted directly in the flower bed so they were more relevant to outdoor plants. In order to eliminate

respondents who did not purchase outdoor plants, we asked potential respondents if they had purchased any plants for any type of outdoor use during the last year (since July 2008). If the respondent did not purchase any plants, then the survey ended and the respondent did not proceed to subsequent questions. An answer of "yes" allowed the respondent to finish the rest of the survey. A total of 1,113 participated in the survey with 834 participants completing the survey. The remainder of the respondents did not finish the survey since they did not purchase any ornamental plants in the past year.

Non-hypothetical Experimental auction

The experimental auctions were conducted in Twin Cities, MN and College Station, TX during May 2009. We chose to conduct the experiment auction in May because April and May are the months when people buy most of their outdoor plants (Yue and Behe, 2009). The participants were recruited through multiple channels including advertisements in local newspapers, *www.craigslist.org,* and community newsletters in order to make the recruitment pool as broadly representative of the local area and state population as possible. To make sure participants were regular buyers of ornamental plants, we specified in the advertisement that "you have to have purchased ornamental plants in the past year and you are at least 18 years old." To avoid self-selection bias, the recruitment advertisement indicated that participants would be asked about their market decisions on plant purchases, but nothing was said about biodegradable containers.

We conducted eight sessions with a total of 113 participants (there were four sessions in MN and TX, respectively). In each of the auctions there was simultaneous bidding on 14 alternatives. At the beginning of each session, participants were given a consent document and a

questionnaire. The questionnaire consisted of similar questions to the conjoint internet survey. To familiarize participants with the auction procedure, we ran one round of practice auction in which participants bid on candy bars. Next, the 14 alternatives were put on a large table and beside each alternative there was a label indicating the container type, percentage of waste materials, and carbon footprint levels. The label for each product was a piece of laminated and printed paper and was placed at a prominent position in front of each plant. Participants walked around the table and placed their bids on their bidding forms as they studied each alternative. Participants were not allowed to communicate with each other during the bidding process. To reduce any systematic ordering effects, the participants could start at any of the 14 alternatives on the table.

After the real auction, each participant randomly drew his or her exclusive binding alternative. The price of an alternative was equal to the 2nd-highest bid for that alternative. If the participants had bid more than the price for their binding alternative they had to buy the alternative. Participants were given $30 to compensate for their time. At the end of the experiment, if a participant won an alternative, he/she would get the alternative he won and get $30 minus the price for the alternative; if a participant did not win, he/she received the entire $30.

Econometric Models

The experimental auction data is analyzed using the following model:

$$Bid=\boldsymbol{\gamma A}+\mu+\boldsymbol{\varepsilon} \qquad (1)$$

where *Bid* is respondents' bid for the alternatives in the experimental auction, $\boldsymbol{\gamma}$ is a row vector of coefficients, $\boldsymbol{A}$ is a column vector of container attributes, μ is a random individual effect that is designed to capture the correlation between the bids submitted by the same participants and is

assumed to follow a normal distribution with mean zero and standard deviation σ_μ, and $\boldsymbol{\varepsilon}$ is the random econometric error. Measures of the difference between the WTP for attribute *i* and attribute *j* are then

$$WTP_{i\text{-}j}=g_{ij}\,(\boldsymbol{A}_i-\boldsymbol{A}_j) \qquad (2)$$

where *g* denotes estimated coefficients for $\boldsymbol{\gamma}$, and *i*, *j* denote different levels of attributes. Instead of using a linear model, we used a linear mixed model in estimating the auction data. Since participants bid on 14 alternatives simultaneously, it is very possible that there is correlation between the bids submitted by the same participants. The linear mixed model is used to capture the possible correlation by including a random individual effect.

