Institute of Agriculture
Department of Agricultural Economics

Research Series 02-02
February, 2002

# CONSUMERS' WILLINGNESS-TO-PAY FOR POWDERY MILDEW RESISTANT FLOWERING DOGWOODS

J. G. Gardner, D. B. Eastwood, J. R. Brooker, J. B. Riley, and W. E. Klingeman
Graduate Student, Professor, Professor, and Professor, Department of Agricultural Economics and Assistant Professor, Department of Plant Science and Landscape Systems, respectively

Department of Agricultural Economics
Research Series
Knoxville, Tennessee

## Table of Contents




Additional copies of this report may be obtained from:

Department of Agricultural Economics
The University of Tennessee
2621 Morgan Circle
Knoxville, TN 37996-4518
865-974-7231
http://web.utk.edu/~agecon/

E11-1215-00-009-02

## List of Tables

## List of Figures

## Abstract

Powdery mildew is a disease affecting flowering dogwoods that can limit growth, detract from the appearance, and may cause plant decline and death. Flowering dogwoods are an important source of revenue for Tennessee's landscape nursery industry, and the state is a major source of supply of these trees. The Dogwood Research Team in the Institute of Agriculture at the University of Tennessee has developed a series of flowering dogwood trees that are resistant to powdery mildew and is considering commercial introduction by the nursery industry.

The feasibility of introducing a series of resistant trees depends to a large extent on consumer acceptance. Since the trees are not commercially available and growers require some indication of retail demand before they are likely to produce the trees, estimates of the value consumers place on the mildew-resistant trees are needed.

This report summarizes a study of consumers' willingness-to-pay(WTP), in urban areas in Tennessee, Mississippi, and Michigan, for a powdery mildew resistant tree. The purpose is to provide information about the WTP and about potential marketing strategies for the introduction of the disease-resistant tree. A contingent valuation approach is used, which asks respondents (consumers) how much they would be willing to pay for products under specified conditions. The situation described is a comparison between a traditional flowering dogwood tree as it is typically available for sale versus the same tree in terms of shape, size, and appearance, but powdery mildew resistant.

On average, survey respondents indicated that they are willing to pay a $13.35 premium for a flowering dogwood tree that is resistant to powdery mildew. It is also important to note that this premium was measured at the retail level and, therefore, reflects a cumulative effect across all stages of the distribution system. That is, the retail-level premium cannot be added at each successive stage in the distribution system from the grower to the consumer. Since people did not actually purchase the trees, the estimated WTP is considered to represent an upper bound for the average retail premium. Regression results led to inferences that the presence of dogwoods in a respondent's yard, presence of dogwoods infected with powdery mildew in a yard, landscape expenditures, presence of flower beds, landscape satisfaction, criteria for selecting plants and trees, retail outlets where respondents shop for landscape materials, geographic location, and income had significant effects on the WTP. Marketing implications include the need to provide information at the point of sale, to place the trees near flowering plants at outlets, and to interact with shoppers to determine characteristics of their yards.



***Key Words***: dogwood, powdery mildew, contingent valuation, marketing, nursery, disease resistance, maximum likelihood

## Introduction

The flowering dogwood tree is important to several groups in Tennessee. It is crucial to suppliers, such as nursery stock producers, distributors, and retailers. In 1998, Tennessee's nursery industry dogwood sales were $6.1 million (Tennessee Agricultural Statistics Service). Nationally, Tennessee was ranked first in nationwide nursery dogwood sales in 1998 (Tennessee Agricultural Statistics Service), with 23.2 percent of the nation's wholesale and retail dogwood sales (U.S. Department of Agriculture). However, these figures understate the Tennessee dogwood industry. Many nurseries produce seedlings which are sold to out-of-state nursery growers. When these unfinished dogwoods are taken into account, six counties in the State supply 80 percent of the country's dogwoods (Simmons). These counties are Coffee, DeKalb, Franklin, Grundy, Warren and White (Windham 2001).

Powdery mildew (*Microsphaera Pulchra*) is a fungal disease affecting flowering dogwoods (*Cornus florida*). Symptoms include disfigured leaves, stunted plant growth, limited flowering, and dead branches. Ultimately, powdery mildew can cause plant health decline and death. An infected tree is also more likely to develop insect, pest, and drought stress problems. Powdery mildew is difficult to control. Prevention and cure require repeated fungicide applications to maintain disease-free plants (Windham and Witte).

The disease increases growing and marketing costs for flowering dogwood nursery stock producers and distributers. Additional costs are primarily due to the increased number of fungicide applications and the loss of trees. In 1984, the estimated cost of pest and disease control during production of one acre of dogwoods was $290 over a three year period (Badenhop, Witte, and Glasgow). For 2000,

this cost estimate increased to $1,075 per acre, with the increase largely due to powdery mildew (Trigano, unpublished data.).

Flowering dogwoods have been popular ornamental trees. Homeowners, new home builders, and professional landscapers have found this tree desirable due to its bright spring flowers and fall foliage (Figure 1).

**Figure 1. Healthy Flowering Dogwood Tree in Full Bloom.**

The demand for flowering dogwoods is likely to decline because of powdery mildew for two reasons. First, as awareness of the disease increases, landscape architects and designers could substitute other ornamental trees, such as the redbud, in place of a susceptible flowering dogwood that may contract powdery mildew. Homeowners seeking to add new flowering trees or replace diseased dogwoods are

likely to choose substitute ornamental trees, as well. Second, powdery mildew confronts homeowners who purchase flowering dogwoods with the need to apply fungicides. Higher maintenance costs increase the total cost of purchasing and owning a flowering dogwood. Economic theory suggests that the result of a decrease in both supply and demand is an empirical issue because the price could increase, decrease or stay the same, depending on the elasticities of supply and demand.

The Dogwood Research Team in the Institute of Agriculture at the University of Tennessee has identified three flowering dogwood varieties that are resistant to powdery mildew. Plant patent applications have been filed and are pending for what will be known as the Appalachian™ series. This new series will have at least four impacts on supply: 1) lower production costs due to reduced spraying, 2) lower production costs due to fewer trees becoming infected while being grown in the nursery, 3) additional learning costs to nurseries as they learn to work with the new variety, and 4) additional costs to recover the expense of developing the resistant trees. Depending on the magnitudes of the impacts of these effects the net impact on supply could be positive or negative.

The introduction of a resistant tree should increase demand for flowering dogwoods. Buyers do not have to incur the risk of loss due to powdery mildew. Maintenance costs are also lowered due to a reduced need for spraying.

The feasibility of introducing a series of resistant trees depends to a large extent on consumer acceptance. Since the trees are not commercially available and growers require some indication of the demand before they are likely to produce the trees, estimates of the value consumers place on the disease-free trees are needed.

A study of consumers' willingness-to-pay (WTP) in urban areas in Tennessee, Mississippi, and Michigan for a powdery mildew resistant tree is described. The objectives were to: 1) estimate WTP for the new tree, 2) estimate WTP as a function of a homeowner's landscape characteristics, knowledge of tree and shrub pest and disease problems and socioeconomic measures, and 3) develop marketing implications based on these estimates. Analysis is based on the contingent valuation approach. Respondents (consumers) were asked how much they would be willing to pay for a product under specified conditions. In this context, it was a comparison between a traditional flowering dogwood tree versus the same tree in terms of shape, size, and appearance, but powdery mildew resistant.

