Perceptions and Socioeconomic Status Influence Purchases of Native Plants

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Abstract. **Plants native to the United States, defined as those being present before European settlement, have aesthetic and environmental benefits. In 2018, only 10% of plant sales were native plants, a plant category that tends to be underrepresented in many residential and commercial landscapes. Although earlier research indicated that consumers find native plants less aesthetically appealing relative to introduced species, more recent research reported a growing demand for native plants. Thus, a better understanding of consumer perceptions would facilitate their marketing. We used an online survey of 1824 participants representing five geographic regions (West, Southwest, Midwest, Southeast, and Northwest) to classify adopters based on their purchase of native plants. A double-hurdle model was used to estimate factors influencing purchasing native plants among US homeowners, and the factors influencing the amount spent on native plants in 2021. Demographically, metropolitan, college-educated, and younger participants were more likely to be native plant adopters; they also spent 80% more on plants compared with nonnative plant adopters. More native plant adopters agreed that native plants were better for the environment than exotic plants (68%), are readily available in their area (67%), and are better adapted to difficult sites (75%). Marketing efforts should capitalize on the environmental benefits to stimulate purchases.**

In the United States, native plants are defined as plants that were present before European settlement and have evolved and occur naturally in a particular region, ecosystem, and habitat. As a result, native plants are often associated with numerous ecological and production benefits, including reduced inputs (i.e., fertilizer, irrigation, pesticides), improved biodiversity, and increased pollinator foraging and habitat sources (Rodriguez et al. 2017; Shaw et al. 2017; Van Heezik et al. 2020). If properly managed and planted, gardens and landscapes with native plants could serve as "wildlife corridors" in urban areas (Rudd et al. 2002), which could aid ecological health, biodiversity, and wildlife habitat (Breuste 2004; Goddard et al. 2010; Grimm et al. 2008; Raymond et al. 2019).

In developed countries, residential landscapes are predominately nonnative species (Burghardt et al. 2009) that have often been deliberately introduced for ornamental purposes (Mack and Erneberg 2002; Randall and Marinelli 1996). Currently, native species are underrepresented in the landscape and garden center industry, but the demand for native plants is expected to increase (Kauth and Perez 2011). Shaw et al. (2017) and Gillis and Swim (2020) found that a major segment of consumers view native plants as aesthetically appealing. In turn, consumers' positive perceptions of the beauty of native plants positively affect their intent to purchase native plants (Gillis and Swim 2020). Regarding proenvironmental behavior, several studies have established a positive correlation between environmental knowledge and purchase likelihood for native plants (Narem et al. 2018) or positive perceptions of native plants (Shaw et al. 2017). Yet, consumer motivations for purchasing native plants are not clearly understood. Moreover, consumers are heterogeneous, and this heterogeneity is driven by social norms, beliefs, and perceptions that tend to change by geographic zone.

Consumer perceptions studies on native plants have addressed the relationship between social norms, aesthetic considerations, proenvironmental behavior, and native plant preferences (Gillis and Swim 2020; Rodriguez et al. 2017; Shaw et al. 2017; Van Heezik et al. 2020). Beck et al. (2002) found that native plants were not considered as aesthetically pleasing as other options and that there was a strong need for natives to imitate traditional definitions of aesthetically pleasing landscape plants. These trends suggest that retailers who understand consumer purchasing behavior of native plants will be better poised to promote their purchase and thus increase overall sales. This survey aimed to discover 1) the factors influencing purchasing native plants among US homeowners, and 2) the factors influencing the amount spent on native plants in 2021.

