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Conservation Professional Attitudes about Cost Effectiveness of the Land Preservation: A Case Study in Maryland

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Abstract

A consensus exists amongst academics that cost-effective land preservation should involve benefits and costs. In reality, the vast majority of conservation programs are not cost-effective, i.e. lower conservation benefits are achieved for the limited funding. Little research has been conducted about the attitudes of conservation professionals about the importance of being cost-effective and little is known about how conservation professionals believe that they can become more cost-effective. This study reports on a survey conducted with conservation professionals associated with the State of Maryland's agricultural protection program, a leading program in the United States. Results suggest that while conservation professionals are generally in favor cost-effective conservation, it is not a top goal for them. Processes such as transparency and fairness are rated more important. This research shows how the willingness of administrators to adopt mathematical programming techniques is significantly influenced by knowledge of optimization technique, administrative requirements, cost concerns, percentage of agricultural land previously preserved in the county, how rural the county is, and lack of incentive for administrators to adopt cost-effectiveness techniques. This finding is important to understand the lack of adoption of cost-effective techniques. Results also suggest that adoption may be enhanced with the availability of software and training.

Keywords: Land conservation, Survey, Conservation professionals, Optimization, Attitudes**,** Willingness to adopt

1. Introduction

Agricultural land preservation involved involves responsible management of public funds to acquire the greatest benefits given the limited amount of money available to conservation programs. For agricultural preservation programs to deliver the greatest 'bang for the buck', it is critical to establish a robust decision support framework that can be used to reliably and consistently evaluate and select potential preservation opportunities. Integrating economic costs into conservation planning is a key to ensuring better conservation outcomes (Naidoo et al., 2006). When trying to select the most cost-effective mix of conservation projects, it is important to determine overall quality based on benefit *and* costs rather than with an analysis strictly of either benefits *or* costs (Babcock et al., 1997; Hughey et al., 2003; Perhans et al., 2008).

Studies have shown that using optimization in conservation programs can yield significantly more acreage with higher overall conservation benefits (e.g. Messer, 2006; Duke et al., 3013). Unfortunately, cost-effective conservation is rarely implemented. Instead, most conservation programs use a rank-based model, called benefit-targeting (BT), selecting projects with the highest benefit scores with little consideration of the project's cost. In situations where numerous high quality projects go unfunded due to budget constraints, BT ensures only that the available resources are spent on the highest ranked projects; however, the model frequently misses opportunities to spend the money in a cost-effective way by funding lower-cost, high-benefit alternatives that would extend limited financial resources and maximize overall conservation benefits (Allen et al., 2010).

In contrast, an optimization model identifies the set of cost-effective projects that maximize aggregate benefits by using data describing the resource benefits of the potential projects and relative priority weights assigned to each benefit measure, as well as estimated project costs and budget constraints (Kaiser and Messer, 2011). Thus, optimization can help decision makers distinguish between high-cost projects that can rapidly deplete available funds while making relatively small contributions to overall conservation goals and "good value" projects that ensure that conservation benefits are maximized given the available budget (Amundsen et al., 2010). An important difference between BT and optimization is the sequence of the selection process. While BT selects the top parcel with the highest benefits first, followed by the parcel with the second highest benefits and so on, optimization focuses on the total benefits of the pool of potential projects.

In Maryland, a leader in agricultural preservation in the United States[1], the Maryland Agricultural Land Preservation Foundation (MALPF), established guidelines for agricultural preservation and relies on Land Evaluation/Site Assessment (LESA) models to help improve investments in agricultural preservation. Baltimore County had also relied upon a LESA model for evaluating parcels for conservation. In 2006, however, Baltimore County staff introduced optimization in their applicant selection process as a pilot project. For the next three years, Baltimore County staff and advisory board evaluated applications for preservation using optimization. The county evaluated their applications over a series of grant cycles tied to different fund sources for 2007, 2008, and 2009 including both state and county funding rounds.

In 2007, Baltimore County used optimization in two different selection processes: (i) to select projects totaling 809 acres for protection given the $4.8 million of funding by MALPF and (ii) to select projects totaling 882 acres for protection given the $3 million of funding from Baltimore County. If LESA-based BT had been employed, Baltimore County would have only protected 733 acres for the $4.8 million of MALPF funds and 651 acres for the $3 million of funding from Baltimore County. In other words, using optimization in 2007, Baltimore County protected 1,691 acres instead of just 1,384 acres, a 22% increase worth an estimated $1.8 million.

[1] Maryland ranks 3rd in terms of federal funding for easement acquisition and technical assistance for the period 1996-2009 (FIC, 2013).

Given its initial success in preserving substantially more conservation benefits, Baltimore County continued applying optimization to its selection processes in 2008 and 2009. In total over the first three years of use, optimization helped Baltimore County protect an additional 680 acres of high-quality agricultural land at a cost savings of approximately $5.4 million (Kaiser and Messer, 2011). Baltimore County serves as an example that optimization tools, when implemented, can help conservation professionals preserve more land and more conservation benefits at the same level of funding. So, why is BT the tool of choice of conservation professionals in almost all conservation programs? and what may change planner's willingness to apply optimization to their respective programs? In order to understand why conservation professionals have not adopted optimization we set out to understand planners' attitudes towards optimization.

We show that while conservation professionals are generally in favor of being cost-effective, cost-effectiveness is not a top goal for them. Our results suggest that the more administrators know about optimization, the less concern they have for it. Similarly, the results suggest that the higher the administrators' understanding of optimization, the higher their willingness to adopt it. Additionally, the more successful administrators, in terms of previously preserved farmland as a percentage of total farmland available, are more willing to adopt more advanced approaches. Furthermore, metro areas that are experiencing particularly strong development pressures are more willing than non-metro areas to step up their efforts by adopting "sophisticated" but cost-effective preservation techniques.

Our results also suggest that the initial investment in technical resources related to using optimization has prevented program administrators from using optimization. Many administrators report that the current system lacks incentives to adopt optimization. Providing software and training on optimization significantly increases administrators' willingness to adopt this optimization.

2. Literature Review

The loss of farmland and forestland to development as a result of population change increases the importance of cost-effective conservation (Kline, 2006; Lynch, 2008; Fooks and Messer, 2012).

