WILLINGNESS TO PAY FOR PRECISION APPLICATION TECHNOLOGY TO REDUCE AGRICULTURAL NONPOINT POLLUTION

D. Hite*, D. Hudson,* D. Parisi**
*Department of Agricultural Economics, Mississippi State University
**Department of Sociology, Mississippi State University

INTRODUCTION

Agricultural production practices have been identified as the predominant contributing factor to nonpoint pollution (NPP) in the United States at present. State water quality surveys of fresh water bodies conducted under the auspices of the US Environmental Protection Agency (USEPA) suggest that great strides have been made towards achieving the goals of the Clean Water Act. However agriculturally related NPP continues to degrade water quality. According to the surveys, NPP impairs the function of lakes, rivers and estuaries such that one-third of all fresh water bodies do not fully support designated uses (USEPA 1998). The externalities that arise from pollution originating from field runoff and practices at intensive confined animal facilities are significant. Among the adverse impacts on streams and lakes are reduction of biodiversity, aesthetic value, food supplies, and recreational opportunities, and increases in the cost of drinking water treatment.

Recent developments in the area of precision agricultural technology have demonstrated potential to reduce agricultural NPP. In particular, precision application methods such as variable rate technology (VRT) can reduce runoff by either reducing the overall application rate of chemicals and fertilizers, or by ensuring their optimal uptake by crops being grown. Specifically, VRT combines the use of MIS (Management Information System) with GPS (Global Positioning Systems) to optimize variable rate applications over subunits of a farm, resulting in decreased runoff of nutrients, pesticides and other chemicals as opposed to conventional single rate application.

VRT has been shown to decrease input costs while increasing yields and economic returns as compared to conventional application (Blackmore et al. 1994; Leiva et. al. 1997). In addition, VRT holds promise for reducing NPP, as has been demonstrated through simulation experiments (Hite et al. 2000). However, precision application technology involves a large fixed cost for equipment that producers may not wish to incur, primarily because of uncertain effects of VRT on profits. Increasing agricultural production and improving water quality are public policy goals of national importance, which VRT may help to achieve. Thus, public programs to assist producers may be needed in order to promote VRT adoption.

In this paper, we present the results of a pilot contingent valuation survey that was designed to assess willingness to pay (WTP) for a program to support implementation of precision application technologies. We use the results to investigate public perceptions of agricultural NPP, to assess attitudinal and demographic factors affecting WTP for agricultural NPP abatement based on precision application technology, and to provide estimates of WTP for implementation of the program.

METHODOLOGY

To investigate public WTP for a policy that would subsidize precision application equipment, a contingent valuation telephone survey was conducted in Mississippi during the first two weeks of July 1999. The survey design followed a factorial format, based on 8 groups. The groups consisted of combinations of four prices ($25, $50, $100, and $150) and two levels of NPP reduction (10% and 20%). The survey was framed as a tax referendum and administered by the Mississippi State University Social Science Research Center; random number dialing was used to select adults (18 years of age or older) in the household that had the most recent birthday.

Areas of inquiry in the questionnaire included government spending programs (e.g. public assistance, crime fighting, etc.), perceptions about agricultural NPP (beliefs, concerns, awareness, and knowledge), and participation in recreational activities at or near freshwater lakes, streams, or rivers. In addition, households' socioeconomic and demographic information was elicited. Of the 1,048 total eligible respondents, 828 completed

the interview, representing a 79.0 % completion rate.

To develop survey questions regarding NPP, we explored popular media through use of the Lexis-Nexis Academic Universe in order to identify relevant areas of public concern regarding damages caused by agricultural NPP. In addition, background material regarding the specific environmental problems associated with agricultural NPP was obtained through USEPA and other sources.

Respondents were asked to vote for a pair consisting of a one-time tax payment and a runoff reduction percentage (e.g. $50 tax and 20% runoff reduction). Respondents were told that the tax would be added to their federal tax return the following year. To obtain a realistic tax payment figure, the total cost of adding precision agricultural applications based on 3 prices ($10,000/sprayer, $15,000 and $20,000/sprayer) for all farms in the United States was calculated and divided by the approximate number of taxpayers. A one-time tax price for the program was estimated to range from approximately $27 to $76 per taxpayer, providing a basis for the referendum prices used in the survey.

