

**Farmland Conservation Easement Valuation Using an  
Attribute-based Choice Survey:  
Comparing Preferences within the United States, Georgia, Ohio and Maine**

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**Abstract**

Farmland preservation has long been viewed by the public as a worthwhile endeavor. A public program can be set up to bring willing buyers and sellers together to facilitate the transfer of development rights. The farmer is paid for the opportunity cost of forfeiting the development rights to the land, while the general public is taxed the amount of their total benefit created by the existence of farmland. Through the data from an attribute-based choice survey (conducted in four geographic areas) the willingness-to-pay (WTP) of the public to preserve farmland that exhibited certain attributes, was estimated. The attributes included different use (grain, hay, vegetable, pasture, forest), location (near urban), quality (prime), size (varied acreage relative to geographic area sampled), and cost (varied costs from \$3 to \$50) components.

Selection bias was tested for in order to confirm that the respondents are an unbiased representation of the geographic areas sampled. If selection bias was present, it would need to be corrected for in order to aggregate the survey results to the population of the geographic areas. Selection bias was tested for using a bivariate probit model with sample selection, a variation on the Heckman correction model. Selection bias was not significant, so the choice model was estimated using a probit model. The response was dependent on the use, location, quality, size, and cost components. Based on the parameter estimates, the geographic areas were compared using the scale parameter. A variation of the

Swait and Louviere method was used to find the optimal scale parameter ratios between pair-wise geographic areas. Heterogeneity of the parameter estimates as well as heterogeneity of variances was tested. Prime farmland was significant and positive in all geographic areas, suggesting it should be included in the national ranking criteria for a farmland preservation program. WTP by household for each attribute was reported. Additionally, the WTP was aggregated to provide a hypothetical range of the monetary benefit farmland provides for the residents of each geographic area.

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## **CHAPTER ONE: Introduction**

### **1.1 Introduction**

Urban sprawl, protection of food supply, and preservation of heritage are just a few of the reasons that the public has concerns about farmland being converted for residential and commercial uses (Fursueth 1987; Kreiger 1999; Kline and Wichelns 1998). Landowners may find farmland conversion is the best financial route to take, but with a limited amount of farmland, a tragedy of the commons<sup>1</sup> can quickly transpire where many of the public's concerns become reality. Reacting to the public, Congress passed the Farmland Protection Policy Act in 1981. Additional programs passed, and by 2002, the USDA put the Farm and Ranch Land Protection Program (FRPP) in place. FRPP aimed to keep the most productive and valuable farmland for agricultural use, into perpetuity. This was accomplished through the purchasing of conservation easements, for which FRPP, in part, provided funds.

From the perspective of a landowner, owning land is nothing more than a collection of rights. These rights can be sold off as a whole, i.e. selling the land completely, or the rights can be sold off individually, i.e. an outside party purchasing an easement to the land. An easement compensates the landowner in exchange for a specific right to the land. The landowner is compensated for the opportunity cost of not being able to convert the land to potentially more lucrative uses of the land. When a farmland conservation easement is purchased, the use of the land is limited to agricultural uses. Therefore, the land cannot be converted<sup>2</sup> for residential or commercial purposes, but the specific agricultural use of the land

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<sup>1</sup>Tragedy of the commons is when rational individuals acting in their individual best interest combine to deplete a shared resource, even when it is clear that their combined actions are not sustainable.

<sup>2</sup>The length of time the conservation easement is in place is up to program, but it is typically assumed that the conservation easement will retire the development rights into perpetuity.

is still up to the landowner. This may include allowing livestock to graze, growing vegetables, or even taking the land out of production and retiring it to forest.

To facilitate the transfer of funds from those who gain welfare from the preservation of farmland to the landowners, a conservation easement program can be set up. The issue with farmland preservation is that a market is not immediately available to the individual consumer. Aggregation of funds from individual consumers of farmland through a government run program which uses tax money to purchase the development rights to the land is the easiest way to mandate participation in such a program. This way, the necessary funds are made available to preserve farmland so the tragedy of the commons of the overdevelopment of land does not occur. The main objective of such a program is to collect funds from the public in the form of taxes and translate the funds into purchased conservation easements to farmland such that the public's welfare is enhanced.

Farmland preservation generates many non-market benefits for the public (Kline and Wichelns 1996). The public gains welfare, or utility, just by the existence of farmland. It could be through the enjoyment of a scenic vista, from the natural protection of nutrient run-off that certain agricultural uses generate, etc. To guarantee the most efficient use of tax-payer funds, policy makers should determine the attributes that farmland possesses that are most valued. Establishing what tax-payers are willing to pay for the preservation of farmland that exhibits these certain attributes would allow for the benefits from a public perspective to be taken from a utility metric to money metric. This would in turn allow for policy makers to establish a target for a conservation easement program.

Several studies exist that set out to value farmland from a non-market perspective have been conducted using contingent valuation. The limitation to contingent valuation is that it aims to value non-market goods in a manner that ignores the willingness-to-pay (WTP) by attribute, and instead concentrates on the

aggregated WTP for a given farmland scenario. From a policy perspective, it is difficult to effectively differentiate aggregated value into transferrable payments when considering heterogeneous goods. To compare heterogeneous goods more effectively, the attributes that give the goods their value must be determined. If the non-market value that is provided by farmland can be effectively dissected into a set of measurable attributes, then conducting a survey and analyzing the choices made by the respondents can put relevant information into the hands of policy makers. This information would allow them to make more informed decisions about the WTP of the general public for conservation easements to farmland. To differentiate between heterogeneous farms, while establishing a WTP, attributes such as land use, land location, land quality, and land size, as well as price can be included. The inclusion of price allows a WTP to be estimated for these attributes, which can eventually be used as part of a cost/benefit analysis.

Estimation of Hicksian surplus for heterogeneous goods has also been estimated with the use of attribute-based choice studies where respondents are asked to choose their preference from alternative scenarios (Holmes and Adamowicz 2003). Using a stated-preference study where marginal values can be estimated for measurable attributes allows policy makers to tailor policies so that the appropriate protocol is in place to bring willing buyers and sellers together at their equilibrium.

Though many studies have been done on farmland valuation, no studies have compared geographic areas. All previous studies have concentrated on one specific geographic area. This thesis aims to continue in the vein of using attribute-based choice questions in a stated-preference setting while expanding into the comparison of different geographic areas throughout the country. Comparing how different geographic areas value farmland will provide a deeper understanding for policy makers to take into account while forming decision rules for

conservation easement programs, especially those that are enacted over a broader geographic region.

## **1.2 Problem Statement**

As “America the Beautiful” points out, America has a vastly diverse and beautiful landscape “from sea to shining sea.” Higher population has forced urban sprawl which in turn has led to a tragedy of the commons to arise.

Suburbanization has infringed upon open and green space. The changing dynamic of land usage has not gone unnoticed. Preserving the remaining open and green space has become an issue on local and state ballots across the United States. All 50 states have programs in place to help acquire or receive scenic land through donation (American Farmland Trust 1997; Daniels 1999; Wiebe *et al.* 1996).

Many of the programs in place target open and green space in general. Half of the almost two billion acres of private land in the United States is used for agriculture (range, crop, and pasture land) (Vesterby *et al.* 1994). This means that farmland is a large part of America’s open and green space. According to the American Farmland Trust, to date, about 1,100,000 farmland acres nationwide have been put under easements at an approximate cost of \$2.3 billion.

Congressional Acts have been passed for decades that allocate funds or issue orders on how agricultural land should be treated. In 1981, the Farmland Protection Policy Act established that federal agencies were required to review the impact of their programs to “minimiz[e] the extent to which federal programs contribute to unnecessary and irreversible conversion of farmland to nonagricultural uses” (U.S. Congress 1981). In 1990, a Farm Bill was passed in which the program Farms for the Future was launched to purchase conservation easements to farmland with subsidized loans from state and local governments (USDA 1990). In 1996, the Federal Agricultural Improvement Act (FAIR) was

passed to supersede Farms for the Future. FAIR allocated up to \$35 million in matching funds for state and local farmland protection programs (USDA 1996). In 2002, FAIR was amended into the Farm Security and Rural Investment Act. This new act established the Farm and Ranch Land Protection Program (FRPP) (USDA 2002). FRPP opened up the funds for the purchase of conservation easements to farmland to Native American Indian tribes and qualifying NGOs on top of state and local governments.

Currently, the 2008 Farm Bill has established the Farmland Protection Program (FPP). There were many adjustments made to the FRPP to create the current FPP. The FPP “provides funds to eligible entities (State, tribal, or local governments and nonprofit organizations) to help purchase easements that would preclude nonfarm development of productive farmland” (USDA 2008). Many adjustments were made to the FRPP to create the 2008 FPP.

In 2002, the FRPP allocated \$499 million for fiscal years 2002-07. The FPP increased the budget to \$743 million for fiscal years 2008-12. Both budgets were/are subject to a provision that enforces regional equity. Regional equity ensures that funds are allocated to different regions more equally. Regional equity also sets a minimum allocation threshold for regions which is higher than previous allocation levels before the regional equity provision was implemented.

The FRPP focused on protecting topsoil, requiring eligible farms to have at least 50% prime, unique, or locally important soil. The FPP shifted focus to protecting agricultural use and conservation values, now allowing heavily forested land to be eligible for its ability to buffer development.

The FRPP and FPP cap the Federal share of the easement’s purchase cost at 50% of fair market value (FMV) for the land. The landowner could donate up to 25% of the FMV under the FRPP. The FPP no longer caps the donation of the landowner.

Both the FRPP and FPP cannot grant priority to farmland to which it is less expensive to purchase an easement.

The FRPP and FPP require a conservation plan for land that is highly erodible.

The 2008 Farm Bill also included the Grassland Reserve Program (GRP). Both the FPP and GRP fall under the heading of Agricultural Land Preservation Programs. The GRP, specifically, “assists owners, through long-term rental agreements or easements, in restoring grassland and conserving virgin grassland while maintaining areas for livestock grazing and hay production” (USDA 2008).

While agricultural policies that preserve farmland have the direct impact of stopping open land from being converted to other uses that do not provide the same set of amenities, agricultural policies can also affect the quality of farmland as open and green space. The Conservation Reserve Program takes land out of agricultural production for ten years while maintaining the land as open or green space that is planted with grasses or trees. This differs from normal crop rotation because the time elapsed allows for highly erodible soils to erode while creating more grassland habitat for wildlife, as opposed to just allowing for nutrient replenishment in the soil.

The motivation behind the public willingness-to-pay for the preservation of farmland can be attributed to many factors. According to Bromley and Hodge (1990), the amenities that farmland produces are a classic example of a joint product that is a public good. Farmland allows for non-rival and non-excludable views that provide public value. While farmers receive payment for the goods and services that are provided through the running of their farms, there is no vehicle in place for farmers to receive compensation for preserving the beautiful scenery that the public enjoys. To attempt to resolve this market inefficiency, the public has

become motivated, through local and state initiatives, to protect the farmland amenities that they appreciate.

### **1.3 Objectives**

The goal this thesis is identify if the public is willing to pay for farmland preservation. If so, what benefits would an easement to limit the development rights of the farmland provide to the public? When estimating the benefits, do specific farmland characteristics provide more or less in terms of value? Do the benefits differ across geographic areas?

The objectives of this thesis are as follows:

- A) Estimate if selected farmland attributes affect the public's support for farmland conservation easement programs
- B) Test if the attributes' effects are statistically similar in the United States, Georgia, Ohio, and Maine
- C) Compute the WTP of farmland attributes and compare them to current conservation easement programs for each geographic area

Objective A was implemented by estimating a choice equation using a probit model. Additionally, selection bias was tested for by comparing the respondents' characteristics to that of their geographic areas. This was done by using a selection equation in combination with the choice equation. Selection bias was estimated using a bivariate probit model with sample selection.

Objective B test whether the true underlying preference parameters are statistically similar, or if there is heterogeneity in preferences among geographic areas. A Swait-Louviere approach was used to test for this. Identifying if

preferences are heterogeneous will provide evidence as to whether or not a one size fits all policy is appropriate.

Objective C takes the parameter estimates from the choice equation estimation and marginalizes them to a household level. After estimating implicit prices for each farmland attribute, the highest WTP for use, location, quality, and size is determined and aggregated. A lower and upper limit for household benefits is provided.

#### **1.4 Organization of Thesis**

Chapter Two will focus on the literature review. The literature review will delve deeper into the conceptual framework of the thesis. Previous empirical research that has focused on similar problems will then be examined. Next, conservation easement programs, both past and current will be outlined. Finally, the contribution of this research will be discussed.

Chapter Three then discusses the models used for the estimation and the survey used to collect the data. First, choice theory and the random utility model are outlined. Then the probit model, used for the choice and selection equations, is detailed. Then the bivariate probit model, used for the detection of selection bias, is summarized. Then the scale parameter is introduced, followed by how it was used in the analysis to compare preferences from one geographic area to the next. Then comes the process used to estimate the consumer surplus. The survey design is the discussed in detail.

Chapter Four takes all of the previous background and puts it to work with empirical results. First, the data are discussed through an overview of the descriptive statistics. Then, the results will follow the objectives, respectively. First, the possibility of selection bias of the respondents will be investigated using the Heckman correction. Next, if selection bias is not detected, the choice models



of each geographic area will be estimated using the probit model. Once all of the models of interest have been estimated, the optimum scale parameter ratios of each pair-wise combination of geographic areas will be estimated. This will provide the basis for comparison of the different geographic area estimations. The marginal WTP estimates for each farmland attribute will be reported. Using each nation's current rubric for identifying the best candidate for farmland preservation, the WTP will be compared to the nation's methodology to see if public opinion is in line with current policy.

Chapter Five takes a step back from all of the analysis and concentrates on conclusions and recommendations that could be used as part of a cost/benefit analysis. First, issues with the procedures and the data will be discussed. Possible extensions of the study will then be mentioned. Finally, the thesis will conclude with parting comments and considerations.

## **CHAPTER TWO: Literature Review**

### **2.1 Conceptual Framework**

Neoclassical economics establishes a framework based on how scarce goods are traded off. Through marginal decision making, a relative valuation becomes evident. The monetary value of goods and services is determined when sacrifices are made between different options, relative to a budget constraint. Value is then reflected by consumers based on their willingness to trade dollars for goods and services. A market that is both competitive and well functioning determines both price and quantity of a good or service based on the interaction between supply and demand. Therefore, value is directly revealed in the market.

Not all markets function well enough to reveal economic value so simply. Value can become imprecise when competition is interfered with or changes are not marginal. If a good is non-rival or non-exclusive, the market for that good fails to reveal its true economic value (Randall 1987). The issue with not having a defined market is that it is difficult to bring together a large number of buyers while correctly identifying the best seller of farmland development rights that meets the buyers' aggregated preferences without having high transaction costs.

Since farmland is a classic example of a non-rival and non-exclusive good, the traditional market framework cannot accurately value it. The discrepancy in value is because nonmarket goods may provide social value that is not reflected through supply and demand alone. Valuing nonmarket goods in the same way as market goods are valued is done through consumer surplus.

Consumer surplus is the social value to be estimated. This is important in the framework of valuing conservation easements because it is the property's development rights themselves that are being valued. Consumer surplus is the total economic worth of a good or service to the public. The total economic benefit

each individual in the public gains is monetized for a given level of that good or service. Freeman (1979a) describes consumer surplus as “the mone[tary] measure of the gains and losses in utility and welfare associated with changes in the individual’s economic circumstances”. In the graphical context, Figure 2.1.1 shows the area under that demand curve as the aggregate consumer surplus, or WTP, of all individuals in society, for a publically provided good with a fixed supply.

While individual WTP can be measured as Hicksian consumer surplus, specific attributes of farmland can cause the WTP of the public to change. These changes are caused by demand and supply shifters, which change the area that account for consumer surplus. Figure 2.1.2 shows which attributes (of those included in the survey) are demand shifters, and which attributes are supply shifters. In terms of the attributes measured in the survey used for this thesis, the different use, location, and quality choices account for demand shifts. The proposed size of the program is the lone supply shifter, as program size is a set limit.