Limited funding typically restricts the effectiveness of conservation programs at providing public benefits. At the same time, this may also render efficiency impossible to achieve as the socially optimal solution may lie outside the bounds of the budget constraint, i.e. it restricts the set of feasible solutions. Hence, in order to ensure responsible use of public money, it is cost-effective conservation that ensures the largest amount of conservation benefits. Great effort has been put into development of theories and techniques to increase the effectiveness of conservation programs. Given the substantial amount of money that is spent on land conservation - the U.S. Farm Bill covering the period 2008-2012 allocated $13 billion to land retirement programs (Duke et al., 2013) and the federal farm and ranch lands protection program reports that approximately $1.2 billion had been spent on agricultural protection by the end of 2012 (see FIC, 2013) - many studies within the economic literature have identified and measured the benefits of farmland preservation (Gardner, 1977; Kline and Wichelns, 1996; Rosenberger, 1998; Duke and Hyde, 2002; Johnston and Duke, 2007; Johnston and Duke, 2009).

In particular, Duke and Hyde, 2002 suggested that providing locally grown food, keeping farming as a way of life, and protecting water quality were the top three attributes sought by the public from preserved land, while protecting agriculture as an important industry, preserving natural places, and providing breaks in the built environment received the least support. Although there may exist public support in favor of agricultural preservation and clearly identified benefits from conservation, studies have largely neglected to consider the needs and attitudes of conservation professionals who make conservation decisions on the public's behalf.

Duke and Lynch, 2007 report that, although, there are many studies that focus on the general public's preferences of preserving farmland, only a few studies focus on what type of techniques may be considered acceptable and effective to policy makers, administrators, and landowners. The authors found that "rights of first refusal" (ROFR) as described in Malcolm et al., 2005, which gives conservation programs the option to match offers landowner receive from developers, was ranked as the most preferred amongst all three groups. Thus, before landowners can sell parcels to developers, conservation programs must be given the opportunity match the offer ensuring that no funds are spent on parcels that may not be developed to begin with. According to Duke and Lynch, ROFR should be cost-effective as it only targets land actually threatened by development.

Others have developed methods that help conservation professionals in their decision-making process. Messer, 2006 showed that cost-effective conservation (CEC) instead of the commonly used approach of benefit-targeting yields substantially higher social benefits. In Messer and Allen, 2010, CEC, using binary linear programming, preserves more parcels of land at higher social net benefits than either sealed-bid-offer auction or benefit-targeting given the same budget (see also Babcock et al., 1997; Polasky et al., 2001).

In reality, however, the lessons suggested in the economic literature are rarely implemented (Duke et al. 2013, Predergast et al., 1999; Lynch, 2008). Given the advantages that CEC offers, what are the reasons that optimization is rarely implemented by planners? Prendergast et al. (1999) argued that the main reason for the low level of adoption of these sophisticated tools is a lack of awareness of their existence. Additionally, insufficient funding, lack of understanding, and antipathy towards "prescriptive" decision tools exist. Closing the gap between researchers and practitioners by facilitating communication and making, often times, costly and scattered literature (Finch and Patton-Mallory, 1992) available may be crucial to overcome these issues. Additionally, workshops and training may also help resolve antipathy and relax preconceived fears of theoretical models and stimulate learning between researchers and practitioners (Ferraro and Pattanayak, 2006; Salafsky et al. 2002).

Moreover, conservation professionals face numerous political and strategic difficulties (Fooks and Messer, 2012) as they receive funding from a multitude of sources, some private, others public, expecting their interest in land preservation presented accordingly. This may mean that conservation professionals need not only consider total benefits preserved, but also whether each group's funding achieved a fair share in the overall benefits. This confronts the optimization model with considerable challenges. Fooks and Messer (2012) note that these may be thought of as secondary objectives. Nonetheless, they do impact conservation professionals in their decision-making process.

Perhaps the first comprehensive synthesis paper of a broad methodological review for conservation professionals seeking to adopt CEC was provided by Duke et al. 2013. In particular, they suggest 15 practical lessons, drawn from theory and applied conservation in the U.S., meant to guide conservation professionals in an attempt to close the gap between theorists and administrators. The authors identify 5 groups into which the 15 practical lessons can be grouped: Optimal selection, benefits, costs, budgets, and incentive problems. While Duke et al., 2013 lay out a well-structured and comprehensive manuscript outlining the issues related to adopting CEC, our experimental survey approach reports on the attitudes collected from conservation professionals in Maryland, identifying specific factors that impact their willingness to adopt optimization as their primary selection process and what can be done to increase adoption of optimization. This may be a natural extension to the target areas summarized by Duke et al., 2013 and help further close the gap between researchers and practitioners.

3. Research Methods

The research approach includes the survey design, the pre-test of the survey, the revision process, the administration of the survey, and the follow-up procedure. A critical series of questions in the survey were related to the concept of optimization of the project selection process. The survey then asks for opinions about two different optimization approaches. One approach is called "Binary Linear Programming," which is the assured optimal algorithm common in the operations research literature (see Kaiser and Messer, 2011). The other approach called "Cost Effectiveness Analysis," which is commonly used in the medical field to determine the treatments that yield the highest health benefits given the expenditure. Our objective with the survey is three-fold.

1. Identify the conservation program's selection criteria in each county and how benefit factors and cost assessments are measured.

2. Identify the administrator's willingness to adopt optimization as a selection process and compare the feasibility of optimization techniques.

3. Identify obstacles to adopting optimization and the severity of the obstacles.

Two survey instruments were used, a pre-survey and a post-survey (Appendix A). The five-part pre-survey was conducted before educational material about optimization was presented. The six-part post-survey was conducted after an educational presentation on optimization was given. Both pre- and post-survey underwent extensive pre-testing before implementation.

After the five-part pre-survey was completed the educational presentation on optimization was given. It was explained how the approach performs, how to implement it, and what are the potential benefits from its implementation. Additionally, a comparison of binary linear programming (BLP) and cost-effectiveness analysis (CEA) was presented.

The participants in the survey were all conservation professionals from Maryland counties. As there are 23 counties, we used several different approaches to survey them. On November 19, 2009, MALPF held an annual conference in Annapolis, Maryland, for all county administrators. Representatives from 12 counties attended the meeting. Another five county representatives used video conference software to participate. Pre-surveys and materials for the optimization presentation were prepared for each seat before the meeting. In total, twenty-three pre-survey questionnaires were collected, 18 from administrators and staff members of the 12 counties at the meeting, one from a county using video conference software, one from a MALPF board member, and three from MALPF staff members.

