ABSTRACT

JENKINS, ETHAN BRYCE. Product Source Labeling and E-Commerce:
Consumer Perception of Horticultural Products through Information and Messaging. (Under the direction of Dr. Melinda Jean Knuth).

Consumer behavior concerning horticultural products has indicated an increased desire for businesses to provide more in-depth labeling and communication regarding product sourcing. However, there is a lack of consensus on what defines certain product attributes, such as a product being local, preventing solidified conclusions addressing consumer perceptions and purchasing tendencies. This research explores North Carolina consumer perceptions and behaviors related to product source labeling and e-commerce in the horticultural industry. Chapter two provides a brief introduction to the topic. The second chapter investigated how labeling information, particularly regarding the local sourcing of ornamental plants, influences consumer purchase intentions. It highlights the increasing importance of marketing strategies that emphasize the sourcing of horticultural products and how consumers perceive local sources. Through a detailed examination of consumer interactions, the research aimed to understand how different information messaging can affect consumer purchasing habits and their overall perceptions of product sources.

In addition, the second chapter utilizes eye tracking technology to gain insights into consumer decision-making processes, since visual attention can impact purchasing behavior. Eye tracking metrics such as time to first fixation and total fixation duration were used to determine which aspects of product labeling captured and held consumer interest. The findings indicate that consumers show a preference for plants produced in-state and regionally over locally sourced plants, and a stronger preference for locally sourced plants compared to domestic or imported

plants. This preference highlights the potential value in providing the sourcing information for ornamental plants in the marketing efforts of these products.

Chapter 3 examines the evolving trends in online plant shopping. The changes brought on by the COVID-19 pandemic and heightened online shopping behavior (in general) have led to an increase in demand for convenient and reliable online shopping options. Here, we evaluate online plant shopping in the context of hobbyist and non-hobbyist plant purchasers. A hobbyist is someone who practices horticulture or gardening strictly as a hobby. The research identifies key factors influencing online purchasing decisions, including the role of social media engagement, retailers used, and overall spending habits among hobbyist and non-hobbyist plant consumers.

Overall, the thesis provides valuable insights into how marketing tactics, such as detailed product information and leveraging online platforms, can enhance consumer engagement and meet consumer demand for horticultural products. It underscores the need for ongoing adaptation and innovation in marketing strategies to meet the changing preferences and behaviors of modern consumers. The findings suggest that businesses in the horticultural industry should focus on providing comprehensive product information, emphasizing product sourcing, and enhancing their online presence to capitalize on the growing trend of e-commerce.

Product Source Labeling and E-Commerce: Consumer Perception of Horticultural Products through Information and Messaging

by
Ethan Bryce Jenkins

A thesis submitted to the Graduate Faculty of
North Carolina State University
in partial fulfillment of the
requirements for the degree of
Master of Science

Horticultural Science

Raleigh, North Carolina
2024

APPROVED BY:

Melinda Knuth Committee Chair	Kathryn Boys
Brian Whipker	Alicia Rihn

DEDICATION

To my late dad and grandpa, Chris and Henry Jenkins. Thank you for instilling an appreciation for agriculture in me, teaching me a strong work ethic, and exemplifying how to treat others the way you wish to be treated; I strive to live a life modeled after yours each day. I love and miss you both and hope I have made you proud.

BIOGRAPHY

I was born in the rural farming community of Cerro Gordo in Columbus County, North Carolina; raised by my wonderful parents, Chris and Peggy Jenkins, alongside my older siblings, Christopher and Kylie, and grew up in a fifth-generation farming family. Living on the farm made for an adventurous childhood alongside our cousins, where we'd often race golf carts and four-wheelers, have dirt clod wars, and go fishing at the pond behind grandma and grandpa's. It instilled my appreciation for agriculture at a young age, and eventually led to my love for plants.

I joined my local chapter of the National FFA Organization at West Columbus High School when I was a sophomore, which is where I discovered my passion for horticulture. Through the competition teams, I gained a community and a sense of my plans for a future career in horticulture. With this goal in mind, I set my sights on attending NC State University to obtain my degree in Horticultural Sciences. After completing two years at Southeastern Community College, I transferred to NC State University as a recipient of the Goodnight Scholarship.

I obtained my Bachelor of Science in Horticultural Sciences 3 years later, with a minor in Biological Sciences. With my sights set on one day opening a plant nursery of my own, I considered the option of attending graduate school at NC State to receive more of a business-oriented perspective of the horticulture industry. After receiving an opportunity to obtain my Master of Science degree through a graduate research assistantship, I began my graduate program.

My time at NC State gave me some of the greatest experiences, lifelong friendships, and has taught me valuable life lessons. Being involved in the Goodnight Scholars Program, Horticulture Club, Pi Alpha Xi, and the Horticultural Sciences Graduate Student Association has taught me leadership, flexibility, and cooperation. I've had my global perspectives expanded

through the opportunity to visit new places including Boston, Milwaukee, Pennsylvania, including conferences and meetings in Greensboro, North Carolina, Savannah, Georgia, Louisville, Kentucky, Columbus, Ohio, Baltimore, Maryland, and even Tokyo, Japan. I learned a sense of community through athletic events, trips with friends, and even through staying up late to study on some nights. Being a part of the NC State Wolfpack community has taught me so much and has prepared me for what lies ahead.

Overall, I have been blessed with a loving and supportive family, lifelong friendships that persist through the good times and the bad, and with incredible opportunities to pursue my passions. I would not be where I am today without the encouragement of my family and friends, and now that I have reached the end of my educational journey at NC State University, and I am looking forward to what the future holds for me in the horticultural industry

ACKNOWLEDGMENTS

I would like to begin by giving a special thank-you to my committee chair and graduate advisor, Dr. Melinda Knuth (Dr. K), for being there every step of the way on the path to completing my graduate program. From encouraging me to network and attend conferences, and by supporting me financially to make these experiences happen, I was able to secure my first job after graduation, and I was able to travel outside the U.S. for the first time. I'm grateful for the life advice, professional guidance, and encouragement to be a well-rounded student.

I would also like to thank the rest of my committee members for their assistance and encouragement during the completion of my graduate program. The advice, support, and leadership provided enabled me to accomplish this, and prepare me for the next chapter of my professional career.

Additionally, I would like to thank the other members of the Cognitive Behavioral Lab. Thank you to Debasish Paul, Amanda Solliday, and Vanessa Woods, for your encouragement and assistance during my time in the program. I will always cherish the friendships we have formed, and I appreciate all the support during my time in the lab. Thank you to Emma Arline, Mariam Mohamed, and Grant Eubanks for helping me hang up flyers, develop surveys, and for assisting during my data collection period. You were all such a big help, and I enjoyed the time we were able to spend together; you have very bright futures ahead of you, so keep up the great work.

To Dr. Patty Van Cappellen and Cheryl Tan of the Interdisciplinary Behavioral Research Center (IBRC) at Duke University and Dr. Sylvia Cox of Southeastern Community College, thank you for your willingness to be host sites for portions of my data collection period. The

professionalism, flexibility, and kindness helped me gather the necessary amount of data needed to complete the study.

I would also like to thank all my fellow graduate students for the comradery we have been able to share through our time together through HSGSA events, movie nights, and dinners; I wish you all the best as you complete your graduate programs and move closer toward your professional goals.

Lastly, another thank-you to my family and friends who have been beside me every step of the way during these last 5 years at NC State. I truly don't know where I would be without your constant love and support.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1

INTRODUCTION

INTRODUCTION

Horticulture marketing tactics have been researched over the past few decades, revealing many factors influencing the decision to purchase plant products. Key factors include price, plant type, sourcing location, and nativeness (Brzuszek and Harkess 2009, Hall et al. 2010, Yue et al. 2011). Studies have shown that consumers value locally sourced food and, more recently, are increasingly exploring locally sourced ornamental plant options (Etheredge et al. 2023, Yue et al. 2011. However, perceptions of what constitutes a "local" product are inconsistent among consumers (Brown 2003, Hawkins et al. 2012, Zepeda and Leviten-Reid 2004), an area this research seeks to investigate further. While the USDA has developed a definition of local adopted from the 2008 Farm Bill (U.S. Congress 2008), understanding consumers' perceptions of locality is essential to address these inconsistencies.

The first study aimed to explore consumer perceptions of locally sourced ornamental plants, and to compare how closely these perceptions align with the USDA definition of local. Additionally, different information regarding plant attributes was provided to evaluate consumer purchase likelihood for ornamental plants with these different attributes. The study was administered through a survey format, and the data collected was used during analysis. These results indicated that the study participants generally perceive local plants to be sourced within 95 miles or within the same state from the point of purchase. Purchase likelihood was also indicated to be higher for in-state and regional sourcing for ornamentals than locally sourced ornamentals, and was lower for domestic and imported ornamentals than locally sourced ornamentals among the study participants. These findings suggest that providing information for the plants' sourcing location on a more proximal scale than "domestic production" may not be worth the investment needed to alter the labeling and information practices for retailers.

The second study explored the purchasing habits of plant hobbyists compared to non-hobbyists and aims to provide greater insight into the state of the online ornamental horticulture market. Online plant shopping has become increasingly prominent, particularly since the Coronavirus Pandemic. Although plant sales surged during the height of the pandemic with new consumers, many of these consumers have indicated reverting to their pre-pandemic plant purchasing habits (San Fratello et al. 2022). The study assesses participants' overall plant purchasing habits from the previous two years, and their online plant purchasing habits from the previous year to provide additional insight into the trend of online plant shopping. For this study, a survey was developed to capture participants' responses, and this data was used during analysis. The results found that, compared to non-hobbyists, hobbyists spend more annually on plants, and are more likely to purchase plants online, but there was no difference in the amount spent purchasing plants online or their likelihood of purchasing plants online again. This may suggest that hobbyists are more selective with their online purchases, or that they purchase more inexpensive plants online than non-hobbyists.

Eye tracking technology in horticulture marketing research has provided valuable insights into why consumers make specific purchasing decisions and how to enhance visual attention to horticultural products. Different market segments require tailored marketing strategies, making it crucial to understand the perceptions and preferences of various groups. Target marketing is a strategy utilized by businesses to direct their marketing efforts to a specific market or sub-market (Cahill 1997). Target marketing is beneficial because it allows businesses to focus their marketing efforts, which uses expenses efficiently, and identifies the consumer group(s) for which their product is most suited (Cahill 1997). One market segment in the horticulture industry that remains underexplored is plant hobbyists. This group represents a potentially profitable

market that can drive demand for plant purchases in both physical retail settings and online platforms. The research will also identify key differences between the perceptions and purchasing habits of hobbyists and non-hobbyists.

In conclusion, this research sought to help bridge gaps in understanding consumer behavior in the horticultural industry, and to lay the foundation for further exploration of consumer behavior and develop more effective marketing strategies tailored to different consumer segments. By examining various factors influencing purchasing decisions, such as locality, product sourcing, and the rise of online shopping, the research may offer valuable insights for retailers and marketers. These insights will aid in developing targeted marketing strategies, ensuring the industry can adapt to changing consumer preferences and sustain its future growth.

REFERENCES

Brown C. 2003. Consumers' Preferences for Locally Produced Food: A Study in Southeast Missouri. American Journal of Alternative Agriculture. 18(4):213–224. https://doi.org/10.1079/AJAA200353.

Brzuszek RF, Harkess RL. 2009. Green Industry Survey of Native Plant Marketing in the Southeastern United States. HortTechnology. 19(1):168–172. https://doi.org/10.21273/HORTTECH.19.1.168.

Cahill DJ. 1997. Target Marketing and Segmentation: Valid and Useful Tools for Marketing. Management Decision. 35(1):10–13. https://doi.org/10.1108/00251749710160133.

Etheredge, C.L., DelPrince, J., Waliczek, T.M. 2023. U.S. Consumer Perceptions & Willingness to Pay for Sustainable Environmental Practices in the Floral Industry. Floral Marketing Fund. Mississippi State University and Texas State University.

Hall CR, Campbell BL, Behe BK, Yue C, Lopez RG, Dennis JH. 2010. The Appeal of Biodegradable Packaging to Floral Consumers. HortScience. 45(4):583–591. https://doi.org/10.21273/HORTSCI.45.4.583.

Hawkins G, Burnett SE, Stack LB. 2012. Survey of Consumer Interest in Organic, Sustainable, and Local Container-grown Plants in Maine. HortTechnology. 22(6):817–825. https://doi.org/10.21273/HORTTECH.22.6.817.

San Fratello D, Campbell BL, Secor WG, Campbell JH. 2022. Impact of the COVID-19 Pandemic on Gardening in the United States: Postpandemic Expectations. HortTechnology. 32(1):32–38. https://doi.org/10.21273/HORTTECH04911-21.

U.S. Congress. 2008. Food, Conservation, and Energy Act of 2008 (H.R. 2419). Available at: https://www.govinfo.gov/content/pkg/BILLS-110hr2419enr/pdf/BILLS-110hr2419enr.pdf.

Yue C, Dennis JH, Behe BK, Hall CR, Campbell BL, Lopez RG. 2011. Investigating Consumer Preference for Organic, Local, or Sustainable Plants. HortScience. 46(4):610–615. https://doi.org/10.21273/HORTSCI.46.4.610.

Zepeda L, Leviten-Reid C. 2004. Consumers' Views on Local Food. Journal of Food Distribution Research. 35(3):1–6. https://doi.org/10.22004/ag.econ.27554.

CHAPTER TWO

CONSUMER PERCEPTIONS OF LOCAL AND IMPACTS OF LOCAL LABELING ON ORNAMENTAL PLANT PURCHASING DECISIONS

INTRODUCTION

Humans have been involved with the exchange of goods and services since the dawn of time. But the process has evolved over the course of millennia. Marketing has become a crucial part of how a product is presented to increase the likelihood of turning a profit. In light of this, marketing is an increasingly important area of interest with horticultural products, and an area that experts across the industry believe should be given greater focus (Jenkins et al. 2023). Marketing is defined as the process by which companies engage customers, build strong relationships, and create customer value in order to capture value from customers in return (Kotler and Armstrong 2022). Through more interactions with consumers, retailers have a greater opportunity to connect and learn what information and attributes are important to them when making purchases (Rapp et al. 2013). In fact, increased interactions encourage brand loyalty, which further increases the potential company profitability by generating repeat customers (Erdoğmuş and Çiçek 2012). Knowing this, leveraging the relationships with consumers built through marketing practices, and using marketing tactics to convey information to consumers can have strong implications on their decision-making processes. Therefore, focusing on effective marketing strategies can significantly impact consumer engagement and loyalty, ultimately benefiting both retailers and consumers alike.

Production Information

An important component of marketing is product information, and more specifically, *how* the information is presented (Kim and Lennon 2008). Providing information for a product is important in not only highlighting what the product itself is, but in helping a consumer decide if they want to purchase the product (Gabellini and Scaramuzzi 2022). Product information can lead consumers to perceive less risk while simultaneously increasing their purchase intent (Kim

and Lennon 2000). For example, origin information on plants improves purchase rates of locally grown plants (Bienenfeld et al. 2016), organic production practice information improves vegetables and ornamental plant value among consumers (Hawkins et al. 2012) and indicating the benefits of planting native plant increases consumers' purchase likelihood for native plants (Rihn et al. 2023). Each of these studies demonstrate the potential of product information to influence consumer behavior.

Sub-category: Labels

Labeling can include information as simple as what the product is, the price, and the materials or ingredients. Depending on the product, some of this information is required (e.g., food labeling) while in other products (such as plants) it is largely voluntary. Voluntary labels provide the benefits of informing buyers of the production practices that many consumers value and may even pay more for products with this information present (Hall et al. 2010).

More marketable information tactics come into play once specifics about where the product is sourced from, how it was produced or sourced, environmental impacts, and including certifications (Hall et al. 2010, Yue et al. 2011). Environmental impact labels indicating levels of carbon generated through the production and sourcing of the product have revealed that environmentally conscious consumers prefer plant containers labeled as "carbon saving" or "carbon-neutral" to those labeled as "carbon-intense" (Hall et al. 2010). Similarly, in the nursery and floriculture industries, locally grown plants and plants grown in biodegradable or compostable containers were indicated as areas of great interest to consumers (Yue et al. 2011). These types of labels have received greater emphasis and inclusion on horticultural products in the last few decades with consumers becoming increasingly aware of the environmental impacts some of these products can have (Behe et al. 2010, Yue et al. 2011).

Ornamental Horticulture Industry

Ornamental horticulture accounted for $13.8 billion of sales in 2019 (USDA 2020). In 2022, U.S. ornamental plant sales were divided into the following categories: annual bedding and garden plants (38% of total ornamental plant sales), potted flowering plants (17%), herbaceous perennials (17%), houseplants (13%), propagative floriculture materials (8%), cut flowers (5%), and cut cultivated greens (2%) (USDA-NASS 2023). In recent years, various studies have been conducted to evaluate which factors consumers consider before purchasing ornamental plants (Behe et al. 2013, Collart et al. 2013, Rihn et al. 2016, Zadegan et al. 2008). Many of these studies have yielded results suggesting that demand for plants has been driven by not only considering the plant's physical attributes, but also by considering the production factors.

One production factor that has been explored for its importance to consumers is water conservation of plants used in the landscape. A study revealed that the more often consumers purchase plants, the higher their priority on water conservation is (Behe et al. 2018). When evaluating the importance of different plant attributes present on a label, the water saving messaging of the plant was considered the most important factor in purchase intention for some consumers from states who historically experience drought (Knuth et al. 2020). Water saving information was even more important than the price and plant guarantee provided (Knuth et al. 2020). Reduced fertilizer levels have also been noted of importance to consumers. One study evaluated consumers' attitudes towards eight different ecologically sustainable practices, and using fewer fertilizers was ranked as the most important practice for ornamental plant production (Isaak and Lentz 2020).

Additionally, there is greater emphasis on where the ornamental plants are sourced from. For instance, the majority of cut flowers sold in the U.S. market are sourced from outside the

U.S. (van Horen 2022), and as recently as the 2020s, consumers have expressed interest in shifting their purchasing habits in favor of buying flowers grown more locally (Etheredge et al. 2023). Buying plants that have a reduced environmental impact due to their origin has become an attribute consumers value (Gabellini and Scaramuzzi 2022). Some reports indicate a premium of 10% more for environmentally friendly plants, which includes their sourcing location (Etheredge et al. 2023). Research has also found that consumers who favor sustainable practices tend to prefer local plants over plants that are not local (Behe et al. 2013, Collart et al. 2013, Gabellini and Scaramuzzi 2022). With an increased sense of importance in knowing where plants are sourced from, many of these trends are believed to be in response to an increased market demand for environmental consciousness and sustainable practices (Stewart 2008).