## Methodology

WTP

Traditionally, consumer demand is considered to be a function of a person's ability and willingness to buy a quantity of a good or service (e.g. Eastwood). The former depends on the money budgeted and prices. The latter is derived from a consumer's preferences for the goods and services. The consumer's objective is to maximize utility, subject to a budget constraint, where the satisfaction derived from goods and services determines the willingness to trade, and money and prices determine the ability to trade. Maximization occurs where the consumer obtains the greatest utility, given preferences, market conditions, and income. Traditional demand analysis models the quantity demanded as a function of income and prices. Advertising (marketing) and demographics are also included as determinants to allow for these variables' effects on preferences.

The resistant flowering dogwood tree is not available in the marketplace, so the demand for the tree cannot be estimated using sales and price data. An alternative approach is to ask people the amount of compensation required (change in income) to remain as well off in different situations. The amount is considered to be an estimate of the WTP. With respect to flowering dogwoods, the two situations are to purchase a nonresistant traditional tree versus an identical powdery mildew resistant tree. It was assumed that the consumer would get more utility from, and spend less maintaining, the resistant tree and, therefore, would be willing to pay more for the tree. The setting involves considerations of the WTP for a resistant tree, or a contingent valuation. The respondent is asked to reveal the value of the disease resistance in such a way that the person is just as well off, regardless of which tree is actually purchased.

There has been much debate as to how a survey should ask the WTP question (e.g., Bishop and Heberlein; Whittington et al.; Mitchell and Carson; Rowe, Schulze, and Breffle). Often a price, called a bid, is given, and the respondent is asked if he or she would pay more or less than this price. This method has been called a bidding game. It can be followed with either an inquiry as to how much more or less the respondent is willing to pay, or with subsequent bids. Much of the debate about this method centers on whether the amount of the initial bid causes a starting point bias (Bishop and Heberlein).

Use of the payment card method, sometimes called the bidding card method, reduces the potential of starting point bias. It is common for a payment card to be anchored, where prices for similar goods or services are placed on the card for reference points. A potential drawback of an anchored payment occurs when there is price variation among retailers, making it difficult to create a single reference price setting. Additionally, the anchors on the card could lead the respondent to an answer, causing a bias. An unanchored payment card, where the respondent is asked to choose a WTP amount within a specified range, was developed in order to minimize these problems.

One criticism of the contingent valuation method in general is the possibility for strategic bias (e.g., Whittington et. al.). Strategic bias occurs when a respondent, in an attempt to increase the likelihood that a good will be brought to market, will overstate his or her WTP. It is also possible for a respondent to understate WTP in an attempt to lower the market price (Mitchell and Carson). According to Whittington et al. (298) "most of the available evidence from the United States and Western Europe fails to support the hypothesis that individuals will act strategically in answering contingent valuation questions..." With respect to dogwoods and powdery mildew, there is little for the individual to gain from acting strategically, and no one individual could influence the survey, just as an individual cannot influence the market.

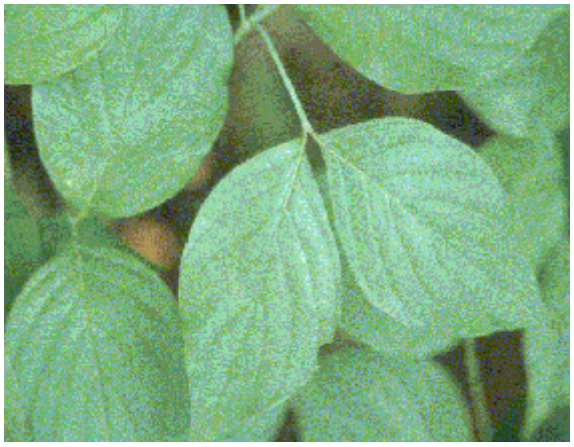
Range bias is more likely to occur when the payment card range is either too large or too small. The respondents might not find their actual WTP within the specified range if it is too small, thus affecting the WTP mean and standard deviation. "Range bias may also result if a larger than necessary range encourages the reporting of spuriously high WTP values that, while not affecting the remainder of the WTP distribution, can bias upward the mean WTP" (Rowe, Schulze and Breffle, 181). Examining the distribution of WTP could reveal these biases. If there is a problem, the upper or lower tails could contain a large number of observations or there may be a tendency for respondents to pick the middle value, a centering bias.

One other potential source of bias is due to substitution effects (Cummings, Ganderton and McHuckin; Hoehn; Hoehn and Loomis; Kahneman and Knetsch). That is, a respondent's WTP could be affected by substitutes and complements. To the extent they are systematically omitted from the decision making, estimates of the WTP would be biased. Such a bias is not considered to be present in this study because alternative landscape trees are promoted where the sampling took place.

Display

A display was designed for use in a booth at home and garden shows. The objective of the display was to inform visitors of the powdery mildew problem. A brief, non-technical explanation of the disease, in large, easy to read text, helped visitors to understand the powdery mildew problem quickly. Pictures at the display served to visualize the effects of powdery mildew. These included a large flowering dogwood in full bloom (Figure 1), a close-up of healthy dogwood leaves, and a close-up of diseased flowering dogwood leaves (Figure 2). The display materials were intended to enable people to identify powdery

mildew on their own flowering dogwoods. Master Gardeners[1] or State Extension personnel were available to answer questions. After viewing the information presented, people were asked to fill out a questionnaire and drop it in a box beside the display.



**Figur**

**e 2. Healthy and Diseased Flowering Dogwood leaves**

Questionnaire

The questionnaire had three parts: (1) a WTP setting; (2) landscape questions, which gathered data on the type of yard, landscape elements present in the yard, awareness and knowledge about tree and shrub diseases and pests; and (3) demographic questions which gathered socioeconomic data on the respondents. Appendix A contains the questionnaire.

[1]Volunteers who have taken part in Extension Service horticulture training, for example 35 hours horticulture Extension instruction at the University of Tennessee (Sams).

The survey began with a statement to create the WTP setting. The respondent was asked to assume that his or her favorite retailer was selling dogwood trees of uniform size in the standard five gallon container; the trunks were one inch in diameter, and height was five feet. Question 1 asked the respondent how much more he or she was willing to pay for an identical dogwood tree, except that it was resistant to powdery mildew. The respondent was then provided a range of values, starting at $0 and ending at $30, increasing by $1 increments. Although not stated in the survey, the range was based on an expected price of a nonresistant dogwood tree being between $50 and $100 dollars, depending on the type of retailer. In this way the range on the payment card was designed to cover the likely range of responses (Cameron and Hupert). In addition, the range used, $0 to $30, was to cover any additional production-related costs, such as learning how to work with a new variety, providing a return to the University of Tennessee Experiment Station, and the administrative cost of a certification program.

In the second section, most questions prompted the respondent to check items from a list, or rank items in a list. These items were designed to discover the characteristics of the respondent's landscape (Questions 2-6 and 8); expenditures on landscaping (Questions 5 and 6), knowledge of landscaping (Questions 7,9,12 and16), criteria for selecting trees and shrubs (Questions 10 and 13), where plants were purchased (Question 14), opinions about quality of plants purchased (Question 15), and opinions about pesticide use (Question 11).