Literature review

The native plant literature can be split into two broad categories: production-related and consumer behavior research. The production literature focuses on the availability of native plants within the market and ecological benefits of native plants. The latest report showed that, in the United States, ~841 vendors sell native plants and there are ~6500 native vascular plant species commercially available (White et al. 2018). In 2018, native plants comprised 10% of all ornamental plant sales in the United States (Khachatryan et al. 2020). Kauth and Perez (2011) identified several barriers to native plant production including limited seed or propagule sources, low availability of desired species, low education (industry and customer) on native plants, and consumer confusion and lack of familiarity with native species. A review article by Wilde et al. (2015)

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identified the need for more native species that are ecologically functional and economically viable. There is a clear need for the environmental benefits of native ornamental plants to be highlighted in retail promotions as value-added traits that may attract and engage environmentally conscious customers (Wilde et al. 2015). For instance, native plants have been shown to benefit more pollinator insect species than introduced species (Zaninotto et al. 2022), particularly specialist bee (superfamily, Apoidea) species (Cecala and Wilson Rankin 2021). Identifying value-added traits (e.g., ecological benefits) has the potential to justify higher price points to customers, which is important given that native plants tend to be more expensive to grow than introduced species (Norcini 2006). Fortunately, price does not seem to be the most important plant characteristic among customers buying native plants (Brzuszek and Harkess 2009).

Consumer behavior literature focuses on marketplace acceptance and valuation. Historically, native plants were difficult to promote because they did not fit society's definition of an aesthetically pleasing landscape (e.g., turfgrass-dominant lawns) (Beck et al. 2002). However, a more recent study by Shaw et al. (2017) determined that homeowners perceive natives as aesthetically appealing and have interest in planting native species with a heightened interest in those plants that encourage wildlife. The shift in perception of the aesthetics of native plants is particularly beneficial given that it positively impacts intent to purchase and installation behaviors for residential yards (Gillis and Swim 2020). In fact, social norms have a strong influence on front yard landscape preferences (Gillis and Swim 2020). Supporting evidence from other studies suggests that promoting native plant benefits to wildlife (Van Heezik et al. 2020) and improving biodiversity in traditional agronomic systems (Shelef et al. 2017) has great potential to encourage native plant sales.

Often literature on native plants is local in nature, which is not surprising given that native plants are geographically specific and area cultural and social norms influence landscape preferences (Champine et al. 2022; Davis et al. 2012; Gillis and Swim 2020). For instance, Yue et al. (2011) found that Minnesotans are willing to pay $0.35 more for native plants when labeled as noninvasive. Their research reported that invasiveness was a primary concern for consumers and required a discount of $1.01 to $1.66 for participants to purchase that plant. They also found that men and younger participants preferred native plants relative to women or older generations (Yue et al. 2012). Similarly, native plants that encourage bird visits resulted in a 75% increase in supporting native plant landscaping in Raleigh, NC, USA (Rodriguez et al. 2017). In Michigan, participants were willing to pay premiums of $94 to $143 per month for a well-designed yard incorporating native species over yards consisting solely of turfgrass (Helfand et al. 2006). Together the production and consumer literature indicate opportunities and barriers in the native plants market. This study serves to provide more information about these topics from the consumer perspective.

Data and methodology

Data description. We used data from an online survey of a representative sample of US consumers. The survey questionnaire was developed based on existing literature and input from researchers, Extension personnel, and industry stakeholders associated with native plant production and distribution. The survey methodology included a consent form and questions related to plant and native plant purchasing behavior, perceptions of native plants, and demographic characteristics. The survey was approved by the corresponding institutional review board (IRB) for compliance with ethical standards for human subjects (IRB-22–06847-XM).

The survey was administered through an online panel provider (Qualtrics LLC, Provo, UT, USA) to their proprietary opt-in panel of US consumers in Sep 2022. Before participation, respondents needed to agree to participate in the survey and were screened to ensure they were at least 18 years old and had decision-making power to purchase native plants (i.e., owned a property or had sole or shared responsibility over lawns). The rationale to include these screening questions was to target the decision-makers who are currently or potentially purchasing native plants. Participants were equally recruited from five US regions, including the West, Southwest, Midwest, Southeast, and Northwest (National Geographic 2022). The rationale to categorize respondents by region follows that native plants are defined by the region where they naturally occur, and they differ across regions according to the US Department of Agriculture (USDA 2023; White et al. 2018). We also eliminated potential respondents who did not pass attention checks (i.e., validation questions asking respondents to specifically select an answer). Questionnaire development was guided by a review of the literature and interviews with industry stakeholders including producers and retailers of native plants.