Figure 2.1.1 Consumer Surplus

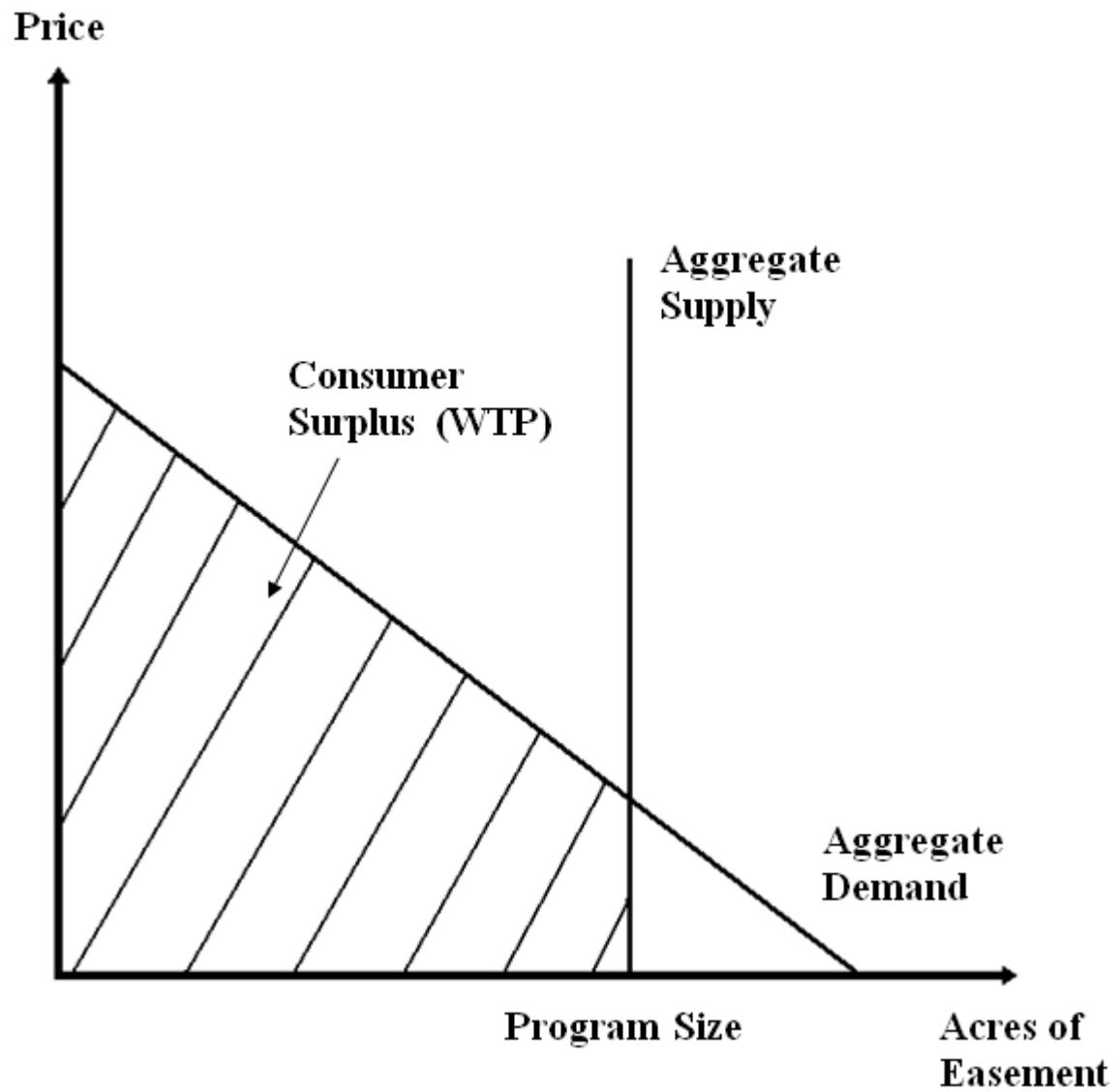
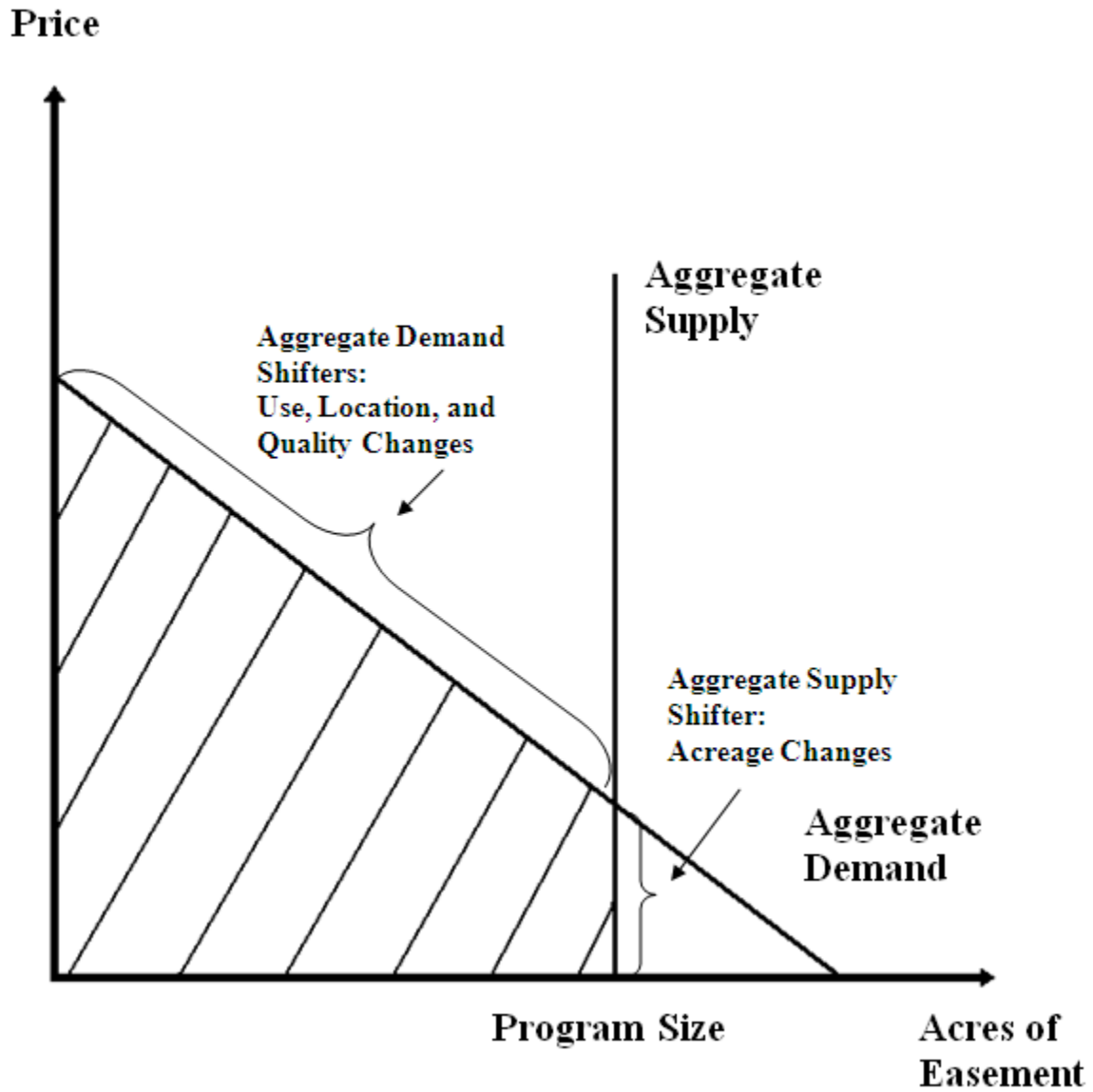


Figure 2.1.2 Aggregate Supply and Demand Shifters



In a market that has a supply curve that is not infinitely sloped, i.e. a varying quantity, there exists a  $p^*$  and a  $q^*$  at the equilibrium. Consumer surplus is the area below the demand curve and above the horizontal line at  $p^*$ . Producer surplus is the area above the supply curve and below the horizontal line at  $p^*$ . Because there is a fixed quantity, there is no producer surplus in the market. This is why the entire area under the demand curve is considered consumer surplus.

Consumer surplus can be measured in five ways. The first way is Marshallian consumer surplus, which is defined as the area under a Marshallian demand curve. A Marshallian demand curve is a function of both prices and income, therefore an income and substitution effect can cause a shift. Marshallian demand does not assume a constant level of utility, which is due to the income effect. Since there is no set utility level, the Marshallian measure is only an approximate measure of welfare change (Willig 1976; Randall and Stoll 1980).

The four measures of Hicksian consumer surplus are: compensating variation, equivalent variation, compensating surplus, and equivalent surplus. There are two dichotomies to consider, when paired, that give the four measures. Variation and surplus differ in whether or not, after a price or quantity change, the individual is allowed to make optimal readjustments to their consumption bundle. Variation allows for readjustment, while surplus forces the original consumption bundle to be kept, even after the price or quantity change in the market.

Compensating and equivalent vary by the level of welfare they refer to. The main difference is whether or not the individual has the “right” to the said welfare level. Compensating says that if there is a price or quantity change, the individual has the right to the original welfare level. Equivalent says that the individual has the right to the new welfare level only after the price or quantity change.

Put into the context of a conservation easement program, the landowner has the right to the land; therefore they have to be compensated for the change in

welfare associated with losing the right to develop their land as they please. After the transfer of funds to the farmer, the public now has the development right, and in terms of welfare is equivalent to where they were before the program.

To make a Pareto<sup>3</sup> improvement, compensating must be used. In terms of a benefit-cost analysis, the Pareto improvement is the appropriate welfare measure. Therefore, in terms of the public having to pay taxes to fund the conservation easement program and pay for the surplus they receive from farmland, the appropriate Hicksian measure of consumer surplus is equivalent variation. While from the landowners' perspectives, compensating variation is the appropriate measure.

Holding utility constant, and allowing for only the substitution effect to change welfare, is the theoretically correct Hicksian demand function. Hicksian consumer surplus can be measured in four different ways. Table 2.1.1 breaks down the dichotomy of the four measures.

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<sup>3</sup>Pareto improvement is when at least one person is made better off while no one is made worse off.

Table 2.1.1 Measures of Hicksian Consumer Surplus

	Can make reoptimizing adjustments	Cannot make reoptimizing adjustments
Have right to initial welfare level	Compensating Variation	Compensating Surplus
Does not have right to initial welfare level	Equivalent Variation	Equivalent Surplus

## 2.2 Previous Empirical Studies<sup>4</sup>

Early research that attempted to estimate the value of farmland amenities employed contingent valuation<sup>5</sup> methodology. In 1984, Halstead used western Massachusetts as a setting for valuing agricultural land preservation. The following year (1985) Bergstrom et al. used Greenville County, South Carolina to concentrate on the estimated value of amenity benefits of prime farmland. Then, in 1986, Beasley et al. considered the Matanuska-Susitna valleys of south central

<sup>4</sup>For a more comprehensive overview of stated preference literature on conservation easement valuation, please see Bergstrom and Ready (2009).

<sup>5</sup>Contingent valuation (CV) uses a similar methodology as choice theory. Both use a household utility maximization approach where data is collected via a survey. In terms of farmland, choice theory varies attributes of the farmland that is being valued, and asks the respondent to choose between two scenarios. CV does not concentrate on marginal prices of attributes like choice theory. CV aims to find the total value of a given scenario. For example, a single farmland preservation program would be laid out, with price varying among surveys, and the respondent would be asked to say if they would support the program or not. (Bell *et al.* 2006)



Alaska while estimating the WTP of residents to prevent the development of agricultural land from being transformed for residential and commercial use. Farmland preservation in three counties in New Brunswick, Canada was valued by Bowker and Didychuk in 1994. Specifically, the WTP for ranchland protection in the Yampa River Valley of Colorado was estimated by Rosenberger and Walsh in 1997. While in 1999, Kreiger used three counties in Chicago to estimate WTP for the protection of farmland. The overarching themes from these studies center on the characteristics of the respondents and the amount of land that would be preserved in the proposed programs of each study.

Duke et al. (2007) performed a choice survey of six Sussex County communities in 2005. The results of the analysis suggest that the value that residents place on farmland preservation can vary greatly. The variance is due to the kind of land considered for preservation, the proposed methods that were to be used to prevent development, and likely risk that unpreserved parcels would be developed.

Cho *et al.* (2005) estimated the WTP of rural communities in the Blue Ridge Mountains of Macon County, NC. At the time of the study, conservation easement programs were not in place. They did find a positive WTP per household that would decrease the rate of land conversion by 14-46% when compared to 1987-1997 period.

Lynch and Lovell (2003) analyzed the likelihood of a farmer to volunteer his/her land for conservation. They analyzed data from a survey as well as spatial data from GIS. Participation increased with farm size, the growing of crops, and the understanding that their children would continue farming that land. Participation decreased as proximity to the nearest city increased.

While putting a dollar figure on many of these characteristics is important, it is also vital that the motivating factors of the public be determined. This topic has

been taken into account by additional studies. The list of motivating factors include protection of food supply and the preservation of heritage and open spaces, as outlined by Fursueth in 1987, in a study conducted in a county in North Carolina. In 1999, Kreiger uncovered similar motivating factors that additionally included slowing development and ensuring rural quality. While in 1998, Kline and Wichelns used a contingent ranking format to determine how protecting environmental resources, scenic quality, food supply, and farming lifestyles influenced Rhode Island residents' motivation to preserve farmland.

Nickerson and Lynch (2001) studied the effects that a conservation easement to farmland had on property values in three counties in Maryland. Due to the loss of development rights, it would be expected that property value would decrease. They found little statistical evidence that voluntary permanent preservation programs significantly decrease the price of farmland in Maryland. They propose that the results also imply that agencies may have a legitimate reason for reducing the easement payments, since land values do not appear to be reduced by the full value of the development rights.

Anderson and Weinhold (2008) analyzed the effect of FMV on farmland when development rights are sold through the purchase of a conservation easement to the land. They analyzed data from South Central Wisconsin, and found a negative but statistically insignificant effect. Yet, when the sample was restricted in such a way that more homogeneous groups were analyzed, a statistically significant and negative impact was detected that ranged up to 50% of FMV for some farms.

Johnston and Duke (2007) examined different specification strategies for estimating the WTP of the public for land preservation. Their results suggest that even with a comprehensive specification strategy, it may be inadequate in preventing a systematic shift in WTP estimates. A widely cited criticism of

estimates based on state preference questions is that these estimates diverge widely depending on the elicitation format used in data collection (Carson and Groves 2007, McFadden 1994)

Revealed preference has also been used to value the WTP of the public for farmland to be preserved. Geoghegan *et al.* (2003) used a hedonic approach to analyze the change in property values for residence in three Maryland counties. They then compared cost of preserving the land to the increase in county property tax revenue based on a hypothetically implemented conservation easement program.

This study differs in two important ways from studies done on farmland valuation in the U.S. previously. First, this study utilizes attribute-based choice modeling rather than contingent valuation, which many prior studies applied. Additionally, other prior studies have used a hedonic approach where proximity to agricultural land is just one of many contributors to residential property values. Identifying the specific attributes of the land that provide public utility will help landowners and potentially aid in establishing public support for such a proposed program. Second, the geographic area for this study was statewide as opposed to sub-state, like previous studies. Most of the conservation easement programs are operating at the state level or require state support for a localized effort. Statewide opinions are therefore very important to consider when forming a policy on the most efficient way to spend public funds.

### **2.3 Contribution of this Research**

The public opinion survey that was sent out to the geographic areas in this thesis was preceded by a series of focus groups in Colorado, Oregon, as well as Ohio, Georgia, and Maine. The focus groups ranged from small groups talking about understanding the terminology of land preservation to looking at pictures of

different farms. Through the focus groups, the final attributes that were included in the survey were finalized. The findings of the focus groups are available in Paterson et al. (2001, 2005).

The public opinion survey was sent out with different versions of the attribute-based choice questions. Through four different set ups, which included a control (which is the data used in this thesis), a cost first option, an attribute-based choice question with only one alternative, and an attribute-based choice question with no status quo, the convergent validity of the version was analyzed. This was done by Boyle and Özdemir in 2009. The only version that did show a significant difference was the version with three alternatives as opposed to two. The rest of the versions did not show a significant difference.

Previous research as outlined above has focused on the willingness-to-pay of the public for farmland protection programs as well as the motivating factors behind this WTP; there is a hole in the research that this study aims to fill. The United States has a wide variety of landscapes, and comparing WTP and motivating factors between different regions of the country would provide greater insight for broader reaching farmland protection programs to consider. This information will allow for the amenities that give farmland its public value to be maintained more efficiently on a regional level, so that countrywide policies are not implemented without necessary consideration of regional levels.

