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Consumer Attitudes and Consumption Patterns for Pecans and Other Tree Nuts: Beyond a Simple Shell Game

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Abstract

This study provides insights into consumer beliefs, awareness, attitudes, and purchasing behavior regarding tree nuts in general and pecans specifically. Findings from a probit regression suggest factors associated with the decision to purchase pecans were age, region, sources of information about tree nuts, and outlets where tree nuts are purchased. Respondents aged 45 and over were more likely to purchase pecans than younger respondents. Conventional media (radio, television, magazines), past experience, and recipes significantly impact the decision to purchase pecans. Tree nut purchases from grocery stores, supercenters, roadside stands, or farmers' markets were positively related to pecan purchases.

Keywords: consumer survey, tree nuts, pecans, probit regression

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Introduction

Federal Marketing Agreement and Order (FMO) No. 986 (7 CFR part 986) established the American Pecan Council (APC) in August 2016 to represent growers and shellers from 15 states, namely Alabama, Arkansas, Arizona, California, Florida, Georgia, Kansas, Louisiana, Missouri, Mississippi, North Carolina, New Mexico, Oklahoma, South Carolina, and Texas (Pecans Grown in the States of Alabama, et al.; Order Regulating Handling, 2016). The FMO authorizes the APC to collect data, conduct research and promotion activities, and regulate the grade, size, quality, pack, and containers for pecans. Under the Order, the U.S. pecan industry is developing a coordinated program designed to strengthen its position in the marketplace. U.S. tree nut stakeholders, particularly those involved with almonds, hazelnuts, pistachios, walnuts, and pecans, have capitalized on nutritional aspects by incorporating health messages about their products in promotional campaigns (Lillywhite, Simonsen, and Heerema, 2014). As such, the growth in the domestic demand for pecans, as well almonds, walnuts, and pistachios, has been buoyed in part by their promotion as nutritious and healthy snacks by marketing boards and trade associations.

The health benefits of nut products have been widely documented. Evidence exists to substantiate the claim that nut consumption reduces the incidence of coronary heart disease, gallstones, diabetes, hypertension, cancer, and inflammation (Fraser et al., 1992; Blomhoff et al., 2006; Kris-Etherton et al., 2008; Ros, 2010) and decreases body mass index (BMI) (King et al., 2008; Mattes, Kris-Etherton, and Foster, 2008). In the latest *Dietary Guidelines for Americans 2020-2025*, nuts are included in the spectrum of nutrient-dense foods and proteins (U.S. Department of Agriculture and U.S. Department of Health and Human Services, 2020), further highlighting their importance in improving the health and nutrition status of consumers. Participants in the Special Supplemental Nutrition Program for Women, Infants, and Children in North Carolina consumed nuts because they were thought to be healthy (Pawlak, Colby, and Herring, 2009).

Out of domestically produced tree nuts, the dominant tree nuts in terms of per capita consumption are almonds, pecans, walnuts, and pistachios. Based on the most recent data (2020/21 season) from the United States Department of Agriculture Economic Research Service (USDA-ERS), per capita consumption of almonds, pecans, walnuts, and pistachios were 2.46 pounds, 0.58 pounds, 0.54 pounds, and 0.60 pounds, respectively. In the 2020/21 season, the total crop value of these tree nuts was as follows: almonds, $5.6 billion; pecans, $435.3 million; walnuts, $957.7 million; and pistachios, $2.87 billion (USDA-ERS, 2022). These figures are indicative of the magnitude of the contribution of nut products to the U.S. agricultural economy. The United States is also the second-largest producer of tree nuts worldwide (Asci and Devadoss, 2021).

However, there is relatively limited research regarding the factors affecting consumption/purchase of tree nuts in the United States. Florkowski and Park (2001) analyzed the variety and uses for nut products, perceived consumer quality attributes, ease of purchase, and familiarity with marketing outlets as factors influencing pecan purchases. By estimating a generalized Heckman model of consumer purchasing decisions, marketing strategies to enhance sales of raw, unprocessed pecans were examined. A key finding of their work was that promotion programs could help stabilize and maintain the demand for pecans.

Gold, Cernusca, and Godsey (2004) conducted a study to gauge consumer familiarity with Chinese chestnuts, eastern black walnuts, and northern pecans to determine interest in buying, consuming, and preparing these nuts and the key attributes that influence purchasing decisions. The attributes included quality, price, locally grown, ease of preparation, taste, and nutrition-diet-health. Data were collected based on a survey questionnaire administered during the 2003 Missouri Chestnut Roast festival. Out of 900 attendees, 232 questionnaires were collected and analyzed. Demographic characteristics included gender, age, education level, and occupation. Quality, locally grown, and nutrition-diet-health were consistently perceived as the most important attributes influencing chestnut purchasing decisions. Three-year findings (2003, 2004, 2006) confirmed that consumers who participated in the Missouri Chestnut Roast festival value ranked product quality, local production, and nutritional value over price as a priority attribute.

Lillywhite, Simonsen, and Heerema (2014) used a web-based panel survey of 1,009 U.S. individuals to explore the demographics of consumers who purchase pecans, gauge their tree nut nutrition knowledge, and examine the preferences surrounding their purchases. Almost three-quarters (74%) of survey respondents consumed pecans; demographic differences were observed among respondents who consumed pecans and those who did not. Demographic factors included in the survey instrument were annual household income, region, gender, marital status, and race/ethnicity. Respondents' knowledge of general and tree nut nutrition concepts varied. Respondents most frequently purchased pecans from a grocery store, bought them shelled as a raw ingredient for baking/cooking, and consumed pecans four to six times per year. Results suggest pecan consumers were more likely to be 55 years of age or older. A higher proportion of African Americans and Hispanics consumed pecans than those who do not. Pecans also were more widely consumed in the southern United States than in other regions of the United States. This finding is logical given the prevalence of pecan production in southern U.S. states.

Most respondents in this investigation purchased pecans in grocery stores. The results of this study differed from those of previous research, which found that farmers' markets and other direct from-producer outlets were used with greater frequency by consumers (Lombardini, Waliczek, and Zajicek, 2008). Further, pecans were purchased predominantly as a baking ingredient. Previous research suggested that consumers often purchased pecans during the holiday season (Lombardini, Waliczek, and Zajicek, 2008).

Cheng, Capps, and Dharmasena (2021) analyzed the factors affecting 61,380 U.S. households' propensity to purchase tree nuts, specifically, pecans, almonds, cashews, walnuts, macadamia nuts, and pistachios. The source of data for their analysis was the Nielsen Homescan Panel for the calendar year 2015. Households located in different regions, households from different races and ethnicities, and seasonality were important factors affecting quantities of tree nuts purchased. Probit models were estimated to determine the factors affecting the decision to purchase or not to purchase various tree nuts. Older households, well-educated households, wealthier households, and households without children were most likely to purchase tree nuts. The propensity to purchase tree nut products was different across regions, race, and ethnicity. For the most part, the propensity to purchase tree nuts was higher in the fourth quarter of the year.

Objectives

The specific objectives of this study are threefold: (i) to provide insights on consumer beliefs, awareness, attitudes, and purchasing behavior regarding tree nuts in general and pecans specifically via an online nationally representative survey; (ii) to determine the impacts of sociodemographic factors, sources of information about tree nuts, and outlets where tree nuts are purchased on the decision to purchase pecans; and (iii) to develop the profile of households to assist stakeholders in strategically positioning pecans in the nuts market. In this way, we provide a micro-perspective viewpoint as to how sociodemographic factors and other factors influence purchasing decisions of pecans. Exploring a detailed household-level analysis for these products is worthwhile to the APC as well as other purveyors in the tree nuts industry.

Similar to the work of Lillywhite, Simonsen, and Heerema (2014), to support APC marketing and promotion activities, we constructed and administered a nationally representative online consumer survey to a panel of U.S. residents. Using SurveyMonkey,[1] a well-known online survey software application, information concerning beliefs, awareness, attitudes, and purchasing behavior about tree nuts in general and pecans, in particular, was obtained. The protocol of SurveyMonkey required all participants to be at least 18 years of age. In this study, panelists were recruited until at least 1,200 responses were obtained. This number was chosen to satisfy statistical criteria, namely a margin of error of plus or minus 3% and a confidence level of 95%,[2] as well as to conform to budgetary restrictions. The number of survey responses collected was 1,308.

The survey responses provide *qualitative* feedback relevant to APC marketing and promotion activities. They also are a unique and recent source of data for analysis and serve as a baseline going forward concerning awareness, attitudes, and purchasing behavior of consumers regarding pecans.

The questions included in the survey are exhibited in the Appendix. The survey begins with questions related to tree nuts in general and then proceeds with questions related specifically to pecans. Survey questions dealing with tree nuts include: (i) which tree nuts (e.g., almonds, walnuts, pecans, pistachios, macadamia nuts) were purchased in the past year; (ii) reasons why tree nuts were not purchased in the past year; (iii) favorite, second favorite, and third favorite tree nuts; (iv) main sources of information about tree nuts; (v) recall of seeing or hearing any advertising for any type of tree nuts; (vi) frequency of purchasing tree nuts; (vii) form of purchase of tree nuts (in the shell; raw, shelled; roasted, salted; roasted, unsalted; candied; and flavored); (viii) type of packaging of tree nuts (bulk, bag, can, and snack-size); and (ix) where tree nuts were purchased.

The list of survey questions dealing specifically with pecans include: (i) frequency of purchase of pecans; (ii) reasons why pecans were not purchased in the past year (if applicable); (iii) form of purchase of pecans (in the shell; raw, shelled; roasted, salted; roasted, unsalted; candied; and flavored); (iv) type of tree nut packaging (bulk, bag, can, and snack-size); (v) where pecans were

[1] SurveyMonkey (https://surveymonkey.com) recruits panelists for various projects every month. The panels are representative of a diverse population that voluntarily joined to participate in surveys.
[2] https://www.surveymonkey.com/mp/sample-size-calculator/

purchased; (vi) which tree nuts would serve as substitutes for pecans; (vii) what comes to mind when thinking about pecans; (viii) recall of seeing or hearing any advertising for pecans; (ix) recall of seeing or hearing any messages that encourage the purchase of pecans; and (x) what specifically would increase the likelihood of purchasing pecans.

Additionally, we capture demographics of tree nut consumers, including gender, race (white, black, Asian, and other), ethnicity (Hispanic or non-Hispanic), education level, income level, household size, number of children in the household, age, and state/region. This information will allow the APC to target segments of the U.S. population in marketing and promoting pecans. We provide a formal statistical analysis of the national survey data via the use of a qualitative choice model, specifically the probit model.

