CAPTURING THE BENEFITS OF SITE-SPECIFIC MANAGEMENT: IS IT TIME FOR A PUBLIC POLICY?

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

INTRODUCTION

U.S. agricultural producers have intensified their use of agricultural chemicals over the past 50 years, resulting in increases in agricultural non-point pollution (NPP) in the form of herbicide, pesticide, sediment, and especially, nutrient, runoff. It is generally recognized that significant mitigation of pollution from point sources has been achieved since the implementation of the 1972 Clean Water Act, but NPP still poses a significant problem. In fact, the U.S. Environmental Protection Agency found that over one-third of all streams, lakes, rivers, and estuaries did not support their designated uses in 1996 (USEPA), and NPP was believed to be the major source of those deficiencies. Agriculture is generally recognized as the largest contributor to NPP (USEPA).

Public awareness and concern over perceived environmental degradation have helped to spur scientific developments and use of more environmentally "friendly" chemicals. In addition, new water quality rules in the form of Total Maximum Daily Load (TMDL) standards for watersheds will intensify regulatory attention on agricultural practices. Thus, additional means to reduce NPP, such as best management practices and site-specific management technologies have been developed and suggested for adoption to agricultural producers.

Site-specific management (SSM) refers to a collection of techniques and technologies ranging from modern computer assisted mapping and guidance and variable rate applicators (seed, fertilizer, and pesticides) to more rudimentary technologies such as soil sampling and testing (Khanna, Epouhe, and Hornbaker). A primary objective of SSM is the management of in-field variability of soil characteristics and conditions. SSM is believed to improve nutrient intake and input productivity by applying a more optimal amount of inputs on a much smaller scale of management (sub-field level). Several studies, however, point to the conclusion that profitability of SSM for producers is questionable (Carr et al.; Morris and Blackmore; Swinton and Lowenberg-DeBoer; Sawyer). Questionable (or highly variable) returns leads to a lower probability of adoption, which appears to be the case for SSM (Khanna, Epouhe, and Hornbaker; Hudson and Hite).

Several studies, however, point to the potential environmental benefits of SSM (Hite, Hudson, and Intarapapong, 2000a; Office of Technology Assessment; Fuglie and Bosch; Khanna and Zilberman; Oriade et al.; Schnitkey and Hopkins). The environmental benefits are derived from reduced chemical runoff and leaching through improved matching of chemical application with crop needs. Assuming that these environmental impacts are tenable, they create a positive externality of reduced pollution that accrues to the public, but currently provides no added monetary incentive for producers to adopt SSM. t could be argued that this pollution is, in fact, a negative externality and that reducing pollution reduces the negative externality. We are arguing from the ***status** quo* of pollution so that reduced pollution becomes a positive externality.

Given that current adoption appears to be low, and the profit motive for adoption appears to be weak, can public subsidization of SSM be used to capture the positive externality of reduced agricultural pollution? We recently conducted two surveys in Mississippi-one for consumers and one for producers—to examine both public demand for pollution abatement and willingness to pay (WTP) for subsidization of SSM, as well as producer WTP for technology under alternative subsidization schemes. Our purpose here is to outline those results as a hypothetical public policy for SSM adoption.

SURVEY RESULTS

The consumer survey was posed as a referendum-based contingent valuation (CV) survey of consumer WTP for the *complete* subsidization of the fixed cost investment in SSM technologies for producers (see Hite, Hudson, and Intarapapong, 2000b for details). Results of the survey show that this set of consumers believed that the traditional point sources of pollution were the primary contributors of NPP (which probably reflects a low level of understanding of NPP and a lack of education on the effects of the 1972 Clean Water Act) while agricultural sources were ranked relatively low (Table 1). At the same time, however, about 70% of the respondents believed that agricultural pollution reduced biodiversity, which reflects the general concern about the effects of agricultural pollution.

