A SIMULATION OF THE ECONOMIC IMPACTS OF NEGATIVE EXTERNALITIES FROM FARM MANAGEMENT PRACTICES IN NORTHEAST ARKANSAS

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Abstract
Increased application of Phosphorus, Nitrogen and Potassium, forms the core strategy to improve agricultural productivity in response to societal demands. Prevailing farming practices involve socially sub-optimal levels of use and containment and cause nutrient runoff into streams, rivers and ultimately to the sea. Such nutrient enrichment of water bodies enhance the growth conditions for aquatic plant-life thereby increasing biological oxygen demand for species competing for resources. This leads to negative externalities downstream of the agricultural region, in the form of water discoloration, reduced fish and other populations of economic interest, and lower recreational values.

The economic value of the downstream impacts is variable, depending on natural factors like rainfall, flooding and topography, as well as anthropogenic factors like fertilizer collection, storage and handling, irrigation management, erosion and runoff control measures. Also, conservation reserve programs addressing run-off issues are not uniformly implemented.

The result is a gap between marginal private costs and marginal social costs in agriculture that leads to economic losses downstream via negative externalities. Best management practices can be incentivized mimicking a traditional Pigouvian Tax to control the losses in downstream values by minimizing the negative externality.

The analytical model in this paper maps various probable equilibria relating to Phosphorus use through analysis of marginal benefits and costs. Benefits are simulated using dose-response models, projected cropping patterns and acreage options. Costs are based on the estimation of negative externalities under different rainfall and land management scenarios. The empirical model determines the net economic values of different levels of P use.

I. NONPOINT SOURCE POLLUTION: ISSUES, INSTANCES AND SOLUTIONS

A. Nonpoint Source Pollution from Agriculture

Nonpoint Source Pollution (NPS) pollution from agriculture is an environmental concern that requires the management of multiple issues and agents. Increasing societal demand on the farm sector makes it necessary to adopt commercial fertilizer and pesticide regimes that may have inadequate containment abilities. The runoff from intensive farming areas has a strong potential for downstream impacts on aquatic flora, fauna, and stream ecosystems. As long as the benefits from the first outweigh the losses of the second, consumer surpluses are expected and an informal flow of a Kaldor-Hicks type of compensation is assumed. The problem occurs when the system overloads and downstream losses exceed the benefits of intensive agriculture.

The expert discussion about nutrient runoff from agriculture contains considerable disagreement on the extent to which agriculture practices affect stream ecologies. A report of the Arkansas Department of Environmental Quality states that agriculture activity is the major source of water body impairment. The same report notes that in-stream turbidity, a major problem, is a consequence of overall surface erosion and not solely that of agriculture activity (ADEQ, 2004). The source of nutrients in streams has also come into question. Preliminary test results from a study on water use and quality in Arkansas rice production indicate that phosphorus (P) levels in the runoff from rice fields may not be significantly different from the groundwater input source (Vories et al. 2006). Soil characteristics can have a major influence on nutrient runoff. In a study of the Neuse River Basin in North Carolina, the soil heterogeneity factor produced "substantially different" results than when the model was run without an accurate representation of the soil and environmental characteristics (Schwabe 2001). Management practices such as type of fertilizer, method of application, tillage practice and irrigation practice are all variables that may influence the amount of nutrient runoff. Due to the complex interaction of factors, more research is needed to help determine the extent of agriculture's contribution to NPS pollution and how best management practices (BMPs) can reduce the nutrient loss. A better understanding of the mechanisms that connect farm practices and their impacts on waterways is essential for designing efficient NPS pollution reduction practices.

B. Nonpoint Source Pollution and Phosphorus (P)

Nonpoint source pollution linked to agriculture stems from five sources: sediment, nutrients, pesticides, pathogens, and salts. The nutrient pollution comes primarily from nitrogen and P. Nitrogen has been widely studied and its impact is fairly recognized. This paper focuses primarily on P - the benefits of its use and the costs of its loss to the environment. Table 1 summarizes the key benefits and costs of Phosphorus use.

Table 1. Benefits and Costs of External Nutrients

BENEFITS	COSTS
Enhances Plant Growth; Speeds Plant Maturity; Component of Photosynthesis; Component of DNA / RNA; Promotes Root Development; Increases Stalk and Stem Strength; Improved Flower / Seed Production.	Excess Nutrient in Water Bodies; Aquatic Plant Growth Accelerates; Decomposition Depletes Oxygen; Species Productivity Effected; Animal Species Threatened; Discolored Water; Reduces Recreational Value of Streams.