## CHAPTER THREE: Models and the Survey

### 3.1 Choice Theory and the Random Utility Model

An individual is assumed to have a utility function ( $U$ ), which depends on  $A_i$  (a vector of attributes associated with alternative ( $i$ )),  $I$  (income) and  $S$  (socio-economic characteristics). In the analysis of the attribute-based choice data, each alternative  $i$  in the choice set ( $i = 1, 2$  (choice of Program A or B) or  $i = 1, 2, 3$  (choice of Program A, B, or status quo)) has a utility level of:

$$U_i = V_i(A_i, I, S) + \varepsilon_i$$

Where  $V_i$  is the systematic, observable component of utility and  $\varepsilon_i$  is the random error (McFadden 1973; Louviere et al. 2000)

If a respondent chooses alternative  $Y$ , then:

$$(V_Y + \varepsilon_Y) > (V_i + \varepsilon_i) \forall i \neq Y$$

Then, the probability ( $Pr$ ) of choosing  $Y$  over any other alternative  $i$  is:

$$Pr(V_Y > V_i) = Pr[(V_Y - V_i) > (\varepsilon_i - \varepsilon_Y)]$$

The probability of choosing alternative  $Y$  can be estimated using a probit model as outlined in the next section.

Decision rules were implemented to disregard respondent's observations that were misleading or inconsistent. Based on Arrow's impossibility theorem axiom of independent of irrelevant alternatives (IIA), a decision rule was implemented to ensure that a respondent was consistent between attribute-based questions based on

the same program. Specifically, a respondent cannot prefer Program A to Program B, only to prefer Program B to Program A when the status quo option is offered. If a respondent responded in this way, all of their responses were thrown out. Conversely, if a respondent did not respond to one of the attribute-based questions, but all of the other responses were consistent, then that respondent's responses were included in the data set.

The observable component of the utility function can be specified as

$$V = a_0 + a_1USE + a_2LOC + a_3QUAL + a_4SIZE + a_5INC + a_6HH$$

where *USE* is a vector of uses, *LOC* is a vector of locations, *QUAL* is a vector of quality, *SIZE* is a vector of size, *INC* is a vector of income, and *HH* is a vector of other household characteristics.

If we assume that under no program that the following vectors are

$$\begin{aligned} USE_{np} &= 0 \\ LOC_{np} &= 0 \\ QUAL_{np} &= 0 \\ SIZE_{np} &= 0 \end{aligned}$$

and that the program does not affect household characteristics such that

$$HH_p = HH_{np}$$

We can then take the difference in observed utility from a program and the observed utility where there is no program.

$$\begin{aligned}
V_p - V_{np} = & a_1(USE_p - USE_{np}) + a_2(LOC_p - LOC_{np}) \\
& + a_3(QUAL_p - QUAL_{np}) + a_4(SIZE_p - SIZE_{np}) \\
& + a_5((I - WTP) - I) + a_6(HH_p - HH_{np})
\end{aligned}$$

This reduces to

$$V_p - V_{np} = a_1USE + a_2LOC + a_3QUAL + a_4SIZE - a_5WTP$$

and setting

$$V_p - V_{np} = 0$$

we can solve for WTP as

$$a_5WTP = a_1USE + a_2LOC + a_3QUAL + a_4SIZE$$

Then, because of binary values for Use, Location, Quality, and Size:

$$WTP = a_1/a_5 USE + a_2/a_5 LOC + a_3/a_5 QUAL + a_4/a_5 SIZE$$

### 3.2 Probit Model

In a choice model, the dependent variable is binary such that

$$Y = \begin{cases} 1 & \text{if } Y^* > 0 \text{ i. e. } -\varepsilon < X'\beta, \\ 0 & \text{otherwise.} \end{cases}$$

The log-likelihood function can be estimated in the following way

$$\ln L(\beta) = \sum_{i=1}^n (y_i \ln \Phi(x_i'\beta) + (1 - y_i) \ln (1 - \Phi(x_i'\beta)))$$

Under the assumption that the error is distributed normally, i.e.

$$\sqrt{n}(\hat{\beta} - \beta) \xrightarrow{d} N(0, \Omega^{-1}),$$

where

$$\Omega = E \left[ \frac{\varphi^2(X'\beta)}{\Phi(X'\beta)(1 - \Phi(X'\beta))} XX' \right],$$

and

$$\hat{\Omega} = \frac{1}{n} \sum_{i=1}^n \frac{\varphi^2(x_i'\hat{\beta})}{\Phi(x_i'\hat{\beta})(1 - \Phi(x_i'\hat{\beta}))} x_i x_i'$$

The choice equation can be specified as

$$\begin{aligned} Pr(RESPDUM = 1|X) = & \delta_{0i}(STATUSQUO) + \delta_{1i}(URBAN) \\ & + \delta_{2i}(PRIME) + \delta_{3i}(GRAIN) + \delta_4(HAY) \\ & + \delta_{5i}(VEGETABLE) + \delta_{6i}(PASTURE) + \delta_{7i}(FOREST) \\ & + \delta_{8i}(MEDIUM) + \delta_{9i}(LARGE) + \delta_{10i}(EXLARGE) \\ & + \gamma_i(COST) + \delta_{11i}(Q2ASC) + \delta_{12i}(Q2ASC) + \delta_{13i}(Q4ASC) \end{aligned}$$

Where  $i = 1, 2, 3, 4$  (for each different geographic area).

### 3.3 Bivariate Probit Model with Sample Selection

The typical Heckman model utilizes an outcome (choice) equation that has a continuous dependent variable. The selection equation is typically a probit model with a binary dependent variable. In this thesis, the choice equation also has a binary variable, which is why the Heckman procedure must be altered to accommodate two probit models. This is known as a bivariate probit model with



sample selection. The general composition of the bivariate probit model will be discussed, and then the specific changes that go along with the sample selection correction will be outlined.

The bivariate probit model is composed of two separate probit models that have correlated errors. This can be translated into a choice framework as two interrelated choices. The first choice is whether or not to fill out the survey. The next set of choices are the decisions made as to the stated-preference attribute-based choice questions in the survey. The last choice is whether or not to bother sending the survey back. Since all of the prior choices to responding to the survey are indistinguishable if the survey is not sent back, then only two identifiable choices arise. These are modeled by the choice and selection equations. Within the bivariate probit model, we have two binary dependent variables,  $y_j, j= 1, 2$ , and the two equations might appear like this

$$\begin{aligned} y_1^* &= x_1\beta_1 + \epsilon_1 \\ y_2^* &= x_2\beta_2 + \epsilon_2 \end{aligned}$$

where  $y_j^*$  are unobservable and related to the binary dependent variable by the following rule

$$y_j = \begin{cases} 1 & \text{if } y_j^* > 0 \\ 0 & \text{if } y_j^* \leq 0 \end{cases}$$

for  $j = 1, 2$ . The models can be estimated separately if the errors between the two probit models are independent. In other words,  $Cov[\epsilon_1, \epsilon_2] = 0$ .

If the covariance of the errors of the two separate models is not 0, then the error terms have some sort of dependence. Such that

$$\begin{aligned}\epsilon_{1i} &= \eta_i + u_{1i} \\ \epsilon_{2i} &= \eta_i + u_{2i}\end{aligned}$$

The error terms are comprised of unique ( $u_{1i}, u_{2i}$ ) and common ( $\eta_i$ ) parts. Therefore the errors are correlated.

The choice equation can then be written

$$\begin{aligned}Pr(y_{2i} = 1) &= Pr(\epsilon_{2i} > -x_2\beta_2) \\ &= Pr(\eta_i + u_{2i} > -x_2\beta_2)\end{aligned}$$

and the selection equation can be written

$$\begin{aligned}Pr(y_{1i} = 1) &= Pr(\epsilon_{1i} > -x_1\beta_1) \\ &= Pr(\eta_i + u_{1i} > -x_1\beta_1)\end{aligned}$$

We are therefore interested in the joint probability of  $y_1$  and  $y_2$ .

The joint probability of two independent random variables is the product of their marginal probabilities. If  $y_1$  and  $y_2$  are independent, then

$$\begin{aligned}Pr(y_1 = 1, y_2 = 1) &= F(y_1) \times F(y_2) \\ Pr(y_1 = 1, y_2 = 0) &= F(y_1) \times [1 - F(y_2)] \\ Pr(y_1 = 0, y_2 = 1) &= [1 - F(y_1)] \times F(y_2) \\ Pr(y_1 = 0, y_2 = 0) &= [1 - F(y_1)] \times [1 - F(y_2)]\end{aligned}$$

If  $y_1$  and  $y_2$  are not dependent because of the correlation in their errors, then their joint probability, given

$$\begin{aligned}Pr(A \text{ and } B) &= Pr(A|B) \times Pr(B) \\ &= Pr(A) \times Pr(B|A)\end{aligned}$$

would be

$$\begin{aligned} Pr(y_1 = 1, y_2 = 1) &= Pr(y_1 = 1|y_2 = 1) \times Pr(y_2 = 1) \\ &= Pr(y_1 = 1) \times Pr(y_2 = 1|y_1 = 1) \end{aligned}$$

Assuming a bivariate normal distribution for the joint distribution of the  $y_i$ s, the joint pdf takes the form

$$\Phi_2 = \Phi(\epsilon_1, \epsilon_2) = \frac{1}{2\pi\sigma_{\epsilon_1}\sigma_{\epsilon_2}\sqrt{1-\rho^2}} e^{\left[-\frac{1}{2}\left(\frac{\epsilon_1^2\epsilon_2^2-2\rho\epsilon_1\epsilon_2}{1-\rho^2}\right)\right]}$$

where  $\rho$  is the correlation parameter which indicates the level of covariance between the  $\epsilon$ s. The joint cdf then take the form

$$\Phi_2 = \Phi(\epsilon_1, \epsilon_2) = \int_{\epsilon_1} \int_{\epsilon_2} \Phi_2(\epsilon_1, \epsilon_2, \rho) d\epsilon_1 d\epsilon_2$$

Under the assumption that the bivariate distribution is IID with correlation  $\rho$ ,

$$\begin{aligned} E[\epsilon_1|x_1, x_2] &= E[\epsilon_2|x_1, x_2] = 0 \\ \text{Var}[\epsilon_1|x_1, x_2] &= \text{Var}[\epsilon_2|x_1, x_2] = 0 \\ \text{Cov}[\epsilon_1, \epsilon_2|x_1, x_2] &= \rho \end{aligned}$$

The probability of joint event can then be made via,

$$\begin{aligned} Pr(y_{1i} = 1, y_{2i} = 1) &= \int_{-\infty}^{\epsilon_{1i}} \int_{-\infty}^{\epsilon_{2i}} \Phi_2(x_1\beta_1, x_2\beta_2; \rho) d\epsilon_{1i} d\epsilon_{2i} \\ &= \Phi_2(x_1\beta_1, x_2\beta_2; \rho) \end{aligned}$$

The log-likelihood of all four events, multiplied by their probabilities and summed gives the log-likelihood of the bivariate probit model.

$$\begin{aligned}
\ln L = & \sum_{i=1}^N \{y_{1i}y_{2i}\ln\Phi_2(x_1\beta_1, x_2\beta_2; \rho) \\
& + y_{1i}(1 - y_{2i})\ln[\Phi(x_1\beta_1) - \Phi_2(x_1\beta_1, x_2\beta_2; \rho)] \\
& + (1 - y_{1i})y_{2i}\ln[\Phi(x_2\beta_2) - \Phi_2(x_1\beta_1, x_2\beta_2; \rho)] \\
& + (1 - y_{1i})(1 - y_{2i}) \\
& \ln[1 - \Phi(x_1\beta_1) - \Phi(x_2\beta_2) - \Phi_2(x_1\beta_1, x_2\beta_2; \rho)]\}
\end{aligned}$$

When we put all of this into a sample selection framework, the equations reduce down. This is because without a response, we cannot know the choice variables. This means that there are three outcomes that are possible.

$$\begin{aligned}
y_1 = 0 & \quad Pr(y_1 = 0) = \Phi(-x_1\beta_1) \\
y_1 = 1, y_2 = 0 & \quad Pr(y_1 = 1, y_2 = 0) = \Phi(x_1\beta_1) - \Phi_2(x_1\beta_1, x_2\beta_2; \rho) \\
y_1 = 1, y_2 = 1 & \quad Pr(y_{1i} = 1, y_{2i} = 1) = \Phi_2(x_1\beta_1, x_2\beta_2; \rho)
\end{aligned}$$

The log-likelihood function reduces down to

$$\begin{aligned}
\ln L = & \sum_{i=1}^N \{y_{1i}y_{2i}\ln\Phi_2(x_1\beta_1, x_2\beta_2; \rho) \\
& + y_{1i}(1 - y_{2i})\ln[\Phi(x_1\beta_1) - \Phi_2(x_1\beta_1, x_2\beta_2; \rho)] \\
& + (1 - y_{1i})\ln\Phi(-x_1\beta_1)\}
\end{aligned}$$

The probit model is based on an assumption about the error term ( $u$ ). If the error term is distributed normally, then the observable component ( $\Delta V$ ) can be specified through the estimation of a utility function. If the

$$Pr(\text{choosing a Program}) = \Delta V + u$$

The selection equation is specified as a discrete choice model where survey response bias was taken into account by controlling for differences in demographic characteristics of respondents and non-respondents based on the zip code in which they reside. The selection equation is empirically specified as:

$$\begin{aligned}
 Pr(resp = 1|X) = & \beta_0 + \beta_1(pctmove) + \beta_2(pctmove\_county) \\
 & + \beta_0(pctmove\_state) + \beta_0(pcths) + \beta_0(pctcol) \\
 & + \beta_0(pct\_farm\_earn) + \beta_0(pct\_renter) + \beta_0(ruc) \\
 & + \beta_0(uic) + \beta_0(amenity) + \beta_0(popchange\_nm\_90) \\
 & + \beta_0(popchange\_nm\_80) + \beta_0(popdensity\_nm\_00) \\
 & + \beta_0(popchange\_90) + \beta_0(popchange\_80) \\
 & + \beta_0(popdensity\_00) + \beta_0(income)
 \end{aligned}$$

Combining the utility equation and the selection equation in a Heckman format using a FIML estimation is the most efficient use of information in the model.<sup>6</sup> Clustering was also used across  $j$ . Controlling for correlation by clustering the responses from each individual respondent accounts for the variance within each respondents set of responses, but does not affect the parameter estimates.

Under the assumption that the utility function is linear in coefficients (Greene 2000), then the estimated choice equation to estimate ( $\Delta V$ ) can be empirically specified as:

$$Pr(RESPDUM = 1|X) = \delta_{0i}(STATUSQUO) + \delta_{1i}(URBAN)$$

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<sup>6</sup> FIML is the most efficient procedure, as opposed to a two step procedure with the choice and selection equations being estimated one step at a time.

$$\begin{aligned}
& +\delta_{2i}(PRIME) + \delta_{3i}(GRAIN) + \delta_4(HAY) \\
& +\delta_{5i}(VEGETABLE) + \delta_{6i}(PASTURE) + \delta_{7i}(FOREST) \\
& +\delta_{8i}(MEDIUM) + \delta_{9i}(LARGE) + \delta_{10i}(EXLARGE) \\
& + \gamma_i(COST) + \delta_{11i}(Q2ASC) + \delta_{12i}(Q2ASC) + \delta_{13i}(Q4ASC)
\end{aligned}$$

Where  $i = 1, 2, 3, 4$  (for each different geographic area).

To ensure that the utility function does not have perfect multicollinearity, SMALL is not included in the specification. Otherwise, both the baseline (STATUSQUO) and all of the total acreage alternatives would be included.

### 3.4 Role of Scale Parameter

In a probit model, it is impossible to recover the scale parameter, as the scale parameter and the true underlying preference parameters are always confounded multiplicatively. This means that estimates from different data sets should not be compared directly, but relative scale should be taken into account. This is because it cannot be determined whether true preferences, a scaling difference, or both play a role in the estimate differences. Using relative scale allows for a test to be run determining the relationship of the parameter estimates when accounting for the relative scale.

Scale parameter ( $\mu$ ) and the true underlying preference parameters ( $\beta$ ) are always represented in multiplicative form such that  $\mu\beta = \alpha$ , where  $\alpha$  are the parameter estimates. Given an estimate of  $\mu$ , it is then possible to test whether parameter vectors ( $\beta$ ) are the same up to a scaling constant.

