Exploring the Hierarchy of Product Attributes in U.S. Pecan Consumption

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Abstract

The U.S. pecan industry has continued to experience global growth, but domestic consumption has remained flat over the last decade. Understanding that U.S. consumers continually search out healthy foods and food products, this research evaluates factors that influence their consumption. Making use of survey data from 509 adult participants and utilizing classification and regression tree (CART) analysis, we use a nonparametric modeling approach to identify factors that affect pecan consumption. We find that perceived health benefits are the most significant factor in the hierarchy of variables that affect pecan consumption, with perceived value, overall pecan attributes, and nutritional information following close behind.

Keywords: CART analysis, consumption, decision tree, health benefits, pecans

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Introduction

Pecan trees (*Carya illinoinensis*) are native to North America and are either the native or seedling type or improved varieties. The trees have been used for centuries by Native Americans both as food and timber sources (Hall, 2000). U.S. Department of Agriculture (USDA) data show that 1 in 10 consumers eats tree nuts (almonds, walnuts, pecans, pistachios, cashews, and others) on any given day. Pecans are sold whole, in pieces, or as meal and are commonly used in desserts, candies, ice cream, and breakfast cereals worldwide. However, the amount eaten in the United States is fairly small (Lin et al., 2001).

Pecans are high in antioxidants and have been shown to reduce or prevent diseases such as coronary heart disease (Rajaram et al., 2000), gallstones, obesity, metabolic syndrome, cancer, inflammation, hypertension, and diabetes in women (Ros, 2010; McKay et al., 2018; Moser, Raffaelli, and McFadden, 2011; Ortiz-Quezada, Lombardini, and Cosmerps-Zevallos, 2011). They also have been identified as having phenolic compounds (Villarreal, Lombardini, and Cisneros-Zevallos , 2007), which act as antioxidants that have been tied to a decrease in chronic diseases such as Alzheimer's, Parkinson's, and other degenerative diseases (Mertens-Talcott and Percival, 2005). Pecans are an excellent source of monounsaturated fats ("good" cholesterol), have a protective effect against coronary heart disease (Lin et al., 2001; McKay et al., 2018; Rajaram et al., 2000), and have just recently been identified as a "heart healthy" food by the American Heart Association.

U.S. production of pecans remained between 264.2 million and 221 million pounds from 2012 through 2018 (U.S. Department of Agriculture, 2015b). In 2018, the majority of U.S. pecans were produced in Georgia (56 million lb), New Mexico (90 million lb) and Texas (28 million lb) in 2018 (U.S. Department of Agriculture, 2019d).

The United States has exported pecans to Mexico at an increasing rate, from 36 million lb in 1990 to over 95 million lb in 2018. Mexico has also continued to export in-shell pecans to the United States, from 4.6 million lb in 1990 to over 50 million lb in 2018. North America continues to dominate the world pecan market, producing 99.3% of total world production (195 million lb). Increased domestic production has also been supported by exports, increasing significantly from just over 4 million lb in 1980 to nearly 69 million lb in 2018 (U.S. Department of Agriculture, 2019). Pecan demand has increased globally, as indicated by the growth in the export markets for shelled and in-shelled pecans and processed products (U.S. Department of Agriculture, 2015a).

U.S. consumers have incorporated tree nuts—especially almonds—into their daily diets. Almond growers have been very successful, raising domestic consumption from 0.42 lb in 1980 to 2.06 lb in 2016/17, a 394% increase in consumption over 30 years. Alternative tree nuts have also experienced some growth: walnuts (14%), pistachios (780%). Overall U.S. tree nut consumption has increased from 1.38 lb per person in 1970 to 3.69 lb per person in 2017. Promotional programs focused on the nutritional benefits of a diet rich in tree nuts, including their beneficial levels of vitamin E and omega fatty acids, have increased awareness and demand for tree nuts, contributing to the growth in per capita nut consumption (U.S. Department of Agriculture, 2019a).The aggregate rates of growth are impressive and demonstrate the U.S. consumer's demand for tree nuts.

Despite the growth in global demand and aggregate U.S. consumption of tree nuts, pecan consumption in the United States has increased only slightly. Figure 1 illustrates the per capita consumption of pecans over the last 35 years. Average per capita pecan consumption between 1980 and 2017 has seen minimal change from a high of 0.62 lb in 1988–1989 to a low of 0.34 lb in 2015–2016, most recently 0.44 lb in 2017. Domestic pecan consumption has struggled to gain consumer support compared to all other major U.S. tree nuts on a per capita basis: walnuts (0.57 lb), pistachios (0.43 lb), and almonds (2.27 lb) (U.S. Department of Agriculture, 2019c). The consumption rate of pecans has been stable and does not reflect the general trend of increased consumption of all tree nuts. This lack of growth has been of great concern for the U.S. pecan industry.
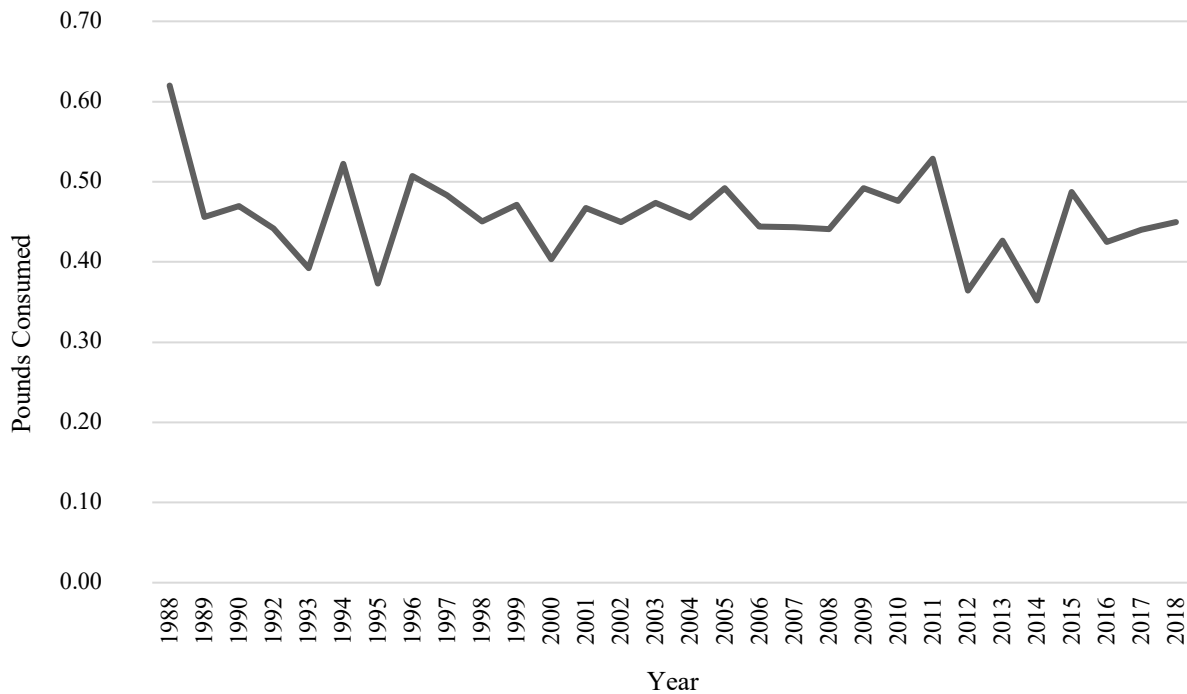

Figure 1. U.S. per Capita Consumption of Pecans

Source: U.S. Department of Agriculture, *Fruit and Tree Nut Yearbook,* 2018.