The socioeconomic measures that were gathered reflected trade-offs among the length of the questionnaire, time required for completion, and a desire to obtain data on both landscape and respondent characteristics. An additional consideration was an interest in avoiding too few observations in some

response categories by trying to gather too much detail from a limited sample. The socioeconomic information gathered included homeownership, age, gender, and income before taxes.

Survey Method

Booths were set up at four lawn and garden shows. The University of Tennessee Extension service had booth space at two shows, one in Knoxville, Tennessee, and the other in Nashville, Tennessee. Michigan and Mississippi Extension Services made similar arrangements in Detroit, Michigan and Jackson, Mississippi, respectively. Booths were staffed by Master Gardeners who chose survey respondents at random. The specific home and garden shows were selected for several reasons: 1) availability of both space 2) geographic dispersion and 3) availability of local staff to conduct the survey.

People attending a home and garden show comprise a desirable target population from which to draw a sample, given the present interest in deriving an estimate of the WTP for a variety of flowering dogwood that is not currently available in the market place. These shows are where consumers can gather information about landscape products they are interested in buying. The setting also helped to mitigate substitution bias because many types of plants, trees and yard care alternatives are on display at these shows.

Modeling the WTP

The additional price a respondent is willing to pay for a powdery mildew resistant flowering dogwood is the dependent variable which is considered to be a function of measures associated with responses to other questions in the survey. WTP is assumed to be normally distributed. The limited payment range of $0 to $30 represents a double-censored variable. A reported WTP an additional $30

for the resistant tree could mean one of two things. The respondent was willing to pay a premium of exactly $30, or he or she would pay more than $30. A reported WTP of $0 could mean the respondent was not willing to pay a premium in this situation, he or she would never pay more in any situation, or the person would pay less to compensate for the risk that the new variety could develop other problems.

Censoring of a dependent variable requires maximum likelihood estimation (Greene). Appendix B outlines the derivation of the regression equation used in this study. The next section of this report contains a description of the variables used in the analysis.

## Results

Survey participants completed 610 questionnaires: 147 from Knoxville, Tennessee; 269 from Nashville, Tennessee; 132 from Detroit, Michigan; and, 62 from Jackson, Mississippi. The Master Gardeners staffing the booths did not report any data on the number of people asked to complete a questionnaire, therefore, the response rate is unknown. Descriptions of the data and univariate and pairwise tests of independence among responses to the questions are available elsewhere (Klingeman et al.). The discussion below presents characteristics of the respondents, landscape characteristics, and awareness and knowledge of disease and pest problems. The coding changes, described in the Independent Variables section, resulted in a reduction in sample size to 472 observations for the regression analysis.

Descriptive Statistics

Characteristics of the respondents are displayed in Table 1. They were typical of people expected to attend home and garden shows and were similar to those found in other surveys of landscape plant buyers (e.g., Safley, Wohlgenant and Rezitisl; Barton et al., Hudson et al. and Hardy et al.). Almost all were homeowners. The percentage of respondents who owned their own homes ranged from a low of 92 percent in Knoxville to 98 percent in Jackson. The typical respondent had a higher income than the median income for the population of the respective state. The median incomes in the four samples were $60,500 for Knoxville, $67,250 for Nashville, $69,750 for Detroit and $63,750 for Jackson. For 1999 the median incomes in Tennessee, Michigan, and Mississippi were $36,536, $46,238 and $32,450, respectively (U. S. Census Bureau 2001a). Given the costs of owner-occupied housing, the prevalence of higher income respondents was not unexpected. Respondents were generally older than the corresponding

population. The median ages of respondents in the four samples were 50.7, 49.8, 53.2 and 51.1 for Knoxville, Nashville, Detroit, and

Table 1. Descriptive Characteristics of Survey Respondents.

| | Knoxville, Tennessee | Nashville, Tennessee | Detroit, Michigan | Jackson, Mississippi |
|---|---|---|---|---|
| **Number of Respondents** | 147 | 269 | 132 | 62 |
| **Homeownership (percentage)** | 92 | 95 | 94 | 98 |
| **Respondent's Median Income** | $60,500 | $67,250 | $69,750 | $63,750 |
| **Median Income for State**[1] | $36,536 | $36,536 | $46,238 | $32,450 |
| **Respondents's Median Age** | 50.7 | 49.8 | 53.2 | 51.1 |
| **Median Age for MSA** | 37.3[2] | 34.5[2] | 35.5[3] | 33.0[4] |
| **Existing Dogwood in Landscape (percentage)** | 86 | 80 | 47 | 72 |
| **Powdery Mildew Present in Landscape (percentage)** | 16 | 29 | 7 | 16 |
| **Average Annual Landscape Expenditures**[5] | $886 | $1,058 | $973 | $552 |

[1]U.S. Census Bureau; "Median Household Income by State: 1984 to 1999;" <http://www.census.gov/hhes/income/histinc/h08.html>: (accessed: 21 June 2001)

[2]U.S. Census Bureau; "Profiles of General Demographic Characteristics 2000 Census of Population and Housing Tennessee;" 2kh47.pdf; published May 2001; <http://www.census.gov/prod/cen2000/index.html>.

[3]U.S. Census Bureau; "Profiles of General Demographic Characteristics 2000 Census of Population and Housing Mississippi;" 2kh28.pdf; published May 2001; <http://www.census.gov/prod/cen2000/index.html>.

[4]U.S. Census Bureau; "Profiles of General Demographic Characteristics 2000 Census of Population and Housing Michigan;" 2kh26.pdf; published May 2001; <http://www.census.gov/prod/cen2000/index.html>.

[5]Among respondents who indicated landscape expenditures during 1999.

Jackson, respectively, versus median population ages for the metropolitan statistical areas (MSA) of 37.3 in the Knoxville MSA, 34.5 in the Nashville MSA, 33.0 in the Jackson MSA, and 35.5 in the Detroit MSA (U.S. Census Bureau 2001b,c,d). An older age distribution, for the sample versus the population, is consistent with the need to accumulate sufficient savings to at least make the down payment on a housing unit.

Landscape characteristics can give insight into the tastes and preferences of respondents for dogwoods. The majority of the respondents in the three southern areas already had dogwoods in their landscapes (86 percent in Knoxville, 80 percent in Nashville, and 72 percent in Jackson). In Detroit 47 percent of respondents indicated the presence of dogwoods in their landscapes. This pattern seems reasonable because dogwoods are more suited to warmer climates.

At least 63 percent of the respondents in each city indicated that they had some pest or disease problems with the dogwoods in their landscapes. Powdery mildew was reported in 16 percent of Knoxville's dogwoods, 29 percent of Nashville's, 7 percent of Detroit's, and 16 percent of Jackson's. Their differences are statistically significant (Klingeman et al.). The low occurrence of powdery mildew in Detroit is likely a result of the climate since powdery mildew survives better in warmer climates (Windham).

Respondents were asked to estimate their annual expenditures in 11 yard-related categories (see Question 5 in Appendix A). These were summed by respondent to obtain an estimate of a household's overall landscape expenditures. The average annual expenditure per lawn and garden ranged from a low of $552 in Jackson to a high of $1,058 in Nashville.