Product Source Labeling for Food Crops

When it comes to product source labeling, it has been noted as something that consumers value with produce and food crops (edibles) for many decades. When testing consumer preferences for produce grown in-state versus out-of-state, residents of Tennessee in the late 1980s had no preference either way if the quality and price were comparable (Eastwood et al. 1987). Since then, local sourcing for food products has become of interest for consumers when making their purchasing decisions (Bienenfeld et al. 2016, Ehmke et al. 2008, Zepeda and Leviten-Reid 2004). A prominent retail avenue commonly associated with local food and products are farmers markets (Conner et al. 2010). From 1994 to 2019, the number of farmers markets operating in the U.S. has increased from 1,755 to 8,771, with an average growth rate of approximately 7% per year (USDA 2022). A 2018 survey found that 55% percent of U.S. consumers made a conscious effort to buy locally grown food, and that 48% of consumers purchased more local produce compared to the five years prior (Martinez and Park 2021).

Studies exploring consumer views on local food have also shown that consumers generally perceive locally sourced produce as having a reduced environmental impact, as being fresher and more nutritious, tastier (Grebitus et al. 2013), of a higher quality, and view it as a way to support the local economy (Feldmann and Hamm 2015).

Local Labeling in Ornamental Plants

Viewing the success of marketing produce and food crops as locally sourced, research for source labeling for ornamental plants emerged leading into the 2010s (Behe et al. 2013, Hawkins et al. 2012, Rihn et al. 2016, Yue and Tong 2009); revealing that the local sourcing of ornamental plants was a factor of increasing importance to many consumers. In 2016, interest for ornamentals like houseplants to be sourced locally was indicated by consumers (Rihn et al. 2016). Ornamental plant consumers have a similar viewpoint to local produce purchasers: that purchasing local ornamental crops supports the local economy (Yue et al. 2011). The horticulture industry has looked into the marketability and profitability of providing this information to consumers (Khachatryan et al. 2018, Rihn et al. 2016, Wei et al. 2019). A 2023 consumer survey for cut flowers purchases gave evidence that over 50% of the floral consumers surveyed considered it at least somewhat important that the cut flowers they purchased were sourced locally, and over 60% stated that they would be willing to spend 10% more for flowers that were sourced locally (Etheredge et al. 2023).

In addition to cut flowers, studies involving the purchase interest of consumers when purchasing ornamental plants that are sourced locally compared to those not sourced locally provided initial evidence that many consumers are more interested in purchasing indoor, landscaping, and vegetable plants they know are sourced locally (Yue et al. 2011). Furthermore, when assessing plant product sourcing preferences in a conjoint design, when given the option

between plants that are sourced “locally,” “regionally,” or “internationally,” local sourcing was placed of higher importance than the others by consumers based on a continuous scale ranging from “definitely would not purchase” to “definitely would purchase” (Behe et al. 2013). No exact definition for these distance scales were provided, but geographic ordering was imposed such that local was produced closer to home than regional, and regional was produced closer to home than international. If a market exists for local, ornamental plant products, then this could open another avenue for businesses to increase their overall profits.

A current approach for marketing local ornamental plants is state promotion programs. These programs have proven to be successful in both Pennsylvania and Oklahoma in increasing sales for ornamental plants grown in-state (Anella et al. 2001, Wehry et al. 2007), improving plant sales by over 80% for participating retailers, and increasing consumer WTP by 10% based on survey data collected from participants before and after they were exposed to point of purchasing in-state advertising (Collart et al. 2013).

However, the level of interest in “local” ornamental plants may not be as significant as other messaging such as “organic,” or “sustainable” (Hawkins et al. 2012). Hawkins et al. (2012) found the level of interest for both local ornamental and vegetable plants was a median of 6 out of 10 (1 = low interest, 10 = high interest), compared to a median of 9 out of 10 for both organic and sustainable ornamental and vegetable plants. Furthermore, it was found that consumers were willing to pay a greater price for local, sustainable, or organic vegetables and herbs than for ornamental plants, and suggested that local messaging was more effective in combination with other messaging than when independently messaged as a local product.

The Misnomer of Locality

While an increased interest in locally sourced plant products has emerged, there is still great variability in how different individuals perceive locality. This can sometimes lead to misconceptions of where the local product is actually produced depending on where the point of purchase is located. For instance, a previous study involving local plants (edible and ornamental) defined local to their participants as being produced within 200 miles from where it was sold (Hawkins et al. 2012). A study with Missouri residents found that the participants viewed local as more of a regional concept that could cross multiple state borders (Brown 2003). Other studies found no consensus on consumers' perceptions of locality in terms of distance from the point of purchase (Zepeda and Leviten-Reid 2004). The results of one study demonstrated that consumers generally perceive that they purchase more local ornamental plants from a greenhouse or nursery retail center than from mass merchandisers (Campbell et al. 2017). This is not always the case, though, as many greenhouses and nurseries source their plant plugs from another entity and then grow them out to selling size, or mass merchandisers will receive finished plant products from nurseries that are located closer to them geographically. The reason some consumers have this outlook on different points of purchase is generally unclear.

In Section 6015 of the 2008 Farm Bill, a definition of what constitutes a product as "local" was presented. According to the definition of locally and regionally produced agricultural food products provided in the 2008 Farm Bill, "*The term 'locally or regionally produced agricultural food product' means any agricultural food product that is raised, produced, and distributed in…the locality or region in which the final product is marketed, so that the total distance that the product is transported is less than 400 miles from the origin of the product; or; the State in which the product is produced.*" (U.S. Congress 2008). This definition explicitly speaks of food crops and produce but is assumed to apply to ornamental plants as well. With a

definition of local being used by the USDA, it begs the question of whether consumers are aware of what a federal agency defines as a local plant product, or if they will continue to purchase based on their perceptions of what makes a plant grown "locally." An additional goal of the present study is to determine how similar consumer perceptions of local plants are to the USDA definition of a local plant.

Eye Tracking in Ornamental Horticultural Research

The recent surge of horticultural marketing research in the last decade has used methods used in general marketing research but applied them to the realm of plant purchases. A primary tool that has been incorporated to generate data has been gauging visual attention through the use of eye tracking technologies (Behe et al. 2015, Huddleston et al. 2015). Eye tracking technology has proven valuable in collecting data on how individuals allocate their attention during decision-making processes in choice experiments (Behe et al. 2014, Scarpa et al. 2013, Van Loo et al. 2018). Studies have demonstrated that there is a direct correlation between where a person looks (visual attention) and what they are considering (attribute attendance or non-attendance) in their choices, which can further help infer their preferences. For example, previous research highlighted that preferences for more complex product attributes are more strongly influenced by visual attention compared to simpler attributes (Krucien et al. 2017). Another study found that increased visual attention correlates with information that consumers deem important (Behe et al. 2014). However, some studies suggest that visual attention might not always be a reliable predictor of individual preferences as there is sometimes a weak correlation between the two (Balcombe et al. 2017, Van Loo et al. 2018). Despite this, eye tracking data remains a critical tool in understanding which attributes are most important to consumers by evaluating more than consumers' responses–their actions.

Eye movements serve as objective indicators of visual attention, reflecting decision-making processes and preferences (Behe et al. 2013, Behe et al. 2017, Mundel et al. 2018). Researchers utilize key metrics such as the time to first fixation (TTFF), total fixation duration (TFD), and the fixation count to understand consumer focus. TTFF measures the attention-capturing effect of an item or area of interest (AOI). An AOI includes all fixations belonging to an object while fixations to other objects are excluded (Orquin et al. 2016). TFD gauges its attention-holding power, and fixation count tracks the number of fixations, which may reveal which stimuli induce fixation. Studies employing eye tracking technology reveal a positive correlation between visual attention and product choice, particularly influenced by consumers' level of product involvement (Behe et al. 2013, Behe et al. 2016, Clement et al. 2013). Attention to information signage emerges as a significant predictor of product choice, with time spent on product information strongly influencing purchase likelihood (Behe et al. 2015). These findings underscore the importance of visual attention to retail signage in driving consumer purchasing behavior. Eye tracking equipment has been instrumental in uncovering the dynamics of purchase decisions, with studies highlighting the pivotal role of visual attention in guiding consumer behavior (Huddleston et al. 2018).

Consumers evaluate relevant stimuli when determining the utility of different products. Visual attention includes fixations [still gaze (Pieters et al. 2002)] and saccades (rapid eye movements between fixations), with fixations indicating attribute importance (Behe et al. 2014). With this in mind, longer durations of fixations or a higher number of fixations to a certain product attribute would indicate a higher level of importance to the consumer, i.e. value. However, factors such as familiarity can reduce fixations on important attributes, as familiarity improves consumers' information processing efficiency, leading to fewer fixations because of

"cherry picking" (Orquin and Mueller Loose 2013). Aside from assessing attribute nonattendance, another benefit is that eye tracking technology is non-intrusive, and participants frequently overlook the fact that their eye movements are being recorded, ensuring that the data accurately represents their assessment of attributes (Maughan et al. 2007). Although there is a conceptual and theoretical connection between visual attendance and decision making (Aribarg et al. 2010), how this translates into the local labeling of plants remains somewhat unclear. Utilizing the capabilities of eye tracking can provide further insight beyond what a person may say they do, by tracking which attributes demand their visual attention when making purchasing decisions.

Consumer Perceptions of Native Plants

Another trend of noted importance to consumers is the value of native plant species. An increased market demand for native plants is in response to consumer education of native plants (Brzuszek and Harkess 2009), a market that comprises 50% of consumers perceiving native plants as a very or extremely important part of their own gardens and landscapes (Rihn et al. 2023). The ecological attitudes that draw consumers to native plants correspond to a high value being placed on sustainable landscape practices including pest control, irrigation, and fertilizer (Rihn et al. 2022). Additionally, studies on consumer perceptions of native plants have explored the interactions among social norms, aesthetic preferences, and pro-environmental behavior in native plant preferences (Gillis and Swim 2020, Rodriguez et al. 2017, Shaw et al. 2017). Social norms can influence the acceptance of native landscapes; with the assumption that surrounding residents prefer mostly grass lawns over native plantings, which may lead to planting natives in less visible areas like side or back yards or discouraging homeowners to plant natives at all (Gillis and Swim 2020). Aesthetic considerations also play a role, with some research indicating

that native plants may not be perceived as aesthetically pleasing unless they are utilized in a more traditional landscape (Zadegan et al. 2008), although other studies suggest that consumers find native plants visually appealing (Gillis and Swim 2020, Shaw et al. 2017). Positive perceptions of native plants' beauty can influence consumers' intent to purchase them (Gillis and Swim 2020). Furthermore, there's evidence linking environmental knowledge with the likelihood of purchasing native plants or having positive perceptions of them (Narem et al. 2018, Shaw et al. 2017). The perceived environmental benefits of native plants have a greater role in driving sales than the demographics of consumers, which means marketing efforts can be more generalized for the population as a whole rather than being catered for different demographics (Rihn et al. 2023). Gaining a deeper understanding of native plants' value to consumers can pave the way for more efficient marketing tactics to promote future sales growth.

The ornamental horticulture industry is one that continues to evolve, so the approaches used for marketing these plant products need to continually evolve as well. Using marketing tactics that provide more information to consumers on ecological plant factors like where it is sourced from and whether it is a native plant species could become a critical component for future success of the industry. The importance of these factors can be determined through consumer feedback, as well as using methods like eye tracking technologies to gain further insight.

The present study seeks to explore the following proposed hypotheses:

First, the presence of local labeling will result in a higher likelihood to purchase these plants compared to plants with an indication of sourcing other than local (H1). This hypothesis was evaluated through survey responses addressing the hypothesis proposed, alongside the corresponding eye tracking data for the relevant questions.

Second, since previous research has indicated greater importance for food crops to be sourced locally than ornamental plants (Behe et al. 2013), then consumers will display a higher preference for purchasing locally grown food crop products than locally grown ornamental plant products (H2).

Lastly, based on perceptions of distance that determines locally sourced food (Feldmann and Hamm 2015), consumers' perceptions of locally grown products will be confined to being produced in the same state as the point of purchase (H3a), or will be conditional on the product being sourced within 100 miles to the point of purchase (H3b). This was addressed by having study participants provide their perception of what makes a product "locally grown," and by providing a distance in miles for locally sourced plants. Hypotheses H2, H3a, and H3b were evaluated through analyzing survey responses and by running the appropriate statistical tests to draw conclusions.

MATERIALS AND METHODS

The following section highlights the techniques and processes utilized during data collection for the present study. Methods for the protocol, survey, analysis, and hypotheses are discussed below.

Protocol

Participant recruitment was conducted through a secure participant database hosted within the Cognitive Behavioral Lab (Raleigh, NC). Participants who registered with the database were solicited through email communication to participate in the study; all participants were screened to ensure they had purchased plants within the last 12 months (adopted from Rihn et al. 2016). A total of 206 participants were included in the study; all participants were residents

of North Carolina, and results are discussed within the context of North Carolina consumers. This study was approved by North Carolina State University's Institutional Review Board (IRB#25671). Participants were invited on-site at one of three locations: North Carolina State University (Raleigh, NC), Duke University (Durham, NC) or Southeastern Community College (Whiteville, NC). Data collection took place from July 6, 2023, to August 12, 2023, at North Carolina State University, and from February 13, 2024, to March 27, 2024, at Duke University and Southeastern Community College.

The web-based survey was developed using *Qualtrics* (Seattle, WA and Provo, UT), a software program commonly used in marketing research. Web-based surveys are commonly used in market research because they are potentially faster to conduct than telephone or face-to-face interviews, generate more accurate information with less human error, and are less expensive (McCullough, 1998). Additionally, these surveys are automatically coded, cost-effective, and multiple surveys can be transmitted at a time (Cobanoglu et al. 2001). Potential drawbacks involved with conducting online surveys include reduced response rates, and a lack of participation, which sometimes leads to not having a completely randomized sample (Lefever et al. 2007). The survey for the present study was administered electronically, but in-person in order to utilize the eye tracking equipment, which may have mitigated some issues with response rate and survey completion rates.

Upon arriving at the location, participants consented to participate, have their eye movements and screen recorded, and have their data used in the analysis (Adopted from Khachatryan et al. 2018). After consenting, each participant was assigned a six-digit participant ID number (indicating collection day number, station number, and participant number) to ensure anonymity of their responses during data analysis. The survey was administered via computer

stations located in the Cognitive Behavioral Lab (North Carolina State University, Raleigh, NC), at the Interdisciplinary Behavioral Research Center (Duke University, Durham, NC), and at one of Southeastern Community College's Administrative Building classrooms (Whiteville, NC) that were equipped with eye tracking equipment, environmental web cameras, and *iMotions* software to complete the study.

Before beginning the survey, participants were asked to adjust their seat to achieve their most comfortable position to maintain for the duration of the study. The table height was also adjusted to ensure the eye trackers were within range to detect the participant's eye movements. The eye trackers were calibrated using 4 calibration points (10-15 seconds) before the study began to achieve maximum tracking capability (adopted from Wei et al. 2019). Survey questions were presented on a computer screen (24" screen diagonal measure, 16:9 ratio, 1,920 x 1,080 pixel resolution). Each computer station was equipped with a *SmartEye* (Gothenburg, Sweden) Aurora eye tracker, which was mounted on the computer monitor. There were four total stations, allowing up to four participants to complete the study at once. The study took around 10-15 minutes to complete. Participants were paid the full $15 regardless of how much of the study they completed, so there was no penalty for participants needing to leave early with an incomplete study. Following the completion of the study, participants were compensated $15 (cash) and were compensated $2 (cash) for parking expenses, if applicable.

Survey

The survey consisted of 47 questions including Likert scale questions (Winter and Dodou 2010) to determine local versus non-local attitudes, a discrete choice experiment block, and multiple choice and short answer responses to evaluate the types of plants purchased, defining characteristics of local, and demographic data. A cheap script was also given to inform study

participants that the information provided for plant purchases was intended to be portrayed in the form of a label for the plants prior to answering the discrete choice purchasing questions. Therefore, the information given for each purchasing question could be assumed to be given in the form of a product label.

Screening Question

The first question in the survey was a screening question to ensure they had purchased plants within the past 12 months (adapted from Rihn et al. 2016). If the participant selected "none of the above," the study would end and the participant's responses were not used, but they were still compensated for their time. The 12 plant options given for participants to select from were annual flowering plants, vegetable plants, herbs, perennials, flowering shrubs, evergreen shrubs, fruit producing trees, evergreen trees, shade trees, indoor flowering potted plants, indoor foliage plants, and succulents (adapted from Behe et al. 2014, Knuth et al. 2018, USDA-NASS 2020).

Local Production

After completing the screening question, the participants were taken through a randomized set of blocks. The first block focused on perceptions and attitudes of local products. Participants were asked to provide their definition of "local" in a distance perspective (in miles), which was included in the survey to help determine consumer perceptions of locality. Despite there being a USDA definition, it is worth exploring the consumer perception of what "local" is exactly. Previous studies have indicated varying degrees of mileage (10-200 miles, or even produced and sold within the same country) from the point of purchase to consider a product "local" (Behe et al. 2013, Campbell et al. 2014, Cranfield et al. 2012, Feldmann and Hamm 2015, Hawkins et al. 2012, Pearson et al. 2011). The present study further explored this

perception to provide more insights into the distance that North Carolinians define as local. To gauge locality from a consumer's perspective, participants were asked to give the distance (in miles) they felt defined a "local" product as a short answer option question, which enabled participants to type-in their response rather than choosing from a predetermined list.

People may associate other attributes with "local" beyond distance. To explore these attributes, a list of opposing attributes was provided, including organic production and conventional production, family business and corporation, neighbors and strangers, sustainable and unsustainable, inexpensive and expensive, safe and unsafe, healthy and unhealthy, and convenient and inconvenient (adapted from Feldmann and Hamm 2015). Participants had to select between the two terms which they felt were more closely associated with "local," which was done by providing three response options for each set of terms, Option 1 ("positive trait"), Option 2 (neither/neutral), or Option 3 (counterpart trait).

To assess past purchasing behavior, participants were asked to indicate the types of local products they purchased in the past. Eight categories of local products were given to participants, who selected all the options that applied to them. The categories of local products given were vegetables, fruits, live plants, meat, dairy, decorative ornamental plants, eggs, and pantry items (adapted from Feldmann and Hamm 2015).

The final question regarding consumer perceptions of "local" asked participants to give their definition of a locally grown product. This question was open-ended, allowing for participants to elaborate as much as they desired and to include any details they would like to as well. The question was presented this way to gain more insight into how different consumers define local beyond what the previous questions could with set parameters. Since the definition

of local differs among consumers (Behe et al. 2013), the goal of this question was to identify certain themes that consumers may associate with local beyond what is already known.

Plant Purchase Likelihood

The questions to evaluate which plant attributes impact consumers' likeliness to purchase were formatted into a hypothetical transaction, and then asked how likely they would be to purchase the plant on a scale of "very unlikely" (1) to "very likely" (5) (adapted from Rihn et al. 2016). Participants, or "consumers," were given information regarding the plant type (annual, perennial, shrub, or tree), the price (low, medium, high, or no price given), the location of production (local, state, regional, domestic, or import), whether it was a native plant or not (native or blank), and three photos were included for each plant type to help inform participants before making their purchasing decisions (adapted from Wei et al. 2019). Three different plant images of plant species popularly grown in North Carolina were used to be recognizable to most participants, while partially controlling for other attributes that could be important to a consumer's purchase decision, such as flower type, color, species preference, and size [Wei et al. 2019; (see Figure 2.1)]. The images used were of three different plant species for each plant type in order to provide a broader representation of each plant type given (Wei et al. 2019). For this reason, the price levels of "low," "medium," and "high" were used to generalize the pricing for each scenario given in the discrete choice section, since each plant species differs in its price. A cheap script was used to define the pricing levels to the study participants in the survey before beginning the discrete choice section of questions.