Approximately 62% of the respondents said they would 'vote' for a one-time tax to support SSM adoption. This result suggests that there is significant consumer demand for pollution abatement, which is reflected through a WTP for subsidies to support technologies to reduce pollution. Analysis of the data suggest a mean WTP of between \$92 and \$128 (depending on the method used to calculate WTP), which generates sufficient tax revenue to purchase SSM equipment to cover all crop acres in Mississippi.

The survey of agricultural producers in Mississippi revealed that current adoption of SSM is low, generally below 20% for the more advanced technologies (Table 2). Producers were offered a hypothetical "package" of SSM technologies including GPS and yield mapping/monitoring equipment and variable rate controllers. The producers were told that the fixed cost investment in this package was \$16,500 per unit, but that the government would subsidize some amount of the purchase price (the subsidies differed in different survey versions in a CV framework; see Hudson and Hite for details). The survey revealed that about 28% of the respondents would be willing to adopt the SSM package at their stated price/subsidy combination (this 28% "adoption" rate represents 32% of the crop acres in Mississippi). Based on these data, the analysis suggested that producers would be WTP \$6,628, on average, for the offered package. This result suggests that the government would need to subsidize about 60% of the purchase price in order to get the average producer to adopt the SSM package.

Taken together, these results suggest that there is sufficient public demand to cover the cost of *fully* subsidizing the adoption of SSM, while only a 60% subsidy is required to for the average producer to adopt SSM. This suggests that implementation of the policy is both financially tenable and generates a surplus to the public after paying for the subsidy. Thus, it would appear that, at least for Mississippi, that implementation of a program to subsidize adoption of SSM would potentially achieve the goals of reduction in NPP that the public desires at a cost less than what the public is willing to pay.

DISCUSSION

We are most familiar with situations where some production process generates a negative externality, which is generally controlled through regulation or some scheme to force the producer to internalize the cost of the externality. Agricultural pollution can be thought of as a negative externality, or by-product, of modern agricultural production. Taxation of chemicals, as some have suggested, may be a way to force agricultural producers to internalize the external costs of agricultural pollution. We propose a program that may achieve the same environmental goals as taxation, but through a program that may be perceived politically as not "penalizing" farmers through "undue" increases in input costs.

There are significant challenges that remain with our proposal. First, is the national level of public support of such a program sufficient to cover the costs? We are currently in the process of examining this topic. Second, are the environmental impacts large enough to warrant subsidizing SSM? This question is, of course, much more difficult to answer. Prior research has shown that there are environmental benefits to SSM in different parts of the country, but knowledge about potential environmental impacts is fragmented at best. A more comprehensive examination of these potential benefits on a national scale is needed before definitive conclusions can be drawn.

Finally, even if you offer a subsidy, will adoption be sufficient to achieve the environmental goals? Prior research shows that adoption is currently low, which may be partly because this technology is relatively new and many producers prefer to "wait and see" if the technology will be of any benefit. Alternatively, low adoption may be because producers already realize the low profit potential that is being observed in many experimental trials. Subsidization will almost certainly increase adoption rates, but by how much? This issue, too, needs further examination.

One element from our producer survey appears to be an important factor for producers—how well does the technology integrate into current farming practices? Producers that believed that SSM technology would integrate well with their current farming practices had a willingness to pay over twice that of producers who did not think the technology would integrate well. This strongly suggests that the technology must be flexible and easy to integrate into current practices if producers will adopt it. Of course factors such as soil variability and quality were important as well, but the integration issue seemed to be the largest concern (in terms of marginal impacts on willingness to pay). Thus, insuring ease of integration would improve adoption and improve the efficacy of any program designed to stimulate adoption.

CONCLUSIONS

Although our example here is a hypothetical public policy, it serves to illustrate an opportunity to use a subsidy versus a tax to achieve the same environmental goal. Viewed in this light, SSM takes on a different role as a public environmental management tool as opposed to a producer's production management tool. The public receives its positive externality of reduced pollution, and the producer receives a technology that has essentially no effect on profits. Farm management productivity, however, may increase due to improved information. TMDL standards may ultimately lead to more widespread use of SSM by virtue of the need for better documentation and monitoring on the part of the producer. All these facts notwithstanding, the potential environmental impacts of SSM adoption need more research as it is these very impacts that may be the saving grace of SSM in many parts of the country where profitability is low and/or uncertain.