Analysis of the Survey Data

As previously discussed, the number of survey responses initially collected via SurveyMonkey was 1,308 (see Figure 1). Owing to 131 incomplete responses, however, the number of useable responses for analysis was 1,177 (90% of the respondents). Out of the 1,177 respondents, 160 did not purchase tree nuts, leaving 1,017 respondents who purchased tree nuts. Consequently, the market penetration for tree nuts is slightly more than 86%. More succinctly, close to 9 out of 10 panelists purchase tree nuts. Of those 1,017 respondents who purchased tree nuts, 234 respondents did not purchase pecans. Hence, the market penetration for pecans is roughly 67% (783 respondents out of a possible 1,177 respondents). In other words, our sample reveals that 2 out of 3 panelists purchase pecans. This finding is in accord with the work of Lillywhite, Simonsen, and Heerema (2014), who reported that almost three-quarters of survey respondents consumed pecans on a regular basis.

To demonstrate the representativeness of our sample to the U.S. population, as exhibited in Table 1, we compared the sociodemographic characteristics of our sample with population statistics provided by the Current Population Survey (CPS) (U.S. Census Bureau, 2020) and by Statista (2020). The respective sociodemographic characteristics include: (i) gender; (ii) race; (iii) household size; (iv) age; (v) region; (vi) household income; (vii) ethnicity; (viii) education level; and (ix) presence/absence of children.

The SurveyMonkey sample matches very well with the distribution of households by household size, region, and household income. However, the sample from SurveyMonkey underestimates the percentage of males and overestimates the percentage of females in the U.S. population. The sample underestimates the percentage of black and Asian households and overestimates the percentage of white households and households of other races. The other category for race includes Native Americans as well as Latino/Mexican Americans and mixed races.

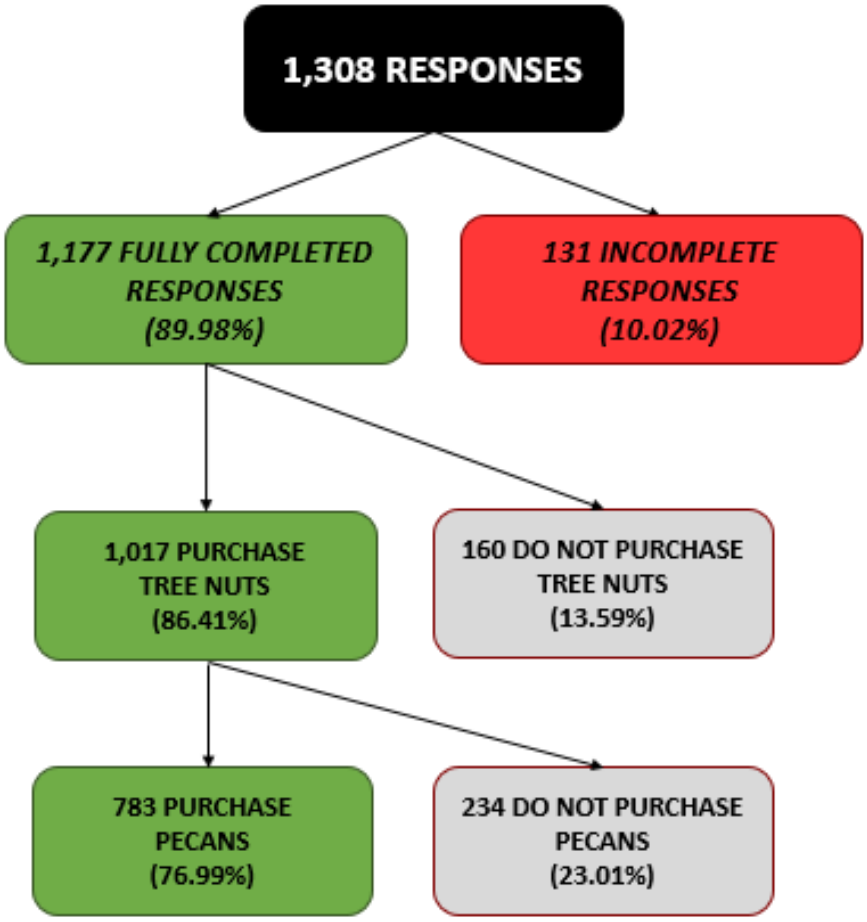


Figure 1. Schematic of Survey Responses

Further, the sample underestimates the distribution by age for the category 18–24 and overestimates the distribution by age for the 35–44 and the 65+ categories. Otherwise, the sample distribution by age for categories 25–34, 45–54, and 55–64 matches well the distribution of the age of the population. The percentage of Hispanic households (6.9%) was lower in our sample compared to the percentage of Hispanic households in the U.S. population (18.4%). Moreover, in our sample, the percentage of households whose heads received some college education or technical school training was 88.3%, compared to 61.1% of the U.S. population. Finally, the SurveyMonkey sample understates the distribution of U.S. households with children under age 18 (24.3% compared to 40.0%) and overstates the distribution of U.S. households without children under age 18 (75.7% compared to 60.0%).

Table 1. Representativeness of the SurveyMonkey Sample Data to the U.S. Population

Socio-Demographic Characteristic	2019/2020 Data[1] %	Survey Monkey Sample Data %
Male	49.3	44.2
Female	50.8	55.1
White	79.0	84.4
Black	13.5	6.0
Asian	6.0	3.7
Other	1.5	5.9
Household size—1	28.4	23.3
Household size—2	34.5	41.3
Household size—3	15.1	16.3
Household size—4	12.8	9.9
Household size—5	5.8	5.1
Household size—6	2.3	2.6
Household size—7 or more	1.2	1.5
18–24 years old	9.2	5.0
25–34 years old	14.0	13.3
35–44 years old	12.7	24.0
45–54 years old	12.5	13.9
55–64 years old	12.9	17.9
65+ years old	16.5	25.9
East north central region	14.3	15.6
East south central region	5.8	3.7
Mid-Atlantic region	12.5	14.4
Mountain region	7.6	8.7
New England region	4.5	6.1
Pacific region	16.3	18.7
South Atlantic region	20.0	17.8
West north central region	6.5	6.7
West south central region	12.4	8.3
Less than $25,000	17.1	13.3
Between $25,000 and $50,000	20.0	18.9
Between $50,000 and $75,000	16.5	17.9
Between $75,000 and $100,000	12.3	16.6
Between $100,000 and $150,000	15.5	14.9
Between $150,000 and $200,000	8.3	9.0
Greater than $200,000	10.3	9.4
Hispanic	18.4	6.9
Not Hispanic	81.6	93.1
Less than high school education	10.6	1.9
High school graduate	28.3	9.9

Table 1. (cont)

Socio-Demographic Characteristic	2019/2020 Data[1] %	Survey Monkey Sample Data %
Some college	23.6	20.2
College graduate	21.3	35.3
Post college	12.1	28.0
Technical school	4.1	4.8
Absence of children	60.0	75.7
Presence of children	40.0	24.3

[1]Source: U.S. Census Bureau (2020) and Statista (2020)

These sample characteristics are in accord with Lillywhite, Simonsen, and Heerema (2014), who found that survey respondents diverged from the general U.S. population in age, gender, and race. Consequently, inferences to the general population should be made with an awareness of the limitations of the survey methodology used. Bottom line, aside from differences in gender, race, ethnicity, education, and absence/presence of children, the sample from SurveyMonkey can be considered representative of the U.S. population.

In the next section, we summarize the 1,177 qualified respondents on a question-by-question basis. We initially focus on tree nuts in general and then center attention on pecans specifically.

Survey Responses Concerning Tree Nuts in General

Q: What tree nuts have you purchased in the past year? (Check all that apply.)

In the past year, the most frequently purchased tree nuts were almonds, cashews, pistachios, walnuts, and pecans, in that order. Roughly 68% of respondents purchased almonds in the past year, 62% purchased cashews, 49% purchased pistachios, 48% purchased walnuts, 48% purchased pecans, 19% purchased macadamia nuts, and 15% purchased hazelnuts (Figure 2). Candied nuts (12%) and Brazil nuts (12%) were among the various tree nuts purchased in the past year.

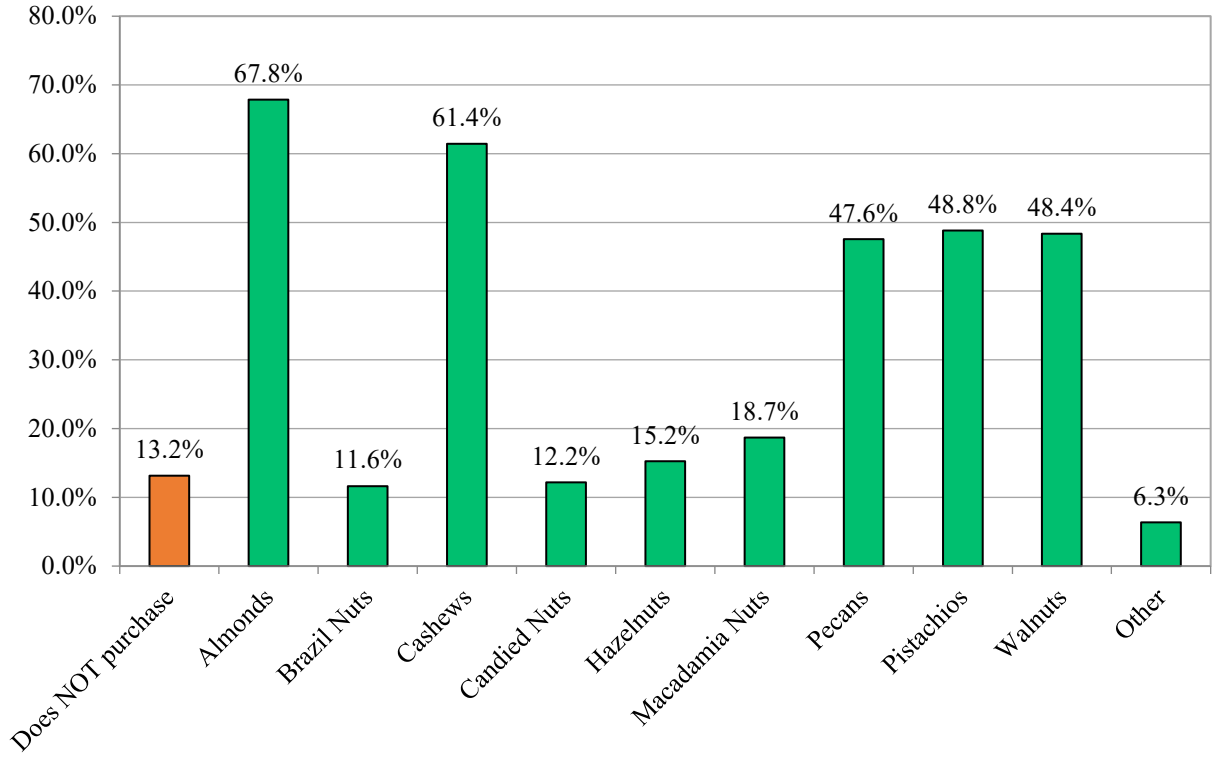
Q: If you did NOT purchase tree nuts in the past year, what is (are) your reason(s)? (Check all that apply.)