Based on Dillman's (1978) total design survey method, our post-survey used a variety of follow-up attempts that included emails, written letters, telephone calls, prepaid return envelopes, and a mailing of the survey accompanied by a DVD with a Powerpoint file containing the presentation given at the meeting. The initial response rate after the November 19 MALPF meeting was 52.2% and rose to 65.2% upon the first email reminder. A series of phone calls and follow-up reminders brought the response rate to 91.3% and, finally, a shortened survey (Appendix B) that focused on the key research questions addressed in this research brought the response rate up to 100%.

4. Results

The results from the pre-survey indicate that the surveyed participants had a high level of conservation knowledge. For example, the average working experience of participants was 11.9 years with participants having spent an average of 8.3 years in the current position. Participants also reported a high degree of knowledge of the MALPF program and their counties' agricultural preservation program. On a scale of 1 (low) to 5 (high), 29 county representatives reported an average score of 4.0 for MALPF's program and 4.4 for their county programs.

Several questions sought to measure how important various attributes of the selection process are to the administrators. Five attributes of the processes were considered: knowledge, fairness, transparency, cost-effectiveness and ease of administration. The importance of each attribute is measured on a scale of one to five with one standing for not important, three for somewhat important, five for very important, and two and four between. Statistical results from responses by the 23 senior representatives show that fairness of the selection process is valued most. Table 1 shows fairness was the attribute that received the highest average score (4.65) followed by transparency of the process, which also ranked very important (4.48). While not statistically different from one another, these two factors were statistically more important than the other three attributes. Interestingly, participants were aware that the current MALPF programs did not secure the best deals available for land conservation. Given six different criteria by which to rate the effectiveness of the MALPF program, acquiring the best deals scored lowest with a score of just 2.76 (Figure 1). The six criteria were as follows:

Max agland	Maximize the number of agricultural acres protected.
Max open space	Maximize the open space quality of acres protected.
Protect soil	Protect the best agricultural land in terms of soil.
Protect large blocks	Preserve large blocks of contiguous agricultural land.
Best deals	Acquire the best deals on agricultural land.

Incentives to farm Increase incentives for participants to remain in farming.

This finding is consistent with the results reported in Table 1, which showed that the current techniques scored lowest with regards to cost effectiveness (3.16 out of 5). Figure 1 also shows that administrators believe that their programs are doing reasonably well at protecting soil (4.10 out of 5) and protecting large blocks of agricultural lands (4.05 out of 5).

Several of the survey questions evaluated the potential obstacles for adopting optimization as a selection process. The survey listed eight obstacles and asked participants to assess the difficulty each one presented on a scale of one to five in which one signified "not difficult at all," three signified "somewhat difficult," and five signified "very difficult." The eight obstacles were as follows:

Lack_expr	Lack of previous experience.
Admin	Administration of the process.
Int_cost	Protect the best agricultural land in terms of soil.
Time	Time to implement the process.
Costinfo	Need for cost information at the time of selection.
Lack_tech	Lack of availability of technical resources.
Lack_incen	Lack of incentives to justify a change in process.
Forgobest	Possibly forgoing the "best" land regardless of cost.

We show in Figure 2 that all eight obstacles received a mean score of approximately 3, suggesting that that no single problem was seen as impossible to overcome and that no single obstacle was seen as more important to overcome than others. The survey results also showed that participants were not familiar with optimization before the educational presentation. However, after the presentation, there was a significant increase in understanding of optimization. The average score for optimization knowledge before the presentation was 2.4 and rose to 3.7 after the presentations (Figure 3). This finding complements the earlier finding from the statistical model that indicates that a better understanding of optimization increases the willingness to adopt it.

In the post-survey, several questions were related to the evaluation of whether people would be more willing to adopt optimization if additional resources, such as optimization software and training, are offered. Our results show that when access to optimization software was offered, willingness rose to 3.3, a 10% increase and significantly different from the previous value of 3.0. When both access and training were offered, willingness to adopt optimization increased to 3.5, a statistically significant 16.7% increase (Figure 4).

Respondents reported that the initial cost of training and software associated with optimization were obstacles preventing adoption. This variable likely captures concerns both about the cost of the technology, but also the limited budgets that were affecting all levels of government in Maryland in 2009-2010. County administrators also cited the lack of incentives as a key reason for the lack of adoption. Although optimization techniques are widespread in the business sector, traditionally the use of these approaches in government and non-profit sectors has lagged. This may suggest that the reason for the lack of adaptation in government and non-profits is the lack of direct financial incentives for staff to alter the status quo. Furthermore, the greater the percentage of agricultural land the county has preserved, the more willing the county staff is to adopt optimization. A possible explanation may be that counties with greater percentages of preserved agricultural land may have larger budgets and more experienced employees, which would provide them with more resources both financially and technically.

The following section explores the answer to the central question: Why is optimization rarely adopted by conservation professionals? Using data collected from the post-survey, an ordered probit model is applied to analyze the relationships between willingness to adopt optimization and the regressors. As such, the ordered probit model analyzes factors that potentially influence a program administrator's decision to adopt optimization as a selection approach. The data set is comprised of 27 observations from administrators and senior staff members from every county in Maryland except Baltimore County (due to their previous experience and implementation of CEC). In total 22 data point were considered in the regression model (5 were excluded due to missing information).

The dependent variable WILLING represents the willingness of administrators to adopt optimization as the selection process for agricultural land preservations in the future and was collected from question 11 in the post-survey. WILLING is measured on a scale of one to five, with 1 meaning "not willing to adopt optimization at all" and 5 meaning "very willing to adopt optimization."

The regressors in the ordered Probit model are OPKNOW, LACK_EXPR, ADMIN, INT_COST, LACK_INCEN, PCT_PRESV, and RURALITY. Five of these independent variables are measured on a scale of one to five by the post-survey. OPKNOW is rated by responses to question 10 of the post-survey. It describes the respondents' level of knowledge and understanding of the optimization method after a presentation on optimization, with 1 meaning "does not understand optimization at all" and 5 "understanding optimization very well."

LACK_EXPR, ADMIN, INT_COST, and LACK_INCEN represent data gathered by questions 12, 13, 14, and 18 in the post-survey. These factors describe potential obstacles to adopting optimization as the selection process. LACK_EXPR is lack of previous experience in applying optimization. ADMIN is the administrative requirements of the process. INT_COST is the initial technical cost for staff training and software. LACK_INC is a lack of incentive to justify a change in process. Respondents rated the difficulties presented by these obstacles on a scale of one to five, with 1 meaning "not difficult at all" and 5 meaning "very difficult."