To better understand U.S. consumers and their reasons for consuming pecans, it is necessary to comprehend the behavioral, psychological, and demographic factors affecting demand. Recognizing the impact of extrinsic cues such as price and country of origin—along with intrinsic cues of health benefits, taste, and nutrition—while also considering the impact of ethnocentrism on consumption will provide a better understanding of pecan consumers. This will shed light on the factors affecting the consumption of pecans and inform marketing opportunities for the U.S. pecan industry.

This research examines pecan consumer subgroups and their perceived homogeneity based on behavioral, psychological, and demographic characteristics that respond differently to ethnocentrism and extrinsic and intrinsic cues. Specifically, we describe current product attributes

and perceptions associated with pecan consumption, determine the hierarchy of variables that influence current pecan consumption, and identify the primary variables in that hierarchy. This research makes use of survey data from 509 adult participants and employs classification and regression tree (CART) analysis, a nonparametric modeling approach developed by Breiman et al. (1984), to identify how U.S. pecan consumption varies with the demographic profile of survey respondents. CART has advantages over traditional regression techniques and has been successfully applied in previous consumer segmentation literature (Cardoso and Mountinho, 2004; Liu, Kanter, and Messer, 2013; Payne, Messer, and Kaiser , 2009).

CART analysis is a decision tree statistical method that allows researchers to separate independent variables into homogeneous groups and determine how these subgroups influence the dependent variable. CART analysis results are tested independently through validation or cross-validation and can reveal how being part of a characteristic group influences the dependent variable and allows for survey respondents to be members of multiple characteristic subgroups. Utilizing the CART analysis allows for simultaneous consideration of multiple interacting independent variables. These findings could assist marketers in segmenting and targeting homogeneous groups of consumers (Hoffman and Novak, 1996; Aaker and Lee, 2001).

Literature Review

The survey instrument used in this study contains elements for measuring consumer behavior, attitude, and consumption frequencies for pecans. This instrument was employed utilizing an online survey panel. Research on U.S. pecan consumers has been limited; however, some initial research establishes a foundation for considering the pecan CART decision tree approach.

Existing pecan consumption research provides some understanding of consumer perceptions and demographics for potential marketing strategies and opportunities to improve overall pecan consumption. Lin, Frazao, and Allshouse (2001) reported that researchers conducted 14,262 in-person interviews asking respondents to recall food and beverage consumption in the previous 24-hour period. The researchers identified characteristics and demographics of pecan consumers but were unable to provide any explanation of what product attributes motivated them to consume pecans.

Based on interviews of U.S. consumers, Wolfe et al. (2007) concluded that pecan purchasers are on average older, more affluent, and more well-educated; 43% attained a degree beyond high school. Asians were identified as being less likely to purchase pecans, whereas Native Americans and people of multiracial backgrounds are more likely to purchase pecans. The researchers suggested a potential marketing strategy for pecans would be to develop pecan products that fit with the active and busy lifestyles of younger consumers and be distributed through convenience stores and other retailers currently not selling pecans. However, this research also failed to provide a clear understanding of the decision process for consuming pecans and only speculated on potential areas for consumption growth.

Lombardini, Waliczek and Zajicek (2008) reported results based on a survey of attendees at the annual Texas Master Gardener Conference in May 2006. The survey included questions concerning pecan nutrition, storage, purchasing attitudes and consumption, consumption of fresh

fruits and vegetables, and demographic questions. This research provided evidence that taste was the main reason people ate pecans, followed by the perception that they were eating something healthy. This research identified the need for nutritional education about pecans, but overall the good eating habits and positive attitude toward pecans provided additional direction for further research.

A more recent article by Lillywhite, Simonsen, and Heerema (2014) explored U.S. pecan consumption and how pecan consumers typically purchase and consume pecans. The researchers explored the demographics of pecan consumers, gauged their current tree nut nutrition knowledge, and examined the preferences surrounding their pecan purchases. The authors identified several key variables that were found statistically significant, including education level, income, gender, age, and overall awareness of pecans and pecan nutrition. However, the relationship between these variables and the hierarchy of influence has not been determined and still leaves significant gaps in the understanding of the decision process to consume pecans and how to appropriately identify variables of significant influence on consumption.

Palma, Collart and Chammoun (2015) explored consumers' perceptions of the difference between native and improved pecan varieties when labels were present to indicate the difference. The results of this discrete conjoint analysis provided evidence that consumers are not heterogeneous in their selections of pecans and that taste, size, status, origin, and variety all vary across respondents. Selection of native pecans over improved pecan varieties is only based on perceptions and perceived quality because of ambiguous label claims that direct consumers to assume native is the more natural option. In a similar study, Moser, Raffaelli, and McFadden (2011) determined that consumers' buying choices were primarily driven by private attributes associated with taste and concerns for their own benefits.

These previous research articles have identified several variables affecting pecan consumption: quality, shopping experiences, perceptions of value, perceptions of nutrition, health benefits, country of origin, and general consumer demographics. However, researchers have struggled to explain the hierarchy of these variables using traditional methodologies and only reveal the "average person." This hurdle can be overcome using CART analysis.

Experimental Design

An online panel survey was conducted over March 3–9, 2016, to collect primary data regarding consumers' pecan preferences and purchasing behavior. The survey was administered by an independent global online market research panel managed by Cint, an independent corporation with U.S. offices in Atlanta, Georgia, and Los Angeles, California. The sample included 1,033 adult consumers living in the United States. All respondents were asked to answer each of the questions in order to proceed to the next question.

Upon completion of the data collection process, attention was focused on respondents who spent 4 or more minutes to complete the survey, passed both strategically placed attention checks within the survey tool, and indicated they were "current pecan consumers." In total, 509 of the 1,033 surveys were identified as successfully completed by "current pecan consumers" and were included in the statistical analysis and CART decision tree. Table 1 reports the demographic breakdown for these 509 respondents.