REFERENCES

Carr, P., G. Carlson, J. Jacobson, G. Nielson, and E. Skogley. 1991. Farming Soils, Not Fields: A Strategy for Increasing Fertilizer Profitability. Journal of Production Agriculture, 4 (1): 57:61.

Fuglie, K. and D. Bosch. 1995. Implications of Soil Nitrogen Testing. American Journal of Agricultural Economics, 77: 891:900.

Hite, D., D. Hudson, and W. Intarapapong. 2000a. The Economic and Environmental Impacts of Variable Rate Fertilizer Application in Comparison with Single Rate: The Case of Mississippi. Mississippi Agricultural and Forestry Experiment Station Publication: Mississippi State University.

Hite, D., D. Hudson, and W. Intarapapong. 2000b. Willingness to Pay for Precision Application Technology: The Case of Mississippi. Staff Working Paper, Department of Agricultural Economics: Mississippi State University.

Hudson, D. and D. Hite. 2000. Producer Willingness to Pay for Precision Application Technology: Implications for Government and the Technology Industry. Staff Working Paper, Department of Agricultural Economics, Mississippi State University.

Khanna, M., O. Epouhe, and R. Hornbaker. 1999. Site-Specific Crop Management: Adoption Patterns and Incentives. Review of Agricultural Economics, 21 (2): 455:472.

Morris, F. and B. Blackmore. 1997. Precision Farming Techniques for Sustainable Agriculture. Paper Presented to the 1st European Conference on Precision Agriculture, September 8-10, 1997, Warwick University Conference Center, Warwick, United Kingdom.

Office of Technology Assessment. 1995. Targeting Environmental Priorities in Agriculture: Reforming Program Strategies. Washington, DC: U.S. Government Printing Office. U.S. Congress OTA-ENV-640.

Oriade, C., R. King, F. Forcella, and J. Gunsolus. 1996. A Bioeconomic Analysis of Site-Specific Management for Weed Control. Review of Agricultural Economics, 18: 523:535.

Sawyer, J. 1994. Concepts of Variable Rate Technology with Considerations for Fertilizer Applications. Journal of Production Agriculture, 7 (2): 195:201.

Schnitkey, G. and J. Hopkins. 1997. Precision Agriculture Technologies: Do They Have Environmental Benefits? Ohio's Challenge, 10: 16:19.

Swinton, S. and J. Lowenberg-DeBoer. 1998. Evaluating the Profitability of Site-Specific Farming. Journal of Production Agriculture, 11 (4): 439:446.

U.S. Environmental Protection Agency (USEPA). 1998. National Water Quality Inventory: 1996 Report to Congress. Washington, DC: Office of Water, EPA841-R-97-008.

TABLE 1. PUBLIC OPINION ON PRIMARY CAUSES OF NON-POINT SOURCE POLLUTION, MISSISSIPPI, 1999.

Source	Proportion Responding Primary Source (%)
Discharge of factory waste	51.3
Sewage from cities and towns	41.9
Leaking garbage dumps	39.4
Agricultural runoff from crops	14.6
Agricultural runoff from livestock	9.4
Runoff from roads and highways	8.8

TABLE 2. ADOPTION OF DIFFERENT SITE SPECIFIC MANAGEMENT TECHNOLOGIES BY MISSISSIPPI PRODUCERS, 2000.

SSM Technology	Proportion of Producers Using (%)
Soil Sampling/Testing	54
GPS Guidance	20
Yield Monitor/Mapping	16
Variable Rate Fertilization	16
Variable Rate Pesticides	15
Variable Rate Seeding	12
Weed Mapping	8