Phosphorus is one of the three plant macronutrients and is necessary for photosynthesis, DNA, and RNA. It is also involved in root development, stalk and stem strength, improved flower formation and seed production, etc. (Merrington et al. 2002). The yield and quality of the major crops grown in Arkansas are dependent on adequate P availability. In a study by Bishnoi, Kaur, and Khan (2007), soybean yield and quality were significantly improved by P applications. Phosphorus applications have been shown to have a significant effect on cotton lint yield in some varieties (Girma et al. 2007). Mid-tillering P concentrations were positively related to yields and may be helpful in determining P limiting soils in Arkansas rice (Slaton et al. 2006).
The costs of P in terms of downstream losses are similar to those associated with the addition of excessive nitrogen into the ecosystem. A process called eutrophication results when too much nitrogen and/or P enters a water body. The resulting nutrient enrichment accelerates plant growth and in freshwater systems, P is normally the limiting factor. Regardless of the amount of nitrogen in the system, plant growth stops if all the available P is used up (Osmond et al. 1995). In coastal waters, nitrogen is typically the limiting factor, but recent studies have shown that P can be the limiting nutrient in phytoplankton growth in these areas as well. (Sylvan et al. 2006) Phytoplankton algae is one species that can have an explosion in growth due to nutrient rich waters, resulting in an algal bloom. The algae then die, sink to the bottom and decompose, thereby depleting the dissolved oxygen. This increases fish morbidity and degrades the recreational value of the water body. The well-publicized hypoxia zone in the Gulf of Mexico is a result of this type of process and has oxygen levels below that necessary to support fish and other aquatic species. This area appears to be correlated with nutrient loading primarily from nonpoint sources (Rabalais et al. 2007).

C. Implications of the Clean Water Act (CWA)

The Chesapeake Bay is an example of a water body that was seriously impaired by excessive nutrients. The Bay, however, has seen a major transformation due to regulations and policies instigated by the Clean Water Act (CWA). A study by Morgan and Owens (2001) estimated that the improvement in water quality in Chesapeake Bay resulted in an annual benefit of $357.9 million to $1.8 billion. Their study showed one of the primary factors in improving the nutrient degradation of the Bay waters was an implementation of nutrient management plans on farms in the surrounding area. In conjunction with these management plans, many states have developed P indexes to help identify areas with a high likelihood of P movement to water bodies (Leytem, Sims, and Coale 2003).

The CWA, which began the major transformation of the Chesapeake Bay, was passed by Congress in 1972. The Act set forth the standards to begin monitoring the nation's streams and preserving their quality. As a result, all states are required to monitor their streams and identify waters not meeting the water quality standard. Streams not meeting water quality standards are placed on the 303(d) list. Once on this list, a state is required to develop a Total Maximum Daily Load (TMDL) for each pollutant, as defined by the United States Environmental Protection Agency (EPA, 2006).

In 1987, Congress amended the CWA to address the problems of NPS pollution. This amendment, called Section 319, provides funding to support educational efforts, demonstration projects, monitoring of implementation projects and other areas. Education of farmers on reducing pollution from agricultural activities, along with nutrient and pesticide application training is a vital part of this program. Education of polluters is only one method the public has of reducing NPS pollution problems. Other approaches include standards, taxes, and subsidies.

D. Bridging the Gap between Social and Private Costs

The negative externalities associated with nutrient discharges to the Gulf of Mexico cost the fishing industry an annual value estimated at $650 million (Babcock and Kling 2008). Continuing to ignore the impacts on this industry will have considerable social costs.

The negative externality of the nutrient pollution is characterized as the marginal external cost which is the vertical gap between the narrowly defined marginal production cost and the more inclusive marginal social cost. These costs increase with increases in demand for the commodity, and as production increases the downstream effect of hypoxia increases the gap between the production costs and the social costs. Internalizing some of the social costs involve producer level decisions on alternate farm management practices.

The traditional remedy recommended in mainstream economics is some form of Pigouvian Tax which is set to the marginal external cost. But, if the producer is mandated to adopt practices that raise the cost of production, the profit-maximizing producer may elect to grow other crops, which may raise a different set of economic issues. Hence, non-traditional farm management practices that help to bridge the gap of external costs need to be advocated with prudence and with stakeholder participation.

Appropriate Best Management Practices (BMPs) need to be designed to reduce the marginal external costs, helping to bridge the gap between private and social costs in agriculture. The traditional solution for implementing BMPs is to offer a subsidy to offset the cost of adoption. This is the theoretical equivalent of the Pigouvian Tax, wherein society bears the cost of the environmental solution as opposed to the producer.