A total of 2066 people were qualified for the study and completed the survey. All analyses were conducted using Stata (release 17; StataCorp, College Station, TX, USA) software to analyze the data. The study sample consisted of 1824 respondents who answered the question "Have you purchased a native plant in the past year?" Respondents who did not answer the question were excluded from the analysis (N = 242 respondents). From our sample of US homeowners, 1086 of them (59.54%) answered they had purchased native plants in 2021 (*adopters)* and the other 40.46% did not (*nonadopters*). We also asked those who purchased native plants in 2021 to answer about how much they spent annually on native plants, with choices ranging from $1–$100, $101–$200, $201–$300, $301–$400, $401–$500, $501–$600, $601–$700, $701–$800, $801–$900, $901–$1000, and $1001 or more. We calculated the midpoint of each interval to compute the amount of average annual expenditure in native plants. Figure 1 illustrates the distribution of dollar expenditures in native plants in 2021, which ranged from $50 to $1050.

Empirical model specification. This section illustrates the methodology used to estimate 1) the factors influencing purchasing native plants among US homeowners, and 2) the factors influencing the annual dollar expenditures in native plants in 2021. Table 1 describes the variables used in the double-hurdle model, including interaction variables between being female and knowledge of natives, growing food, and rating native plants as leggy. Variables in the double-hurdle included demographic characteristics (e.g., gender, age, educational attainment, household size, and income level),

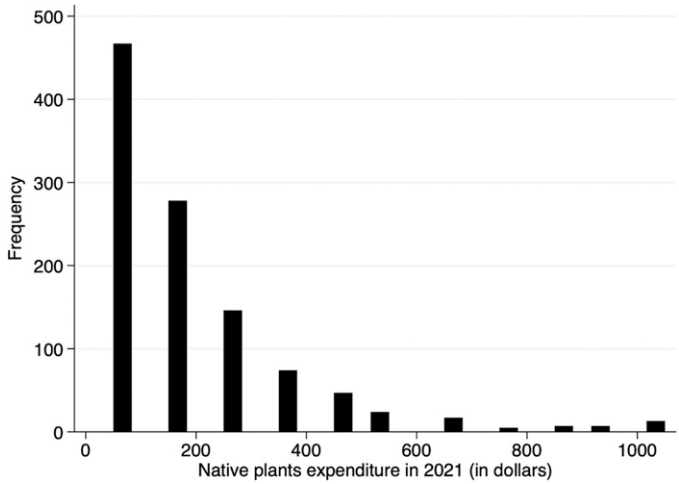

Fig. 1. Number of US homeowners who spent money on native plants in 2021 and their US dollar expenditures. The x-axis represents the annual US dollar expenditure on native plants. The y-axis represents the number of respondents who spent that amount on native plants.

gardening characteristics (e.g., knowledge of natives, plant expenditures, importance of natives, and having natives in landscape), visual preferences for natives (e.g., uniform, compact, aesthetically pleasing, aligning with preferences, colorful, and showy), and perceptions regarding native plants (e.g., availability in area, adaption to difficult sites, expensive, and markets). Given the lack of descriptive scales available for native plants, a scale was created to capture a wide swath of potential characteristics/attributes of native plants (in general). Each line of the scale contained two opposite adjectives of each characteristic/attribute. The adjectives were primarily based on existing literature (e.g., aesthetically pleasing (Beck et al. 2002; Gillis and Swim 2020), encourage wildlife, better for the environment (Narem et al. 2018; Shaw et al. 2017), limited availability (Kauth and Perez 2011), and difficult sites (Brzuszek and Harkess 2009). Several of the aesthetic characteristics were generated to capture any additional perceptions related to the overall aesthetic of native plants vs. introduced species (e.g., dull – colorful, uniform – variable growth, showy – plain, aligns with preferences – does not align with preferences).

To model the two-step purchasing decision-making, we used a double-hurdle regression (Cameron and Trivedi

Table 1. Variable descriptions by category included in the model for the decision to purchase native plants.