Scale is inversely related to variance, therefore a larger scale means a lower variance, and vice versa. Swait and Louviere (1993) used a method for comparing

independent data sets while using a multinomial logit model for each geographic area.

### **3.5 Method for Estimating Likelihood Ratios for Pair-wise Comparisons Using Scale Parameter**

When comparing estimates of the same model, using different geographic areas, it is necessary to account for differences in the scale parameters ( $\mu_i$ ) of the estimates. Otherwise, a significant difference in the estimates could be detected when a standardization of the scale parameter could account for the difference. The following process is the same that was outlined by Swait and Louviere (1993).

The first step is to select the two geographic areas that are going to be compared. This study tests all pair-wise geographic areas. With four geographic areas, the US, GA, OH, and ME, this means that six tests were performed.

The second step is to estimate the models using the exact same set of variables. There are three models to be estimated. The first two are the estimations of the individual geographic areas. The third is with the concatenated data of both geographic areas. From each of these estimations, the log-likelihood value is stored for later use in the hypothesis tests. Additionally, the parameter estimates are saved from each of the individual geographic area estimations for use in the next step. The constant term is dropped from each parameter estimate matrix after the estimation. Therefore the parameter estimate matrices that were  $((k + 1) \times 1)$  become  $(k \times 1)$ . These truncated matrices are used in the third step.

The third step is to use the stored truncated parameter estimates to create a confidence interval for the scale parameter. The confidence interval will be used as a range in which the scale parameter is varied in a future step. The confidence interval is constructed by regressing one truncated parameter estimates matrix on

the other, while forcing no constant term in the estimation. The resulting parameter estimate is the parameter estimate for the standardized scale parameter. Assuming a normal distribution of the standardized scale parameter, a 99% confidence interval is constructed. This range is the range that will be used to vary the scale parameter in a loop in the next step.

The fourth step is to program a loop that varies the scale parameter. It is important to note that the statistical package that was used to estimate the models automatically standardizes the scale parameter to unity. Using the concatenated data, a loop that varies the scale parameter, estimates the equation of interest, and stores the resulting log-likelihood value is programmed. The geographic area data, which corresponds with the parameter estimates that were used as the regressor in step three, are multiplied by the varying scale parameter during each iteration of the loop. At the end of the loop, the data that was multiplied by the scale parameter is restored to their pre-loop iteration values. Once all iterations of the loop have been run, spanning the range of the confidence interval, the maximum log-likelihood value that resulted from any of the scale parameter values is stored. In this study, the confidence interval range was divided by 100 to determine the size of each step in the loop.

Finally, all of the statistics needed for the hypothesis tests are stored. The log-likelihood ratio statistics can be tested to determine the statistical significance of the relationship between the pair-wise geographic areas while accounting for the scale parameter. The following table outlines the two hypotheses tests and the corresponding log-likelihood ratio statistics.



Table 3.6.1 Hypotheses and Log-Likelihood Ratio Tests

$H_A: \beta_1 = \beta_2$	$H_B: \mu_1 = \mu_2$
$\lambda_A = -2[L_\mu - (L_1 + L_2)]$	$\lambda_B = -2[L_p - L_\mu]$
$L_\mu$ from optimally adjusted pooled data	$L_p$ from unadjusted pooled data
$L_1$ from $X_1$ model	$L_\mu$ from optimally adjusted pooled data
$L_2$ from $X_2$ model	

A significant result for  $H_A$  indicates that there is heterogeneity in preferences between the geographic areas. A significant result for  $H_B$  indicates that there is heterogeneity in the amount of variance or noise between the two geographic areas.

### 3.6 Method for Predicting WTP using Implicit Prices

Under the assumption that utility is linear in parameters, then differentiation of the utility function with respect to an attribute gives the marginal utility of that attribute. Dividing one marginal utility by another gives the marginal rate of substitution between those two attributes. In terms of money, the negative of the parameter estimate is the marginal utility of money. To calculate the implicit price of any of the attributes, divide the marginal utility of the attribute by the negative of the marginal utility of money. This provides the household's willingness-to-pay for the conservation of farmland that did not exhibit the attribute of interest but will now.

### 3.7 Estimating Consumer Surplus

Using the WTP of each attribute, any farmland conservation program can take the sum of the implicit prices of each attribute in the proposed program, and find what amount the public is willing to pay to conserve that farmland. From the farmer's perspective, the value of a Conservation Easement "reflects the difference between the higher value they would receive if they sold the land for residential, commercial, or other non-farm uses, and the lower value if they sold to another

farmer.” From a household’s perspective, it reflects how much they are willing to pay so that the land is never developed commercially or residentially.

For this thesis, it is assumed that all households are homogeneous in their WTP. It is also assumed that the WTP that is estimated is representative of that homogeneous WTP. A WTP range will be provided. The lower end of the estimate will retract from the homogeneous assumption slightly, and will break the respondents into a group that has a homogeneous WTP identical to that which is estimated, while the non-respondents will have an assumed WTP of zero. The response percentages will be extrapolated onto the household population as a whole in each geographic area. The sum of this WTP will be lower end. The upper end will eliminate the assumption that non-respondents have a WTP of zero. All households in the geographic area will have an assumed WTP that is identical to the estimated WTP.

### **3.8 Survey Design**

To find out the farmland attributes that are most valued by the public, a public opinion survey<sup>7</sup> was conducted in 2002. The survey was distributed nationwide (US) as well as in Georgia (GA), Ohio (OH), and Maine (ME). The core of the survey was an attribute-based choice study where respondents had a choice between Program A and Program B and then could choose between Program A, Program B, and the status quo of no program. Program A and Program B were different farmland concentration easements that varied in attributes. There were four such scenarios with varying farmland use, location, land quality, total acreage, and cost for each program. Additionally, demographic

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<sup>7</sup>A copy of the Public Opinion Survey that was sent out to one of the geographic areas (Maine) is available in Appendix A. The size component varied between geographic areas to provide a measure relative to the size of the geographic area being sampled.

information on the respondent and the respondent's household were collected to allow for tests of response bias.

Dillman's method was followed while sending out the surveys to the households. The survey was sent out to 1000 households in each geographic area other than ME, which had 500 households receive a survey. First, an introductory letter was sent to the households to let them know about the survey and to ask them to complete the survey and return it. A week later, the information booklets<sup>8</sup> along with the survey were sent to the households. The following week, postcards were sent to remind the households about the survey and inform them about the importance of their response to the research. Two weeks after that, all non-response households received a second survey.

Table 3.8.1 shows an example attribute-based choice question. Four such questions were presented in every public opinion survey. As stated above, farmland use, location, land quality, total acreage, and cost for each program were varied.

Table 3.8.2 shows the farmland attribute's possible attribute levels. The different choice question attribute combinations were randomly generated in a way that the funding agency for the project could potentially use the data to analyze interaction effects. More commonly the approach to developing the attribute combinations is to use an orthogonal approach. According to Lusk and Norwood (2005), welfare estimates are not biased by the approach used for this study.

The attributes in the attribute-based choice questions were designed using a random factorial. Only main effects, and not interaction effects, were calculated in this research. Combining all of the possible attribute combinations yields 574

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<sup>8</sup>A copy of one of the information booklet that accompanied the survey with one of the geographic areas (Maine) is available in Appendix B. The information booklet provided information specifically on the geographic area being sampled that would help the respondents make more informed decisions.

different program scenarios for the survey. This is done by multiplying the six use, two location, two prime, four size, and six cost options.

Table 3.8.1 Example Attribute-Based Choice Question

Suppose you had to vote between two conservation easement programs, Program A and Program B. These programs differ in terms of the attributes of the farms that would receive priority in the bidding process, the number of acres in the program and the cost to you. Please tell us which of the two programs you would support if you had to choose between Program A and Program B. You will also be able to tell us if you would vote for one of these programs or do nothing.

	Conservation Easement Program A	Conservation Easement Program B
Farmland use priority	Growing vegetables, berries, fruit and nut crops	Growing hay
Farmland location priority	Near urban areas	No priority
Land quality priority	No priority	Prime farmland
Total acres of easement purchased	120,000	60,000
One-time cost to your household in 2002*	\$5	\$7

9. Which program do you prefer? (PLEASE CIRCLE ONE NUMBER)

- 1                      Program A
- 2                      Program B

10. Now, suppose you could vote between Program A, Program B and doing nothing. How would you vote? (CIRCLE ONE NUMBER)

- 1                      I would vote for Program A
- 2                      I would vote for Program B
- 3                      I would not vote for either program

\* Respondents were told that the payment vehicle was a one-time increase in their state income taxes: "Money to purchase Conservation Easements would come from a one-time payment that everyone in the state would pay through an increase in their 2002 state income taxes."

Table 3.8.2 Attributes and Attribute Levels

Attributes		Attribute levels			
Farmland use priority		Growing grain crops			
		Growing hay			
		Growing vegetables, berries, fruits and nuts crops			
		Pasture for livestock			
		Forested land			
		No priority			
Farmland location priority		Near urban areas			
		No priority			
Land quality priority		Prime farmland			
		No priority			
Total acres of easement purchased		US	GA	OH	ME
	SMALL	9,000,000	100,000	140,000	12,000
	MEDIUM	45,000,000	500,000	700,000	60,000
	LARGE	90,000,000	1,000,000	1,400,000	120,000
	EXLARGE	180,000,000	2,000,000	2,800,000	240,000
One-time cost to household in 2002 (increase in state income taxes)		\$0 (status quo only)			
		\$3			
		\$5			
		\$7			
		\$10			
		\$25			
	\$50				

Table 3.8.3 defines all of the variables that are used in both the choice and selection equations. The choice equation variables are in all caps while the selection equation variables are in all lower case. The choice equation data comes from the responses made to the survey. The selection equation data comes from the USDA and the 2000 census. The choice equation only has data for households that responded. The selection equation only has zip code level data from which the household that was sent a survey resides.

Table 3.8.3 Variable Definitions

Variables	Variable definitions
<b>Choice Equation</b>	
RESPDUM	1 if respondent chose that program, 0 otherwise
STATUSQUO	1 if no conservation easement, 0 otherwise
COST	\$3, \$5, \$7, \$10, \$25, \$50
URBAN	1 if near urban area, 0 otherwise
PRIMEFARM	1 if prime farmland, 0 otherwise
GRAIN	1 if growing grain crops, 0 otherwise
HAY	1 if growing hay, 0 otherwise
VEGETABLE	1 if growing vegetable, fruit and nuts crops, 0 otherwise
PASTURE	1 if pasture for livestock, 0 otherwise
FOREST	1 if forested land, 0 otherwise
MEDIUM	1 if MEDIUM acres, 0 otherwise
LARGE	1 if LARGE acres, 0 otherwise
EXLARGE	1 if EXLARGE acres, 0 otherwise
Q2ASC	1 if ABC question 2, 0 otherwise (alternative specific constant)
Q3ASC	1 if ABC question 3, 0 otherwise (alternative specific constant)
Q4ASC	1 if ABC question 4, 0 otherwise (alternative specific constant)
<b>Selection Equation</b>	
resp	1 if responded to survey, 0 otherwise
pctmove	percent moved in last five years
pctmove_county	percent moved from different county in last five years
pctmove_state	percent moved from different state in last five years
pcths	percent with high school or better education
pctcol	percent with college or better education
pct_farm_earn	percent of earnings from farms
pct_renter	percent of residents who rent
ruc	rural urban continuum, 0 urban 9 rural
uic	urban influence code, 1 urban 9 rural
amenity	amenity scale, higher is nicer
popchange_nm_90	percent population change in nonmetro area since 1990
popchange_nm_80	percent population change in nonmetro area since 1980
popdensity_nm_00	population density in nonmetro area per square mile 2000
popchange_90	percent population change since 1990
popchange_80	percent population change since 1990
popdensity_00	population density per square mile 2000
income	median income of zip code of respondent

## CHAPTER FOUR: Data and Empirical Results

### 4.1 Descriptive Statistics

Table 4.1.1 shows how respondent choices were distributed by program. The first question asked whether the respondent preferred program A or program B. The second question asked whether the respondent preferred program A, program B, or no program (status quo option).

Table 4.1.2 is comprised of demographic descriptive statistics of the respondents only compared with the demographic descriptive statistics of the geographic areas from the 2000 census. The respondent data is from the public opinion survey, which was conducted in 2002. While the census data was from the American FactFinder website.

Table 4.1.1 Percentage of Choosing Program A, Program B, and Status Quo

	US		GA		OH		ME	
	Q1	Q2	Q1	Q2	Q1	Q2	Q1	Q2
Choice of A (%)	54	39	52	38	53	40	52	41
Choice of B (%)	46	35	48	33	47	36	48	35
Status Quo (%)	NA	26	NA	29	NA	24	NA	24



Table 4.1.2 Demographic Characteristics by Geographic Area

	United States		Georgia		Ohio		Maine	
	Respondents	Nationwide	Respondents	Statewide	Respondents	Statewide	Respondents	Statewide
Gender (%)								
Male	67.4	49.1	63.6	49.2	68.3	48.6	71.3	48.7
Female	32.6	50.9	36.4	50.8	31.7	51.4	28.7	51.3
Age (years)								
Median	55.7	35.3	52.5	33.4	56.7	36.2	56.5	38.6
Education (%)								
Eight years or less	4.2	7.5	0.5	7.6	0.9	4.5	1.2	5.4
Some high school	3.8	12.1	5.6	13.8	5.2	12.6	5.9	9.2
High school graduate	20.8	28.6	19.2	28.7	22.6	36.1	29.4	36.2
Some college or technical school	19.1	21	22.2	20.4	29.6	19.9	20.6	19
Technical school graduate	6.4	6.3	4.5	5.2	5.7	5.9	3.5	7.9
College graduate	24.2	15.5	24.7	16	22.2	13.7	24.1	14.9
Post graduate work	21.6	8.9	23.2	8.3	13.9	7.4	15.3	7.9
Population (persons)								
Average household	2.62	2.59	2.76	2.65	2.48	2.49	2.49	2.39
Average family		3.14		3.14		3.04		2.9
Income (\$)								
Median household	47500	41994	55000	42433	55000	40956	47500	37240

Based on the comparison between the respondents and the census data, outlined in Table 4.1.3, it is apparent that an older, male dominated, more highly educated, and wealthier group responded. Unfortunately, demographic statistics are not available for every household that responded. This is the inherent problem with survey data when trying to detect selection bias. It must be assumed that every household that does not respond is a homogeneous representation of the average household in, for example, that household's zip code. This is the best way known to attempt to detect selection bias, given the limitations that the data present. And this is the process that is used to try to detect selection bias within the data used for this thesis. But, it is apparent that the respondents do exhibit atypical demographic characteristics when compared to the rest of the geographic area.

Table 4.1.3 ANOVA of Demographic Characteristics by Geographic Area

	United States	Georgia	Ohio	Maine
Gender	0.0000 Reject	0.0000 Reject	0.0000 Reject	0.0000 Reject
Age	0.0000 Reject	0.0000 Reject	0.0000 Reject	0.0000 Reject
Population	0.7271 Fail to Reject	0.2765 Fail to Reject	0.9085 Fail to Reject	0.2587 Fail to Reject
Income	0.0020 Reject	0.0000 Reject	0.0000 Reject	0.0000 Reject

## **4.2 Probit Estimation with Sample Selection Results**

Using the methodology outlined in Chapter Four, probit models for each geographic area were estimated. First, the probit models with sample selection were estimated, using a Heckman correction format. This is adaptation of the Heckman format which uses a probit model for the choice equation and OLS for the selection equation. The Heckman probit format utilizes a probit model for both the choice and selection equations.

To determine if there is selection bias that needs to be accounted for and corrected, a Wald test is performed to determine if the choice and selection equations are independent. Then the significance level is calculated. If the Heckman probit estimation yields a result that says that the selection equation is significant, then the bias must be corrected for. If the selection equation is insignificant, then the selection equation can be dropped from the analysis, and the choice equation can be estimated on its own.