A more market friendly solution involves education of the producer so that there is recognition of the issue and participation in problem resolution by the stakeholders. Agriculture research may be able to show benefits from the adoption of BMPs either from some economic byproducts or via indirect inputs into farming. Inclusion of this into agricultural policy will make these practices more acceptable to the farmer.

The core issue that needs to be addressed to find an economic solution to reducing marginal external costs is to determine BMPs that are suitable to the region. The cropping practices that reduce, control or eliminate nutrient run-offs and are also viable cropping options in the Arkansas Delta are:

- No-till crop production,
- Nutrient management,
- Cover crops,
- CRP acreage allocation.

The socio-economic question is, how can these practices be implemented?

E. Addressing the NPS Externality Question

An aggressive approach to remedy NPS pollution is to institute a system of taxes, known in economic literature as Pigouvian Taxes. These can include input taxes (e.g., on fertilizer) or sophisticated systems based on ambient standards. Ambient standards can be developed and monitored to determine the ecological condition of a river. The observed values can be used to determine whether the public pays a subsidy to farmers when pollution falls below a certain level or charge a tax when the pollution levels rise too high (Shortle et al. 1998). The ambient tax has obvious drawbacks because it can attract free riders: compliant producers sharing the burden of the non-compliant ones. In addition, there can be a significant time lag between the movements of the pollution from the field to the stream. Taxes, in general, appear to be a poor solution to the nutrient pollution problem (Pearce and Koundouri, 2003). Estimates show that a five hundred percent tax would cut on-farm use by just eight percent (Ag Answers, 1999) and have very little impact on the environment and a devastating impact to the farm economy.

USDA currently has several programs in place that are subsidy based rather than tax-based systems. These are theoretical equivalents of the Pigouvian Tax. These incentive-based systems are paid directly to a farmer that improves environmental quality on his farm. The primary program is the Environmental Quality Incentives Program (EQIP) and provides an assistance payment for about 250 eligible conservation practices. Another program called the Conservation Reserve Program (CRP) is mainly for retiring highly erodible land from production. A subset of this program is the continuous CRP. This program includes a rental payment for land when a farmer employs such practices as riparian buffers, filter strips, bottomland hardwood tree planting and upland habitat program for quail, etc. An alternative to CRP contracts are the Wetlands Reserve Program (WRP) where farmland is returned to a wetland condition permanently or for a 30-year contract in exchange for a one-time payment. A relatively new program that rewards producers for good conservation and environmental practices is the Conservation Security Program (CSP). This program is targeted to a specific watershed. Farmers within these areas receive payments based on soil quality and water quality practices they already employ on their farm. Soil quality practices include soil testing, cover crops, no-till farming, etc. Water quality practices include specific tillage practices, filter strips, grassed waterways, nutrient and pesticide management plans, irrigation scheduling practices, etc. (NRCS, 2005)

II. Modeling Phosphorous Run-Off Impacts

A. Phosphorus Dose-Response in Crops

Soil test recommendations are based on crop yield response curves. In tests to develop these curves, different rates of P are applied to soils to determine an optimum rate of P for maximizing yield. Although not used for soil test recommendations a variation of these curves called maximum economic yield is more valuable to a farmer. These curves actually take into account the cost of the P fertilizer and the value of the crop to determine what rate of P is optimum.

The top four crops in Arkansas based on the value of production are soybeans, rice, corn and cotton. Their acreage and value for the latest available year (2014) are given in Table 2. These crops have the biggest economic impact in Arkansas; the next highest crop is hay at $284.2 million (NASS, 2014). Agriculture as a whole accounted for 17.7% of the Arkansas gross state product in 2012 (BEA). If laws restricting P use are enforced to preserve state water quality, it could have a significant impact on the Arkansas economy.

Table 2. Four Major Arkansas Crops: Average Acres, Yield, and Value

Crop	Harvested Acres	Yield per Acre	Units	Average Price	Value
Soybeans	3,200,000	49.5	Bushels	$ 10.60	$ 1,717,350,000
Rice	1,480,000	7,560	Pounds	$ 0.127	$ 1,421,854,000
Corn	530,000	187	Bushels	$ 4.13	$ 401,396,000
Cotton	330,000	1,145	Pounds	$ 0.644	$ 243,638,000

Source: NASS, 2014.