A variety of other factors may have influenced WTP for powdery mildew resistant dogwoods. The type of outlet where a respondent purchased trees could be related to WTP. The market price is only

one component of the price the consumer pays to use goods and services (Eastwood). With respect to dogwoods, other components of the consumer's price are transportation costs and time involved in shopping, acquiring information, and caring for the tree. Consequently, market price variation across outlets is consistent with differences in consumers' WTP for resistant trees.

Independent garden centers, retail chains, nurseries, and mail order businesses were the retail outlets used most frequently by the respondents in all four cities. Some people (16 percent in Knoxville, 24 percent in Nashville, 33 percent in Detroit, and 13 percent in Jackson) indicated that they purchased landscape plants from farm markets or truck stands. These percentages were significantly different across cities (Klingeman et al.). Respondents typically reported that the quality of landscape plants purchased was good, regardless of the type of retail outlet.

Over half of the respondents (54 percent in Knoxville, 58 percent in Nashville, 64 percent in Detroit, and 50 percent in Jackson) have annual flower beds in their landscapes. In Knoxville, Nashville, Detroit and Jackson, 32 percent, 41 percent, 52 percent, and 43 percent of respondents, respectively, were content with their landscapes.

Question ten prompted the respondent to indicate why he or she chose landscape trees. Of particular interest to this study was disease resistance which was reported as important by 22 percent of all respondents. The top reasons for selecting trees were reported as size/shape, ease of maintenance, attracts birds/animals, flower color, and flowering season. Responses for this partial list are summarized in Table 2.

WTP

The goal of estimating the regression equation was to identify determinants of respondents' WTP more for the resistant flowering dogwood. Figure 3 shows the distribution of WTP, the dependent variable, by percentage of respondents. Only eight respondents

Table 2. Reasons to Select Trees for Landscape Use (percent).

| Factor | Knoxville (n=147) | Nashville (n=269) | Detroit (n=132) | Jackson (n=62) | Combined (n=610) |
|---|---|---|---|---|---|
| **Size/Shape** [1] | 51 | 48 | 61 | 40 | 51 |
| **Ease of Maintenance** | 47 | 43 | 44 | 42 | 45 |
| **Attracts Birds/Animals** | 37 | 31 | 38 | 32 | 34 |
| **Flower Color** | 30 | 35 | 32 | 37 | 33 |
| **Flowering Season** | 35 | 31 | 32 | 35 | 32 |
| **Disease Resistance** | 20 | 22 | 24 | 23 | 22 |

[1] Significantly different across cities at the 0.5 level, chi-square = 8.67.

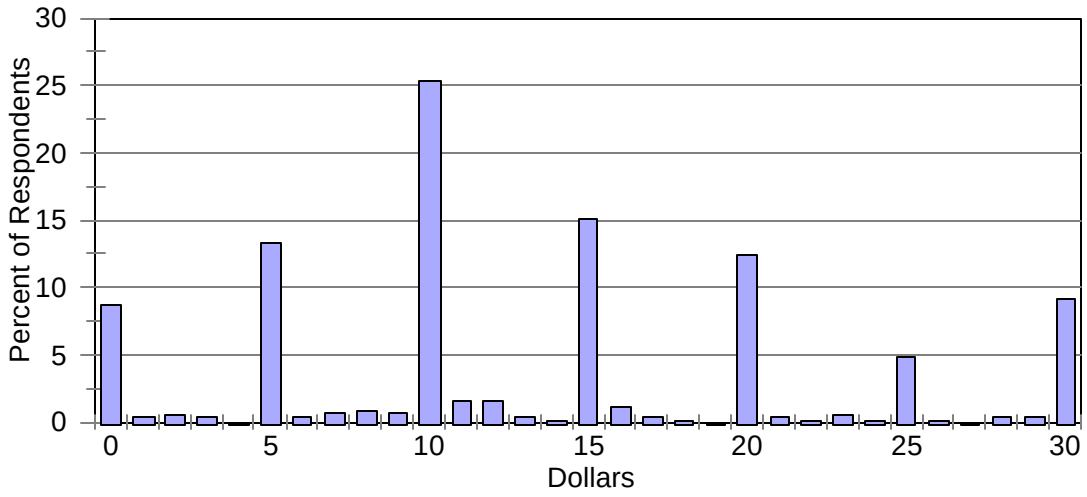


**Figure 3. Distribution of Respondents' WTP**

indicated that they would not pay more for the resistant tree. Forty-five respondents (7 percent) did not answer the WTP question. Less than 10 percent (56 respondents) indicated they would pay $30 or more for the resistant tree.

Nonresponses to the WTP question were treated as responses of $0 in order to avoid a bias (Edwards and Anderson; Wang). The assumption is that a nonresponse reflects one of three possibilities. First, the respondent considered the problem to be unimportant. Second, the two trees in question were so similar that the respondent could not determine WTP. Third, the individual may have felt that a discount was needed in order to purchase a new variety. All three possibilities are consistent with the censoring incorporated into the model.

There was a tendency for responses to cluster in multiples of five dollars. The clustering of responses in $5 increments may reflect two possibilities. First, these amounts were shown on the number line (see Appendix A), and second, many respondents may have been more comfortable making decisions in $5 multiples. The mean and standard deviation were $13.35 and $8.43 respectively, while the most common response was $10.00. Respondents could only indicate WTP amounts in integers. However, the dependent variable was considered to be continuous because if the resistant flowering dogwood was available on the market it would not have to be priced in dollar increments. The WTP shows some tendency for the WTP to be normally distributed, as reflected in the symmetric and unimodal distribution shown in Figure 3 with respect to the $5 increments. Furthermore, the tails do not contain large

proportions of the responses suggesting the range used was appropriate. A centering bias does not appear to be present, because the mean is below $15.

Independent Variables

Having a dogwood in the landscape (Question 3) was coded as a dummy variable: one equaled presence, zero equaled absence. Its impact could be either positive or negative. One possibility was that respondents who already owned a dogwood could be less likely to purchase another one, let alone the resistant tree, so in this situation the variable's coefficient would be negative. Alternatively, if the variable's coefficient is positive, the inference would be that respondents who already own a dogwood understood the cost of preventing powdery mildew. Therefore, direction of causality is an empirical issue. There were 446 respondents who had dogwoods in their yards, and 164 who did not.

Question 4 listed several diseases and problems that may be present in dogwoods, or associated with dogwoods. This list included drought injury, dogwood anthracnose, dogwood borer injury, and powdery mildew. It was expected that when powdery mildew was present, WTP for a resistant flowering dogwood would increase. For the remaining dogwood-specific problems, it was expected that the presence of the item would increase WTP, the assumption being that respondents who had dogwoods with one of these problems would be more likely to be in the market for a new tree. There were 120 who indicated the presence of powdery mildew and 141 who indicated the presence of other problems.

The sum of the 11 types of landscape expenditures listed in Question 5 was used in the regression for two reasons. First, the total landscape expenditure gives a better overall picture of the respondent's

landscape than does any single item. Second, many respondents only indicated expenditures on just a few of the items listed. As landscape expenditures increased, WTP was expected to increase. There were 96 respondents who did not answer the question. Expenditures ranged from $0 to $24,333 with a mean expenditure of $803.

Landscape characteristics (Question 6) were coded as one equals the presence of and zero equals the absence of each item. There was no *a priori* expectation as to which of these variables may have affected WTP or the direction of causality. The coding did not affect the number of observations used in the regressions.