Table 4.2.1 Estimation of Choice Equation for Bivariate Probit with Sample Selection

<b>Choice Equation</b>				
RESPDUM	United States	Georgia	Ohio	Maine
Q2ASC	-0.005 (0.016)	-0.027 (0.02)	-0.024 (0.021)	-0.023 (0.027)
Q3ASC	-0.018 (0.017)	-0.016 (0.022)	-0.051 ** (0.023)	-0.049 * (0.027)
Q4ASC	-0.009 (0.017)	-0.031 (0.024)	-0.026 (0.023)	-0.054 * (0.028)
STATUSQUO	-0.141 *** (0.026)	-0.136 *** (0.029)	-0.098 *** (0.027)	-0.059 * (0.034)
URBAN	0.045 (0.067)	0.194 *** (0.067)	0.173 *** (0.066)	0.319 *** (0.076)
PRIME	0.213 *** (0.062)	0.285 *** (0.064)	0.288 *** (0.062)	0.428 *** (0.067)
GRAIN	0.358 *** (0.11)	0.177 * (0.102)	0.212 ** (0.106)	0.029 (0.113)
HAY	-0.069 (0.105)	-0.301 *** (0.108)	-0.258 *** (0.092)	-0.211 * (0.116)
VEGETABLE	0.383 *** (0.107)	0.411 *** (0.107)	0.285 ** (0.112)	0.266 ** (0.12)
PASTURE	0.082 (0.1)	0.099 (0.111)	0.016 (0.105)	0.064 (0.12)
FOREST	0.179 * (0.097)	0.092 (0.1)	0.291 *** (0.098)	0.008 (0.123)
MEDIUM	0.128 (0.085)	0.098 (0.086)	0.167 * (0.092)	0.204 ** (0.096)
LARGE	0.229 ** (0.093)	0.205 (0.088)	0.475 *** (0.078)	0.301 *** (0.105)
EXLARGE	0.169 * (0.091)	0.280 *** (0.092)	0.481 *** (0.093)	0.633 *** (0.108)
COST	-0.009 *** (0.002)	-0.012 *** (0.002)	-0.012 *** (0.02)	-0.010 *** (0.002)
CONSTANT	-0.472 *** (0.096)	-0.393 *** (0.099)	-0.640 *** (0.102)	-0.654 *** (0.089)

Table 4.2.2 Estimation of Selection Equation for Bivariate Probit with Sample Selection

<b>Selection Equation</b>				
resp	United States	Georgia	Ohio	Maine
pctmove	1.826 (1.529)	0.203 (1.758)	-1.562 (1.436)	1.508 (2.976)
pctmove_county	-1.068 (1.58)	-1.021 (1.557)	0.627 (1.418)	-1.665 (2.327)
pctmove_state	1.087 (1.738)	0.071 (1.545)	-0.233 (1.789)	2.062 (2.832)
pcths	-1.394 (0.935)	3.386 *** (1.28)	0.021 (0.982)	-2.026 (1.742)
pctcol	1.723 (1.189)	-2.381 ** (1.138)	1.849 * (1.067)	1.945 (1.869)
pct_farm_earn	0.586 (0.556)	0.425 (0.612)	0.043 (0.493)	1.980 (1.224)
pct_renter	-0.716 (1.157)	0.967 (1.037)	-0.813 (0.896)	-1.784 (1.675)
ruc	0.032 (0.054)	-0.002 (0.052)	0.035 (0.052)	0.046 (0.078)
uic	-0.009 (0.05)	0.008 (0.048)	-0.038 (0.051)	-0.116 * (0.071)
amenity	0.029 (0.079)	-0.038 (0.07)	-0.013 (0.07)	-0.329 *** (0.116)
popchange_nm_90	2.136 (3.88)	-13.060 *** (4.519)	-3.656 (5.682)	-3.038 (16.43)
popchange_nm_80	-2.639 (2.165)	7.057 *** (2.578)	1.643 (3.048)	-1.088 (8.875)
popdensity_nm_00	-0.001 (0.005)	0.011 *** (0.004)	-0.002 (0.002)	0.066 *** (0.018)
popchange_90	0.571 (4.734)	14.015 *** (4.687)	7.208 (6.604)	-45.010 ** (19.941)
popchange_80	0.627 (2.125)	-5.567 ** (2.338)	-3.203 (2.779)	19.815 *** (7.739)
popdensity_00	0.001 (0.002)	-0.002 * (0.001)	-0.001 (0.001)	-0.010 *** (0.002)
income	0.000 * (0)	0.000 (0)	0.000 * (0)	0.000 (0)
constant	-1.000 (1.042)	-3.658 *** (1.324)	-0.378 (0.854)	2.347 (1.655)

Table 4.2.3 Summary Statistics for Bivariate Probit with Sample Selection

Number of obs.	14448	15278	16082	8129
Censored obs.	10600	11620	12040	5040
Uncensored obs.	3848	3667	4042	3089
Clusters	735	778	882	414
Wald chi <sup>2</sup> (15)	1081.49	743.63	631.37	428.1
p-value	0.0000	0.0000	0.0000	0.0000
Log pseudolikelihood	-10714.2	-10488.1	-11386.9	-6262.0

Table 4.2.4 Selection Bias Test from Bivariate Probit with Sample Selection Estimation

rho	0.039 (0.053)	-0.028 ** (0.039)	0.062 (0.057)	0.008 * (0.024)
Wald test of indep. eqns. (rho = 0):				
chi <sup>2</sup> (1)	0.53	0.490	1.19	0.11
p-value	0.466	0.482	0.275	0.7454
Notes:				
Significant at the * = 10 percent, ** = 5 percent, *** = 1 percent.				
Standard errors in parentheses				

The significance level of the selection equation for the United States is 0.4661. Therefore, the selection equation is insignificant and can be dropped from the analysis. The significance level of the selection equation for Georgia is 0.4824. Therefore, the selection equation is insignificant and can be dropped from the analysis. The significance level of the selection equation for Ohio is 0.2751. Therefore, the selection equation is insignificant and can be dropped from the

analysis. The significance level of the selection equation for Maine is 0.7545. Therefore, the selection equation is insignificant and can be dropped from the analysis.

All of the geographic areas show that under the assumption of zip code homogeneity, there is not response bias within the sample. This means that the selection equation can be dropped from all of the models, and the choice equation can be estimated solely.

### **4.3 Probit Estimation Results**

From all of the Heckman probit estimates, we can discern that compared to the zip code averages, there was no response bias between those who did respond and those that did not. Therefore, the probit estimates of the choice equations for all four geographic areas can be used for the rest of the analysis.

Probit parameter estimates cannot be directly interpreted, other than sign, which reveals whether the relationship between each variable is direct or indirect. The probability of an affirmative response to the choice questions is increased/decreased by the marginal parameter estimate for each variable.

Table 4.3.1 Probit Estimation for Geographic Areas

<b>Choice Equation</b>				
RESPDUM	United States	Georgia	Ohio	Maine
Q2ASC	0.003 (0.016)	-0.024 (0.02)	-0.029 (0.021)	-0.018 (0.027)
Q3ASC	-0.005 (0.017)	-0.010 (0.022)	-0.051 ** (0.022)	-0.045 * (0.027)
Q4ASC	-0.011 (0.017)	-0.023 (0.023)	-0.028 (0.023)	-0.051 * (0.028)
STATUSQUO	-0.123 *** (0.024)	-0.129 *** (0.028)	-0.098 *** (0.027)	-0.061 * (0.033)
URBAN	0.069 (0.063)	0.193 *** (0.066)	0.173 *** (0.065)	0.315 *** (0.075)
PRIME	0.196 *** (0.059)	0.285 *** (0.063)	0.285 *** (0.062)	0.429 *** (0.067)
GRAIN	0.406 *** (0.105)	0.165 (0.102)	0.204 * (0.105)	0.030 (0.113)
HAY	-0.091 (0.099)	-0.297 *** (0.108)	-0.271 *** (0.092)	-0.212 * (0.116)
VEGETABLE	0.391 *** (0.103)	0.416 *** (0.106)	0.288 *** (0.111)	0.261 ** (0.118)
PASTURE	0.099 (0.097)	0.132 (0.112)	0.016 (0.104)	0.058 (0.119)
FOREST	0.204 ** (0.094)	0.127 (0.101)	0.309 *** (0.098)	-0.008 (0.123)
MEDIUM	0.165 ** (0.083)	0.099 (0.086)	0.173 * (0.09)	0.200 ** (0.095)
LARGE	0.281 *** (0.088)	0.214 ** (0.088)	0.471 *** (0.078)	0.294 *** (0.105)
EXLARGE	0.240 *** (0.09)	0.289 *** (0.091)	0.465 *** (0.092)	0.630 *** (0.108)
COST	-0.009 *** (0.002)	-0.012 *** (0.002)	-0.012 *** (0.002)	-0.010 *** (0.002)
CONSTANT	-0.491 *** (0.07)	-0.447 *** (0.081)	-0.562 *** (0.072)	-0.645 *** (0.085)



Table 4.3.2 Summary Statistics for Probit Estimation for Geographic Areas

Number of obs.	4236	3727	4144	3109
Clusters	225	200	226	163
Wald chi <sup>2</sup> (15)	1050.45	703.5	666.17	433.87
p-value	0.0000	0.0000	0.0000	0.0000
Pseudo R <sup>2</sup>	0.0345	0.0515	0.0633	0.0799
Log pseudolikelihood	-2748.58	-2376.52	-2608.71	-1923.96
Notes:				
Significant at the * = 10 percent, ** = 5 percent, *** = 1 percent.				
Standard errors in parentheses				

The location variable in the model is URBAN. Among the four geographic areas, URBAN is significant and positive in the three states but not nationally. This suggests that among the three states sampled, conserving land near urban areas is more important than nationally, and specific consideration within those states should be taken when developing a state level effort for land preservation.

The quality variable in the model is PRIME. All four geographic areas consider PRIME farmland a highly significant and positive attribute that conservation easement programs should put great value into when determining farmland to conserve. Therefore, the states should follow the national programs lead when considering farmland for their programs.

The use variables in the model are GRAIN, HAY, VEGETABLE, PASTURE, and FOREST. Throughout the different geographic areas, only two of the potential uses are consistently viewed. VEGETABLE is considered highly significant and positive, while PASTURE is not significant at all. This suggests that VEGETABLE should be a national priority, while PASTURE should actually not be considered in any program.

The size variables in the model are STATUSQUO, MEDIUM, LARGE, and EXLARGE. SMALL is the reference level, as both SMALL and STATUSQUO could not be included in the model in order to avoid perfect multi-collinearity. The negative coefficient for STATUSQUO cannot directly be interpreted in terms of marginal price of SMALL as it acts as a catch all in some sense. What can be interpreted is that STATUSQUO has a negative marginal price so the general public would prefer a SMALL program to no program at all. Other than MEDIUM in Georgia, all of the size parameter estimates are positive. It is interesting to note that in the US and OH, that size is not a monotonically increasing estimate. EXLARGE actually has a smaller parameter than LARGE. This suggests that while more land preserved is better for the most part, a program with an EXLARGE size is beyond the threshold of optimal size.

The COST variable is significant and negative as expected.

#### **4.4 Optimum Scale Parameter and Likelihood Ratio Test Results**

Chapter Three outlined the methodology used to estimate the optimum scale parameter ratio between any two geographic areas. Table 4.4.1 outlines the results of the hypotheses test.

Table 4.4.1 Geographic area Pair-wise Comparison Using Scale Parameter Ratios

Optimum Scale Parameter Ratio			
	United States	Georgia	Ohio
United States	—————	—————	—————
Georgia	1.121	—————	—————
Ohio	1.162	1.049	—————
Maine	1.237	1.126	1.066
H <sub>A</sub> p-value			
	United States	Georgia	Ohio
United States	—————	—————	—————
Georgia	0.1979	—————	—————
Ohio	0.0503	0.1276	—————
Maine	0.0000	0.0079	0.0020
H <sub>B</sub> p-value			
	United States	Georgia	Ohio
United States	—————	—————	—————
Georgia	0.1600	—————	—————
Ohio	0.0407	0.4799	—————
Maine	0.0039	0.0937	0.3094

The optimum scale parameter ratios for each pair-wise combination of geographic areas are listed first. The larger the scale parameter the lower the variance, as they are inversely related. The first hypothesis test is whether or not

the parameter estimates between the two geographic areas are statistically similar. If a 10% significance level is used as the cut-off, then the US-OH, US-ME, GA-ME, and OH-ME combinations show that  $H_A$  is rejected, and that the parameter estimates are heterogeneous.

The second hypothesis test is whether or not the scale parameter between the geographic areas is statistically similar. Again, if a 10% significance level is used as the cut-off, then the US-OH, US-ME, and GA-ME combinations show that  $H_B$  is rejected, and that the variances or noise associated with the two geographic areas are heterogeneous. This suggests that the geographic areas with more noise are less likely to truly exhibit a homogeneous WTP as is assumed when aggregating.

#### **4.5 WTP Predictions**

Table 4.5.1 shows the implicit prices that each attribute has per household. Table 4.5.2 shows the lower and upper geographic area wide WTP estimates by summing the attribute from each component. The lower limit aggregated the WTP by multiplying the household WTP by the total number of households in the respective geographic area, and then multiplying by the response rate to the survey for each geographic area. The lower limit therefore assumes that all non-respondents have a WTP that is less than or equal to zero. The upper limit was calculated the same way as the lower limit, but assumes that the respondents are an accurate representation of the entire population of each geographic area, and therefore have the same WTP as each household. So the multiplication by the response rate is not included. The total number of households is only available for the year 2000, so the estimates may be biased lower than actuality because of population growth. The total number of households in the US (105,480,101), GA (3,000,369), OH (4,445,773), and ME (518,200), in 2000 was used for

aggregation. The response rates of 24.4%, 21.3%, 24.8%, and 34.6% were used to calculate the lower limits.

To determine the budget that a conservation easement program would have in any of the geographic areas, a use, location, quality, and size attribute needs to be chosen that the program is targeting. Because of the assumption of linearity, the sum of each of the WTP estimates would equal the total budget.

Table 4.5.1 Marginal WTP by Attribute per Household

<b>Per Household</b>		United States	Georgia	Ohio	Maine
Location					
urban		\$8	\$16	\$15	\$31
Quality					
prime		\$22	\$23	\$24	\$42
Use					
grain		\$46	\$13	\$18	\$3
hay		-\$10	-\$24	-\$23	-\$21
vegetable		\$44	\$34	\$25	\$26
pasture		\$11	\$11	\$1	\$6
forest		\$23	\$10	\$27	-\$1
Size					
small		\$14	\$10	\$8	\$6
medium		\$19	\$8	\$15	\$20
large		\$32	\$17	\$40	\$29
exlarge		\$27	\$23	\$40	\$62

Table 4.5.2 Program with Highest WTP by Geographic Area Lower Limit and Upper Limit

<b>Highest WTP</b>		United States	Georgia	Ohio	Maine
Location					
urban		\$8	\$16	\$15	\$31
Quality					
prime		\$22	\$23	\$24	\$42
Use					
grain		\$46	\$0	\$0	\$0
hay		\$0	\$0	\$0	\$0
vegetable		\$0	\$34	\$0	\$26
pasture		\$0	\$0	\$0	\$0
forest		\$0	\$0	\$27	\$0
Size					
small		\$0	\$0	\$0	\$0
medium		\$0	\$0	\$0	\$0
large		\$32	\$0	\$40	\$0
exlarge		\$0	\$23	\$40	\$62
Total		\$107	\$96	\$106	\$162
Lower Limit		\$2,765,345,907	\$61,133,937	\$116,897,865	\$28,995,603
Upper Limit		\$11,333,384,863	\$287,013,791	\$471,362,357	\$83,802,320

#### 4.6 Current Program Comparisons

The national ranking criteria are:

1. Percent of prime, unique, and important farmland in the parcel to be protected.
2. Percent of cropland, pastureland, grassland, and rangeland in the parcel to be protected.

3. Ratio of the total acres of land in the parcel to be protected to average farm size in the county according to the most recent USDA Census of Agriculture ([www.agcensus.usda.gov](http://www.agcensus.usda.gov)).
4. Decrease in the percentage of acreage of farm and ranch land in the county in which the parcel is located between the last two USDA Censuses of Agriculture ([www.agcensus.usda.gov](http://www.agcensus.usda.gov)).
5. Percent population growth in the county as documented by the United States Census ([www.census.gov](http://www.census.gov)).
6. Population density (population per square mile) as documented by the most recent United States Census ([www.census.gov](http://www.census.gov)).
7. Proximity of the parcel to other protected land, including military installations.
8. Proximity of the parcel to other agricultural operations and infrastructure.

Consistent with the WTP estimates, prime farmland is a leading attribute considered when deciding whether or not a conservation easement should be purchased to farmland. Based on the results, pasture may be overvalued within the ranking criteria. Size is being considered, as it should be, but only in relative as opposed to absolute terms. The rest of the ranking criteria have to do with county level changes and proximity to other places of interest. There was no GIS data included in the models to affirm or denounce the validity of these criteria.