The photos used are from North Carolina State University's Extension Gardener Plant Toolbox and were selected to show a wide range of potential choices among the three photos displayed for each question, and to partially control for other attributes that could be important to

consumer's purchase decision (such as flower type, color, and size) (adopted from Wei et al. 2019). The plant species chosen were selected because they are popular in many North Carolina landscapes and have different physical characteristics so they would be recognizable to most participants for the study, while still being distinct from one another (see Table 2.1).

This section of the survey was set up as a rating-based discrete choice experiment. This set of questions was composed of 20 discrete choice scenario questions, which was determined by using *JMP Pro 17* statistical software (Cary, NC) to achieve a D-efficiency value of 97.88. D-efficiency refers to the efficiency of the experimental design to maximize efficiency and minimize variance, a D-efficiency of 100 would indicate a theoretically perfectly efficient experiment design (Atkinson et al. 2007). For reference, a D-efficiency value of 80 or higher is typically acceptable and indicates the experiment design is quite efficient (Atkinson et al. 2007). Of the 20 scenarios, an equal number of questions for each plant type were generated (5 questions each for annual, perennial, shrub, and tree), and the remaining attributes (price, location, native) were randomly assigned different levels using the. This set of questions was further segmented into two blocks of 10 questions, for a total of 20 questions evaluating consumer likeliness to purchase. The questions were split into two blocks to mitigate question fatigue (Egleston et al. 2011), which did not negatively impact the D-efficiency value. Each participant answered all 20 questions, the questions were equally divided into two separate blocks that were not presented directly after one another. The same three photos were used for each question of the same plant type to control for aesthetic variances (Wei et al. 2019).

Demographics

The demographic question block was compiled of questions adopted from the U.S. Census Bureau (Suitland, MD) including age, gender, ethnicity, race, level of education, annual

household income, and zip code (U.S. Census Bureau 2023). The study demographics consisted of 63% White (Caucasian), 8.6% Black (African American), 26.8% Asian, and 1.4% American Indian/Alaska Native. All participants for this study were residents of North Carolina due to the in-person participation requirement, so all conclusions made are in the context of North Carolina demographic data.

Eye tracking

Eye tracking data was collected to give further context to the participants' selections. Using gathered information such as gaze duration, eye movements, and time to fixation can help reveal which factors the participants considered most during their purchasing decisions, which factors may have dissuaded them from making a purchasing decision, and which visual traits engage their focus (Behe et al. 2013, Behe et al. 2017, Mundel et al. 2018).

The software used to conduct the study is *iMotions*. *iMotions* (Copenhagen, Denmark) is a human insight software program that aids in assessing behavior data by recording eye tracking, facial expression analysis, and other indicators available through the platform (see online resource; iMotions 2022). The survey portion of the study generated through *Qualtrics* was also housed within *iMotions* so each portion of the study could be administered through the iMotions platform. The *Aurora* eye tracker is a device developed by *Smart Eye* that uses infrared light to detect eye movements through reflections on the cornea and pupils (see online resource; Smart Eye). *iMotions* also provides the ability to isolate the eye movements occurring at certain sections of the screen by drawing areas of interest (AOIs). For example, to gather eye tracking metrics for a specific image on a page, simply drawing a box (AOI) around the image collects eye tracking metrics for the pre-defined area inside the identified AOI, allowing for much more targeted data collection.

Analysis

An *a priori* power calculation was done using *JMP Pro 17,* indicating a need to have a minimum sample size of 130 participants to detect a meaningful effect; 206 participants' responses were used. Participant responses were removed if recordings indicated inaccurate data results based on high distraction levels (such as answering a phone call during the study or spending 20-30+ consecutive seconds looking away from the computer screen), failure to follow the provided instructions (if recording indicated they spent too little time to fully read all of the instructions provided or clicked directly through it), or failing the attention check question; four participants' data were removed due to these issues.

Based on the literature review, several hypotheses were formed. To test each hypothesis, different statistical analyses were performed to yield the results pertinent for each hypothesis. All estimations were conducted using Stata 16.0 (StataCorp LLC, College Station, TX). Specifically, we hypothesize that:

H1: Consumers will indicate a higher likelihood to purchase plants labeled as locally sourced than those labeled with other source locations.

To test H1, an ordered logit model was used to evaluate the eye tracking data alongside participants' survey responses. The dependent variable was an ordinal PL rating score (1 = very unlikely to purchase; 5 = very likely to purchase). Due to the ordinal nature of the dependent variable, an ordered logit analysis was appropriate because the response categories are ordered but not necessarily equally spaced between the levels (Long and Freese 2006). Ordered logit regression addresses this by not assuming equal distances between categories (McKelvey and Zavoina 1975). This model has been effectively applied in assessing the impact of ordinal variables on consumer preferences for fresh produce (Smith et al. 2009). It allows for the

analysis of different types of variables—continuous, dichotomous, and ordinal—within the same framework, acknowledging their ordinal nature without imposing arbitrary scale assumptions (Winship and Mare 1984). The ordered logit model was suitable for the data with its mix of variable types, including plant type, price, product sourcing location, and native designation.

The probability of a given observation for ordered logit is:

Eq. [2.1]

$$pij = \Pr(yi = i) = \Pr\left(ki - 1 < xj\beta + u \leq ki\right) = \frac{1}{1+\exp(-ki+xj\beta)} - \frac{1}{1+\exp(-ki_{-1}+xj\beta)}$$

Whereas p_{ij} is the probability that the dependent variable y_j takes on the value i; *Pr* is the probability; y_j is the dependent variable for observation j, i is the specific category of the ordinal outcome, k_i is the threshold parameter (cutpoint) for category i, x_j is a vector of the independent variables for observation j, β is a vector of the coefficients to be estimated, u is the random error term assumed to follow a logistic distribution, exp is the exponential function, and κ0 is defined as −∞ and κk as +∞ (StataCorp 2023).

The ordered logit model analyzed the relationship between the different plant attributes given (plant type, price, location, and native designation), and the preference for each level of the attributes provided when making selections based on the Likert scale responses.

H2: There will be a greater preference for purchasing locally sourced food crop products than for ornamental plant products.

A chi-square test of independence was conducted to examine the association between plant types and purchasing behavior. Additionally, to gauge participants' perceptions of local and other traits they may associate with local products, and how that may impact the types of plants they purchase, a list of eight traits was provided along with their counterparts. The traits given were "organic production," "family business," "neighbors," "sustainable," "inexpensive," "safe,"

"healthy," and "convenient." The respective opposite traits given were "conventional production," "corporation," "strangers," "unsustainable," "expensive," "unsafe," "unhealthy," and "inconvenient." The traits were displayed respectively to the order listed previously with the left option indicating the "positive trait" to be associated with "local," the middle option indicating neither option to be associated with "local," and the right option indicating the counterpart option to be associated with "local." The values for determining attribute association (-1 = counterpart trait association, 0 = neutral, 1 = "positive trait" association) were aggregated to generate an overall value for local trait perceptions and associations. Additionally, a two-sample paired t-test was conducted to evaluate the association of positive traits with local plants and the types of plants they purchase. This was tested by using the aggregated value for trait association with "local" to see if any associations can be made with the types of plants the participants purchased overall.

H3: Consumers' perceptions of local will be confined within state boundaries (a), or within 100 miles to the point of purchase (b).

A two-sample paired t-test was conducted to test correlations between different factors of plant sourcing locality involving the distances given for local. Additionally, themes of participants' free response definitions of "local" were identified to gain further insight into what constitutes consumers' perceptions of a local plant.

RESULTS AND DISCUSSION

Demographics

The median age of participants was 35 years old (s.d. = 16.22), which is below the median age of North Carolina residents of 39.2 years old (see Table 2.3) (U.S. Census Bureau

2023). The sample gender mean was 0.65 (0 = male; 1 = female) with a standard deviation of 0.49; compared to the North Carolina mean of 0.51 (U.S. Census Bureau 2023). This female majority in the sample was fitting for plant purchasing research since women account for the majority of purchases in the lawn and garden space (Miller 2016; Whitinger et al. 2023). The median household income for 2023 of participants was $54,950 (s.d. = $39,817), lower than the North Carolina data, where the median household income was $67,481 for 2022 (U.S. Census Bureau 2023). Participant ethnicities were as follows: 63% White (Caucasian), 8.6% Black (African American), 26.8% Asian, and 1.4% American Indian/Alaska Native; 4% of participants identified as Hispanic/Latino. The North Carolina population makeup for each of these ethnicity groups are 60.5% White, 20.2% Black, 3.3% Asian, 1% American Indian/Alaska Native, and 10.7% Hispanic/Latino (U.S. Census Bureau 2023). Compared to the overall North Carolina population, the study populations of Black, Asian, and Hispanic individuals are notably different. This is likely due to the necessity of recruiting participants for in-person participation in the study.

H1: Consumers will indicate a higher likelihood to purchase plants labeled as locally sourced than those labeled with other source locations.

H1 was not supported by the ordered logit model estimates. The ordered logit results are provided in Table 2.4. For plant type, the purchase intent for each of the four plant types was determined by using one plant type, trees, as a baseline. The baseline attribute levels were used to compare the likelihood of purchase for each of the other levels in that attribute (e.g., trees were the base variable among the plant types). Positive correlations between the plant types and purchasing intent were increasingly stronger with each of the remaining plant types based on

coefficient values: shrubs (0.355), annuals (0.653), and perennials (1.153). The odds ratios increased for each plant type as well, indicating a greater likelihood to purchase for each type of plant (95% confidence interval abbreviated to CI): shrubs (1.426, CI [1.419 - 1.432]), annuals (1.921, CI [1.913 - 1.93]), with perennials (3.168, CI [3.155 - 3.18]) relative to trees. The odds ratio values indicate how much more likely each level of "plant type" is to be purchased than the baseline (or predictor) level ("tree" in this instance) for each increase of 1 unit for the baseline value (Institute for Digital Research and Education 2024). For instance, for each 1 unit increase in purchase likelihood for "tree," the purchase likelihood for "perennials" would increase by 3.168 times as much. Since none of the CI ranges included a value of 1, the purchasing intention differences for each plant type are significant. The indicated purchase likelihood could be partially due to the life cycle and the frequency of which these plants typically need to be purchased. For instance, consumers often replace or purchase annuals and perennials more frequently than trees and shrubs, which may have been a consideration when making their purchase likelihood decisions.

Pricing levels indicated the expected outcome of lower likelihood to purchase as price increased. Low pricing was used as the baseline (low = 0) for price level comparisons. As price levels increased, there was an increasing negative relationship between price level and participants' likelihood to purchase the plant listed. The different price levels compared to low pricing were having no price listed (blank; -0.388), medium (-0.914), and high (-1.601). The odds ratio for the price levels were 0.678, CI [0.675 - 0.682] for blank, 0.401, CI [0.399 - 0.403] for medium, and 0.201, CI [0.201 - 0.203] for high. Each pricing level, including no price given (blank), was individually coded in the *Stata* software as an attribute level so each level would be

ranked accordingly based on the model results. These data indicate significant differences in the likelihood to purchase based on the different price levels, and reduced likelihoods of purchase as the price increases, even more than having no price listed at all. The results support the claims from previous studies that consumers are price-sensitive, suggesting that price is an important component of consumers' purchasing decisions (Al-Mamun et al. 2014, Han et al. 2001, Mahmudur Rahman and Haque 2011). Although consumers naturally prefer lower prices to higher ones (Behe et al. 2005), other studies have found that price is not always the most important factor in purchase decision making (Behe 1999, Kelley et al. 2004, Knuth et al. 2020).

Location of product sourcing preferences were determined by using local as the baseline (local = 0). Plants labeled as being sourced within the state had a coefficient value of 0.176, those sourced regionally had a value of 0.130, domestic sourcing was -0.051, and imported plants had a value of -0.606. All origin labels were statistically significant relative to local labels. The odds ratios for each of the sourcing location categories were 1.192, CI [1.186 - 1.198] for in-state, 1.138, [CI 1.133 - 1.144] for regional, 0.950, CI [0.946 - 0.955] for domestic, and 0.545, CI [0.542 - 0.548] for imported. Based on these results, in-state and regional sourcing locations indicated a higher likelihood to purchase than locally sourced plants, and locally sourced plants had a higher likelihood to purchase than domestic and imported sourcing, meaning H1 is not supported. This could be due to the participants categorizing other source locations, like regional and in-state, within their perception of local, which may not greatly impact their purchase likelihood between these different source locations. Alternatively, the study participants could perceive local as similar to the USDA definition (within 400 miles) and may perceive in-state or regional sourcing as being closer in proximity than local. Similar studies have also revealed

inconclusive differentiation between these geographic sourcing locations (Brown 2003, Hawkins et al. 2012, Zepeda and Leviten-Reid 2004). However, the study sample data reveals that there is a strong preference against imported plants when compared to all levels of domestic production of ornamentals, which aligns with previous study findings (Behe et al. 2013).

The presence of native labeling for plants was used as the baseline (native = 0), and having no native labeling had a higher coefficient value (blank = 0.483); the odds ratio for no native labeling was 1.620, CI [1.614 - 1.626]. This could mean that native labeling was not as great of a consideration factor in the likelihood to purchase a plant than the other attributes given for each plant. Additionally, being unfamiliar with certain benefits associated with native plants could have led to little consideration of this attribute when making purchasing decisions (Brzuszek and Harkess 2009). This has been reflected in other studies that show native plants can sometimes be perceived as more expensive (Brzuszek and Harkess 2009, Rihn et al. 2022). Although the study participants were informed of the definition of "native," purchasing hesitancy can result from a lack of education and familiarity with native species (Narem et al. 2018, Zadegan et al. 2008).

Additionally, eye tracking data was collected using *Aurora* eye trackers to measure the total fixation duration (TFD), time to first fixation (TTFF), and fixation count for location sourcing labeling. These measurements were collected for the sourcing location labels. TFD and TTFF are measured in a number of milliseconds (ms), and fixation count is measured by the number of revisits to a stimulus (location sourcing labeling in this instance). TFD had a f-ratio of 72.7579 (p-value <0.0001), TTFF had a f-ratio of 10.0430 (p-value <0.0001), and fixation count had a f-ratio of 5.5375 (p-value <0.0001) (Table 2.5). These results indicate a significant

difference across the souring location levels. However, the differences between each sourcing location level (local, in-state, regional, domestic, and imported) were not evaluated individually with one another, only the overall location attribute variable. Varying levels of visual attention given to different sourcing locations for ornamental plants was recorded in a previous study as well (Rihn et al. 2016).

H2: There will be a greater preference for purchasing locally sourced food crop products than for ornamental plant products.

H2 was supported by the analysis results. Vegetable plants (62%), flowering annuals (56%), and herbs (55%) were the three most purchased categories of plants from the previous year (see Table 2.6). Followed by indoor flowering potted plants (48%), succulents (47%), indoor foliage plants (45%), and flowering herbaceous perennials (41%). The least commonly purchased plant categories were flowering shrubs (26%), fruit producing trees (20%), evergreen shrubs (11%), shade trees (10%), and evergreen trees (9%). The results were analyzed and a significant difference in the plant type's impact on purchase history was found (Pearson ChiSquare = 381.685, Prob>ChSq = <.0001). These findings display that the most popular categories of plants purchased by participants were edible plants, followed by a similar demand for both flowering ornamental plants and houseplants, and the lowest demand indicated for non-flowering ornamental plants. These findings are fairly consistent with previous studies that have found a similar preference hierarchy for each of the plant categories provided (Gabellini and Scaramuzzi 2022, Knuth et al. 2023). These results indicate that, in general, the study participants purchase edibles, flowering plants/perennials, and houseplants most frequently, and

purchase shrubs and trees least frequently. This could be in part due to the varying lifespans and purposes of the different plant types. For instance, houseplants and annuals have shorter lifespans, and can be used as decorative items, whereas shrubs and trees typically require greater consideration since they are a multi-year commitment and are usually not replaced as often. Considering these factors provides plausible insight into why certain plant categories may be purchased more frequently than others.

For further insight into the type of *local* products consumers buy, participants indicated the types of local horticultural products they purchase (see Table 2.7). Participants were asked to provide the types of local products they buy, which distinguished between local fruits and vegetables as products rather than the local fruit and vegetable plants being purchased. With local edible products, 91% of participants indicated that they buy local vegetables, and 81% indicated that they buy local fruits. When compared to local ornamental plants purchased, 75% indicated that they buy local live plants, and 48% said they buy local decorative plants (cut flowers, wreaths, Christmas trees, etc.). When conducting a two-sample paired t-test, the mean values for fruits and vegetables were aggregated to create a mean value for "food crops," and the mean values for live plants and decorative plants were aggregated to create a mean value for "ornamentals." The results of the test indicated a significantly higher proportion of participants purchasing locally sourced food crop products compared to locally sourced ornamental plant products overall (t-ratio = 2.85, p-value = 0.0048), which supports H2. These results are also reflective of a previous study evaluating purchasing between local food crops compared to local ornamental plants (Behe et al. 2013).

Additionally, participants were asked to provide feedback on different factors that they associate with the term "local" (See Table 2.8). Eight attributes that may be affiliated with the definition of local were given as options to select (+1), along with their counterparts (-1), and a neutral stance (0) to see how participants associated these attributes with the term "local." The "positive" traits given were "organic production," "family business," "neighbors," "sustainable," "inexpensive," "safe," "healthy," and "convenient." The respective opposite attributes given were "conventional production," "corporation," "strangers," "unsustainable," "expensive," "unsafe," "unhealthy," and "inconvenient." The calculated means from these results indicated a slight association of "local" with each of the positive traits. The highest mean values for the attributes to associate with "local" were "healthy" (0.32), "safe" (0.31), "organic production" (0.21), and "sustainable" (0.20). Whereas the lowest mean values for the attributes to associate with "local" were "inexpensive" (0.08), "family business" (0.13), "convenient" (0.15), and "neighbors" (0.15). These results align with previous studies that have found positive perceptions associated with local food products (Feldmann and Hamm 2015, Grebitus et al. 2013).

The relationship between perceptions of "local" and the types of plants they purchase was also explored. Each participant's responses for trait association with "local" (1 = "positive trait," 0 = neutral, -1 = counterpart trait) were aggregated into a single mean value and compared with the types of plants they had reported purchasing in the previous year. The analysis yielded a t-ratio of 1.89, with a p-value of 0.0595 (see Table 2.6), indicating no significant relationship between the participants' perceptions of "local" with the types of plants they purchased in the previous year. This suggests that the study participants' general plant purchases are not impacted by their perception of local products.