Of the 155 sample respondents who did not purchase tree nuts, 43% of them simply did not like tree nuts. Close to 14% had cost/budgetary restrictions, 10% were allergic to tree nuts, and slightly more than 8% had dietary restrictions (see Figure 3).

Q: What are your favorite tree nuts?

As depicted in Figure 4, roughly 32% of the respondents listed cashews as their favorite tree nut, followed by almonds (22%), pistachios (15%), pecans (12%), macadamia nuts (6%), and walnuts (6%). About 2% of respondents did not indicate a favorite tree nut. Second favorite tree nuts were cashews (21%), almonds (19%), pistachios (18%), pecans (14%), walnuts (10%), and macadamia nuts (8%). Third favorite tree nuts were pistachios (18%), almonds (18%), walnuts (16%), pecans

(15%), cashews (12%), and macadamia nuts (9%). Of importance to the American Pecan Council, pecans ranked fourth among total respondents listing them as their favorite, second favorite, or third favorite tree nut. Overall, the top tree nuts are cashews, almonds, pistachios, pecans, walnuts, and macadamia nuts, in that order.



Note: Other category responses include mixed nuts, peanuts, chestnuts, pine nuts, pumpkin seeds, sunflower seeds, Japanese nuts, etc.

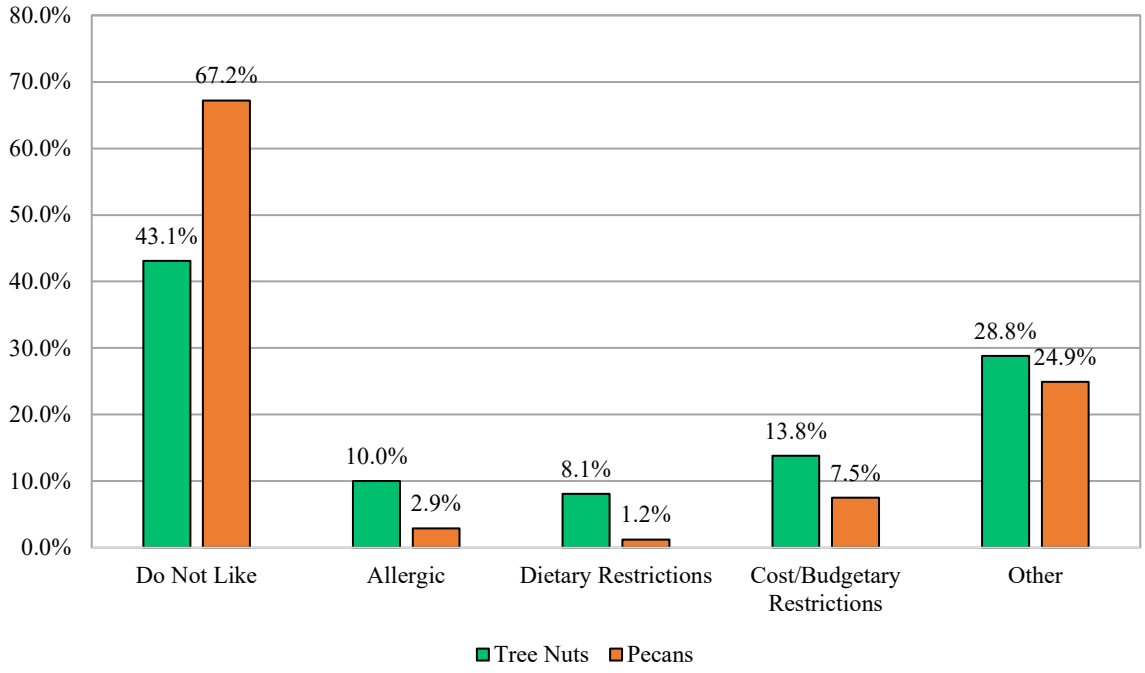
Figure 2. Tree Nuts Purchased in the Past Year

Q: What is (are) your main source(s) of information about tree nuts? (Check all that apply.)

By far, the main source of information about tree nuts is past experience (61%), followed by package labels (38%), recipes (32%), and friends and family (25%). Magazines (11%), television (10%), and radio (3%) are additional sources of information about tree nuts (see Table 2). However, Facebook (4%) and Twitter (0.5%) are not primary sources of information about tree nuts. The other category (10.3%) included open responses indicating Pinterest, Google, Yahoo, YouTube, and medical and nutritional websites as principal sources of information about tree nuts.

Q: Within the past year, do you recall seeing or hearing any advertising for any type of tree nut?

Nearly 50% of those surveyed recall seeing or hearing advertising for some type of tree nut (Figure 5). Close to 30% did not hear any advertising for any tree nuts, and slightly over 20% do not recall seeing or hearing any advertising for any tree nuts.



Note: Other category responses include not the main shopper, painful to eat nuts, no interest, no reason/need, prefer other tree nuts, prefer to purchase in pies, etc.

Figure 3. Reasons Behind NOT Purchasing Tree Nuts and Pecans

Table 2. Main Sources of Information Regarding Tree Nuts and Pecans

Source	Percentage Tree Nuts	Percentage Pecans
Facebook	4.1%	1.7%
Twitter	0.5%	0.7%
Television	10.6%	9.9%
Radio	2.7%	1.5%
Magazines	11.1%	7.3%
Friends and family	25.0%	10.7%
Recipes	32.1%	22.0%
Past experience	60.8%	N/A
Package labels	37.4%	N/A
Billboards	N/A	0.9%
I do not recall.	N/A	63.8%

Note: Other category responses include Pinterest, Google, Yahoo, YouTube, and medical and nutritional websites.

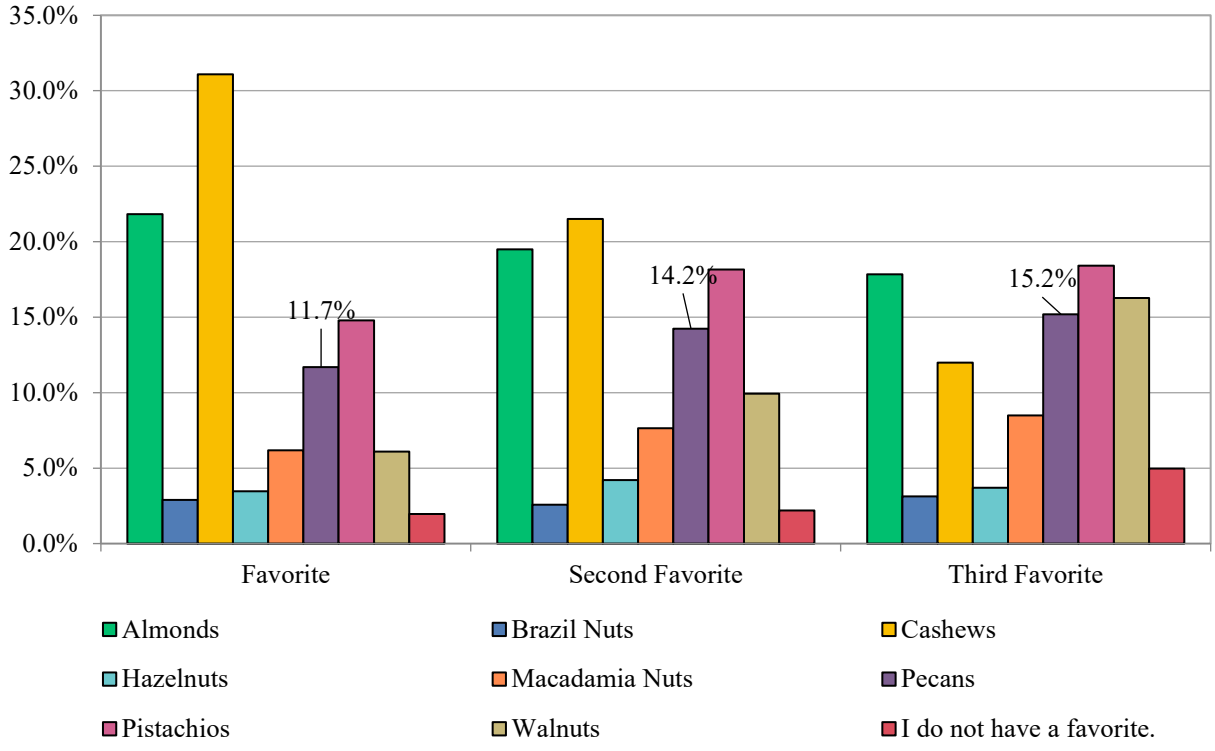


Figure 4. Top Three Favorite Tree Nuts

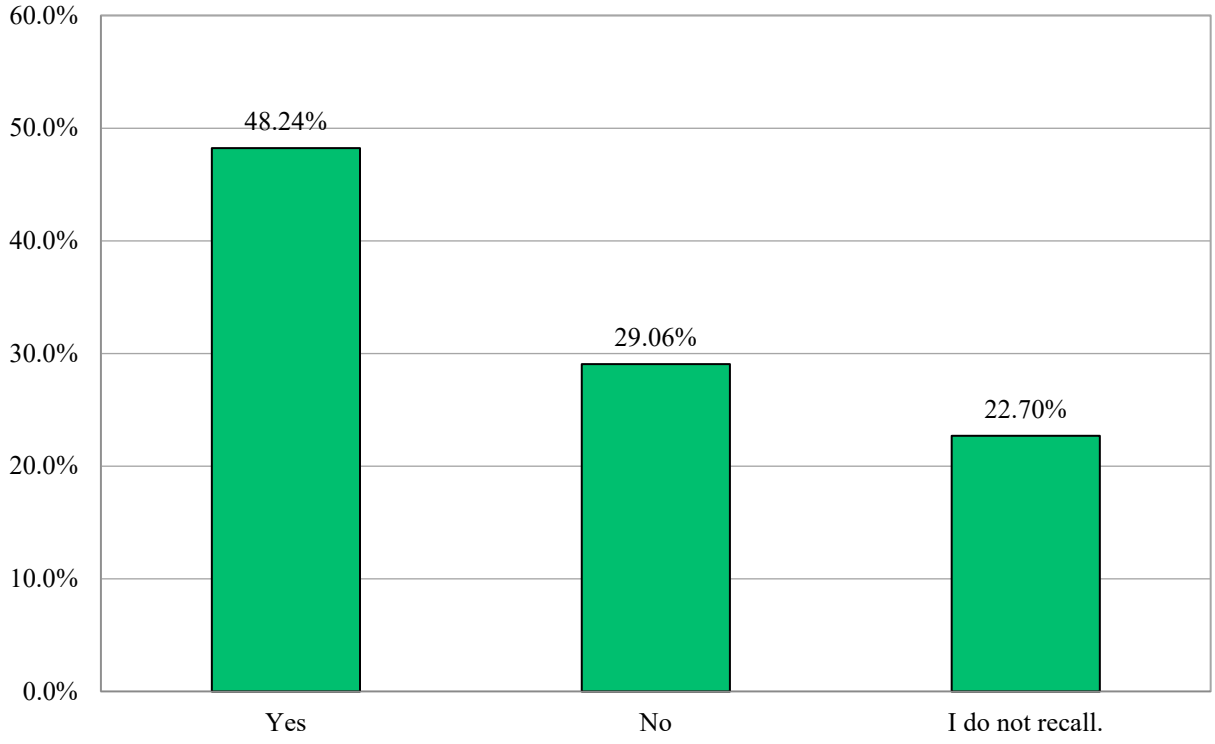


Figure 5. Recollection of Tree Nut Advertising

Q: How often do you purchase tree nuts?