## **CHAPTER FIVE: Conclusions and Recommendations**

### **5.1 Issues with Procedures**

The limitation that is presented with the lack of data on non-respondents is difficult to deal with. The assumption that non-respondents must be a homogeneous representation of their zip code is unrealistic. Unfortunately, it is the only way to attempt to control for selection/response bias. It is obvious that the demographic characteristics of those who responded were not average. Demographic characteristics are not the only cause for having a WTP for conservation easements, but it is hard to see the disparity and just ignore it.

The assumption that welfare from farmland is homogeneous across an entire population is a difficult assumption to defend. Therefore, the upper limit of the aggregate WTP estimation is unrealistic. Some people may have a negative utility for farmland, while others may have a WTP that is less than the average WTP of the geographic area. These households will be forced to make a one-time payment that is having a decrease in their overall utility. Aggregate WTP is a consumer surplus estimation, but the only realistic way to accurately estimate it would be to have a household by household WTP fill in the blank, where the household gives their own consumer surplus payment. Summing all of the payments would give the actual budget.

### **5.2 Research Extensions**

Based on the national ranking criteria for farmland that is being considered for a conservation easement, it would be interesting to add a spatial element to the variables. The USDA is placing a premium on spatial relationships of farmland. It would be interesting to see if these characteristics are in the consciousness of households, or if they play an out of sight, out of mind kind of role in valuation.



### **5.3 Conclusions**

While with some attributes, there is consistent valuation, among other attributes, different geographic areas have different views. Therefore, there should be a set of national ranking criteria that programs consider as well as a set of state or local ranking criteria that enter into the equation.

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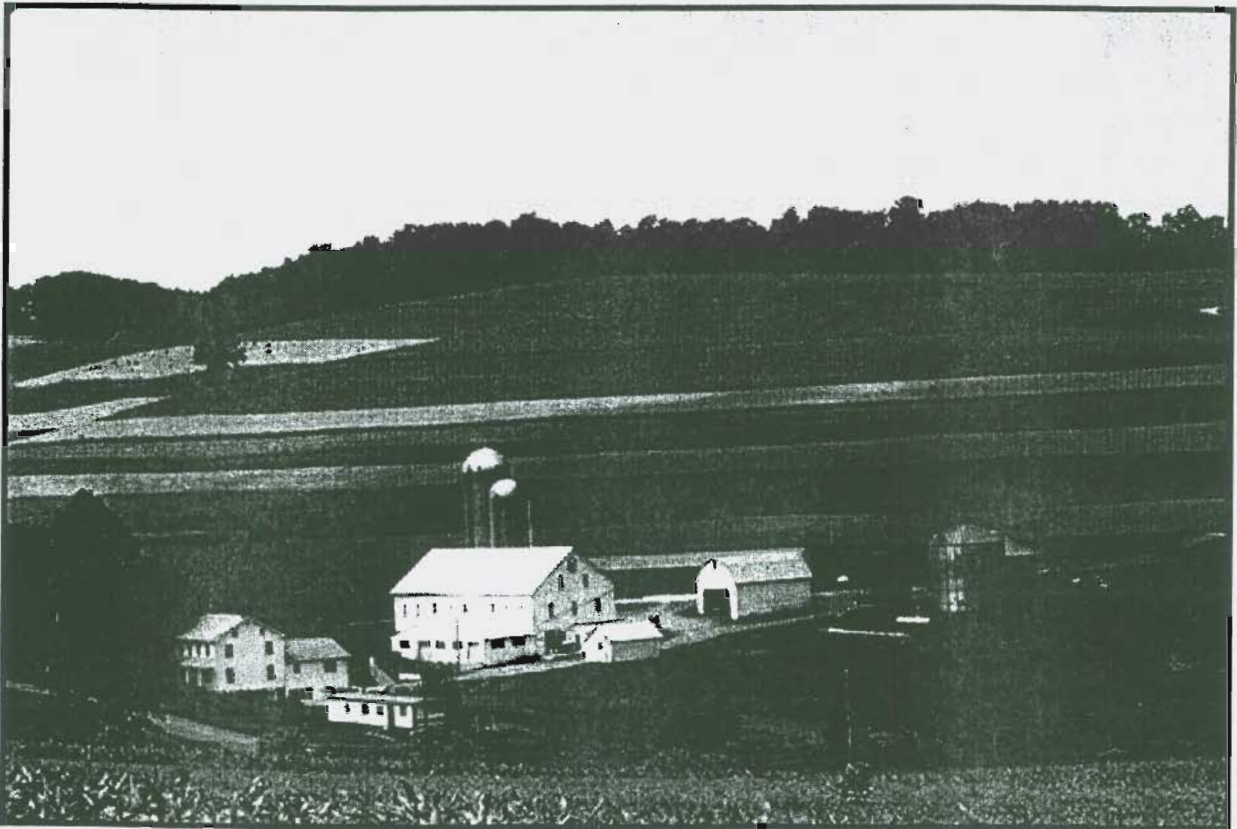
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## **Appendix A: Public Opinion Survey**

# *Public Opinion Survey*

## **Purchasing Conservation Easements to Agricultural Land in the United States**

**WHAT DO YOU THINK?**



132

V1 - IL

V2 - Version 1 - traditional (Georgia, Ohio, Vermont = 1)

2 - Cost 1st

3 - At vs. Status Quo

4 - No Status Quo

Q 9-16

V 29-36



**Section A.** We presented a lot of material in the Information Booklet. In this section, we will ask a few questions to make sure we presented the information clearly. Please **feel free** to refer to the *Background Information Booklet* when answering the questions on this page and other questions in the survey.

1. For each statement below, please circle "T" if you think the statement is true and "F" if you think the statement is false.  
(CIRCLE ONE LETTER FOR EACH STATEMENT)

	True	False	
Half of the land owned by United States farmers is <b>forested</b> .....	T	F	V3
<b>Farmers will be required</b> to sell Conservation Easements to their land.....	T	F	V4
<b>The Conservation Easements will permanently</b> retire the right to develop the land for residential or commercial purposes.....	T	F	V5
Farmers will be <b>paid for giving up rights</b> to sell or use their land for residential subdivisions, commercial developments or other non-farm uses.....	T	F	V6
Farmers who sell Conservation Easements <b>will be able to change</b> the <b>types of livestock</b> they raise <b>or crops</b> they grow.....	T	F	V7
Most of the farms in the United States <b>are owned by families</b> .....	T	F	V8
<b>Uses of farmland in the United States include</b> growing crops (grains, vegetables, berries and fruits), growing hay, as pasture for livestock and as forestland.....	T	F	V9

T = 1

F = 0

Missing = 9

**Section B.** In this section we are interested in learning about your experience with farms.

V10 2. Does your job involve working with farms, farm supplies or farm products?  
(CIRCLE ONE NUMBER)  
code #  
Missing = 9

1	YES
2	NO

V11 3. Have you ever lived on a farm?  
(CIRCLE ONE NUMBER)  
code #  
Missing = 9

1	YES
2	NO

V12A 4. Have any of your relatives or friends ever lived on a farm?  
(CIRCLE ALL NUMBERS THAT APPLY)  
1 - Yes, relatives  
2 - NO

1	YES, relatives
2	YES, friends
3	NO

V12B  
1 - Yes, friends  
2 - NO  
Missing = 95.

Please tell us how frequently you do each of the following activities:  
(CIRCLE ONE NUMBER FOR EACH ITEM)

	Regularly	Sometimes	Rarely	Never
V13 Buy produce and other products directly from farmers	1	2	3	4
V14 Look for local farm products to buy at the grocery store	1	2	3	4
V15 Purchase organic farm products	1	2	3	4
V16 Look for farms to see when you travel	1	2	3	4

code #  
Missing = 9

1  
2



\* histogram

**Section C.** In this section we will ask you to rate how much priority you think should be given to certain farm characteristics when setting priorities for accepting farmers' bids to sell Conservation Easements. Please feel free to use the Information Booklet if you need it.

6. How much priority do you think should be given to purchasing Conservation Easements to farmland where the following types of crops are grown?  
(CIRCLE ONE NUMBER FOR EACH ITEM)



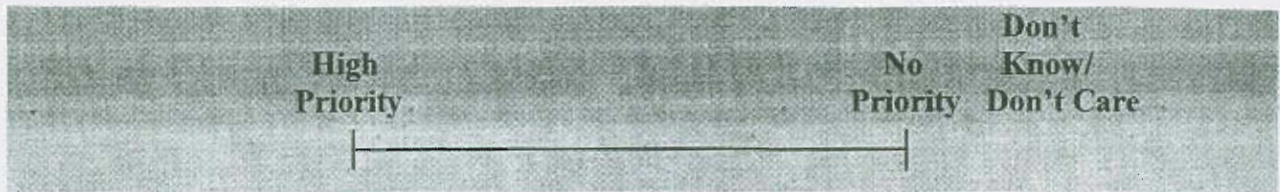
**Farms that raise:**

	6	5	4	3	2	1	0	
Grains								V17
Vegetables								V18
Grass for Pasture								V19
Fruits and Berries								V20
Greenhouse and Nursery Crops								V21
Hay								V22
Trees for Timber								V23

code #  
missing 9



7. Please tell us how much priority you think should be given to purchasing Conservation Easements to: (CIRCLE ONE NUMBER FOR EACH ITEM)



V24

Farmland near urban areas

6 5 4 3 2 1 0

V25

Prime farmland with high quality soils

6 5 4 3 2 1 0

V26

A large amount of Farmland

6 5 4 3 2 1 0

V27

Land that will continue to be farmed after the easement is purchased

6 5 4 3 2 1 0

code #  
missing: 9

8. How much priority do you think should be given making sure the cost of purchasing Conservation Easements is inexpensive to taxpayers? (CIRCLE ONE NUMBER)



V28

6 5 4 3 2 1 0

code #  
missing: 9

---

**Section D.** In this section we ask what you think about a number of programs to purchase Conservation Easements to farmland.

---

- The Conservation Easement Programs we wish you to consider will be the same as described in the Information Booklet.
- Please feel free to refer back to the Information Booklet.
- Only family-owned farmland will be eligible for the program.
- In this section we will ask you to choose between two Conservation Easement programs that give priority to purchasing conservation easements to different types of farmland.
- The programs differ in terms of the characteristics of farms that will be given priority when accepting farmers' bids to sell Conservation Easements.
- The Conservation Easement programs also differ in terms of the total acreage in the nation to be purchased and the cost to your household.
- After you tell us which of the two programs you prefer, we will ask you if you would vote to have one of these programs or to have no Conservation Easement program at all.
- There are four sets of these questions.

Suppose you had to vote between two conservation easement programs, Program A and Program B. These programs differ in terms of the attributes of the farms that would receive priority in the bidding process, the number of acres in the program and the cost to you. Please tell us which of the two programs you would support if you had to choose between Program A and Program B. You will also be able to tell us if you would vote for one of these programs or to do nothing.

	Conservation Easement Program A	Conservation Easement Program B
Farmland use priority	Pasture For Livestock	Growing Hay
Farmland location priority	Near Urban Areas	Near Urban Areas
Land quality priority	Prime Farmland	No Priority
Total acres of easements purchased in United States	9,000,000	45,000,000
One-time cost to your household in 2002	\$3	\$3

132

- V29  
code #  
missing: 4  
(ME version 3=8)
9. Which program do you prefer?  
(PLEASE CIRCLE ONE NUMBER)
- 1 Program A
  - 2 Program B

- V30  
code #  
missing: 9  
(ME version 4=8)
10. Now, suppose you could vote between Program A, Program B and doing nothing. How would you vote? (CIRCLE ONE NUMBER)
- 1 I would vote for Program A
  - 2 I would vote for Program B
  - 3 I would not vote for either program

Suppose you had to vote between two conservation easement programs, Program A and Program B. These programs differ in terms of the attributes of the farms that would receive priority in the bidding process, the number of acres in the program and the cost to you. Please tell us which of the two programs you would support if you had to choose between Program A and Program B. You will also be able to tell us if you would vote for one of these programs or to do nothing.

	Conservation Easement Program A	Conservation Easement Program B
Farmland use priority	Growing Grain Crops	Growing Vegetables, Berries, Fruit And Nut Crops
Farmland location priority	Near Urban Areas	No Priority
Land quality priority	Prime Farmland	Prime Farmland
Total acres of easements purchased in United States	9,000,000	90,000,000
One-time cost to your household in 2002	\$25	\$10

11. Which program do you prefer?  
(PLEASE CIRCLE ONE NUMBER)

- 1 Program A
- 2 Program B

√31  
code #  
missing: 9  
(ME version 3 = 8)

12. Now, suppose you could vote between Program A, Program B and doing nothing.  
How would you vote? (CIRCLE ONE NUMBER)

- 1 I would vote for Program A
- 2 I would vote for Program B
- 3 I would not vote for either program

√32  
code #  
missing: 9  
(ME version 4 = 8)



Suppose you had to vote between two conservation easement programs, Program A and Program B. These programs differ in terms of the attributes of the farms that would receive priority in the bidding process, the number of acres in the program and the cost to you. Please tell us which of the two programs you would support if you had to choose between Program A and Program B. You will also be able to tell us if you would vote for one of these programs or to do nothing.

	Conservation Easement Program A	Conservation Easement Program B
Farmland use priority	Growing Grain Crops	Forested Land
Farmland location priority	No Priority	No Priority
Land quality priority	Prime Farmland	No Priority
Total acres of easements purchased in United States	45,000,000	45,000,000
One-time cost to your household in 2002	\$50	\$7

- V33  
code #  
missing: 9  
(ME version 3 = 8)
13. Which program do you prefer?  
(PLEASE CIRCLE ONE NUMBER)
- 1 Program A  
2 Program B

- V34  
code #  
missing: 9  
(ME version 4 = 8)
14. Now, suppose you could vote between Program A, Program B and doing nothing.  
How would you vote? (CIRCLE ONE NUMBER)
- 1 I would vote for Program A  
2 I would vote for Program B  
3 I would not vote for either program



Suppose you had to vote between two conservation easement programs, Program A and Program B. These programs differ in terms of the attributes of the farms that would receive priority in the bidding process, the number of acres in the program and the cost to you. Please tell us which of the two programs you would support if you had to choose between Program A and Program B. You will also be able to tell us if you would vote for one of these programs or to do nothing.