Lastly, the association between perceptions of "local" and the distance (in miles) they associate with "local" was explored. Each participant's responses for attribute association with local (1 = "positive trait," 0 = neutral, -1 = counterpart trait) were aggregated into a single mean value and compared with their definition of local in miles. The analysis yielded a t-ratio of 0.24, and a p-value of 0.811 (see Table 2.8), indicating that there was no difference in the participants' trait association with "local" and their given definition of "local" in mileage. This suggests that the participants' positive/negative associations with local products do not impact their distance perceptions of local products. This likely means that other factors influenced the participants' distance perceptions of local rather than their overall positive/negative perception.

H3a: Consumers' perceptions of local will be confined within state boundaries.

Defining a Locally Grown Product

H3a was supported by the analysis conducted. Another question in the survey asked participants to give their definition of a locally grown product. This question was a free response question at the end of the survey, which allowed participants to provide any information on how they perceive a local product without any given parameters. These responses were manually sifted through to draw out overarching themes among responses. These themes were derived from direct quotes from responses or developed using similar words for key phrases used in the responses. Some responses were categorized into more than one theme category, since participants were allowed to provide as much information as they desired. The themes identified and the percentage of responses for each theme are given in Table 2.9.

Several themes were identified that indicated a certain distance from the point of purchase; these themes include “Grown In-State” (23% of participants), “Grown Regionally” (12.26% of participants), “Grown within 100 miles” (10.78% of participants), “Grown within 50 miles” (6.86% of participants), “Grown in same county” (6.37% of participants), “Grown within 25 miles” (4.9% of participants), “Grown Within 3 hours” (3.92% of participants), “Grown within 300 miles” (1.47% of participants), “Grown within 400 miles” (1.47% of participants), and “Grown within 200 miles” (0.5% of participants). These themes are of importance because they help gauge the similarities between the USDA definition of local (within 400 miles or within the same state/region), and how consumers perceive local.

Other themes that were identified involve perceived traits about locally grown products; these themes include “Convenient/Accessible” (4.9% of participants), “Native” (4.41% of participants), “Organic” (3.43% of participants), “Cheap/Inexpensive” (2.94% of participants), “Chemical-Free” (1.96% of participants), and “Quality/Healthy/Fresh” (1.96% of participants). These themes are of interest because although there is no inclusion of these traits in the USDA definition for a local product, there is association of these traits through consumer perceptions. The remaining identified themes are associations made through consumer perceptions; these themes are “Farm/Farmer” (11.76% of participants), “Community” (2.94% of participants), “Farmer’s Market” (2.94% of participants), and “Home” (2.45% of participants). These are general connections that consumers make when they think of locally grown products; these can be leveraged as marketing tools for determining selling locations as well as deciding what labeling/signage to use.

The most predominant theme identified among participants’ responses was “Grown In-

State," with 23% of all respondents providing this theme in their response. If you consider other responses that the "Grown In-State" theme encompasses (including "same County," "community," and other responses that go under the umbrella of "Grown In-State") then around 40% of responses indicate an association of "local" with being grown within the same state as the point of purchase. Based on the USDA definition of local (product origin and final market within the same state), 40% of respondents provided a response that falls under this definition as well. The results support H3a since the most prominent choice among participants indicated local being sourced within state. This question was asked at the end of the study, after other questions evaluating perceptions of local, so this may have impacted responses to be quite similar to their previous responses.

H3b: Consumers' perception of local will be confined within 100 miles to the point of purchase.

Defining Local in Miles

H3b was supported by the data provided. The average distance given was 120 miles, with a standard deviation of 257.3 miles. This was with the inclusion of three outlier responses of 700, 2000, and 2802 miles. These responses likely indicate that these three participants view the domestic production (within the U.S.) of plants as local. When these outliers were excluded, the average distance dropped to 95 miles with a standard deviation of 112.1 miles (See Figure 2.2). One hundred sixty-four of the 206 participants gave a distance of 100 miles or less (78% of the sample). However, by the USDA definition of "local" (within 400 miles from the point of purchase; U.S. Congress 2008), about 96% of responses fall within the scope of what defines local. Based on the mean and majority percentage of responses within 100 miles, H3b is

supported by the results. It is also important to note that a given number of miles from the point of purchase remaining within state lines varies greatly depending on geographic location; while there is no way to accurately quantify whether the mileages given would fall within state bounds, further testing and analysis in the future could yield results that would also support the claims of H3b using mileage data.

CONCLUSIONS

This study explored consumers' likelihood to purchase ornamental plants based on attributes such as plant type, price, sourcing location, and native indication. The study was conducted using a survey created in *Qualtrics* and was administered via *iMotions* software. The data gathered was analyzed using ordered logit modeling, by conducting a chi-square test, and by running two-sample paired t-tests. It concluded that the participants favored ornamental plants sourced within the same state or region from the point of purchase over plants labeled as being sourced locally, and they favored locally sourced ornamental plants over plants sourced within the U.S. and over imported ones. Trees were indicated as the plant type with the lowest purchase likelihood, followed by shrubs, annuals, and, lastly, perennials with the highest likelihood to purchase. Participants preferred low-priced plants the most and showed a higher preference for plants without price labels over medium and high-priced ones. Interestingly, plants labeled as native were less preferred than those without native labeling, indicating that native labeling was not a significant factor in purchasing decisions. Eye tracking data was collected as well and indicated a significant difference in visual attention metrics (TTFF, TFD, and fixation count) across the sourcing location levels, but differences between each sourcing location level were not

considered. H1 was not supported by these findings since a higher purchase likelihood was indicated for ornamental plants with in-state and regional sourcing labeling than those with local sourcing labeling. However, it was concluded that ornamental plants with any level of domestic sourcing labeling (local, in-state, regional, domestic) are highly preferred over ornamental plants with imported sourcing labeling. The results suggest that providing domestic source labeling could increase the likelihood of consumers purchasing ornamental plants with this information available.

Additionally, consumer purchasing habits for local food crop products and local ornamental plant products were collected during the study. The participants indicated a higher proportion of locally sourced food crop products were purchased than locally sourced ornamental plant products. These results support H2, since participants had a higher proportion of local food crop product purchases than local ornamental plant product purchases. This finding is indicative of previous research that has found a greater preference for local food crops compared to local ornamental plants (Behe et al. 2013). Providing domestic sourcing labeling could provide greater incentives for consumers to purchase ornamental plants based on the findings from H1.

Lastly, the study evaluated consumer perceptions of "local" products, comparing them to the USDA definition of local. Participants considered a plant to be locally sourced if it came from within an average of 95 miles of the point of purchase, aligning with the USDA definition of local being sourced within 400 miles. In-state production was the most prominent theme identified in the participants' definition of local, suggesting that "local" labeling and state-specific labels (e.g., "Grown in North Carolina") might similarly influence purchasing behavior.

The findings imply that having a standardized definition and labeling for local products could help sellers market these products more effectively and potentially justify higher prices.

Study Limitations

Although the study results yielded interesting findings regarding consumer perceptions of local and the importance of certain plant attributes, limitations for the study need to be acknowledged. Due to the nature of the data collection setup using eye tracking equipment, study participants were required to complete the study in-person, meaning the sample was localized to North Carolina residents. Consequently, the study results are indicative of the state of North Carolina and would need to be replicated in other states to test the robustness of the study. However, the study was conducted at three different locations within the state (Raleigh, Durham, and Whiteville, NC), so this may have slightly reduced the impact of localized sampling.

Secondly, the demographics were not fully representative of the overall North Carolina population, with a much higher Asian population (27% compared to 3.3%), and smaller Hispanic/Latino (4% compared to 10.7%) and Black (8.6% compared to 20.2%) populations. This is likely because data collection was conducted at educational institutions (North Carolina State University, Duke University, and Southeastern Community College), leading to local students participating in the study, alongside others of a similar demographic.

Lastly, since the study was conducted using a non-physical product and transaction process, a certain level of hypothetical bias may exist since money was not actually spent by the study participants and images of plants were used rather than physical plants (Yue and Tong 2009). Future research with increased pre-screening processes for participant recruitment,

increased representation across multiple states, and the implementation of a physical transaction process may yield more conclusive results.

Further Work

The results of this study provide a foundation to build from for future research of source labeling for ornamental plants. These experiments can be replicated in a physical transaction environment to provide information beyond survey response data, and to capture visual attention data of physical plant products rather than using images. Additionally, these studies can be expanded to include plant species besides ornamentals to provide a more comprehensive comparison of ornamentals and edibles. Providing the USDA definition for local products in future studies could also be valuable in determining if consumers tend to agree or disagree with the mileage statements and the regional/territorial bounds used to define local plants.

REFERENCES

Al-Mamun A, Rahman M, Robel SD. 2014. A Critical Review of Consumers' Sensitivity to Price: Managerial and Theoretical Issues. Journal of International Business and Economics. 2:1–9.

Anella LB, Schnelle MA, Maronek DM. 2001. Oklahoma Proven: A Plant Evaluation and Marketing Program. HortTechnology. 11(3):381–384. https://doi.org/10.21273/HORTTECH.11.3.381.

Aribarg A, Pieters R, Wedel M. 2010. Raising the BAR: Bias Adjustment of Recognition Tests in Advertising. Journal of Marketing Research. 47(3):387–400.

Atkinson A, Donev A, Tobias R. 2007. Optimum Experimental Designs, With SAS. OUP Oxford.

Balcombe K, Fraser I, Williams L, McSorley E. 2017. Examining the Relationship Between Visual Attention and Stated Preferences: A Discrete Choice Experiment using Eye-tracking. Journal of Economic Behavior & Organization. 144:238–257. https://doi.org/10.1016/j.jebo.2017.09.023.

Behe, B., Nelson, R., Barton, S., Hall, C., Safley, C.D., and Turner, S. 1999. Consumer Preferences for Geranium Flower Color, Leaf Variegation, and Price. HortScience 34(4):740-742.

Behe BK, Bae M, Huddleston PT, Sage L. 2015. The Effect of Involvement on Visual Attention and Product Choice. Journal of Retailing and Consumer Services. 24:10–21. https://doi.org/10.1016/j.jretconser.2015.01.002.

Behe BK, Campbell B, Dennis J, Hall C, Lopez R, Yue C. 2010. Gardening Consumer Segments Vary in Ecopractices. HortScience. 45(10):1475–1479. https://doi.org/10.21273/HORTSCI.45.10.1475.

Behe BK, Campbell BL, Hall CR, Khachatryan H, Dennis JH, Yue C. 2013. Consumer Preferences for Local and Sustainable Plant Production Characteristics. HortScience. 48(2):200–208. https://doi.org/10.21273/HORTSCI.48.2.200.

Behe BK, Campbell BL, Khachatryan H, Hall CR, Dennis JH, Huddleston PT, Fernandez RT. 2014. Incorporating Eye Tracking Technology and Conjoint Analysis to Better

Understand the Green Industry Consumer. HortScience. 49(12):1550–1557. https://doi.org/10.21273/HORTSCI.49.12.1550.

Behe BK, Huddleston P, Sage L. 2016. Age Cohort Influences Brand Recognition, Awareness, and Likelihood to Buy Vegetable and Herb Transplants. HortScience. 51(2):145–151. https://doi.org/10.21273/HORTSCI.51.2.145.

Behe BK, Huddleston PT, Hall CR, Khachatryan H, Campbell B. 2017. Do Real and Fictitious Plant Brands Differ in Brand Recognition, Awareness, Purchase Intention, and Visual Activity? HortScience. 52(4):612–621. https://doi.org/10.21273/HORTSCI11538-16.

Behe BK, Knuth M, Hall CR, Huddleston PT, Fernandez RT. 2018. Consumer Involvement with and Expertise in Water Conservation and Plants Affect Landscape Plant Purchases, Importance, and Enjoyment. HortScience. 53(8):1164–1171. https://doi.org/10.21273/HORTSCI13119-18.

Behe BK, Walden RM, Duck MW, Cregg BM, Kelley KM, Lineberger RD. 2005. Consumer Preferences for Tabletop Christmas Trees. HortScience. 40(2):409–412. https://doi.org/10.21273/HORTSCI.40.2.409.

Bienenfeld JM, Botkins ER, Roe BE, Batte MT. 2016. Country of Origin Labeling for Complex Supply Chains: The Case for Labeling the Location of Different Supply Chain Links. Agricultural Economics. 47(2):205–213. https://doi.org/10.1111/agec.12223.

Brown C. 2003. Consumers' Preferences for Locally Produced Food: A Study in Southeast Missouri. American Journal of Alternative Agriculture. 18(4):213–224. https://doi.org/10.1079/AJAA200353.

Brzuszek RF, Harkess RL. 2009. Green Industry Survey of Native Plant Marketing in the Southeastern United States. HortTechnology. 19(1):168–172. https://doi.org/10.21273/HORTTECH.19.1.168.

Campbell B, Khachatryan H, Rihn A. 2017. Pollinator-friendly Plants: Reasons for and Barriers to Purchase. HortTechnology. 27(6):831–839. https://doi.org/10.21273/HORTTECH03829-17.

Campbell BL, Khachatryan H, Behe BK, Dennis J, Hall C (eds). 2014. U.S. and Canadian Consumer Perception of Local and Organic Terminology. International Food and Agribusiness Management Review. https://doi.org/10.22004/ag.econ.167903.

Clement J, Kristensen T, Grønhaug K. 2013. Understanding Consumers' In-store Visual Perception: The Influence of Package Design Features on Visual Attention. Journal of Retailing and Consumer Services. 20(2):234–239. https://doi.org/10.1016/j.jretconser.2013.01.003.

Cobanoglu C, Warde B, Moreo PJ. 2001. A Comparison of Mail, Fax and Web-based Survey Methods. International Journal of Market Research. 43(4):441–452.

Collart AJ, Palma MA, Carpio CE. 2013. Consumer Response to Point of Purchase Advertising for Local Brands. Journal of Agricultural and Applied Economics. 45(2):229–242.

Conner D, Colasanti K, Ross RB, Smalley SB. 2010. Locally Grown Foods and Farmers Markets: Consumer Attitudes and Behaviors. Sustainability. 2(3):742–756. https://doi.org/10.3390/su2030742.

Cranfield J, Henson S, Blandon J. 2012. The Effect of Attitudinal and Sociodemographic Factors on the Likelihood of Buying Locally Produced Food. Agribusiness. 28(2):205–221. https://doi.org/10.1002/agr.21291.

Eastwood DB, Brooker JR, Orr RH. 1987. Consumer Preferences for Local Versus Out-Of-State Grown Selected Fresh Produce: The Case of Knoxville, Tennessee. Journal of Agricultural and Applied Economics. 19(2):183–194. https://doi.org/10.1017/S0081305200025450.

Egleston BL, Miller SM, Meropol NJ. 2011. The Impact of Misclassification due to Survey Response Fatigue on Estimation and Identifiability of Treatment Effects. Statistics in Medicine. 30(30):3560–3572. https://doi.org/10.1002/sim.4377.

Ehmke MD, Lusk JL, Tyner W. 2008. Measuring the Relative Importance of Preferences for Country of Origin in China, France, Niger, and the United States. Agricultural Economics. 38(3):277–285. https://doi.org/10.1111/j.1574-0862.2008.00299.x.

Erdoğmuş İE, Çiçek M. 2012. The Impact of Social Media Marketing on Brand Loyalty. Procedia - Social and Behavioral Sciences. 58:1353–1360. https://doi.org/10.1016/j.sbspro.2012.09.1119.

Etheredge, C.L., DelPrince, J., Waliczek, T.M. 2023. U.S. Consumer Perceptions & Willingness to Pay for Sustainable Environmental Practices in the Floral Industry. Floral Marketing Fund. Mississippi State University and Texas State University.

Eye Tracking. Smart Eye. https://www.smarteye.se/technology/eye-tracking/. [accessed 18 Feb 2024].

Feldmann C, Hamm U. 2015. Consumers' Perceptions and Preferences for Local Food: A Review. Food Quality and Preference. 40:152–164. https://doi.org/10.1016/j.foodqual.2014.09.014.

Gabellini S, Scaramuzzi S. 2022. Evolving Consumption Trends, Marketing Strategies, and Governance Settings in Ornamental Horticulture: A Grey Literature Review. Horticulturae. 8(3):234. https://doi.org/10.3390/horticulturae8030234.

Gillis AJ, Swim JK. 2020. Adding Native Plants to Home Landscapes: The Roles of Attitudes, Social Norms, and Situational Strength. Journal of Environmental Psychology. 72:101519. https://doi.org/10.1016/j.jenvp.2020.101519.

Grebitus C, Lusk JL, Nayga RM. 2013. Effect of Distance of Transportation on Willingness to Pay for Food. Ecological Economics. 88:67–75. https://doi.org/10.1016/j.ecolecon.2013.01.006.

Hall CR, Campbell BL, Behe BK, Yue C, Lopez RG, Dennis JH. 2010. The Appeal of Biodegradable Packaging to Floral Consumers. HortScience. 45(4):583–591. https://doi.org/10.21273/HORTSCI.45.4.583.

Han S, Gupta S, Lehmann DR. 2001. Consumer Price Sensitivity and Price Thresholds. Journal of Retailing. 77(4):435–456. https://doi.org/10.1016/S0022-4359(01)00057-4.

Hawkins G, Burnett SE, Stack LB. 2012. Survey of Consumer Interest in Organic, Sustainable, and Local Container-grown Plants in Maine. HortTechnology. 22(6):817–825. https://doi.org/10.21273/HORTTECH.22.6.817.

How does it work - iMotions. 2022. https://imotions.com/how-does-it-work/. [accessed 18 Feb 2024].

Huddleston P, Behe BK, Minahan S, Fernandez RT. 2015. Seeking Attention: An Eye Tracking Study of In-store Merchandise Displays. International Journal of Retail & Distribution Management. 43(6):561–574. https://doi.org/10.1108/IJRDM-06-2013-0120.

Huddleston PT, Behe BK, Driesener C, Minahan S. 2018. Inside-outside: Using Eye-tracking to Investigate Search-choice Processes in the Retail Environment. Journal of Retailing and Consumer Services. 43:85–93. https://doi.org/10.1016/j.jretconser.2018.03.006.

Institute for Digital Research and Education. 2024. Ordered Logistic Regression. UCLA: Statistical Consulting Group. https://stats.oarc.ucla.edu/stata/output/ordered-logistic-regression/ (accessed May 24, 2024).

Isaak M, Lentz W. 2020. Consumer Preferences for Sustainability in Food and Non-Food Horticulture Production. Sustainability. 12(17):7004. https://doi.org/10.3390/su12177004.

Jenkins EB, Knuth MJ, Hall CR, Palma MA. 2023. Shifts in the American Floriculture Industry: Insight from Industry Experts. Journal of Environmental Horticulture. 41(4):133–140. https://doi.org/10.24266/0738-2898-41.4.133.

Kelley KM, Behe BK, Biernbaum JA, Poff KL. 2004. Consumer and Professional Chef Perceptions and Acceptance of Edible Flowers. S. Acta Hortic. (633):475–482. https://doi.org/10.17660/ActaHortic.2004.633.59.