For the conjoint analysis data, similar to Boyle et al. (2001), we assume that respondents have linear preferences over the container attributes in the experimental design such that

$$V(.)=\boldsymbol{\beta A}+\alpha\$+\tau+\boldsymbol{e} \qquad (3)$$

where $V(.)$ is an indirect utility function, $\boldsymbol{\beta}$ is a row vector of coefficients, $\boldsymbol{A}$ is a column vector of container attributes, α is the marginal utility of money, $\$$ is price in the experimental design, τ is a random individual effect that is designed to capture the correlation between the ratings submitted by the same participants and is assumed to follow normal distribution with mean zero and standard deviation σ_τ, and *e* is the random econometric error. Measures of the difference between the WTP for attribute *i* and attribute *j* are then

$$WTP_{i\text{-}j}=b_{ij}\,(\boldsymbol{A}_i-\boldsymbol{A}_j)/a_{ij}, \qquad (4)$$

where a_{ij} and b_{ij} denote estimated coefficients for $\boldsymbol{\alpha}$ and $\boldsymbol{\beta}$, respectively, and *i*, *j* denote different levels of attributes. The confidence interval for $WTP_{i\text{-}j}$ can be calculated using Delta method (Greene, 2002).

We analyzed the ratings data using a mixed ordered probit model. Probit model assumes that there is a postulated continuous latent variable that is partially observed and there is an existing transformation from ratings space to utility space. In the ordered-probit model, the ratings have ordinal interpretation, i.e. a rating of five is not necessarily twice as far from rating of one as rating of three. Instead of using ordered probit model, we use mixed ordered probit model by introducing an individual random effect into the model. Since in the conjoint analysis each participant evaluated multiple items (16 alternatives in our experiment) it's very possible that the ratings from the same participant on the 16 alternatives are correlated. The random individual effect is designed to capture this correlation.

Results and Discussion

Table 2 shows the socio-demographic background information of experimental auction participants and conjoint analysis internet survey participants. The average age of participants was 40-59 years old for both the experimental auction and internet survey. This is consistent with earlier studies that gardening plants purchasers tend to be older (Yue and Behe, 2008). The average household size of both experimental auction participants and internet survey participants were 2 to 3 people per household. Auction participants had relatively higher average education and income levels than internet participants. In addition, more auction participants were female (70%) than internet participants (52%). To compare the socio-economic variables of the auction participants and conjoint analysis internet survey participants we ran two-sample Wilcoxon rank-sum tests for medians for variables *Age, Education, Household Size* and *Income* and Z test for variable *Gender*. The two samples did not differ significantly from each other on *Age* and

Household Size (p-values were 0.21 and 0.24, respectively) but the two samples differed significantly on *Education*, *Gender*, and *Income* (p-values were less than 0.01). We ran the analysis by including and excluding the socio-demographic variables for both experimental auction data and internet survey data. We incorporated and controlled socio-demographic variables in the analysis to make sure that the possible difference (if any) in the estimated WTP from experimental auction data and conjoint analysis data are not due to the difference in socio-demographic backgrounds of participants from the two experiments.

Table 3 shows the estimation results of the experimental auction data using two linear mixed models. Model 1a only included the product attributes and Model 1b included both product attributes and participants' socio-demographics such as age, gender, education level, household size and income levels. In the estimation, plastic, 0% waste composition and carbon neutral were used as the reference levels for the estimation. By incorporating the socio-demographic variables, Model 1b did not yield statistically significantly different coefficients than Model 1a. The estimation results show that participants were willing to pay a higher premium for biodegradable containers and the average premiums were not the same for biodegradable containers that are made from different materials. The WTP estimates and corresponding confidence intervals from experimental auctions are shown in the second column of table 5. Compared with plastic containers, participants liked rice hull pots the best and they were willing to pay the highest premium which was around $0.58 per pot. Participants were willing to pay about $0.37 premium for straw pots, and $0.23 premium for wheat starch pots compared with the traditional plastic containers.

The composition of waste materials in a given container also affected consumer WTP based on the auction data estimation results. We found that the higher the percentage of waste

materials in a pot, the higher the premium. For example, compared with 0% waste material, participants were willing to pay about $0.16 for a pot comprised of 1-49% waste materials and about $0.23 for a container comprised of 50-100% waste materials.