Close to 60% of respondents purchase tree nuts monthly (see Figure 6). Slightly less than 25% purchase tree nuts annually, while slightly more than 10% purchase tree nuts on a weekly basis. About 8% of the respondents purchase tree nuts only during holidays.

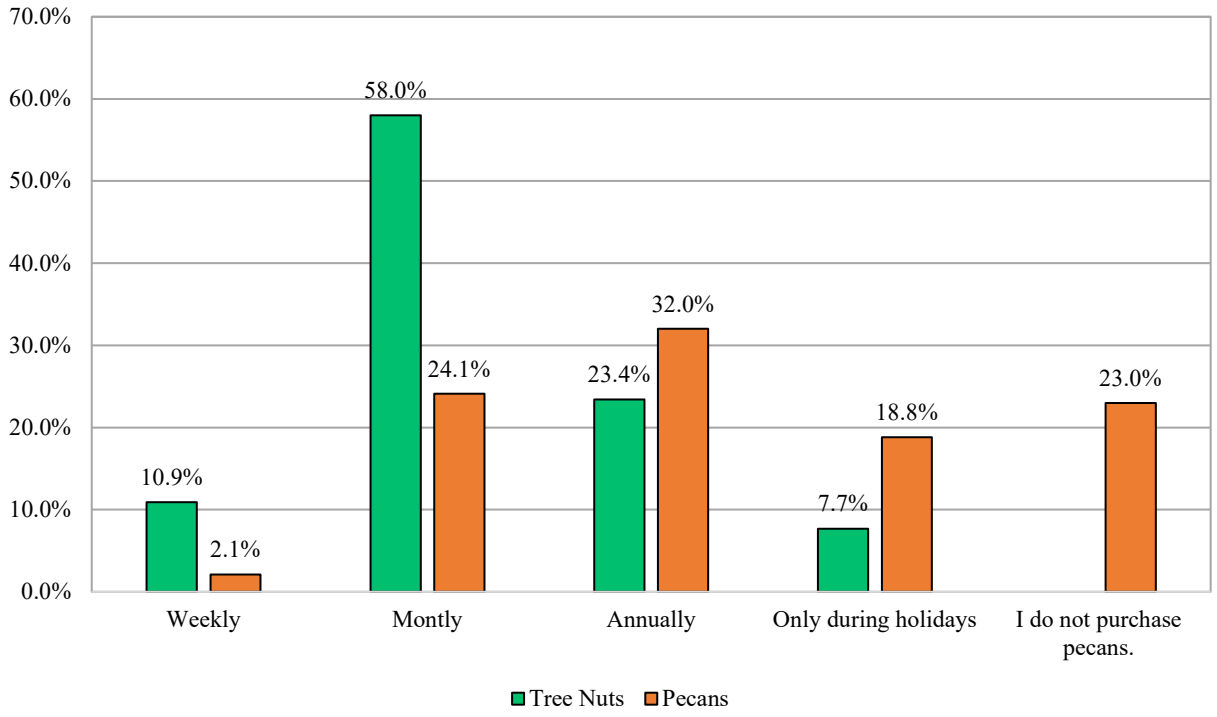


Figure 6. Frequency of Tree Nuts Purchases and Pecan Purchases

Q: In what form do you purchase tree nuts?

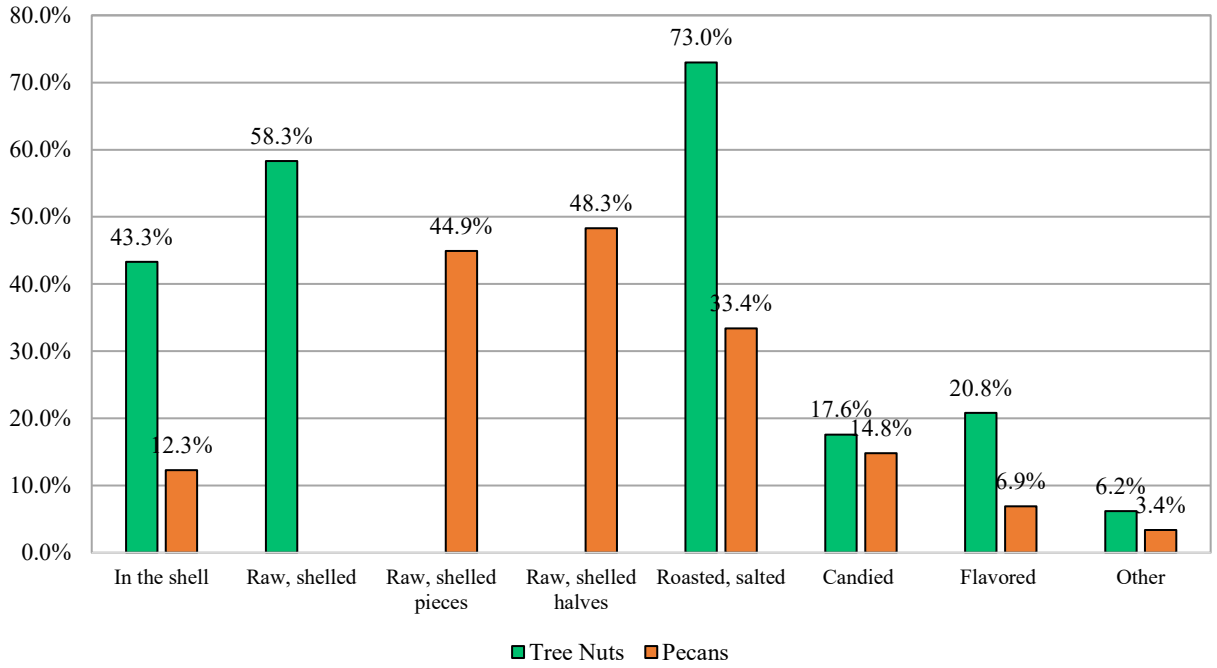
The most common forms of purchases of tree nuts are roasted, salted (73%), followed by raw, shelled (58%), and in the shell (43%) (see Figure 7). Flavored (21%) and candied (18%) forms of purchases also were evident.

Q: In what type of packaging do you purchase tree nuts? (Check all that apply.)

The most predominant type of packaging for purchases of tree nuts is bags (83%) (Figure 8). The next most common type of packaging is cans (48%), followed by snack-size (29%) and in bulk (24%).

Q: Where do you purchase tree nuts? (Check all that apply.)

Roughly 5 out of 6 respondents purchase tree nuts at grocery stores, and nearly 3 of 5 respondents purchase tree nuts at supercenters, such as Walmart, Sam's Club, or Target (Table 3). Additional purchasing locations are convenience stores (18%), farmers' markets (12%), specialty stores (11%), Amazon (9%), roadside stands (6%), other online sources (4%), and mall kiosks (1%). Costco and pharmacies also are notable places for purchasing tree nuts.



Note: Other category responses include nut spread; nut milk; roasted, unsalted; honey roasted; chopped; pecan pie; roasted and unsalted; mixed nuts, etc.

Figure 7. Form of Tree Nuts Purchases and Pecan Purchases

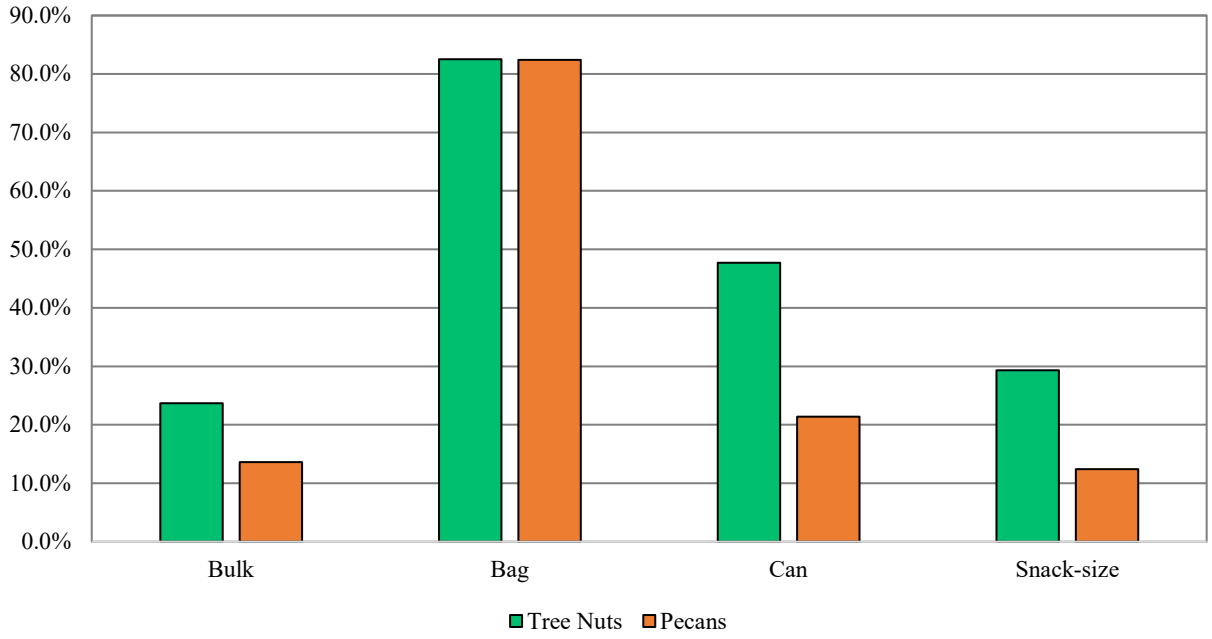


Figure 8. Packaging Type of Purchased Tree Nuts and Pecans

Survey Responses Concerning Pecans Specifically

Q: How often do you purchase pecans?

About 23% of respondents who purchase tree nuts do not purchase pecans. The most common frequency of pecan purchases is annually (Figure 6). The second most common purchase frequency is monthly. A notable number of respondents also purchase pecans during the holidays, particularly Thanksgiving and Christmas, for baking and candies. Relatively few respondents purchase pecans on a weekly basis. The frequency of pecan purchase differs considerably from the frequency of tree nut purchases in general.

Q: If you did NOT purchase pecans in the past year, what is (are) your reason(s)? (Check all that apply.)

