Understanding consumers' ornamental plant preferences for disease-free and water conservation labels

David L. Hartter

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Kevin J. Boyle, Co-Chair
James W. Pease, Co-Chair
Klaus Moeltner
J. Roger Harris

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ABSTRACT

Product labeling is increasingly used as a tool to differentiate products with public and private benefits that cannot be readily evaluated by a consumer at the time of purchase. Our research investigates how a labeling program may be applied in the sale of ornamental plants to address two key issues; plant disease and irrigation water use. A choice modeling survey was utilized to estimate consumers' willingness to pay a premium for six ornamental plants with disease-free and/or water conservation certification labels. The results of the mixed logit models show consumers are willing to pay a premium for plants certified as disease-free and/or produced with water conservation practices. The results strongly suggest producers can recoup some of the costs of implementing water conservation measures such as water recycling and disease control measures amid regulatory and drought concerns. Our research also investigated consumers' preferences for multiple third party certifying authorities and whether preferences for the labels varied among consumers. The results showed ornamental plant consumers did not reveal a preference for a particular certifying authority. The results are mixed as to whether willingness to pay for the labels varies among respondents. We show willingness to pay does vary among respondents for three of the plant models indicating preference heterogeneity.

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1. Introduction

Product labeling programs are increasingly used as both policy and marketing mechanisms to differentiate products. For products with public and private benefits which cannot be readily evaluated at the time of purchase, labeling enables a producer to enhance transparency and consumers' trust (Thogersen, 2002). This research examines how a labeling program may be applied in the production of ornamental plants[1] to address plant disease and irrigation water use; two key and related issues affecting producer profitability, consumer satisfaction and environmental quality. Labeling may be advantageous to producers of ornamental plants by allowing them to recoup some of the costs associated with addressing plant disease and irrigation water use issues through informing consumers of production practices they may find desirable.

Plant health in ornamental crops is threatened by water-borne diseases caused by *Pythium* and *Phytophthora*. *Pythium* affects greenhouse crops such as bedding and potted plants (Moorman, 2010a) and *Phytophthora* affects nursery crops such as broadleaf evergreen and herbaceous plants (Moorman, 2010b). It is estimated plant pathogens including *Phytophthora* and *Pythium* cause crop losses of 12% in the United States[2] (Pimentel, 1997). In Georgia, it was estimated that diseases resulted in ornamental crop losses of 7%, leading to economic losses of $40 million in 2008 (Williams-Woodward, 2010). Though producers attempt to prevent any diseased plant from reaching consumers, disease can lead to plant loss at the producer, retailer or consumer levels.

In addition to plant disease, irrigation water use is increasingly becoming a concern in the production of ornamental crops due to drought and run-off regulations. It is estimated that ornamental crops grown in greenhouse operations require between 11,000 and 22,000 gallons per

[1] We use the phrase ornamental plants to refer to outdoor plants that are used to decorate a house, yard or garden.
[2] Though disease is considered a major issue affecting ornamental plants by industry experts, very little recent data is available on actual damages and economic loss related to plant disease in the United States.

acre per day of irrigation and nursery operations require up to 27,000 gallons (Robbins, 2010). This significant water requirement leaves greenhouse and nursery operations vulnerable to water use restrictions due to severe drought. Drought is increasingly a concern now for the entire United States with sixty-one percent of the contiguous United States experiencing moderate to exceptional drought conditions during July 2012 (United States, 2012). Nursery and greenhouse operations are also under increasing regulatory pressure to reduce run-off of excess fertilizers and pesticides. California, Florida, Maryland, Oregon and Texas have all enacted regulations to control run-off from agricultural non-point sources including greenhouse and nursery operations (Oki & White, 2011). In the Chesapeake Bay watershed, the establishment of a “pollution diet” in 2010 will force greenhouse and nursery operations to reduce run-off and leachate (United States, 2010a).

Greenhouse and nursery operations are implementing practices such as water recycling to reduce water use and run-off; however plant disease potential can be exacerbated. Water recycling allows growers to conserve 40-50% of irrigation water through capture and re-use of water lost due to run-off (Wilson & von Broembsen, n.d.). However, if water-borne pathogens such as *Pythium* and *Phytophthora* are present in the irrigation system, recycled water will lead to repeated inoculation of plants and potentially, a widespread and catastrophic infection (Hong and Moorman, 2005). As a result, the increased risk of spreading water-borne plant pathogens is one factor that has slowed the adoption of water recycling technology and subsequent societal benefit of protecting public water resources (Hong, 2001; von Broembsen, n.d.).

Economic concerns are also hindering the adoption of water recycling and disease control measures. Currently, a grower implementing these measures will incur upfront infrastructure costs and increased operating costs without corresponding revenue enhancement. This research investigates if producers can recoup some of the costs through premiums paid by consumers for ornamental plans certified as disease-free and/or grown with water conservation practices. These certifications would be conveyed to consumers through labels placed on plant tags that are inserted in plant containers.

The primary research objective is to investigate if consumers will pay more for selected ornamental plants that are certified disease-free and/or grown with water conservation practices. Secondary objectives are to investigate if: 1) consumers have a preference for a particular certifying authority and 2) if the results differ among ornamental plant consumers, indicating preference heterogeneity. The research investigates consumer preferences for multiple third party certifying authorities including governmental organizations, industry organizations, and non-profit organizations.

A choice-modeling survey was administered to a sample of ornamental plant consumers to investigate these objectives. Results indicate consumers are willing to pay more for plants with disease-free and water conservation labels, providing evidence that producers may be able to recoup some of the costs associated with the adoption of water recycling and disease control measures. The research is applicable for ornamental plant producers as well as producers in other industries adopting new technologies to address both societal and economic concerns.

2. Previous Studies

Horticulture products providing benefits to consumers such as those in this research have been the subject of numerous studies including; mildew resistant dogwoods (Gardner et al., 2002), “eco” labeled roses (Michaud et al., 2010), Texas Earth-Kind branded roses (Collart et al., 2010), origin-certified plants (Curtis & Cowee, 2010) and biodegradable containers (Yue et al., 2010). Yue et al. (2010) found consumers are willing to pay a premium for plants grown in biodegradable containers vs. plastic and preferred a container that was carbon saving. Michaud et al. (2010) found consumers were willing to pay more for roses with an “eco-label” and for roses with a low carbon footprint. Gardner et al. (2002) found consumers were willing to pay more for powdery mildew resistant dogwoods. These previous articles show that consumers are willing to pay a premium for product attributes that provide a societal benefit in addition to private benefits that only affect personal utility.

A number of research studies have also investigated consumer preferences for products sold with certifications including; Michaud et al., (2010), Curtis and Cowee (2010) and several have compared multiple certification authorities including; Aguilar and Vlosky (2007), Jaffry et al. (2004), Wolf et al. (2011), Olynk et al. (2010), Sacket et al. (2012). These and other studies have shown consumers have a propensity to pay more for certified products over products without certifications. Additionally, consumers generally prefer third party certifications over first party or “self-certification.” The results for studies investigating multiple third party certifications have had mixed results though generally conclude a governmental agency is the preferred certifying authority (Jaffry et al., 2004; Wolf et al., 2011; Olynk et al., 2010; Sacket et al., 2012). Contrary to those studies, Agular and Vlosky (2007) found consumers are indifferent between a governmental organization and an environmental non-governmental organization.

For research investigating policy and product alternatives that are hypothetical in nature, choice modeling is commonly utilized to investigate consumer preferences and determine willingness to pay. Specifically, choice modeling has been utilized in the research of agricultural products including food products; Sackett et al. (2012), James et al. (2009), Lusk et al. (2006), Olynk et al. (2010) and to a lesser extent non-food products; Michaud et al. (2010), Yue et al. (2010). The research of non-food products is more relevant to our research since private and public benefits are not confounded as sometimes is found in food product studies. For example, a consumer's willingness to pay for organically labeled food may be affected by a perceived health benefit in addition to public benefits. Several of the aforementioned studies investigate whether there is preference heterogeneity among respondents where preferences vary among respondents. To do so, mixed logit model has been utilized instead of the more restrictive multinomial logit model to show there is preference heterogeneity among respondents for; "eco" labeled roses (Michaud et al., 2010), livestock (Olynk et al., 2010), and milk (Wolf et al., 2011).

Results of previous studies led to the utilization of choice modeling to investigate consumer preferences for plants with disease-free and water conservation certification labels. Furthermore, consumers have shown preference heterogeneity qualifying the employment of a mixed logit model. Previous results also show consumers prefer certification and in particular a third party over a first party certification. The results are mixed however as to consumer preferences for a particular third party organization, suggesting further examination of multiple certifying authorities. The research presented utilizes these findings to examine implications of policies to reduce water use and run-off in greenhouse and nursery operations.

3. Study Design

A choice model approach was employed to estimate consumer preferences for ornamental plants certified as disease free and/or grown with water conservation practices. The research focused within a study area consisting of; Georgia, Maryland, Pennsylvania and Virginia. Maryland, Pennsylvania and Virginia were chosen because they are where three of the principal investigators of the research reside. Georgia was chosen given its recent history with severe drought conditions. Expert advice including from horticulture experts in academia and ornamental plant growers, was sought throughout the study development.

The research started by seeking expert advice in combination with industry sales data to determine the ornamental plants to include in the choice modeling. The intent of the research was to focus on popular plants that were susceptible to water-borne diseases within the study area. Annual bedding and broadleaf evergreen plants, two types of ornamental plants were chosen as the focus of the research. They represent 28% of the entire horticultural specialty sales category, which generated sales of $11.7 billion in 2007 (United States, 2010b). Additionally, by choosing both annual bedding and broadleaf evergreen plants, we were able to investigate if respondent preferences are different for annual and perennial plants. Expert advice combined with sales data was then used to determine three types of both annual bedding and broadleaf evergreen plants that are susceptible to water-borne diseases. The three annual bedding plants chosen were Geraniums (*Pelargonium* spp.), Petunias (*Petunia* spp.) and Chrysanthemums (*Chrysanthemum* spp.) and the three broadleaf evergreen plants chosen were Azaleas (*Rhododendron* spp.), Holly (*Ilex* spp.) and Boxwood (*Buxus* spp.). Focusing on six plants and thus six separate choice experiments improves the robustness of the results while increasing the likelihood a respondent would be in the market for a particular plant.

Three focus groups and two pilot studies were utilized to aid in the development of the survey and choice experiments. The three focus groups consisted of ornamental plant consumers with varied levels of gardening experience and were held in Virginia[3]. The pilot studies[4] were small sample studies primarily used to evaluate the online survey instrument and to estimate initial coefficient values for the experimental designs.

[3] Each focus group consisted of two sessions with 7-9 individuals. The focus groups were held in Virginia (Blacksburg, Richmond and Virginia Beach) between September 2011 and January 2012.
[4] The pilot studies consisted of a sample of 152 respondents interested in gardening and a sample consisting of 350 respondents from a Washington D.C. area ornamental plant retailer.

3.1 Survey Development

An online survey instrument was developed consisting of questions about the respondent's ornamental plant purchases, gardening experience, awareness of plant disease and water use issues, experience with plant loss, residential and demographic characteristics in addition to the choice questions. The Tailored Design Method (TDM), a systematic method developed to increase the validity and reliability of survey instruments, was used throughout the survey development and administration process (Dillman, 2008). The three focus groups were used throughout the survey development process to identify survey questions, ensure the survey was readily understood, and evaluate the online survey instrument. The two pilot studies were administered to refine the survey and ensure the survey could be completed in a reasonable amount of time to avoid respondent fatigue[5].

The final online survey was administered to 14,175 individuals in April 2012 through the survey sample provider qSample[6]. The individuals were recruited by qSample through email and online marketing, which targeted those interested in gardening to increase the likelihood of a survey recipient having purchased one of the six plants. The total number of survey recipients was determined based on our request to have 1,600 completed surveys within the study area.

3.2 Choice Experiment

The focus groups and pilot studies were also used to develop the choice experiments and in particular, to determine attributes and levels. To determine the attributes and levels, focus group participants were asked how they typically select a plant to purchase at their preferred retailer. Participants mentioned the type, variety and size of the plant along with visual

[5] The average time during the pilot studies was approximately 20 minutes per completed survey.
[6] qSample provides survey samples for clients including private firms and universities. Other academic clients include the University of Montana and the University of California, Davis. For more information, go to: http://qsample.com/

characteristics. Visual characteristics mentioned included the shape, density, color and blossoms if it was a plant with buds which bloom.

