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Differences between Farmer and Agency Attitudes Regarding Policies to Reduce Phosphorus Pollution in the Minnesota River Basin

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Introduction

Due to past abatement efforts that focused on point sources of pollution in the United States, there is a general realization that further progress will require more emphasis on nonpoint sources such as households and farms where emissions are difficult to measure. In this situation, policies such as emissions taxes and standards tend not to be feasible. In the case of nonpoint sources of water pollution, alternatives that have been proposed by economists include emissions charges based on estimates, taxes on inputs or outputs, cross compliance requirements, marketable permits, deposit-refund systems, correcting distorted incentives, subsidies for mitigating inputs, legal liability, and cost-sharing programs. Policies that do not involve economic incentives include education, easements, mandatory land use practices, and bans. In the case of agricultural nonpoint source pollution, we typically observe programs or policies based on education, cost sharing/technical assistance, land retirement, and conservation compliance. This study elicits opinions of farmers and agency staff concerning alternative policies to reduce agricultural nonpoint source phosphorus pollution in the Minnesota River and attempts to identify factors that help explain the prevalence of existing policies.

The Minnesota River, which empties into the Mississippi River, has a variety of water quality problems including bacterial contamination, sedimentation, and nutrient enrichment. Many of these pollutants come from nonpoint sources such as private septic systems and runoff from fields and feedlots. In the Minnesota River, phosphorous has been found to be the limiting nutrient for the algal growth that causes eutrophication (MPCA 1994). The decomposition process of the algae reduces the levels of dissolved oxygen in the water, thus affecting aquatic life such as game fish. Phosphorous loading from agricultural fields is affected by the amount of phosphorous in the topsoil, the amount of erosion that occurs, and the proportion of the runoff that reaches the waterway.

The Minnesota River is typical of the very productive river basins in the Midwestern corn-soybean producing region. It drains a large part of the southwestern portion of Minnesota from the South Dakota and Iowa borders to where it discharges into the Mississippi River at the Twin Cities. The Minnesota Basin includes 29% of the cultivated area in Minnesota and accounts for 41% of Minnesota's corn and hog production and 51% of its soybeans. Agriculture is the major source of phosphorous in the river during high rainfall years. Yet the agricultural sources of phosphorous vary across the basin. The rainfall and runoff increase from west to east with the runoff averaging 2 inches in the west at Montevideo, and 5 inches in the east at Mankato. Consequently, the eastern half of the region contributes, on average, about 80% of the phosphorous discharged into the river.

The problem facing the state is to determine how best to reduce these phosphorous discharges and improve the water quality in a basin that will continue to support intensive agriculture. The state has set as its goal a 40% reduction in phosphorous loading. To better understand how this goal can be achieved effectively, this study tries to determine which conservation practices are the most acceptable and lowest cost for the region. To do this, two surveys relating to agricultural phosphorous in the river were conducted. The farmer survey consisted of an eight-page questionnaire that was sent to randomly selected farmers in the Minnesota River Basin. The effective response rate was 50 percent with 358 usable surveys returned after three mailings using the approach developed by Dillman (1978). The agency[1] survey consisted of a 4-page questionnaire that was sent to selected staff of government agencies, environmental groups, and industry organizations that had attended state-sponsored meetings on the Minnesota River. The response rate was 75 percent after three mailings.

[1]The term agency refers to public officials, public agency staff, and representatives of environmental groups, industrial organizations and public education institutions.

Farm Characteristics and Production Practices

Compared to the averages from the 1992 Census of Agriculture, the age of operator in the sample is slightly older (51.7 versus 48.3 years), the number of hogs per hog farm is somewhat greater (459 versus 414), and the farm size is larger (503 versus 367). The survey was conducted five years after the census and the differences are consistent with time trends for these variables (e.g., the aging of the farm population and increases in farm size). In 1995, the farmers in the Southwestern Minnesota Farm Business Management Association had an average age of 45.4 years, and had 625 total crop acres (Olson et al. 1996). The sample respondents seem to roughly represent the sampled population so no severe selection bias or sample response bias seems to be present. There were also no significant differences between those responding to the first survey, the postcard, or the second survey with respect to their responses to four questions: 1) size of operation, 2) index value for agriculture's contribution to phosphorus pollution, 3) index value of resistance to a prohibition on winter manure application, and 4) index value for use of University of Minnesota as an information source.

The majority of survey respondents grow row crops with 94 percent of farmers producing corn either alone or in rotation with soybeans. A slight majority (54 percent) of respondents had livestock of some kind with beef cattle being the most common followed by swine and diary cattle. On average, almost 41 percent of farmed acreage was rented in. Among survey respondents, the majority (63 percent) report that their land is primarily well drained. The question did not distinguish between land that was well drained because of tiling and land that was naturally well drained. Most (78 percent) of the farms have less than 5 percent highly erodible land, which may affect their response to questions regarding a requirement for conservation tillage on highly erodible land.

Twenty-five percent of respondents had enrolled in the Conservation Reserve Program (CRP). The questionnaires asked how much the farmers would require to participate in a voluntary permanent

conservation easement program called Reinvest in Minnesota (RIM). The questions were asked on the basis of both a yearly payment and a one-time payment. The yearly payment required by respondents was $121 per acre which is higher than the land rental rate of $84 reported by the Southwestern Minnesota Farm Business Management Association (Olson et al. 1996) for corn and soybean production. It is also higher than the average rental rate for these counties reported in Lazarus and Molenaar (1996). A minority (39 percent) responded to the question regarding the one-time payment. Several indicated that they were not interested in participating in a permanent easement program which may mean that some respondents did not correctly understand that the annual payments were also for a permanent easement. The average value for the one-time payment was $1,943 per acre, which is higher than the average sale price for these counties calculated from Taff (1996).