Khachatryan H, Rihn A, Campbell B, Behe B, Hall C. 2018. How do Consumer Perceptions of “Local” Production Benefits Influence their Visual Attention to State Marketing Programs? Agribusiness. 34(2):390–406. https://doi.org/10.1002/agr.21547.

Kim M, Lennon S. 2008. The Effects of Visual and Verbal Information on Attitudes and Purchase Intentions in Internet Shopping. Psychology & Marketing. 25(2):146–178. https://doi.org/10.1002/mar.20204.

Kim M, Lennon SJ. 2000. Television Shopping for Apparel in the United States: Effects of Perceived Amount of Information on Perceived Risks and Purchase Intentions. Family and Consumer Sciences Research Journal. 28(3):301–331. https://doi.org/10.1177/1077727X00283002.

Knuth M, Behe BK, Hall CR, Huddleston P, Fernandez RT. 2018. Consumer Perceptions of Landscape Plant Production Water Sources and Uses in the Landscape during Perceived and Real Drought. HortTechnology. 28(1):85–93. https://doi.org/10.21273/HORTTECH03893-17.

Knuth MJ, Behe BK, Rihn A, Hall CR. 2023. Effects of Benefits Messaging on Consumer Purchasing of Plants. HortScience. 58(5):481–487. https://doi.org/10.21273/HORTSCI16993-22.

Knuth MJ, Behe BK, Huddleston PT, Hall CR, Fernandez RT, Khachatryan H. 2020. Water Conserving Message Influences Purchasing Decision of Consumers. Water. 12(12):3487. https://doi.org/10.3390/w12123487.

Kotler, P., and G.T. Armstrong. 2022. Principles of Marketing. 17th ed. Pearson India.

Krucien N, Ryan M, Hermens F. 2017. Visual Attention in Multi-attributes Choices: What Can Eye-tracking Tell Us? Journal of Economic Behavior & Organization. 135:251–267. https://doi.org/10.1016/j.jebo.2017.01.018.

Lefever S, Dal M, Matthíasdóttir Á. 2007. Online Data Collection in Academic Research: Advantages and Limitations. British Journal of Educational Technology. 38(4):574–582. https://doi.org/10.1111/j.1467-8535.2006.00638.x.

Long, J.S., and J. Freese. 2006. Regression Models for Categorical Dependent Variables Using Stata. 2nd ed. Stata Press, College Station, TX.

Mahmudur Rahman K, Haque M. 2011. Exploring Price Sensitivity of a Green Brand: A Consumers' Perspective. World Review of Business Research. 1:84–97.

Martinez, S.W., and T. Park. 2021. Marketing Practices and Financial Performance of Local Food Producers: A Comparison of Beginning and Experienced Farmers. EIB-225. U.S. Department of Agriculture, Economic Research Service. Available at: https://www.ers.usda.gov/webdocs/publications/101786/eib-225.pdf?v=1153.8.

Maughan L, Gutnikov S, Stevens R. 2007. Like More, Look More. Look More, Like More: The Evidence from Eye-tracking. Journal of Brand Management. 14(4):335. https://doi.org/10.1057/palgrave.bm.2550074.

McCullough, D. 1998. Web-based Market Research: The Dawning of a New Age. Direct Marketing 61:36–38.

McKelvey RD, Zavoina W. 1975. A Statistical Model for the Analysis of Ordinal Level Dependent Variables. The Journal of Mathematical Sociology. 4(1):103–120.

Miller C. 2016. Woman Power! Cater To Your Most Important Plant Retail Customers with These Insights. Greenhouse Grower. https://www.greenhousegrower.com/management/retailing/woman-power-cater-to-your-most-important-plant-retail-customers-with-these-insights/. [accessed 25 Apr 2024].

Mundel J, Huddleston P, Behe B, Sage L, Latona C. 2018. An Eye Tracking Study of Minimally Branded Products: Hedonism and Branding as Predictors of Purchase Intentions. Journal of Product & Brand Management. 27(2):146–157. https://doi.org/10.1108/JPBM-07-2016-1282.

Narem DM, Meyer MH, Yue C, Roth N. 2018. Point of Sale Displays Influence Consumer Decisions to Purchase Native Grasses. HortTechnology. 28(6):748–754. https://doi.org/10.21273/HORTTECH04124-18.

National Agricultural Statistics Service (NASS). 2020. U.S. Horticulture Operations Report $13.8 Billion in Sales. Available at: https://www.nass.usda.gov/Newsroom/archive/2020/12-08-2020.php.

National Agricultural Statistics Service (NASS). 2023. Floriculture Crops 2023 Summary. Available at: https://www.nass.usda.gov/Publications/Highlights/2023/Floriculture_Highlights.pdf.

North Carolina Extension Gardener Plant Toolbox. https://plants.ces.ncsu.edu/. [accessed 18 Feb 2024].

Orquin JL, Ashby NJS, Clarke ADF. 2016. Areas of Interest as a Signal Detection Problem in Behavioral Eye-Tracking Research. Journal of Behavioral Decision Making. 29(2–3):103–115. https://doi.org/10.1002/bdm.1867.

Orquin JL, Mueller Loose S. 2013. Attention and choice: A Review on Eye Movements in Decision Making. Acta Psychologica. 144(1):190–206. https://doi.org/10.1016/j.actpsy.2013.06.003.

Pearson D, Henryks J, Trott A, Jones P, Parker G, Dumaresq D, Dyball R. 2011. Local Food: Understanding Consumer Motivations in Innovative Retail Formats. British Food Journal. 113(7):886–899. https://doi.org/10.1108/00070701111148414.

Pieters R, Warlop L, Wedel M. 2002. Breaking Through the Clutter: Benefits of Advertisement Originality and Familiarity for Brand Attention and Memory. Management Science. 48(6):765–781.

Rapp A, Beitelspacher LS, Grewal D, Hughes DE. 2013. Understanding Social Media Effects Across Seller, Retailer, and Consumer Interactions. J of the Acad Mark Sci. 41(5):547–566. https://doi.org/10.1007/s11747-013-0326-9.

Rihn A, Behe BK, Barton S, Torres A. 2023. Greater Appeal of Native Plants for Environmentally Conscious Consumers1. Journal of Environmental Horticulture. 41(1):7–13. https://doi.org/10.24266/2573-5586-41.1.7.

Rihn A, Khachatryan H, Campbell B, Hall C, Behe B. 2016. Consumer Preferences for Organic Production Methods and Origin Promotions on Ornamental Plants: Evidence from Eye-tracking Experiments. Agricultural Economics. 47(6):599–608. https://doi.org/10.1111/agec.12258.

Rihn AL, Knuth MJ, Peterson BJ, Torres AP, Campbell JH, Boyer CR, Palma MA, Khachatryan H. 2022. Investigating Drivers of Native Plant Production in the United States Green Industry. Sustainability. 14(11):6774. https://doi.org/10.3390/su14116774.

Rodriguez SL, Peterson MN, Moorman CJ. 2017. Does Education Influence Wildlife Friendly Landscaping Preferences? Urban Ecosyst. 20(2):489–496. https://doi.org/10.1007/s11252-016-0609-2.

Scarpa R, Zanoli R, Bruschi V, Naspetti S. 2013. Inferred and Stated Attribute Non-attendance in Food Choice Experiments. American Journal of Agricultural Economics. 95(1):165–180. https://doi.org/10.1093/ajae/aas073.

Shaw A, Miller KK, Wescott G. 2017. Australian Native Gardens: Is there Scope for a Community Shift? Landscape and Urban Planning. 157:322–330. https://doi.org/10.1016/j.landurbplan.2016.07.009.

Smith TA, Huang CL, Lin B-H. 2009. Does Price or Income Affect Organic Choice? Analysis of U.S. Fresh Produce Users. Journal of Agricultural and Applied Economics. 41(3):731–744.

StataCorp. 2023. Ologit: Ordered Logistic Regression. Stata.com. https://www.stata.com/manuals/rlogit.pdf

Stewart A. 2008. Flower Confidential: The Good, the Bad, and the Beautiful. Algonquin Books.

U.S. Census Bureau. 2023. North Carolina profile: Race and ethnicity. Available at: https://data.census.gov/profile/North_Carolina?g=040XX00US37#race-and-ethnicity.

U.S. Congress. 2008. Food, Conservation, and Energy Act of 2008 (H.R. 2419). Available at: https://www.govinfo.gov/content/pkg/BILLS-110hr2419enr/pdf/BILLS-110hr2419enr.pdf.

U.S. Department of Agriculture, National Agricultural Statistics Service. 2020. 2019 Census of Horticultural Specialties. Available at: http://www.nass.usda.gov/Data_and_Statistics/Special_Tabulations/index.php.

USDA Economic Research Service. 2022. Growth in the Number of U.S. Farmers Markets Slows in Recent Years. Available at: https://www.ers.usda.gov/data-products/chart-gallery/gallery/chart-detail/?chartId=104402.

van Horen, L. 2022. A Mixed Bouquet of Developments in Floriculture: World Floriculture Map 2021. Rabobank, RaboResearch Food & Agribusiness. Available at: https://research.rabobank.com/far/en/sectors/fresh-produce/a-mixed-bouquet-of-developments-in-floriculture-world-floriculture-map-2021.html.

Van Loo EJ, Nayga RM Jr, Campbell D, Seo H-S, Verbeke W. 2018. Using Eye Tracking to Account for Attribute Non-attendance in Choice Experiments. European Review of Agricultural Economics. 45(3):333–365. https://doi.org/10.1093/erae/jbx035.

Wehry RH, Kelley KM, Berghage RD, Sellmer JC. 2007. Capturing Consumer Preferences and Interests in Developing a State Plant Promotional Program. HortScience. 42(3):574–580. https://doi.org/10.21273/HORTSCI.42.3.574.

Wei X, Khachatryan H, Rihn AL. 2019. Investigating Consumer Preferences for Production Process Labeling Using Visual Attention Data. Behavioral Sciences. 9(7):71. https://doi.org/10.3390/bs9070071.

Whitinger, D., T. Gell, J. Eisenhauer, C. Coville, and J. Feinson. 2023. National Gardening Survey 2023. National Gardening Association, GardenResearch.com, and DriveResearch.com.

Winship C, Mare RD. 1984. Regression Models with Ordinal Variables. American Sociological Review. 49(4):512–525. https://doi.org/10.2307/2095465.

Winter JFC de, Dodou D. 2010. Five-Point Likert Items: t test versus Mann-Whitney-Wilcoxon (Addendum added October 2012). Practical Assessment, Research & Evaluation. 15:11.

Yue C, Dennis JH, Behe BK, Hall CR, Campbell BL, Lopez RG. 2011. Investigating Consumer Preference for Organic, Local, or Sustainable Plants. HortScience. 46(4):610–615. https://doi.org/10.21273/HORTSCI.46.4.610.

Yue C, Tong C. 2009. Organic or Local? Investigating Consumer Preference for Fresh Produce Using a Choice Experiment with Real Economic Incentives. HortScience. 44(2):366–371. https://doi.org/10.21273/HORTSCI.44.2.366.

Zadegan YR, Behe BK, Gough R. 2008. Consumer Preferences for Native Plants in Montana Residential Landscapes and Perceptions for Naturalistic Designs. Journal of Environmental Horticulture. 26(2):109–114.

Zepeda L, Leviten-Reid C. 2004. Consumers' Views on Local Food. Journal of Food Distribution Research. 35(3):1–6. https://doi.org/10.22004/ag.econ.27554.

Tables

Table 2.1 Plant species and images used for discrete choice questions

Plant Type	**Plant Name**	**Image URL**
Annual	*Celosia sp.*	https://plants.ces.ncsu.edu/plants/celosia/
Annual	*Petunia x hybrida* 'Picnic Purple'	https://plants.ces.ncsu.edu/plants/petunia-x-hybrida/
Annual	*Salvia splendens 'Lighthouse Red*	https://plants.ces.ncsu.edu/plants/salvia-splendens/
Perennial	*Canna americanallis* 'Bengal Tiger'	https://plants.ces.ncsu.edu/plants/canna-americanallis-var-variegata/
Perennial	*Echinacea purpurea*	https://plants.ces.ncsu.edu/plants/echinacea-purpurea/
Perennial	*Liriope sp.*	https://plants.ces.ncsu.edu/plants/liriope/
Shrub	*Fatsia japonica*	https://plants.ces.ncsu.edu/plants/fatsia-japonica/
Shrub	*Hydrangea macrophylla*	https://plants.ces.ncsu.edu/plants/hydrangea-macrophylla/
Shrub	*Ilex crenata* 'Helleri'	https://plants.ces.ncsu.edu/plants/ilex-crenata-helleri/
Tree	*Betula nigra*	https://plants.ces.ncsu.edu/plants/betula-nigra/
Tree	*Cercis canadensis*	https://plants.ces.ncsu.edu/plants/cercis-canadensis/
Tree	*Lagerstroemia* 'Biloxi'	https://plants.ces.ncsu.edu/plants/lagerstroemia-biloxi/

Table 2.2 Plant attribute presentation for each discrete choice question

Plant Type	Price	Location	Native	Block
Tree	Medium	Regional	Native	1
Shrub	High	Domestic	Native	1
Annual	High	Local	Blank	1
Perennial	Low	In-state	Blank	1
Tree	Low	Domestic	Blank	1
Shrub	Blank	In-state	Native	1
Annual	Blank	Regional	Blank	1
Tree	Medium	Local	Native	1
Perennial	High	Imported	Native	1
Shrub	Medium	Imported	Blank	1
Annual	Medium	In-state	Native	2
Tree	High	In-state	Blank	2
Perennial	Blank	Local	Native	2
Annual	Low	Imported	Native	2
Annual	Blank	Domestic	Native	2
Perennial	Medium	Domestic	Blank	2
Shrub	Low	Local	Blank	2
Shrub	High	Regional	Blank	2
Tree	Blank	Imported	Blank	2
Perennial	Low	Regional	Native	2

Table 2.3 Demographic data for study sample

		Sample		NC
Variable	**Definition**	**Median**	**SD**	**Median**
n	Number of people	206		10.44 million
Age	Years (no.)	35	16.22	39.2
Gender	0 = male; 1 = female	0.65	0.49	0.51
Income	Median Household Income (2023)	$54,950	$39,817	$67,481
Ethnicity	1 = White; 0 = not selected	0.63	0.48	0.61
	1 = Black; 0 = not selected	0.09	0.28	0.20
	1 = Asian; 0 = not selected	0.27	0.44	0.03
	1 = American Indian/Alaska Native; 0 = not selected	0.01	0.12	0.01
	1 = Hispanic/Latino; 0 = not selected	0.04	0.2	0.11
	Prefer Not to Answer	0.01	0.1	-

Table 2.4 Ordered logit model results for discrete choice question responses

Choice	**Coefficient**	**Std. err.**	**z**	**P>|z|**	**[95% conf. interval]**		**Odds Ratio**	**Std. err.**	**z**	**P>|z|**	**[95% conf. interval]**	
Plant Type												
Tree*												
Shrub	0.355	0.002	149.56	0	0.350	0.359	1.426	0.003	149.56	0	1.419	1.432
Annual	0.653	0.002	284.94	0	0.649	0.658	1.921	0.004	284.94	0	1.913	1.930
Perennial	1.153	0.002	569.52	0	1.149	1.157	3.168	0.006	569.52	0	3.155	3.180
Price												
Low*												
Medium	-0.914	0.003	-365.35	0	-0.919	-0.909	0.401	0.001	-365.35	0	0.399	0.403
High	-1.601	0.003	-629.47	0	-1.606	-1.596	0.202	0.001	-629.47	0	0.201	0.203
blank	-0.388	0.003	-154.57	0	-0.393	-0.383	0.678	0.002	-154.57	0	0.675	0.682

Location												
Local*												
State	0.176	0.002	73.84	0	0.171	0.180	1.192	0.003	73.84	0	1.186	1.198
Regional	0.130	0.002	53.84	0	0.125	0.134	1.138	0.003	53.84	0	1.133	1.144
Domestic	-0.051	0.002	-21.65	0	-0.055	-0.046	0.950	0.002	-21.65	0	0.946	0.955
Imported	-0.606	0.003	-225.02	0	-0.612	-0.601	0.545	0.001	-225.02	0	0.542	0.548
Native?												
Native*												
blank	0.483	0.002	262.97	0	0.479	0.486	1.62	0.003	262.97	0	1.614	1.626
Number of obs = 6,650,171 LR $Chi^2(11)$ = 1501210.85 Prob > Chi^2 = 0.0000 Pseudo R^2 = 0.0726												

Note: Number of participants = 206

Note: * Indicates baseline/predictor value

Table 2.5 Eye tracking data for sourcing location plant attribute

Attribute Label	Eye Tracking Measurement	f-ratio	p-value
Sourcing Location	TFD (ms)	72.7579	<0.0001
Sourcing Location	TTFF (ms)	10.0430	<0.0001
Sourcing Location	Fixation Count	5.5375	<0.0001

Note: TFD and TTFF are calculated in number of milliseconds

Table 2.6 Plant types purchased by study sample

Plant Type	Mean	SD	Pearson ChiSquare	Pearson Prob>ChSq	t-ratio	p-value
Sample Results			381.685	<.0001		
Annual flowering plants (e.g., petunia, marigold, impatiens)	0.56	0.5				
Vegetable plants (e.g., tomato, pepper)	0.62	0.49				
Herbs (e.g., basil, parsley, sage)	0.55	0.5				
Perennials (e.g., hosta, chrysanthemum, day lily, cone flower)	0.41	0.49				
Flowering shrubs (e.g., hydrangea, lilac)	0.26	0.44				
Evergreen shrubs (e.g., boxwood, taxus)	0.11	0.32				
Fruit producing trees (e.g., apple, pear, cherry)	0.20	0.40				
Evergreen trees (e.g., pine, conifer)	0.09	0.28				
Shade trees (e.g., maple, oak)	0.10	0.30				
Indoor flowering potted plants (e.g., orchid, African violet)	0.48	0.50				
Indoor foliage plants (e.g., monstera, philodendron)	0.45	0.50				
Succulents (and cacti)	0.47	0.50				
Perceptions of Local					1.89	0.0595

Note: Selected Response (1); Not selected (0)

Table 2.7 Local products purchased by study sample

Types of Local Products Purchased	Mean	SD	t-ratio	p-value
Vegetables	0.91	0.29	2.85	0.0048
Fruits	0.81	0.39		
Live Plants	0.75	0.44		
Cut flowers/wreaths/xmas tree	0.48	0.5		

Note: Selected Response (1); Not selected (0)

Table 2.8 Factors associated with local by study sample

Option 1 (1)	Option 2 (0)	Option 3 (-1)	Mean	SD	t-ratio	p-value
Organic Production	Neutral	Conventional Production	0.21	0.67		
Family Business	Neutral	Corporation	0.13	0.42		
Neighbors	Neutral	Strangers	0.15	0.50		
Sustainable	Neutral	Unsustainable	0.20	0.47		
Inexpensive	Neutral	Expensive	0.08	0.81		
Safe	Neutral	Unsafe	0.31	0.48		
Healthy	Neutral	Unhealthy	0.32	0.48		
Convenient	Neutral	Inconvenient	0.15	0.50		
Local Distance (in miles)			95.02	112.07	0.24	0.8109