Attributes were then selected based on the research objectives, the perceived importance based on the focus groups and how readily an attribute could be conveyed in an online survey instrument. Based on the selection criteria, we chose blossoms and fullness to be the attributes representing the visual characteristics in the choice experiment. Blossoms described the amount of flower buds that were in bloom for a given plant. Respondents were told that any buds not in bloom at the time of purchase had yet to bloom in order to distinguish from buds that were past bloom. Blossoms was not included as an attribute for the broadleaf evergreen plants, as those plants either do not bloom or would likely not be in bloom at the time of purchase. Fullness described a given plant's density of foliage and shape, although respondents were instructed that all plants to be considered had good overall shape. The other attributes included were price and label attributes for disease-free and water conservation. Table 1 below lists the attributes and levels shown to respondents.

Table 1: Plant attributes and levels for choice questions.

Attribute	Level	Description
Blossoms (bedding plants only)	Low Partial Full	Less 30% of buds in bloom Between 30% and 79% of buds in bloom Greater than 80% of buds in bloom
Fullness	Low Medium Full	Low density of foliage, good overall shape Medium density of foliage, good overall shape Full density of foliage, good overall shape
Water Conservation	No label ANA ENGO USDA	No certification Certified by American Nursery Association (ANA) Certified by Water for Tomorrow Certified by United States Department of Agriculture (USDA)
Plant Health	No label ANA GO USDA	No certification Certified by American Nursery Association (ANA) Certified by Plant Society of America Certified by United States Department of Agriculture (USDA)
Price	4 levels	Price in dollars

For both disease-free and water conservation certifications, three categories of third party certifying authorities were represented; governmental organization, industry organization and non-governmental organization (NGO). The U.S. Department of Agriculture (USDA) represented the governmental organization for both disease-free and water conservation certifications. A fictitious certifying authority, American Nursery Association (ANA) was used to represent an industry organization. Water for Tomorrow and Plant Society of America represented fictitious NGO's for the water conservation and disease-free certifications, respectively. Figure 1 presents the labels shown to respondents in the choice questions. The labels are differentiated only by the certifying authority to eliminate confounding factors that might affect a respondent's choice.

Water Conservation Labels

U.S. Department of Agriculture (USDA)	American Nursery Association (ANA)	Water for Tomorrow

Disease-free Labels

U.S. Department of Agriculture (USDA)	American Nursery Association (ANA)	Plant Society of America

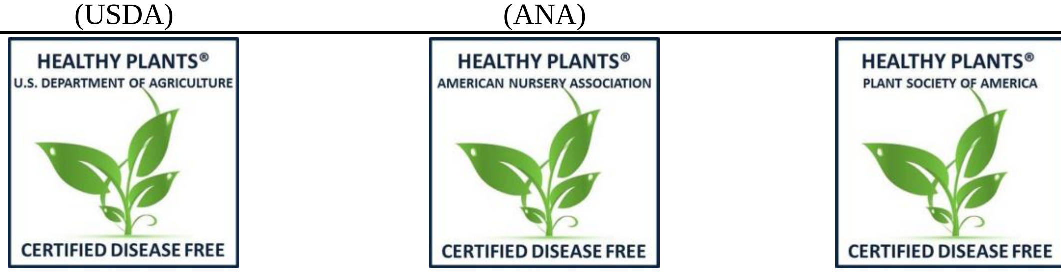

Figure 1: Water conservation and disease-free certification labels

Price data was gathered from various garden centers and nurseries within the study area. Price levels were then chosen to encompass the range of prices observed in the market place[7]. Table 2 shows the price levels chosen for the six different plants.

Table 2: Plant price levels for choice questions

	Price Levels ($)			
Plant	1	2	3	4
Geranium	2.44	3.64	4.84	6.04
Petunia	2.45	3.15	3.84	4.54
Chrysanthemum	3.54	4.54	5.53	6.53
Azalea	3.03	4.37	5.70	7.04
Holly	5.94	9.22	12.50	15.78
Boxwood	6.94	8.87	10.81	12.74

For product attributes that are important to a respondent's purchase decision and that were not included as an attribute in the choice experiment such as color, the respondents were instructed to consider them the same for each alternative in a choice set. Color was specifically mentioned because it has been shown to be an important attribute (Behe et al., 1999). Furthermore, the respondents were given the plant type and container size in each choice set and instructed that they were the same for each alternative within a choice set[8].

Preceding the choice questions, respondents were given instructions and information about the attributes and levels they would be asked to consider. Each certifying authority was defined and it was explained that growers are regularly audited and monitored by the certifying authority to ensure requirements are met. Additional information was given to respondents for the water conservation labels to ensure they understood that water conservation practices such as water recycling were used during the production of the plant and not at their preferred garden center. Additionally, it was important that the respondents understood that water conservation

[7] A non-scientific study was conducted consisting of calling and visiting garden centers in the study area to gather retail prices for the six different plants. Price levels were chosen to encompass price levels observed.
[8] Example of information given: Please consider the annual Geranium options below for purchase at your preferred retailer. The Geraniums are sold in a 4 inch pot. Please assume characteristics that are not listed are the same for both options.

practices did not mean the plants would require less water after they had purchased them. The study provided no additional information on the issues of water conservation or plant-disease. This was done to mimic the information the respondent would likely see at a retailer and to estimate their preferences based on their current level of awareness. Respondents were then shown how the labels would look on a plant tag if they were to see them at their preferred retailer (Figure 2).

Figure 2: Plant tag examples with labels

A cheap talk script[9] was presented to inform respondents that they were to make their selection as if they were actually at their preferred garden retailer given budgetary constraints. The cheap talk script was included to ensure respondents did not choose a selection they would normally not choose if they were actually at their preferred retailer thus reducing the potential for hypothetical bias and artificially high willingness to pay estimates (Cummings & Taylor, 1999; Carlsson et al., 2005).

[9] Cheap talk script:
Before you answer the following questions, we'd like you to keep something in mind:

Surveys such as this estimate what consumers would pay for a product with certain characteristics. Since this is a hypothetical situation, it is common that respondents may not take into consideration all other demands on their household budget. It is particularly common for some people to state they will buy a product when they wouldn't if making the choice at a retailer given budget constraints.

Try to make your choices as if you are really facing the choice of products at your preferred ornamental plant retailer and would be required to pay the price associated with the product chosen. If the two plant choices you are given are not appealing, please select not to purchase either plant.

After the cheap talk script, respondents were shown two choice questions for each plant that they had purchased in the specified timeframe[10] or would consider purchasing in the future. This ensured a respondent was only shown the choice questions for plants they purchase. Thus, if a respondent was a purchaser or potential purchaser of all six plants, the maximum number of choice questions a respondent could be given was twelve which was reasonable to avoid respondent fatigue. Respondents were given two alternatives and the option to not purchase either in each choice question (Figure 3), which may reduce hypothetical bias by removing "forced-choice" situations when respondents would not be in the market (Sackett et al., 2012).

	Option A	**Option B**	**'No Purchase' Option**
Blossoms:	Low bloom	Full bloom	If the Geraniums shown are the only choices at my preferred retailer, I would not purchase either product.
Fullness:	Medium	Full	
Water Conservation:	WATER SMART® AMERICAN NURSERY ASSOCIATION GROWN USING CERTIFIED WATER CONSERVATION	None	
Plant Health:	None	HEALTHY PLANTS® PLANT SOCIETY OF AMERICA CERTIFIED DISEASE FREE	
Price:	$3.64	$4.84	
	○	○	○

Figure 3: Sample alternative and attribute presentation for Geranium choice experiment.

The experimental designs for the stated preference experiments were created using the software Ngene[11] (Collins et al., 2007). Separate experimental designs were created for annuals,

[10] The time frame was one year for annual bedding plants and two years for the broadleaf evergreen plants.
[11] Ngene software is available through Choice Metrics Pty Ltd (http://www.choice-metrics.com). It is commonly used in transportation studies (Weis et al., 2010) as well as other stated preference ares such as tropical river management (Zander et al., 2009). Inputs required for the Ngene software algorithm were the attributes, types of attributes, attribute levels, number of choice sets, number of simulation iterations and prior coefficient estimates.

azaleas and shrubs (Holly and Boxwood)[12]. Given there were up to five attributes with up to four levels, a full factorial design was not feasible. We chose experimental designs consisting of sixteen choice sets, each consisting of a pair of alternatives and an option not to purchase either alternative. Respondents were presented two choice questions drawn at random from the sixteen possible choice sets.

D-efficiency, which minimizes the determinant of the covariance matrix, was used to select between the experimental designs (Burgess & Street, 2003). To improve D-efficiency of the experimental designs, prior coefficient values were estimated for the attributes and levels based on the conditional logit model results from the two pilot studies. The Ngene software utilized prior parameter estimates to rank multiple experimental designs based on D-efficiency. In addition to D-efficiency, the final designs were evaluated to ensure dominate alternatives were not present. If dominant alternatives were present in a particular choice set, the attribute levels were subjectively modified along with another choice set so as to improve utility balance in both choice sets.

4. Economic Model

The economic modeling of the choice experiments was based on Lancaster's "new approach to consumer theory" (Lancaster, 1966) and random utility theory (McFadden, 1974). The utility received from alternative j by individual i can then be described as:

(1) $U_{ij} = V_{ij} + \varepsilon_{ij}$

Where an individual's utility, denoted U_{ij} contains a systematic component, denoted V_{ij}, and a random or stochastic component, denoted ε_{ij}.

[12] Plants were divided into separate experimental designs based on the category. Azaleas was split from Boxwood and Holly designs because of difference in price levels.

The systematic component contains what can be readily observed and measured by the researcher. The random component contains unobserved utility influencers and measurement error creating uncertainty. In order to make probabilistic statements, a distribution needs to be specified for the random component. The logit family of models, which were used for this research, assume ε_{ij} is independently and identically distributed extreme value. Given the maintained hypothesis that consumers maximize utility, individual i chooses alternative j over alternative k such that:

(2) $U_{ij} > U_{ik} \; \forall \; k \neq j$

Alternatively, equation 2 can be written:

(3) $V_{ij} + \varepsilon_{ij} > \; V_{ik} + \varepsilon_{ik} \; \forall \; k \neq j$

The data collected in the choice experiments was analyzed using a mixed logit or otherwise known as a random parameters logit (RPL). The mixed logit model alleviates three limitations of the standard logit model by allowing taste variation, unrestricted substitution patterns and correlation in unobserved factors over time (Train, 2003). For this research, mixed logit was particularly advantageous because it allows for: (1) parameters to vary across individuals and account for preference heterogeneity (Hensher and Green, 2003) and (2) correlation in unobserved factors over time in repeated choice scenarios (Revelt and Train, 1998). The utility equation can then be expressed as:

(4) $U_{ijt} = \beta_i x_{ijt} + \varepsilon_{ijt}$

where t is introduced to distinguish between multiple choice sets given to a single individual. The probability an individual makes a sequence of choices over T choice experiments is expressed as the product of the logit formulas (Train, 2003):

$$L_{ni}(\beta) = \prod_t^T \left[\frac{e^{\beta_n' x_{i_t j}}}{\sum_k e^{\beta_n' x_{i_t k}}} \right] \quad (5)$$

The unconditional mixed logit choice probability for choosing alternative j out of k alternatives then takes the form:

$$P_{ij} = \int L_{ni}(\beta)\, f(\beta) d\beta \quad (6)$$

where $f(\beta)$ is a density function and must be specified for each random parameter.

The mixed logit model estimated for this article estimated only main effects for the systematic utility component, V_{ij}. The estimated model specified the systematic utility for each alternative j as:

$$V_{ij} = ASC_i + \beta_{Price}(Price_j) + \beta_{1i}(partialbloom_j) + \beta_{2i}(fullbloom_j) + \beta_{3i}(medium_j) + \beta_{4i}(full_j) + \beta_{5i}(USDAWC_j) + \beta_{6i}(ANAWC_j) + \beta_{7i}(ENGOWC_j) + \beta_{8i}(USDAPD_j) + \beta_{9i}(ANAPD_j) + \beta_{10i}(GOPD_j) \quad (7)$$

where ASC is the alternative specific constant and β_{ki} consists of the coefficients of the observed attributes which are multiplied by the levels of the attributes in any given alternative. The ASC is 1 if a plant was chosen and a value of 0 if the respondent chose not to purchase either plant. $Price$ is the price of the plant in the given choice set. $Partialbloom$, $fullbloom$, $medium$, and $full$ are dummy variables for the visual characteristics of a plant. The omitted visual characteristics are low bloom and low density. $Partialbloom$ and $fullbloom$ are not included in the broadleaf evergreen plant models. $USDAWC$, $ANAWC$, and $ENGOWC$ are dummy variables for the water conservation labels and $USDAPD$, $ANAPD$, and $GOPD$ are dummy variables for the disease-free labels delineated by certification authorities. The omitted label characteristics are plants without water conservation or disease-free certification labels.