The average fertilizer cost was over $14,000 per year but the standard deviation was very high. Less than one third of the respondents answered the question about their soil phosphate levels and those that did had an average of 31 parts per million (ppm). The 74 farmers who answered the question about banding of phosphate applications indicated it took almost two hours more per 40 acres to band phosphorus than to broadcast it which may explain the lower adoption rate of this technology. Average banding equipment cost was $3,750.

Fertilizer cost is a large expense in most corn farming operations. According to Olson et al. (1996), fertilizer expense for corn on owned land is $44.58 per acre or 17 percent of the total expense. Fertilizer expense for soybeans ($1.39 per acre or 0.8 percent of total expense) is much lower than that for corn because of the minimal nitrogen requirements for legumes and a 30 percent lower phosphorous requirement (Griffith 1996). The purchases of these fertilizers would be expected to decrease by almost 30 percent in response to a 100% increase in price due to a tax (Denbaly and Vrooman 1993). Average net return over labor and management for soybeans on owned land was $49.19 per acre for members of the Southwestern Minnesota Farm Business Management Association. If phosphate fertilizers represent the majority of the

fertilizer cost for soybeans, the tax would decrease net returns over labor and management by only about 1 percent. If the tax were levied on all fertilizers and if we looked at corn instead of soybeans, the effect on profitability would be much more pronounced, essentially halving the return over labor and management.

While average phosphorus levels are not high, there was one farm in the survey with a level of 300 ppm and several with levels over 100 ppm. Soil test levels of 30 ppm are adequate to achieve maximum wheat yields in the north central region (Sharpley and Halvorson 1994). The highest level reported was on a swine operation. The vast majority (96 percent) of farmers, including the swine operation, indicated that they would decrease their fertilizer applications if their soil test results indicated excessive instead of very high phosphorous levels. Changing how P results are reported was suggested by Sharpley and Halvorson (1994) as a way to reduce over-application of phosphate fertilizers. Also, the significant number of farmers that did not have access to their soil test results indicates that it would be helpful to send them multiple copies so that they could keep one and make others available to their input suppliers.

Manure management seems to be a potential problem area. A minority (24 percent) of livestock farmers tested their manure for nutrient levels and half of them did not even follow recommended published values for manure application. This failure to heed test results indicates that manure is seen primarily as a waste to dispose of instead of a nutrient rich resource. A manure test costs about $40 or the cost of fertilizer for one acre of corn. Schmitt et al. (1996) indicate that the complexity of manure nutrient calculations and applications may be a factor limiting the appropriate use of manure. Over half the respondents who applied manure, did so in the winter, which might indicate a lack of manure storage facilities as well as reinforcing the conclusion that manure is often seen as a waste disposal problem rather than a resource.

The majority of farmers (85 percent) indicated that they practice conservation tillage. The number of farmers who said they practiced conservation tillage was higher than the number meeting residue targets according to the transect survey (MPCA 1995). The transect survey is a method developed by Purdue

University in which teams measure the surface residue after planting for randomly chosen fields. On average, only 35 percent of fields planted to soybean met a 30 percent residue threshold.

When asked why they didn't practice conservation tillage, 14 respondents mentioned costs, especially equipment costs, and 13 indicated that conservation tillage was not appropriate for their soil conditions or rotation practices. Weed problems, poor drainage, and a lack of highly erodible land were also mentioned. When queried regarding their biggest problem with conservation tillage, residue or trash, ground warming in spring, soil not drying out, and weeds were the most common responses.

A majority of those practicing conservation tillage indicated that they had to buy some equipment to implement the practice. The most commonly purchased piece of equipment for conservation tillage was a chisel plow (53 percent of those responding to the question). Average conservation tillage equipment cost was $13,080. Conservation equipment cost may overstate the minimum cost necessary to implement conservation tillage since many farmers only bought a chisel plow while others bought very expensive equipment. Those who spent a lot may have been upgrading for a variety of reasons and the equipment was also suitable for conservation tillage. One respondent listed a four-wheel drive pickup which doesn't seem to be directly related to conservation tillage. In addition, not all farmers who practiced conservation tillage needed to purchase additional equipment to implement this practice. Farmers did spend less time on tillage operations by using conservation tillage, an average of 5.43 hours less per 40 acres.

Survey participants were asked several questions about the amount of time they spent learning about different practices and/or programs. Almost 75 percent of farmers said they spent less than 10 hours deciding whether to participate in CRP and several farmers wrote in zero. Over 58 percent of respondents indicated that they spent less than 10 hours learning about best management practices for reducing phosphorus pollution.

In contrast, a substantial amount of time was spent learning about conservation tillage both before and after implementation of the practice. Only those farmers who had indicated that they practiced

conservation tillage were asked the question regarding time spent learning about conservation tillage. Only 37 percent spent less than 10 hours learning about it before implementing the practice, 25 percent spent 10-20 hours (the median response), and 16 percent said they spent over 40 hours. For those respondents indicating they spent time learning about the practice after implementation, an average of 15 additional hours was spent. This is in addition to the hours spent learning beforehand by discussing the practice with other farmers, reading magazines or fact sheets, and attending meetings. If we use the midpoint of the median time category, 15 hours and add to it the mean of time spent after implementing the practice, about 30 hours was spent on information costs. If the opportunity cost of farmers time is $10 per hour, this amounts to $300. This is less than half of the decreased time spent on tillage operations which is 75 hours per year (550 acres/40 acres times 5.43 hours less per 40 acres).