Question 7 gathered information about who identified and treated pests and diseases on landscape trees, plants, and shrubs. Each item was coded so that a value of one was assigned if the item was checked, and a value of zero was assigned to blank items. It was expected that respondents who used a commercial service would be willing to pay more for the resistant tree. These people would be able to reduce their lawn care costs in the future through the purchase of the resistant tree. There were 54 respondents who used a commercial service to identify pests and disease, and 72 used a commercial service to control them.

Question 8, satisfaction with the appearance of the landscape, was coded so that a "no" response was assigned a value of zero, and a "yes" a value of one. Respondents who were satisfied with their landscapes were hypothesized to be willing to pay less for a resistant dogwood. There were 243 respondents who were satisfied with their landscapes.

Question 9 asked respondents if they regularly read gardening magazines. It was expected that respondents who did so would be more aware of landscape diseases and, therefore, be willing to pay more for the resistant tree. There were 391 respondents who claimed to read gardening magazines regularly.

Question 10 prompted the respondents to rank the top five reasons for selecting landscape trees. Many respondents, however, simply checked five items. Each reason was coded as a dummy variable: a zero meant the respondent had not ranked or checked the respective item, and a one represented it having been checked or ranked. Criteria that are associated with dogwoods (e.g., flowering) were expected to have positive coefficients, and criteria that are not (e.g., fruit) were expected to have negative coefficients. Disease resistance was expected to be significant and positive because respondents who prefer landscape plants that are resistant to disease are more likely to pay more for a disease resistant flowering dogwood tree.

Question 11 asked respondents how much landscape injury they felt would be acceptable if they were able to reduce pesticides. Respondents could chose one of four options: high, moderate, low, or none. High was assigned a value of one, and none a value of four. The expectation was that the greater the damage the respondent would accept due to pesticide reduction, the more he or she would be willing to pay for the resistant dogwood. There were 44 respondents who would accept no landscape damage due to pesticide reduction, 232 indicated low damage, 254 indicated moderate damage and 31 would accept high damage in order to reduce pesticide use.

Question 12 gathered information on the respondent's knowledge of integrated pest management. Eleven terms were listed, and the respondent indicated a level of familiarity with each. "Never heard of it" was coded as zero. The other three responses reflected at least some awareness of the respective term

and were converted to one. This coding was used to distinguish between respondents who were unaware of the respective term versus those who had at least heard of it. Respondents who left a term or concept blank were considered to have never heard of it. It was hypothesized that individuals who have heard of the term or concept in question would be willing to pay more for a resistant dogwood. Urban landscape and organic gardening were the two most well known terms with 530 and 533, respectively, of the respondents indicating at least some familiarity with the terms. Insecticide resistance and pheromone trapping were the least familiar terms with 164 and 254 respondents indicating at least some familiarity with the terms.

Question 13 prompted the respondent to indicate reasons for selecting landscape shrubs, perennials and annuals. Variables were coded zero for no response and one for a positive selection criteria. Because this question did not specifically deal with trees, there were no *a priori* expectations as to significance or sign. The coding did not affect the sample size for the estimation.

Question 14 listed eight types of retail outlets, which were converted to eight dummy variables, where a zero (one) meant that the respondent did not (did) shop for landscape trees and plants at a particular location. The two most popular retail outlets were farm markets or truck stands, with 385 respondents, and independent or specialty garden centers, with 372 respondents. Respondents could have indicated more than one outlet type from this list.

Question 15 asked the respondents about the quality of landscape plants that they had purchased. Not sure was assigned a value of zero. The next four choices (excellent, good, mediocre and poor) were assigned a value between one and four, where excellent was four, and poor was one. There were no *a priori* expectations as to the sign of this variable's coefficient. It could be that those who were dissatisfied

might be willing to pay more for the resistant tree, or given perceptions of quality, the person would not be willing to pay more. The majority of respondents rated the quality of the plants and trees they had purchased as good (413) or excellent (58).

Question 16 asked the respondent to name a beneficial insect, bird, and plant. This was coded as a dummy variable equal to one (zero) if the respondent did (not) name at least one. The purpose of this question was to assess the respondent's level of landscape knowledge. It was assumed that if a person named at least one, then the respondent possessed a higher level of landscape knowledge than someone who did not do so and, therefore, was willing to pay more for the resistant dogwood tree. There were 439 respondents who named at least one beneficial organism.

For Question 17, gender, male was assigned a value of one, and female was assigned a value of zero. There were no prior expectations as to who would be willing to pay more, male or females. There were 337 respondents who indicated that they were female, 211 indicated that they were male, and 62 did not respond.

Responses to Question 18, age, were coded as six separate dummy variables, where a one indicated the presence of the age group, and a zero its absence. This was to allow for the possibility that the various age categories had different effects on the WTP. There were 7 between 15 and 24, 43 between 25 and 34, 134 between 35 and 44, 175 between 45 and 54, 135 between 55 and 64, 50 who were over 65 or older, and 40 did not respond.

Income categories (Question 19) were transformed into six dummy variables where a one represented presence of the income category and a zero denoted its absence. This transformation permitted different effects among the income categories. It was expected that the higher the income group, the higher

would be the WTP. There were 29 who indicated less than $25,000, 127 between $25,000 and $49,000, 143 between $50,000 and $74,999, 77 between $75,000 and $99,999, 64 between $100,000 and $124,999, and 50 who indicated $125,000 or more. There were 120 respondents who did not respond to this question.

Estimation and Final Regression Model

Estimation focused on finding the best overall fit (the greatest maximum likelihood). Often, when estimating an equation, it is important to determine marginal effects of each variable when all others are held constant. Because only one variable in the model is not binary (landscape expenditure), marginal effects are not presented. In addition, the marginal effect of any one variable is dependent upon the relative level of the other variables, and thus comparison is difficult.

The binary coding of most of the independent variables suggested that multicollinearity would be a problem if a regression was estimated using all of the independent variables. Consequently, a sequential approach was taken. Initially, regressions of the WTP on each individual variable were estimated. Variables that had insignificant coefficients were not considered in subsequent estimations. Regressions of combinations of significant independent variables from the simple regressions were estimated. Equations were compared on the basis of their log-likelihood values, with the objective of finding the set of variables that generated the largest log-likelihood value. Table 3 contains the set of variables used in the final regression. The equation that generated the highest log-likelihood is given in Table 4. The computed chi square leads to the inference of a significant overall fit.

As hypothesized, the presence of a dogwood in the landscape decreased the WTP. The inference is that consumers who already own a dogwood tree were not likely to purchase another and were, therefore, unwilling to express a higher value for a disease resistant tree.

The dollar amount spent on landscaping, as expected, had a positive effect on the WTP.

One item from Question 6 was found to be statistically significant, the presence of annual flower beds in the landscape. This could be interpreted as a reflection of the tastes and preferences of the respondents. Flowering dogwoods are most noteworthy for their spring blooming season. Respondents who placed a high value on flower beds were likely to have appreciated a dogwood in full bloom, and thus, the positive coefficient.

The respondents who were content with their landscapes were willing to pay less for the resistant tree.