Table 1. Demographic Characteristics of the Sample (*N* = 509)

Variable	Category	Sample Frequency	Percentage
Gender	Male	231	45.4
	Female	278	54.6
Age	< 20	140	2.7
	20–34	210	28.8
	35–54	97	40.2
	55–64	53	17.2
	65–79	0	10.8
	≥ 80	0	0.2
Education	2-year degree	54	10.6
	4-year degree	146	28.7
	Doctoral degree	8	1.6
	High school/GED	80	15.7
	Less than high school	6	1.2
	Master's degree	68	13.4
	Professional degree	12	2.4
	Some college	135	26.5
Ethnicity	American Indian/Alaskan	4	1.2
	Asian	28	6.7
	Black/African American	27	7.2
	Hispanic/Latino	33	6.4
	Native Hawaiian/Pacific Islander	0	0.1
	White/Caucasian	406	76.8
	Other	11	1.7
Marital status	Divorced/widowed/separated	68	13.3
	Married	278	53.4
	Single	149	31
	Other	14	2.3
Household income	< $24,999	75	14.7
	$25,000–$49,000	154	30.3
	$50,000–$99,999	193	37.9
	$100,000–$149,000	62	12.2
	≥ $150,000	25	4.9

The instrument included 22 statements relating to pecan consumption and associated activities. These statements were grouped based on subject to create the scale and tested for their internal reliability using the Cronbach's alpha (α). The statements are considered reliable when $\alpha \geq 0.70$, indicating that respondents understand the question. Each variable was measured by using a five-point Likert-type scale anchored with either "strongly agree" and "strongly disagree" or "very important" to "very unimportant." Each scale was selected based on historical use and ability to measure the selected consumption subject.

The consume pecan scale was derived from the *U.S. Consumer Preferences & Nutritional Knowledge of Pecans* (Lillywhite, Simonsen, and Heerema. 2014) and included the following six statements, measured using a five-point Likert-type scale anchored with "very important" and "very unimportant":

  i.   They taste good.
  ii. They are a nutritious food.
  iii. They have specific health benefits I am interested in.
  iv. They are a good value.
  v.   They are included in recipes and/or prepared meals.
  vi. My doctor advises me to consume nuts.

These six items were used to create the consume pecans scale and were found to be reliable (Field, 2014; Cronbach's $\alpha = 0.803$).

The pecan health benefits scale was developed using Rezai et al. (2014) and included four statements, measured using a five-point Likert-type scale anchored with "strongly agree" and "strongly disagree":

  i.   I believe that consuming pecans creates a healthy diet for me.
  ii. I believe that consuming pecans will help to prevent and reduce the risks of specific health conditions.
  iii. I believe that by consuming pecans, I can have a balanced diet.
  iv. I believe that consuming pecans can lower the risk of specific health conditions.

The pecan health benefit scale was found to be reliable (Field, 2014; Cronbach's $\alpha = 0.911$).

The consumer food shopping scale was originally published by Botonaki and Konstadinos (2009) and includes two statements, measured using a five-point Likert-type scale anchored with "strongly agree" and "strongly disagree":

  i.   I try to do my food shopping as quickly as possible.
  ii. I do not like spending too much time shopping for food.

These two statements were used to create the construct for shopping and were found to be reliable (Field, 2014; Cronbach's $\alpha = 0.85$).

To measure consumers' perceived value of buying pecans, we developed a scale specifically for this research. This scale included three statements, measured using a five-point Likert-type scale anchored with "strongly disagree" and "strongly agree":

i.   Buying pecans are a good value for the money.
ii. When buying tree nuts, pecans seem to be a good buy.
iii. Pecans are a fairly cheap alternative compared to other nuts.

Overall reliability of the perceived value scale was confirmed (Field, 2014; Cronbach's $\alpha = 0.852$).

The next two variables were included based on the current world pecan-producing regions: the United States and Mexico, which currently produce over 99% of the world's pecans. To determine consumers' interest in pecans produced in Mexico, the Mexico country-of-origin construct was employed. This scale was first published by Parameswaran and Pisharodi (1994) and includes three statements, measured using a five-point Likert-type scale anchored with "strongly disagree" and "strongly agree":

i.   The pecans from Mexico are a good value.
ii. The pecans from Mexico are easily available.
iii. The pecans from Mexico are a prestigious product.

The Mexico country-of-origin scale was found to be reliable (Field, 2014; Cronbach's $\alpha = 0.737$).

Similar to the Mexico country-of-origin scale, we asked questions to develop a U.S. country-of-origin construct, again using Parameswaran and Pisharodi's (1994) approach and including three statements, measured using a five-point Likert-type scale anchored with "strongly disagree" and "strongly agree":

i.   The pecans from the U.S. are a good value.
ii. The pecans from the U.S. are easily available.
iii. The pecans from the U.S. are a prestigious product.

The U.S. country-of-origin scale was found to be reliable (Field, 2014; Cronbach's $\alpha = 0.705$).

To understand pecan consumers' interest in nutritional details, each participant was asked to respond to the following statement: "Do you read the nutrition facts label printed on the food packages you consume?" This construct used a five-point Likert-type question anchored by "always" and "never." Additional demographic questions were included in the instrument to allow for additional understanding of pecan consumers. Table 2 reports supplementary details for all of the scales.

Classification and Regression Tree Analysis (CART)

CART has been an effective tool to investigate consumer heterogeneity and to segment consumers (Lu, Kadane, and Boatwright, 2008). The decision tree procedure creates a tree-based classification model, which assigns cases into groups or predicts values of a dependent variable

Table 2. Survey Scale Description

Title	Study	α	Measurement
1. Shopping: consumer food shopping (modified) • I try to do my food shopping as quickly as possible. • I do not like spending too much time shopping for food.	Botonaki and Konstadinos (2010)	0.85	Strongly disagree – strongly agree
2. Perceived value: price perception scale • Generally speaking, the higher the price of the product, the higher the quality. • The old saying "You get what you pay for" is generally true. • The price of a product is a good indicator of its quality. • You always have to pay a bit more for the best.	Lichtenstein, Ridgway, and Netemeyer (1993)	0.842	Strongly disagree – strongly agree
3. Consume "Pecans": U.S. consumer preferences and nutritional knowledge of pecans • They taste good. • They are a nutritious food. • They have specific health benefits I am interested in. • They are a good value. • They are included in recipes and/or prepared meals. • My doctor advises me to consume nuts.	Lillywhite, Simonsen, and Heerema (2014)	0.803	Very important – very unimportant
4. "Pecan" Health Benefits • I believe that consuming pecans creates a healthy diet for me. • I believe that consuming pecans will help to prevent and reduce the risks of specific health conditions. • I believe that by consuming pecans, I can have a balanced diet. • I believe that consuming pecans can lower the risk of specific health conditions.	Rezai et al. (2014)	0.911	Strongly disagree – strongly agree

Table 2. (continued)

Title	Study	α	Measurement
5. Value of "pecans" • Buying pecans are a good value for the money. • When buying tree nuts, pecans seem to be a good buy. • Pecans are a fairly cheap alternative compared to other nuts.	n/a	0.852	Strongly disagree – strongly agree
6. Mexico origin "pecans": country-of-origin scale • The pecans from Mexico are a good value. • The pecans from Mexico are easily available. • The pecans from Mexico are a prestigious product.	Parameswaran and Pisharodi (1994)	0.737	Strongly disagree – strongly agree
7. U.S. origin "pecans": country-of-origin scale • The pecans from the U.S. are a good value. • The pecans from the U.S. are easily available. • The pecans from the U.S. are a prestigious product.	Parameswaran and Pisharodi (1994)	0.705	Strongly disagree – strongly agree
8. Nutrition label: Do you read the nutrition facts label printed on the food packages you consumer?			Always – never
9. Pecan consumption: On average, how often do you consume pecans?			Very often – very rarely
10. Gender: male/female			1–2
11. Household income: categorical			1–6
12. Number of members of household: categorical			1–4
13. Number of children under 18: categorical			1–5
14. Race: categorical			1–7
15. Age: categorical			1–6
16. Marital status: categorical			1–4
17. Education level: categorical			1–8

based on values of independent variables (SPSS Inc., 2001a). CART analysis is unique: It not only identifies optimal splits in continuous independent variables that allow for the greatest possible explanation in a dependent variable but also allows for simultaneous consideration of multiple interacting independent variables (Payne, Messer, and Kaiser, 2009).