Potential runoff reduction was estimated via the EPIC (Erosion/Productivity Impact Calculator) simulation program. A hypothetical farm representative of soil type, topography, crop, crop practices, and weather in the Mississippi Delta was developed. We then used the representative farm to estimate a baseline model (typical conditions) and a model that attempted to simulate the impact of use of VRT. All other farming practices were assumed to be conventional, i.e. conventional tillage, no use of border strips or other best management practices. Runoff rates from the baseline and VRT models were compared; the results of the experiment suggested that the runoff when VRT is used would be approximately 10% than under the baseline. In order to provide a scope test with which to investigate the robustness of our survey, we used two runoff reductions—the 10% level derived from our EPIC model, as well as a 20% level.

SURVEY RESULTS

Our sample is comprised of 65.8% white, 29.8% black, whereas the 1990 Census reported 63.5% white, and 35.6% black. The average age of survey respondents was 45.4, while the average age in the 1990 Census was 33.9. Thus our data are skewed slightly away from population norms. Classifying by respondents' place of residence, the sample consists of 8.6% farm or ranch respondents, 41.9% non-farm rural respondents, and 46.5% urban respondents.

Select results from the survey section dealing with public opinion on government spending are presented in Table 1. Level of respondent support for environmental programs, such as for air and water pollution, lags behind support for other public programs like highway improvement, public education, crime prevention, and health care; for example, 44.1 and 47.7% of respondents feel that the government spends too little for air and water pollution respectively, but 75.8, 69.0 and 73.7% feel that too little is spent on public education, crime fighting and health care. On the other hand, only 22.9% of Mississippians feel that too little is spent on public assistance programs. These results imply that respondents rank the importance of environmental issues below all others except for public assistance.

Statistics regarding attitudes and beliefs regarding pollution are presented in Table 2. Respondents are generally uneducated about the extent that agriculture contributes to NPP. Respondents were asked to name which one or two sources they believed to contribute most to NPP; agricultural runoff from livestock was the second least mentioned (9.4%), and agricultural runoff from crops was the third least mentioned (14.6%). However, a solid majority of respondents believe that agricultural pollution does reduce biodiversity (69.2%), and vast majority feels that a national goal of protecting nature and preventing pollution is at least a somewhat important national goal. Finally, most respondents feel that technology can be used in ways that are beneficial to the environment.

Of the 828 total respondents, 62.4% voted for supporting precision application technology, and 24.3% voted against. The large number of respondents voting Yes gave their reason as protecting the environment for human health (81.4%), and the second rank was to help farmers (7.74), while the respondents who voted No believed that we already pay too much in taxes (45.8%) (Table 3).

ECONOMETRIC MODEL

We employ a logistic regression model in a straightforward way to examine factors that con-

tribute to the probability of a Yes vote. Of particular interest are the 'Tax Price' and 'Runoff Level' variables. As the tax price increases, respondents are significantly less likely to vote Yes; as the runoff reduction level is increased from 10 to 20%, respondents are more likely to vote Yes for the program (though not significantly so). Respondents are significantly more likely to vote Yes if they believe that agriculture NPP is a problem, and if they have contributed to an environmental cause in the past 12 months. Those living in rural areas are (insignificantly) less likely to vote for the program, and male respondents are significantly less likely to vote Yes.

Using the model, we estimate the predicted probability of Yes votes at each tax price for the entire sample, and then simulate the probability of a Yes vote if respondents had voted entirely on either a 10% or a 20% reduction level. Using the predicted probabilities, we estimate the Turner Lower Bound means (TLB) for the unadjusted sample, the 10% simulation and the 20% simulation. We find that, although it appears that the survey does not pass a scope test based on the significance level of the runoff reduction variable, the actual predicted WTP difference from the model is quite distinct. For the unadjusted sample, the TLB is $91.73; for the 10% and 20% samples the TLB is $72.27 and $106.83, respectively.

CONCLUSIONS

From our study, we can draw some preliminary conclusions. First, we find that the level of awareness of agriculture related NPP is fairly high. In addition, although Mississippi is a predominantly rural state, and arguably the poorest in the US, significant public support exists for a program to reduce agriculture related NPP. Future research will extend the current analysis to the national level, using the results from this pilot study to help us to improve the survey instrument and survey administration.