PCT_PRESV is the percentage of total agricultural land preserved by individual counties from 2002 to 2007. The amount of farmland preserved was collected from MALPF's 2002-2007 annual report. Information on the total number of acres of farmland in Maryland in 2007 was collected from the 2007 Census of Agriculture collected by the U.S. Department of Agriculture's (USDA's) National Agricultural Statistics Service, thus, *PCT_PRESV = Acres of Preserved Agricultural land ÷ Acres of Total Agricultural land*.

RURALITY is a measure of how rural a county is using data derived from urban influence codes (UIC) formulated by USDA's Economic Research Service (ERS). It is one of three widely accepted rural classification systems. Based on the concepts of central place theory in regional economics, these codes were developed to account for factors such as population size, urbanization, and access to larger economies (Parker, 2007). However, the urban influence coding structure does not reflect a continuous decline in urban influence. Therefore, RURALITY cannot be used to explain the relationship between urban influence and program administrators' willingness to adopt optimization. Rather, the relationship provides a legitimate assumption that adjacency to metro areas brings a strong development threat to agricultural lands and triggers motivation among administrators to improve their selection techniques and processes. We, therefore, used the 2003 urban influence codes that categorize counties as metropolitan or non-metropolitan. Metropolitan counties are then divided into two groups by the size of the metro area. Non-metropolitan counties are located outside of the boundaries of metro areas and are further subdivided into two types: micropolitan areas, which are defined as centered on urban clusters of 10,000 or more persons, and all remaining "noncore" counties. Micropolitan counties fall into one of three groups that are defined by adjacency to urban areas while noncore counties are divided into seven groups based on their adjacency to metro or micro areas and whether they have their "own town" of at least 2,500 residents (Cromartie, 2007) (See Table 2).

Table 3 displays the regression results. Six of the seven explanatory variables are significant at the 5% level. The survey's parameter estimators of OPKNOW and ADMIN are significantly positive. The positive OPKNOW coefficient indicates that the more knowledge the respondent has about optimization, the more willing she is to adopt it. The positive ADMIN coefficient indicates that willingness increases when more difficulties are predicted in administration of the optimization process. This may imply that program administrators' assumptions about the superiority of a method are in direct proportion to the method's perceived sophistication. It may also imply that the administrative process is not the major concern in determining whether a new method shall be adopted. Participants may assume that optimization can ultimately simplify the whole administration process once people have abundant experience with it. In addition, a WALD test shows that the coefficient of ADMIN is not statistically different from that of OPKNOW is not statistically significant (p=0.4284). Therefore, both variables have essentially the same influence on willingness.

The three survey parameter estimators LACK_EXPR, INT_COST, and LACK_INCEN represent significant obstacles the adoption of optimization. The LACK_EXPR coefficient is -1.88, showing that the less experience a county has with optimization, the less willing it is to adopt it. The INT_COST coefficient is -2.66, indicating that the initial technical cost is a considerable obstacle to adoption. Both limited budgets and a prediction of high technical costs discourage administrators from using optimization. The LACK_INCEN coefficient is -2.85, meaning the more unwilling a county is to change the status quo, the less willing it is to adopt a new approach. The three coefficients are not statistically significantly different from one another. Therefore, lack of experience, the initial technical cost, and a lack of incentive to change have about the same effect on the adoption decision.

The PCT_PRESV coefficient is significantly positive, meaning that the greater the percentage of agricultural land the county has previously preserved, the more willing it is to adopt optimization. Counties with greater percentages of preserved agricultural land may have larger budgets or more experienced employees, which would provide them with more resources both financially and technically. Such counties may also have more incentive to develop better practices, further improving their effectiveness. Their administrators may place a high value on techniques in the preservation process and be more open to adopt new ideas and approaches. The absolute value of the coefficient is not comparable to those of the previously discussed parameters because this variable is not a categorical value obtained from the survey but is a very small contiguous percentage number instead. Finally, the RURALITY estimator takes a negative sign and a value of -0.33, which is not significant at the 10% level but is significant at the 15% level, indicating that the closer a county is located to an urbanized area, the more willing it is to adopt optimization.

5. Conclusion

While a clear consensus exists amongst academics that cost-effective lands preservation should involve careful measurement of the likely benefits and costs associated with each project, the reality remains that the vast majority of conservation programs continue to follow practices that are not cost-effective and thus lower conservation benefits are achieved for the limited available funding. Little research has investigated the attitudes of conservation professionals concerning the importance of cost-effectiveness, and little is known about how conservation professionals believe that they can become more cost-effective. This research reports on a survey conducted with conservation professionals associated with the State of Maryland's agricultural protection program, a leading program in the United States.

Our results suggest that while conservation professionals are generally in favor of being cost-effective, cost-effectiveness is not a top goal for them. When asked to indicate the importance of 5 attributes (knowledge, fairness, transparency, cost-effectiveness and ease of administration) on a scale of 1 (not important) to 5 (very important), fairness and transparency received the highest average scores, while, cost-effectiveness and ease of administration, though still moderately important, received the lowest scores.

An ordered probit regression analyzes how the willingness of administrators to adopt optimization may be influenced by knowledge of optimization technique, administrative requirements, cost concerns, percentage of agricultural land previously preserved in the county, rurality, and lack of incentive for administrators to adopt cost-effectiveness techniques. All except one of these variables influence willingness to adopt and are significant at the 5% level. The rurality estimator, indicating that the closer a county is located to an urbanized area, the more willing it is to adopt optimization, is significant at the 15% level.

These results also show that the willingness to adopt increases when access to optimization software and/or training is provided. Moreover, administrators' willingness to adopt optimization rises by 10% when access to software was offered and by 16.7% when both software and training was offered.

The results reported on in this study shed light on a number of important issues related to the attitude of conservation professionals to adopt optimization. First, conservation professionals report that being cost-effective is not a priority for them, in part because their jobs lack incentives for being cost-effective. Second, several other variables had a significant effect on the willingness to adopt.

Lastly, we show that software accessibility and training can significantly increase the willingness to adopt optimization. These results are helpful in understanding the needs of conservation planners and suggest ways by which economists can improve their communication with conservation planners to help them make their programs more cost-effective.