Table 2.9 Metrics to define local

Defining Local Themes	% of Participants
Cheap/Inexpensive	2.94
Chemical-Free	1.96
Community	2.94
Convenient/Accessible	4.9
Farm/Farmer	11.76
Farmer's Market	2.94
Grown in same County	6.37
Grown In-State	23
Grown Regionally	12.26
Grown within 100 miles	10.78
Grown within 200 miles	0.5
Grown within 25 miles	4.9
Grown Within 3 Hours	3.92
Grown within 300 miles	1.47
Grown within 400 miles	1.47
Grown within 50 miles	6.86
Home	2.45
Native	4.41
Organic	3.43
Quality/Healthy/Fresh	1.96

Figures

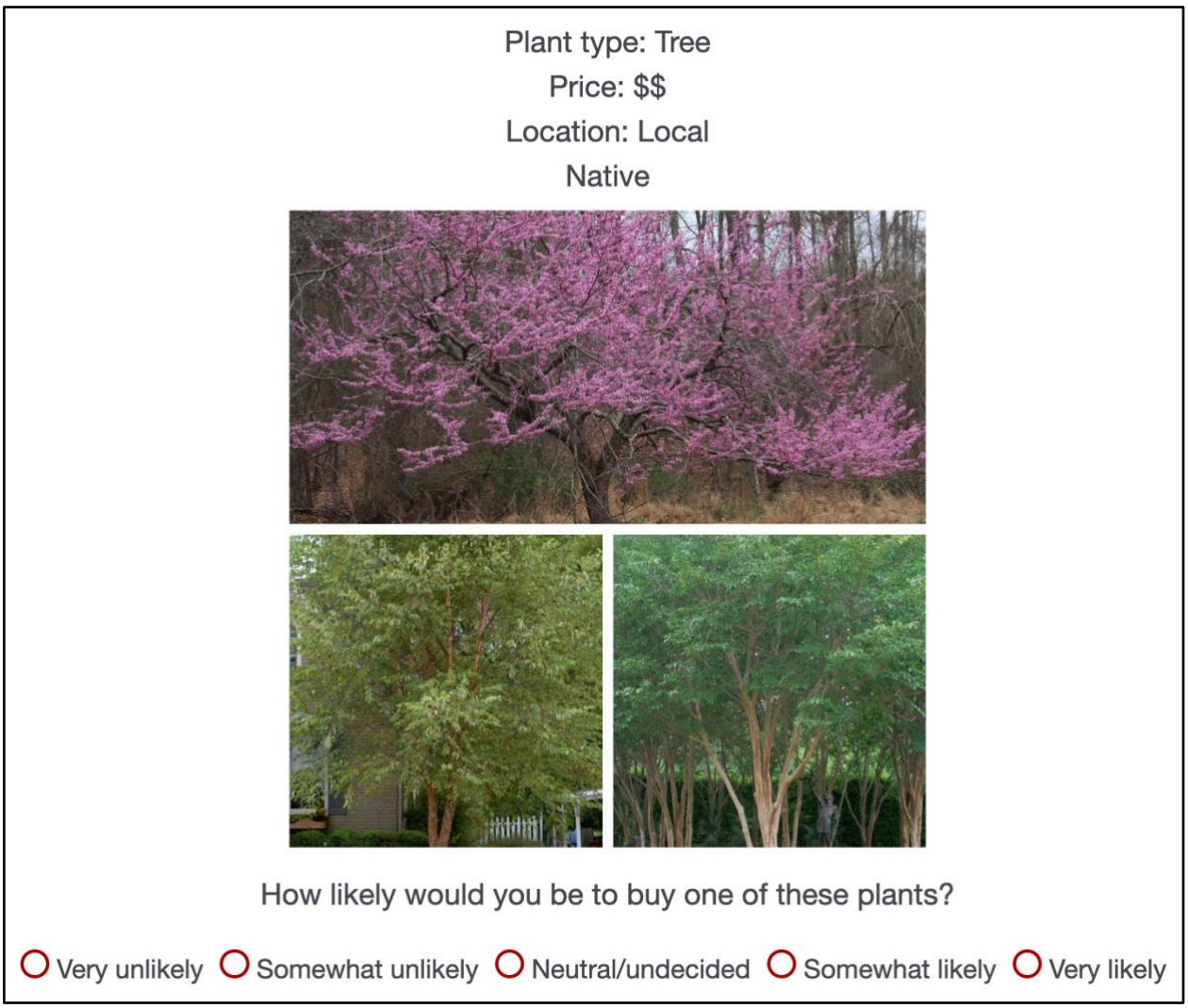

Figure 2.1 Discrete choice example question: the four traits tested are displayed in text form (plant type, price, sourcing location, and native/non-native), followed by three different images and species of the plant type given. Three images were used for each question and the images differed for each of the plant types given. Three images of three different plant species were used to provide a broad representation of the plant type presented. Five Likert Scale answer choices were provided in response to the question, "How likely would you be to buy one of these plants?"

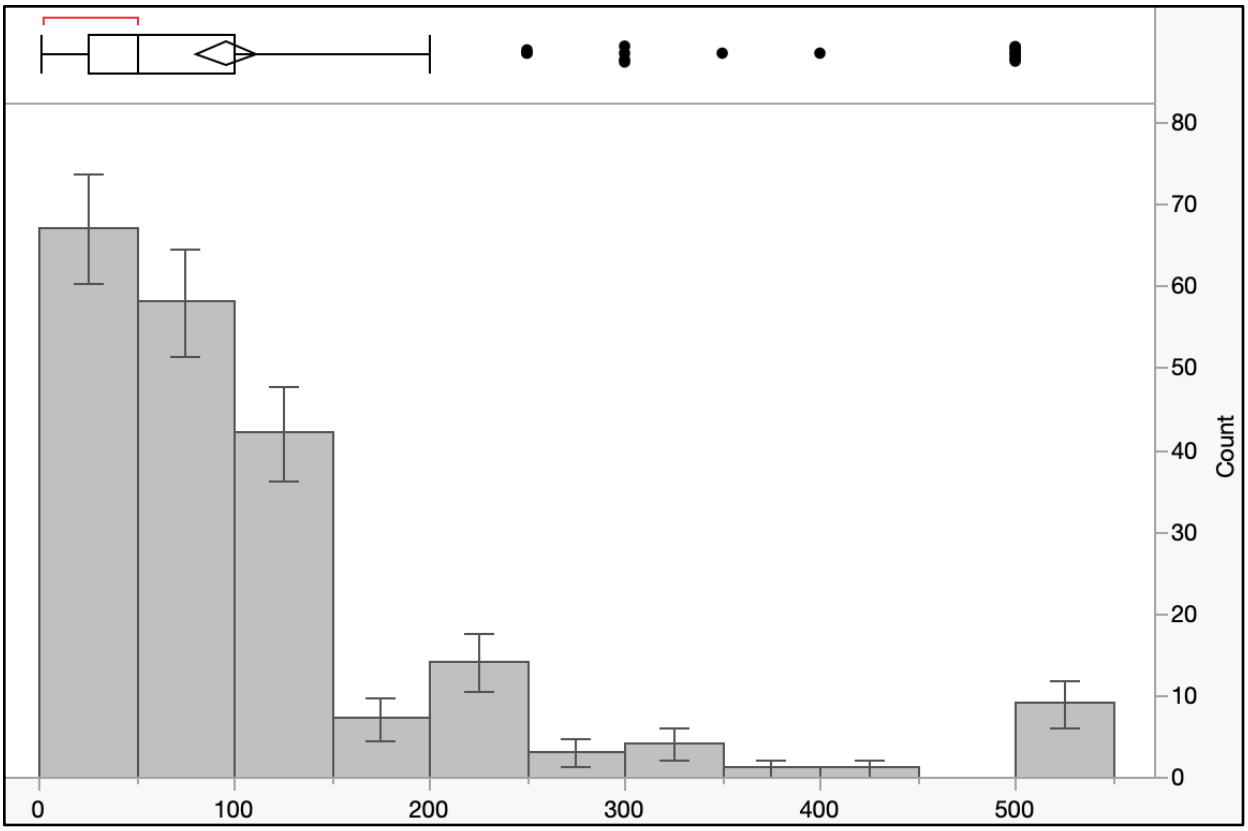

Figure 2.2 This box plot was generated from the study participants' responses to the question, "In your opinion, what is the greatest distance that a plant can originate from and be considered 'local' to the point of purchase?" The box plot indicates the distance (in miles) that a product can be sourced from to be considered local, according to the data.

Note: X-axis: Number of miles, Y-axis: Number of participant responses

CHAPTER THREE

PLANT PURCHASING HABITS OF HOBBYISTS AND NON-HOBBYISTS

INTRODUCTION

Ornamental plants are an avenue for humans to connect with nature and immerse themselves in the world around them. Historically, plants have been utilized in the landscapes of public spaces to raise visual interest (Nancy 2020), and in personal home landscapes to increase property value (Rosiers et al. 2002) and to provide social and ecological services (Cook et al. 2012). However, in a more modernized society, ornamental plants have assumed a somewhat different role. Recently, researchers have found that plants can be used to alleviate mental health concerns, such as depression, stress, and anxiety, that have continued to rise in the fast-paced nature of modern society (Hall and Knuth 2019, Pérez-Urrestarazu et al. 2021). The rise in these mental health concerns during and after the Coronavirus pandemic (Yarrington et al. 2021) are partially responsible for the increased demand for plants (Campbell et al. 2021), alongside the perception that gardening and landscaping are healthy hobbies (Conway 2016), and new entrants into the market (Fratello et al. 2022). The horticultural industry may be in a position to utilize innovative marketing strategies and the rise of online shopping to expand market reach. Understanding these trends is crucial, particularly as the industry adapts to changing consumer behaviors and the growing preference for online plant shopping (Campbell et al. 2021, Knuth et al. 2021a). This study will investigate the plant purchasing habits of plant hobbyists compared to non-hobbyists in North Carolina, and their attitudes towards online plant shopping.

With traditional roles of ornamental plants in public and private spaces, along with newer health-related uses, the significance of ornamentals has grown within the U.S. horticulture industry. In 2019, the U.S. horticulture industry generated approximately $13.8 billion in sales (USDA 2020). These sales numbers include floriculture, nursery, and specialty crops. The U.S. floriculture sales numbers for 2019 were estimated at $4.42 billion (USDA-NASS 2020). The

sales numbers for U.S. floriculture in 2019 are nearly one-third of the total U.S. horticulture sales numbers for 2019, indicating that ornamental plants are a significant contributor to the overall horticulture sales. More recently, U.S. sales of floriculture crops in 2023 totaled to $6.69 billion and were distributed across various categories: annual bedding and garden plants (38.7% of floriculture crops), herbaceous perennials (16.2%), potted flowering plants (15.7%), houseplants (14.4%), propagative floriculture materials (8%), cut flowers (5.5%), and cut cultivated greens (1.5%) (USDA 2024). The increase in sales for the floriculture sector of the U.S. ornamental horticulture industry suggests that sales for ornamental plants may continue to increase, and, therefore, more marketing strategies may need to be implemented.

The increasing use of social media marketing has allowed green industry firms to expand their influence and brand awareness, engaging a broader range of consumers (Torres et al. 2021), and has played a role in increasing the demand for unique or rare plant options (Airhart 2019). This increased engagement is, in part, due to the increased amount of power given to end consumers to express perceptions and opinions (Torres et al. 2021). Leveraging the power of social media to market horticultural products may become a vital way to maintain engagement with an expanding younger demographic of consumers (McGinnis et al. 2020). A houseplant purchasing report in 2021 of 1,700 participants indicated that around 30% of houseplant consumers surveyed interact with retailers and growers on social media platforms such as *Facebook*, *Instagram*, *Pinterest*, and *Twitter* (now *X*) (Knuth et al. 2021a).

The Upward Trend of Shopping Online for Plants

In 2005, the value of all online retail sales was $172 billion in the U.S. (Zhou et al. 2007). Since then, the total value of online sales is estimated to be nearly $1.12 trillion, an increase of over 550% within the last two decades (U.S. Department of Commerce 2024). With online

shopping becoming a prominent form of acquiring goods (Baker et al. 2018), it is important to understand how to best utilize the online space to market plant products.

In 2016, Schettler et al. conducted a focus group to assess the views of purchasing cut flowers online. The overall conclusion for the study participants was skepticism; being wary of purchasing a highly perishable product used primarily for its visual appearance through an online shop. The reasons given included not knowing the exact condition of the product before purchase, the absence of in-person assistance and expertise while shopping, and a lack of sensory evaluation of the product being purchased (Schettler et al. 2016). In 2018, it was also reported that 82% of businesses selling plants were not selling online but were maintaining their traditional retail operation for in-person purchases (Baker et al. 2018).

The Coronavirus pandemic caused many plant businesses to adjust the ways they sold products to their customers due to stay-at-home orders, the closing of "non-essential" businesses, and the decline of in-person shopping. These restrictions led many businesses to experiment with diversifying their retail services. Several firms adopted new or expanded existing retail practices including curbside pickups, shipping availability, and a more robust online shopping experience (Campbell et al. 2021). With online shopping for plants becoming more accessible and consumers spending more time at home, this period led to an increase in plant purchases online.

Despite initial skepticism, consumers have recently expressed interest in increasing their online purchasing of houseplants by over 50% between 2020 and 2021 (Knuth et al. 2021a). It was also revealed that plant purchasers are less likely to shop for houseplants in-person than they were in 2019, and that nearly 50% of plant consumers have purchased at least one houseplant through an online outlet (Knuth et al. 2021a). Furthermore, consumers who have adopted online plant-purchasing habits are less likely to revert back to former purchasing habits (i.e., in-store)

when buying plants (Campbell et al. 2021). Additionally, it was projected that many of the consumers who began gardening in 2020 would leave the market once stay-at-home orders were alleviated (Fratello et al. 2022), and that curbside pickup may not be a worthwhile investment as a primary retail option long-term since the consumers using this option were more likely to return to their pre-pandemic shopping norms (Campbell et al. 2021). The growing shift of purchasing plants online offers businesses a valuable chance to innovate and cater to the increasing need for convenient, reliable online shopping options for plant purchasers, but critically assessing the plant market to understand the post-pandemic market is vital for growers and retailers (Fratello et al. 2022).

Houseplant Purchasing

When considering online purchases, houseplants are of particular interest. The 2021 National Gardening Survey (NGS), the largest horticultural consumer survey in the nation, reported that the houseplant sector of the plant market was valued at approximately $1.67 billion (Whitinger and Cohen 2021). More than thirty-seven million households participated in indoor houseplant gardening in 2020. This equates to about 30% of American households participating in indoor houseplant gardening, marking an increase of 13.9% since 2019. From 2016-2020, the average spending per household on indoor houseplant gardening rose by nearly 50% (from $30 to $44) (Whitinger and Cohen 2021).

Following the Coronavirus pandemic, an expanded market of plant consumers emerged; specifically, the houseplant market increased its sales (Bulgari et al. 2021, Pérez-Urrestarazu et al. 2021). Among households that purchased at least one lawn and garden product in 2020, 23% said they purchased more houseplants in response to the Coronavirus pandemic (Whitinger and Cohen 2021). The NGS found an increase of 5% in foliage plant buyers in the U.S. from 2016-

2021 (Whitinger and Cohen 2021). Knuth et al. also found that current plant purchasers increased their gardening hobbies in 2020 and anticipated increasing their spending the following year (Knuth et al. 2021a).

Millennials accounted for 25% of all horticultural purchases in 2018, and their purchases of houseplants between 2016-2018 increased by about 50% to $1.7 billion (McGinnis et al. 2020). The current market for houseplants is primarily 18–36-year-olds, with younger consumers having a higher affinity for houseplants than older generations (Knuth et al. 2021a). This may be partially driven by their living situations. Often considered "entry level" products in horticulture, houseplants are popular among urban dwellers, because they don't require a garden or lots of space to thrive (Knuth et al. 2021b).

Plant Hobbyists

Hobbyists are another potential market of interest that has not been adequately explored. Plant hobbyists can be defined as those practicing gardening, horticulture, or farming just as a hobby (Vigoroso et al. 2021). Plant hobbyists are over 10% more likely to purchase a houseplant if they collect plants as a hobby (Halouzková 2023). Another study exploring plant hobbyists' (referred to as "plant parents" in the cited study) perceptions of online plant retail outlets revealed that hobbyists have positive perceptions of online shopping in the sense that it is convenient and entertaining (Reyes and Navarra 2022). Conversely, they have a somewhat negative perception due to the inability to see the physical product prior to purchase (Reyes and Navarra 2022). This was true especially with those who have been plant hobbyists for longer (Reyes and Navarra 2022). Exploring what plant hobbyists value when purchasing plants and assessing their shopping experience could serve as the first step in exploring this potential market segment.

Understanding the preferences and behaviors of plant hobbyists not only helps in filling the existing knowledge gaps but also aligns with the broader trend of increased online shopping and e-commerce (in general). As hobbyists often seek both convenience and engagement in their purchasing experiences (Reyes and Navarra 2022), businesses can leverage these insights to better cater to this segment. The rise of online platforms offers an opportunity to reach plant hobbyists and provide them with a convenient way to explore and purchase plants. By addressing the needs of hobbyists through tailored online shopping experiences, companies can enhance customer satisfaction and loyalty, ultimately driving growth in this niche market.

The present study will explore the following proposed hypotheses to address the online purchasing habits of hobbyists compared to non-hobbyists, the price they pay for plants, and whether the trend for online shopping was primarily in response to the pandemic or other factors. Based on the increased likelihood for hobbyists to purchase plants (Halouzková 2023):

First, plant hobbyists are more likely to purchase plants online compared to non-hobbyists (H1). This hypothesis was evaluated by comparing the tendency to purchase plants online between participants who identify themselves as hobbyists and non-hobbyists.

Second, plant hobbyists will have different perceptions of purchasing plants online than non-hobbyists (H2). This was tested by exploring the differences between hobbyists and non-hobbyists in the number of different outlet types they purchase plants from, and the likelihood they will purchase plants online again in the future.

Third, plant hobbyists will spend more on plants (online or conventional retail) than non-hobbyists (H3). This was determined by comparing the total annual spending of plant products and the amount spent shopping for plants online between hobbyists and non-hobbyists.

Lastly, another goal of the present study was to evaluate the annual plant spending habits since the Covid pandemic (H4). This was assessed by comparing the data from previous reports regarding annual spending on plant products with the survey results of the present study.