As expected, carbon footprint level also significantly influenced participant WTP for a container. Specifically, we found that compared with a neutral carbon footprint, participants were willing to pay about $0.17 more for a container that was carbon saving and they discounted carbon intensive containers by around $0.43. The significant estimate of gender shows that female participants' WTP for plants were higher than that of male participants. The estimate of the random individual effect is significant (σ_μ), indicating that there is correlation between the multiple bids submitted by the same participants. Therefore, the linear mixed model rather than linear model should be used since the use of the linear model would lead to biased estimation.

Tables 4 shows the estimation results on the conjoint internet survey using a mixed probit model. The inclusion of socio-demographic variables does not change the coefficients of the product attributes significantly, but we found that the estimation results from the conjoint analysis internet survey are quite different from those from experimental auction. The negative coefficient of *Price* means that as price goes up consumers' likelihood of choosing the product is lower. The coefficients of *Rice Hull* and *Straw* are significant and positive and the coefficients of *Carbon Intense* are negative and significant. The positive coefficients of *Rice Hull* and *Straw* indicate that participants were more willing to buy biodegradable containers made from rice hull and straw and they were willing to pay positive premiums for them. The coefficient of *Rice Hull* is higher than that of Straw, which indicates participants liked containers made of rice hull better than the containers made of straw. The coefficients of the

variables measuring the percentage of waste materials, *Wheat Starch*, and *Carbon Saving* are not significant.

If we divide the coefficient of a product attribute by the absolute value of the coefficient of price we get the estimated WTP for that specific product attribute compared with the baseline attribute (Boyle et al., 2001). The estimates of WTP for different product attributes and the corresponding 95% confidence intervals from the conjoint analysis internet survey based on models 2a and 2a' were listed in columns 3 and 4 of table 5. The results show that compared with plastic containers, participants were willing to pay about $0.82 more for rice hull containers and they are willing to pay around $0.61 more for straw containers. Compared with carbon neutral containers, participants discounted carbon intense containers by around $1.04 per container. Estimates of WTP for other product attributes such as wheat starch container, carbon saving container, and the percentage of waste materials are not significantly different from their baseline product attributes (plastic container for container type, carbon neutral for carbon level, 0% waste material for percentage of waste material composition).

Table 5 shows that the WTP estimates from auction data are quite different from the WTP estimates from conjoint analysis data. Compared with the auction results, the premiums for rice hull pots and straw pots are higher but are not significantly different. The discount for carbon intense containers is significantly higher than the conjoint analysis results. While the premiums for wheat starch pots, carbon saving, higher percentage of waste material (1-49% and 50-100%) are positive and significant from auction results, no premiums were found for these attributes from conjoint analysis internet survey results. These differences stem from four major sources with the first being the differences that can occur between a non-hypothetical study versus hypothetical study and the second stemming from the use of real products versus

the use of pictures of products. The experimental auction involved real exchange of money and goods. Participants were asked to buy the products if they won and the procedure is incentive compatible. The conjoint analysis internet survey did not involve real exchange of money and goods. It was a hypothetical method and participants were not required to purchase anything. Extensive literature has shown that if there is no involvement of exchange of money and goods, it also leads to hypothetical bias. Hypothetical bias measures the difference between what people say they would pay and their real WTP (Alfnes and Rickertsen 2003; Lusk, Feldkamp and Schroeder 2004; Yue, et al., 2009). Another difference between the two studies is that the experimental auction used real products while the conjoint internet survey used pictures of products. Being presented with real products, participants get the chance to see, touch, and feel the products, which gives participants a better idea about the products' texture, color, size, sturdiness and other physical quality attributes. By seeing only a product's picture, participants' judgments about products' quality is purely based on the appearance of the products shown in pictures and they have to imagine other dimensions of the product quality based on their own experiences and knowledge.