The primary reason for not purchasing pecans given by non-purchasers is that 67% of these respondents simply do not like pecans (Figure 3). Cost/budgetary restrictions are a secondary reason for not purchasing pecans, as are dietary restrictions and pecan allergies. Other category responses primarily were no need; prefer other tree nuts; and prefer to purchase in pies.

Q: In what form do you purchase pecans? (Check all that apply.)

As exhibited in Figure 7, the most common form of pecan purchases is raw, shelled halves (48%) and raw, shelled pieces (45%), followed by roasted, salted (34%), candied (15%), in the shell (12%), and flavored (7%). The form of pecan purchases differs markedly from the form of tree nut purchases in general. Other category responses include chopped; pecan pie; roasted and unsalted, mixed nuts, etc.

Q: In what type of packaging do you purchase pecans? (Check all that apply.)

The most predominant type of packaging for pecan purchases is bags (82%) (Figure 8), followed by cans, (21%), in bulk (14%), and snack-size (12%). Opportunities may exist for stakeholders in the pecan industry to pursue packaging in cans or for snack sizes.

Q: Where do you purchase pecans? (Check all that apply.)

Roughly 4 of 5 respondents purchase pecans at grocery stores, and nearly half of the respondents purchase pecans at supercenters, such as Walmart, Sam's Club, or Target (Table 3). This finding is very similar to other places to purchase other tree nuts. Additional places to purchase pecans are specialty stores (8%), farmers' markets (8%), convenience stores (7%), roadside stands (4%), Amazon (4%), other online sources (3%), and mall kiosks (2%). Additionally, pecans are also purchased at Costco and pharmacies such as CVS and Walgreen's.

Table 3. Where Tree Nuts and Pecans Are Purchased

Location Description	Percentage Tree Nuts	Percentage Pecans
Grocery stores (e.g., HEB, Kroger, Whole Foods)	83.1	77.8
Supercenters (e.g., Walmart, Sam's Club, Target)	55.8	48.0
Roadside stands	5.8	4.3
Farmers' markets	11.6	7.5
Convenience stores	17.4	7.3
Specialty stores	10.4	7.8
Mall kiosks	1.3	1.8
Amazon	8.7	4.1
Other online sources	4.1	2.9
Other (Costco, Trader Joe's, CVS, Walgreens, family/friends)	6.6	5.6

Q: If pecans were not available for their intended use, which of the following would serve as a substitute for that purpose? (Check all that apply.)

Walnuts, by far, are the most popular substitute for pecans, according to survey respondents (Figure 9). About 55% of respondents revealed that walnuts would serve as a substitute for pecans. Interestingly, almonds came in second as a substitute for pecans, with 26% of respondents selecting almonds. Other notable potential substitutes for pecans are cashews (20%) and pistachios (12%). Macadamia nuts (7%), hazelnuts (7%), and Brazil nuts (4%) also are potential substitutes for pecans. Of particular importance is the finding that nearly 20% would not purchase a substitute if pecans were not available for their intended use.

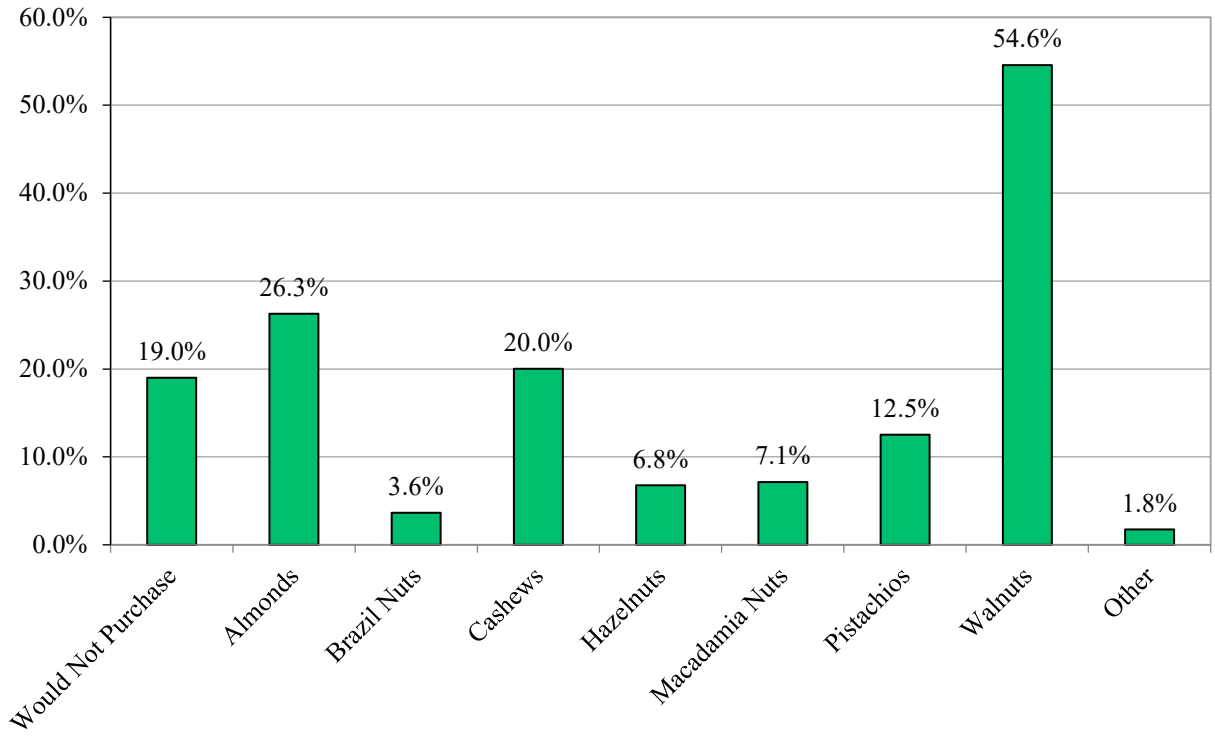


Figure 9. Substitutes for Pecans

Q: What comes to mind when you think about pecans? (Check all that apply.)

A number of things come to consumers' minds when thinking about pecans, including ingredient for cooking or pies (56%), delicious desserts (35%), and family/holiday gatherings (31%) (Table 4). Additional perceptions of pecans are wholesome (26%), heart-healthy (25%), and expensive (22%), followed by packed with multiple health-promoting nutrients (18%), heart-smart food (16%), nutrition powerhouse (14%), high caloric content (10%), and homegrown (9%). For close to 11% of respondents, pecan perceptions include family memories, Texas, snack, delicious/tasty, pecan pies, southern states, and squirrels. About 2% to 3% of survey respondents mentioned that pecans are America's only major native tree nut, the original supernut, and contribute to a decreased risk of mortality. For about 1 in 6 respondents, nothing comes to mind when thinking about pecans.

Table 4. What Comes to Mind When the Respondents Think about Pecans

Description	Percentage
Nothing comes to mind	15.9
Wholesome	25.7
Homegrown	9.4
Heart-healthy	24.6
High caloric content	9.9
Packed with multiple health-promoting nutrients	17.7
Nutrition powerhouse	14.2
The original super nut	1.9
Heart-smart food	16.4
Expensive	22.3
Linked to a decreased risk of mortality	2.2
America's only major native tree nut	2.8
Ingredient for cooking or pies	56.2
Family/holiday gatherings	30.6
Delicious desserts	34.5
Other (family memories, Texas, snack, delicious/tasty, squirrels)	10.8

Q: Where specifically do you recall seeing or hearing messages that would encourage you to purchase pecans? (Check all that apply.)

Slightly more than 60% of respondents do not recall seeing or hearing messages that would encourage them to purchase pecans (Table 2). The predominant source of messaging comes from recipes (22%). Additional sources of messaging include friends and family (11%), television (10%), and magazines/newspapers (7%). Respondents do not recall seeing or hearing messages that would encourage them to purchase pecans on social media such as Facebook and Twitter.

Q: What specifically would make you more likely to purchase more pecans? (Check all that apply.)

Slightly more than 40% of respondents revealed that lowering the price would make them more likely to purchase more pecans (Table 5). Roughly 28% placed emphasis on health and nutrition considerations that would make them more likely to purchase more pecans. Additional suggestions to improve the likelihood of purchasing more pecans include: (i) recipes featuring pecans (25%); (ii) promotional specials (coupons, etc.) (18%); (iii) more variety in available pecans (roasted, salted, spiced, candied, etc.) (14%); (iv) more information in general about pecans (11%); (v) wider availability (9%); and (vi) advertising and promoting pecans (8%). Roughly 20% of respondents did not know what would make them more likely to purchase more pecans. Moreover, close to 8% of those surveyed said nothing would make them more likely to purchase more pecans.

Table 5. What Would Make Respondents More Likely to Purchase Pecans?

Description	Percentage
Health and nutrition considerations	27.9
Wider availability	9.0
More variety in available pecans (roasted, salted, spiced, candied, etc.)	13.8
More information in general about pecans	10.9
Lower price	43.3
Promotional specials (coupons, etc.)	18.2
Advertising and promotion about pecans	8.2
Recipes featuring pecans	24.5
I do not know	20.3
Other (predominantly nothing)	7.8

Econometric Analysis of the Decision by Consumers to Purchase Pecans

To delve deeper into the decision by consumers of whether or not to purchase pecans, an econometric analysis was conducted using a probit regression model based on the survey results. The use of probit models is commonplace in economic analyses of the food industry (Byrne, Capps, and Saha, 1996; Alviola and Capps, 2010; Capps, Ahad, and Murano, 2017). The probit regression model in this analysis is a binary choice model, where the dependent variable takes on two values—zero for non-purchases of pecans and 1 for purchases of pecans by reference person *i*. The reference person in the household is the household head who completed the survey.

The use of the probit/logit analysis, particularly of binary choices, is well established in the economic literature (Maddala, 1983; McFadden, 1984; Pindyck and Rubinfeld, 1998). Capps and Kramer (1985) demonstrated that the probit and logit models yield similar results in binary choice models. Additionally, since the logistic density function closely resembles the *t*-distribution with seven degrees of freedom (Hanushek and Jackson, 1977), the logit and probit formulations are quite similar. The only difference is that the logistic density has a slightly heavier tail than the standard normal density.