Among reasons a respondent selected landscape trees, two were statistically significant: disease resistance and fruit. Disease resistance, as expected, had a positive coefficient. People who were concerned about disease resistance were willing to pay more. Respondents who were interested in fruit trees were willing to pay less for the resistant tree.

It was expected that the type of outlet where respondents purchased landscape trees and plants affected WTP. Those who shopped at outlets where the price of a dogwood was higher, or where the quality of plants was perceived to be higher, were expected to indicate a WTP more for any landscape plant. Only one of the outlets had a significant coefficient at the .05 level, farm market or truck stand, and its coefficient was negative. These outlets are generally less expensive, and therefore, WTP a premium for

disease resistance was lower. The implication is that the demand curve for the resistant tree is not parallel to the demand curve for a non-resistant tree.

The city in which the survey was conducted had a significant effect on the WTP. Nashville, Knoxville, and Detroit all had positive effects on the WTP versus Jackson residents. The inference is that respondents in Jackson were less likely to pay more for the resistant tree.

One income category had a significant coefficient if the respondent indicated a household income of more than $125,000 a year then he or she would be more likely to pay more for the

Table 3. Characteristics of Variables Used in Maximum Likelihood Estimation.

| Variable | | Mean |
|---|---|---|
| **WTP for Resistant Dogwood** | Dollars | $13.35 |
| **Presence of Dogwood in Landscape** | 0 = No, 1= Yes | 0.74 |
| **Presence of Powdery Mildew in Dogwoods** | 0 = No, 1= Yes | 0.20 |
| **Sum of Landscape Expenditures** | Dollars | $803.36 |
| **Presence of Annual Flower Bed** | 0 = No, 1= Yes | 0.57 |
| **Satisfied with Landscape** | 0 = No, 1= Yes | 0.41 |
| **Select Landscape Trees Based on Disease Resistance** | 0 = No, 1= Yes | 0.22 |
| **Select Landscape Trees Based on Fruit** | 0 = No, 1= Yes | 0.10 |
| **Shop for Landscape Plants, Shrubs and Trees from Farm Market/Truck Stand** | 0 = No, 1= Yes | 0.23 |
| **Knoxville, Tennessee** | 0 = No, 1= Yes | 0.24 |
| **Nashville, Tennessee** | 0 = No, 1= Yes | 0.44 |
| **Detroit, Michigan** | 0 = No, 1= Yes | 0.22 |
| **Income of $125,000 or More** | 0 = No, 1= Yes | 0.10 |

Table 4. The Estimated Regression Equation.

| Variable | Coefficient* | Standard Error |
|---|---|---|
| **Constant** | 10.5909 | 1.4253 |
| **Presence of Dogwood in Landscape** | -2.7932 | 0.8927 |
| **Presence of Powdery Mildew in Dogwoods** | 2.2491 | 0.9306 |
| **Sum of Landscape Expenditures** | 0.0007 | 0.0002 |
| **Presence of Annual Flower Bed** | 2.1098 | 0.7330 |
| **Satisfied with Landscape** | -2.7693 | 0.7410 |
| **Select Landscape Trees Based on Disease Resistance** | 3.3267 | 0.8655 |
| **Select Landscape Trees Based on Fruit** | -2.7873 | 1.1247 |
| **Shop for Landscape Plants, Shrubs and Trees from Farm Market/Truck Stand** | -2.1029 | 0.8440 |
| **Knoxville, Tennessee** | 3.3260 | 1.4019 |
| **Nashville, Tennessee** | 2.4146 | 1.3001 |
| **Detroit, Michigan** | 3.9564 | 1.4513 |
| **Income of $125,000 or More** | 3.9564 | 1.2177 |

*All coefficients are statistically significant at the .05 level.
Log-Likelihood = -1521.753
Chi square = 75.524*
Sample Size = 472

resistant tree versus the other income categories. This result combined with the significant farm market or truck stand coefficient indicates that the WTP for the resistant dogwood changes with the market price. That is, the demand curve for the resistant tree lies above the one for the traditional dogwood, but they are not parallel.

## Marketing Implications

Results suggest that, when compared to an identical flowering dogwood tree, consumers were willing to pay on average $13.35 more for a flowering dogwood tree that is resistant to powdery mildew. The most frequently circled price premium was $10. A WTP response represents an upper bound on the premium because: (1) no payment occurred, (2) respondents were drawn from people attending home and garden shows, and (3) information about the disease was presented prior to completing the questionnaire. This premium represents a valuation at the end of the distribution channel. Therefore, it cannot be added at each stage of the marketing systems. It must be shared, resulting in a total of $13.35 or less. Furthermore, the results suggest the WTP varies by type of outlet with lower price venues having lower WTP.

Nurseries, wholesalers, and retailers can use these results in developing marketing plans. Among the considerations are the points noted below. People who attend home and garden shows are likely to be representative of the target market of flowering dogwood purchasers. These individuals were older and in higher income brackets than the population as a whole and interested in their yards. Whether homeowners who have dogwoods in their landscapes may be willing to pay more for a resistant tree depends on whether their trees have the disease and whether they are satisfied with their landscapes. Individuals who spent more on landscaping were willing to pay more for a resistant dogwood. Retailers could instruct employees to get to know their customers and their spending patterns and target these customers when marketing resistant flowering dogwoods. Promotional materials (e.g., direct mail, newspaper inserts) should be focused on explanations of the disease and easy ways for people to recognize

the problem in dogwoods in their landscapes. The distributional emphasis of the materials should be primarily in higher income neighborhoods.

Several location related factors emerged. Based on the relationship between perennial flower beds and increased WTP, retailers could place resistant flowering dogwood displays near perennial flower displays. Respondents who selected landscape trees based on disease resistance were willing to pay more for a resistant flowering dogwood. An implication is that information about powdery mildew and the resistant tree should be provided at the point of sale. This display should consist of pictures and non-technical explanations, much like the display used for the survey.

Consumers who are in the market for fruit trees are willing to pay less for a resistant flowering dogwood tree. This is consistent with the possibility of substituting another type of flowering tree. It suggests care must be taken in the pricing of the resistant tree so that it reflects consumers' valuation of powdery mildew.

People are willing to pay a smaller premium when purchasing disease-resistant flowering dogwoods from farm markets and truck stands. Given the significance of this variable, an implication is that the price increase at the retail level may differ by outlet. This does not necessarily mean that these retailers should avoid stocking disease-resistant flowering dogwoods. There are at least three reasons for the lower WTP. First, these outlets may have a lower price level in general, and therefore, WTP a premium for a disease-resistant tree may be less. Second, this type of retail outlet may attract buyers who pay lower purchase prices but are willing to pay higher opportunity costs such as travel cost to the point-of-sale and tree maintenance. Third, consumers may feel there is more risk when buying from this type of retailer.

The premium that respondents were willing to pay varied by city. Respondents in Nashville, Knoxville, and Detroit indicated that they were willing to pay more for a disease-resistant tree than those in Jackson, Mississippi. This could be the result of a lower price level in general and does not mean that retailers in Jackson should avoid resistant flowering dogwood stock.

In addition to the tools that can assist retailers in marketing resistant flowering dogwood trees, there may be considerable savings in production costs. Nursery growers producing resistant flowering dogwoods may be able to reduce the investment in both chemicals and labor to control powdery mildew.