Data was obtained from published sources on soil P content in lbs. per acre and matched with yields of corn, cotton and soybean grown on these tested soils (see for e.g., ASPB, 2005; Oldham, 2003; Snyder, 2004). The crop yield data were then converted to a percentage of maximum crop yield obtainable from P nutrition. The crop yield percentages of maximum yield were regressed on their respective tested soil P contents.

Different functional forms were attempted to best express the causal relationships between yields and P application. For example, an R2 = 0.99 and significant t-statistics were obtained when using a linear form in (1), linear-log in (2) and log-log in (3), in regressing Yields over log P and log P2. The specifications were changed to a liner-log form, following an astute recommendation from an anonymous reviewer, "because that is the most elegant form and easy to interpret, even though it may not be the best fit".

(1) $Y_{COR} = -28.02 + 35.52 \log P^2$
[R2 = 0.96 and t-statistics are significant at $\alpha = 0.001$]

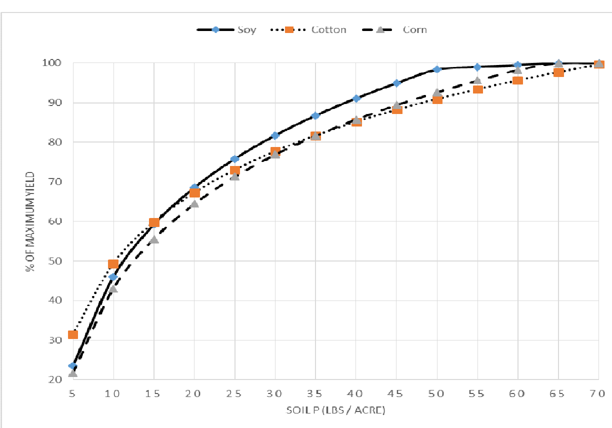
(2) $Y_{COT} = -10.04 + 29.71 \log P^2$
[R2 = 0.95 and t-statistics are significant at $\alpha = 0.001$]

(3) $Y_{SOY} = -28.81 + 37.43 \log P^2$
[R2 = 0.95 and t-statistics are significant at $\alpha = 0.001$]

Where, YCOR, YCOT, YSOY: are % of maximum yield for Corn, Cotton, and Soy, respectively;
And, P is the application of P on tested soil, in lbs. / acre.

Figure A is the plot of crop yield (percentage of maximum yield) to soil P for corn, cotton and soybeans in the functional forms shown above. It shows that soybean yields reach their maximum between 35 to 40 pounds of soil P, while the response of cotton yield to tested soil P is more abrupt, dropping off at about 50 pounds of soil test P. The response curve for corn lies in the middle of the soybean and cotton curves and has been included since the potential exists for increased corn acres due to ethanol mandates.

Figure A. Crop Response to Soil Phosphorus Level



Sources: Snyder 2004, Cox and Barnes 2002

No P curve was developed for rice, since research has shown very little correlation with the soil test P, primarily because of the complex soil chemistry involved under the flooded conditions. Some of the previously unavailable P, on the iron and aluminum sites becomes available. Under these waterlogged conditions, pH actually becomes a better predictor of P response in rice than soil test P (based on interview with Clifford Synder, Southeast Director, Potash & Phosphate Institute, April 05, 2006). This would imply that a pure rice-cropping regime would result in fewer P applications.

*B. Run-off Scenarios (3*3*3) and Impact Analysis*

There is much uncertainty involved with predicting future runoff rates from different amounts of P fertilization due to weather, topography, tillage practices and other factors in all Arkansas watersheds. In addition, the true social cost of the fertilizer application needs to be determined by accounting for the pollution damage done to the Arkansas streams and rivers. This study has extrapolated data from two watersheds in the northeast delta area of the state located east of Crowley's Ridge, a loessial formation that splits the delta in the northeast part of the state. The two watersheds called the Little River Ditches and the Lower St. Francis River drain the land in this area of the state. The study area comprises the counties of St. Francis, Cross, Lee, Poinsett, Craighead, Greene, Clay, Mississippi and Crittenden.

The impacts of three different use rates of P2O5 across the area have been simulated for the period 2006-2020. In addition, each rate was assumed to be applied under three runoff scenarios representing a low, medium, and high P loss from the soil due to a combination of tillage practices and climatological impacts. Estimates of P loss, obtained from the literature, were used to generate impact values. The water bodies involved were rated for three types of resilience – fragile, moderate and strong – representing 20%, 10% and 5% susceptibility to damage by increased pollutant loads.