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Table 1: Assessment of preservation selection techniques from senior representatives

	Fairness	Transparency	Knowledge	Cost-effectiveness	Ease of administration
Importance of criteria	4.65**	4.48**	4.26	4.17	3.87
	(0.65)	(0.79)	(0.62)	(0.65)	(0.76)
Current technique	4.05^{*,b,c}	4.00^{*,b,c}	4.10^{*,b,c}	3.16^{c}	3.74^{b,c}
	(0.74)	(0.92)	(0.62)	(0.96)	(0.81)
Binary Linear Programming	3.11^{a}	2.67^{a}	2.26^{a,c}	3.56*	2.78^{a,c}
	(0.83)	(0.97)	(1.19)	(0.70)	(0.94)
Cost Effectiveness Analysis	3.33^{a}	3.11^{a}	2.63^{a,b}	3.78^{*,a}	3.17^{a,b}
	(0.84)	(1.08)	(1.16)	(0.73)	(0.92)

* and ** denote numbers that are significantly different from the rest in the corresponding row at the 10% and 5% levels respectively.

^{a} denotes number significantly different from that with current technique at the 5% level.

^{b} denotes number significantly different from that with binary linear programming at the 5% level.

^{c} denotes number significantly different from that with cost effectiveness analysis at the 5% level.

482 **Figure 1: Assessments of the performance of current selection processes**

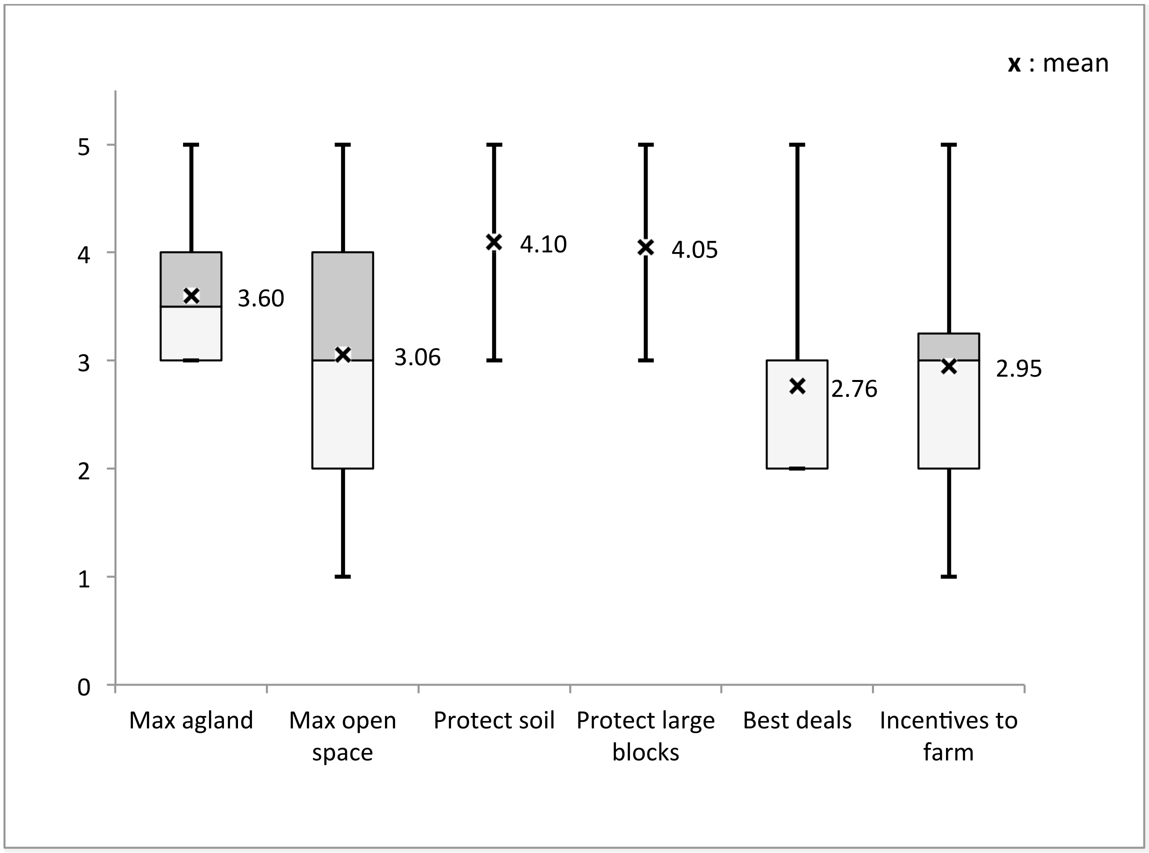

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Figure 2: Obstacles to adopting optimization