Category	Variable name	Description of variable
Demographics	percent female	1 = if respondent is female
	age years	age in years
	metro area	1 = if live in urban or suburban
	college	1 = if respondent educational attainment is 4-year bachelor's degree, graduate school, or professional degree
	HH size	number of individuals in household including children
	upper class	1 = if household income is $100,000 or higher
Gardening	gardener	1 = if respondent is the primary gardener or plant purchaser in the household
	knows native	1 = if respondent self-reported as very or extremely knowledgeable of native plants
	spent on plants	amount of dollars spent on all plants in 2021, excluding soil amendments, fertilizers, pesticides, and landscape services
	natives important	1 = if respondent believes incorporating native plants into gardens is very or extremely important
	has natives	1 = if respondent had native plants in garden/landscape at the time of the survey
	grows food	1 = if respondent grows some of their own food
Appeal	natives variable	rating that native plants are uniform, with 1 = uniform and 5 = variable
	natives leggy	rating that native plants are leggy, with 1 = compact and 5 = leggy
	natives no pleasing	rating that native plants are aesthetically unpleasing, with 1 = pleasing and 5 = less pleasing
	natives no aligning	rating that native plants do not align with preferences, with 1 = aligning with preferences and 5 = does not align with preferences
	natives dull	rating that native plants are dull, with 1 = colorful and 5 = dull
	natives plain	rating that native plants are plain, with 1 = showy and 5 = plain
Perceptions	better environment	1 = if respondent agrees or strongly agrees that native plants are better for the environment than exotic plants
	available	1 = if respondent agrees or strongly agrees that native plants are readily available in their area
	adapted	1 = if respondent agrees or strongly agrees that native plants are better adapted to difficult sites
	not interested	1 = if respondent agrees or strongly agrees that s/he is not interested in planting native plants
	female X knows natives	interaction between female and knowledge of native
	female X grows food	interaction between female and grows food
	female X natives leggy	interaction between female and rating for leggy
Expenditure	natives expensive	rating that native plants are expensive, with 1 = inexpensive and 5 = expensive
	knows market	1 = if respondent agrees or strongly agrees that she or he knows where to shop to purchase native plants

2009; Duan et al. 2012). The double-hurdle model is a useful methodology used to estimate these two separate and consecutive decisions into two steps, especially because the double-hurdle model mitigates the potential of selection bias. Selection bias occurs when a sample is not randomly generated and may fail to represent the general population. Thus, modeling the two decisions with the double-hurdle approach can address the unobservable characteristics found in the first selection error term before performing the second stage, that otherwise could lead to endogenous covariates if modeled separately (Cameron and Trivedi 2009; Duan et al. 2012).

The rationale from using a double-hurdle model is that the variables included in each step of the decision-making process need to reflect the factors that are relevant for each step of the process. For example, the second step in the regression, which measures the amount spent on native plants (stage 2) had similar variables influencing the decision to purchase native plants (stage 1) in addition to the variables *expensive* and *market* that control for the impact of prices and specific markets on native plant expenditures.

The double-hurdle model is an extension of the standard Tobit model, in which the double-hurdle relaxes the assumption that factors affecting the decision to purchase native plants (stage 1 or selection decision) have the same effect on the amount spent on native plants (stage 2 or quantity decision). Torres et al. (2021) used a similar model to decouple a two-step decision-making of business owners. The double-hurdle two-step model is given by Eq. [1], illustrating the first stage in which a US homeowner "hurdles" into the second stage (y_2) if she or he purchased native plants in 2021(if $y_1 = 1$):

$$f(y_2 \mid x) = \begin{cases} \Pr\,[y_1 = 0 \mid x] & if\ y_2 = 0 \\ Pr[y_1 = 1 \mid x]\, f(y_2 \mid y_1 = 1,\ x) & if\ y_2 = 1 \end{cases} \quad [1]$$