Table 3. Northeast Arkansas Phosphorus Use

Year	Tons P_2O_5 Sold	Row Crop Acreage	Avg. Application (lbs./ac)
2003	18,337	2,545,700	14.4
2004	19,144	2,583,200	14.8
2005	17,441	2,575,300	13.5
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Average	18,307	2,568,067	14.3

Sources: Tons P_2O_5 sold was calculated from Fertilizer Sales by County Booklets prepared by ASPB, 2003-2005. Row crop acreage is a sum of the corn, sorghum, cotton, soybeans and rice acreages in the counties studied (NASS, 2003-2005).

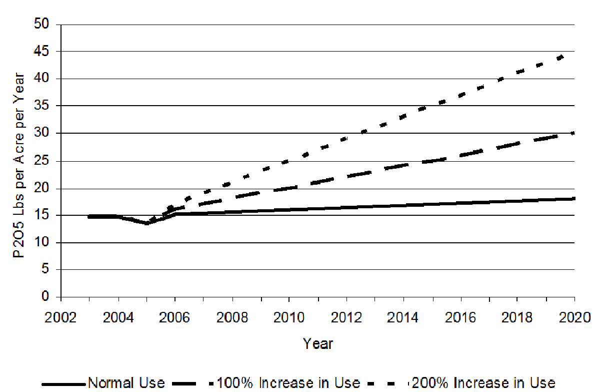
The starting point for P2O5 application rates across the area was obtained from the Arkansas Distribution of Fertilizer Sales by County document published by the Arkansas State

Plant Board, and shown in Table 3. The sales data provided the information necessary to calculate the actual amount of P2O5 applied per county. Acreage statistics were tabulated from county level information available from the USDA-NASS acreage reports. Although the watershed splits some counties it was assumed that cropping patterns and practices were similar across the county and therefore the per acre use rate would be about the same. Average P2O5 applied per acre across the watersheds averaged approximately 15 pounds per acre for the 3-year period, 2003 – 2005 (ASPB, 2005). Although the application rate may seem low, a certain number of acres within the counties do not receive P2O5 applications.

With the recent surge of interest in biofuels causing commodity price swings and farm program flexibility, the acreage mix across the Delta is subject to speculation and transition. This could result in marked changes in P application. For example, a medium fertility soil testing 55 lbs. per acre of soil test P requires a P2O5 application rate of 0, 40, and 70 lbs. per acre for rice, soybeans, and corn respectively [Slaton 2001, CES 2000, CES 2003]. A big shift to corn for ethanol production could result in heavy P use and affect the nutrient balance in the streams and rivers. On the other hand, a shift to a more rice acres could result in P use at or slightly below current levels over the study period. Therefore, the first P rate chosen for the scenario analysis is the current average use rate plus a 20% increase over the time of the study or 18 lbs. per acre total. Treatments 2 and 3 assumed a 100 and 200 percent increase in use due to crop acreage shifts stemming from the demand for biofuels. These treatments are 30 and 45 pounds per acre.

An illustration of the increased P applications over time is presented in Figure B. The literature (Hart, 2004) reports on several studies showing that fertilizer P was lost in runoff after a surface application. Values ranged from 3.8% to 11.5%. Using this information, runoff treatments assuming a loss of 3, 7 and 12 percent were selected to represent low, medium and high probability of P runoff due to weather, tillage, and application influences. A control treatment of 15 lbs. per acre and 7% runoff loss was selected.

Figure B. Projected Phosphorus Use per Acre Under Three Scenarios



III. Findings and Conclusions

A. *Simulation of Downstream Impacts*

The results of the simulations have been summarized in Tables 4 and 5 below. The first two columns refer to the nine runoff scenarios based on three different management alternatives and three different P application rates. The projected P use scenarios multiplied by typical runoff rates resulted in the loss rate in lbs. per acre at the end of the study period, shown in column 3. The change in stream P loads were calculated by comparison with the control treatment and were shown as a percentage increase / decrease in column 4.