This procedure can identify consumer segmentation, stratification, and prediction. Identifying key determinants allows strategic decisions to be made based on the segments. This type of information would be ideal for pecan marketers, food manufacturers, and pecan producers to assist them in understanding each of the homogeneous groups of pecan consumers based on their behavioral, psychological, and demographic characteristics (Payne, Messer, and Kaiser, 2009).

CART analysis begins with a dependent variable—in this case "frequency of pecan consumption"—to develop the CART decision tree. Identifying the dependent variable, the analysis evaluates each of the independent "binary" variables and determines which of these variables will produce the greatest reduction in error variance in the dependent variable. Specifically, the CART analysis identifies the independent variables and creates a binary split from a continuous variable or uses a binary split from an established binary variable. Either of these "splits" are confirmed to produce the greatest dependent-variable separation and are only allowed for binary decisions. This removes the potential to measure misclassification and the properties of the final tree selected (Liu, Kanter, and Messer, 2013, Payne, Messer, andKaiser, 2009). Reducing the error variance in the dependent variable by accounting for the binary independent variable is considered an "improvement score." This improvement score is the pooled, weighted estimate of variance between subgroups that is obtained by determining the least squared deviation or weighted variance for each group:

(1)
$$Variance(t) = \frac{1}{N(t)} \sum_{i \in t} (y_i - \bar{y}(t))^2,$$

where $N(t)$ is the number of people in a particular group, y_i is the frequency of pecan consumption of the ith person in the group, and $\bar{y}(t)$ is the mean frequency of pecan consumption. The variance and associated variance of the subgroups are subtracted from the variance of the parent group:

(2)
$$Improvement = Rp(t) - p_t R(t_t) - p_b R(t_b),$$

where $Rp(t)$ is the variance of frequency of pecan consumption (t) multiplied by the ratio of people (p) in the group to total people in the population; $p_t R(t_t)$ is the variance of subgroup (t) multiplied by the ratio of people (p_t) in the highest-ranking subgroup to total people in the population; and $p_b R(t_b)$ is the variance of a subgroup (t) multiplied by the ratio of people (p_t) in the lowest subgroup to total people in the population (Payne, Messer, and Kaiser, 2009; SPSS Inc., 2001b).

Results

In this CART analysis, 22 variables were used as candidate variables for possible classification of homogeneous groups of pecan consumers (see Table 2 for variable/scale descriptions). Participants' frequency of pecan consumption is the dependent (target) variable. Figure 2 illustrates the initial classification tree generated by the CART analysis. Each subgroup (node) indicates a significant variable in the decision process and consists of the mean, standard deviation, and number of observations for each split. Through the initial CART analysis three variables—health benefits, perceived value, and product attributes—were among the largest splits of homogeneous groups of pecan consumers, with health benefits being the highest level in the hierarchy.
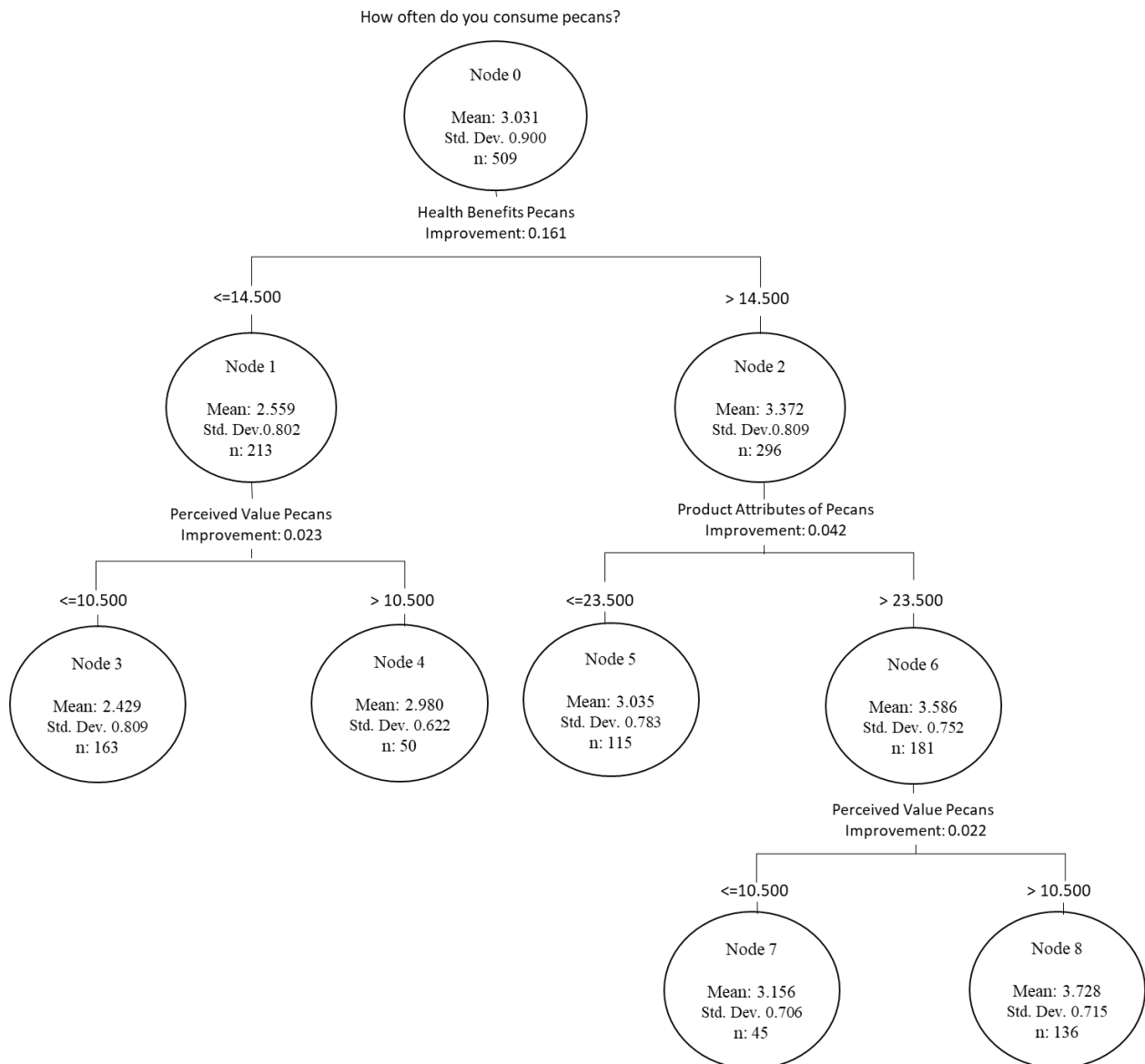