Mathematically, the probit model takes the following form:

$$y_i = \boldsymbol{x}_i'\boldsymbol{\beta} + e_i$$

$$y_i = 1 \quad \text{if purchases of pecans were made by reference person } i$$

$$y_i = 0 \quad \text{if no purchases of pecans were made by reference person } i \qquad (1)$$

and

$$\Pr(\, y_i = 1 \,|\, \boldsymbol{x}_i') = \Phi(\boldsymbol{x}_i'\boldsymbol{\beta}) \,, \qquad (2)$$

where Φ is the cumulative distribution function (CDF) of the standard normal distribution; $\boldsymbol{x}_i'$ is a column vector of explanatory variables; $\boldsymbol{\beta}$ is a vector of parameters associated with the explanatory variables; and e_i is the random error. Operationally, the decision to purchase pecans is denoted by Purchase_Pecans and is defined in equation (3) as:

$$\text{Purchase\_Pecans}_i=\beta_0+\beta_1*\text{Household\_Size}_i+\beta_2*\text{Number\_Children}_i+\beta_3*\text{Male}_i+\beta_4*\text{Black}_i \quad (3)$$

$$+\beta_5*\text{Asian}_i+\beta_6*\text{White}_i+\beta_7*\text{Hispanic}_i+\beta_8*\text{College}_i+\beta_9*\text{Age\_25to34}_i+\beta_{10}*\text{Age\_35to44}_i$$

$$+\beta_{11}*\text{Age\_45to54}_i+\beta_{12}*\text{Age\_55to64}_i+\beta_{13}*\text{Age\_65Plus}_i+\beta_{14}*\text{Hincome}_i+\beta_{15}*\text{New England}_i+$$

$$\beta_{16}*\text{Mid\_Atlantic}_i+\beta_{17}*\text{East\_North\_Central}_i+\beta_{18}*\text{West\_North\_Central}_i+\beta_{19}*\text{South\_Atlantic}_i+$$

$$\beta_{20}*\text{East\_South\_Central}_i+\beta_{21}*\text{West\_South\_Central}_i+\beta_{22}*\text{Mountain}_i+\beta_{23}*\text{SOR\_Social Media}_i$$

$$+\beta_{24}*\text{SOR\_Friends\_Family}_i+\beta_{25}*\text{SOR\_Internet}_i+\beta_{26}*\text{SOR\_Conv\_Media}_i+$$

$$\beta_{27}*\text{SOR\_Package\_Labels}_i+\beta_{28}*\text{SOR\_Past\_Experience}_i+\beta_{29}*\text{SOR\_Recipes}_i$$

$$+\beta_{30}*\text{Grocery\_Stores}_i+\beta_{31}*\text{Supercenters}_i+\beta_{32}*\text{Convenience\_Stores}_i+\beta_{33}*\text{Farmer\_Direct}_i$$

$$+\beta_{34}*\text{Online\_Purch\_Tree\_Nuts}_i+\beta_{35}*\text{Other\_Stores}_i+e_i$$

The explanatory variables correspond to sociodemographic factors, namely household size, number of children living in the household, gender, race, ethnicity, education, age, household income, and region. Gender, race, ethnicity, education, age, and region are indicator or dummy variables. As such, these variables take on the value of 1 or 0. For example, Male = 1 if the respondent is male, and 0 if the respondent is female. The base or reference categories for the respective discrete or dummy variables are as follows: (i) gender: female; (ii) race: other; (iii) ethnicity: non-Hispanic; (iv) education: no college; (v) age: 18 to 24 years of age; and (vi) region: Pacific.

Hill and Lynchehaun (2002) and Dharmasena and Capps (2014) identified various cultural and socioeconomic factors influencing consumer preferences, including age, ethnicity, income, education, gender, presence of children, region, and race. Hence, we hypothesize that these factors also are determinants of the decision to purchase pecans. Further, because education level often is positively associated with health consciousness (Alviola and Capps, 2010), we hypothesize that this sociodemographic factor is positively related to the decision to purchase pecans. Moreover, given that pecans are produced predominantly in Alabama, Arkansas, Arizona, California, Florida, Georgia, Kansas, Louisiana, Missouri, Mississippi, North Carolina, New Mexico, Oklahoma, South Carolina, and Texas, we expect that respondents located in the South Atlantic, the East South Central, and the West South Central regions are more likely to purchase pecans than respondents located in other regions.

The specification of the probit model also includes additional indicator variables to reflect the main sources of information about tree nuts (see Table 2) and where tree nuts (not just pecans) are purchased (see Table 3). Lillywhite, Simonsen, and Heerema (2014) found that U.S. tree nut stakeholders capitalized on nutritional aspects by incorporating health messages about their products in promotional campaigns. This finding suggests that it is not unreasonable to consider main sources of information about tree nuts and their impact on the likelihood of purchasing pecans. In addition, Florkowski and Park (2001) found that marketing outlets were factors influencing pecan purchases. Lombardini, Waliczek, and Zajicek (2008) found that farmers' markets and other direct from-producer outlets were used with greater frequency by consumers than other outlets. The extant literature has paid little attention to the impact of main sources of information about tree nuts and where tree nuts are purchased on the likelihood of purchasing pecans. This research fills this void.

SOR_Social_Media is equal to 1 if the reference person relies on the use of Facebook or Twitter for information about tree nuts, and 0 otherwise. SOR_Family_Friends is equal to 1 if the reference person relies on the use of family or friends for information about tree nuts, and 0 otherwise. SOR_Internet is equal to 1 if the reference person relies on the use of the internet for information about tree nuts, and 0 otherwise. SOR_Conv_Media is equal to 1 if the reference person relies on radio, television, or magazines for information about tree nuts, and 0 otherwise. SOR_Package_Labels is equal to 1 if the reference person relies on the use of package labels, and 0 otherwise. SOR_Past_Experience is equal to 1 if the reference person relies on the use of past experience, and 0 otherwise. Finally, SOR_Recipes is equal to 1 if the reference person relies on the use of recipes, and 0 otherwise.

Grocery_Stores is equal to 1 if the reference person purchases tree nuts at grocery stores, and 0 otherwise. Supercenters is equal to 1 if the reference person purchases tree nuts at supercenters, and 0 otherwise. Convenience_Stores is equal to 1 if the reference person purchases tree nuts at convenience stores, and 0 otherwise. Farmer_Direct is equal to 1 if the reference person purchases tree nuts at roadside stands or farmers' markets, and 0 otherwise. Online_Purch_Tree_Nuts is equal to 1 if the reference person purchases tree nuts on Amazon or on other online sources, and 0 otherwise. Other_Stores is equal to 1 if the reference person purchases tree nuts at specialty stores, mall kiosks, drug stores, or discount stores, and 0 otherwise.

Data for the Econometric Analysis

As mentioned previously, the survey response data for this analysis came from a national panel of U.S. residents via SurveyMonkey.[3] The survey was administered in December 2020. The dataset used in this analysis consists of 944 observations. Each observation corresponds to a unique respondent *i*. Thus, the data set is equivalent to a cross-sectional representation of U.S. households. Prior to data cleaning, the original sample size was 1,308 observations. We dropped 131 households who failed to complete the survey, and we dropped 183 households who failed to report gender, household income, and/or region.

[3] https://www.surveymonkey.com

About 67% of the sample purchased pecans (see Table 6). Concerning age, 4% of the sample were 18 to 24 years old; 14% were 25 to 34 years old; 26% were 35 to 44 years old; 14 % were 45 to 54 years old; 18% were 55 to 64 years old; and 25% were 65 years old and over. Household size was about 2.5, and the average income was roughly $80,000. Roughly 83% of the sample had at least some college education (college) and slightly less than 45% of the sample were male. Approximately 7% were of Hispanic ethnicity. Further, roughly 85% of the sample were white, 6% were Black, and about 3% were Asian.

Table 6. Descriptive Statistics of the Variables in the Probit Analysis

Variable Name	Mean	Variable Name	Mean
Purchase Pecans		**Source of Information about Tree Nuts**	
(Dependent variable in the probit model)		SOR_SOCIAL_MEDIA social media (Facebook, Twitter)	0.0402
Yes	0.6680	SOR_FRIENDS_FAMILY friends and family	0.2173
No	0.3320	SOR_INTERNET—internet	0.0412
Race		SOR_CONV_MEDIA—conventional media (tv, radio, magazines)	0.1600
White	0.8481	SOR_PACKAGE_LABELS package labels	0.3260
Black	0.0644	SOR_PAST_EXPERIENCE past experience	0.5302
Asian	0.0332	SOR_RECIPES recipes	0.2746
Other (reference/base category)	0.0543	**Where Tree Nuts are Purchased**	
Region		GROCERY_STORES grocery stores	0.7324
New England	0.0584	SUPERCENTERS supercenters	0.4899
Mid-Atlantic	0.1368	CONVENIENCE_STORES convenience stores	0.1579
East North Central	0.1519	FARMER_DIRECT roadside stands and farmers' markets	0.1338
West North Central	0.0644	ONLINE_PURCH_TREE_NUTS Amazon and other online sources	0.1127
South Atlantic	0.1782	OTHER_STORES mall kiosks, drugstores, specialty stores, and discount stores	0.1147
East South Central	0.0423		
West South Central	0.0825		
Mountani	0.0946		
Pacific (reference/base category)	0.1911		
Household income			
Hincome	$80,636		
Household size			
Household_Size	2.46		
Education			
College	0.8300		
No college (reference/base category)	0.1700		
Gender			
Male	0.4497		
Female (reference/base category)	0.5503		

Table 6. (cont)

Variable Name	Mean	Variable Name	Mean
Purchase Pecans			
Ethnicity			
Hispanic	0.0714		
Non-Hispanic (reference/base category)	0.9286		
Age			
Age_18to24 (reference/base category)	0.0402		
Age_25to34	0.1388		
Age_35to44	0.2555		
Age_45to54	0.1408		
Age_55to64	0.1771		
Age_65plus	0.2475		
Number of children			
Number_Children	0.4809		

Source: Calculated by the authors using IHS Global, Inc.'s (2020) EVIEWS econometrics software package.

Approximately 6% of the sample were located in the New England region (Connecticut, Maine. Massachusetts, New Hampshire, Rhode Island, and Vermont); 14% were in the mid-Atlantic region (New Jersey, New York, and Pennsylvania); 15% were in the East North Central region (Indiana, Illinois, Michigan, Ohio, and Wisconsin); 6% were in the West North Central region (Iowa, Kansas, Minnesota, Missouri, Nebraska, North Dakota, and South Dakota); 18% were in the South Atlantic region (Delaware, District of Columbia, Florida, Georgia, Maryland, North Carolina, South Carolina, Virginia, and West Virginia); 4% were in the East South Central region (Alabama, Kentucky, Mississippi, and Tennessee); 8% were in the West South Central region (Arkansas, Louisiana, Oklahoma, and Texas); 9% were in the Mountain region (Arizona, Colorado, Idaho, New Mexico, Montana, Utah, Nevada, and Wyoming); and 19% were in the Pacific region (Alaska, California, Hawaii, Oregon, and Washington).

Roughly 53% of the sample relied on past experience as their source of information about tree nuts, followed by package labels (33%), recipes (27%), friends and family (22%), and conventional media (16%). Only 4% of the sample relied on the use of social media (Facebook and Twitter) and the use of the internet for information about tree nuts. About 73% of the sample purchased tree nuts at grocery stores, and 49% purchased tree nuts at supercenters. Roughly 15% of the sample purchased tree nuts at convenience stores, 13% at roadside stands or farmers' markets, 11% from Amazon or other online sources, and 11% at specialty stores, mall kiosks, drug stores, or discount stores.