For example, the premium for wheat starch from experimental auction results is significant and positive while there is no premium for wheat starch containers based on the conjoint analysis internet survey results. The wheat starch containers and plastic containers are very much alike in appearance shown in pictures. Consumers might assume that products made from wheat starch might not be as sturdy as plastic even though they are biodegradable, which results in no premium in WTP. Whereas in the experimental auction, participants got the chance to value the texture, sturdiness, and other aspects of the container and better assess the quality of containers made from wheat starch. The validation of the quality and biodegradable nature led

to participants' premium value for the product. Similar results hold for waste material composition. Without the chance of seeing the real products, participants might assume that the containers made from waste materials might be of lower quality. Even though the product may be more environmentally friendly, they are reluctant to pay a premium for a product consisting of higher percentage of waste materials if they have no opportunity to assess its quality in person.

Additionally, the conjoint analysis and auctions elicited subjects' WTP in different ways (one posted price and the other one asked subjects to name their own prices), which can lead to different WTP estimates (Lusk and Schroeder, 2006) and we used different recruiting methods, which can also lead the differences in results. Due to the focus of the research project and cost considerations, we did not identify the exact effect of each of the four factors.

In the literature, conjoint analysis data are mainly estimated using linear, tobit, or probit models (Wittink, Vriens and Burhenne, 1994; Boyle et al., 2001; Manalo and Gempesaw, 1997; Anderson and Bettencourt 1993; Harrison, Stringer and Prinyawiwatkul, 2002; Sy et al., 1997) instead of using mixed probit model. However, the linear model has been shown to have limitations for estimating qualitative data in the literature (Doyle, 1977; Louviere, 1988; Sy et al., 1997). The ordered probit model shows that the random individual effect is significant (σ_τ), which means a correlation exists between the ratings on multiple products from the same participants. The last two columns of table 4 show the estimation results ordered probit model without considering the random individual effects. From the results we can see that the estimation results of ordered probit model are different from the results of mixed ordered probit models. The log likelihood of the mixed ordered probit model is greater than that of the ordered probit model and the likelihood ratio test statistics are statistically significant (p-value<0.001),

which indicates the mixed ordered probit model is a better fit for the conjoint analysis data. Ignoring the random individual effect would lead to biased estimation. Therefore, for our data, the mixed ordered probit model should be used instead of the ordered probit model to get accurate estimation. To compare the possible differences between the WTP estimation results, we also estimated the WTP using a probit model as shown in the last column of table 5. From table 5, we can see that compared with the mixed ordered probit model, the ordered probit model generates different WTP estimates even though some of the differences might not be statistically significant. Additionally, the confidence intervals of the estimates are much wider from the probit model than those from mixed probit model. Ignoring the significant random individual effects can not only lead to biased WTP estimates but also lose efficiency by generating wider confidence intervals. Therefore, panel models such as mixed ordered probit model should be used in the conjoint analysis data instead of ordered probit model to capture the random individual effects.

Conclusions

A widely discussed topic in the Green Industry is the greater degree of awareness being exhibited by consumers on the issue of environmental sustainability. This awareness has lead to an increased development of products that not only solve the needs of consumers, but are also produced and marketed using sustainable production, distribution, and marketing methods. A greater emphasis has also been placed on product packaging in the mainstream marketplace and this has carried over to the Green Industry in the form of biodegradable pots. While various forms of these eco-friendly pots have been available for several years, their marketing appeal was limited due to their less-than-satisfying appearance. With the recent availability of more

attractive options of biodegradable plant containers, this has renewed interest in their suitability in the floriculture sector and their acceptance on the part of floral customers. However, these biodegradable (sustainable) pot alternatives may also require a price premium in the marketplace to be economically sustainable.

The presence of environmentally sensitive or "green" consumers has been acknowledged for some time and such consumers are more likely than the general population to take environmentalism into account when purchasing goods. The presence of such consumers has also been assumed to generate profits for companies with a track record of environmentally-friendly practices.