Figure 2. CART Analysis – Health Benefit Split

The first split is the health benefit variable, which indicates participants' pecan consumption is separated by their perceptions of the health benefits of pecans. This separation ranked highest in the tree and indicates the importance of health benefits to the decision process. Node 2, the 296 participants who agree or strongly agree that pecans are healthy, indicated that 58.2% of the sample perceived pecans as a healthy item. The remaining participants who ranked pecans as less than "agree" that pecans are healthy were reported in Node 1 and represented 41.8% of participants. Node 1 also had a split and led to further classification into Nodes 3 and 4. The participants from Node 1 were also concerned with the value of pecans. In total, 163 (32%) of these individuals considered pecans to be expensive or a poor value, while just under 10% considered them to be a good value by indicating they "agree" or "strongly agree." Understanding the relationship between these two splits provides some intuitive understanding of pecan consumption.

To further our understanding, we split Node 2 into Nodes 5 and 6, where participants who are aware of pecans' health benefits also consider pecan attributes to be a significant reason for consumption. Interestingly, Node 5 represents a split, with 115 participants indicating they were "neutral" or less concerned with pecan attributes with a mean of 3.035. The 181 participants in Node 6 indicated it was "important" or "very important" for pecans to taste good, be nutritious, have health benefits, are a good value, easy to use in their recipes, and have been mentioned by their doctor to consume more. This node had a mean of 3.586 and represents a total of 35.6% of all participants and 61% of those who consume pecans because of their health benefits (Node 2).

The "perceived value" variable is also significant at the Node 6 split indicating the individuals who consume pecans because of their health benefits and who enjoy the product's attributes, such as taste and nutrition, also consider their perceived value, as indicated in Nodes 7 and 8. The 136 pecan consumers in Node 8 indicated they generally perceive pecans are a good value to other tree nuts, are considered a good buy in general and are a cheap alternative to other tree nuts. The mean of Node 8 was 3.728 with a standard deviation of 0.715. This split also reflected a smaller group of pecan consumers, Node 7, that were either neutral or less when considering the perceived value of pecans. This population was significantly smaller than its sister node, with only 45 participants.

Considering the splits of this CART decision tree with a total of 509 observations a close evaluation of the distribution is necessary to truly understand the significance of each of these variables and how they influence consumption. The top level of the decision tree, Node 3 with 163 (32%), has the lowest level of pecan consumption. This node represents a group of pecan consumers that consider the cost of pecans to be too expensive, even considering their health benefits. This same "perceived value" variable also is found to be involved in the more enthusiastic pecan consumers in Nodes 7 and 8. Consumers of pecans recognize the value of pecans and acknowledge the influence of value on their consumption. Table 3 shows the distribution of observations into different groups. This CART analysis accounts for a 16.1% of the unexplained variance in frequency of pecan consumption.

Moving this research forward and recognizing the importance of product origin, two additional CART analyses were done to examine the change in the decision tree when using the variables "U.S. origin pecans" or "Mexico origin pecans" to generate a decision tree. Figures 2 and 3 illustrate the differences. These two variables provide an opportunity to examine the influence of product origin when evaluating consumers' consumption of pecans. As was initiated in the general

Table 3. Classification of Participants' Pecan Consumption Gain Summary for Nodes

Percentage	Mean
26.7	3.73
8.8	3.16
22.6	3.03
9.8	2.98
32.0	2.43

Note: Growth method: CRT. Dependent variable: On average, how often do you consume pecans?

pecan consumption decision tree (Figure 2), all 22 variables were included in each of the origin forced CART analyses. These two different decision trees reflect the significance of product origin on the decision process.

Reviewing the U.S. country-of-origin decision tree (Figure 3) demonstrates the importance of the health benefits on consumption of pecans in the United States. Nodes 1 and 2 indicate the effect of pecan origin on consumption and at the point of the split, the value of 10.5 indicates the importance of health when forcing the initial split. This initial split results in the sample distribution of 58.5% (Node 1) and to 41.5% (Node 2).

From Node 1, the next significant variable is health benefits of pecans. The consumers who consider the product origin to be less important or neutral, consistent with the initial model, indicated the overall importance of the health benefits of pecans. Node 3 represents 135 participants, while Node 4 represents 163. Node 4 continues to split, identifying "perceived value" as the next significant variable. This split is also consistent with the general decision tree and reflects the participants perceived value concerns of pecans. Node 7 represents 115 respondents who answered with "neutral" to "very unimportant" when asked about the value of pecans. These 115 respondents demonstrate the consumers concern for the price of pecans in relations to other tree nuts and alternatives nuts. Node 8 represents only 48 participants who indicated that they "agree" or "strongly agree" that pecans are a good value, are a good buy compared to other tree nuts, and are a cheap alternative compared to other nuts.