Farmers were queried regarding their sources of information on farming practices. On a scale of 1 (don't use) to 10 (very important), a majority of farmers (65 percent) gave the Internet a score of 1. This was also the most common response for consultants, commodity groups, Minnesota Pollution Control Agency (MPCA), and non-profit organizations. The highest mean score (6.66) was for other farmers followed by extension (6.30) and agribusiness (6.26). Magazines, National Resource Conservation Service (NRCS), and the Minnesota Department of Agriculture were also seen as important sources of information. MPCA is not usually thought of as an information source but livestock farmers generally indicated that MPCA was an important source of information. This is probably due to the permitting process for feedlots and waste storage facilities. Farmers obtain information from various sources and the importance given to farm input suppliers indicates that the dealers should be involved in educational efforts regarding nutrient management. A majority of farmers (63 percent) had contact with an extension educator in the last two years, and 68 percent had contact with an NRCS or SWCD staff member.

When asked to check who should set water quality goals for the Minnesota River, the largest number of people indicated that state government agencies should make those decisions (Table 1). In all, 61 percent

of respondents indicated that state government should be involved in setting the goals. County government involvement was supported by over 52 percent of the farmers. A separate question asked whether the process by which the goals were set would influence their compliance. The largest percentage indicated it would have some effect (61 percent), while 22 percent indicated it would definitely have an influence, and 16 percent indicated it wouldn't have any influence.

Farmers perceived urban runoff and waste treatment plants as being larger sources of pollution than septic systems or agricultural runoff with feedlots being intermediate. Other sources of phosphorous pollution volunteered by the respondents included factories, which were mentioned by 8 respondents, salt on roads, lawns, golf courses, hog lots, and natural sources.

Table 1. Level of Government That Should Set Water Quality Goals

Level or levels of Government	Percent of farmers
State government organizations (e.g. MPCA, DNR, MDA, Leg.)	23.8
State government, County government, and Local residents	12.2
County government	11.6
County government, Local residents	10.2
Local residents	9.3
Federal, State, and County governments and Local residents	8.7
State and County governments	7.0
Federal government (e.g. USDA, NRCS, EPA)	5.8
State government and Local residents	4.1
Federal, State and County governments	2.9
Federal and State governments	2.3
Other or other combinations	2.0

A minority (35 percent) of respondents participate in some activity near the river that is closest to their farm. The most common activity is fishing, followed by picnics, and then boating. Swimming was less

popular which may be linked to the quality of the water, to a preference for swimming in lakes, or to the age of the respondents. Educating farmers about the effects of sediment and phosphorus on fish populations may have some potential since fishing is a popular activity. On the other hand, few respondents mentioned affiliation with sports organizations that have an emphasis on Minnesota River quality. Mobilizing members of sports organizations has been mentioned as a way to improve water quality in the River. Most respondents are concerned about the quality of the Minnesota River and think that it is polluted. Almost 83 percent of respondents indicated that they were at least somewhat concerned and felt that it was at least somewhat polluted. None of the respondents indicated that the river was not at all polluted and only 7 were not at all concerned about it's quality.

Policy Alternatives for Reducing Phosphorous Losses

To be able to effectively translate these farmer concerns about water quality into action, policy alternatives need to be selected that are cost effective and acceptable. Clearly, the farmer's response to various policies will be important in determining their effectiveness. Consequently, we need to know the relative costs and acceptability of alternative policies.

1. Farmer and Agency Opinions Concerning Policy Costs

Farmers were asked about both the acceptability and the costs to them of a variety of alternative policies that would be expected to have a positive impact on the quality of the Minnesota River.[2] While a specific percentage tax on phosphorous fertilizers was not mentioned in the survey, farmers indicated a phosphorous tax (8.07) would be the highest cost policy for them (Table 2). The current tax on fertilizer in Minnesota is $0.35 per ton, or approximately 0.175 percent of the cost of a ton of fertilizer. A tax rate that

[2] The acceptability question was asked first so that farmers would be less likely to exhibit strategic behavior on the cost question. However, since farmers where asked to only rank policies based on cost, it was difficult for them to exhibit much strategic behavior.

would reduce phosphorus loadings by 40 percent would necessarily be much higher (Denbaly and Vroomen 1993, Roberts 1986).

The next highest cost policy was perceived by farmers to be a tax on manure (6.91), followed by a requirement for phosphorus banding (6.88) and conservation tillage on all land planted to annual crops (6.77). The lowest cost policy was recognition programs for good land stewardship (3.96). The most frequent response for requiring conservation tillage on all land was 10 (very expensive) while the most frequent response for requiring conservation tillage only on highly erodible land was 1 (not at all expensive). It is also interesting that requiring soil testing is seen as an expensive policy (5.63), even though the majority of farmers already use soil testing and the tests only cost about $7. Farmers also indicated that even if there was a possibility of receiving a subsidy (payment) based on the amount of pollution leaving the farm, the tax-payment program (6.17) was still seen as a costly policy.

Table 2. Farmer versus agency perceptions of farmer costs of alternative policies
(1=not at all expensive, 10=very expensive)

	Farmer		Agency	
Policy/Program	Mean	Rank	Mean	Rank
Education/Extension programs about best management practices (BMP's)	4.07	2	2.87	4
Recognition programs for good land stewardship	3.96	1	2.37	1
Require grass buffers around surface tile inlets	5.25	7	5.63	10
Require conservation tillage on all land planted to annual crops	6.77	14	6.55	13
Require conservation tillage on all highly erodible land	4.97	4	5.49	8
Prohibit manure applications during winter months	5.61	10	6.89	15
Require manure incorporation within 72 hours of application	5.25	7	5.97	12
Expand the Reinvest in Minnesota Program so more acres could be enrolled	5.43	8	2.84	3
Adoption of best management practices as a condition for receiving farm payments	5.62	11	5.42	7
Phosphorus tax on purchased fertilizer	8.07	17	6.71	14
Tax on manure produced on the farm based on phosphorus content	6.91	16	7.15	17
Payments from factories and waste treatment plants to farmers who implement BMP's	4.68	3	2.74	2
A program in which a farmer would either pay a tax or receive a payment depending on the amount of pollution leaving the farm.	6.17	13	5.81	11
Requirement for phosphorus banding at planting	6.88	15	5.56	9
Require soil testing before allowing purchase of fertilizer	5.63	12	4.90	6
Tighten feedlot requirements to reduce runoff	5.11	5	7.10	16
Cost sharing for the implementation of BMP's	5.52	9	4.14	5