This objective of this study was to determine the characteristics of biodegradable pots that consumers deem most desirable when purchasing potted flowering plants and to solicit their willingness-to-pay (WTP) for this type of sustainable product. This study utilized both conjoint analysis and experimental auctions to elicit WTP on the part of floral customers for four types of biodegradable containers. While conjoint analysis allowed the research team to simultaneously investigate a number of product attributes and determine the relative importance of each attribute in the consumer's preference, the experimental auctions enabled the team to distinguish what consumers "say they will do" against what they "actually did" in making purchasing decisions.

The results of the study show that participants were willing to pay a price premium for biodegradable containers and their revealed WTP is heterogeneous for biodegradable containers that are made from different materials. The composition of waste materials in a given container also affected consumer WTP based on the auction data estimation results. We found that the higher the percentage of waste material composition in a pot, the higher the premium. Lastly, as expected, the carbon footprint associated with a given container also significantly influenced

WTP. Specifically, we found that compared with a neutral carbon footprint, participants were willing to pay more for a container that was carbon saving and they discounted containers that were labeled as carbon intensive.

In addition to the empirical contributions, this paper also makes theoretical contributions. We show mixed ordered probit model generates more accurate results when analyzing our conjoint analysis data than the widely used models in the literature such as the ordered probit model. We found significant individual random effects when estimating mixed ordered probit model for our data. Additionally, the confidence intervals of the WTP estimates are much wider from the probit model than those from the mixed probit model. Therefore, if the random individual effect is statistically significant, ignoring the significant random individual effects can not only lead to biased WTP estimates but a loss of efficiency by generating wider confidence intervals. Accordingly, panel models such as mixed ordered probit model should be used in the conjoint analysis data instead of ordered probit to capture the random individual effects.

Through intelligent packaging and system design, it is possible to "design out" many potential negative impacts of plant packaging on the environment and society – in this case, the prominent amount of virgin plastic produced as requisite to the green industry. *Cradle to cradle* principles offer strategies to improve the material health of packaging and close the loop on packaging materials including the creation of economically viable recovery systems that effectively eliminate waste. The use of biodegradable pots reflects these cradle to cradle principles. This research will greatly benefit floral consumers by ensuring that environmentally-friendly products marketed to them in the future truly meet their "sustainability" needs and/or expectations.

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Table 1. Container attributes and the attribute levels tested in this study of WTP for biodegradable containers for potted flowering plants using conjoint analysis and experimental auction methodologies.

Attributes	Level 1	Level 2	Level 3	Level 4
Container Type	Plastic	Rice Hull	Wheat Starch	Straw
Waste Material Level	0%	1-49%	50%+	------
Carbon Footprint	Saving	Neutral	Intensive	------
Price[a]	$2.49	$2.99	$3.49	------

[a] Price was not an attribute in the experimental auction since participants bid the price they were willing to pay for each alternative.

Table 2. Summary statistics of socio-demographic characteristics of the sample frame of Minnesota and Texas consumers participating in a 2009 WTP study of biodegradable containers for potted flowering plants.

Variable	Variable Definition	Experimental Auction (N=113)		Conjoint Analysis (N=834)	
		Mean	Standard Deviation	Mean	Standard Deviation
Age [a]	1=Under 20 years old 2=20-29 years old 3=30-39 years old 4=40-49 years old 5=50-59 years old 6=60-69 years old 7=70 years old or over	4.32	1.41	4.23	1.68
Education [b]	1=Some high school or less 2=High school diploma 3=Some college 4=College Diploma or higher	3.61	0.71	2.70	0.92
Gender [c]	0=Male 1=Female	0.70	0.46	0.52	0.50
Household Size [d]	Number of people in a household	2.64	1.31	2.70	1.39
Income [e]	1=$15,000 or under 2=$15,001 - $25,000 3=$25,001 - $35,000 4=$35,001 - $50,000 5=$50,001 - $65,000 6=$65,001 - $80,000 7=$80,001 - $100,000 8=over $100,000	5.29	2.14	4.68	2.24

[a] The p-value of Wilcoxon rank-sum test for the two samples is 0.22.
[b] The p-value of Wilcoxon rank-sum test for the two samples is <0.01.
[c] The p-value of Z-test of proportions for the two samples is <0.01.
[d] The p-value of Wilcoxon rank-sum test for the two samples is 0.24.
[e] The p-value of Wilcoxon rank-sum test for the two samples is <0.01.