This U.S. country-of-origin decision tree deviates from the initial general decision tree beginning with Node 2. Node 2 splits, with consumers indicating the importance of the health benefits of pecans. Splitting into Nodes 5 and 6 representing a total of 211 participants, divided at the point of "agree" or "strongly agree" on the health benefits of eating pecans, with a mean of 3.412. Node 6 represents the consumers who believe consuming pecans to be healthy for their diet, will help prevent and reduce the risks of specific health conditions, helps maintain a balanced diet, and can lower the risk of specific health conditions (mean 3.791). Node 6 also splits into Nodes 9 and 10, which focus on the importance of the nutrition facts label on packaging. Node 10 represents 44 respondents with a mean of 4.091, while Node 9 has a mean of 3.511 and represents 47 respondents. Table 4 reports the distribution of the observations and the gains summary. This result provides evidence and direction for pecan marketers that consumers do in fact use the nutritional label on the packaging. Understanding that current pecan consumers consider the health benefits of pecans and do reference the nutrition facts label on the packaging provides pecan producers with additional information on how to influence consumption of U.S.-grown pecans. This CART
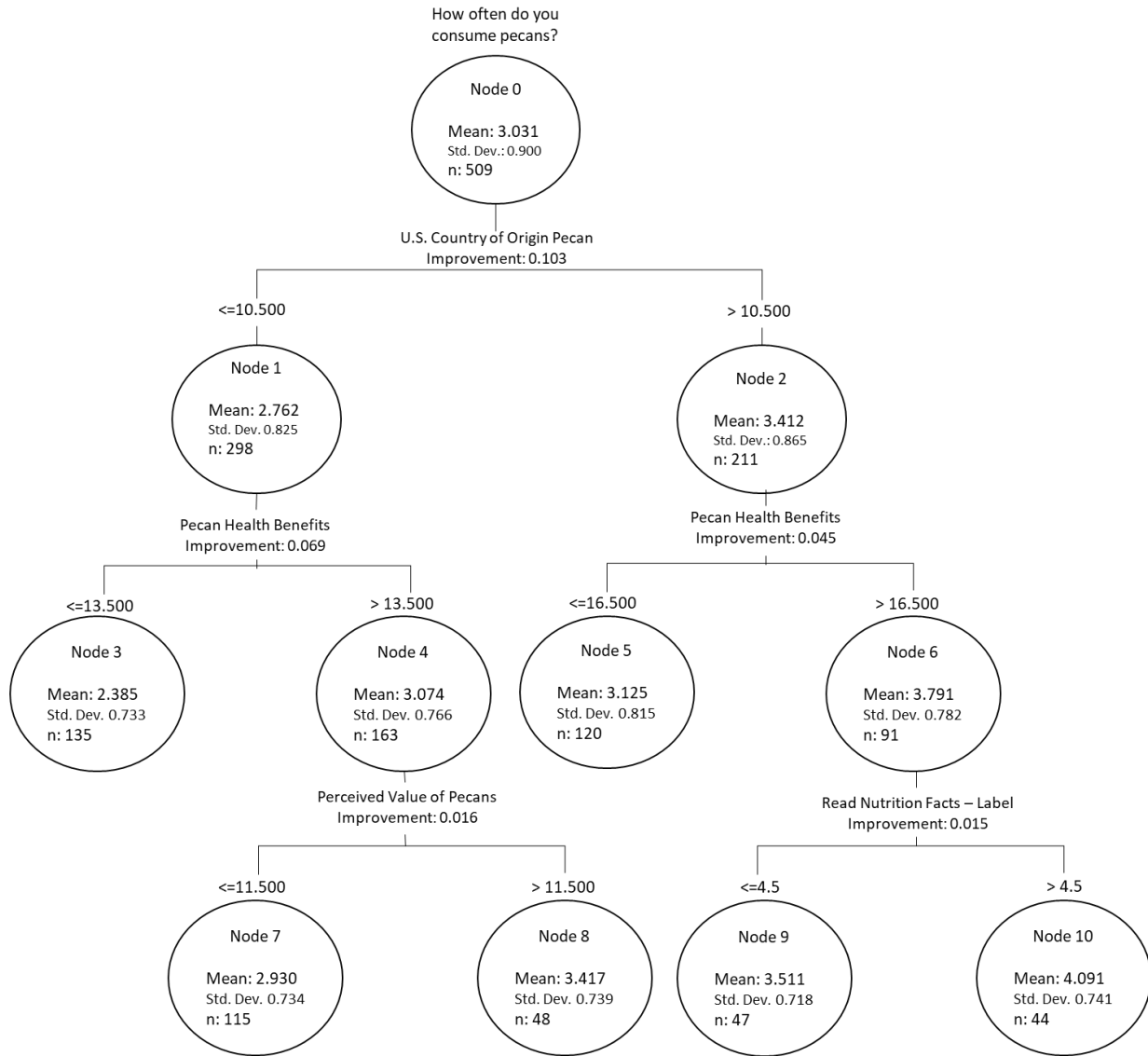
Figure 3. CART analysis – U.S. Country of Origin Split

Table 4. Classification of U.S. Pecan Origin Gains Summary for Nodes

Percentage	Mean
8.6	4.09
9.2	3.51
9.4	3.42
23.6	3.13
22.6	2.93
26.5	2.39

Note: Growth method: CRT. Dependent variable: On average, how often do you consume pecans?

analysis accounts for 10.3% of the unexplained variance in frequency of pecan consumption when forcing the U.S. pecan origin variable to be the first split.

The final CART analysis, the Mexico country-of-origin decision tree, also provides evidence of the effects of different variables' impacts on the pecan consumption. Applying the same 22 independent variables to the consumers' pecan consumption dependent variable, while forcing the initial split to be on the Mexico country-of-origin variable demonstrates a change of the ranking of several of the key variables and their influence on consumption. Figure 4 provides the illustration of the decision tree and CART analysis for the Mexico country-of-origin variable.

Forcing the initial split to utilize the Mexico country-of-origin variable rather than the U.S. country-of-origin CART analysis provided a very different perspective of respondents. The initial split, Node 1 and Node 2, was divided at "neutral" to "strongly disagree" that Mexico-grown
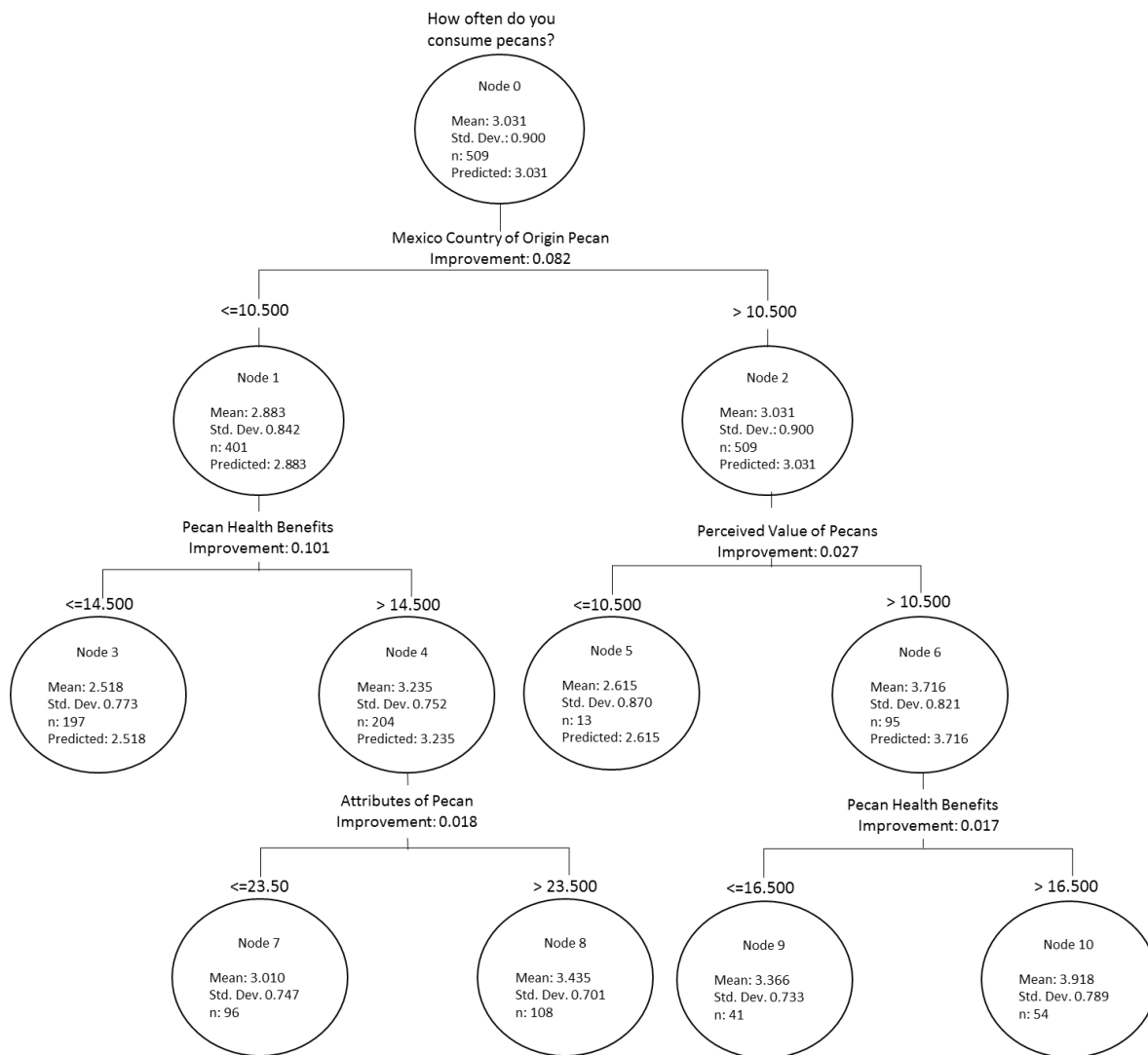