## References


Badenhop, M. B., W. T. Witte, and T. E. Glasgow. *Production Systems and Costs for Producting Balled and Burlapped Trees of Dogwood Cultivars.* Tennessee Agricultural Experiment Station Bulleting 637 (1985).

Barton, S.S., J. R. Brooker, C.R. Hall, and S.C. Turner. "Review of Customer Preference Research in the Nursery and Landscape Industry." *Journal of Environmental Horticulture.* 16 V. 2 (June 1998): 118-124.

Bishop, R.C. and T. A. Heberlein "The Contingent Valuation Method." *Economic Valuation of natural Resources: Issues Theory, and Applications.* Johnson, R. L. and Johnson, G. V. eds. Boulder, Co: Westview Press, 1990. 81-104

Cameron, T. A., and D.D. Huppert. "OLS versus ML Estimation of Non-market Resource Values with Payment Card Interval Data." *Journal of Environmental Economics and Management*. 17 (1989): 230-246.

Cummings, R. G., P. T. Ganderton, T. McGuckin. "Substitution Effects in CVM Values." *American Journal of Agricultural Economics.* 76 (May 1994): 205-214.

Eastwood, D.B., *The Microeconomics of Consumer Behavior*. Houston, TX. Dame Publications Inc., 1997.

Edwards, S.F. and G. D. Anderson. "Overlooked Biases in Contingent Valuation Surveys: Some Considerations." *Land Economics*. 63 2 (May 1987): 168-178

Hardy, J., B. K. Behe, S. S. Barton, T. J. Page, R. E. Schutzki, K. Muzii, R. T. Fernandez, M. T. Haque, J. Brooker, C. R. Hall, R. Hinson, P. Knight, R. McNiel, D. B. Rowe, and C. Safley. "Consumer Preferences for Plant Size, Type of Plant Material and Design Sophistication in Residential Landscaping." *Journal of Environmental Horticulture.* 18-4 (December 2000): 224-230

Hoehn, J. P. "Valuing the Multidimensional Impacts of Environmental Policy: Theory and Methods." *American Journal of Agricultural Economics*. 73 (May 1991): 289-299

Hoehn, J.P. and J.B. Loomis. "Substitution Effects in the Valuation of Multiple Environmental Programs." *Journal of Environmental Economics and Management*. 25 (1993): 56-75

Hudson, J. T., B. K. Behe, H.G. Ponder, and W.E. Barrick. "Consumer Perceptions and Expectations of Garden Center Product and Service Quality." *Journal of Environmental Horticulture*. 15 V.1 (March 1997): 12-15.

Green, W. H. *Econometric Analysis* Third Edition. Upper Saddle River, NJ. Prentice Hall 1997.

Kahneman, D. and J. L. Knetsch. "Valuing Public Goods: The Purchase of Moral Satisfaction." *Journal of Environmental Economics and Management.* 22 (1992): 57-70

Klingeman W.E., J. R. Brooker, D. B. Eastwood, B. K. Behe, J. B. Riley, P. Knight. *Consumer Perceptions of Landscape Characteristics, Disease and Pest Problems, and the Value of Powdery Mildew Resistant Dogwood.* (University of Tennessee, Department of Agricultural Economics Research Series Report, 07-01 (November, 2001).

Mitchell, R. C. and R. T. Carson. "Measurement Bias." *Using Surveys to Value Public Goods: The Contingent Valuation Method*, 1989 Resources for the future, Washington, D.C. 231-259

Rowe, R.D., W.D. Schulze, and W.S. Breffle. "A Test for Payment Card Biases." *Journal of Environmental Economics and Management.* 31 (1996): 178-185.

Safley C.D., M.K.Wohlgenant, and A.N. Rezitis. *Economic and Socioeconomic Factors Affecting Consumer Purchases of Fall Nursery Products.* NCCES/NCAN/NCDACS ARE Report 19, January, 2000.

Sams, David. "Introduction." *Tennessee Master Gardener Handbook.* University of Tennessee Agriculture Extension Service publication number PB-1578. February 1997.

Simmons, M. "Disease Free Dogwood on the Way." *The Knoxville News Sentinel*. April 7, 2000 sect. A1.

Tennessee Agricultural Statistics Service. *Tennessee Agriculture 2000*, Tennessee Department of Agriculture Bulletin 35, 2001.

U.S. Census Bureau; "Median Household Income by State: 1984 to 1999;" <http://www.census.gov/hhes/income/histinc/h08.html>: (accessed: 21 June 2001) a.

U.S. Census Bureau; "Profiles of General Demographic Characteristics 2000 Census of Population and Housing Mississippi;" 2kh28.pdf; published May 2001 b; <http://www.census.gov/prod/cen2000/index.html>.

U.S. Census Bureau; "Profiles of General Demographic Characteristics 2000 Census of Population and Housing Tennessee;" 2kh47.pdf; published May 2001 c; <http://www.census.gov/prod/cen2000/index.html>.

U.S. Census Bureau; "Profiles of General Demographic Characteristics 2000 Census of Population and Housing Michigan;" 2kh26.pdf; published May 2001 d; <http://www.census.gov/prod/cen2000/index.html>.

U.S. Department of Agriculture, *1998 Census of Horticultural Specialties*, Washington, D.C..

University of Tennessee Extension Service <dogwood.ag.utk.edu/dpm.htm> (accessed August 14, 3001).

Wang, H. "Treatment of 'Don't-Know' Responses in Contingent Valuation Surveys: A Random Valuation Model." *Journal of Environmental Economics and Management*. 32, (1997): 219-232.

Whittington, D., J. Brisco, X, Mu, and W. Barron. "Estimating the Willingness-to-pay for Water Services in Developoing Countries: A Case Study of The Use of Contingent Valuation Surveys in Southern Haiti." *Economic Development and Cultural Change* 38 (January 1990).

Windham, M. T. and W. T. Witte. "Naturally Occurring Resistance to Powdery Mildew in Seedlings of *Cornus Florida" The Journal of Environmental Horticulture*16(3): 173-175. September 1998 1.

Windham, M. T. Personal interview, October 17, 2001.

**Appendix A**: **Questionnaire.**

# University of Tennessee Landscape Plant Survey

## All responses are voluntary and will remain anonymous

After viewing the poster on display and reading the information, assume your favorite retailer is selling dogwood trees (*Cornus florida*) that are 5 feet tall, have a 1-inch trunk diameter, are sold in a 5-gallon container, which are the typical size produced for consumers at garden centers and mass merchandisers.

1. How much <u>more</u> would you be willing to pay for an identically sized flowering dogwood that is resistant to powdery mildew?

$0 | | | | $5 | | | | $10 | | | | $15 | | | | $20 | | | | $25 | | | | $30

2. Do you presently:
   [ ] own a home, [ ] rent a home or apartment,
   [ ] plan to buy a home within 2 years?

3. Do you currently have a dogwood in your landscape? [ ] Yes, [ ] No

   If yes, are <u>the majority of your</u> dogwoods in

   [ ] SUN; [ ] PART SHADE; [ ] SHADE

4. Do any of your dogwoods have (*check all that apply*):
   ____ powdery mildew ____ anthracnose (leaf spots)
   ____ dogwood borer injury ____ dogwood twig gall midge
   ____ trunk cracks/splits ____ drought injury (brown leaf edges)
   ____ don't know

5. Approximately how much did you spend last year (1999) in your home garden and landscape on:
   $_____ annuals & perennials; $_____ shrubs;
   $_____ trees; $_____ seeds;
   $_____ mulch; $_____ spray service;
   $_____ fertilizer; $_____equipment;
   $_____ mowing / maintenance; $_____ pesticides;
   $ _____ other _____

6. Describe your yard (*check all that apply*). Estimate its size in ____ Acres or ____ Sq. Ft.

[ ] wooded lot,
[ ] perennial beds,
[ ] landscaped borders,
[ ] grass lawn,
[ ] mostly open yard,
[ ] vegetable or herb garden,
[ ] annual beds,
[ ] container plantings.