Probit Model Results

A maximum likelihood procedure with the IHS Global, Inc.'s (2020) EVIEWS econometrics software package was used to estimate the probit model. The parameter estimates, standard errors,

and associated *p*-values of the respective explanatory variables in the probit model are exhibited in Table 7. The goodness-of-fit statistic, McFadden's (1984) R^2, is 0.2368. The overall significance of the probit regression model was examined using a likelihood ratio test. Specifically, we tested the null hypothesis that all estimated coefficients, except the intercept coefficient, are jointly equal to zero. The *p*-value associated with the likelihood ratio test (see Table 7) suggests the null hypothesis is rejected, and therefore, at least one of the estimated coefficients is statistically different from zero.

Table 7. Econometric Results from the Probit Analysis of the Purchase of Pecans

Variable*	Coefficient	Std. Error	z-Statistic	Prob.
C	**-1.3903*** **	**0.3902**	**-3.5628**	**0.0004**
HOUSEHOLD_SIZE	0.0531	0.0537	0.9889	0.3227
NUMBER_CHILDREN	-0.0936	0.0759	-1.2335	0.2174
MALE	0.0843	0.0998	0.8455	0.3978
BLACK	0.0700	0.3085	0.2270	0.8204
ASIAN	-0.5093	0.3345	-1.5226	0.1278
WHITE	-0.2489	0.2383	-1.0446	0.2962
HISPANIC	0.0735	0.2047	0.3590	0.7196
COLLEGE	0.0800	0.1303	0.6140	0.5392
AGE_25TO34	0.1608	0.2567	0.6265	0.5310
AGE_35TO44	0.1590	0.2471	0.6432	0.5201
AGE_45TO54	**0.4694***	**0.2619**	**1.7921**	**0.0731**
AGE_55TO64	**0.8290*** **	**0.2620**	**3.1639**	**0.0016**
AGE_65PLUS	**0.7899*** **	**0.2592**	**3.0480**	**0.0023**
HINCOME	6.78E-07	9.37E-07	0.7232	0.4696
NEW_ENGLAND	0.1621	0.2162	0.7499	0.4533
MID_ATLANTIC	-0.0278	0.1616	-0.1720	0.8635
EAST_NORTH_CENTRAL	0.0672	0.1634	0.4111	0.6810
WEST_NORTH_CENTRAL	**0.4397** **	**0.2217**	**1.9833**	**0.0473**
SOUTH_ATLANTIC	**0.3397** **	**0.1572**	**2.1609**	**0.0307**
EAST_SOUTH_CENTRAL	0.3729	0.2692	1.38512	0.1660
WEST_SOUTH_CENTRAL	**0.4612** **	**0.2054**	**2.2457**	**0.0247**
MOUNTAIN	-0.0183	0.1835	-0.0996	0.9206
SOR_SOCIAL_MEDIA	0.2460	0.2672	0.9208	0.3571
SOR_FRIENDS_FAMILY	0.1897	0.1252	1.5152	0.1297
SOR_INTERNET	-0.0438	0.2399	-0.1825	0.8552
SOR_CONV_MEDIA	**0.2563***	**0.1452**	**1.7649**	**0.0776**
SOR_PACKAGE_LABELS	-0.0131	0.1044	-0.1252	0.9004
SOR_PAST_EXPERIENCE	**0.2692** **	**0.1053**	**2.5557**	**0.0106**
SOR_RECIPES	**0.5597*** **	**0.1210**	**4.6249**	**0.0000**
GROCERY_STORES	**0.7941*** **	**0.1168**	**6.7987**	**0.0000**
SUPERCENTERS	**0.5080*** **	**0.1002**	**5.0705**	**0.0000**
CONVENIENCE_STORES	0.0012	0.1362	0.0088	0.9930

Table 7. (cont)

Variable*	Coefficient	Std. Error	z-Statistic	Prob.
C				
FARMER_DIRECT	**0.3482****	**0.1601**	**2.1755**	**0.0296**
ONLINE_PURCH_TREE_NUTS	0.0383	0.1542	0.2480	0.8041
OTHER_STORES	0.1083	0.1582	0.6847	0.4935
McFadden R-squared	**0.2368**			
LR statistic	**299.2499**			
Prob (LR statistic)	**0.0000**			
Observations with dep = 0	330	Total observations		994
Observations with dep = 1	664			

Reference category for gender: female
Reference category for race: other (F-statistic 1.53; p-value 0.2051)
Reference category for ethnicity: non-Hispanic
Reference category for age: age 18 to 24 (F-statistic 6.53; p-value 0.0000)
Reference category for region: Pacific (F-statistic 1.82; p-value 0.0704)

Variables with statistically significant coefficients are marked in bold; single, double, and triple asterisks (, **, ***) indicate statistical significance at the 10%, 5%, and 1% levels.
Source: Estimation of the probit model done using IHS Global, Inc.'s (2020) EVIEWS econometrics software package.

Variance inflation factors, condition indices, and variance proportions were used to examine potential collinearity issues in the probit model (Belsley, Kuh, and Welsch, 1980). No degrading collinearity issues were evident from this examination.

All variables with estimated coefficients statistically different from zero are in bold in Table 7, either at the 10%, 5%, or 1% significance levels. Drivers associated with the decision to purchase pecans are: (i) age; (ii) region; (iii) source of information about tree nuts; and (iv) outlets where tree nuts are purchased. Neither household size, number of children, race, gender, education nor ethnicity are factors that significantly affect the decision to purchase pecans.

Older respondents aged 45 to 54, 55 to 64, and 65 and over are more likely to purchase pecans relative to younger respondents. Finally, respondents located in the West North Central, South Atlantic, and West South-Central regions are more likely to purchase pecans than respondents located in the New England, Mid-Atlantic, East North Central, East South Central, and Pacific regions of the United States.

The sources of information about tree nuts that significantly impact the decision to purchase pecans are conventional media (radio, television, or magazines), past experience, and recipes. Information about tree nuts available from social media, family and friends, the internet, and package labels does not significantly impact the decision to purchase pecans.

Purchases of tree nuts from grocery stores, supercenters, and roadside stands or farmers' markets are positively related to the decision to purchase pecans. Purchases of tree nuts from convenience

stores, online sources, or other stores (specialty stores, mall kiosks, drugstores, or discount stores) do not significantly impact the decision to purchase pecans.

Marginal effects provide insight about how changes in the righthand side variables affect the probability of purchasing pecans. To calculate the marginal effect for any explanatory variable, the estimated coefficient associated with that variable is multiplied by the standard normal density function $f(\boldsymbol{x}_i'\boldsymbol{\beta})$. The marginal effects in Table 8 were calculated at the sample means for each of the explanatory variables in the probit model. Only marginal effects of those explanatory factors whose estimated coefficients are significantly different from zero are discussed.

Relative to household heads who are between 18 and 24 years of age, the likelihood of purchasing pecans is higher by16.2%for those in the 45 to 54 age bracket; 28.6% higher for those aged 55 to 64; and 27.2% higher for those 65 years of age and over. Relative to respondents located in the Pacific region, the probability of purchasing pecans is higher by 15.2% for those located in the West North Central region; 11.7% higher for those located in the South Atlantic region; and 15.9% higher for those located in the West South Central region.

The likelihood of purchasing pecans is higher by 8.8% if conventional media is the source of information about tree nuts; higher by 9.3% if past experience is the source of information about tree nuts; and higher by 19.3% if recipes are the source of information about tree nuts. The likelihood of purchasing pecans is higher by 27.4% if tree nuts are purchased at grocery stores; higher by 17.5% if tree nuts are purchased at supercenters; and higher by 12% if tree nuts are purchased at roadside stands or farmers' markets.

About 67% of the survey respondents purchased pecans (664 out of 994 respondents). Hence, in the derivation of the prediction-success (see Table 9), the cutoff probability for classification purposes is 0.668008. That is, we predict that the *ith* reference person will purchase pecans if the probability of doing so exceeds 0.668008 and will not purchase pecans if the probability of doing so is less than 0.668008. In agreement with Greene (2012, p. 658), "in general any prediction rule will make two types of errors; it will incorrectly classify zeros as 1s and 1s as zeros." Within sample, the probit model correctly classifies the decision to not make purchases of pecans with 70.6% accuracy (233 out of 330). Within sample, the probit model correctly classifies the decision to make purchases of pecans with 74.3% accuracy (493 out of 664). Overall, within sample, the model correctly classifies all decisions 726 out of 994 times, with 73% accuracy. For binary choice models, to the best of our knowledge, no benchmark exists regarding correct classifications. The probit model composed of sociodemographic factors, sources of information about tree nuts, and where tree nuts are purchased can discern the decision to purchase as well as not to purchase pecans. Overall, the model provides correct classifications 73 out of 100 times.

Table 8. Marginal Effects Associated with the Probit Analysis Calculated at the Sample Means of the Data

Variable	Marginal Effects
HOUSEHOLD_SIZE	0.0183
NUMBER_CHILDREN	-0.0323
MALE	0.0291
BLACK	0.0241
ASIAN	-0.1756
WHITE	-0.0858
HISPANIC	0.0253
COLLEGE	0.0276
AGE_25TO34	0.0554
AGE_35TO44	0.0548
AGE_45TO54	**0.1618**
AGE_55TO64	**0.2858**
AGE_65PLUS	**0.2723**
HINCOME	0.0000[a]
NEW_ENGLAND	0.0559
MID_ATLANTIC	-0.0096
EAST_NORTH_CENTRAL	0.0232
WEST_NORTH_CENTRAL	**0.1516**
SOUTH_ATLANTIC	**0.1171**
EAST_SOUTH_CENTRAL	0.1286
WEST_SOUTH_CENTRAL	**0.1590**
MOUNTAIN	-0.0063
SOR_SOCIAL_MEDIA	0.0848
SOR_FRIENDS_FAMILY	0.0654
SOR_INTERNET	-0.0151
SOR_CONV_MEDIA	**0.0883**
SOR_PACKAGE_LABELS	-0.0045
SOR_PAST_EXPERIENCE	**0.0928**
SOR_RECIPES	**0.1930**
GROCERY_STORES	**0.2737**
SUPERCENTERS	**0.1751**
CONVENIENCE_STORES	0.0004
FARMER_DIRECT	**0.1200**
ONLINE_PURCH_TREE_NUTS	0.0132
OTHER_STORES	0.0373

[a]The marginal effect for income was estimated to be 2.33E-007.
Bold indicates marginal effects of those explanatory variables whose estimated coefficients are significantly different from zero.
Source: Calculations by the authors

Table 9. Expectation-Prediction Evaluation of the Probit Model within Sample*

	Dep = 0	Dep = 1	Total
P(Dep = 1) < = C	233	171	404
P(Dep = 1) > C	97	493	590
Total	330	664	994
Correct	233	493	726
% Correct	70.61	74.25	73.04

*Success cutoff: C = 0.668008
Dep = 0 indicates non-purchase of pecans; Dep = 1 indicates purchase of pecans.
Source: Calculations by the authors

Concluding Remarks

The main conclusions from the nationally representative consumer survey conducted in December 2020 are: (i) close to 9 out of 10 households purchase tree nuts; (ii) 2 out of 3 households purchase pecans; (iii) pecans ranked fourth in regard to favorite, second favorite, or third favorite tree nut; (iv) almost a quarter of respondents who purchase tree nuts do not purchase pecans; (v) the most common frequency of pecan purchases is annually; (vi) the primary reason for non-purchases of pecans is non-preference for pecans, but cost/budgetary restrictions, dietary restrictions, and allergies to pecans are also frequently cited as reasons for non-purchases; (vii) roughly 4 out of 5 respondents purchase pecans at grocery stores, and nearly half purchase pecans at supercenters; (viii) walnuts by far are the most popular substitute for pecans; (ix) principal pecan perceptions that come to mind include ingredient for cooking or pies, delicious/tasty desserts, family/holiday gatherings and memories, wholesome, snacks, heart-healthy/heart-smart, expensive, nutrition powerhouse, high caloric content, homegrown, and Texas/southern states; (x) slightly more than 60% of respondents do not recall seeing or hearing messages that would encourage them to purchase pecans; (xi) the predominant source of messaging concerning pecans comes from recipes; (xii) slightly more than 40% of respondents revealed that lowering the price would make them more likely to purchase more pecans, while nearly 30% placed emphasis on health and nutrition considerations in purchasing pecans; and (xiii) close to 8% said nothing would make them more likely to purchase more pecans, and about 20% did not know what would make them more likely to purchase more pecans.