All parameters, with the exception of price, were specified as random and a normal distribution was assumed. By assuming price to be a fixed constant, mean willingness to pay

(WTP) for the various attributes is easily computed by dividing the attribute coefficient by the price coefficient. As a result WTP estimates have a normal distribution.

$$(8)\ WTP_j = -\left(\frac{\hat{\beta}_j}{\hat{\beta}_{price}}\right)$$

Given WTP estimates have a normal distribution, standard errors and confidence intervals were computed using the Krinsky-Robb (Krinsky, 1986) parametric bootstrapping method. This method has been shown to be similar to other methods such as the Delta and Fieller methods used to compute confidence intervals for logit models (Hole, 2007b).

5. Results

Of those the survey was sent to, 4,720 clicked on the survey and 1,630 completed the survey for a click rate of 33.3% and completion rate of 11.5%. There were 1,596 usable completed surveys as thirty four completed surveys were excluded because they reside outside the study area or had multiple violations including providing inconsistent answers[13] or answer speeding[14]. Table 4 shows the response summary for the six plants.

Table 3: Response summary for bedding and broadleaf evergreen plants

	Geranium	Petunia	Chrysanthemum	Azalea	Holly	Boxwood
# of Respondents	1,474	1,440	1,341	1,404	945	979
% of Respondents	92.3%	90.2%	84.0%	88.0%	59.3%	61.3%
# of Observations[15]	8,844	8,640	8,046	8,424	5,676	5,874

5.1 Descriptive Statistics

Table 4 shows the socio-demographic information of the respondents. Of the respondents, 71% were female, 91% were white and 62% had a college degree or higher degree. Using the midpoint of the income intervals, the average income was $94,000. The average age was 55. The demographic results are different than the general population, although the results

[13] e.g. respondents provided the same Likert score for all questions in an inconsistent reciprocal matrix.
[14] Speeding was determined as respondents who finished the survey in the fastest 10th percentile.
[15] The number observations is the number of respondents multiplied by six as each respondent was given two choice sets consisting of two plant options and an option not to purchase either option.

for age, gender and household size are generally consistent with other studies involving horticultural products (Behe, 2006; Yue et al., 2010, Yue and Tong, 2009). Previous studies also indicate a greater percentage of gardening consumers tend to; be white, earn a higher income and have achieved a higher level of education. Additionally, anecdotal evidence suggests that the demographic characteristics are consistent with what is observed for ornamental plant consumers.

Respondents had an average of 26 years of gardening experience and rated themselves approximately a 5 out of 10 on a scale ranging from 1 (novice) to 10 (expert). Given the age of the sample, the high number of years of gardening experience is expected. Additionally, 5% of respondents are members of a gardening organization such as Master Gardeners.

Table 4: Summary statistics of socio-demographic characteristics

Demographic variables		Percentage			Percentage
Gender	Male	28.4%	Income	< $20k	3.6%
	Female	71.6%		$20k to $40k	11.2%
				$40k to $60k	16.8%
Race	Asian	2.9%		$60k to $80k	16.7%
	Black	3.7%		$80k to $100k	17.3%
	White	90.8%		$100k to $120k	12.4%
	Other	2.6%		$120k to $140k	7.1%
				$140k to $160k	5.6%
Education	Some high school or less	0.6%		$160k to $180k	3.2%
	High school graduate	9.3%		$180k to $200k	2.9%
	Some technical school	3.4%		$200k to $300k	3.2%
	Some college	24.4%		>$300k	1.7%
	College graduate	31.2%			
	Master's degree	23.9%	Age	Mean	55
	Doctorate degree	3.9%		Standard Deviation	13.88
	Professional degree	3.3%			
			Household Size	Mean	2.36
Housing Type	Detached House	82.5%		Standard Deviation	1.05
	Attached House	13.6%			
	Apartment	3.4%	Years in Residence	Mean	16.19
	Other	0.5%		Standard Deviation	12.38

A high percentage of respondents had experienced plant loss. Forty six percent of respondents had lost a bedding plant within 30 days of purchase and 5% of the those respondents thought disease was the reason for the plant death. In addition, 54% of respondents had lost a non-annual plant such as a broadleaf evergreen or perennial plant within a year of purchase and

3% of those respondents claimed disease was the likely cause. Though most respondents did not attribute a recent plant loss to disease, a significant proportion of respondents who had lost a bedding or broadleaf evergreen plant did not know the reason (37% and 39%, respectively).

Questions were asked to gauge the respondents' level of awareness of plant disease and water use issues[16]. Five percent of respondents said it was "very likely" and 24% said it was "somewhat likely" for a plant to die from disease. Respondents said it was more likely a plant would die from poor soil conditions, too little water, or insects than from disease. Concern for disease may be low based on anecdotal evidence which suggests consumers may assume soil conditions or too little water have caused a plant to die when in fact, disease is the primary reason. When asked about the issue of water use and conservation, 56% of respondents "strongly agreed" or "somewhat agreed" drought was a concern where they resided. Additionally, 40% of respondents "strongly agreed" or "somewhat" agreed the production of ornamental plants requires a significant amount of water.

5.2 Econometric Model Results

Separate models[17] were estimated for each of the six plants. For each plant, four models were estimated:

1. All parameters were specified as random with the exception of price which was fixed.
2. The label parameters were specified as fixed.[18]
3. The label parameters were aggregated into single fixed label parameters for disease-free and water conservation.

[16] Questions for awareness of water issues were given to approximately half of the respondents based on additional research objectives not explored in this article.
[17] The models were estimated by simulated maximum likelihood using 1,000 Halton draws utilizing the software program Stata/IC and specifically the mixlogit package developed by Arne Risa Hole (Hole, 2007a).
[18] All other parameters remained as specified in model 1 unless specifically mentioned in models 2 through 4.

4. The label parameters were aggregated and specified as random into single label parameters for disease-free and water conservation.

All random parameters were assumed to be a normal distribution. The four models for each plant allowed the following null hypotheses to be tested:

A. The individual label variances are zero and there is no preference heterogeneity.
B. The label means do not differ between certifying authorities and can be aggregated into single label attributes for disease-free and water conservation. Hypothesis B was sequentially tested after hypothesis A.
C. The label parameters (means and variances) can be aggregated into single label parameters for disease-free and water conservation.

5.2.1 Bedding Plant Model Results

Tables 5 through 7 present the estimation results for; Geraniums, Petunias and Chrysanthemums, respectively. In all models, the price coefficient is negative and significant, as expected and suggests consumers are less likely to purchase a plant as prices increases. The coefficients for medium and full density are positive and significant, suggesting respondents prefer medium or full density over low density. The results also suggest respondents prefer partial bloom and full bloom plants given the positive and significant coefficients. The ASC[19] is positive and significant in all models, indicating other attributes that were not specified in the choice questions also factored into the consumers' plant decision. The coefficients for the disease-free and water conservation labels are positive and significant. This strongly suggests respondents prefer plants that are labeled as certified disease-free and grown with water conservation practices.

[19] Models were run without the ASC using separate constants for choice A and B. As expected in this unlabeled model, there was no significant difference in the coefficients for choices A and B, justifying the use of an ASC.

The standard deviation for the ASC is significant in all models suggesting preference heterogeneity in other characteristics a respondent uses to make their purchase decision. Full bloom is the only other attribute where the standard deviation is significant in all models. The only significant standard deviation for the individual label attributes was for the disease-free label certified by the American Nursery Association in Geranium model 1. The results are unexpected and may suggest there is no preference heterogeneity among respondents for the label attributes.

Table 5: Estimated mixed logit models for Geraniums

	Model 1		**Model 2**		**Model 3**		**Model 4**	
VARIABLES	Mean	SD	Mean	SD	Mean	SD	Mean	SD
price	-0.582***		-0.548***		-0.522***		-0.580***	
	(0.046)		(0.037)		(0.032)		(0.042)	
ASC	2.477***	2.682***	2.375***	2.616***	2.343***	2.535***	2.467***	2.555***
	(0.220)	(0.225)	(0.196)	(0.212)	(0.193)	(0.200)	(0.210)	(0.221)
partialbloom	0.496***	-0.016	0.511***	-0.002	0.435***	-0.005	0.458***	-0.024
	(0.105)	(0.287)	(0.099)	(0.259)	(0.086)	(0.272)	(0.094)	(0.268)
fullbloom	0.647***	1.064***	0.643***	-0.953***	0.566***	0.981***	0.583***	1.124***
	(0.101)	(0.190)	(0.095)	(0.164)	(0.084)	(0.161)	(0.094)	(0.184)
medium	0.444***	0.000	0.418***	-0.004	0.396***	0.000629	0.442***	0.00286
	(0.108)	(0.252)	(0.100)	(0.227)	(0.091)	(0.221)	(0.101)	(0.254)
full	0.685***	0.305	0.661***	0.131	0.614***	0.220	0.703***	0.375
	(0.110)	(0.371)	(0.103)	(0.537)	(0.090)	(0.421)	(0.101)	(0.324)
WClabel					0.822***		0.895***	-0.236
					(0.089)		(0.099)	(0.640)
usdawc	0.894***	0.392	0.895***					
	(0.125)	(0.472)	(0.116)					
anawc	0.899***	-0.027	0.862***					
	(0.117)	(0.295)	(0.107)					
engowc	0.944***	-0.023	0.902***					
	(0.123)	(0.381)	(0.112)					
PDlabel					0.907***		0.984***	1.110***
					(0.085)		(0.104)	(0.199)
usdapd	0.865***	0.0167	0.839***					
	(0.102)	(0.330)	(0.093)					
anapd	0.965***	0.920***	1.005***					
	(0.138)	(0.286)	(0.122)					
gopd	1.051***	0.000	1.003***					
	(0.113)	(0.977)	(0.103)					
Log Likelihood	-2714.559		-2716.915		-2718.938		-2712.242	

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 6: Estimated mixed logit models for Petunias

	Model 1		Model 2		Model 3		Model 4	
VARIABLES	Mean	SD	Mean	SD	Mean	SD	Mean	SD
price	-0.793***		-0.771***		-0.722***		-0.873***	
	(0.072)		(0.064)		(0.056)		(0.080)	
ASC	3.360***	2.664***	3.312***	2.633***	3.228***	2.570***	3.523***	2.547***
	(0.280)	(0.244)	(0.267)	(0.237)	(0.260)	(0.229)	(0.310)	(0.276)
partialbloom	0.418***	0.556*	0.418***	0.503	0.371***	-0.597**	0.455***	0.687**
	(0.106)	(0.328)	(0.102)	(0.325)	(0.090)	(0.280)	(0.110)	(0.340)
fullbloom	0.726***	1.053***	0.702***	1.019***	0.647***	1.009***	0.766***	1.255***
	(0.104)	(0.175)	(0.097)	(0.163)	(0.088)	(0.165)	(0.113)	(0.210)
medium	0.417***	-0.006	0.417***	-0.019	0.367***	-0.0133	0.440***	-0.083
	(0.105)	(0.356)	(0.101)	(0.371)	(0.092)	(0.410)	(0.109)	(0.420)
full	0.890***	-0.030	0.871***	-0.028	0.798***	-0.170	0.990***	-0.294
	(0.114)	(0.522)	(0.107)	(0.595)	(0.094)	(0.515)	(0.120)	(0.463)
WClabel					0.715***		0.797***	0.952***
					(0.089)		(0.108)	(0.274)
usdawc	0.832***	0.007	0.808***					
	(0.123)	(0.388)	(0.115)					
anawc	0.868***	-0.0227	0.848***					
	(0.115)	(0.392)	(0.106)					
engowc	0.711***	0.0251	0.704***					
	(0.117)	(0.321)	(0.112)					
PDlabel					1.096***		1.321***	1.371***
					(0.090)		(0.130)	(0.214)
usdapd	1.092***	0.242	1.061***					
	(0.107)	(0.632)	(0.096)					
anapd	1.273***	0.211	1.246***					
	(0.135)	(0.651)	(0.127)					
gopd	1.136***	-0.582	1.117***					
	(0.114)	(0.364)	(0.105)					
Log Likelihood	-2578.999		-2579.445		-2582.920		-2570.697	

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 7: Estimated mixed logit models for Chrysanthemums