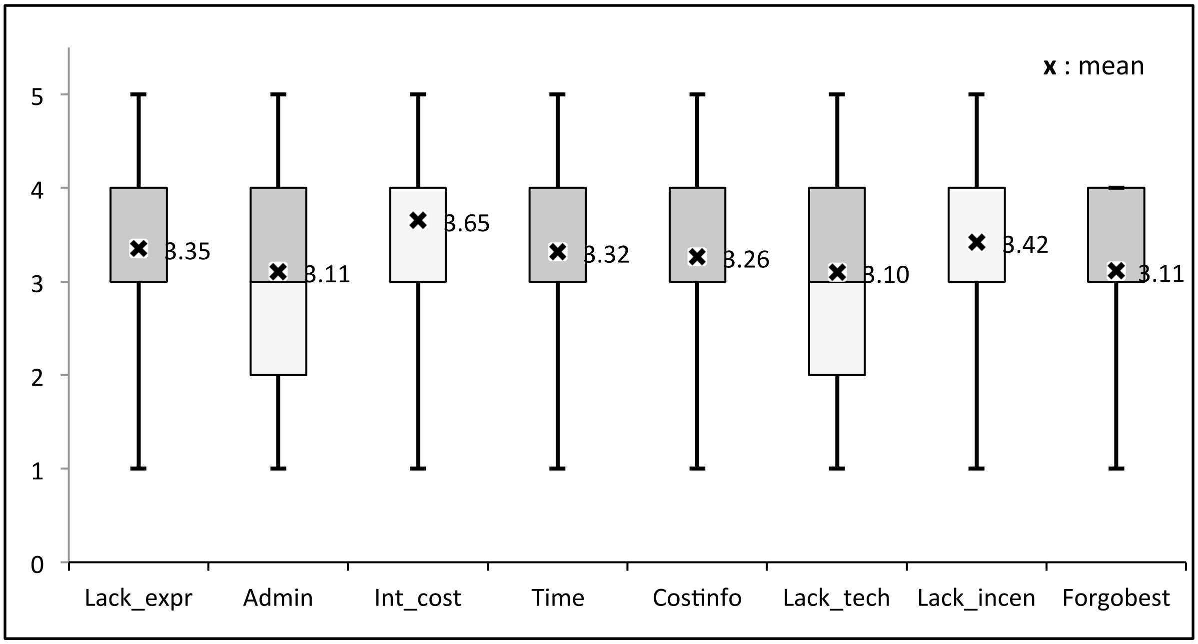
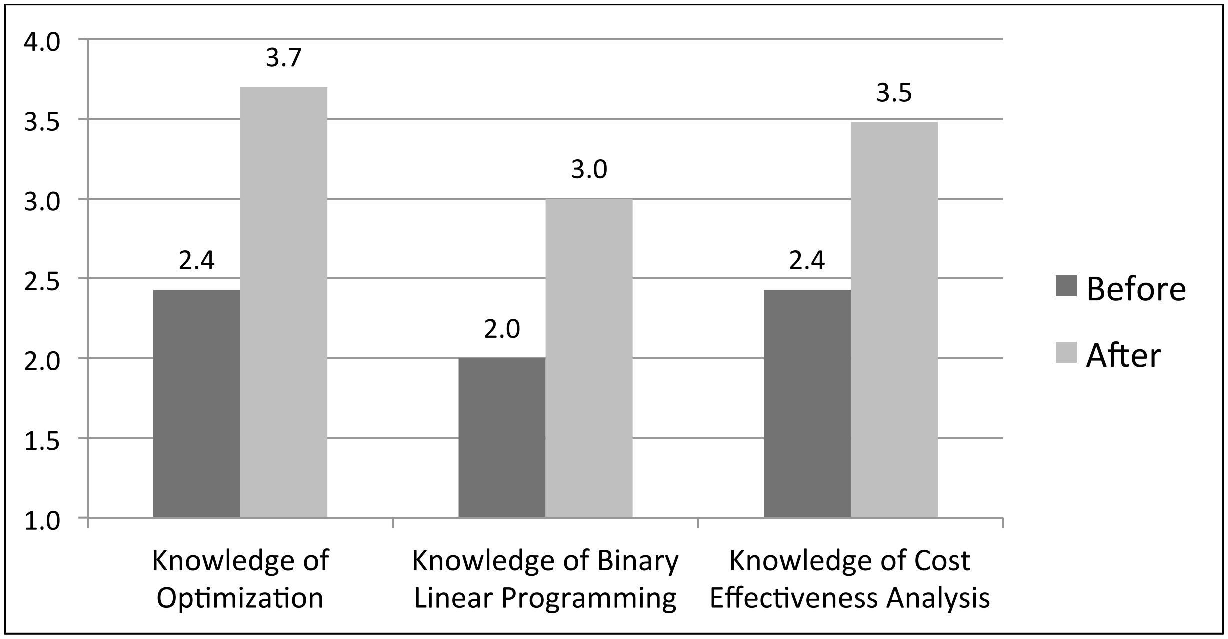


Figure 3. Knowledge about the various techniques before and after the education session.



491 **Figure 4: Willingness to adopt optimization under different scenarios**

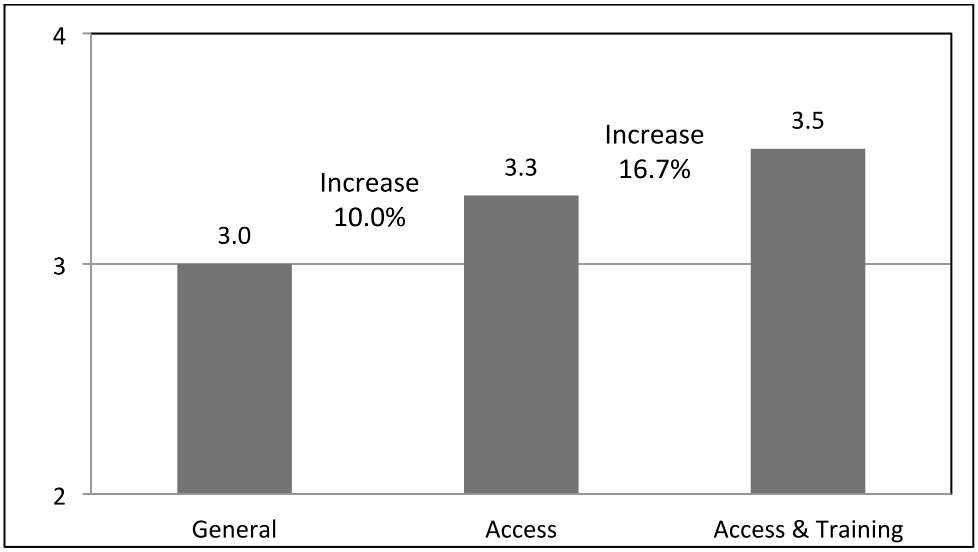


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Table 2: 2003 Urban influence codes

Code	2003 Urban Influence Codes
1	Large—in a metro area with at least 1 million residents or more
2	Small—in a metro area with fewer than 1 million residents
3	Micropolitan area adjacent to a large metro area
4	Noncore adjacent to a large metro area
5	Micropolitan area adjacent to a small metro area
6	Noncore adjacent to a small metro area with town of at least 2,500 residents
7	Noncore adjacent to a small metro area and does not contain a town of at least 2,500 residents
8	Micropolitan area not adjacent to a metro area
9	Noncore adjacent to micro area and contains a town of at least 2,500 residents
10	Noncore adjacent to micro area and does not contain a town of at least 2,500 residents
11	Noncore not adjacent to a metro/micro area and contains a town of 2,500 or more residents
12	Noncore not adjacent to a metro/micro area and does not contain a town of at least 2,500 residents

Table 3: Ordered Probit regression on Willingness to Adopt Optimization.

	Coefficient
OPKNOW	2.317^{*}
	(0.980)
LACK_EXPR	-1.883^{*}
	(0.858)
ADMIN	2.791^{*}
	(1.124)
INT_COST	-2.670^{*}
	(1.0577)
LACK_INCEN	-2.853^{**}
	(1.015)
PCT_PRESV	241.294^{**}
	(93.118)
RURALITY	-0.329
	(0.228)
LR chi2(7)	37.25
Prob > chi2	0.000
Log likelihood	-11.423
N	22

Notes: Standard errors listed in parentheses. * signifies statistical significance at the 0.05 level. ** signifies statistical significance at the 0.01 level.