Based on the survey data collected using SurveyMonkey, a probit model was estimated incorporating sociodemographic variables, sources of information about tree nuts, and where tree nuts are purchased as explanatory variables. Drivers associated with the decision to purchase pecans are: (i) age; (ii) region; (iii) source of information about tree nuts; and (iv) outlets where tree nuts are purchased. Neither household size, number of children, race, gender, education, nor ethnicity are factors that significantly affect the decision to purchase pecans.

Older respondents aged 45 to 54, 55 to 64, and 65 and over are more likely to purchase pecans relative to younger respondents. Finally, respondents located in the West North Central, South Atlantic, and West South Central regions are more likely to purchase pecans than respondents

located in the New England, mid-Atlantic, East North Central, East South Central, Mountain, and Pacific regions.

The sources of information about tree nuts that significantly impact the decision to purchase pecans are conventional media (radio, television, or magazines), past experience, and recipes. Information about tree nuts available through social media, family and friends the internet, and package labels does not significantly impact the decision to purchase pecans. Purchases of tree nuts from grocery stores, supercenters, and roadside stands or farmers' markets are positively related to the decision to purchase pecans. Purchases of tree nuts from convenience stores, online sources, specialty stores, mall kiosks, drugstores, or discount stores do not significantly impact the decision to purchase pecans.

The bottom line is that on the basis of the survey sample used in this study, the primary targets for American Pecan Council promotion are older households residing in the West North Central, South Atlantic, and West South Central regions of the United States. Additionally, households who rely on radio, television, or magazines, past experience, and recipes with tree nuts, and households who purchase tree nuts at grocery stores, supercenters, roadside stands, or farmers' markets also are targets for the American Pecan Council. These results should help stakeholders in the pecan industry increase sales by targeting households that are more likely to purchase pecans. This research provides a benchmark for future studies concerning the decision to purchase pecans. We have answered a question that has not been addressed previously, namely, what sociodemographic factors, sources of information about tree nuts, and outlets where tree nuts are purchased affect the decision to purchase pecans in the United States.

Moreover, information contained in various recent snack food and grocery trade publications indicates substantial growth in consumption of salty snacks, particularly among the millennial demographic. Given the predominant end use of pecans (and walnuts) in baked goods rather than salty snacks, the case can be made that the pecan industry should aggressively expand its product market to salty snack products and their target consumers in age cohorts younger than 45.

Future research using scanner data and other quantitative demand metrics would be valuable to validate these findings. As well, this work can be expanded to include a probit analysis for tree nuts in general, not necessarily specific to pecans. Moreover, a multivariate choice model analysis could be done dealing with the frequency of pecan purchases (none at all, weekly, monthly, annually, and only during holidays). Also, multivariate discrete choice models could be developed centering attention on the favorite type of tree nut purchased.

Limitations of the study include the absence of data on the quantity of tree nuts purchased. As such, no estimates of own-price, cross-price, and income elasticities are provided. Nevertheless, this study provides information for marketing strategies to the American Pecan Council as well as other stakeholders in the tree nut industry.

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Data Availability

All data associated with this work are available from the authors upon request. These data were obtained via the construction and administration of a nationally represented online consumer survey to a panel of U.S. residents using SurveyMonkey (https://www.surveymonkey.com/), a well-known online survey software application.

Competing Interest

All authors have contributed to this article.

References

Alviola, P.A., and O. Capps, Jr. 2010. "Household Demand Analysis of Organic and Conventional Fluid Milk in the United States Based on the 2004 Nielsen Homescan Panel." *Agribusiness: An International Journal* 26(3):369–388.

Asci, S., and S. Devadoss. 2021. "Trends and Issues Relevant for the U.S. Tree Nut Sector." *Choices* 36(2):1–7.

Belsley, D.A., K. Kuh, and R.E. Welsch. 1980. *Regression Diagnostics: Identifying Influential Data and Sources of Collinearity*. New York: John Wiley & Sons.

Blomhoff, R., M.H. Carlsen, L.F. Andersen, and D.R. Jacobs, Jr. 2006. "Health Benefits of Nuts: Potential Role of Antioxidants." *British Journal of Nutrition* 96(supplement 2):S52–S60.

Byrne, P.J., O. Capps, Jr., and A. Saha. 1996. "Analysis of Food-Away-From-Home Expenditure Patterns for U.S. Households 1982-1989." *American Journal of Agricultural Economics* 78(3):614–627.

Capps, Jr., O., A. Ahad, and P.S. Murano. 2017. "Understanding Spending Habits and Buying Behavior of the American Muslim Community: A Pilot Study." *Journal of Food Distribution Research* 48(3):51–74.

Capps, Jr., O., and R.A. Kramer. 1985. "Analysis of Food Stamp Participation Using Qualitative Choice Models." *American Journal of Agricultural Economics* 67(1):49–59.

Cheng, G., O. Capps, Jr., and S. Dharmasena. 2021. "Demand Analysis of Peanuts and Tree Nuts in the United States: A Micro-Perspective." *International Food and Agribusiness Management Review* 24(3):523–544.

Dharmasena, S., and O. Capps, Jr. 2014. "Unraveling Demand for Dairy-Alternative Beverages in the United States: The Case of Soymilk." *Agricultural and Resource Economics Review* 43(1):140–157.

Florkowski, W.J., and T.A. Park. 2001. "Promotional Programmes and Consumer Purchasing Decisions: Pecan Demand Models." *Applied Economics* 33(6):763–770.

Fraser, G.E., J. Sabate, W.L. Beeson, and T.M. Strahan. 1992. "A Possible Protective Effect of Nut Consumption on Risk of Coronary Heart Disease: The Adventist Health Study." *Archives of Internal Medicine* 152(7):1416–1424.

Gold, M., M.M. Cernusca, and L. Godsey. 2004. "Consumer Preferences for Chestnuts, Eastern Black Walnuts, and Pecans." *HortTechnology* 14(4):583–589.

Greene, W.H. 2012. *Econometric Analysis*, 7th ed. New York: Pearson.

Hanushek, J., and E. Jackson. 1977. *Statistical Methods for Social Scientists*. New York: Academic Press.

Hill, H., and F. Lynchehaun. 2002. "Organic Milk: Attitudes and Consumption Patterns." *British Food Journal* 104(7):526–542.

IHS Global Inc. 2020. *EVIEWS*, version 11. Available online: https://www.eviews.com.

King, J.C., J. Blumberg, L. Ingwersen, M. Jenab, and K.L. Tucker. 2008. "Tree Nuts and Peanuts as Components of a Healthy Diet." *The Journal of Nutrition* 138(9):1736S–1740S.

Kris-Etherton, P.M., F.B. Hu, E. Ros, and J. Sabaté. 2008. "The Role of Tree Nuts and Peanuts in the Prevention of Coronary Heart Disease: Multiple Potential Mechanisms." *The Journal of Nutrition* 138(9):1746S–1751S.

Lillywhite, J.M., J.E. Simonsen, and R.J. Heerema. 2014. "U.S. Consumer Purchases and Nutritional Knowledge of Pecans." *HortTechnology* 24(2):222–230.

Lombardini, L., T.M. Waliczek, and J.M. Zajicek. 2008. "Consumer Knowledge of Nutritional Attributes of Pecans and Factors Affecting Purchasing Behavior." *HortTechnology* 18(3):481–488.

Maddala, G.S. 1983. *Limited Dependent and Qualitative Variables in Econometrics.* Cambridge, United Kingdom: Cambridge University Press.

Mattes, R.D., P.M. Kris-Etherton, and G.D. Foster. 2008. "Impact of Peanuts and Tree Nuts on Body Weight and Healthy Weight Loss in Adults." *The Journal of Nutrition* 138(9):1741S–1745S.

McFadden, D. 1984. "Econometric Analysis of Qualitative Response Models." In Z. Griliches and M. Intriligator, eds. *Handbook of Econometrics* 2:1395–1457.

Pawlak, R., S. Colby, and J. Herring. 2009. "Beliefs, Benefits, Barriers, Attitude, Intake and Knowledge about Peanuts and Tree Nuts among WIC Participants in Eastern North Carolina." *Nutrition Research and Practice* 3(3):220–225.

Pindyck, R.S., and D.L. Rubinfield. 1998. *Econometric Models and Economic Forecasts,* 4th ed. New York: McGraw-Hill.

Ros, E. 2010. "Health Benefits of Nut Consumption." *Nutrients* 2(7):652–682.

Statista. 2020. *Statista.* Available online: www.statista.com [Accessed December 2020].

SurveyMonkey 2020. *SurveyMonkey.* Available online: https://www.surveymonkey.com/.

U.S. Census Bureau. 2020. *Current Population Survey (CPS)*. Available online: https://www.census.gov/main/www/cprs.html.

U.S. Department of Agriculture. 2022. *Fruit and Tree Nuts Yearbook Tables.* Washington, DC: Economic Research Service. Available online: https://www.ers.usda.gov/data-products/fruit-and-tree-nuts-data/fruit-and-tree-nuts-yearbook-tables/#Tree%20Nuts.

U.S. Department of Agriculture and U.S. Department of Health and Human Services. 2020. *Dietary Guidelines for Americans, 2020-2025*, 9th ed. Available online: https://www.dietaryguidelines.gov/sites/default/files/2020-12/Dietary_Guidelines_for_Americans_2020-2025.pdf.