	Conservation Easement Program A	Conservation Easement Program B
Farmland use priority	Pasture For Livestock	Growing Hay
Farmland location priority	Near Urban Areas	No Priority
Land quality priority	No Priority	Prime Farmland
Total acres of easements purchased in United States	180,000,000	90,000,000
One-time cost to your household in 2002	\$5	\$10

15. Which program do you prefer?  
(PLEASE CIRCLE ONE NUMBER)

- 1 Program A
- 2 Program B

V35

code #  
missing 9

(ME version 3 = 8)

16. Now, suppose you could vote between Program A, Program B and doing nothing.  
How would you vote? (CIRCLE ONE NUMBER)

- 1 I would vote for Program A
- 2 I would vote for Program B
- 3 I would not vote for either program

V36

code #  
missing 9

(ME version 4 = 8)

**Section E.** In this section we will ask you a few questions about your opinions on some aspects of farms.

17. If you had to choose between purchasing Conservation Easements to different types of land, how would you rate each of these alternatives?  
 (CIRCLE ONE NUMBER FOR EACH ALTERNATIVE)

								Don't Know/ Don't Care
		6	5	4	3	2	1	0
V37	Farmland	6	5	4	3	2	1	0
V38	Forestland	6	5	4	3	2	1	0
V39	Lake frontage	6	5	4	3	2	1	0
V40	River frontage	6	5	4	3	2	1	0
V41	Ocean frontage	6	5	4	3	2	1	0
V42	Wetlands	6	5	4	3	2	1	0
V43	Prairie	6	5	4	3	2	1	0
V44	Mountains	6	5	4	3	2	1	0
V45	Undeveloped land in cities	6	5	4	3	2	1	0

code #  
 missing: 9

18. Please tell us how strongly you agree or disagree with each of the following statements.  
(CIRCLE ONE NUMBER FOR EACH STATEMENT)

	Strongly Agree	Neither			Strongly Disagree	Don't Know/ Don't Care	
	5	4	3	2	1	0	
Farms help to protect water quality in lakes, rivers and streams.	5	4	3	2	1	0	V46
Farms help to protect the quality of well water people use for drinking.	5	4	3	2	1	0	V47
Pesticides and herbicides used by farmers are major environmental problems.	5	4	3	2	1	0	V48
Disposal of livestock manure is not a major environmental problem.	5	4	3	2	1	0	V49
Soil erosion from farms is a major problem.	5	4	3	2	1	0	V50
Farmland protects rural communities from flooding.	5	4	3	2	1	0	V51
Farms do not contribute to beautiful scenery.	5	4	3	2	1	0	V52
I like to see livestock in fields.	5	4	3	2	1	0	V53
Farms should not raise animals in feedlots and confinement buildings.	5	4	3	2	1	0	V54
Farms provide good wildlife habitat.	5	4	3	2	1	0	V55
Active farms reduce residential and commercial sprawl.	5	4	3	2	1	0	V56
Farms are an important part of rural communities.	5	4	3	2	1	0	V57

code #  
missing: 9



19. Please share your views about farming by indicating your level of agreement with the following statements. (CIRCLE ONE NUMBER FOR EACH STATEMENT)

		Strongly Agree	Neither			Strongly Disagree	Don't Know/Don't Care
		-----					
V58	Most farmers are not wealthy.	5	4	3	2	1	0
V59	The government bails farmers out too much.	5	4	3	2	1	0
V60	Farming is a more satisfying occupation than most others.	5	4	3	2	1	0
V61	The family farm must be preserved.	5	4	3	2	1	0
V62	Corporate farms are more efficient than family farms.	5	4	3	2	1	0
V63	Large farms get too many government benefits.	5	4	3	2	1	0
V64	Small farms are better stewards of the land than larger farms.	5	4	3	2	1	0
V65	Government should treat farms just like other businesses.	5	4	3	2	1	0
V66	Government should not protect farmland for future generations.	5	4	3	2	1	0
V67	Today's food is safer than it ever has been.	5	4	3	2	1	0
V68	Today's food is not as fresh as it has been.	5	4	3	2	1	0
V69	Our country is likely to suffer food shortages in the near future.	5	4	3	2	1	0
V70	Conservation easements help to insure our nation's food supply.	5	4	3	2	1	0

code #  
missing: 9

---

**Section F.** In this last section, we would like to ask you some questions about your background which will help us compare your answers with those of other people. Please be assured that all of your responses are strictly confidential.

---

20. Are you: (CIRCLE ONE NUMBER)

- 1 Male
- 2 Female

✓ 71  
code #  
missing: 9

21. What year were you born? (FILL IN THE BLANK)

19\_\_\_\_

✓ 72  
code # in blank  
missing: 99

22. How many years of schooling have you completed? (CIRCLE ONE NUMBER)

- 1 Eight years or less
- 2 Some high school
- 3 High school graduate
- 4 Some college or technical school
- 5 Technical school graduate
- 6 College graduate
- 7 Post graduate work

✓ 73  
code #  
missing: 9

23. How many people live in your household? (FILL IN ALL BLANKS)

\_\_\_\_\_ People age 18 and older

✓ 74

\_\_\_\_\_ People under the age of 18

✓ 75

\_\_\_\_\_ Total number of people in your household

✓ 76

code #  
missing: 99

24. Which of the following categories comes closest to your 2001 household income?  
(CIRCLE ONE NUMBER)

V 77

code # (1, 2, 3, ...)  
missing: 99

- |   |                      |    |                      |
|---|----------------------|----|----------------------|
| 1 | Less than \$10,000   | 9  | \$45,000 to \$49,999 |
| 2 | \$10,000 to \$14,999 | 10 | \$50,000 to \$59,999 |
| 3 | \$15,000 to \$19,999 | 11 | \$60,000 to \$69,999 |
| 4 | \$20,000 to \$24,999 | 12 | \$70,000 to \$79,999 |
| 5 | \$25,000 to \$29,999 | 13 | \$80,000 to \$89,999 |
| 6 | \$30,000 to \$34,999 | 14 | \$90,000 to \$99,999 |
| 7 | \$35,000 to \$39,999 | 15 | Over \$100,000       |
| 8 | \$40,000 to \$44,999 |    |                      |

**THANK YOU FOR YOUR HELP!**

**Please return this completed survey  
in the enclosed postage-paid envelope.**

Respondent attributes and zip codes are appended at the end of the survey response data. The order they occur is as follows:

- Attributes for Program A to the first conjoint question
- Attributes for Program A to the second conjoint question
- Attributes for Program A to the third conjoint question
- Attributes for Program A to the fourth conjoint question
  
- Attributes for Program B to the first conjoint question
- Attributes for Program B to the second conjoint question
- Attributes for Program B to the third conjoint question
- Attributes for Program B to the fourth conjoint question
  
- Zip code variable follows immediately after attribute variables.

Names of conjoint attribute level variables are followed by numbers (1, 2, 3 or 4 to designate conjoint questions) and letters (A or B to designate alternatives). The order of the conjoint attribute variables and their coding is as follows:

Farmland Use Priority: GRAIN: 1 if growing grain crops  
0 otherwise

HAY: 1 if growing hay  
0 otherwise

VEGET: 1 if growing vegetables, berries, fruit and nut crops  
0 otherwise

PASTURE: 1 if pasture for livestock  
0 otherwise

FOREST: 1 if forested Land  
0 otherwise

(if no priority then all farmland use variables equal to 0)

Farmland Location Priority: LOC: 1 if near urban areas  
0 if no priority

Land Quality Priority: QUAL: 1 if prime farmland  
0 if no priority

Surv = id  
q, i = don't need  
choice = attribute conjoint ques  
V2 var on is regular<sup>79</sup> until 77



Program Size: SMALL: 1 if small  
0 otherwise

MEDIUM: 1 if medium  
0 otherwise

LARGE: 1 if large  
0 otherwise

EXLARGE: 1 if exlarge  
0 otherwise

	<b>US</b>	<b>GEORGIA</b>	<b>OHIO</b>	<b>MAINE</b>
<b>SMALL</b>	9,000,000	100,000	140,000	12,000
<b>MEDIUM</b>	45,000,000	500,000	700,000	60,000
<b>LARGE</b>	90,000,000	1,000,000	1,400,000	120,000
<b>EXLARGE</b>	180,000,000	2,000,000	2,800,000	240,000

COST: \$3, \$5, \$7, \$10, \$25, \$50



## **Appendix B: Background Information Booklet**



# ***Background Information Booklet***

**A Program to Purchase Conservation  
Easements to Farmland in Maine**

***Please Read Before You Begin the Survey***



## LOSS OF FARMLAND IN THE UNITED STATES

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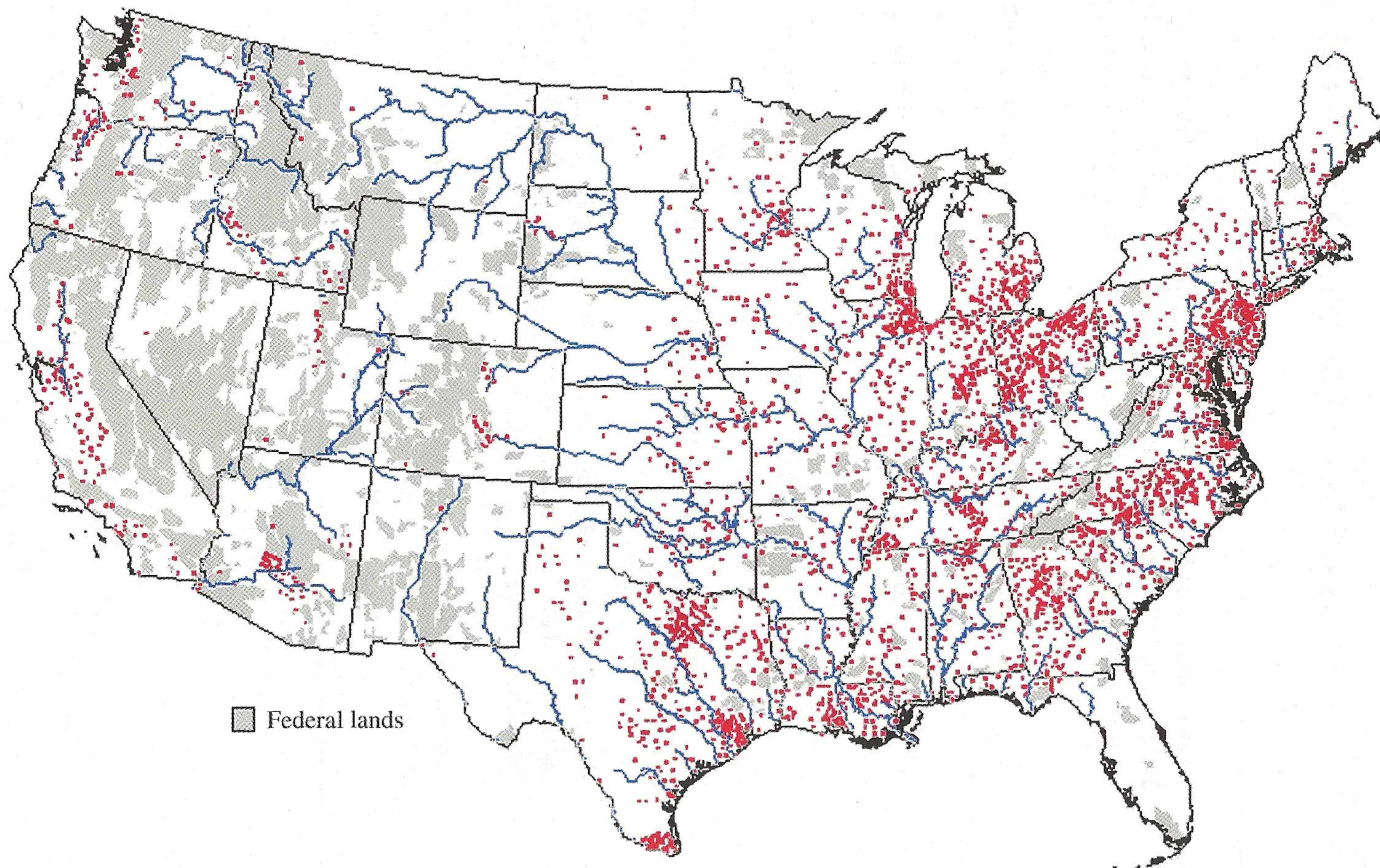
- **Many communities and individuals across the nation are concerned about farmland being converted to residential, commercial and other non-farm uses.** (For more information you can look at the following site on the internet: <http://www.farmland.org>)
    - ▶ Some people are concerned about the amount of farmland being converted.
    - ▶ Others are concerned about the loss of large, open fields.
    - ▶ Others worry that the rural scenery will be diminished.
    - ▶ Others worry about the sprawl of residential construction into rural areas.
  - **The map on the next page shows where prime farmland was converted to nonagricultural uses in Maine and other states between 1982 and 1997.** Prime farmland is land that scientists have determined is the best for growing agricultural crops.
  - The purpose of this survey is to learn about **your own** opinions on farmland conversion in Maine.
-



# Acres of Prime Farmland Converted to Developed Land, 1982-1997

\*Each red dot represents 2,000 acres of newly developed land\*  
\*7,347,000 total acres developed\*

2





## **FACTS ABOUT FARMLAND IN MAINE**

(Source: U.S. Department of Agriculture's Census of Maine Farmers)

---

- **Farmers own a small share of the land in Maine.** Farmers own about 1,212,000 acres and this represents about 6% of the land area in Maine.
  - **Farmers own cropland, pastures and woodlands.**
  - **About 47% percent of the land owned by farmers in Maine is forested.**
  - **The amount of farmland in Maine has decreased by about 8% over the last 10 years.**
  - **Over the same 10 year period, about 40,000 acres of prime farmland has been converted to other uses in Maine.**
  - **Pressure for new development is concentrated in a few areas.** Farmland is being converted to other uses in Cumberland County three times as fast as it is being converted in Aroostook County.
-



## A PROGRAM TO REDUCE THE CONVERSION OF FARMLAND

---

Suppose a Conservation Easement program was proposed where people who own family farms could voluntarily sell Conservation Easements to their farmland. A family farm is any farm that is owned by a family and is not owned by stockholders who are not related by family or marriage.

- Farmers could submit bids to sell Conservation Easements to all of their land or to just a portion of their land.
  - The Conservation Easements would retire the rights to convert farmland to residential subdivisions, commercial developments, or other non-farm uses by placing permanent restrictions on the legal deeds to the properties.
  - A Conservation Easement does not make a farmer's land public property like a state park. The land is still owned by the farmer.
  - Money to purchase Conservation Easements would come from a one-time payment that everyone in the state would pay through an increase in their 2002 state income taxes.
  - The State Legislature would appoint a Citizens Board to administer the program.
  - The Citizens Board would have members from different regions of the state.
  - Funding for the program would allow for the Citizens Board to hire a staff person to review farmers' proposals, purchase easements, and to monitor compliance on lands where Conservation Easements have been purchased.
  - The Conservation Easement Program would only be established if it was approved by a majority of Maine voters in a referendum vote.
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## **OTHER STATES HAVE RECENTLY IMPLEMENTED PROGRAMS TO PURCHASE CONSERVATION EASEMENTS TO FARMLAND**

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- At least nineteen states have programs to purchase Conservation Easements to farmland.
  - In these other states, Conservation Easements have currently been purchased to over 500,000 acres of farmland.
  - The prices paid to farmers for Conservation Easements reflect the difference between the higher value they would receive if they sold the land for residential, commercial, or other non-farm uses, and the lower value if they sold to another farmer.
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## **WHAT THE PURCHASES OF CONSERVATION EASEMENTS TO FARMLAND MEAN TO THE CITIZENS OF MAINE**

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- The land could never be converted to a residential subdivision, commercial development or other non-farm uses.
  - The program would help to maintain farmland for farming and large areas of undeveloped farmland.
  - Farmland provides important habitat for wildlife that is not provided by other types of land ownership and uses in the state.
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## WHAT THE SALE OF CONSERVATION EASEMENTS MEAN TO FARMERS

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- Farmers will decide if it is in their best interests to offer to sell a Conservation Easement to their land.
  - The purchase of a Conservation Easement does not mean that the Citizens Board owns the land; Conservation Easements permanently retire **only** the right to develop the land.
  - Farmers who voluntarily sell a Conservation Easement to their land still own their land.
  - Farmers can use the money from the sales of Conservation Easements for operating capital for their farms, income or other uses they choose.
  - Farmers can continue all of their agricultural activities.
  - Farmers who sell Conservation Easements to their land can change crops grown or livestock raised in response to market prices, or choose not to farm.
  - Farmers can still build new buildings on the land for their agricultural operations and housing for family members who stay on the farm.
  - Farmers can pass their farms on to their children.
  - Farmers can sell their land.
  - However, the Conservation Easements apply to all future owners.
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## **WHAT TYPES OF FARMLAND SHOULD THE CITIZENS BOARD CHOOSE FOR THE PURCHASES OF CONSERVATION EASEMENTS?**