We followed Duan et al. (2012) and Cameron and Trivedi (2009) to define the first decision as a probit regression by Eq. [2] and the second decision as a least-square regression by Eq. [3]. In the following equations, Eq. [2] is a normally distributed probability regression, where y_1 is equal to 1 if the respondent purchased native plants in 2021, and y_1 is equal to zero otherwise; and x is the vector of the demographic characteristics, gardening behavior, and homeowner's perceptions regarding native plants and the environment. Eq. [3] used a continuous value of the annual expenses in native plants (y_2), in which the variable y_2 is observed only if $y_1 = 1$. Eq. [3] used an ordinary least squares regression to measure how the vector of explanatory variables x from Eq. [2] influences the homeowner's expenditure in native plants (in dollars), given that the homeowner purchased native plants. In Eq. [3], the variable expensive measures the homeowner's perceptions that native plants are expensive, the variable market represents the respondent's agreement that she or he knows where to shop for native plants, and e is the error term.

$$\Pr\ (y_1 = 1 \mid x) = \phi\ (x'\beta) \quad [2]$$

$$(y_2 \mid y_1 = 1,\ x) = x'\beta_1 + \beta_2 expensive + \beta_3 market + e \quad [3]$$

Results

Descriptive statistics. Table 2 illustrates the mean and standard deviation for all the variables used in the double-hurdle model. Table 2 also illustrates the mean differences between those who purchased native plants (adopters) and those who did not purchase native plants in 2021 (nonadopters). Most respondents in the sample were women, with a larger percentage of men being adopters, relative to their counterparts ($P < 0.01$). The average homeowner in our sample was 57 years old, with a larger proportion of younger homeowners being adopters, relative to their counterparts ($P < 0.01$). Most respondents were homeowners in metro areas (60%), and more native plant purchasers tend to live in metro areas, relative to nonadopters ($P < 0.01$). Almost half of the respondents had a college education or higher, and more college-educated respondents were also purchasers of native plants ($P < 0.01$). A quarter of respondents reported earnings of $100,000 or more, with a larger proportion of them in the adopter category ($P < 0.01$).

When looking into the gardening behavior, 88% of respondents were the primary gardener or plant purchaser in the household, with a larger percentage of gardeners in the adopter category ($P < 0.01$). Adopters also had a larger proportion of respondents who self-reported as very or extremely knowledgeable of native plants, believed incorporating natives into gardens is important, grew some of their own food, and had native plants in their garden ($P < 0.01$). The average respondent spent $220.34 on all plants per year, with larger plant expenditures among adopters ($268.78) than nonadopters ($149.05) ($P < 0.01$).

We asked respondents to rate attributes of native plants in general. Ratings ranged from 1 to 5 between plant attributes and included uniform vs. variable, compact vs. leggy, aesthetically pleasing vs. less pleasing, plants align with preferences vs. not aligning with preferences, and colorful vs. dull (see Table 1). In other words, the larger the rating, the less desirable the attribute. The least desirable attributes among all respondents for native plants are variable, leggy, and not pleasing. Most respondents in our sample perceived that native plants are better for the environment than exotic plants (68%), native plants are readily available in their area (67%), and native plants are better adapted to difficult sites (75%). For all these perceptions, the proportion of adopters was larger than nonadopters ($P < 0.01$). Most respondents in our sample (67%) agreed that they knew where to purchase native plants, a perception twice as frequent among adopters than nonadopters ($P < 0.01$).

Factors influencing the decision to purchase native plants. Stage 1 of the double-hurdle model, which assesses the factors influencing a consumer's decision to purchase native plants is shown in Table 3. Results show that younger homeowners are more likely to purchase native plants, relative to older homeowners ($P < 0.01$). Homeowners who are also the primary gardener or plant purchaser are more likely to choose native plants for their garden or yard ($P < 0.05$). Homeowners who consider themselves very or extremely knowledgeable about native plants are more likely to purchase native plants ($P < 0.1$). Adopters are more likely to be those spending more money in plants ($P < 0.01$), growing some of their own food ($P < 0.01$), and those who already have native plants ($P < 0.01$) or think natives are important to incorporate into gardens ($P < 0.01$).