In addition to the farmer survey, a short survey was sent to selected individuals who had attended meetings sponsored by the University of Minnesota and state government agencies regarding water quality

in the Minnesota River. Within this group, individuals were selected to represent a variety of agencies and organizations involved with the water quality in the river. Because the survey method was not random, the results cannot be validly extrapolated to a larger population. The groups represented included county water plan coordinators, Minnesota Department of Agriculture, Metropolitan Council, Minnesota Pollution Control Agency, Minnesota Department of Natural Resources, education/research organizations, farm input supply organizations, county commissioners, environmental organizations, commodity groups, soil and water conservation districts, legislative staff, the Natural Resource Conservation Service, and the Board of Soil and Water Resources. Survey data was used to examine the relation between policy preferences, perceived abatement costs, and perceived transaction costs. In the survey, the term administrative costs was used since this was considered to be more understandable to the surveyed population than transaction costs. However, it is possible that administrative costs has a narrower connotation than the definition of transaction costs used for this study.

The policies that were perceived by agencies to be least costly to farmers were recognition programs (2.37) such as the River Friendly Farmer Program, payments from point sources to farmers who implement best management practices (BMP's) (2.74), and expanding the Reinvest in Minnesota (RIM) program (2.84) (Table 2). The most expensive policies for farmers were perceived to be a tax on manure (7.15), tightening of feedlot requirements (7.10), a prohibition on manure applications during winter months (6.89), and a tax on phosphorous fertilizers (6.71).

2. Farmer and Agency Opinions Concerning Policy Acceptability

Farmers were also asked about the acceptability of the various policies and programs (Table 3). The program with the highest mean score (7.55 on a scale of 1 to 10) was requiring conservation tillage on all highly erodible land. This may be partly due to the fact that few of the farmers have highly erodible land, although this was not considered to be the least costly policy. It may also be due to their perception that runoff is primarily a problem on these lands. The next most acceptable policies were extension programs

about best management practices (6.89), recognition programs for good land stewardship (6.38), and tightening feedlot requirements to reduce runoff (6.31). Requiring manure incorporation (5.29) was

Table 3. Farmer acceptability of alternative programs (1=not at all acceptable, 10=very acceptable) **and agency expectation of farmer resistance** (1=very low, 10=very high).

	Farmer		Agency	
Policy/Program	Mean	Rank*	Mean	Rank*
Education/Extension programs about best management practices (BMP's)	6.89	2	3.20	2
Recognition programs for good land stewardship	6.38	3	2.41	1
Require grass buffers around surface tile inlets	5.72	6	7.36	11
Require conservation tillage on all land planted to annual crops	4.03	13	7.84	14
Require conservation tillage on all highly erodible land	7.55	1	6.12	6
Prohibit manure applications during winter months	4.38	11	7.87	15
Require manure incorporation within 72 hours of application	5.29	8	6.88	8
Expand the Reinvest in Minnesota Program so more acres could be enrolled	5.61	7	3.26	4
Adoption of best management practices as a condition for receiving farm payments	5.00	9	6.83	7
Phosphorus tax on purchased fertilizer	2.09	17	8.39	16
Tax on manure produced on the farm based on phosphorus content	2.09	17	8.97	17
Payments from factories and waste treatment plants to farmers who implement BMP's	4.75	10	3.25	3
A program in which a farmer would either pay a tax or receive a payment depending on the amount of pollution leaving the farm.	3.32	14	7.54	12
Requirement for phosphorus banding at planting	2.86	15	7.64	13
Require soil testing before allowing purchase of fertilizer	4.21	12	7.21	10
Tighten feedlot requirements to reduce runoff	6.31	4	7.07	9
Cost sharing for the implementation of BMP's	5.79	5	3.43	5

*The rank will be *high* for those programs that have *high* farmer acceptability or *low* farmer resistence.

more acceptable than prohibiting manure applications during the winter (4.38), although it seems that farmers assumed that the incorporation requirement was for those applications that occurred outside of the winter months. This result is consistent with the prohibition on winter manure applications being perceived as costly. The least acceptable policies were those for which the perceived costs were highest, a phosphorus tax (2.09) and a manure tax (2.09), followed by the requirement for phosphorus banding at planting (2.86).

Most of the cost and acceptability rankings by farmers were fairly similar except that the cost of payments from factories to farmers was seen as being fairly low (#3), although it was in the bottom half of the acceptability rankings (#10). This seems fairly surprising and it may stem from resentment toward urbanites and the feeling that waste treatment plants and urban runoff are the primary problems. Lowry Nelson in 1948 (p. 158) wrote that farmers perceive city people to be "effete, sophisticated, superficial, and corrupt" while rural people are seen as "virtuous, industrious, moral and leading a more natural life." While rural/urban differences may have diminished, comments on the survey indicate a certain antagonism toward the Twin Cities and its problems. While the survey did not contain a question regarding the perceived effectiveness of alternative policies, it may be that this influences the acceptability rankings.