MATERIALS AND METHODS

The goals of this study were to determine what factors are most important to consumers when buying plants online, specifically if there are differences in purchasing habits for plant hobbyists versus non-plant hobbyists. A plant hobbyist, in this scenario, is defined as an individual who purchases plants for the enjoyment of collecting or caring for them (adapted from Vigoroso et al. 2021). To categorize participants as plant hobbyists or non-hobbyists, they were asked in the survey if they collected plants as a hobby. Someone who does not identify themselves as a plant hobbyist may purchase plants strictly for aesthetic purposes, as a value-building component of their residence, as a gift for others, or any other purchasing motivation that isn't primarily for the personal, intrinsic enjoyment of plants.

Protocol

Participant recruitment was conducted through a secure participant database hosted within the Cognitive Behavioral Lab. Participants who registered with the database were solicited through email communication to participate in the study; all participants were screened to ensure they had purchased plants within the last 12 months (adopted from Rihn et al. 2016). The Institutional Review Boards (IRB) for North Carolina State University approved this study before the data collection process commenced (IRB#25176).

Individuals were invited to on-site locations (North Carolina State University, Raleigh, NC, Duke University, Durham, NC, and Southeastern Community College, Whiteville, NC) to

complete the experiment. The data collection dates were between July 6, 2023, to August 12, 2023, and again from February 13, 2024, to March 27, 2024. Upon on-site registration, participants received a consent form outlining the study's procedure, confidentiality assurance, expectations, equipment details, data collection specifics, and the utilization of their data. Following the completion of the consent form, each participant received a unique ID number (a combination of day of data collection, eye-tracking station, and participant number). The trained research team members facilitated the study initiation for each participant, explaining the process and addressing any questions or concerns that might arise during the study.

The survey for this study was created using Qualtrics (Seattle, WA and Provo, UT), a widely used software program in marketing research. Web-based surveys are often preferred in market research due to their faster administration compared to telephone or face-to-face interviews, their potential for generating more accurate data with reduced human error, and their cost-effectiveness (McCullough, 1998). Additionally, these surveys benefit from automatic coding, cost efficiency, and the ability to send multiple surveys simultaneously (Cobanoglu et al., 2001). Potential drawbacks involved with conducting online surveys include reduced response rates, and a lack of participation, which sometimes leads to not having a completely randomized sample (Lefever et al. 2007) Although the survey for this study was administered electronically, it was conducted in-person to utilize the eye-tracking equipment.

The survey utilized stations equipped with *Smart Eye Aurora* (Gothenburg, Sweden) eye tracking devices, environmental web cameras, and *iMotions* software (Copenhagen, Denmark) to carry out the study. Due to the purpose of the study being focused on gaining initial insights into the purchasing habits of plant hobbyists, eye-tracking data was not part of the analysis. The estimated time of completion for this study was around 20-30 minutes. Participants were paid the

full $15 regardless of how much of the study they completed, so there was no penalty for participants needing to leave early with an incomplete study. Following the completion of the study, participants were compensated $15 (cash) and were compensated.

Question Blocks

The *Qualtrics* survey was composed of 45 questions enquiring about the participants' plant purchasing behaviors, their presence and shopping habits online, risk perceptions of buying online, their passive and active online engagement, their perceptions of the economy, and demographic information. For this analysis, the data from the plant purchases, online plant purchases, and online plant interaction blocks are analyzed.

The first question block explores the participants' plant purchases. This question block evaluates how much money consumers spend on plants and supplies annually (Knuth et al. 2023, Rihn et al. 2016), and another question was constructed to see if the participants purchase plants as a hobby. The question was asked as, "Thinking back over the plants and gardening supplies you purchased in the previous year, approximately how much did you spend (in total) on gardening supplies and plants (excluding mechanical equipment like mowers and tillers)?" The answer choices given were ranges of $0, $1-24, $25-49, $50-99, $100-149, $150-199, $200-249, $250-299, $300-349, $350-399, $400-449, $450-499, and $500 or more. This information is especially valuable when making purchasing decision comparisons between hobbyists and non-hobbyists.

The next block of questions was used to determine the participants' considerations when purchasing plants online. A set of questions were asked regarding how much time they spend shopping online, which types of plants they might purchase online, how much money they spend shopping for plants online, which websites they used to shop for plants, the number of different

retail outlet types they purchase plants from, and their overall experience with buying plants online (Knuth et al. 2024, Neumann et al. 2023, Rihn et al. 2024). Additionally, participants were asked how much risk they believe is involved with buying plants online and how much they trust the online reviews for items prior to purchase (adapted from Dowling 1986, Featherman et al. 2021, Khwaja et al. 2020, Mitchell 1999). The retail outlet types were given in a list for participants to select all that applied for where they made plant purchases in the past 12 months. The options given were "home improvement store (e.g. Home Depot, Lowes)," "independent garden center," "online (e.g. Amazon, Facebook Marketplace)," "wholesale club (e.g. Costco, Sam's Club)," "box store (e.g. Target, WalMart)," "direct from grower (e.g. farmers market, farm stand)," "other." For each participant, each selection was coded as one, unselected responses were coded as zero, and the sum for each participant was averaged together across hobbyist and non-hobbyist groups to generate a mean value for both hobbyists and non-hobbyists. Participants were also asked "Approximately how much did you spend on plants online in the previous year?" The answer choices provided were ranges of $0, $1-24, $25-49, $50-99, $100-149, $150-199, $200-249, $250-299, $300-349, $350-399, $400-449, $450-499, and $500 or more.

The last blocks explore the participants' use of social media (Rihn et al. 2024) and their perceptions of the current state of the economy (Kliesen 2003). Seven questions were asked about the social media platforms the participants use, how frequently they are active on them, if they follow pages that sell plants, and how these factors may impact their likelihood of buying plants online. The next set of questions explored how the participants perceive the current state of the economy and asked them to evaluate their personal financial stability.

Lastly, demographic data regarding income level, age, gender, ethnicity, race, level of education, and residing location (zip code) were collected to explore if there were differences among hobbyists and non-hobbyists.

Analysis

A total of 199 individuals participated in the study. Upon data collection completion, the data underwent preparation for analysis. This cleaning process involved aligning participant identification numbers between the survey instrument and the eye-tracking data recording, eliminating duplicate surveys from a single participant, excluding participant responses if recordings showed inaccurate data due to high distraction levels (i.e., answering a phone call during the study or looking away from the computer screen for several consecutive seconds), not following the provided instructions, or failing the attention check question. An attention check question was also included to ensure that all participants were reading through every question and following instructions, rather than simply clicking through to complete the survey (Pei et al. 2020). The question simply read, "To ensure that all survey respondents are reading every question, please check 'Yes'." Additionally, to categorize participants as "hobbyists" and "non-hobbyists," the twelve participants who selected "maybe" instead of "yes" (hobbyists) or "no" (non-hobbyists) were excluded during the analysis process. As a result, a total of 187 (94% of the sample) were included in data analysis.

To distinguish the data between these two categories of plant shoppers, the overall study data was segmented by the self-reported response variable indicating whether they were a hobbyist or not. To determine significant differences between hobbyists and non-hobbyists, two-sample paired t-tests were conducted. Two-sample paired t-tests were used to assess differences because the study sample was split into two groups (hobbyists and non-hobbyists) but were all

asked the same questions for comparing responses. For example, previous literature has used two-sample t-tests when evaluating preferences for indoor foliage and fruit-producing plants (Rihn et al. 2016), and when testing how different appearances impacted fixation counts for plant purchasing scenarios (Khachatryan et al. 2018).

RESULTS AND DISCUSSION

The primary goal of this study is to explore differences in the purchasing habits of plant hobbyists and non-hobbyists in North Carolina. Since hobbyists are defined as collecting plants for intrinsic value (Vigoroso et al. 2021), and non-hobbyists may purchase plants for other reasons, then the purchasing habits of these two categories of plant shoppers may differ. First, the demographics of hobbyists and non-hobbyists are discussed, followed by the hypothesis results.

Overall Sample Demographics

Participants for the study were recruited from the Cognitive Behavioral Lab's subject database at North Carolina State University. A total of 187 individuals took part in the experiment, and demographic data were collected (see Table 3.1). The median age for the participants in this study was 34 years old (s.d. = 15.88), which is lower than the North Carolina median age of 39.2 (U.S. Census Bureau 2023). The mean for participants' gender was 0.65 (s.d. = 0.48) (0 = male; 1 = female), whereas the North Carolina mean for gender is 0.51. The median household income for the study sample was $54,999 (s.d. = $35,730), compared to the North Carolina median household income of $67,481. The proportion of participant ethnicities are as follows: 61% White (Caucasian), 9% Black (African American), 28% Asian, 4% Hispanic, and 2% American Indian/Alaska Native; participants were allowed to select multiple ethnicity groups

they identify with, and each selection was individually counted towards the proportion of each ethnicity group. The North Carolina population breakdown for these ethnicities is 61% White, 20% Black, 3.3% Asian, 1% American Indian/Alaska Native, and 11% Hispanic/Latino, and 3.7% other (U.S. Census Bureau 2023).

When categorizing participants by consumer type (hobbyist or non-hobbyist), there were 82 participants (43.9% of the sample) classified as non-hobbyists, and 105 participants (56.1% of the sample) are hobbyists (Table 3.2). The median age is 36 years (s.d. = 16.99) for non-hobbyists, and 33 years (s.d. = 15.18) for hobbyists with no significant difference (f-ratio = 0.5974; p-value = 0.5513). The median household income was $54,999 (s.d. = $33,330) for non-hobbyists, and $64,999 (s.d. = $39,250) for hobbyists with no significant difference (f-ratio = 0.5549; p-value = 0.5750). The mean of each ethnic group for non-hobbyists is 0.61 (s.d. = 0.49) White, 0.10 (s.d. = 0.30) Black, 0.28 (s.d. = 0.45) Asian, 0.02 (s.d. = 0.16) Hispanic, and 0.02 (s.d. = 0.16) American Indian/Alaska Native; for hobbyists the means are 0.65 (s.d. = 0.48) White, 0.08 (s.d. = 0.27) Black, 0.25 (s.d. = 0.43) Asian, 0.05 (s.d. = 0.21) Hispanic, and 0.01 (s.d. = 0.10) American Indian/Alaska Native). The mean gender (0 = male; 1 = female) for non-hobbyists is 0.49 (s.d. = 0.50) and 0.79 (s.d. = 0.41) for hobbyists which was significantly different between hobbyists and non-hobbyists (f-ratio = 11.3533; p-value = <0.0001). These results indicate that hobbyists for the study sample were much more likely to be female than non-hobbyists. These results align with previous research that has found women to be accountable for the majority of purchases in the lawn and garden space (Miller 2016; Whitinger et al. 2023).

H1: Plant hobbyists are more likely to purchase plants online than non-hobbyists.

Two-sample paired t-tests were used to assess H1. Participants indicated whether they had purchased plants online before (0 = no; 1 = yes). Non-hobbyists indicated a lower level of

participation in online plant shopping at 40% (s.d. = 0.49), while approximately 57% (s.d. = 0.5) of hobbyists had purchased a plant online (Table 3.3). The t-ratio value for this comparison was 2.22, and the p-value was 0.0275, indicating that the difference between responses of hobbyists and non-hobbyists is significant. These results support H1 by verifying that hobbyists are more likely to purchase plants online than non-hobbyists. With this in mind, the potential demand for online plant shopping could increase if more marketing efforts were targeted towards plant hobbyists. Additionally, since hobbyists are approximately 10% more likely to purchase houseplants than non-hobbyists (Halouzková 2023), houseplant retailers in particular could benefit through targeting this market segment in their marketing efforts.

H2: Plant hobbyists will have a different perception of purchasing plants online than non-hobbyists.

H2 was not supported by the analyses conducted. Hobbyists indicated a mean value of 3.06 (s.d. = 1.27) for the number of retail outlet types where they purchased plants from in the past 12 months (Table 3.3), while non-hobbyists purchased plants from 2.38 (s.d. = 1.17) retail outlet types. The t-ratio for this comparison is 3.75, and the p-value is 0.0002. These results show a strongly significant difference between the number of outlets hobbyists and non-hobbyists purchased plants from in the previous year. This may suggest that hobbyists tend to take more of an omni-channel approach when purchasing plants, whereas non-hobbyists tend to adopt more of a mono-channel shopping approach. This suggests that hobbyists are more likely to purchase from a broader range of outlet types (online, in-person, etc.) or from a greater number of retail locations compared to non-hobbyists.

Additionally, study participants indicated their likelihood of purchasing plants online again (Table 3.3). The scale given was 1-5 (1 = extremely unlikely; 5 = extremely likely), and

non-hobbyists gave a mean response of 3.68 (s.d. = 1.15) while hobbyists gave a mean response of 3.9 (s.d. = 1.2). The two-sample paired t-test revealed that the relationship between the likelihood of purchasing plants online again and shopper type (hobbyist or non-hobbyist) was not significant (t-ratio = 0.05; p-value = 0.9573). Since no difference in repurchase intention for online shopping was indicated, H2 is not supported by these results. These results are indicative of a previous study's findings that hobbyists have both positive and negative perceptions of shopping online for plants due to different factors like not being able to physically see the product (negative) or convenience (positive) (Reyes and Navarra 2022). Increased attention in meeting the online shopping expectations of plant consumers may be a necessary step to maintain increased online plant shopping. This could be accomplished by considering and implementing consumer feedback for their online shopping experience preferences, providing comprehensive plant imaging for plants sold online, or by providing a plant quality guarantee when ordering plants online.

H3: Plant hobbyists will spend more on plants than non-hobbyists.

H3 was supported by the analysis results. To determine the spending habits of hobbyists compared to non-hobbyists, the study participants provided the amount they spent purchasing gardening supplies and plants in the previous two years (Table 3.3). For two years prior, hobbyists indicated a mean annual spending of $223 (s.d. = $79.65) on plants and gardening supplies, and non-hobbyists reported a mean annual spending of $158.05 (s.d. = $74.51). For the previous year, hobbyists indicated a mean annual spending of $258 (s.d. = $80.50), and non-hobbyists reported a mean annual spending of $193 (s.d. = $67.75) on plants and gardening supplies (online and in-store). The two-sample paired t-test results for each of the years given were t-ratio = 2.17, p-value = 0.0309 for the spending two years prior, and t-ratio = 2.21, p-value

= 0.0281 for the previous year's spending. These results show that there is a significant difference between the annual spending on plants and gardening supplies of hobbyists compared to non-hobbyists. The overall spending amounts are greater for hobbyists than non-hobbyists, which supports H3. Also, the results indicate that the participants spent more on plants and gardening supplies in the previous year than they did two years prior. These results suggest that hobbyists likely spend more on plants annually than non-hobbyists because they purchase plants as a hobby, and likely purchase plants more frequently than non-hobbyists, leading to an increased level of spending on plants each year.

Participants also included the amount of money they had spent on online only plant shopping during the previous year to determine if there was a difference in the amount of money spent by hobbyists and non-hobbyists. For the previous year, hobbyists provided a mean of $73.29 (s.d. = $29.15), and non-hobbyists gave a mean of $95.09 (s.d. = $24.45). The two-sample paired t-test revealed that this data was not significantly different based on participants being classified as a hobbyist or non-hobbyist (t-ratio = 0.8, p-value = 0.428), signifying no difference in the amount of money spent shopping online for plants between hobbyists and non-hobbyists. This result is intriguing since the previous results in the present study indicated that hobbyists are more likely to purchase plants online than non-hobbyists ("Purchased plants online before?" 1 = yes, 0 = no; 0.4 for non-hobbyists, 0.57 for hobbyists), and spend more on plants/gardening supplies (in general). This may imply that although hobbyists are more likely to purchase plants online, they may be more selective when making plant purchases, leading to no difference in the amount spent shopping for plants online between hobbyists and non-hobbyists. This could be further explained by the previously referenced research that indicates some negative perceptions regarding online plant shopping (Reyes and Navarra 2022). This may

indicate a perceptual or attitudinal barrier among hobbyists regarding purchasing plants online, which warrants future research to explore what this apprehension may be caused by.

H4: Data from the present study will be compared to previous data results regarding plant purchasing behavior.

To explore how the study participants' plant purchasing habits compared to previous findings, data from previously conducted research was gathered and compared. The factor considered was the annual spending average on plants and lawn and garden products per U.S. household (Figure 3.1). The averages were gathered from each year's NGS (Cohen and Baldwin 2018, National Gardening Association 2015, Whitinger et al. 2021, Whitinger et al. 2023, Whitinger et al. 2024), and the present study's survey results were included for 2023 as well. The average amount spent per U.S. household was $347 in 2012, $420 in 2013, $317 in 2014, $401 in 2015, $407 in 2016, $503 in 2017, $570 in 2018, $485 in 2019, $458 in 2020, $541 in 2021, $599 in 2022, and $671 in 2023 (from the NGS findings). The results for 2023 gathered from the present study sample revealed an average of approximately $255, drastically lower than 2023's indicated average from the NGS. This could mean that the present study sample does not match the sample demographics of the NGS when it comes to purchasing plant products, which is plausible considering that the present study sample comes only from the state of North Carolina and was performed on a much smaller scale than the NGS (187 participants for present study sample, and 2,428 participants for the 2024 NGS). Although the average annual spending for plants cannot be directly compared between the present study results and previous NGS results due to differences in question phrasing and the scale at which the data was collected from (North Carolina compared to nation-wide), the present study results and NGS data were provided to

give insight into North Carolina plant consumer purchasing tendencies and to display the overall trend of plant shopping nationally.

CONCLUSIONS

This study explored the different online plant spending habits and purchasing intentions between plant consumers classified as hobbyists and non-hobbyists. The study was conducted using a survey created in *Qualtrics* and was administered in *iMotions* software. The data gathered was analyzed using two-sample paired t-tests to compare the different responses given by hobbyists and non-hobbyists. The results indicated that hobbyists spend more each year on plant products (in general), are more likely to purchase plants online, and purchase plants using more of an omni-channel approach than non-hobbyists. The results supported H1 and H3 with a greater likelihood of purchasing plants online, a greater amount spent shopping for plants in general, and a greater number of retail outlets utilized when purchasing plants for hobbyists than non-hobbyists. Additionally, the amount spent shopping for plant products online was found to be no different between hobbyists and non-hobbyists, meaning hobbyists are likely more selective when purchasing plants, which did not support H2. These results suggest that certain niche markets, like the houseplant market, could benefit through targeting hobbyists for more efficient marketing efforts in order to meet the demand of this particular market segment. Additionally, greater efforts to meet the online shopping expectations of consumers may be necessary to maintain the increased market share for online plant shopping.

Study Limitations

The results of this study garnered insights into the purchasing behaviors of hobbyists compared to non-hobbyists, but certain limitations should be addressed. First, the demographics

of the overall study sample were not completely aligned with the North Carolina population with a much higher Asian population (28% compared to 3.3%), a much lower Hispanic population (4% compared to 11%), and a lower black population (9% compared to 20%). This is likely due to the nature of the data collection being conducted in-person at educational institutions (North Carolina State University, Duke University, and Southeastern Community College), which restricted the sample pool to those in close proximity to each study site. Additionally, all participants of the study sample were residents of North Carolina, meaning the study would need to be conducted in other states to create a more representative study sample of the U.S. population. Some level of hypothetical bias could exist as well, which may occur when participants are asked to provide their preference or amount being spent, meaning what they state in a hypothetical transaction environment (like a survey) to be slightly different than the amount they would actually spend or their given preference in a physical transaction (Loomis 2011). The plant types and parts of the plants could also be considered in the participants' decision making, so the wording in future studies should be considered in future studies to explicitly state what to consider in their purchasing decision.