Among native plant attributes, homeowners rating native plants as variable ($P < 0.1$) or compact ($P < 0.01$) are more likely to be adopters. Having native plants readily available in the area increases a homeowner's probability to be adopters ($P < 0.01$). Results from

Table 2. Comparison of descriptive statistics of demographics, gardening behavior, native plants appeal, perceptions, and purchasing variables of 1824 US homeowners participating in an online survey about native plants.

	Full sample		Purchased			Not purchased	
	n = 1824		n = 1086			n = 738	
Variable (mean value)	Mean	*SD*	Mean	*SD*		Mean	*SD*
Percent female	0.76	0.43	0.74	0.44	**	0.79	0.41
Age (years)	57.03	14.64	55.37	15.02	***	59.47	13.71
Percent living in urban or suburban areas	0.60	0.49	0.61	0.49	*	0.57	0.49
Percent achieving 4-year bachelor's degree, graduate school, or professional degree	0.48	0.50	0.51	0.50	***	0.44	0.50
Mean household size	3.31	1.64	3.34	1.57		3.28	1.75
Percent with household income >$100,000	0.25	0.43	0.26	0.44	**	0.22	0.42
Percent reporting they are the primary plant purchaser or gardener in the household	0.88	0.32	0.91	0.29	***	0.85	0.36
Percent reporting they are very or extremely knowledgeable about native plants	0.13	0.34	0.20	0.40	***	0.04	0.18
Dollars spent on all plants in 2021 (excluding soil amendments, fertilizers, pesticides, and landscape services)	220.34	217.20	268.78	235.86	***	149.05	162.03
Percent responding that incorporating native plants into gardens is very or extremely important	0.50	0.50	0.66	0.47	***	0.27	0.44
Percent growing some of their own food	0.61	0.49	0.66	0.47	***	0.54	0.50
Percent having native plants in landscape at time of completing survey	0.82	0.39	0.94	0.24	***	0.64	0.48
Rating for native plants being "variable vs. uniform"	3.52	1.06	3.58	1.09	***	3.43	1.01
Rating for native plants being "leggy vs. compact"	2.89	0.96	2.83	0.96	***	2.99	0.94
Rating for native plants being "aesthetically less pleasing vs. pleasing"	2.23	1.03	2.09	1.00	***	2.43	1.04
Rating for native plants being "not aligned with preferences vs. aligned with preferences"	2.14	1.01	1.96	0.99	***	2.40	0.99
Rating for native plants being "dull vs. colorful"	2.22	1.03	2.13	1.01	***	2.36	1.05
Rating for native plants being "plain vs. showy"	2.72	1.06	2.65	1.05	***	2.82	1.06
Percent of respondents agreeing that native plants are better for the environment compared with exotic plants	0.68	0.46	0.74	0.44	***	0.61	0.49
Percent agreeing that native plants are readily available in their area	0.67	0.47	0.78	0.42	***	0.52	0.50
Percent agreeing that native plants are better adapted to difficult sites	0.75	0.43	0.79	0.40	***	0.69	0.46
Percent agreeing that they are not interested in native plants	0.09	0.28	0.08	0.27		0.10	0.30
Percent agreeing that native plants are expensive	3.37	0.96	3.34	0.92		3.40	1.01
Percent agreeing that they know where to shop for native plants	0.67	0.47	0.81	0.40	***	0.47	0.50

*, **, *** Significant at $P < 0.1$, 0.05, 0.01, respectively.

interaction terms show that women homeowners who grow food are less likely to purchase native plants ($P < 0.01$) and rating native plants as leggy increases the probability of women to purchase native plants ($P < 0.05$).

Factors influencing the amount spent on native plants. Table 3 also shows the factors significantly influencing the annual dollar expenditures on native plants, among adopters, including demographic characteristics, gardening behavior, native plants attributes, interaction terms, and market-specific variables (two variables were added to the second stage only, including native plants are expensive and respondent knows where to shop for native plants). Increasing the age of homeowners reduces the amount spent on native plants ($P < 0.01$). In other words, younger homeowners seem to be the ones spending more on native plants.