	Model 1		Model 2		Model 3		Model 4	
VARIABLES	Mean	SD	Mean	SD	Mean	SD	Mean	SD
price	-0.669***		-0.642***		-0.596***		-0.671***	
	(0.058)		(0.050)		(0.042)		(0.058)	
ASC	3.032***	3.090***	2.954***	3.035***	2.887***	2.954***	3.113***	2.947***
	(0.258)	(0.256)	(0.238)	(0.243)	(0.231)	(0.231)	(0.269)	(0.254)
partialbloom	0.427***	-0.001	0.433***	0.001	0.370***	-0.008	0.421***	0.030
	(0.113)	(0.306)	(0.108)	(0.303)	(0.094)	(0.329)	(0.107)	(0.379)
fullbloom	0.687***	1.094***	0.666***	1.008***	0.575***	1.020***	0.621***	1.142***
	(0.113)	(0.200)	(0.105)	(0.173)	(0.092)	(0.174)	(0.105)	(0.203)
medium	0.594***	0.002	0.593***	-0.009	0.486***	-0.007	0.542***	0.004
	(0.118)	(0.256)	(0.111)	(0.244)	(0.099)	(0.261)	(0.112)	(0.307)
full	0.916***	0.373	0.897***	-0.331	0.787***	0.390	0.873***	0.496
	(0.124)	(0.379)	(0.117)	(0.365)	(0.100)	(0.310)	(0.115)	(0.315)
WClabel					0.855***		0.917***	0.909***
					(0.098)		(0.114)	(0.274)
usdawc	1.105***	0.003	1.073***					
	(0.137)	(0.324)	(0.128)					
anawc	0.824***	0.631	0.807***					
	(0.125)	(0.414)	(0.115)					
engowc	0.895***	-0.037	0.865***					
	(0.133)	(0.618)	(0.123)					
PDlabel					0.935***		1.014***	0.911***
					(0.092)		(0.111)	(0.251)
usdapd								
	1.012***	0.035	0.962***					
	(0.118)	(0.652)	(0.102)					
anapd								
	1.107***	0.540	1.089***					
	(0.149)	(0.420)	(0.134)					
gopd								
	1.035***	-0.083	0.984***					
	(0.125)	(0.637)	(0.110)					
Log Likelihood	-2528.114		-2528.836		-2533.253		-2529.861	

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

The results of the likelihood ratio tests utilized to test the hypotheses outlined above are presented in table 8. The first likelihood ratio test was performed to compare models 1 and 2 and determine if respondents show preference heterogeneity for the label attributes (hypothesis A). The results indicate that we fail to reject the null hypothesis in all three bedding plant models, suggesting there is no preference heterogeneity when the labels are delineated by certifying authority. The second likelihood ratio test compares models 2 and 3 (hypothesis B) and tests whether respondents have a preference for a particular certification authority when the label attributes are fixed. The results are mixed given we fail to reject the null hypothesis for the Geranium and Petunia models suggesting there is no preference for a particular certifying agency. However, the null hypothesis was rejected for the Chrysanthemum model. Finally, a likelihood ratio test was performed to compare models 1 and 4 to determine if the means and variances of the individual label attributes could be aggregated (hypothesis C). The null hypothesis was rejected for Petunia model suggesting the labels could not be aggregated. However, we failed to reject the null hypothesis for the Geranium and Chrysanthemum models. Based on the likelihood ratio tests, we chose model 4 for Chrysanthemums and Geraniums and model 2 for Petunias. A formal discussion of the choice of models for all plant models is found in the discussion section.

Table 8: Likelihood-ratio test results for bedding plants.

	Model 1	Model 2	Model 3	Model 4
Critical Value (0.1 level)	-	10.645	7.779	13.326
df	-	6	4	8
Baseline Log Likelihood	-	Model 1	Model 2	Model 1
Geraniums				
χ^2 Statistic	-	4.713	4.046	4.633
Decision	-	Fail to reject	Fail to reject	Fail to reject
Petunias				
χ^2 Statistic	-	0.893	6.950	16.603
Decision	-	Fail to reject	Fail to reject	Reject
Chrysanthemums				
χ^2 Statistic	-	1.444	8.833	3.494
Decision	-	Fail to reject	Reject	Fail to reject

Willingness to pay results for the chosen bedding plant models are presented in table 9 with 90% confidence intervals[20]. As expected from the utility model results, the WTP for a full bloom plant is higher than for a plant in partial bloom as is the case for a full density plant compared to a plant having medium density. However, the difference is only significant for both visual characteristics in the Petunia model and for density in the Chrysanthemum model based on non-overlapping confidence intervals. The WTP for the ASC was relatively high in all three models given the price levels in the choice experiment. This could indicate the presence of hypothetical bias where the results indicate respondents would pay a higher premium than if they were actually purchasing the product given their budget constraints.

It is evident from all bedding plant WTP estimates that respondents are willing to pay a premium for disease-free and water conservation certification labels. In most models, mean WTP for plants certified disease-free is higher than those produced with water conservation, though a significant difference is only evident in the Petunia model.

[20] Estimated using 15,000 draws using Krinsky-Robb method

Table 9: Willingness to pay results for bedding plants

	Geranium		Petunia		Chrysanthemum	
	Mean ($)	90% CI	Mean ($)	90% CI	Mean ($)	90% CI
ASC	4.26	3.67-4.93	4.47	3.88-5.15	4.64	4.08-5.29
partialbloom	0.79	0.54-1.03	0.51	0.32-0.70	0.63	0.38-0.86
fullbloom	1.01	0.76-1.26	0.90	0.72-1.07	0.92	0.69-1.16
medium	0.76	0.50-1.03	0.51	0.31-0.70	0.81	0.56-1.06
full	1.21	0.97-1.45	1.10	0.94-1.28	1.30	1.08-1.53
WClabel	1.54	1.30-1.79	0.99	0.81-1.18	1.37	1.12-1.62
PHlabel	1.70	1.46-1.95	1.52	1.34-1.71	1.51	1.30-1.74

5.2.2 Broadleaf Evergreen Plant Model Results

Tables 10 through 12 present the estimation results for; Azalea, Holly and Boxwood, respectively. In all models, the price coefficient is negative and significant, as expected. As with the bedding plant models, the coefficients for the ASC, medium density, full density and label attributes are positive and significant. Corroborating the results of the bedding plant models, the results suggest respondents prefer plants that are labeled as certified disease-free and grown with water conservation practices. The exceptions are Holly models 1 and 2, where the water conservation labels certified by the USDA and an ENGO were not found to be significant.

Similar to the bedding plant models, the standard deviation for the ASC is significant in all models suggesting preference heterogeneity for the attributes not specified in the choice questions. The standard deviation for the attribute full density is also significant in all models. Of the label attributes, only the standard deviation for water conservation certified by the American Nursery Association in the Azalea and Boxwood models and disease-free certification in the Azalea model are significant. As with the bedding plants, the results are slightly unexpected and may suggest there is no preference heterogeneity among respondents for the label attributes.

Table 10: Estimated mixed logit models for Azaleas

	Model 1		Model 2		Model 3		Model 4	
VARIABLES	Mean	SD	Mean	SD	Mean	SD	Mean	SD
price	-0.631***		-0.599***		-0.706***		-0.782***	
	(0.063)		(0.055)		(0.055)		(0.0664)	
ASC	3.364***	2.589***	3.332***	2.498***	4.096***	2.911***	4.345***	2.953***
	(0.368)	(0.283)	(0.347)	(0.259)	(0.366)	(0.275)	(0.413)	(0.319)
medium	0.876***	-0.821**	0.841***	0.681**	0.997***	0.225	1.055***	0.335
	(0.139)	(0.350)	(0.123)	(0.310)	(0.121)	(0.708)	(0.138)	(0.570)
full	1.424***	1.755***	1.369***	1.551***	1.635***	1.381***	1.791***	1.615***
	(0.180)	(0.228)	(0.162)	(0.173)	(0.160)	(0.156)	(0.189)	(0.195)
WClabel					0.879***		0.959***	1.299***
					(0.095)		(0.117)	(0.232)
usdawc	0.726***	0.0170	0.702***					
	(0.131)	(0.663)	(0.121)					
anawc	1.007***	-0.975***	0.917***					
	(0.146)	(0.342)	(0.119)					
engowc	0.760***	-0.008	0.699***					
	(0.139)	(0.392)	(0.122)					
PDlabel					1.627***		1.850***	0.729**
					(0.113)		(0.155)	(0.330)
usdapd	1.725***	0.150	1.560***					
	(0.176)	(0.486)	(0.133)					
anapd	1.399***	-0.070	1.292***					
	(0.158)	(0.560)	(0.132)					
gopd	2.077***	0.806*	1.851***					
	(0.205)	(0.412)	(0.141)					
	-0.631***		-0.599***		-0.706***		-0.782***	
Log Likelihood	-2416.498		-2418.791		-2432.052		-2423.591	

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 11: Estimated mixed logit models for Holly

	Model 1		Model 2		Model 3		Model 4	
VARIABLES	Mean	SD	Mean	SD	Mean	SD	Mean	SD
price	-0.305***		-0.290***		-0.272***		-0.313***	
	(0.025)		(0.020)		(0.019)		(0.025)	
ASC	3.409***	2.475***	3.284***	2.407***	3.085***	2.361***	3.374***	2.265***
	(0.293)	(0.244)	(0.253)	(0.225)	(0.243)	(0.222)	(0.284)	(0.264)
medium	0.523***	0.552	0.514***	-0.575*	0.470***	0.392	0.565***	-0.265
	(0.128)	(0.403)	(0.122)	(0.336)	(0.113)	(0.456)	(0.129)	(0.691)
full	1.067***	0.794***	1.019***	0.766***	0.917***	0.845***	1.100***	1.077***
	(0.128)	(0.238)	(0.114)	(0.222)	(0.110)	(0.209)	(0.139)	(0.236)
WClabel					0.320***		0.313***	1.239***
					(0.091)		(0.113)	(0.227)
usdawc	0.157	0.0131	0.139					
	(0.125)	(0.333)	(0.118)					
anawc	0.252**	0.059	0.252**					
	(0.115)	(0.526)	(0.110)					
engowc	0.159	0.505	0.165					
	(0.139)	(0.516)	(0.132)					
PDlabel					1.220***		1.380***	1.095***
					(0.129)		(0.159)	(0.281)
usdapd	1.639***	-0.621	1.587***					
	(0.196)	(0.409)	(0.180)					
anapd	1.332***	-0.012	1.268***					
	(0.161)	(0.312)	(0.143)					
gopd	1.149***	-0.301	1.106***					
	(0.167)	(0.645)	(0.153)					
Log Likelihood	-1737.087		-1737.777		-1747.928		-1738.084	

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 12: Estimated mixed logit models for Boxwood

	Model 1		Model 2		Model 3		Model 4	
VARIABLES	Mean	SD	Mean	SD	Mean	SD	Mean	SD
price	-0.362***		-0.318***		-0.314***		-0.416***	
	(0.040)		(0.026)		(0.025)		(0.039)	
ASC	4.065***	2.411***	3.730***	2.277***	3.696***	2.263***	4.482***	2.450***
	(0.404)	(0.268)	(0.316)	(0.238)	(0.309)	(0.236)	(0.427)	(0.353)
medium	0.612***	0.004	0.535***	0.006	0.564***	0.006	0.800***	0.027
	(0.128)	(0.362)	(0.110)	(0.345)	(0.106)	(0.350)	(0.140)	(0.311)
full	1.183***	-0.694***	1.055***	0.676***	1.049***	0.666***	1.538***	0.909***
	(0.144)	(0.245)	(0.104)	(0.203)	(0.101)	(0.202)	(0.167)	(0.266)
WClabel					0.459***		0.649***	1.591***
					(0.084)		(0.128)	(0.244)
usdawc	0.571***	-0.006	0.513***					
	(0.122)	(0.267)	(0.108)					
anawc	0.439***	-0.984***	0.428***					
	(0.114)	(0.299)	(0.097)					
engowc	0.403***	-0.021	0.362***					
	(0.125)	(0.302)	(0.116)					
PDlabel					1.240***		1.761***	1.974***
					(0.120)		(0.206)	(0.292)
usdapd	1.471***	0.576	1.347***					
	(0.192)	(0.452)	(0.156)					
anapd	1.444***	0.270	1.291***					
	(0.169)	(0.756)	(0.133)					
gopd	1.382***	0.003	1.239***					
	(0.176)	(0.347)	(0.142)					
Log Likelihood	-1749.158		-1751.586		-1753.342		-1724.110	

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

The results of the likelihood ratio tests utilized to test the hypotheses outlined above are presented in table 13. The results of the first likelihood test (hypothesis A) indicate that we fail to reject the null hypothesis for all broadleaf evergreen plant models, suggesting there is no preference heterogeneity for the individual label attributes as was also found for the annual bedding plants. The results of the second likelihood ratio test (hypothesis B) are mixed, given we fail to reject the null hypothesis for the Boxwood model while rejecting the null hypothesis for the Azalea and Holly models. The third likelihood ratio test (hypothesis C) also provides mixed results as the null hypothesis was rejected for Azalea and Boxwood models suggesting the labels could not be aggregated. However, we failed to reject the null hypothesis for the Holly model. Based on the likelihood ratio tests, we chose model 2 for Azaleas, model 3 for Boxwoods and model 4 for Hollies.