Perceived farmer resistance to alternative policies was also evaluated in the agency survey (Table 3). The policies expected to encounter the least resistance were recognition programs for good land stewardship (2.41), extension/educational programs (3.20), and payments from point sources to farmers who implement BMP's (3.25). Resistance was expected to be high for a tax on manure (8.97), a tax on phosphorus fertilizers (8.39), the prohibition of winter applications of manure (7.87), and a requirement for conservation tillage on all land planted to annual crops (7.84).

Agency staff had a fairly good idea of the costs and acceptability to farmers of alternative policies. Holtman (1997) indicates that knowledge of the regulated party should be a criterion for assessing the quality of government decision-making. Both farmers and agencies ranked recognition programs for good land

stewardship as the least costly policy for farmers. Other policies ranked among the five least costly policies by both groups included education programs and payments from factories to farmers who implement BMP's. Taxes on manure and phosphorus fertilizers and a requirement for conservation tillage on all cropped land were seen as very costly by both groups. Tightening feedlot requirements was seen as very costly by agency personnel but farmers viewed it as one of the least costly policies (#16 vs. #5). Farmers saw banding phosphorous as more costly than did agency staff (#15 vs. #9). Farmer and agency staff both viewed educational programs, recognition programs, and cost sharing as among the most acceptable policies listed. Agency people *underestimated the acceptability* of tightening feedlot requirements (#9 vs. #4), and requiring conservation tillage on highly erodible land (#6 vs. #1). They *overestimated the acceptability* of RIM and payments from factories to farmers (#3 vs. #10). Agency perceptions of the resistance to a tax on manure or phosphorous fertilizers coincided with the farmers responses.

3. Agency Costs and Preferences

Agency survey respondents were asked to give their perception of the administrative costs associated with various policies (Table 4). They were asked to consider costs to all organizations, not just their own. The response rate was lower for policies involving conservation tillage requirements, manure application restrictions, and taxes. The least costly programs were perceived to be recognition programs for good land stewardship (4.01), a tax on phosphate fertilizers (4.44), and extension/educational programs (5.48). The most expensive policies were a tax/subsidy scheme (8.21), a manure tax (6.88), and the RIM program (6.81).

The least preferred policies were taxing manure based on phosphorous content (3.37), recognition programs for good land stewardship (4.01), and a tax/subsidy scheme (4.82). The most preferred policies were requiring tillage on highly erodible land (8.01), expanding the RIM program (7.97), and extension/educational programs (7.89). Thus the number one agency preference coincided with that of the farmers. There was also agreement on educational programs. RIM was preferred by agency staff but was not particularly popular with farmers (#2 vs. #7). Agency staff gave recognition programs low scores but

Table 4. Administrative Costs and Preference for Alternative Policies by Agency Staff (1=very low, 10=very high)

	Admin. Costs		Preference	
Policy/Program	Mean	Rank*	Mean	Rank*
Education/Extension programs about best management practices (BMP's)	5.48	3	7.89	3
Recognition programs for good land stewardship	4.01	1	4.01	16
Require grass buffers around surface tile inlets	5.61	6	6.76	7
Require conservation tillage on all land planted to annual crops	6.27	11	4.89	13
Require conservation tillage on all highly erodible land	5.55	4	8.01	1
Prohibit manure applications during winter months	5.60	5	5.69	10
Require manure incorporation within 72 hours of application	5.97	8	6.57	8
Expand the Reinvest in Minnesota Program so more acres could be enrolled	6.81	15	7.97	2
Adoption of best management practices as a condition for receiving farm payments	6.70	14	7.01	5
Phosphorus tax on purchased fertilizer	4.44	2	4.87	14
Tax on manure produced on the farm based on phosphorus content	6.88	16	3.37	17
Payments from factories and waste treatment plants to farmers who implement BMP's	6.51	13	5.18	12
A program in which a farmer would either pay a tax or receive a payment depending on the amount of pollution leaving the farm.	8.21	17	4.82	15
Requirement for phosphorus banding at planting	5.69	7	5.28	11
Require soil testing before allowing purchase of fertilizer	6.04	9	6.30	9
Tighten feedlot requirements to reduce runoff	6.29	12	6.94	6
Cost sharing for the implementation of BMP's	6.26	10	7.64	4

*Ranking is highest for those practices that have the *lowest* administrative cost or *highest* staff preference.

these programs were popular with farmers (#16 vs. #1). Agency preferences for tightening feedlot requirements more closely matched farmer preferences (#6 vs. #4) than did agency perceptions of farmer preferences (#9 vs. #4).

Determinants of Farmer Resistance to Policies

The transaction costs to government agencies of implementing alternative policies can be expected to be affected by farmer resistance to policies. For example, if farmers agree that a policy is acceptable, enactment, monitoring and enforcement costs are likely to be lower. In order to examine what factors affect acceptability of policies by farmers, the acceptability rating was regressed on possible determinants. It was expected that educational level and age may affect farmer knowledge about the environment and agricultural externalities. People who use the river for recreation would be expected to be more open to policies to clean it up. A dummy variable that indicates whether the Minnesota River is the closest river to them should be positively related to acceptability, since they are more likely to perceive their actions as having an effect on water quality. A higher percentage of rented land may be expected to have a negative effect on acceptability since farmers will be less concerned with the long term productivity of rented land. People who have had contact with Extension would have been exposed to information on best management practices to improve water quality. Those who already practice conservation tillage and soil testing may be more willing to implement other practices. A livestock dummy is included, since some policies only affect livestock operations so crop farmers should find these policies more acceptable. Whether agriculture is perceived to be a significant contributor to water quality problems in the Minnesota River would be expected to be positively related to the acceptability of policies to clean it up. The amount of erodible land would also be expected to have a relationship but it might be positive due to their realization that they may affect the river water quality or negative due to the realization that they may be targeted for conservation practices.