Appendix A

Survey Questionnaire

PRE-SURVEY

1. Your name:____

2. Maryland county and/or your organization:____

3. How many years have you worked for this county/organization?_____________________________

4. Your current job title:____

5. How many years have you been employed in this position?_______________________________

6. How many people in your county/organization work on agricultural preservation programs?

a. Full-time employees ___________________________
b. Part-time employees ___________________________
c. Volunteers ___________________________

7. How knowledgeable are you regarding the **Maryland Agricultural Land Preservation Foundation's** (MALPF) agricultural preservation program? (Circle one)

Not Knowledgeable		*Somewhat Knowledgeable*		*Expert*
1	2	3	4	5

8. How knowledgeable are you regarding your **County/Organization's** agricultural preservation program? (Circle one)

Not Knowledgeable		*Somewhat Knowledgeable*		*Expert*
1	2	3	4	5

9. In your county, *approximately* what percentage of agricultural land, measured by acreage, has been protected by the following sources over the past five years? (Total should sum to 100%)

a. Maryland Agricultural Lands Preservation Foundation	_____%
b. Your county's agricultural preservation program	_____%
c. Rural Legacy Program	_____%
d. Maryland Environmental Trust (MET) Program	_____%
e. Program Open Space	_____%
f. Other ______________	_____%
Total:	100 %

10. List, *in order of importance*, the 3 to 5 **most important benefit factors** (such as, soil quality, acres, biodiversity value, or development potential) in your county/organization's selection process.

Indicate how each benefit is measured (such as, GIS mapping, Land Evaluation and Site Assessment (LESA), or site visits).

Benefit Factor	***How Measured***
1.	
2.	
3.	
4.	
5.	

11. Who determines the benefit factors and weights for your county/organization's selection process? (Circle ALL that apply)

a. County program staff
b. County advisory board
c. MALPF guidelines
d. County guidelines
e. Other____
f. Don't know

12. If your county/organization has a LESA system to help determine the benefit score for any preservation program, please describe how this LESA system is used.

Program	***How LESA system is used***
1. MALPF program	
2. County Program	
3. Rural Legacy Program	
4. MET Program	
5. Program Open Space	
6. Other	

13. Do any of your preservation programs use **price caps** to determine the easement cost? (Circle one)

Yes No Unsure

If you answered "Yes", please describe what advantages and disadvantages your county has experienced with price caps:

Advantages	***Disadvantages***

If you answered "No", please complete one of the following:

We are planning to use price caps because:

We are *not* planning to use price caps because:

14. For each program in the table below, which of the following methods determines the easement cost in your county? (Please check all that apply for each program.)

Method \ Program	MALPF	County	Rural Legacy	MET	Program Open Space	Other ____
Asking price	☐	☐	☐	☐	☐	☐
Seller discount	☐	☐	☐	☐	☐	☐
Calculated easement value	☐	☐	☐	☐	☐	☐
Price caps	☐	☐	☐	☐	☐	☐
Appraised value	☐	☐	☐	☐	☐	☐
Other_______________	☐	☐	☐	☐	☐	☐
Don't know	☐	☐	☐	☐	☐	☐
Not applicable	☐	☐	☐	☐	☐	☐

15. For each program in the table below, how are easement costs factored into your county/organization's selection process? (Please check all that apply for each program.)

Program	MALPF	County	Rural Legacy	MET	Program Open Space	Other ___
Not explicitly included, except to determine whether funds are still available in the budget	☐	☐	☐	☐	☐	☐
Considered as part of the parcel benefit scoring	☐	☐	☐	☐	☐	☐
Used in an optimization process	☐	☐	☐	☐	☐	☐
Used in calculation of benefit-cost ratios	☐	☐	☐	☐	☐	☐
Other__________________	☐	☐	☐	☐	☐	☐
Don't know	☐	☐	☐	☐	☐	☐
Not applicable	☐	☐	☐	☐	☐	☐

16. For each program in the table below, how are the parcels selected for agricultural preservation in your county/organization? (Please check all that apply for each program.)

Method / Program	MALPF	County	Rural Legacy	MET	Program Open Space	Other ___
Parcels with the highest benefit scores are selected first until the budget is exhausted	☐	☐	☐	☐	☐	☐
Parcels with the highest benefit-cost ratios are selected first until the budget is exhausted	☐	☐	☐	☐	☐	☐
Parcels are selected based on advisory board recommendations	☐	☐	☐	☐	☐	☐
Parcels are selected based on political considerations	☐	☐	☐	☐	☐	☐
Parcels are selected based on their benefits and costs using binary linear programming	☐	☐	☐	☐	☐	☐
No official selection system is used	☐	☐	☐	☐	☐	☐
Other	☐	☐	☐	☐	☐	☐
Don't know	☐	☐	☐	☐	☐	☐
Not applicable	☐	☐	☐	☐	☐	☐

Assess the **ability** of your county/organization's **current selection processes** for agricultural land preservation according to the following criteria:	Poor	Fair	Excellent		
17. Maximize the number of agricultural acres protected	1	2	3	4	5
18. Maximize the open space quality of acres protected	1	2	3	4	5
19. Protect the best agricultural land in terms of soil	1	2	3	4	5
20. Preserve large blocks of contiguous agricultural land	1	2	3	4	5
21. Acquire the best deals on agricultural land	1	2	3	4	5
22. Increase incentives for participants to remain in farming	1	2	3	4	5

Assess the technique used for your county/organization's **current selection processes** for agricultural land preservation according to the following criteria:	Poor	Fair	Excellent		
23. Knowledge of staff on how to use this technique	1	2	3	4	5
24. Fairness to applicants	1	2	3	4	5
25. Transparency (i.e. ease of explanation to public, advisory board, or potential applicants)	1	2	3	4	5
26. Cost-effectiveness	1	2	3	4	5
27. Ease of administration	1	2	3	4	5
28. Other	1	2	3	4	5

Please rate the following programs according to their **efficiency** in preserving agricultural land:	Low	Medium	High		
29. MALPF Program	1	2	3	4	5
30. County Program	1	2	3	4	5
31. Rural Legacy Program	1	2	3	4	5
32. MET Program	1	2	3	4	5
33. Program Open Space	1	2	3	4	5
34. Other program ___________________________________	1	2	3	4	5

POST-SURVEY

1. Your name:____

2. Maryland county and/or your organization:_________________

Please rate the following criteria for an agricultural preservation selection process in terms of importance:	**Low**		**Medium**		**High**
3. Knowledge of staff on how to use the selection process	1	2	3	4	5
4. Fairness to applicants	1	2	3	4	5
5. Transparency (i.e. ease of explanation to public, advisory board, potential applicants, etc.)	1	2	3	4	5
6. Cost-effectiveness	1	2	3	4	5
7. Ease of administration	1	2	3	4	5
8. Other	1	2	3	4	5

Optimization is a process of including both benefit information and acquisition costs to identify parcels that provide a high level of aggregate benefits at the best possible price ('getting the most bang for the buck').