Table 13: Likelihood ratio test results for broadleaf evergreen plants

	Model 1	Model 2	Model 3	Model 4
df	-	10.645	7.779	13.326
Critical Value (0.1 level)	-	6	4	8
Baseline Log Likelihood	-	Model 1	Model 2	Model 1
Azaleas				
χ^2 Statistic	-	4.586	26.522	14.186
Decision	-	Fail to reject	Reject	Reject
Holly				
χ^2 Statistic	-	1.380	20.302	1.995
Decision	-	Fail to reject	Reject	Fail to reject
Boxwood				
χ^2 Statistic		4.856	3.512	50.096
Decision		Fail to reject	Fail to reject	Reject

Willingness to pay estimates are presented for the final models of the broadleaf evergreen plants in table 14 with their corresponding confidence intervals. As expected from the utility results and similar to bedding plant model results, all models show respondents are willing to pay more for a plant with full density than a plant with medium density. The difference is also significant in all final models based on non-overlapping confidence intervals. As with the bedding plant models, the WTP for the ASC was relatively high in all three models given the price levels in the choice experiment and could indicate the presence of hypothetical bias.

The results strongly suggest respondents are willing to pay more for disease-free and water conservation certification labels. Using overlapping confidence intervals as the criteria for significance, it is shown that the label attributes for disease-free certification are significantly higher than the label attributes for water conservation certification in all models.

Table 14: Estimated models of willingness to pay for broadleaf evergreen plants

	Azalea		**Holly**		**Boxwood**	
	Mean	90% CI	Mean	90% CI	Mean	90% CI
ASC	5.57	4.9-6.27	10.79	9.77-11.91	11.77	10.53-13.13
medium	1.40	1.14-1.67	1.81	1.16-2.44	1.80	1.27-2.33
full	2.29	2.02-2.56	3.52	2.92-4.14	3.34	2.86-3.86
WClabel			1.00	0.41-1.60	1.80	1.27-2.33
usdawc	1.17	0.90-1.44				
anawc	1.53	1.24-1.85				
engowc	1.17	0.88-1.46				
PHlabel			4.41	3.73-5.12	3.95	3.40-4.55
usdaph	2.61	2.23-3.06				
anaph	2.16	1.88-2.46				
goph	3.09	2.68-3.61				

6. Discussion

The results show respondents prefer plants with disease-free and water conservation labels in all cases, strongly suggesting they are willing to pay a premium for plants with either label attribute. Furthermore, we uniformly failed to reject hypothesis A, suggesting there is no preference heterogeneity among respondents in any of the models for the labels when they are delineated by certifying authority.

The results were mixed when testing whether the means of the label attributes were the same and variances were zero (hypothesis B). We failed to reject the null hypothesis for the Geranium, Petunia, and Boxwood models. The results suggest we are able to aggregate the fixed labels and respondents do not distinguish between the certifying authorities. However, for the

Chrysanthemum, Azalea and Holly models, we rejected the null hypothesis, suggesting the fixed labels cannot be aggregated.

The results were also mixed when testing whether the label means and variances could be aggregated (hypothesis C). We failed to reject the null hypothesis for the Geranium, Chrysanthemum and Holly models suggesting the random labels could be aggregated. Additionally, the results show the standard deviations for the aggregated label parameters are significant with the exception of the water conservation label for the Geranium model, suggesting there is preference heterogeneity among respondents. We rejected the null hypothesis for the Petunia, Azalea and Boxwood models indicating we cannot aggregate the label means and variances.

The results indicate model 4 is preferred for the Geranium, Chrysanthemum and Holly models given we fail to reject hypothesis C and the standard deviations for the aggregated label attributes are generally significant. Model 2 is preferred for the Azalea model since both hypotheses B and C are rejected. Finally, model 3 is recommended for the Petunia and Boxwood models given we fail to reject hypothesis B and reject hypothesis C.

In all but the Azalea model, the results suggest the respondents do not prefer a particular certifying authority. However, when respondents were asked whom they trust most to protect public water sources; 33% chose the government and 31% chose an environmental non-governmental agency. Only 18% preferred an industry organization such as the American Nursery Association and the rest did not choose any of the three certifying authority categories. It would therefore be recommended that a governmental organization or environmental NGO administer certification. The recommended models yielded mixed results as to whether there was preference heterogeneity among respondents. The recommended models for Geraniums, Chrysanthemums and Hollies indicate preference heterogeneity among respondents, though the models for Azalea and Boxwood suggest the labels can be fixed.

A positive and significant willingness to pay for the disease-free and water conservation label attributes was found in all recommended models. Furthermore, the results suggest producers will be able to recoup some of the cost to adopt water recycling and disease control measures through a labeling program. WTP for the disease-free label was generally higher for the bedding plants, though only significant for the Petunia model. For the broadleaf evergreen plants, WTP for the disease-free label is significantly higher than for the water conservation label in all models. The results would be expected from consumers whose personal utility is more important to them than is a measure of social benefit. Furthermore, the difference could be more pronounced in the broadleaf evergreen plant models as it would be expected respondents are willing to pay more to ensure they do not lose a plant that is expected to last many seasons.

7. Conclusions

Plant disease and irrigation water use will continue to be two key issues affecting producer profitability, consumer satisfaction and environmental quality in the sale and production of ornamental plants. Producers will be under increasing pressure to adopt solutions to address both issues due to regulatory and drought concerns. However, adoption will continue to be low if producers are uncertain about potential revenue enhancements. Ornamental plant producers could benefit from a labeling program to increase consumer awareness and enable them to recoup some of the increased costs. The main objective of this research was to determine if consumers have a preference for disease-free and water conservation labels resulting in a positive willingness to pay.

The research used data from a choice modeling survey of ornamental plant consumers to estimate mixed logit models for six plants. The findings strongly suggest that consumers have a preference and are willing to pay a premium for water conservation and disease-free certification labels. Furthermore, the results suggest there is an opportunity for labeling programs of either attribute, which will allow producers to recoup some of the cost of implementing water conservation and disease control practices. Given the results, a voluntary label policy should be investigated further as an alternative to governmental standards or regulations, which may be costly to greenhouse and nursery operations. A successful labeling program would result in more producers implementing water conservation and disease control practices, which, in turn, will benefit the public by protecting public water resources and improving plant health.

We have also shown that for most of the plant models, respondents did not show preference for a particular certifying authority, suggesting the labels could be aggregated into a single label. Given the results were not the same for each of the plant models, caution is advised in possible future studies that purport to use only a single model to draw conclusions about labeling. However, when respondents were asked directly, they indicated they trust a governmental organization or environmental NGO to administer certification more than an industry organization. It is therefore recommended that the preferred certifying authority should be explored further with the likely outcome being a government agency or non-governmental organization.

Finally, we investigated if the results varied among ornamental consumers in the form of preference heterogeneity of the label parameters. Our results are mixed, although three of the plant models show that when the labels are aggregated, there is evidence of preference heterogeneity among respondents. The results were generally different when the labels were separated for the various certifying authorities, as the models do not show preference heterogeneity of the label parameters. As a result, the question of heterogeneity should be explored further if a labeling program is able to account for preference heterogeneity among ornamental plant consumers.

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9. Appendices

Appendix A: Ngene Script

Software: Ngene Version 1.1.0 (Build 262)
Comments:

- Prior values from pilot study as of 3/30/2012
- Prior values aggregated for annuals and broadleaf evergreen plants
- Three designs developed with price levels averaged respectively

Bedding Plant Script

```
Design
;alts = A, B, C
;rows = 16
;eff = (mnl,d)
;alg = swap(stop=total(100000 iterations))
;model:[21]
U(A) = b1[1.136] + b2.dummy[0.664|0.899]* X1[0,1,2] + b3.dummy[0.930|0.661]*X2[0,1,2] +
b4.dummy[0.587|0.414|0.671] * X3[3,2,1,0] + b5.dummy[0.406|0.914|0.293] * X4[3,2,1,0] + b6[-0.466] *
X5[2.81,3.77,4.74,5.70] /
U(B) = b1[1.136] + b2 * X1        + b3 * X2        + b4 * X3        + b5 * X4        + b6 * X5 $
```

Azalea Script

```
Design
;alts = A, B, C
;rows = 16
;eff = (mnl,d)
;alg = swap(stop=total(100000 iterations))
;model:
U(A) = b1[1.136] + b2.dummy[0.930|0.661]*X1[0,1,2] + b3.dummy[0.587|0.414|0.671] * X2[3,2,1,0] +
b4.dummy[0.406|0.914|0.293] * X3[3,2,1,0] + b5[-0.466] * X4[3.03,4.37,5.70,7.04] /
U(B) = b1[1.136] + b2 * X1        + b3 * X2        + b4 * X3        + b5 * X4$
```

Holly and Boxwood Script

```
Design
;alts = A, B, C
;rows = 16
;eff = (mnl,d)
;alg = swap(stop=total(100000 iterations))
;model:
U(A) = b1[1.136] + b2.dummy[0.930|0.661]*X1[0,1,2] + b3.dummy[0.587|0.414|0.671] * X2[3,2,1,0] +
b4.dummy[0.406|0.914|0.293] * X3[3,2,1,0] + b5[-0.466] * X4[6.44,9.05,11.65,14.26] /
U(B) = b1[1.136] + b2 * X1        + b3 * X2        + b4 * X3        + b5 * X4$
```

[21] Prior values were computed from aggregating data from two pilot studies 3/30/2012. All annual data was aggregated and analyzed. Azalea data was analyzed separately. Holly and Boxwood data was aggregated and analyzed. Conditional logit models were used to obtain prior values.

Appendix B: Choice Experiment Attributes and Levels

Table 15: Choice experiment attributes and levels

Attribute	Level	Value	Description	
Bloom[22]	2	Low bloom	Less than 30% of buds are in bloom	
	1	Partial bloom	30 to 79% of buds are in bloom	
	0	Full bloom	80 to 100% of buds are in bloom	
Fullness	2	Light	The plant has a light density of foliage	
	1	Medium	The plant has a medium density of foliage	
	0	Full	The plant has a full density of foliage	
Water Conservation	3	ENGO Cert	Plant is certified by environmental non-governmental organization for water conservation, Water for Tomorrow	
	2	ANA Cert	Plant is certified by industry association for water conservation, American Nursery Association	
	1	USDA Cert	Plant is certified by government agency for water conservation, U.S. Department of Agriculture	
	0	None	Plant is grown using typical watering practices	
Plant Health	3	GO Cert	Plant is certified disease-free by gardening organization, Plant Society of America	
	2	ANA Cert	Plant is certified disease-free by industry association, American Nursery Association	
	1	USDA Cert	Plant is certified disease-free by government agency, U.S. Department of Agriculture	
	0	None		
Price ($)		**Geranium**	**Petunia**	**Chrysanthemum**
	3	6.04	4.54	6.53
	2	4.84	3.84	5.53
	1	3.64	3.15	4.54
	0	2.44	2.45	3.54
		Azalea	**Holly**	**Boxwood**
	3	7.04	15.78	12.74
	2	5.70	12.50	10.81
	1	4.37	9.22	8.87
	0	3.03	5.94	6.94

[22] Blooms was not included for woody plants (Azaleas, Hollies, and Boxwoods) since they either don't bloom or it is less likely they will be blooming at time of purchase.

Appendix C: Label Information

Table 16: Water conservation certification label information given to respondents

Label	Description
None	'None' describes a plant that is grown using typical watering practices.
	A choice labeled 'Water Smart' by the U.S. Department of Agriculture (USDA) means the ornamental plants were grown to meet U.S. Department of Agriculture requirements concerning water conservation and produced with water recycling technology. The USDA is a government agency charged with developing policy concerning farming, food and agriculture. The certification implies growers are regularly audited and monitored by the USDA to ensure requirements are met.
	A choice labeled 'Water Smart' by the American Nursery Association (ANA) means the ornamental plants were grown to meet American Nursery Association requirements concerning water conservation and produced with water recycling technology. The American Nursery Association is an industry association representing the producers of ornamental plants. The certification implies growers are regularly audited and monitored by the industry association to ensure requirements are met.
	A choice labeled 'Water Smart' by Water for Tomorrow means the ornamental plants were grown to meet Water for Tomorrow requirements concerning water conservation and produced with water recycling technology. Water for Tomorrow is an environmental non-governmental organization (NGO) which advocates for the protection of public water resources. Examples of other NGO's in the U.S. are the Sierra Club and The Forest Stewardship Council. The certification implies growers are regularly audited and monitored by Water for Tomorrow to ensure requirements are met.