Since the dependent variable, policy acceptability, ranges from 1 to 10, it is an ordinal dependent variable. Also, because only the endpoints are fixed, we can assume this represents interval data, that the

distance from 1 to 2 is the same as that from 5 to 6. Linear regression is typically used in these cases (Long 1997, Pam Schomaker personal communication). Problems using ordinary least squares primarily arise when response options are not equally distant from each other such as "strongly agree" to "agree" versus "agree" to "disagree" (Kennedy 1992).

The policy cost index ranges from 1 to 10, while the age variable is in years. The Minnesota River dummy variable was set equal to 1 for farmers who indicated that the closest river to them was the Minnesota and 0 otherwise. The activity dummy variable was set equal to 1 if the farmer indicated that they engaged in recreational activities near or on the river and 0 otherwise. The importance of the contribution of agricultural runoff to phosphorous problems in the Minnesota River on a scale of 1 (not important) to 10 (very important) was included as a variable. The dummy variable for extension contact was set equal to 1 if they indicated they had contact with an extension educator in the last two years and 0 otherwise. If farmers practiced conservation tillage currently, the dummy variable was set equal to 1 and 0 otherwise. Total acreage refers to total crop acres reported. The animal dummy variable was set equal to 1 if they indicated that they had livestock and 0 otherwise. There is also a dummy variable for percentage of erodible land which is set equal to 1 if the farmer has less than 5 percent erodible land and 0 otherwise. The dummy variable for soil testing is equal to 1 if they soil test at least every 3-4 years and 0 otherwise. For the set of education dummy variables, the category of 4 year degree or higher was dropped and serves as the base. The other categories are less than high school, completed high school, and some college or technical school. The counties were divided into two groups depending on their location in the watershed. The counties of Pope, Chippewa, Yellow Medicine, Lincoln, Renville, and Redwood are in the west and were given a value of zero for the dummy variable, while the eastern counties of Sibley, Scott, Blue Earth, Waseca, Martin and Faribault were assigned a value of 1.

Table 5 gives the results of regressions of the acceptability of various policies as a function of the explanatory variables. None of the models explained more than 37 percent of the variation in the acceptability

index. The coefficient on perceived, or perhaps more appropriately, the reported, cost of the practice or policy was negative and significantly different from zero in all cases. The negative correlation is what we would expect from economic theory, since utility is increasing with profits, *ceteris paribus*. On the other hand, it is remarkable that perceived cost explains so little of the variation in acceptability scores. For the other variables, whether they were significant depended on the policy.

Table 5. Regressions of Policy Acceptability versus Explanatory Variables.

Variable	Education	CT - erodible	CT - all	RIM	Cost Sharing	P tax
Intercept	8.31***	9.25***	6.04***	7.63***	8.16***	5.16***
Policy Cost	-0.20***	-0.43***	-0.58***	-0.14**	-0.13*	-0.23***
Age	0.001	0.007	0.02	-0.01	-0.01	-0.03**
MN closest river?	0.98	-0.38	0.49	-0.42	1.30	0.21
Eastern Basin	0.21	0.52	0.85**	-0.55	0.41	-0.06
Rec. Activity?	0.17	-0.16	0.02	-0.16	-0.31	-0.43
Ag Contrib. to P	0.05	-0.02	-0.07	0.05	0.12	0.01
Ext. Contact?	-0.19	0.38	-0.03	-0.23	-0.19	0.19
Practice CT?	-0.45	0.74	1.01**	-0.16	0.84	0.04
Total Acres	-0.000	-0.000**	0.000	0.000	0.000	-0.000
Livestock?	-0.09	-0.09	0.16	-0.07	-1.07**	0.30
% rented in	-0.005	-0.004	0.005	-0.01	-0.01*	0.001
no erodible land	0.32	0.13	-0.11	-0.20	-0.78	-0.15
Soil test?	0.07	-0.79*	-0.17	0.60	-0.10	0.05
< High school	-1.13	-1.01	-0.08	-0.76	-2.78***	0.77
High school	-0.65	0.42	0.15	-0.81	-0.41	0.11
Some college	-1.47*	0.40	-0.37	0.04	-0.88	-0.15
R^2	0.13	0.26	0.37	0.08	0.18	0.14

*** p<0.01, ** p<0.05, * p<0.1

For extension or other *educational programs*, farmers with some college or technical school education were significantly less likely to support the policy than those with a B.S. or more. One would expect people who value education for themselves to value educational programs and this is what we see for farmers with a B.S. degree or more.

Requiring *conservation tillage on highly erodible land* was the most popular of the policies examined. While the coefficient on total acres was significant, it was essentially equal to zero. Having less than 5 percent erodible land did not affect the acceptability compared to those with more than 5 percent. The coefficient on soil testing was large, negative, and significant. This is opposite to the result that was expected and remains unexplained.

Requiring *conservation tillage on all cropped land* was more acceptable to farmers who already practice it. This was expected since they already have the equipment and the knowledge and may have adopted the practice to reduce labor requirements as well as conserve their soil resources. This model had more explanatory power than the other models but it still did not explain very much of the variation in acceptability scores. This was the only model in which the basin variable was significant, which suggests that farmers in the eastern part of the basin are more favorably disposed toward conservation tillage on all land.

In the model for the *Reinvest in Minnesota* program, perceived policy cost was the only significant explanatory variable. This may indicate that appropriate explanatory variables were not included in the model, or that there is wide variability in perceptions of the program and reasons for participation.

Acceptability of *cost sharing programs* had the greatest number of significant variables, although the conservation tillage model explained more of the variability in acceptability scores. Livestock producers were less likely to find it acceptable than those who only had crops. The difference in acceptability may be due to the fact that the emphasis has traditionally been on cost sharing measures in crop production. The more land was rented in, the lower the acceptability index for the cost share program. The lower index could

be explained if there is a more complicated process for obtaining cost sharing on rented, as compared to owned, land. Those with less than a high school education were significantly less supportive than those who had a college degree. The very large magnitude of this coefficient is striking and suggests that agencies with cost share programs should examine this issue. Farmers with limited education may feel left out of some of the programs or feel that more educated people are better able to take advantage of the programs.