Gardening behavior is significantly correlated with the amount of money spent annually on native plants. Adopters who self-identified as very or extremely knowledgeable of native plants tended to spend more money on native plants ($P < 0.01$), similar to those perceiving that native plants are important to incorporate into gardens ($P < 0.01$). Once homeowners purchase native plants, increasing the amount spent annually on all plants ($P < 0.01$) and having native plants in the landscape ($P < 0.01$) increases the amount spent on native plants. These results suggest that exposure to native plant benefits can increase the expenditure on native plants among adopters.

Adopters who perceive that native plants align with their preferences will spend more money on native plants ($P < 0.01$). Alternatively, Table 3 shows that perceiving that native plants are dull ($P < 0.1$) or too showy ($P < 0.1$) decreases the amount spent on native plants. These results are interesting because they suggest that adopters will spend more money on natives as long as they are colorful (not dull) and plain (not showy), which may seem counterintuitive. This result may suggest that adopters are looking for native plants that are not too dull or too showy, as these two attributes may be perceived as too extreme for their landscape. An alternative explanation may be that adopters have different expectations about the attributes colorful and showy in natives than what we intended to ask; thus, our survey questions might have been misinterpreted by some respondents.

Adopters tend to spend more money on native plants if they find them readily available in their area ($P < 0.01$). Although adopters were characterized as having higher income and

Table 3. Double-hurdle results of the factors influencing 1) the purchasing of native plants, and 2) the amount spent on purchasing native plants among US homeowners.

	Stage 1			Stage 2		
	Decision to purchase natives			Decision on amount purchased of natives		
Variable	Coefficient	*SE*		Coefficient	*SE*	
Percent female	−0.32	0.29		12.12	36.74	
Age (in years)	−0.01	0.01	***	−1.59	0.43	***
Live in urban or suburban area	0.06	0.07		3.80	9.73	
Attained 4-year bachelor's degree, graduate school, or professional degree	−0.06	0.07		−9.36	9.76	
Number of individuals in household including children	−0.01	0.02		2.18	2.98	
Household income >$100,000	−0.11	0.09		−0.30	11.34	
Primary gardener or plant purchaser	0.25	0.10	**	24.44	15.94	
Self-reported knowledgeable about native plants	0.52	0.27	*	66.00	22.72	***
Dollars spent on plants in 2021	0.01	0.01	***	0.64	0.03	***
Belief that native plants are very or extremely important	0.64	0.07	***	84.04	17.88	***
Has native plants growing in landscape	1.01	0.10	***	125.83	32.98	***
Grows some of their own food	0.61	0.15	***	21.73	23.18	
Rating that native plants are uniform vs. variable	0.06	0.03	*	−2.32	4.42	
Rating for native plants are leggy vs. compact	−0.24	0.08	***	−5.35	10.09	
Rating for native plants are aesthetically not pleasing vs. pleasing	−0.06	0.04		−0.45	5.92	
Rating for native plants do not align with preferences vs. does align	−0.03	0.04		−14.74	5.54	***
Rating for native plants being dull vs. colorful	0.01	0.04		−10.17	5.69	*
Rating for native plants being plain vs. showy	−0.01	0.04		9.07	5.31	*
Level of agreement that native plants are better for the environment compared with exotic plants	0.01	0.08		−4.95	10.74	
Level of agreement that native plants are readily available in their area	0.33	0.08	***	37.51	13.95	***
Level of agreement that native plants are better adapted to difficult sites	0.01	0.08		−0.46	11.66	
Level of agreement that they are not interested in native plants	−0.02	0.13		5.72	16.85	
Interaction term between female and knowledge of native plants	−0.20	0.31		−38.65	26.51	
Interaction term between female and grows their own food	−0.57	0.17	***	−27.57	24.94	
Interaction term between female and rating for leggy vs. compact	0.19	0.09	**	−9.70	11.18	
Level of agreement that native plants are expensive	—	—		−9.18	4.33	**
Level of agreement that they know where to buy native plants	—	—		−1.26	10.36	
Constant	−0.38	0.38		−114.98	76.17	
Number of observations		1824		1085		
Probability>χ^2		0.00				
lambda		164.57	***			

SE = standard errors from the first and second stages from the double-hurdle model.
*, **, *** Significant at $P < 0.1$, 0.05, 0.01, respectively.

spending more on all plants, results on Table 2 suggest that adopters are price sensitive, and perceiving that natives are expensive decreases the amount of native plant expenditures ($P < 0.05$).