Further Work

Future research to emerge from these study results could focus on determining what barriers may exist for hobbyist consumers when purchasing plants online since hobbyists indicated a much greater amount spent on plant products annually compared to non-hobbyists, while the annual amount spent shopping for plants online was similar among the two consumer types, along with the repurchase intention for online plant shopping.

REFERENCES

Airhart E. 2019. The Instagram-famous Plant that used to be Impossible to Find. Vox. https://www.vox.com/the-goods/2019/3/21/18274568/pilea-peperomioides-plant-instagram-sill-circular-leaves. [accessed 23 Apr 2024].

Baker LM, Boyer CR, Peterson HH, King AEH. 2018. Online Opportunities: A Quantitative Content Analysis Benchmark Study of Online Retail Plant Sales. HortTechnology. 28(4):516–523. https://doi.org/10.21273/HORTTECH03901-17.

Bulgari R, Petrini A, Cocetta G, Nicoletto C, Ertani A, Sambo P, Ferrante A, Nicola S. 2021. The Impact of COVID-19 on Horticulture: Critical Issues and Opportunities Derived from an Unexpected Occurrence. Horticulturae. 7(6):124. https://doi.org/10.3390/horticulturae7060124.

Campbell BL, Rihn AL, Campbell JH. 2021. Impact of the Coronavirus Pandemic on Plant Purchasing in Southeastern United States. Agribusiness. 37(1):160–170. https://doi.org/10.1002/agr.21685.

Cobanoglu C, Warde B, Moreo PJ. 2001. A Comparison of Mail, Fax and Web-based Survey Methods. International Journal of Market Research. 43(4):441–452.

Cohen, P., Baldwin, I. 2018. National Gardening Survey: A Comprehensive Study of Consumer Gardening Practices, Trends, and Product Sales. GardenResearch.com, Williston, VT. 281 pp.

Conway TM. 2016. Home-based Edible Gardening: Urban Residents' Motivations and Barriers.

Cook EM, Hall SJ, Larson KL. 2012. Residential Landscapes as Social-ecological Systems: a Synthesis of Multi-scalar Interactions between People and their Home Environment. Urban Ecosyst. 15(1):19–52. https://doi.org/10.1007/s11252-011-0197-0.

Dowling GR. 1986. Perceived risk: The Concept and its Measurement. Psychology & Marketing. 3(3):193–210. https://doi.org/10.1002/mar.4220030307.

Featherman M, Jia S (Jasper), Califf CB, Hajli N. 2021. The Impact of New Technologies on Consumers Beliefs: Reducing the Perceived Risks of Electric Vehicle Adoption.

Technological Forecasting and Social Change. 169:120847. https://doi.org/10.1016/j.techfore.2021.120847.

Fratello DS, Campbell BL, Secor WG, Campbell JH. 2022. Impact of the COVID-19 Pandemic on Gardening in the United States: Postpandemic Expectations. https://doi.org/10.21273/HORTTECH04911-21.

Hall C, Knuth M. 2019. An Update of the Literature Supporting the Well-Being Benefits of Plants: A Review of the Emotional and Mental Health Benefits of Plants. Journal of Environmental Horticulture. 37(1):30–38. https://doi.org/10.24266/0738-2898-37.1.30.

Halouzková, E. 2023. Willingness to pay for houseplants in the Czech Republic. Bachelor's Thesis. Charles University, Faculty of Social Sciences, Institute of Economic Studies, Prague.

How Does it Work - iMotions. 2022. https://imotions.com/how-does-it-work/. [accessed 18 Feb 2024].

Khachatryan H, Rihn A, Campbell B, Behe B, Hall C. 2018. How do Consumer Perceptions of "Local" Production Benefits Influence their Visual Attention to State Marketing Programs? Agribusiness. 34(2):390–406. https://doi.org/10.1002/agr.21547.

Khwaja MG, Mahmood S, Zaman U. 2020. Examining the Effects of eWOM, Trust Inclination, and Information Adoption on Purchase Intentions in an Accelerated Digital Marketing Context. Information. 11(10):478. https://doi.org/10.3390/info11100478.

Kliesen, K. L. 2003. Consumer Confidence Surveys: Do they Boost Forecasters' Confidence? *Regional Economist*, Federal Reserve Bank of St. Louis. Available at: https://www.stlouisfed.org/publications/regional-economist/april-2003/consumer-confidence-surveys-do-they-boost-forecasters-confidence#figure2.

Knuth MJ, Behe BK, Rihn A, Hall CR. 2023. Effects of Benefits Messaging on Consumer Purchasing of Plants. HortScience. 58(5):481–487. https://doi.org/10.21273/HORTSCI16993-22.

Knuth M, Khachatryan H, Hall C. 2021a. Consumer Houseplant Purchasing Report 2021. Floral Marketing Fund.

Knuth MJ, Khachatryan H, Hall CR. 2021b. How Consistent Are Consumers in Their Decisions? Investigation of Houseplant Purchasing. Behavioral Sciences. 11(5):73. https://doi.org/10.3390/bs11050073.

Knuth MJ, Rihn AL, Behe BK, Hall CR. 2024. Plant Purchasers Perceptions of Mental Health and Optimism for the Future. Environ Soc Psychol. 9(4). https://doi.org/10.54517/esp.v9i4.2209.

Lefever S, Dal M, Matthíasdóttir Á. 2007. Online Data Collection in Academic Research: Advantages and Limitations. British Journal of Educational Technology. 38(4):574–582. https://doi.org/10.1111/j.1467-8535.2006.00638.x.

Loomis J. 2011. What's to Know About Hypothetical Bias in Stated Preference Valuation Studies? Journal of Economic Surveys. 25(2):363–370. https://doi.org/10.1111/j.1467-6419.2010.00675.x.

McCullough, D. 1998. Web-based Market Research: The Dawning of a New Age. Direct Marketing 61:36–38.

McGinnis E, Rihn A, Bumgarner N, Krishnan S, Cole J, Sclar C, Khachatryan H. 2020. Enhancing Consumer Horticulture's Millennial Outreach: Social Media, Retail, and Public Garden Perspectives. HortTechnology. 30(6):642–649. https://doi.org/10.21273/HORTTECH04697-20.

Miller C. 2016. Woman Power! Cater To Your Most Important Plant Retail Customers With These Insights. Greenhouse Grower. https://www.greenhousegrower.com/management/retailing/woman-power-cater-to-your-most-important-plant-retail-customers-with-these-insights/. [accessed 25 Apr 2024].

Mitchell V. 1999. Consumer Perceived Risk: Conceptualisations and Models. European Journal of Marketing. 33(1/2):163–195. https://doi.org/10.1108/03090569910249229.

Nancy. 2020. The History of Landscape Design. Optima. https://www.optima.inc/history-landscape-design/. [accessed 23 Apr 2024].

National Gardening Association. 2015. National Gardening Survey: A Comprehensive Study of Consumer Gardening Practices, Trends, and Product Sales. National Gardening Association, Williston, VT. 237 pp.

Neumann D, Huddleston PT, Behe BK. 2023. Fear of Missing Out as Motivation to Process Information: How Differences in Instagram Use Affect Attitude Formation Online. New Media & Society. 25(1):220–242. https://doi.org/10.1177/14614448211011834.

Pei W, Mayer A, Tu K, Yue C. 2020. Attention Please: Your Attention Check Questions in Survey Studies Can Be Automatically Answered, p 1182–1193. Proceedings of The Web Conference 2020. ACM, Taipei Taiwan. https://doi.org/10.1145/3366423.3380195.

Pérez-Urrestarazu L, Kaltsidi MP, Nektarios PA, Markakis G, Loges V, Perini K, Fernández-Cañero R. 2021. Particularities of Having Plants at Home During the Confinement due to the COVID-19 Pandemic. Urban Forestry & Urban Greening. 59:126919. https://doi.org/10.1016/j.ufug.2020.126919.

Reyes S, Navarra N. 2022. Exploring Perceptions on Online Plant Shops: A Case Study of South Triangle Residents. IOP Conference Series Earth and Environmental Science. 1092(1):012021. https://doi.org/10.1088/1755-1315/1092/1/012021.

Rihn A, Khachatryan H, Campbell B, Hall C, Behe B. 2016. Consumer Preferences for Organic Production Methods and Origin Promotions on Ornamental Plants: Evidence from Eye-tracking Experiments. Agricultural Economics. 47(6):599–608. https://doi.org/10.1111/agec.12258.

Rihn A, Knuth M, Behe B, Huddleston P, 2024 (accepted). Online Spending: Blooming Business: How Consumer Satisfaction Shapes Online Plant and Cut Flower Spending. HortTech.

Rosiers FD, Theriault M, Kestens Y, Villeneuve P. 2002. Landscaping and House Values: An Empirical Investigation. The Journal of Real Estate Research. 23(1/2):139–161.

Schettler C, Rombach M, Bitsch V. 2016. Perceived Advantages and Barriers of Buying Cut Flowers Online. Acta Hortic. (1132):9–16. https://doi.org/10.17660/ActaHortic.2016.1132.2.

Torres AP, Rihn AL, Barton SS, Behe BK, Khachatryan H. 2021. Evaluating the Business and Owner Characteristics Influencing the Adoption of Online Advertising Strategies in the U.S. Green Industry. HortScience. 56(6):659–666. https://doi.org/10.21273/HORTSCI15766-21.

United States Department of Agriculture National Agricultural Statistics Service. (2024). 2023 Floriculture Crops Summary. Retrieved from https://www.nass.usda.gov/Publications/Highlights/2024/2023-floriculture-highlights.pdf

U.S. Census Bureau. 2023. North Carolina profile: Race and ethnicity. Available at: https://data.census.gov/profile/North_Carolina?g=040XX00US37#race-and-ethnicity.

U.S. Department of Agriculture. 2020. U.S. Horticulture Operations Report $13.8 Billion in Sales. https://www.nass.usda.gov/Newsroom/archive/2020/12-08-2020.php. [accessed 21 May 2024].

U.S. Department of Agriculture, National Agricultural Statistics Service. 2020. 2019 Census of Horticultural Specialties Summary. Available at: https://www.nass.usda.gov/Data_and_Statistics/Special_Tabulations/index.php.

U.S. Department of Commerce. 2024. Quarterly Retail E-Commerce Sales 4th Quarter 2023.

Vigoroso L, Pampuro N, Bagagiolo G, Cavallo E. 2021. Factors Influencing Adoption of Compost Made from Organic Fraction of Municipal Solid Waste and Purchasing Pattern: A Survey of Italian Professional and Hobbyist Users. Agronomy. 11(6):1262. https://doi.org/10.3390/agronomy11061262.

Whitinger, D., Cohen, P., McKinley, S., and Feinson, J. 2021. National Gardening Survey: The Definitive Guide to Lawn & Garden Business Trends, Analysis, and Understanding. National Gardening Association, Williston, VT. 237 pp.

Whitinger, D., Gell, T., Eisenhauer, J., Coville, C., and Feinson, J. 2023. National Gardening Survey: The Definitive Guide to Lawn & Garden Business Trends, Analysis, and Understanding. National Gardening Association, Williston, VT. 250 pp.

Whitinger, D., Gell, T., Eisenhauer, J., Coville, C., and Feinson, J. 2024. National Gardening Survey 2024. National Gardening Association, GardenResearch.com.

Yarrington JS, Lasser J, Garcia D, Vargas JH, Couto DD, Marafon T, Craske MG, Niles AN. 2021. Impact of the COVID-19 Pandemic on Mental Health among 157,213 Americans. Journal of Affective Disorders. 286:64–70. https://doi.org/10.1016/j.jad.2021.02.056.

Zhou, L., Dai, L., Zhang, D. 2007. Online Shopping Acceptance Model — A Critical Survey of Consumer Factors in Online Shopping. Journal of Electronic Commerce Research 8(1): 41-50.

Tables

Table 3.1 Demographic data for study sample

		Sample		NC.
Variable	**Definition**	**Median**	**SD**	**Median**
n	Number of people	187		10.44 million
Age	Years (no.)	34	15.88	39.2
Gender	0 = male; 1 = female	0.65	0.48	0.51
Income	Median Household Income	$54,999	$35,730	$67,481
Ethnicity	1 = White; 0 = other	0.61	0.49	0.61
	1 = Black; 0 = other	0.09	0.29	0.20
	1 = Asian; 0 = other	0.28	0.45	0.03
	1 = Hispanic; 0 = other	0.04	0.18	0.11
	1 = American Indian/Alaska Native; 0 = other	0.02	0.12	0.01
	Other	0.01	0.07	0.01
	Prefer not to Answer	0.01	0.1	-

Table 3.2 Demographic data for plant hobbyists and non-hobbyists

		Non-Hobbyist		Hobbyist		NC	f-ratio	p-value
Variable	**Definition**	**Median**	**SD**	**Median**	**SD**	**Median**		
n	Number of people (187 total)	82		105		10.44 million		
Age	Years (no.)	36	16.99	33	15.18	39.2	0.5974	0.5513
Gender	0 = male; 1 = female	0.49	0.50	0.79	0.41	0.51	11.3533	<0.0001
Income	Household Income	$54,999	$33,330	$64,999	$39,250	$67,481	0.5549	0.5750
Ethnicity	1 = White; 0 = other	0.61	0.49	0.65	0.48	0.61		
	1 = Black; 0 = other	0.10	0.30	0.08	0.27	0.20		
	1 = Asian; 0 = other	0.28	0.45	0.25	0.43	0.03		
	1 = Hispanic; 0 = other	0.02	0.16	0.05	0.21	0.11		
	1 = American Indian/Alaska Native; 0 = other	0.02	0.16	0.01	0.10	0.01		
	Other	0.00	0.00	0.01	0.10	0.01		
	Prefer not to Answer	0.01	0.11	0.01	0.10	-		

Table 3.3 Comparing results from plant hobbyists and non-hobbyists

Survey Question	Non-Hobbyist		Hobbyist		t-ratio	p-value
Online Plant Interactions (0 = No; 1 = Yes)	Mean	SD	Mean	SD		
Follow grower or retailer on social media?	0.3	0.45	0.52	0.5	2.98	0.0033
Part of a plant-oriented social media group?	0.15	0.36	0.58	0.5	6.37	0.0001
Purchased Plants Online?	0.4	0.49	0.57	0.5	2.22	0.0275
Purchase Plants Online Again? (1 = extremely unlikely; 5 = extremely likely)	3.68	1.15	3.9	1.2	0.05	0.9573
*Number of different outlet types where plants were purchased from in past year	2.38	1.17	3.06	1.27	3.75	0.0002
Total amount spent on gardening supplies and plants two years ago?	$158.05	$74.51	$223	$79.65	2.17	0.0309
Total amount spent on gardening supplies and plants last year?	$193	$67.75	$258	$80.50	2.21	0.0281
Amount Spent Online Plant Shopping (previous year)	$95.09	$24.45	$73.29	$29.15	0.80	0.4280

Note: *The randomized outlet types provided were “home improvement store (e.g. Home Depot, Lowes),” “independent garden center,” “online (e.g. Amazon, Facebook Marketplace),” “wholesale club (e.g. Costco, Sam’s Club),” “box store (e.g. Target, WalMart),” “direct from grower (e.g. farmers market, farm stand),” “other.”

Figures

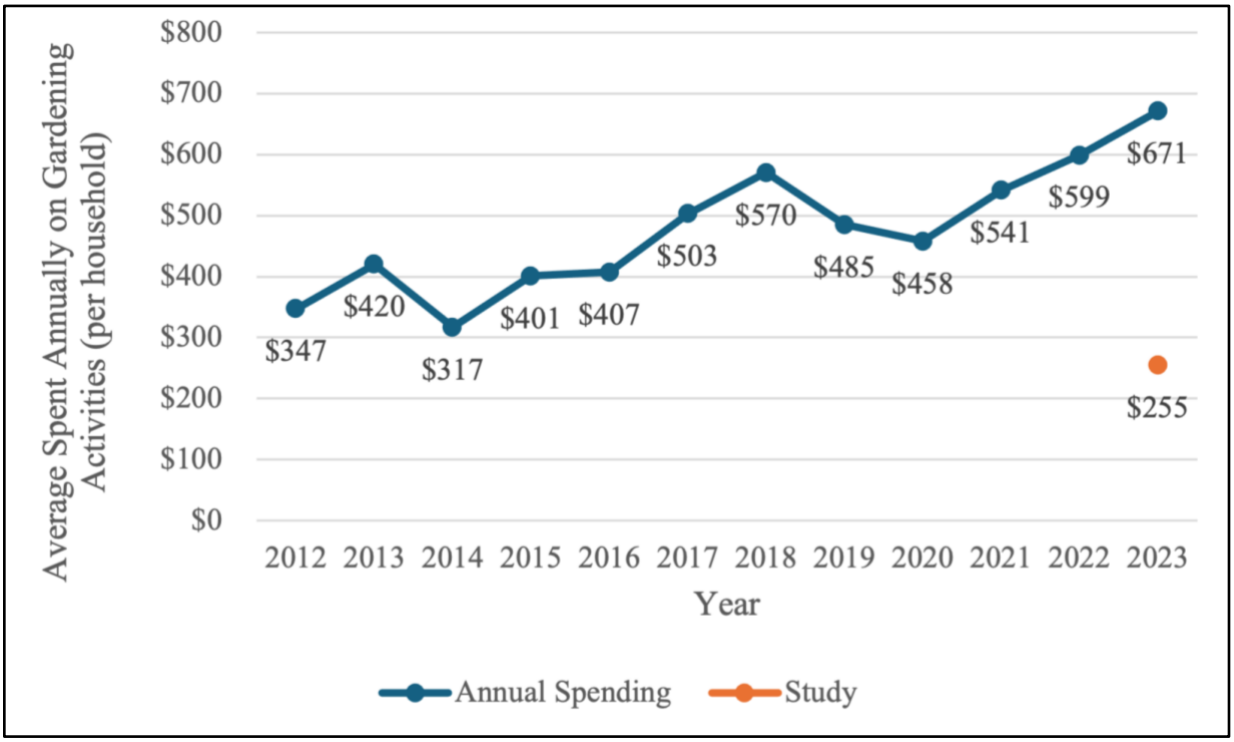

Figure 3.1 Graph displaying the annual spending averages on plants and lawn and garden products for each U.S. household over the past 12 years.

The 2012-2023 data was gathered from annual National Gardening Surveys (Cohen and Baldwin 2018, National Gardening Association 2015, Whitinger et al. 2021, Whitinger et al. 2023, Whitinger et al. 2024), and the second 2023 data point is from the average given by the present study's participants.

*Study results s.d. = $80.50