The *phosphorous tax* was the least acceptable of the policies. Older farmers were less likely to support a tax policy than younger farmers. This suggests that younger farmers are more resigned to taxes than older farmers are or have a better understanding of the user-pays principle for effluents.

Other than the perceived policy cost, few of the explanatory variables were statistically significant, although their signs are of interest. Being located close to the Minnesota River makes farmers more likely to favor extension, conservation tillage on all land, cost sharing programs, and a phosphorous tax than people who live closer to another tributary. It was expected that farmers who participated in recreational programs would be more likely to favor policies to clean up the river, but in most cases the coefficient on this variable is negative. It could be that they are already conscientious in limiting their pollution of the river and resent taxes and regulations that would require it. The coefficient on the extension contact dummy variable was negative for extension programs as well as cost sharing and the RIM program. Practicing conservation tillage made people less likely to favor extension and RIM than people who did not practice conservation tillage. Less educated farmers were less likely than those with a B.S. degree to favor extension, cost sharing, and the RIM program.

Determinants of Policy Preference by Agency Personnel

The results for the regression of policy preference rating by agency personnel on perceived administrative costs, perceived farmer costs, and perceived farmer resistance indicate that these variables explain only a small amount of the variation in preference scores (Table 6). All explanatory variables are significant when regressed individually on preference. In the full model however, farmer cost is not

significant while farmer resistance is highly significant with a P value of $6.51(10)^{-20}$. In addition, the regression model explains only 13.5 percent of the variation. The sign on all the coefficients is as expected with preference for a policy being inversely proportional to its cost and to farmer resistance. The correlation coefficient for farmer cost and farmer resistance is 0.64 which is not high enough to cause problems with estimation (Kennedy 1992).

It should be noted that a question regarding the efficacy of the policies or programs was not included in the survey. It may be that the correspondence found between farmer resistance and preference over policies may be due to both farmers and policy makers seeing some policies as ineffective. If a question on efficacy were added to the survey, this instrument would offer a quick way of getting expert opinion on policies. Selected policies could then be evaluated in more depth. In addition, each policy was not fully described in the mail survey and some of the policies actually exist while others are purely hypothetical. For example, if it were actually implemented, the tax on manure produced on the farm would probably be based on number of animals which may be less burdensome administratively than what the respondents may have had in mind when they answered the question.

Table 6. Regression of Policy Preference on Administrative Cost, Farmer Cost, and Farmer Resistance. (n=1094, R^2=0.135)

Variable	Coefficient	Standard Error	T-Statistic
Intercept	9.01***	0.259	34.75
ADMCOST	-0.069*	0.035	-1.98
FARCOST	-0.022	0.040	-0.55
FRESIST	-0.336***	0.036	-9.32

* $p<0.05$, *** $p<0.001$

The regression results indicate that administrative costs do affect preferences for the various policies but that perceived farmer resistance is much more significant both in the magnitude of the coefficient and in the P-value. This was an anonymous survey, although respondents may take account of how their

response affects the overall result of the survey. While some of the respondents are elected officials such as county commissioners, the majority are not and thus would not be voted out of office for their stand on this issue. However, agency personnel may fear that the legislature may cut funding to an agency that adversely affects their constituents. It could also be that staff realize that an unpopular policy will make their position more difficult so they prefer policies that are popular with farmers whether or not they are effective or expensive. It is surprising that farmer cost is not significant. This may further indicate that it is the ramifications for themselves that affects their preferences, not the actual cost to farmers. On the other hand, it may be that agency preferences are actually aligned with the perceived preferences of the farmers.

Conclusions

Farmers in the Minnesota River Basin do perceive runoff from fields and feedlots as part of the phosphorous problem in the Minnesota River but they also indicated that urban sources such as waste treatment plants and runoff from lawns are a greater problem. This survey indicates a willingness on the part of farmers to adjust their production practices if they perceive a problem and a solution. As an example, the most acceptable policy for the farmers was a requirement for conservation tillage on highly erodible land while a requirement for conservation tillage on all cropped land was one of the least acceptable policies, especially in the western part of the basin. Because the runoff is greater and the yield reductions due to conservation tillage are lower on steep land, this targeted policy is also more efficient economically. Because farmers can often observe runoff from sloping fields, they realize it is a problem, whereas believing that the runoff from flat fields far from streams is a problem takes a leap of faith. One possibility would be to develop on-farm tests, such as sediment collection boxes, that can be used to demonstrate the extent of the problem.

Another win-win solution suggested by these surveys is changing how soil test results are reported. Phosphorous levels above which no yield increases are possible and which have negative consequences for the environment should be reported as excessive. While the answers on a survey may not predict actual

behavior, it would be relatively inexpensive to implement and definitely seems to hold potential. Requiring that duplicate copies of the soil test results be sent to the farmer may also have a positive effect on reducing phosphorous levels, since a number of farmers said the fertilizer dealer had their test results. Data from the Minnesota Department of Agriculture (1996) indicate that farmers who get their fertilizer recommendations from independent consultants instead of fertilizer dealers apply lower amounts of fertilizer.

Manure management is a problem. Few farmers test their manure and half of them do not use published values as a guide to application rates. There may be potential for an on-farm manure testing kit so that the results would be available immediately. A large number of farmers also spread manure year round or do not incorporate the manure so nutrients are more likely to end up in waterways. There is also some support among farmers for tightening restrictions on feedlot runoff. This is another example of farmers being more supportive when they can see the problem and recognize that there is a solution. Comments from some farmers indicated that they feel current regulations regarding feedlots and factories are not being enforced or are being selectively enforced. Strict enforcement of existing regulations would be another policy option that would likely have lower transaction costs than creating new regulations.