Table 3. Linear mixed model estimation results for experimental auction data (n=1,580) collected as part of a 2009 WTP study of biodegradable containers for potted flowering plants.

	Model 1a		Model 1b	
Variables	Coefficient	Standard Error	Coefficient	Standard Error
Constant	2.064***[a]	0.178	2.214***	0.180
Rice Hull	0.583***	0.066	0.600***	0.067
Straw	0.366***	0.069	0.375***	0.071
Wheat Starch	0.226***	0.066	0.233***	0.067
Waste 1-49%	0.159***	0.056	0.163***	0.057
Waste 50-100%	0.231***	0.056	0.243***	0.057
Carbon Saving	0.166***	0.056	0.174***	0.057
Carbon Intense	-0.432***	0.060	-0.422***	0.057
Age[b]	---	---	0.111	0.314
Education[b]	---	---	-0.238	0.281
Gender[b]	---	---	0.349**	0.170
Household size[b]	---	---	-0.032	0.189
Income[b]	---	---	-0.132	0.177
σ_μ	1.757***	0.119	1.737***	0.119
Log Likelihood	-2300.221		-2252.650	

[a] Double and triple asterisks (*) denote significance at the 0.05, and 0.01 levels, respectively.
[b] The variables are standardized in the estimations, which makes interpretation of the product attribute coefficients straightforward because the variables have zero means and unitary standard deviations (s.d.). After the variables are standardized, the coefficient (β) of an independent variable would be interpreted in this way: changing the independent variable by one standard deviation, holding other independent variables constant, would change the dependent variable by β standard deviations.

Table 4. Mixed Ordered Probit model estimation results for conjoint analysis data (n=13,194) [a] collected as part of a 2009 WTP study of biodegradable containers for potted flowering plants.

	Model 2a		Model 2b		Model 2a' (Ordered Probit Model)	
Variables	Coefficient	Standard Error	Coefficient	Standard Error	Coefficient	Standard Error
Price	-0.354***[ba]	0.026	-0.355***	0.026	-0.174***	0.024
Rice Hull	0.291***	0.029	0.292***	0.029	0.143***	0.027
Straw	0.217***	0.028	0.217***	0.029	0.110***	0.027
Wheat Starch	-0.043	0.028	-0.043	0.029	-0.019	0.027
Waste 1-49%	-0.040	0.023	-0.040	0.023	-0.022	0.021
Waste 50-100%	-0.036	0.028	-0.036	0.029	-0.019	0.027
Carbon Saving	-0.015	0.023	-0.016	0.024	-0.006	0.022
Carbon Intense	-0.370***	0.028	-0.371***	0.029	-0.181***	0.027
Age[c]	---	---	0.048**	0.023	---	---
Education[c]	---	---	0.180***	0.020	---	---
Gender[c]	---	---	-0.095***	0.020	---	---
Household size[c]	---	---	0.155***	0.019	---	---
Income[c]	---	---	0.118***	0.020	---	---
σ_τ	1.457***	0.032	1.521***	0.036	---	---
Constant1	-2.935***	0.082	-2.782***	0.083	-1.360***	0.073
Constant2	-2.231***	0.081	-2.082***	0.082	-1.083***	0.072
Constant3	-1.535***	0.080	-1.407***	0.081	-0.777***	0.072
Constant4	-0.997***	0.079	-0.879***	0.080	-0.516***	0.072
Constant5	-0.147*	0.079	-0.035	0.079	-0.055	0.072
Constant6	0.346***	0.079	0.459***	0.079	0.230***	0.072
Constant7	0.962***	0.079	1.072***	0.080	0.589***	0.072
Constant8	1.604***	0.080	1.717***	0.081	0.966***	0.073
Log Likelihood	-21171.876		-21125.123		-27996.452	

[a] We had 834 participants and each participant evaluated 24 alternatives, which leads to a total of 13,344 observations. After deleting outliers and observations with missing values (about 1%), we had 13,194 observations for our estimation.
[b] Double and triple asterisks (*) denote significance at the 0.05, and 0.01 levels, respectively.
[c] The variables are standardized in the estimations, which makes interpretation of the product attribute coefficients straightforward because the variables have zero means and unitary standard deviations (s.d.).