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TABLE 1: PUBLIC OPINION ON GOVERNMENT SPENDING

Question	Sample Percentage
Is government spending to improving highways and public transportation	48.1
Too little	38.3
About right	9.9
Too much	
Is government spending to improving public education	
Too little	75.8
About right	16.2
Too much	5.8
Is government spending for public assistance programs	
Too little	22.9
About right	27.3
Too much	42.3
Is government spending to reducing air pollution	
Too little	44.1
About right	29.2
Too much	8.0
Is government spending to reducing water pollution	
Too little	47.7
About right	28.4
Too much	5.1
Is government spending to fighting crime	
Too little	69.0
About right	22.1
Too much	3.7
Is government spending for health care	
Too little	73.7
About right	15.1
Too much	5.4

TABLE 2. PUBLIC OPINION ON POLLUTION

Primary Causes of NP Pollution	Sample Percentage
Runoff from roads and highways	8.8
Sewage from cities and towns	41.9
Agricultural runoff from from livestock	9.4
Agricultural runoff from Crops	14.6
Discharge of factory waste	51.3
Leaking garbage dumps	39.4

Attitudes about Agricultural Pollution	Sample Percentage
Is a national goal of protecting nature and preventing pollution	
Very Important	58.8
Somewhat Important	36.8
Not at all Important	3.5
Can technology be used to achieve a cleaner environment while promoting an increasingly good standard of living?	
Agree	80.2
Neutral	10.0
Disagree	4.6
Do you believe that agricultural pollution causes reduced biodiversity?	
Yes	69.2
No	18.7

TABLE 3. RESPONDENTS' REASONS FOR VOTE "YES" AND "NO"

"Yes"	_N_	%	"No"	_N_	%
To protect the environment for human health	421	81.43	We already pay too much in taxes	92	45.77
To help farmers	40	7.74	I don't want government involvement	32	15.92
The cost of the program is low compared to the benefits	20	3.87	I don't believe program will help the environment	30	14.93
To protect the environment for biodiversity	14	2.71	The program costs too much	19	9.45
To protect the environment for uses like hunting and fishing	11	2.13	None of these—some other reason	27	13.43
To protect the environment for uses like swimming and boating	1	0.19	Don't know	1	0.50
None of these-some other reason	6	1.16			
Don't know	4	0.77			

TABLE 4. LOGISTIC MODEL

Variable	Estimate	Wald Chi-Square		Odds Ratio
Intercept	0.0574	0.4225		
Tax Price	-0. 00423	5.4351	**	0.996
Runoff Level	0.00770	0.1921		1.008
Believe Ag NPP Damage (0,1)	0.8225	19.5873	***	2.276
Race (0,1)	0.0420	0.1229		1.043
Employed (0,1)	0.4012	4.8742	**	1.494
Rural (0,1)	-0.1446	0.6570		0.865
High Education (0,1)	-0.2994	1.4455		0.741
Contributor (0,1)	0.5659	6.4633	**	1.761
Male (0,1)	-0.4449	5.7594	**	0.641

Model Significance Tests

Likelihood Ratio	43.2739	9	<0.0001
Score	42.2075	9	<0.0001
Wald	39.5380	9	<0.0001

Note: Tax price: 25, 50, 75, 150; Runoff level : 10%, 20%; Race: White=1; Rural: live in rural area or town<2500, High Education: college grad or better, Contributor: Contributed to environmental organization in last year.

TABLE 5. ESTIMATED PROBABILITY OF YES

Pooled Sample

Tax Price	_N_	Mean	Std. Error
25	209	0.6788	0.1135
50	206	0.6468	0.1253
100	205	0.6210	0.1193
150	208	0.5508	0.1229

Turner Lower Bound Mean: $91.73

Estimated Probability of Yes, 10% Runoff

Tax Price	_N_	Mean	Std. Error
25	209	0.5581	0.0876
50	206	0.5227	0.0945
100	205	0.4814	0.0860
150	208	0.4235	0.0873

Turner Lower Bound Mean: $72.27

Estimated Probability of Yes, 20% Runoff

Tax Price	_N_	Mean	Std. Error
25	209	0.7633	0.1558
50	206	0.7374	0.1705
100	205	0.7282	0.1680
150	208	0.6580	0.1821

Turner Lower Bound Mean: $106.83