The farmers' information costs associated with programs such as conservation tillage and RIM seem to be relatively small. None of the farmers indicated that a lack of information prevented them from practicing conservation tillage although it could be the case that misperceptions did. For example, farmers may perceive yield reductions from conservation practices to be more of a problem than they actually are. Questions regarding the time required to comply with regulations, fill out paperwork, etc. were not included on the survey so it only addressed one component of farmer transaction costs. Inclusion of these questions in the farmer survey would allow comparisons of the transaction costs borne by farmers with those borne by government agencies.

Perceived farmer resistance rather than high transaction costs seems to explain the fact that tax schemes to reduce agricultural pollution are seldom observed. Policy makers do not want to implement

unpopular policies. The distribution of costs and benefits appears to be an important issue for farmers and agency personnel. Many feel that while abatement costs for these programs are borne by farmers, the benefits accrue to wealthy urbanites. A tax on fertilizers would be very costly to farmers. Fairness may also be an important issue. Farmers who had overapplied phosphorous over the years would be less affected by a tax on fertilizer than farmers who have always applied optimal amounts.

Recognition programs, such as the River Friendly Farmer program for producers adopting a group of BMP's, merit further study. Because it is voluntary and provides a positive incentive it is fairly popular. Since it does not involve a transfer of money, there is less incentive to manipulate the program. In contrast, regulations on a particular practice or a tax on an input may have unintended side effects.

While local institutions are assumed to be more responsive and to have better knowledge of the people in their community, the farmer survey indicated that most think a combination of local and state decision making is appropriate in the case of the Minnesota River Basin. It may be that local organizations do not have the larger view or are more politicized than state organizations. Vogel, in discussing water management districts in Florida, indicates that state decision making and local implementation may be preferable because the water districts have difficulty "...making the tough political, economic, and balanced decisions given their multiple and often conflicting missions" (Vogel 1997, p.10).

The mail survey of government organizations and farmers is potentially a way to get information from a wide variety of people in a fairly short time frame. Policies identified as having potential could then be explored in more depth. A question regarding the perceived effectiveness of the programs should be added to take account of not only the costs, but also the expected results for a given policy.

References

Denbaly, Mark and Harry Vroomen. 1993. "Dynamic Fertilizer Nutrient Demands for Corn: A Cointegrated and Error-Correcting System" *AJAE* Vol. 75(1): 203-209.

Dillman, Don A. 1978. *Mail and Telephone Surveys - The Total Design Method* John Wiley and Sons, New York.

Griffith, Bill. 1996."Phosphorous Management Techniques for Top Efficiency." World Wide Web address: http:// www.ctic.purdue.edu/AgManagementPractices/PhosManage.html.

Holtman, Charles B. 1997. "An Architecture of Public Decision Making: An Organization Theory Approach to Improving the Quality of Government Decisions." M.A. Thesis, University of Minnesota.

Kennedy, Peter. 1992. Chapter 15. "Qualitative and Limited Dependent Variables." In: *A Guide to Econometrics*, Third Edition. The MIT Press, Cambridge, Massachusetts.

Lazarus, William and James Molenaar. 1996. "Using Surveys and Farm Records to Track Farmland Rental Rates." *Minnesota Agricultural Economist* No. 686, Fall.

Long, J. Scott. 1997. Chapter 5. "Ordinal Outcomes: Ordered Logit and Ordered Probit Analysis" *Regression Models for Categorical and Limited Dependent Variables*. Sage Publications, Thousand Oaks, California.

Minnesota Department of Agriculture. 1996. Survey of 28 Farms in the Bevens Creek Watershed and Sand Creek Watershed.

Minnesota Pollution Control Agency. 1994. Minnesota River Assessment Project Report.

Minnesota Pollution Control Agency. 1995. Crop Residue Management for Water Quality Improvement in the Minnesota River Basin: A report on the 1995 transect survey of surface crop residue.

Nelson, Lowry. 1948. *Rural Sociology.* American Book Company, New York.

Olson, Kent D., Dary E. Talley, James Christensen, Erlin J. Weness, Perry A. Fales and Dale W. Nordquist. 1996. "1995 Annual Report of the Southwestern Minnesota Farm Business Management Association." Staff Paper P96-4, Dept. of Applied Economics, University of Minnesota. March.

Roberts, Roland K. 1986. "Plant Nutrient Demand Functions for Tennessee With Prices of Jointly Applied Nutrients." *Southern J. of Agricultural Economics* December: 107-112.

Schmitt, Michael A., John P. Schmidt and Gyles W. Randall. 1996 "Nutrient Credits for Manure--Differences Between Theory and Reality," pp.94-99. In: Proceedings of the 26th North Central Extension-Industry Soil Fertility Conference. St. Louis, MO, November 20-21, 1996. Potash & Phosphate Inst. 700 22nd Ave. S., Brookings, SD.

Sharpley, A.N. and A.D. Halvorson 1994 "The Management of Soil Phosphorus Availability and its Impact on Surface Water Quality." In *Soil Processes and Water Quality.* R. Lal and B.A. Stewart (eds), Lewis Publishers, Boca Raton, Florida.

Taff, Steven J. 1996. "1996 Farm Real Estate Sales Prices Up Sharply Across Minnesota." *Minnesota Agricultural Economist* No. 686, Fall.

Vogel, Cathy. 1997. "Florida Water Law: Bureaucratic to the Last Drop." *Outside the Lines*, Series No. 008, February 28, 1997. Foundation for Florida's Future.