9. How well did you understand optimization **before today**?

Not at all		*Somewhat*		*Very well*
1	2	3	4	5

10. How well do you understand optimization **now**?

Not at all		*Somewhat*		*Very well*
1	2	3	4	5

11. How willing do you think your county/organization would be to adopt **optimization** as the selection process for agricultural land preservation in the future?

Not at all		*Somewhat*		*Very well*
1	2	3	4	5

Assess the **difficulty** of the following potential obstacles for adopting **optimization** as the selection process in your county/organization's agricultural preservation program:	**Not**		**Somewhat**		**Very**
12. Lack of previous experience	1	2	3	4	5
13. Administration of the process	1	2	3	4	5
14. Initial technical costs (staff training, software, etc.)	1	2	3	4	5
15. Time to implement the process	1	2	3	4	5

16. Need for cost information at the time of selection	1	2	3	4	5
17. Lack of availability of technical resources	1	2	3	4	5
18. Lack of incentives to justify a change in processes	1	2	3	4	5
19. Possibly forgoing the ‘best’ land regardless of cost	1	2	3	4	5
20. Other	1	2	3	4	5

21. If your county was given **access** to user-friendly software to help with optimization, how willing do you think your county/organization would be to adopt this selection process in the future?

Not at all		*Somewhat*		*Very willing*
1	2	3	4	5

22. If your county was given **access to and training for** user-friendly software to help with optimization, how willing do you think your county/organization would be to adopt this selection process in the future?

Not at all		*Somewhat*		*Very willing*
1	2	3	4	5

Binary Linear Programming is an **optimization technique** that seeks to use mathematical programming software to identify the set of acquisitions that maximizes the total possible benefits given a variety of constraints (i.e. budget constraints, staff constraints, minimum acreage goals, etc.).

23. How well did you understand optimization using binary linear programming **before today**?

Not at all		*Somewhat*		*Very well*
1	2	3	4	5

24. How well do you understand optimization using binary linear programming **now**?

Not at all		*Somewhat*		*Very well*
1	2	3	4	5

Assess **binary linear programming** as a technique in the selection process to preserve agricultural land in your county/organization according to the following criteria:	**Poor**	**Fair**	**Excellent**		
25. Knowledge of staff on how to use this technique	1	2	3	4	5
26. Fairness to applicants	1	2	3	4	5
27. Transparency (i.e. ease of explanation to public, advisory board, potential applicants, etc.)	1	2	3	4	5
28. Cost-effectiveness	1	2	3	4	5
29. Ease of administration	1	2	3	4	5
30. Other	1	2	3	4	5

31. How willing do you think your county/organization would be to adopt **binary linear programming** in the selection process for agricultural land preservation in the future?

Not at all		*Somewhat*		*Very willing*
1	2	3	4	5

Cost-Effectiveness Analysis is an **optimization technique** that assesses a parcel's conservation value by taking the ratio of benefits divided by costs, and then acquiring the parcels with the highest benefit-cost ratios until the acquisition funds are exhausted.

32. How well did you understand optimization using cost-effectiveness analysis **before today**?

Not at all		*Somewhat*		*Very well*
1	2	3	4	5

33. How well do you understand optimization using cost-effectiveness analysis **now**?

Not at all		*Somewhat*		*Very well*
1	2	3	4	5

Assess **cost-effectiveness analysis** as a technique in the selection process to preserve agricultural land in your county/organization according to the following criteria:	**Poor**	**Fair**	**Excellent**		
34. Knowledge of staff on how to use this technique	1	2	3	4	5
35. Fairness to applicants	1	2	3	4	5
36. Transparency (i.e. ease of explanation to public, advisory board, potential applicants, etc.)	1	2	3	4	5
37. Cost-effectiveness	1	2	3	4	5
38. Ease of administration	1	2	3	4	5
39. Other	1	2	3	4	5

40. How willing do you think your county/organization would be to adopt optimization using **cost-effectiveness analysis** in the selection process for agricultural land preservation in the future?

Not at all		*Somewhat*		*Very willing*
1	2	3	4	5

41. Are there any other thoughts you would like to share with us concerning your county/organization's current selection process, or the optimization selection process?

42. Do you have any comments or suggestions about this survey?

Thank you very much for your participation.

If you have any further questions or suggestions, please don't hesitate to contact us:

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Appendix B

Revised Survey

REVISED-SURVEY

1. Your name:____

2. Maryland county and/or your organization:____

3. How many years have you worked for this county/organization?__________________________________

4. Your current job title:____

5. How many years have you been employed in this position?______________________________________

6. How many people in your county/organization work on agricultural preservation programs?

a. Full-time employees ______________________________
b. Part-time employees ______________________________
c. Volunteers ______________________________

7. How knowledgeable are you regarding the **Maryland Agricultural Land Preservation Foundation's** (MALPF) agricultural preservation program? (Circle one)

Not Knowledgeable		*Somewhat Knowledgeable*		*Expert*
1	2	3	4	5

8. How knowledgeable are you regarding your **County/Organization's** agricultural preservation program? (Circle one)

Not Knowledgeable		*Somewhat Knowledgeable*		*Expert*
1	2	3	4	5

Please rate the following criteria for an agricultural preservation selection process in terms of importance:	Low	Medium		High	
9. Knowledge of staff on how to use the selection process	1	2	3	4	5
10. Fairness to applicants	1	2	3	4	5
11. Transparency (i.e. ease of explanation to public, advisory board, potential applicants, etc.)	1	2	3	4	5
12. Cost-effectiveness	1	2	3	4	5
13. Ease of administration	1	2	3	4	5

14. How willing do you think your county/organization would be to adopt **optimization** as the selection process for agricultural land preservation in the future?

Not at all		*Somewhat*		*Very willing*
1	2	3	4	5

15. If your county was given **access** to user-friendly software to help with optimization, how willing do you think your county/organization would be to adopt this selection process in the future?

Not at all		*Somewhat*		*Very willing*
1	2	3	4	5

16. If your county was given **access to and training for** user-friendly software to help with optimization, how willing do you think your county/organization would be to adopt this selection process in the future?

Not at all		*Somewhat*		*Very willing*
1	2	3	4	5

17. How willing do you think your county/organization would be to adopt optimization using **cost-effectiveness analysis** in the selection process for agricultural land preservation in the future?

Not at all		*Somewhat*		*Very willing*
1	2	3	4	5