Table 5. WTP estimates using different models to analyze data collected as part of a 2009 study of biodegradable containers for potted flowering plants.

Product Attributes	Experimental Auction	Conjoint analysis	
	Mixed Linear	Mixed Ordered Probit	Ordered Probit Model
Rice Hull	0.583*** [0.454, 0.712][a]	0.822*** [0.645, 1.000]	0.821*** [0.484, 1.159]
Straw	0.366*** [0.230, 0.501]	0.612*** [0.440, 0.784]	0.632*** [0.301, 0.962]
Wheat Starch	0.226*** [0.097, 0.355]	-0.121 [-0.281, 0.039]	-0.110 [-0.414, 0.194]
Waste 1-49%	0.159*** [0.049, 0.269]	-0.112 [-0.240, 0.016]	-0.127 [-0.371, 0.116]
Waste 50-100%	0.231*** [0.121, 0.341]	-0.101 [-0.257, 0.051]	-0.106 [-0.400, 0.187]
Carbon Saving	0.166*** [0.057, 0.276]	-0.042 [-0.171, 0.089]	-0.032 [-0.280, 0.215]
Carbon Intense	-0.432*** [-0.549, -0.314]	-1.045*** [-1.262, -0.827]	-1.042*** [-1.456,-0.628]

[a] 95% confidence intervals.

Table 4. Marginal probabilities for purchasing and recycling behaviors and beliefs by consumer segment with respect to a vector of explanatory variables (computed at the mean), continued.