Table 17: Disease-free certification label information given to respondents

Label	**Description**
None	'None' describes a plant that has no plant health certification.
HEALTHY PLANTS® U.S. DEPARTMENT OF AGRICULTURE CERTIFIED DISEASE FREE	A choice labeled 'Healthy Plants - Certified Disease Free' by the U.S. Department of Agriculture (USDA) means the plant was grown under conditions that meet U.S. Department of Agriculture (USDA) requirements to ensure the plant is free of disease and healthy. The USDA is a government agency charged with developing policy concerning farming, food and agriculture. The certification implies plants and growers are regularly audited and monitored by the USDA to ensure requirements are met.
HEALTHY PLANTS® AMERICAN NURSERY ASSOCIATION CERTIFIED DISEASE FREE	A choice labeled 'Healthy Plants - Certified Disease Free' by the American Nursery Association (ANA) means the plant was grown under conditions that meet American Nursery Association requirements to ensure the plant is free of disease and healthy. The American Nursery Association is an industry association representing the producers of ornamental plants. The certification implies the plants growers are regularly audited and monitored by the industry association to ensure requirements are met.
HEALTHY PLANTS® PLANT SOCIETY OF AMERICA CERTIFIED DISEASE FREE	A choice labeled 'Healthy Plants - Certified Disease Free' by Plant Society of America means the plant was grown under conditions that meet Plant Society of America requirements to ensure the plant is free of disease and healthy. Plant Society of American is a gardening organization promoting gardening and healthy plants. The certification implies the plants growers are regularly audited and monitored by Plant Society of America to ensure requirements are met.

Appendix D: Cheap Talk Script

Before you answer the following questions, we’d like you to keep something in mind:

Surveys such as this estimate what consumers would pay for a product with certain characteristics. Since this is a hypothetical situation, it is common that respondents may not take into consideration all other demands on their household budget. It is particularly common for some people to state they will buy a product when they wouldn't if making the choice at a retailer given budget constraints.

Try to make your choices as if you are really facing the choice of products at your preferred ornamental plant retailer and would be required to pay the price associated with the product chosen. If the two plant choices you are given are not appealing, please select not to purchase either plant.

Appendix E: Choice Experiment Designs

Table 18: Bedding plant choice experiment design

Choice 1	A	B	**Choice 9**	A	B
Bloom	2	0	Bloom	0	1
Fullness	0	1	Fullness	2	1
Water Conservation	3	2	Water Conservation	2	0
Plant Health	2	0	Plant Health	3	2
Price	2	1	Price	0	2
Choice 2	A	B	**Choice 10**	A	B
Bloom	0	2	Bloom	0	2
Fullness	1	2	Fullness	1	0
Water Conservation	1	2	Water Conservation	2	1
Plant Health	0	1	Plant Health	2	0
Price	3	0	Price	2	0
Choice 3	A	B	**Choice 11**	A	B
Bloom	0	1	Bloom	1	2
Fullness	2	0	Fullness	2	0
Water Conservation	1	2	Water Conservation	0	1
Plant Health	1	3	Plant Health	1	3
Price	0	3	Price	0	3
Choice 4	A	B	**Choice 12**	A	B
Bloom	1	0	Bloom	1	0
Fullness	2	0	Fullness	0	1
Water Conservation	3	2	Water Conservation	2	3
Plant Health	3	1	Plant Health	2	3
Price	1	1	Price	2	1
Choice 5	A	B	**Choice 13**	A	B
Bloom	2	2	Bloom	1	2
Fullness	2	2	Fullness	0	1
Water Conservation	0	0	Water Conservation	1	0
Plant Health	0	1	Plant Health	1	2
Price	2	3	Price	3	0
Choice 6	A	B	**Choice 14**	A	B
Bloom	2	1	Bloom	0	1
Fullness	0	2	Fullness	1	2
Water Conservation	3	1	Water Conservation	3	1
Plant Health	0	2	Plant Health	1	0
Price	0	3	Price	3	0
Choice 7	A	B	**Choice 15**	A	B
Bloom	2	0	Bloom	2	0
Fullness	1	0	Fullness	1	0
Water Conservation	1	3	Water Conservation	2	0
Plant Health	3	0	Plant Health	0	3
Price	1	2	Price	1	2
Choice 8	A	B	**Choice 16**	A	B
Bloom	1	0	Bloom	0	1
Fullness	0	2	Fullness	0	1
Water Conservation	0	3	Water Conservation	0	3
Plant Health	3	2	Plant Health	2	1
Price	1	2	Price	3	1

Table 19: Azalea choice experiment design

Choice 1	A	B	Choice 9	A	B
Fullness	0	1	Fullness	0	2
Water Conservation	2	0	Water Conservation	3	0
Plant Health	0	3	Plant Health	1	2
Price	1	0	Price	2	0
Choice 2	**A**	**B**	**Choice 10**	**A**	**B**
Fullness	2	2	Fullness	1	0
Water Conservation	0	3	Water Conservation	1	0
Plant Health	3	1	Plant Health	2	1
Price	2	3	Price	1	0
Choice 3	**A**	**B**	**Choice 11**	**A**	**B**
Fullness	1	0	Fullness	1	0
Water Conservation	3	1	Water Conservation	2	3
Plant Health	3	2	Plant Health	0	2
Price	0	2	Price	1	3
Choice 4	**A**	**B**	**Choice 12**	**A**	**B**
Fullness	0	1	Fullness	1	2
Water Conservation	3	2	Water Conservation	0	2
Plant Health	3	1	Plant Health	0	3
Price	2	1	Price	3	3
Choice 5	**A**	**B**	**Choice 13**	**A**	**B**
Fullness	0	2	Fullness	2	0
Water Conservation	1	3	Water Conservation	2	1
Plant Health	3	0	Plant Health	2	0
Price	3	0	Price	0	1
Choice 6	**A**	**B**	**Choice 14**	**A**	**B**
Fullness	0	1	Fullness	0	2
Water Conservation	0	1	Water Conservation	0	1
Plant Health	2	1	Plant Health	1	3
Price	1	1	Price	3	2
Choice 7	**A**	**B**	**Choice 15**	**A**	**B**
Fullness	2	1	Fullness	2	0
Water Conservation	1	2	Water Conservation	1	3
Plant Health	0	2	Plant Health	1	0
Price	0	2	Price	0	2
Choice 8	**A**	**B**	**Choice 16**	**A**	**B**
Fullness	2	1	Fullness	1	0
Water Conservation	2	0	Water Conservation	3	2
Plant Health	1	0	Plant Health	2	3
Price	3	3	Price	2	1

Table 20: Boxwood and Holly choice experiment design

Choice 1	A	B	**Choice 9**	A	B
Fullness	0	2	Fullness	1	2
Water Conservation	0	2	Water Conservation	3	2
Plant Health	3	1	Plant Health	2	0
Price	2	0	Price	3	2
Choice 2	A	B	**Choice 10**	A	B
Fullness	1	0	Fullness	0	2
Water Conservation	1	3	Water Conservation	2	1
Plant Health	2	0	Plant Health	1	3
Price	2	0	Price	3	0
Choice 3	A	B	**Choice 11**	A	B
Fullness	2	2	Fullness	0	1
Water Conservation	1	0	Water Conservation	2	3
Plant Health	0	0	Plant Health	0	1
Price	2	1	Price	1	3
Choice 4	A	B	**Choice 12**	A	B
Fullness	0	1	Fullness	1	0
Water Conservation	0	2	Water Conservation	1	3
Plant Health	1	2	Plant Health	0	3
Price	0	1	Price	0	2
Choice 5	A	B	**Choice 13**	A	B
Fullness	2	1	Fullness	1	0
Water Conservation	3	1	Water Conservation	2	1
Plant Health	2	3	Plant Health	3	2
Price	0	1	Price	0	2
Choice 6	A	B	**Choice 14**	A	B
Fullness	2	0	Fullness	0	1
Water Conservation	0	1	Water Conservation	3	0
Plant Health	3	1	Plant Health	3	2
Price	2	3	Price	1	0
Choice 7	A	B	**Choice 15**	A	B
Fullness	2	0	Fullness	2	0
Water Conservation	2	0	Water Conservation	0	2
Plant Health	1	3	Plant Health	0	2
Price	3	2	Price	1	3
Choice 8	A	B	**Choice 16**	A	B
Fullness	1	2	Fullness	0	1
Water Conservation	3	0	Water Conservation	1	3
Plant Health	1	0	Plant Health	2	1
Price	3	1	Price	1	3

Appendix F: Data Screening Process

- 1,630 respondents completed the entire survey
- 7 respondents listed states other than GA, MD, PA and VA as the place of their current residence and were therefor excluded from analysis
- 27 respondents were excluded for the following reasons:
    - Listed 1900 as year they were born (2)
    - Completed survey in less than 5 minutes (8)[23]
    - Answered all 1's or all 5's for NEP questions (3)
    - Had three or more red flags (10) – see below
    - Completed survey in less than 6 minutes plus 2 red flags (4)
- Several other questions were used as red flags:
    - Within 10th percentile[24] for completion time
    - Answered choice questions for at least 4 plants and answered always the same
    - Answered all plant loss concern questions the same
    - Answered all psychographic questions the same
    - Answered all NEP questions the same (all 1's and 5's were immediately excluded)
    - Given that respondents were either given the NEP or psychographic questions there were four possible red flags per respondents
- As a result, there were 1,596 usable responses

[23] The less than 5 (~0.5% fastest) and less than 6 minutes (~1.5% fastest) were deemed suitable given the survey took 3 minutes at a minimum to click through without reading any questions.
[24] The 10th percentile was those respondents that completed the survey in less than 551 seconds.

Appendix G: Example Stata Do Files

Random Parameter Logit Do File

```
log using FinalRPLlog.txt, replace
drop _all
clear all
set more off
cd C:\ThesisModel\FinalData\FinalRuns\AllCompleteData\AllRPL

*Install plug-in programs
ssc install mixlogit
ssc install estsave
ssc install mat2txt2
ssc install outreg2
ssc install WTP

*Specify # of Halton draws
global HD "1000"
*Specify # of Krinsky-Robb reps
global KR "15000"

*Geraniums Analysis
use "C:\ThesisModel\FinalData\StataData\AllComplete\GeraniumACD.dta", clear

*Generate variables
gen ASC = a | b
global randvars " ASC partialbloom fullbloom medium full usdawc anawc engowc usdaph anaph goph "

*Mix Logit - Main effects only
mixlogit choice price, rand($randvars) group( gid) id( pid) nrep($HD)
estsave, gen(GeraniumRPL)
scalar gerLL = e(ll)
outreg2 using AnnualML, replace excel
wtp price $randvars, krinsky reps(15000) level(90)
matrix gerwtp = r(wtp)
```

<repeat similar script for other 5 plants>

```
*Display results
mat2txt2 gerwtp petwtp chrwtp azawtp holwtp boxwtp using RPLwtp.txt, replace
scalar list
log close
```

Appendix G: Example Stata Do Files

Conditional Logit Do File

```
log using CLogitLog.txt, replace

drop _all
clear all
set more off
cd C:\ThesisModel\FinalData\FinalRuns\AllCompleteData\CLogit

*Install plug-in programs
ssc install mixlogit
ssc install estsave
ssc install mat2txt
ssc install outreg2
ssc install WTP

*Specify # of Krinsky-Robb reps
global KR "15000"

*Geranium Analysis
clear
use "C:\ThesisModel\FinalData\StataData\AllComplete\GeraniumACD.dta", clear

*Generate variables
gen ASC = a | b
global randvars " partialbloom fullbloom medium full usdawc anawc engowc usdaph anaph goph "

clogit choice ASC $randvars price, group( gid)
scalar ger1LL = e(ll)
outreg2 using Clogit, replace excel
wtp price ASC $randvars, krinsky reps(15000) level(90)
matrix ger1wtp = r(wtp)
```

<repeat similar script for other 5 plants>

```
*Display results
mat2txt2 ger1wtp pet1wtp chr1wtp aza1wtp hol1wtp box1wtp using RPLwtp.txt, replace
scalar list

log close
```

Appendix H: Model Results

Table 21: Conditional logit model results

	Geranium	Petunia	Chrysanthemum	Azalea	Holly	Boxwood
VARIABLES	Mean	Mean	Mean	Mean	Mean	Mean
price	-0.383***	-0.531***	-0.420***	-0.362***	-0.214***	-0.252***
	(0.0228)	(0.0399)	(0.0289)	(0.0288)	(0.0121)	(0.0200)
ASC	1.274***	1.641***	1.419***	1.492***	1.903***	2.169***
	(0.104)	(0.123)	(0.127)	(0.136)	(0.126)	(0.177)
partialbloom	0.213***	0.172**	0.115			
	(0.0717)	(0.0727)	(0.0752)			
fullbloom	0.351***	0.444***	0.359***			
	(0.0663)	(0.0670)	(0.0697)			
medium	0.190***	0.220***	0.311***	0.414***	0.381***	0.441***
	(0.0734)	(0.0744)	(0.0768)	(0.0785)	(0.0990)	(0.0982)
full	0.339***	0.555***	0.494***	0.811***	0.795***	0.888***
	(0.0718)	(0.0737)	(0.0763)	(0.0880)	(0.0893)	(0.0872)
usdawc	0.419***	0.479***	0.583***	0.421***	0.0915	0.438***
	(0.0817)	(0.0820)	(0.0858)	(0.0790)	(0.101)	(0.0970)
anawc	0.487***	0.573***	0.436***	0.712***	0.166*	0.365***
	(0.0791)	(0.0781)	(0.0827)	(0.0825)	(0.0923)	(0.0871)
engowc	0.504***	0.423***	0.459***	0.478***	0.154	0.325***
	(0.0797)	(0.0798)	(0.0835)	(0.0833)	(0.108)	(0.102)
usdaph	0.645***	0.829***	0.751***	1.120***	1.110***	1.072***
	(0.0747)	(0.0749)	(0.0795)	(0.0818)	(0.130)	(0.126)
anaph	0.563***	0.833***	0.602***	0.877***	0.932***	1.054***
	(0.0855)	(0.0871)	(0.0901)	(0.0836)	(0.111)	(0.110)
goph	0.677***	0.816***	0.652***	1.329***	0.744***	0.995***
	(0.0769)	(0.0769)	(0.0808)	(0.0790)	(0.114)	(0.115)
Log Likelihood	-2826.045	-2669.062	-2673.502	-2503.653	-1805.946	-1799.016
Observations	8,844	8,640	8,046	8,424	5,676	5,874