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- The program will only be available to family-owned farms.
  - While the bids submitted by farmers will be an important factor, the Citizens Board will also consider factors such as the crops grown and location of the farm in making their decisions to purchase Conservation Easements.
  - Other states have used these types of factors to make decisions regarding the purchases of Conservation Easements.
  - Below is some information about farms in Maine that you might want to consider when answering questions in the survey. (Source: U.S. Department of Agriculture's 1997 Census of Maine Farmers. You can find this information at the following internet site: <http://www.nass.usda.gov/census/> ).
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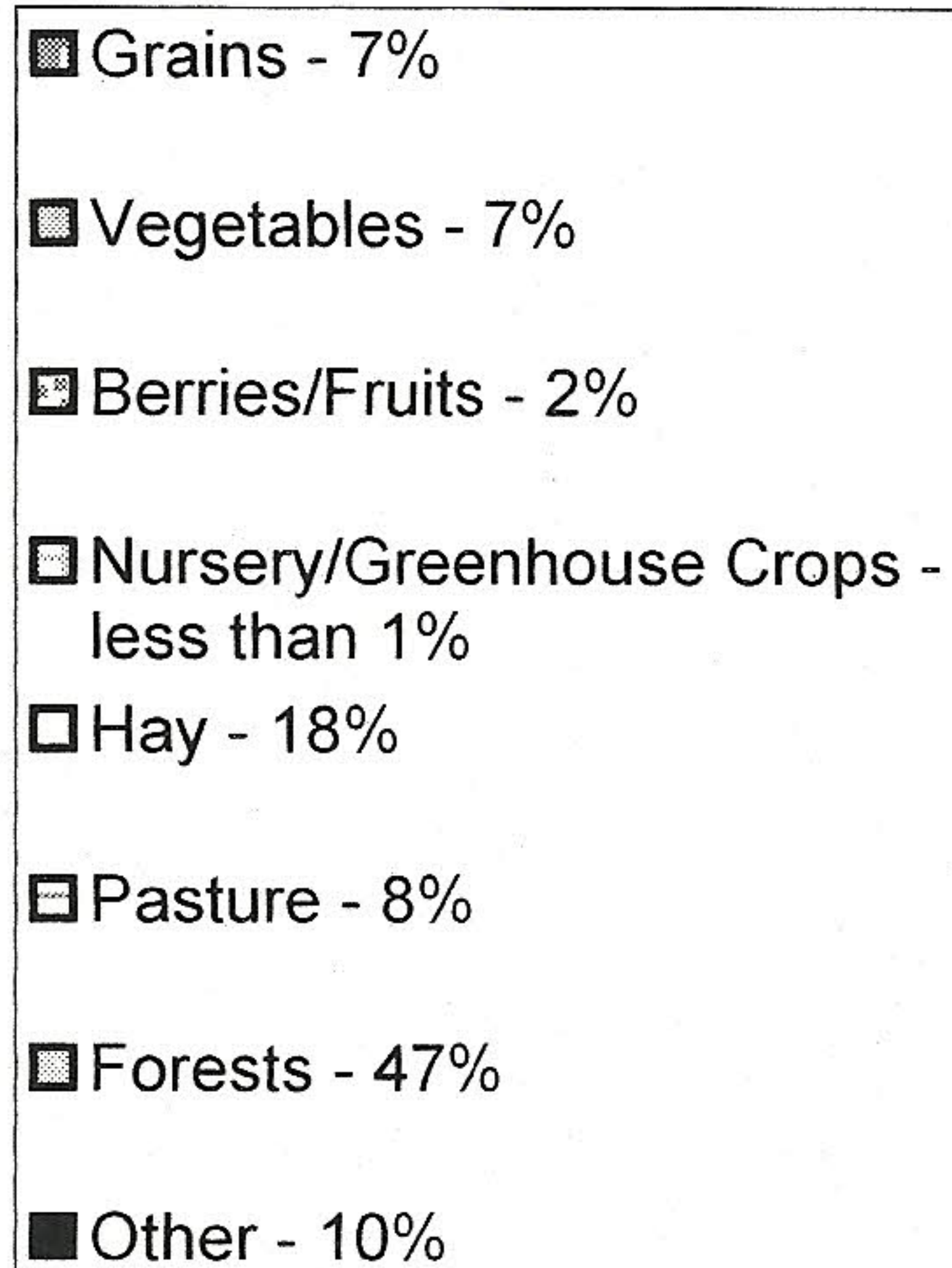
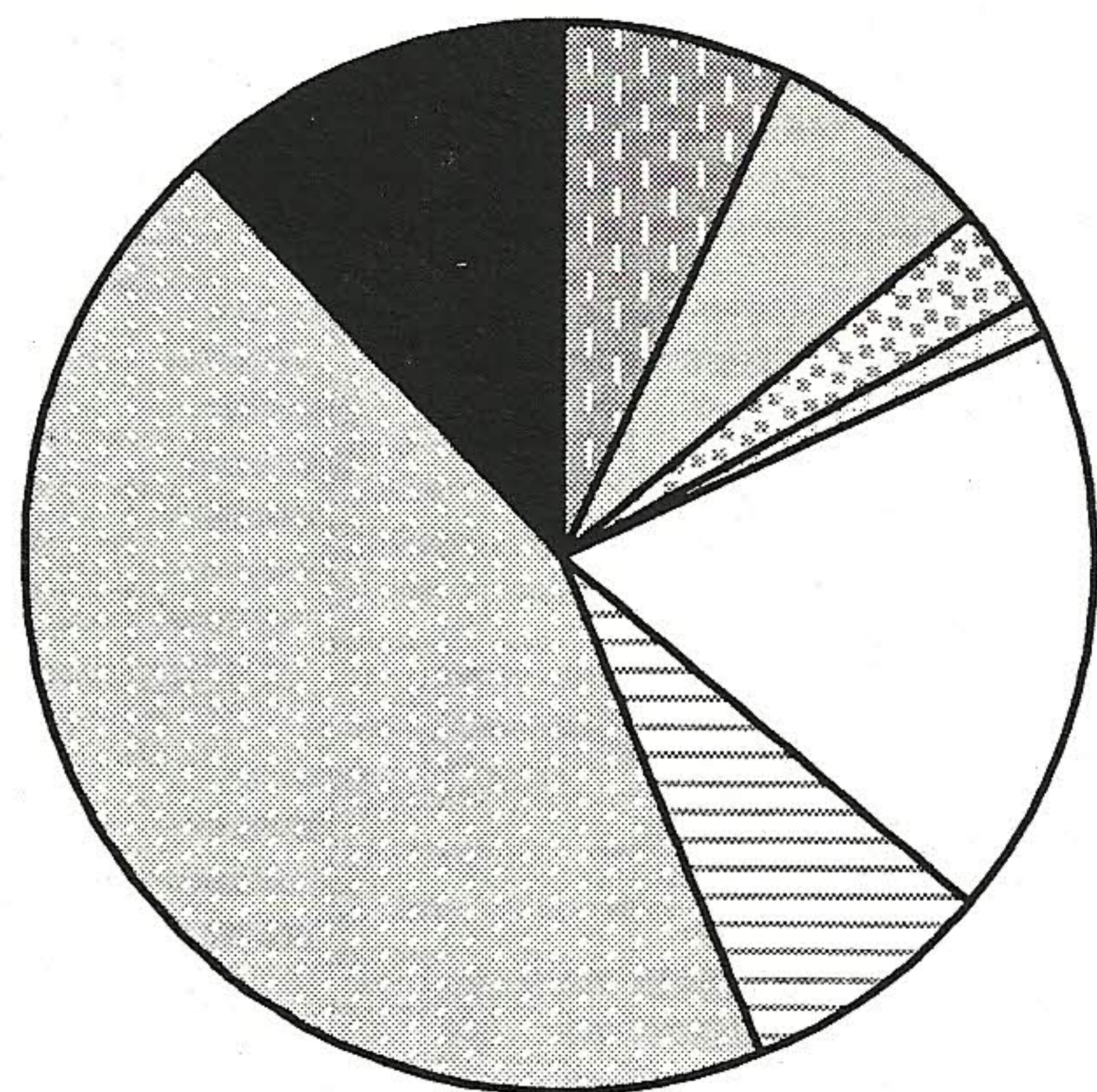


## USES OF FARMLAND IN MAINE

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- Maine farms raise about 83,000 acres of **grains** (primarily barley, corn for silage and oats).
- Maine farms raise about 85,000 acres of **vegetables** (primarily potatoes, sweet corn, peas and broccoli).
- Maine farms raise about 30,000 acres of **berries and fruits** (primarily wild blueberries and apple orchards).
- Maine farms raise about 7,000 acres of **nursery crops and greenhouse crops** (Christmas trees, small trees and shrubs for landscaping, flowers, etc.).
- Maine farms raise about 214,000 acres of **hay**.
- Maine farms have about 93,000 acres of **pasture land**.

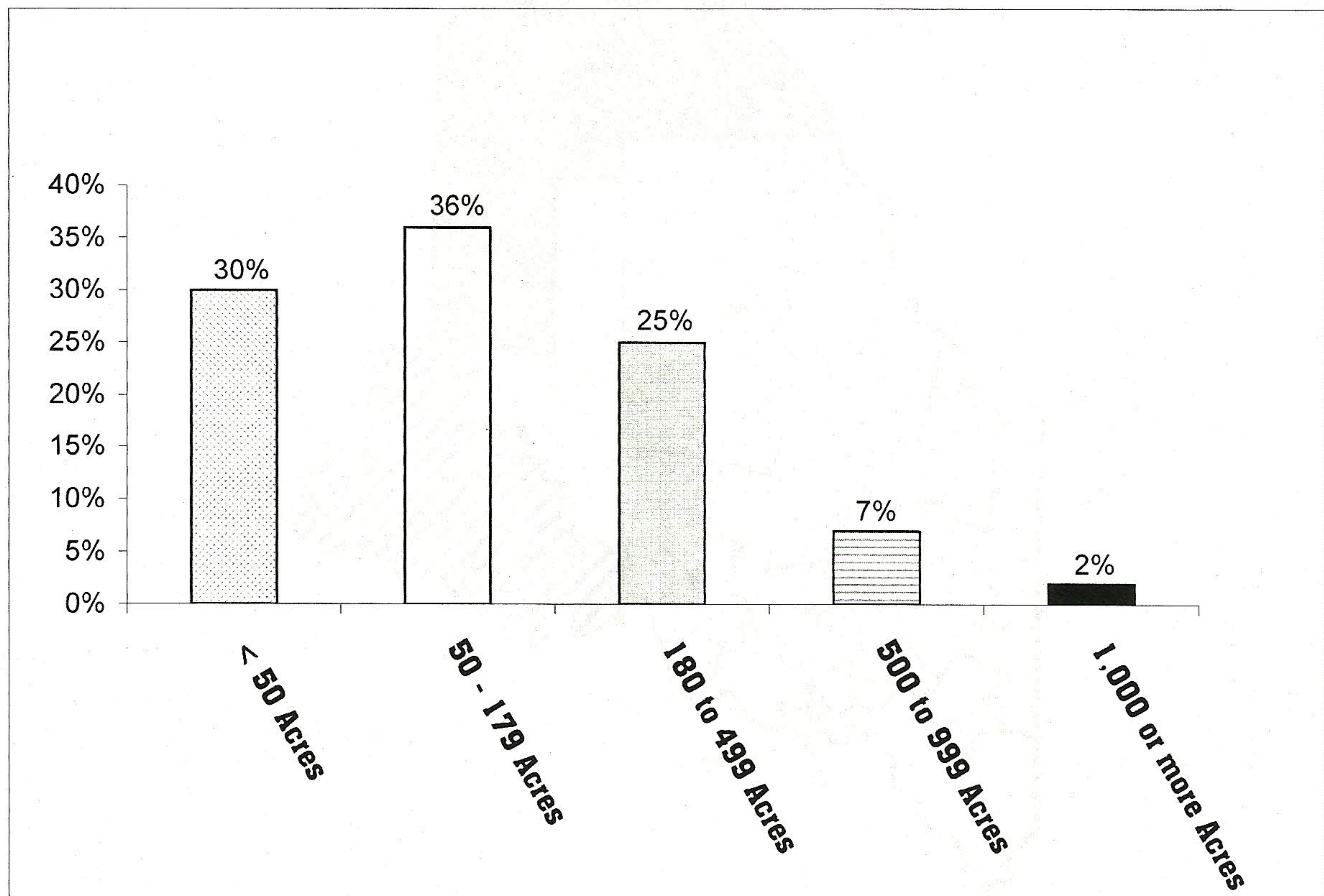
**Farmland Allocation  
to Selected Uses  
in Maine**





## SIZES OF MAINE FARMS

- 30% of Maine farms own fewer than 50 acres
- 36% of Maine farms own between 50 and 179 acres
- 25% of Maine farms own between 180 and 499 acres
- 7% of Maine farms own between 500 and 999 acres
- 2% of Maine farms own 1,000 acres or more

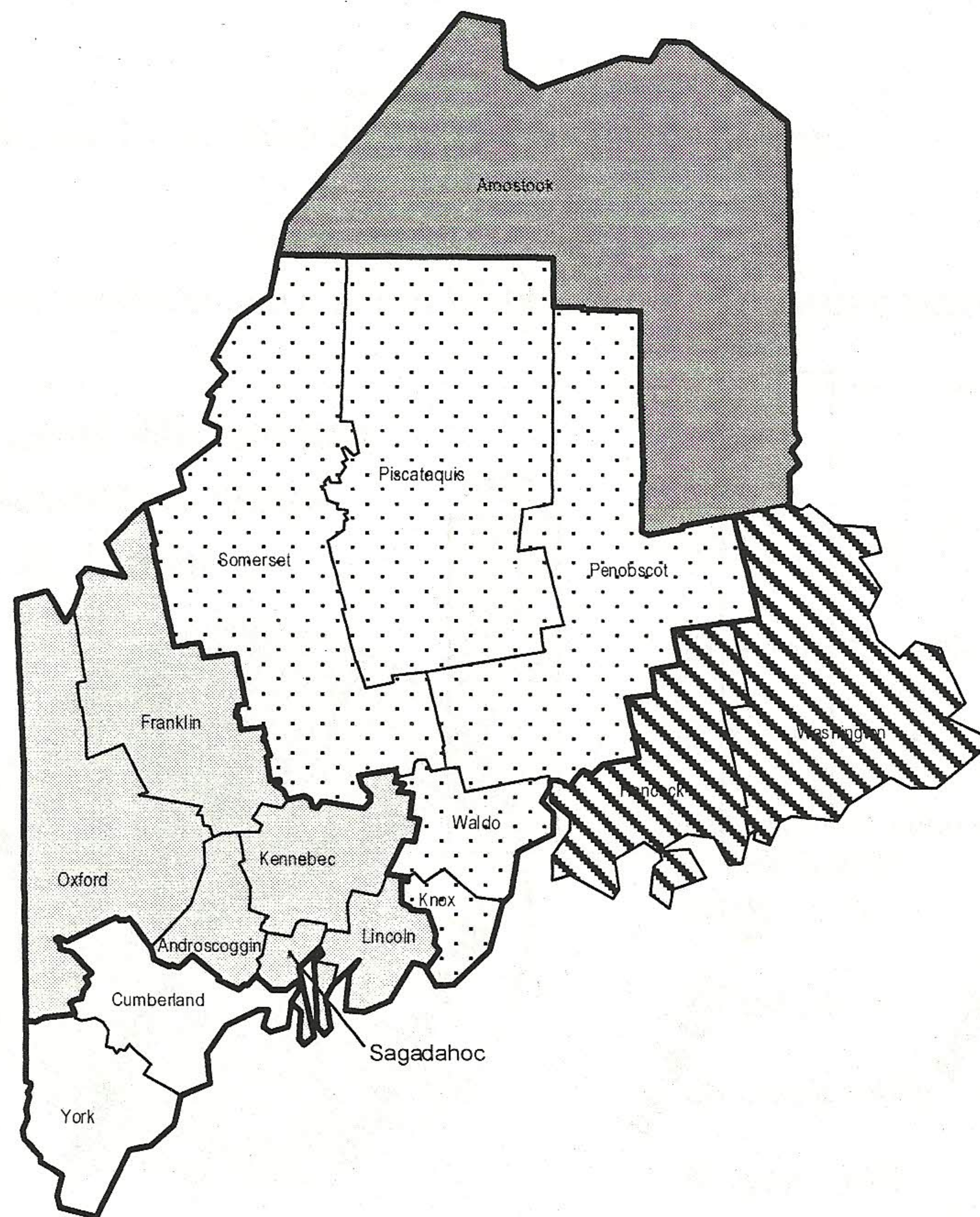




## LOCATION OF MAINE FARMS

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- 15% percent of the farms are located in Aroostook County in **northern** Maine and mostly grow potatoes
- 12% percent of the farms are located in Hancock and Washington Counties in **eastern** Maine and mostly grow blueberries
- 35% percent of the farms are located in Kennebec, Knox, Penobscot, Piscataquis, Somerset and Waldo Counties in **central** Maine and are mostly dairy farms
- 16% percent of the farms are located in Cumberland and York Counties in **southern** Maine and are involved in a variety of types of agriculture
- 22% percent of farms are located in other counties





## FARM OWNERSHIP IN MAINE

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- 81% of farmers live on the farm
  - 49% of farmers say farming is their principal occupation
  - 87% of farms are owned by an individual or family
  - 7% of farms are owned by corporations (farms owned by stockholders who are not related)
- 

## SOIL QUALITY

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- Prime farmland with high quality soil for farming is very limited in Maine.
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**Please complete the survey now**

**Feel free to refer back to this information booklet  
when answering the survey questions**



# Appendix C: Graphs of Optimum Scale Parameter Ratios and Log-likelihood Values for Pair-wise Geographic Area Comparisons