Figure 4. CART Analysis – Mexico Country of Origin Split

pecans are a good value, easily available, and are a prestigious product (Node 1: mean = 2.883, $n = 401$). Node 1 further splits into Nodes 3 and 4, representing the "health benefit" variable. Node 3 (mean = 2.518; $n = 197$) represents a group of respondents that indicated they were "neutral" to "strongly disagree" that consuming pecans creates a healthy diet, will prevent and reduce the risks of specific health conditions, helps maintain a balanced diet, and can help lower the risk of specific health conditions. Node 4 (mean = 3.235; $\underline{n}$ = 204), also based on the same scale, was categorized in the "agree" to "strongly agree" groups concerning the health benefits of consuming pecans. Node 4 was further split into Nodes 7 and 8 by the pecan attributes variable. Node 8 (mean = 3.435; $n = 108$) indicates the importance of the actual attributes of pecans: taste, nutrition, and specific health benefits.

Node 2 had only 108 respondents, who indicated they "agree" or "strongly agree" that Mexico-grown pecans were a good value, easily available, and a prestigious product (mean = 3.583; $n = 108$). This split progresses to include the "perceived value" of pecans in Nodes 5 and 6. Node 6 is significant (mean = 3.716; $n = 95$), representing the group that responded with "agree" to "strongly agree" that pecans are a good value, a good buy compared to other tree nuts. and a fairly cheap alternative to other nuts. Node 6 further splits to Nodes 9 and 10 with the health benefit variable. These final nodes were split, with 41 respondents in Node 9 (mean = 3.366) and Node 10 reporting "neutral" to "strongly agree" that consuming pecans creates a healthy diet helps prevent and reduce the risks of specific health conditions, helps maintain a balanced diet, and lowers the risk of specific health conditions (mean = 3.981). The gains summary in Table 5 breaks down each Node division and reports the means. CART analysis accounts for 8.2% of the unexplained variance in frequency of pecan consumption when forcing the Mexico pecan origin variable to be the first split.

Table 5. Classification of Mexico Pecan Origin Gains Summary for Nodes

Percentage	Mean
10.6	3.98
21.2	3.44
8.1	3.37
18.9	3.01
2.6	2.62
38.7	2.52

Note: Growth method: CRT. Dependent variable: On average, how often do you consume pecans?

Several key variables were found to be significant in all three of these CART analyses: health benefits, pecan attributes, and perceived value. However, they each failed to find any of the specific demographics variables—age, income, marital status, education, and ethnicity—to be significant.

Conclusion

This work provides evidence, through CART analysis, of homogeneous characteristics of consumers who currently consume pecans. This CART analysis was applied to data from a nonstudent online survey asking participants to provide details about their current pecan consumption, shopping perceptions, health perceptions, and demographic details. This data along

with the statistical approach followed allows researchers to explore how consumers in diverse groups have different hierarchical vales for product perceptions and pecan attributes. This CART analysis produced three different decision trees that indicated several key variables that were consistent throughout this research. The most significant evidence was the ranking of perceived health benefits, which was the first split for all three decision trees. Perceived value, pecan attributes, and nutrition label details all trailed perceived health benefits but were found to be significant.

Understanding how consumers perceive the health benefits of pecans and how they view their own health could provide additional opportunities to increase domestic consumption. The scales that included health and the perceived health benefits of pecans were found to be significant in all three CART analyses. These results are largely consistent with the current literature on pecan consumer demographics but provides evidence of the hierarchical status of the perceptions of health benefits. With this evidence and an effort to emphasize health benefits within the marketing activities may provide the desired growth for domestic consumption. A potential direction for pecan marketers could be to provide consumers with additional information about how consuming pecans may improve their health. Messages focused on how pecans are a good source of "good cholesterol," are "heart healthy," and provide a good source of naturally occurring antioxidants and minerals may connect with potential new consumers.

To further the discussion on increasing consumption, consumer perceptions of value ranked below perceived health benefits, providing evidence for marketers to communicate the overall value of consuming pecans. The perception of value was significant in all three decision trees but ranked in different node levels. Pecan producers and marketers must understand the significance of this variable and how it can negatively affect overall pecan consumption. Producers and marketers must be careful to price pecans competitively relative to other tree nuts, while realizing that consumers have many options for consuming healthy nuts. Substitution of other nuts based on pricing should be closely monitored and considered when considering how to expand U.S. consumption of pecans.

Unique only to the U.S. pecan origin decision tree was the variable concerning the nutrition facts label. The significance of this variable, splitting from the health benefits of pecans, confirms that these consumers are reading the nutrition fact label on the packaging. They are searching for nutrition information on pecans and should be open to receive new facts about pecans benefits. This outcome provides evidence that current U.S. pecan consumers are searching for information on pecans.

This study also suggests that factors which have been commonly accepted as variables to increase pecan consumption—such as income, gender, education level, ethnicity—were not primary determinants of the frequency of pecan consumption. These results indicate some of the inconsistencies among the current understanding of the pecan consumer. These inconsistencies may be mitigated through additional research of pecan consumers through the recruitment of additional research participants, restructuring the online survey to target more specifically the relationship between demographics and consumption, and further application of CART analysis technique.

Overall, the CART analysis confirmed that respondents enjoy pecans. They like their taste, know they are nutritious and can be part of a healthy diet, and are more likely to view U.S.-grown pecans as a good value. Increasing U.S. consumption of pecans could be as easy as the inclusion in a new healthy snack item, a feature in a health-focused magazine or website, or product development of a new line of easy-to-prepare meals with healthy pecans as a feature source of protein. Consumers will continue to consume pecans as long as the price of the product is competitive to other tree nuts and they continue to be viewed as part of a healthy diet.