	Marginal probabilities of membership in each segment													
Variable [zyx]	Prob. [Seg. = I] Coefficient	*p-value*	Prob. [Seg. = II] Coefficient	*p-value*	Prob. [Seg. = III] Coefficient	*p-value*	Prob. [Seg. = IV] Coefficient	*p-value*	Prob. [Seg. = V] Coefficient	*p-value*	Prob. [Seg. = VI] Coefficient	*p-value*	Prob. [Seg. = VII] Coefficient	*p-value*
Interest in purchasing following plant types? [w]														
Conventional bedding plants	0.031	*0.16*	-0.014	*0.15*	-0.005	*0.51*	**0.027**	*0.06*	-0.008	*0.40*	-0.001	*0.59*	-0.031	*0.23*
Organic bedding plants	-0.005	*0.86*	-0.005	*0.64*	-0.012	*0.23*	0.016	*0.32*	0.012	*0.36*	0.000	*0.85*	-0.005	*0.87*
Sustainable bedding plants	**-0.067**	*0.01*	-0.003	*0.80*	0.000	*0.96*	**0.031**	*0.04*	0.000	*1.00*	0.000	*0.82*	0.038	*0.22*
Locally produced bedding plants	-0.040	*0.14*	0.010	*0.36*	**0.018**	*0.03*	**0.031**	*0.08*	0.002	*0.92*	0.000	*0.90*	-0.020	*0.53*
Grown in organic fertilizer	0.012	*0.69*	0.018	*0.14*	-0.001	*0.92*	-0.010	*0.58*	**-0.023**	*0.09*	0.001	*0.68*	0.004	*0.92*
From energy efficient greenhouse	0.024	*0.32*	-0.010	*0.26*	0.002	*0.83*	-0.005	*0.69*	0.010	*0.38*	0.000	*0.70*	-0.020	*0.49*
Grown in biodegradable pots	0.011	*0.71*	-0.002	*0.91*	-0.013	*0.23*	-0.018	*0.21*	0.018	*0.19*	0.000	*0.73*	0.005	*0.89*
Grown in compostable pots	**0.056**	*0.04*	0.007	*0.45*	-0.013	*0.11*	-0.005	*0.74*	0.006	*0.62*	0.000	*0.84*	**-0.052**	*0.10*
Grown in recyclable pots	-0.032	*0.15*	0.009	*0.28*	**0.027**	*0.00*	-0.012	*0.41*	0.004	*0.73*	0.000	*0.95*	0.005	*0.87*
Reason to purchase env. friendly plants?														
Feel good about helping environment	-0.085	*0.12*	0.000	*1.00*	-0.005	*0.83*	**-0.052**	*0.09*	-0.013	*0.67*	0.001	*0.53*	**0.155**	*0.06*
These plants are environ. friendly	**-0.095**	*0.07*	0.022	*0.42*	-0.012	*0.59*	**-0.061**	*0.06*	-0.021	*0.47*	0.000	*0.99*	**0.168**	*0.02*
Check if package can be recycled [v]	0.000	*0.74*	0.000	*0.99*	-0.010	*0.39*	**-0.042**	*0.06*	-0.022	*0.17*	0.001	*0.55*	0.063	*0.15*
Sorting HH waste is too inconvenient [v]	**-0.040**	*0.09*	0.000	*1.00*	**0.019**	*0.05*	-0.005	*0.76*	**-0.028**	*0.02*	-0.001	*0.66*	**0.056**	*0.08*
Recycling pots more important [v]	**-0.106**	*0.00*	**0.045**	*0.00*	0.015	*0.23*	0.004	*0.85*	0.012	*0.51*	0.000	*0.63*	0.030	*0.46*
Check if package is from recyl. material [v]	-0.021	*0.50*	-0.028	*0.12*	0.010	*0.48*	-0.006	*0.79*	**-0.035**	*0.05*	-0.001	*0.61*	**0.081**	*0.06*
How often do you recycle containers?														
Sometimes	-0.024	*0.68*	-0.015	*0.58*	-0.010	*0.68*	0.003	*0.95*	0.000	*0.99*	-0.001	*0.57*	0.048	*0.55*
Usual/Always	-0.073	*0.29*	**-0.060**	*0.02*	0.032	*0.39*	0.044	*0.39*	0.004	*0.89*	-0.001	*0.57*	0.053	*0.56*
How often do you recycle plastic tags?														
Sometimes	0.028	*0.71*	-0.033	*0.19*	0.052	*0.23*	**-0.053**	*0.09*	0.055	*0.28*	0.000	*0.90*	-0.049	*0.58*
Usual/Always	0.046	*0.61*	0.013	*0.75*	-0.003	*0.92*	**-0.062**	*0.08*	0.014	*0.74*	0.000	*0.82*	-0.009	*0.94*
Agree with carbon saving definition? [vu]	**-0.081**	*0.02*	-0.003	*0.85*	-0.005	*0.67*	0.039	*0.15*	**0.053**	*0.02*	0.000	*0.85*	-0.003	*0.95*
Agree with carbon intensive definition? [vt]	**-0.085**	*0.01*	-0.015	*0.40*	**0.022**	*0.10*	0.008	*0.74*	0.018	*0.26*	0.000	*0.67*	0.050	*0.20*

[z] Base categories not yes/no answer include: dollar expenditures = 0, where purchase = other store type, heard of sustainability = not sure, reason to purchase environmentally friendly plants = other, how often buy plastic containers = never, how often buy recycled plastic tags = never.
[y] Bold indicates significance at the 0.1 level, but p-values are also given.
[x] Survey question regarding expenditures and purchases were for the last year (July 2008-July 2009).
[w] The interest in purchasing question was on a 1-7 scale where 1 = "low interest" and 5 = "high interest."
[v] A 1-5 scale was used where 1 = "strongly disagree" and 5 = "strongly agree."
[u] The survey asked for agreement with the following statement: A carbon saving footprint for a product means it takes less energy to make or ship the product to where I buy it.
[t] The survey asked for agreement with the following statement: A carbon intensive footprint for a product means it takes a lot of energy to make or ship the product to where I buy it.