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 22: Conditional logit model willingness to pay results

Geranium			**Petunia**			**Chrysanthemum**		
	wtp	90% CI		wtp	90% CI		wtp	90% CI
ASC	3.32	2.87-3.83	ASC	3.09	2.74-3.49	ASC	3.38	2.96-3.84
partialbloom	0.55	0.26-0.85	partialbloom	0.32	0.11-0.53	partialbloom	0.27	-0.02-0.56
fullbloom	0.92	0.65-1.18	fullbloom	0.84	0.65-1.03	fullbloom	0.86	0.60-1.11
medium	0.50	0.19-0.80	medium	0.41	0.19-0.63	medium	0.74	0.45-1.03
full	0.89	0.60-1.16	full	1.04	0.85-1.24	full	1.18	0.91-1.44
usdawc	1.09	0.75-1.43	usdawc	0.90	0.66-1.14	usdawc	1.39	1.06-1.72
anawc	1.27	0.92-1.62	anawc	1.08	0.83-1.34	anawc	1.04	0.71-1.38
engowc	1.32	0.97-1.66	engowc	0.80	0.55-1.04	engowc	1.09	0.77-1.42
usdaph	1.68	1.37-2.03	usdaph	1.56	1.31-1.85	usdaph	1.79	1.47-2.14
anaph	1.47	1.14-1.79	anaph	1.57	1.34-1.80	anaph	1.43	1.12-1.74
goph	1.77	1.45-2.10	goph	1.53	1.30-1.80	goph	1.55	1.24-1.88

Azalea			**Holly**			**Boxwood**		
	wtp	90% CI		wtp	90% CI		wtp	90% CI
ASC	4.12	3.65-4.63	ASC	8.88	8.14-9.68	ASC	8.62	7.93-9.38
medium	1.14	0.81-1.48	medium	1.78	1.04-2.50	medium	1.75	1.14-2.37
full	2.24	1.94-2.55	full	3.71	3.08-4.36	full	3.53	2.99-4.13
usdawc	1.16	0.83-1.49	usdawc	0.43	-0.35-1.21	usdawc	1.74	1.10-2.43
anawc	1.97	1.60-2.36	anawc	0.77	0.06-1.49	anawc	1.45	0.88-2.06
engowc	1.32	0.96-1.68	engowc	0.72	-0.14-1.55	engowc	1.29	0.61-1.97
usdaph	3.09	2.65-3.61	usdaph	5.18	4.26-6.12	usdaph	4.26	3.49-5.09
anaph	2.42	2.07-2.81	anaph	4.35	3.55-5.18	anaph	4.19	3.50-4.95
goph	3.67	3.19-4.24	goph	3.47	2.61-4.35	goph	3.96	3.19-4.81

Table 23: Mixed logit Geranium willingness to pay results

	Model 1		**Model 2**		**Model 3**		**Model 4**	
	Mean	90% CI	Mean	90% CI	Mean	90% CI	Mean	90% CI
ASC	4.26	3.66-4.95	4.33	3.70-5.03	4.49	3.85-5.18	4.26	3.67-4.93
partialbloom	0.85	0.57-1.13	0.93	0.67-1.18	0.83	0.58-1.08	0.79	0.54-1.03
fullbloom	1.11	0.86-1.37	1.17	0.93-1.41	1.08	0.84-1.32	1.01	0.76-1.26
medium	0.76	0.48-1.04	0.76	0.48-1.03	0.76	0.48-1.03	0.76	0.50-1.03
full	1.18	0.92-1.43	1.21	0.95-1.44	1.18	0.93-1.41	1.21	0.97-1.45
WClabel					1.57	1.33-1.83	1.54	1.30-1.79
usdawc	1.54	1.22-1.86	1.63	1.35-1.90				
anawc	1.55	1.24-1.86	1.57	1.29-1.87				
engowc	1.62	1.32-1.93	1.65	1.36-1.94				
PHlabel					1.74	1.51-1.96	1.70	1.46-1.95
usdaph	1.49	1.23-1.77	1.53	1.26-1.81				
anaph	1.66	1.33-1.99	1.83	1.56-2.09				
goph	1.81	1.54-2.09	1.83	1.56-2.10				

Table 24: Mixed logit Petunia willingness to pay results

	Model 1		**Model 2**		**Model 3**		**Model 4**	
	Mean	90% CI	Mean	90% CI	Mean	90% CI	Mean	90% CI
ASC	4.24	3.68-4.90	4.29	3.73-4.94	4.47	3.88-5.15	4.03	3.54-4.63
partialbloom	0.53	0.33-0.72	0.54	0.35-0.73	0.51	0.32-0.70	0.52	0.33-0.71
fullbloom	0.92	0.75-1.08	0.91	0.75-1.08	0.90	0.72-1.07	0.88	0.70-1.06
medium	0.53	0.33-0.72	0.54	0.34-0.73	0.51	0.31-0.70	0.50	0.31-0.70
full	1.12	0.95-1.29	1.13	0.96-1.29	1.10	0.94-1.28	1.13	0.97-1.30
WClabel					0.99	0.81-1.18	0.91	0.73-1.10
usdawc	1.05	0.85-1.25	1.05	0.85-1.24				
anawc	1.09	0.89-1.31	1.10	0.90-1.32				
engowc	0.90	0.68-1.11	0.91	0.71-1.12				
PHlabel					1.52	1.34-1.71	1.51	1.33-1.72
usdaph	1.38	1.17-1.62	1.37	1.17-1.61				
anaph	1.60	1.41-1.80	1.62	1.43-1.81				
goph	1.43	1.23-1.66	1.45	1.25-1.67				

Table 25: Mixed logit Chrysanthemum willingness to pay results

	Model 1		Model 2		Model 3		Model 4	
	Mean	90% CI	Mean	90% CI	Mean	90% CI	Mean	90% CI
ASC	4.53	3.96-5.20	4.60	4.01-5.26	4.85	4.23-5.53	4.64	4.08-5.29
partialbloom	0.64	0.38-0.88	0.67	0.42-0.91	0.62	0.38-0.86	0.63	0.38-0.86
fullbloom	1.03	0.79-1.26	1.04	0.81-1.26	0.96	0.73-1.20	0.92	0.69-1.16
medium	0.89	0.63-1.15	0.92	0.67-1.16	0.82	0.56-1.06	0.81	0.56-1.06
full	1.37	1.14-1.60	1.40	1.17-1.61	1.32	1.10-1.55	1.30	1.08-1.53
WClabel					1.44	1.20-1.68	1.37	1.12-1.62
usdawc	1.65	1.39-1.91	1.67	1.42-1.93				
anawc	1.23	0.95-1.52	1.26	0.99-1.53				
engowc	1.34	1.07-1.61	1.35	1.08-1.61				
PHlabel					1.57	1.36-1.79	1.51	1.30-1.74
usdaph	1.51	1.26-1.79	1.50	1.25-1.77				
anaph	1.65	1.37-1.93	1.70	1.45-1.94				
goph	1.55	1.29-1.81	1.53	1.29-1.79				

Table 26: Mixed logit Azalea willingness to pay results

	Model 1		Model 2		Model 3		Model 4	
	Mean	90% CI	Mean	90% CI	Mean	90% CI	Mean	90% CI
ASC	5.33	4.66-6.08	5.57	4.9-6.27	5.80	5.22-6.4	5.56	5.01-6.14
medium	1.39	1.1-1.68	1.40	1.14-1.67	1.41	1.2-1.62	1.35	1.13-1.56
full	2.26	1.97-2.55	2.29	2.02-2.56	2.31	2.1-2.52	2.29	2.07-2.51
WClabel					1.24	1.07-1.43	1.23	1.03-1.43
usdawc	1.15	0.87-1.44	1.17	0.90-1.44				
anawc	1.60	1.27-1.95	1.53	1.24-1.85				
engowc	1.21	0.9-1.51	1.17	0.88-1.46				
PHlabel					2.30	2.07-2.57	2.37	2.12-2.65
usdaph	2.73	2.31-3.22	2.61	2.23-3.06				
anaph	2.22	1.91-2.55	2.16	1.88-2.46				
goph	3.29	2.8-3.86	3.09	2.68-3.61				

Table 27: Mixed logit Holly willingness to pay results

	Model 1		Model 2		Model 3		Model 4	
	Mean	90% CI	Mean	90% CI	Mean	90% CI	Mean	90% CI
ASC	11.19	10.13-12.37	11.34	10.24-12.48	11.35	10.20-12.57	10.79	9.77-11.91
medium	1.72	1.05-2.39	1.77	1.12-2.44	1.73	1.07-2.38	1.81	1.16-2.44
full	3.50	2.95-4.09	3.52	2.96-4.10	3.37	2.77-3.98	3.52	2.92-4.14
WClabel					1.18	0.64-1.72	1.00	0.41-1.60
usdawc	0.52	-0.16-1.19	0.48	-0.19-1.16				
anawc	0.83	0.21-1.45	0.87	0.25-1.50				
engowc	0.52	-0.24-1.29	0.57	-0.18-1.32				
PHlabel					4.49	3.81-5.19	4.41	3.73-5.12
usdaph	5.38	4.49-6.31	5.48	4.61-6.37				
anaph	4.37	3.66-5.13	4.38	3.64-5.13				
goph	3.77	2.96-4.62	3.82	3.00-4.64				

Table 28: Mixed logit Boxwood willingness to pay results

	Model 1		Model 2		Model 3		Model 4	
	Mean	90% CI	Mean	90% CI	Mean	90% CI	Mean	90% CI
ASC	11.23	10.09-12.60	11.74	10.50-13.08	11.77	10.53-13.13	10.77	9.74-11.91
medium	1.69	1.17-2.22	1.69	1.15-2.24	1.80	1.27-2.33	1.92	1.43-2.41
full	3.27	2.79-3.80	3.32	2.84-3.84	3.34	2.86-3.86	3.69	3.23-4.20
WClabel					1.80	1.27-2.33	1.56	1.09-2.05
usdawc	1.58	1.06-2.13	1.62	1.07-2.21				
anawc	1.21	0.70-1.77	1.35	0.85-1.87				
engowc	1.11	0.55-1.69	1.14	0.55-1.75				
PHlabel					3.95	3.40-4.55	4.23	3.59-4.91
usdaph	4.06	3.37-4.82	4.24	3.54-4.99				
anaph	3.99	3.43-4.62	4.06	3.45-4.73				
goph	3.82	3.19-4.53	3.90	3.20-4.65				

Appendix I: Descriptive Statistics

Table 29: Descriptive statistics for demographic characteristics

Gender	Level	Description	#	%
	1	Male	453	28.38%
	2	Female	1143	71.62%
Race	Level	Description	#	%
	1	Asian	47	2.94%
	2	Native American	4	0.25%
	3	Black	59	3.70%
	4	White	1449	90.79%
	5	Hispanic	14	0.88%
	6	Other	23	1.44%
Year Born				
Mean	Median	Standard Deviation	Min	Max
1957	1954	13.878	1922	1993
Education	Level	Description	#	%
	1	< 8th grade	0	0.0%
	2	Some high school	9	0.6%
	3	High school grad	148	9.3%
	4	Some technical school	54	3.4%
	5	Some college	390	24.4%
	6	College graduate	498	31.2%
	7	Master's degree	382	23.9%
	8	Doctorate degree	63	3.9%
	9	Professional degree	52	3.3%
Income	Level	Description	#	%
	1	< $20k	58	3.6%
	2	$20k to $40k	175	11.2%
	3	$40k to $60k	263	16.8%
	4	$60k to $80k	262	16.7%
	5	$80k to $100k	271	17.3%
	6	$100k to $120k	195	12.4%
	7	$120k to $140k	112	7.1%
	8	$140k to $160k	88	5.6%
	9	$160k to $180k	50	3.2%
	10	$180k to $200k	45	2.9%
	11	$200k to $300k	50	3.2%
	12	>$300k	27	1.7%
Income				
Mean	Median	Standard Deviation	Min	Max
93,935	90,000	61,065	10,000	350,000