7. Is your lawn and landscape maintained:
[ ] by yourself or a family member; [ ] by hired help, [ ] left to grow on its own.

8 Are you content with the appearance of your landscape? [ ] Yes, [ ] No

9. Do you regularly read a gardening/grower magazine? [ ] Yes, [ ] No
If yes, which ones? _____

10. Rank the **TOP 5 reasons** you pick landscape **TREES** (Rank Only 5; 1=most important).

_____ length of flowering period
_____ availability
_____ water needs
_____ longevity
_____ sun / shade preferences of tree
_____ resistance to insects / mites
_____ familiarity
_____ easy maintenance
_____ fruit
_____ growth rate
_____ attracts butterflies/beneficial insects
_____ native
_____ winter appearance
_____ flower color
_____ disease resistance
_____ size / shape
_____ soil preferences
_____ attracts birds / animals
_____ leaf color
_____ flowering season
_____ university tested
_____ to create shade
_____ other: _____

11. To reduce pesticide use, what level of injury to plants in your landscape would you accept?
[ ] high, [ ] moderate, [ ] low, [ ] none

12. Are you familiar with these terms or concepts?

| Term or Concept | Never Heard It | Sounds Familiar | I Know a Little | I can explain |
|---|---|---|---|---|
| Pest Tolerance | [ ] | [ ] | [ ] | [ ] |
| Biological Control | [ ] | [ ] | [ ] | [ ] |
| Mycorrhizal Fungi | [ ] | [ ] | [ ] | [ ] |
| Insecticide Resistance | [ ] | [ ] | [ ] | [ ] |
| Integrated Pest Management (IPM) | [ ] | [ ] | [ ] | [ ] |
| Pest Scouting / Monitoring | [ ] | [ ] | [ ] | [ ] |
| Beneficial Insects | [ ] | [ ] | [ ] | [ ] |
| Urban Landscape | [ ] | [ ] | [ ] | [ ] |
| Land Stewardship | [ ] | [ ] | [ ] | [ ] |
| Organic Gardening | [ ] | [ ] | [ ] | [ ] |
| Pheromone Trapping | [ ] | [ ] | [ ] | [ ] |

13. If you were choosing plants for your landscape, what would your **TOP 5 considerations** be? (Rank Only 5; 1 = most important)

_____ insect/mite resistance
_____ water requirements
_____ to try a new plant
_____ sun / shade requirements
_____ soil preferences
_____ season of bloom
_____ winter appearance
_____ plant quality
_____ longevity
_____ attracts butterflies / beneficial insects
_____ University tested
_____ familiarity
_____ size / shape
_____ leaf color
_____ availability
_____ native
_____ length of flowering period
_____ disease resistance
_____ easy maintenance
_____ attracts birds / animals
_____ other: _____

14. Where do you shop for landscape plants? (*Check all that apply*)

____ retail chain
____ landscaper / contractor
____ independent / specialty garden center
_____ mail order catalog
_____ farm market / truck stand
_____ grocery
_____ direct from nursery
____ other _____

15. In your opinion, is the quality of landscape plants you purchase:

[ ] excellent, [ ] good, [ ] mediocre, [ ] poor, [ ] not sure

16. Name a Beneficial (or Environmentally Helpful . . . ):

insect _____ bird _____
plant / flower _____

17. Are you [ ] Male, [ ] Female?

18. What is your approximate age?
[ ]15-24; [ ]25-34; [ ]35-44; [ ]45-54; [ ]55-64; [ ]65+

19. Estimate your Gross Household Income before taxes this past year:

| | | |
|---|---|---|
| [ ] less than $25,000 | [ ] $25,000 - $49,999 | [ ] $50,000 - $74,999 |
| [ ] $75,000 - $99,999 | [ ] $100,000 - $124,999 | [ ] $125,000 or more |

## Appendix B: Derivation of the Maximum Likelihood Function.

For respondent i, the actual WTP, w*, is a linear function of K independent variables, including an intercept, and a normally distributed error term, e.

The underlying regression is:

$w^* = Xb + e$

$w^*$ is an n x 1 vector of actual WTP.

X is an n x K matrix of independent variables.

$e$ is an n x 1 vector of errors, and is distributed normally with mean 0 and variance-covariance matrix $s_e^2 I$

The observed WTP is $w_i$:

$w_i = L$ if $w^*_i \leq L$,

$w_i = U$ if $w^*_i \geq U$,

$w_i = w^*_i$ if $L < w^*_i < U$.

L is the lower censoring value, and U is the upper censoring value. Since ε is distributed normally, w* is distributed normally.

The conditional expected value of $w_i$ for a given set of values of X, $X_i$, can be expressed in terms of the three components of the distribution (lower bound, upper bound, and values between bounds):

$$E(w_i | L < w_i^* < U) = L[Pr(w_i = L)] + U[Pr(w_i = U)] + Pr([L < w_i < U) E(w_i^* | L < w_i < U)$$

The expected value can be expressed in terms of standardized normal values and density functions.

$\phi^*_j$ = probability density function for $w^*_j$.

$\phi_j$ = standardized probability density function, ö[(j-$X_j$â)/ó].

Ö*$_j$ = cumulative density functions for $w^*_j$.

Ö$_j$ = standardized cumulative density function, Ö[(j-$X_j$â)/ó].

$$E(w_i^* | L < w_i^* < U) = L\left(\frac{L - X_i\beta}{\sigma}\right) + U\left[1 - \Phi\left(\frac{U - X_i\beta}{\sigma}\right)\right]$$
$$\left[\Phi\left(\frac{U - X_i\beta}{\sigma}\right) - \Phi\left(\frac{L - X_i\beta}{\sigma}\right)\right]X_i\beta$$
$$+ \sigma\left(\frac{L - X_i\beta}{\sigma} - \frac{U - X_i\beta}{\sigma}\right)$$
$$= X_i\beta + \sigma\frac{\phi_L - \phi_U}{\Phi_U - \Phi_L}$$

The conditional mean is:

The unconditional mean is

$$E(w_i) = \Phi_L L + X_i\beta(\Phi_U - \Phi_L) + \sigma(\phi_L - \phi_U)U$$

The likelihood function is

$$L(\beta, \sigma | w_i, X_i, L, U) = \prod_{W_i = L} \Phi\left(\frac{L - X_i\beta}{\sigma}\right) \prod_{w_i = w_i^*} \frac{1}{\sigma}\phi\left(\frac{w_i X_i\beta}{\sigma}\right) \prod_{w_i = U}\left[1 - \Phi\left(\frac{U - X_i\beta}{\sigma}\right)\right]$$