References

Aaker, J.L., and A.Y. Lee. 2001. "'I' Seek Pleasures and 'We' Avoid Pains: The Role of Self-Regualtory Goals in Information Processing and Persuasion." *Journal of Consumer Research* 28(1): 33–49.

Botonaki, A., and M. Konstadinos. 2010. "Revealing the Values behind Convenience Food Consumption." *Appetite* 55(3): 629–638.

Breiman, L., J. Friedman, R. Olshen, and C. Stone. 1984. *Classification and Regression Trees*. Belmont, CA: Wadsworth International Group.

Cardoso, M.G.M.S., and L. Mountinho. 2003. "A Logical Type Discriminant Model for Profiling and Segment Structure." *Journal of Targeting, Measurement and Analysis for Marketing* 12: 27–41.

Field, A. 2014. *Discovering Statistics Using IBM SPSS Statistics*, 4th ed. Los Angeles, CA: Sage.

Hall, G.D. 2000. "Pecan Food Potential in Prehistoric North America." *Economic Botany* 54: 103–112.

Hoffman, D.L., and T.P. Novak. 1996. "Marketing in Hypermedia Computer-Mediated Environments: Conceptual Foundations." *Journal of Marketing* 60(3): 50–68.

Lichtenstein, D.R., N.M. Ridgway, and R.G. Netemeyer. 1993. "Price Perceptions and Consumer Shopping Behavior: A Field Study." *Journal of Marketing Research* 30(2): 234–245.

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.

Lin, B.H., E. Frazao, and J. Allshouse. 2001. "U.S. Consumption Patterns of Tree Nuts. Industry Report." *FoodReview* 24(2): 54–58.

Liu, Z., C.A. Kanter, and K.D. Messer. 2013. "Identifying Significant Characteristics of Organic Milk Consumers: A CART Analysis of an Artefactual Field Experiment." *Applied Economics* 45: 3110–3121.

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.

Lu, F., J.B. Kadane, and P. Boatwright. 2008. "The Dirt on Bikes: An Illustration of CART Models for Brand Differentiation." *Journal of Product & Brand Management* 17(5): 317–326.

McKay, D.L., M. Eliasziw, C.Y. Chen Oliver, and J.B. Blumberg. 2018. "A Pecan-Rich Diet Improves Cardiometabolic Risk Factors in Overweight and Obese Adults: A Randomized Controlled Trial." *Nutrients* 10(3): 339.

Mertens-Talcott, S.U., and S.S. Percival. 2005. "Ellagic Acid and Quercetin Interact Synergistically with Resveratrol in the Induction of Apoptosis and Cause Transient Cell Cycle Arrest in Human Leukemia Cells." *Cancer Letters* 218(2): 141–151.

Moser, R., R. Raffaelli, and D.T. McFadden. 2011. "Consumer Preferences for Fruits and Vegetables with Credence-Based Attributes: A Review." *International Food and Agribusiness Management Review* 14(2): 121–142.

Ortiz-Quezada, A.G., L. Lombardini, and L. Cosmerps-Zevallos. 2011. "Antioxidants in Pecan Nut Cultivars [*Carya illinoinensis* (Wangenh.) K: Koch]." In V.R. Preedy, R.R. Watson, and V. B. Patel, eds., *Nuts and Seeds in Health and Disease Prevention*. Amsterdam, Netherlands: Elsevier, pp. 881–889.

Palma, M.A., A.J. Collart, and C.J. Chammoun. 2015. "Information Asymmetry in Consumer Perceptions of Quality-Differentiated Food Products." *Journal of Consumer Affairs* 49(3): 596–612.

Parameswaran, R., and R.M. Pisharodi. 1994. "Facets of Country of Origin Image: An Empirical Assessment." *Journal of Advertising* 23(1): 43–56.

Payne, C.R., K.D. Messer, and H.M. Kaiser. 2009. "Which Consumers Are Most Responsive to Media-Induced Food Scares?" *Agricultural and Resource Economics Review* 38(3): 295–310.

Rajaram, S., L. Burke, B. Connell, T. Myint, and J. Sabate. 2000. "Effect of Pecan Rich Diet on Serum Lipids and Lipoproteins in Healthy Men and Women." *FASEB Journal* 14: 293.

Rezai, G., P.K. Teng, Z. Mohamed, and M.N. Shamsudin. 2014. "Structural Equation Modeling of Consumer Purchase Intention toward Synthetic Functional Foods." *Journal of Food Products Marketing* 20(1): 13–34.

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

SPSS Inc. 2001a. *Answer Tree 3.0: User's Guide.* Chicago, IL: SPSS Inc.

SPSS Inc. 2001b. *SPSS User's Guide*. Chicago, IL: SPSS Inc.

U.S. Department of Agriculture. 2015a. *National Pecan Statistics*. Washington, DC: U.S. Department of Agriculture, National Agricultural Statistics Service. Available online: https://www.nass.usda.gov/Statistics_by_Subject/pecans [Accessed January 11, 2015].

U.S. Department of Agriculture. August 2015b. *Pecans*. Washington, DC: U.S. Department of Agriculture, Agricultural Marketing Resource Center. Available online: http://agmrc.org/commodities-produts/nuts/pecans. [Accessed October 18, 2019].

U.S. Department of Agriculture. 2019a. *Almonds Lead Increase in Tree Nut Consumption*. Washington, DC: U.S. Department of Agriculture, Economic Research Service.

U.S. Department of Agriculture. 2019b. *Express Query*. Washington, DC: U.S. Department of Agriculture, Foreign Agricultural Service, *Global Agricultural Trade System*. Available online: apps.fas.usda.gov/gats/expressquery1 [Accessed October 17, 2019].

U.S. Department of Agriculture. 2019c. *Fruit and Tree Nuts Yearbook Tables*. Washington, DC: U.S. Department of Agriculture, Economic Research Service. Available online: https://www.ers.usda.gov/data-products/fruit-and-tree-nut-data/fruit-and-tree-nut-yearbook-tables/#treenuts [Accessed October 17, 2019].

U.S. Department of Agriculture. 2019d. *Pecan Production*. Washington, DC: U.S. Department of Agriculture, National Agricultural Statistical Service.

U.S. Department of Agriculture. 2019e. *Pecans: US Exports by Volume*. Washington, DC: U.S. Department of Agriculture, Economic Research Service. Available online: http://data.ers.usda.gov [Accessed July 16, 2019].

Villarreal, J.I., L. Lombardini, and L. Cisneros-Zevallos. 2007. "Phytochemical Constituents and Antioxidant Capacity of Different Pecan [*Carya illinoinensis* (Wangenh.) K. Koch] Cultivars." *Food Chemistry* 102(4): 1241–1249.

Wolfe, K., J. Daniels, K. Swickard, and J.C. McKissick. 2007. *U.S. Pecan Consumer Profile Results from National Survey*. Athens, GA: University of Georgia, College of Agricultural and Environmental Sciences, Center for Agribusiness and Economic Development.