Conclusions and discussion

Consumer perceptions of native plants are fundamental to creating more effective marketing strategies and increasing sales. In the present study, we found younger homeowners in metropolitan areas are more likely to be native plant adopters, which is consistent with Yue et al. (2012). If leveraging this finding, incentives and policies tailoring adoption of native plants would facilitate the establishment of "wildlife corridors" in urban areas suggested by Rudd et al. (2002). This is especially true as adopters in our study spend 80% more on plants than nonadopters, making them more viable targets for marketing because they appear to allocate a sizable portion of their budget on plant expenditures.

This study sheds light on the main characteristics of adopters (i.e., purchasers of native plants) and the factors motivating the purchase and amount purchased of native plants. The fact that adopters report they are more knowledgeable about native plants may lessen the need for educating them on what native plants are rather than emphasizing the environmental benefits of native plants. Another contribution of this study is the use of a double-hurdle model that explains a homeowner's demand through a simultaneous two-step process (i.e., adoption and amount of adoption), which accurately depicts the consumer's purchasing behavior. The double-hurdle model is an econometrically efficient way of decoupling these two steps, while correcting for selection bias, even in the case of missing data. For example, the double-hurdle model allowed us to understand that making native plants readily available not only increases the purchase of natives, but also the amount spent on native plants.

Our findings suggest that marketing efforts should emphasize benefits conveying that native plants are better for the environment compared with exotic plants, and native plants

Table 4. Marketing messages that highlight environmentally friendly attributes of native plants based on findings from a study of 1824 US homeowners participating in an online survey about native plants.

Environmentally friendly attribute	Marketing message
Pollinator-friendly attributes	Bee-come a Hero for Pollinators! Our Native Plants are the superheroes of your garden, providing a feast for bees and butterflies.
	Join the movement for a greener, pollinator-friendly world. Plant native, save pollinators!
	Blossom with Purpose: Our Native Plants are Pollinator Paradise. Invite pollinators to dance amidst the blooms, creating a harmonious haven for bees and butterflies.
Climatization attributes	Instant Green Magic! Experience the swift transformation of your space with our quick-establishing native plants. Elevate your garden in no time and enjoy the beauty of nature at its fastest!
	Why wait for beauty? Our native plants are quick to establish, turning your garden into a haven of colors and life in the blink of an eye.
	Express Yourself with Greenery! Our native plants are the shortcut to a lush, vibrant garden. Enjoy the thrill of instant establishment and let your space bloom with the beauty of nature on the fast track.
Low-input attributes	Smart Garden, Happy Planet! Introducing our native plants – the superheroes of low-water landscaping. Conserve water without compromising on a lush, vibrant garden.
	Green with Less: Our Native Plants, the Water-Efficient Choice! Save water, sow beauty.
	Choose native plants for a garden that thrives on minimal maintenance, making sustainability a breeze.
	Fuss-Free Flourish: Choose Native Plants for Minimal Fertilizer Needs! Elevate your garden effortlessly with our low-maintenance natives.

are better adapted to difficult sites. Table 4 offers examples of marketing messages that can be used by retailers of native plants to appeal to environmentally conscious consumers. This result arises from the finding that native plant adopters shared these perceptions more that nonadopters. These results fit well with metropolitan dwellers who may have a need for plants in less-than-ideal sites. Emphasizing native plant benefits may lead to subsequent native plant purchases. This is due to the finding that after a homeowner purchases a native plant, they are more likely to spend more on all plants and on native plants.

A potential study limitation may be the fact that a web-based survey can carry biases, but they are generally accepted research protocols for investigating consumer behavior, while reducing study costs and ensuring data collection speed. Our sample size and sample representativeness helped us address potential biases. Future research should investigate how marketing strategies impact the purchase of native plants, as well as the return on investment of such marketing efforts.

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