Table 30: Descriptive statistics for residential characteristics

State of Residence				
State	#	%		
VA	394	24.69%		
MD	394	24.69%		
PA	397	24.87%		
GA	411	25.75%		
Years in Residence				
Mean	Median	Standard Deviation	Min	Max
16.192	13.000	12.384	0	69
Housing Type	Level	Description	#	%
	1	Detached House	1182	82.54%
	2	Attached House	194	13.55%
	3	Apartment	49	3.42%
	4	Other	7	0.49%
Number in Household				
Mean	Median	Standard Deviation	Min	Max
2.363	2.000	1.047	1	7

Table 31: Descriptive statistics of respondents' gardening experience and expertise

Gardening Experience				
Mean	Median	St. Dev.	Min	Max
25.565	25.000	15.632	1.000	75.000
Gardening Expertise[25]				
Mean	Median	St. Dev.	Min	Max
5.475	6.000	1.874	1.000	10.000
Garden Club Member	Level	Description	#	%
	1	Yes	52	5.4%
	2	No	918	94.6%

[25] Respondents rated themselves on a scale from 1 (Novice) to 10 (Expert)

Table 32: Descriptive statistics for respondent experience with plant loss

Plant loss within 30 days	Level	Description	#	%
(Annual Bedding)	1	Yes	741	46.46%
	2	No	854	53.54%
Likely reason	Level	Description	#	%
	1	Too much water	36	4.85%
	2	Too little water	107	14.42%
	3	Poor soil	78	10.51%
	4	Too much sun	47	6.33%
	5	Too little sun	34	4.58%
	6	Insects	27	3.64%
	7	Deer	60	8.09%
	8	Disease	37	4.99%
	9	Don’t know	276	37.20%
	10	Other	40	5.39%
Plant loss within 1 year				
(Broadleaf Evergreen)	1	Yes	854	53.54%
	2	No	742	46.52%
Likely reason	Level	Description	#	%
	1	Too much water	33	3.86%
	2	Too little water	98	11.48%
	3	Poor soil	128	14.99%
	4	Too much sun	40	4.68%
	5	Too little sun	44	5.15%
	6	Insects	24	2.81%
	7	Deer	70	8.20%
	8	Disease	28	3.28%
	9	Don’t know	337	39.46%
	10	Other	52	6.09%

Table 33: Summary of who respondents trust most to protect public water resources

Certifying Authority	#	%
Government	520	32.58%
Industry	289	18.11%
ENGO	489	30.64%
None	298	18.67%

Table 34: Respondents perceptions of water use issues (n = 811)

	SA[26]	SWA	U	SWD	SD
Water shortages and drought are a concern where I live	17.0%	38.7%	14.2%	24.5%	5.5%
The production of ornamental plants requires significant amounts of water	7.3%	33.2%	45.1%	12.9%	1.5%
It is too hard for an individual to help protect our water resources	2.6%	13.2%	18.1%	48.3%	17.8%
My actions to conserve water at home will help protect our water resources	27.3%	52.3%	13.8%	6.0%	0.6%
Purchasing 'Water Smart' labeled plants will help protect our water resources	13.2%	43.5%	37.4%	3.9%	2.0%
Most people do their part to protect our water resources	1.6%	24.0%	24.4%	40.4%	9.5%
Most people are willing to pay higher prices to protect water resources	3.5%	22.6%	34.2%	34.5%	5.3%

[26] SA denotes ‘strongly agree’, SWA denotes ‘somewhat agree’, U denotes ‘neither agree or disagree’, SWD denotes ‘somewhat disagree’ and SD denotes ‘ strongly disagree’

Appendix J: IRB Approval Letters

Focus Group 1 IRB Approval Letter

VirginiaTech

Office of Research Compliance
Institutional Review Board
2000 Kraft Drive, Suite 2000 (0497)
Blacksburg, Virginia 24060
540/231-4606 Fax 540/231-0959
e-mail irb@vt.edu
Website: www.irb.vt.edu

MEMORANDUM

DATE: August 26, 2011

TO: Chuanxue Hong, Kevin Boyle, James W. Pease, David Hartter

FROM: Virginia Tech Institutional Review Board (FWA00000572, expires May 31, 2014)

PROTOCOL TITLE: SCRI - Consumer Focus Groups

IRB NUMBER: 11-623

Effective August 25, 2011, the Virginia Tech IRB Chair, Dr. David M. Moore, approved the new protocol for the above-mentioned research protocol.

This approval provides permission to begin the human subject activities outlined in the IRB-approved protocol and supporting documents.

Plans to deviate from the approved protocol and/or supporting documents must be submitted to the IRB as an amendment request and approved by the IRB prior to the implementation of any changes, regardless of how minor, except where necessary to eliminate apparent immediate hazards to the subjects. Report promptly to the IRB any injuries or other unanticipated or adverse events involving risks or harms to human research subjects or others.

All investigators (listed above) are required to comply with the researcher requirements outlined at http://www.irb.vt.edu/pages/responsibilities.htm (please review before the commencement of your research).

PROTOCOL INFORMATION:
Approved as: **Expedited, under 45 CFR 46.110 category(ies) 6, 7**
Protocol Approval Date: **8/25/2011**
Protocol Expiration Date: **8/24/2012**
Continuing Review Due Date*: **8/10/2012**
*Date a Continuing Review application is due to the IRB office if human subject activities covered under this protocol, including data analysis, are to continue beyond the Protocol Expiration Date.

FEDERALLY FUNDED RESEARCH REQUIREMENTS:
Per federally regulations, 45 CFR 46.103(f), the IRB is required to compare all federally funded grant proposals / work statements to the IRB protocol(s) which cover the human research activities included in the proposal / work statement before funds are released. Note that this requirement does not apply to Exempt and Interim IRB protocols, or grants for which VT is not the primary awardee.

The table on the following page indicates whether grant proposals are related to this IRB protocol, and which of the listed proposals, if any, have been compared to this IRB protocol, if required.

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Focus Group 2 IRB Approval Letter

VirginiaTech

Office of Research Compliance
Institutional Review Board
2000 Kraft Drive, Suite 2000 (0497)
Blacksburg, Virginia 24060
540/231-4606 Fax 540/231-0959
e-mail irb@vt.edu
Website: www.irb.vt.edu

MEMORANDUM

DATE: September 29, 2011

TO: Chuanxue Hong, Kevin Boyle, James W. Pease, David Hartter

FROM: Virginia Tech Institutional Review Board (FWA00000572, expires May 31, 2014)

PROTOCOL TITLE: SCRI - Consumer Focus Groups

IRB NUMBER: 11-623

Effective September 28, 2011, the Virginia Tech IRB Chair, Dr. David M. Moore, approved the amendment request for the above-mentioned research protocol.

This approval provides permission to begin the human subject activities outlined in the IRB-approved protocol and supporting documents.

Plans to deviate from the approved protocol and/or supporting documents must be submitted to the IRB as an amendment request and approved by the IRB prior to the implementation of any changes, regardless of how minor, except where necessary to eliminate apparent immediate hazards to the subjects. Report promptly to the IRB any injuries or other unanticipated or adverse events involving risks or harms to human research subjects or others.

All investigators (listed above) are required to comply with the researcher requirements outlined at http://www.irb.vt.edu/pages/responsibilities.htm (please review before the commencement of your research).

PROTOCOL INFORMATION:
Approved as: **Expedited, under 45 CFR 46.110 category(ies) 6, 7**
Protocol Approval Date: **8/25/2011**
Protocol Expiration Date: **8/24/2012**
Continuing Review Due Date*: **8/10/2012**
*Date a Continuing Review application is due to the IRB office if human subject activities covered under this protocol, including data analysis, are to continue beyond the Protocol Expiration Date.

FEDERALLY FUNDED RESEARCH REQUIREMENTS:
Per federally regulations, 45 CFR 46.103(f), the IRB is required to compare all federally funded grant proposals / work statements to the IRB protocol(s) which cover the human research activities included in the proposal / work statement before funds are released. Note that this requirement does not apply to Exempt and Interim IRB protocols, or grants for which VT is not the primary awardee.

The table on the following page indicates whether grant proposals are related to this IRB protocol, and which of the listed proposals, if any, have been compared to this IRB protocol, if required.

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Focus Group 3 IRB Approval Letter

VirginiaTech

Office of Research Compliance
Institutional Review Board
2000 Kraft Drive, Suite 2000 (0497)
Blacksburg, Virginia 24060
540/231-4606 Fax 540/231-0959
e-mail irb@vt.edu
Website: www.irb.vt.edu

MEMORANDUM

DATE: November 21, 2011

TO: Chuanxue Hong, Kevin Boyle, James W. Pease, David Hartter

FROM: Virginia Tech Institutional Review Board (FWA00000572, expires May 31, 2014)

PROTOCOL TITLE: SCRI - Consumer Focus Groups

IRB NUMBER: 11-623

Effective November 21, 2011, the Virginia Tech IRB Chair, Dr. David M. Moore, approved the amendment request for the above-mentioned research protocol.

This approval provides permission to begin the human subject activities outlined in the IRB-approved protocol and supporting documents.

Plans to deviate from the approved protocol and/or supporting documents must be submitted to the IRB as an amendment request and approved by the IRB prior to the implementation of any changes, regardless of how minor, except where necessary to eliminate apparent immediate hazards to the subjects. Report promptly to the IRB any injuries or other unanticipated or adverse events involving risks or harms to human research subjects or others.

All investigators (listed above) are required to comply with the researcher requirements outlined at http://www.irb.vt.edu/pages/responsibilities.htm (please review before the commencement of your research).

PROTOCOL INFORMATION:
Approved as: **Expedited, under 45 CFR 46.110 category(ies) 6, 7**
Protocol Approval Date: **8/25/2011**
Protocol Expiration Date: **8/24/2012**
Continuing Review Due Date*: **8/10/2012**
*Date a Continuing Review application is due to the IRB office if human subject activities covered under this protocol, including data analysis, are to continue beyond the Protocol Expiration Date.

FEDERALLY FUNDED RESEARCH REQUIREMENTS:
Per federally regulations, 45 CFR 46.103(f), the IRB is required to compare all federally funded grant proposals / work statements to the IRB protocol(s) which cover the human research activities included in the proposal / work statement before funds are released. Note that this requirement does not apply to Exempt and Interim IRB protocols, or grants for which VT is not the primary awardee.

The table on the following page indicates whether grant proposals are related to this IRB protocol, and which of the listed proposals, if any, have been compared to this IRB protocol, if required.

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Survey IRB Approval Letter

VirginiaTech

Office of Research Compliance
Institutional Review Board
2000 Kraft Drive, Suite 2000 (0497)
Blacksburg, Virginia 24060
540/231-4606 Fax 540/231-0959
e-mail irb@vt.edu
Website: www.irb.vt.edu

MEMORANDUM

DATE: February 8, 2012

TO: Chuanxue Hong, Kevin Boyle, James W. Pease, David Hartter

FROM: Virginia Tech Institutional Review Board (FWA00000572, expires May 31, 2014)

PROTOCOL TITLE: SCRI - Consumer Focus Groups

IRB NUMBER: 11-623

Effective February 7, 2012, the Virginia Tech IRB Chair, Dr. David M. Moore, approved the amendment request for the above-mentioned research protocol.

This approval provides permission to begin the human subject activities outlined in the IRB-approved protocol and supporting documents.

Plans to deviate from the approved protocol and/or supporting documents must be submitted to the IRB as an amendment request and approved by the IRB prior to the implementation of any changes, regardless of how minor, except where necessary to eliminate apparent immediate hazards to the subjects. Report promptly to the IRB any injuries or other unanticipated or adverse events involving risks or harms to human research subjects or others.

All investigators (listed above) are required to comply with the researcher requirements outlined at http://www.irb.vt.edu/pages/responsibilities.htm (please review before the commencement of your research).

PROTOCOL INFORMATION:
Approved as: **Expedited, under 45 CFR 46.110 category(ies) 6, 7**
Protocol Approval Date: **8/25/2011**
Protocol Expiration Date: **8/24/2012**
Continuing Review Due Date*: **8/10/2012**
*Date a Continuing Review application is due to the IRB office if human subject activities covered under this protocol, including data analysis, are to continue beyond the Protocol Expiration Date.

FEDERALLY FUNDED RESEARCH REQUIREMENTS:
Per federally regulations, 45 CFR 46.103(f), the IRB is required to compare all federally funded grant proposals / work statements to the IRB protocol(s) which cover the human research activities included in the proposal / work statement before funds are released. Note that this requirement does not apply to Exempt and Interim IRB protocols, or grants for which VT is not the primary awardee.

The table on the following page indicates whether grant proposals are related to this IRB protocol, and which of the listed proposals, if any, have been compared to this IRB protocol, if required.

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