Table 4. Phosphorus Impact Scenarios – Stream Resilience

				Stream Resilience		
P_2O_5 Application Rate (lbs. / acre) [a]	Runoff Scenarios [b]	P_2O_5 Loss (lbs. / acre)	% increased P load from Control	Fragile (-20%)	Moderate (-10%)	Strong (-5%)
	High 12%	5.4	414%	-83%	-41%	-21%
High (45)	Medium 7%	3.2	200%	-40%	-20%	-10%
	Low 3%	1.4	29%	-6%	-3%	-1%
	High 12%	3.6	243%	-49%	-24%	-12%
Medium (30)	Medium 7%	2.1	100%	-20%	-10%	-5%
	Low 3%	0.9	-14%	3%	1%	1%
	High 12%	2.2	106%	-21%	-11%	-5%
Low (18)	Medium 7%	1.3	20%	-4%	-2%	-1%
	Low 3%	0.5	-49%	10%	5%	2%
Control (15)	Control 7%	1.1	0%	0%	0%	0%

Notes:

a. P_2O_5 application rates are based on end of pipe scenario of 2020.

b. Runoff scenarios were extrapolated from literature (see text).

c. Stream value has been set at a hypothetical $1,000,000 and may be easily replaced by a "real" value if available. However, the hypothetical value do not diminish this analysis since relative changes are shown

The projected damage to the stream was calculated depending on the sensitivity of the segment and was depicted under the header of "stream resilience". Finally, the percent damage ratings were converted to relative monetary values based on a hypothetical value. The hypothetical value does not take away from the comparative static analysis since only the relative impacts to the stream have been analyzed. However, this can be fine-tuned as better stream value data becomes available.

Values differ from the control treatment by a positive impact of about $97k in the low application, low run-off (better land management) scenario to a negative impact of about $828k in the high application, high run-off scenario. It is interesting to note that even a 200% increase in fertilizer use can result in minimal additional stream damage if proper management practices are in place to keep runoff losses in the low range. On the other hand, poor stewardship resulting in high losses can increase stream P loads significantly even at current use rates.

Table 5. Phosphorus Impact Scenarios – Stream Valuation

P_2O_5 Application Rate (lbs. / acre) [a]	Runoff Scenarios [b]	P_2O_5 Loss (lbs. / acre)	% increased P load from Control	Stream Valuation ($) [c] Fragile (-20%)	Moderate (-10%)	Strong (-5%)
High (45)	High 12%	5.4	414%	($828,571)	($414,286)	($207,143)
	Medium 7%	3.2	200%	($400,000)	($200,000)	($100,000)
	Low 3%	1.4	29%	($57,143)	($28,571)	($14,286)
Medium (30)	High 12%	3.6	243%	($485,714)	($242,857)	($121,429)
	Medium 7%	2.1	100%	($200,000)	($100,000)	($50,000)
	Low 3%	0.9	-14%	$28,571	$14,286	$7,143
Low (18)	High 12%	2.2	106%	($211,429)	($105,714)	($52,857)
	Medium 7%	1.3	20%	($40,000)	($20,000)	($10,000)
	Low 3%	0.5	-49%	$97,143	$48,571	$24,286
Control (15)	Control 7%	1.1	0%	-	-	-

Notes:
a. P_2O_5 application rates are based on end of pipe scenario of 2020.
b. Runoff scenarios were extrapolated from literature (see text).
c. Stream value has been set at a hypothetical $1,000,000 and may be easily replaced by a "real" value if available. However, the hypothetical value do not diminish this analysis since relative changes are shown

B. Concluding Observations

Phosphorus is an essential nutrient for crop production and its application is integral to the economy and employment of the study region where land use is dominated by row crops. However, excess P leads to negative externalities in the waterways and lakes of the Delta and eventually flows to the Gulf of Mexico influencing the hypoxia zone at the mouth of the Mississippi. This paper has examined the literature for information on the benefits of P use based on value added in crop production, and the costs based on its negative environmental impacts. It was found that any new standards or taxes used to correct the externality would impose a serious burden on the region's farming communities and lead to economic distortions. On the other hand, the various simulations showed that education of farmers on BMPs could be the best instrument to address the externality problem.

Legislation resulting from the Clean Water Act has resulted in better monitoring of nutrient and other pollutant loads in Arkansas. It is now the responsibility of the state to develop TMDL's for the impaired Arkansas streams and rivers. As a result, legislation aimed at agriculture P applications will continue to expand. Even so, it is difficult to quantify all the variables involved in P use, P application and the control of subsequent runoff parameters. Using BMPs to reduce the loss of P into the aquatic system can make a significant difference in the overall social cost of P use. Balancing the benefits and costs can lead to improved water quality and sustainable agriculture production.

The impact model can be given sharper resolution by running different P management scenarios through a P model (AGNPS) to obtain more detailed nutrient loadings specific to the various watersheds. In addition, a contingent valuation survey at the stream locations can enhance the estimation of comprehensive economic losses, including losses of non-market goods, in the watershed due to pollutant loading.

This analysis can also be extended to develop marginal cost and marginal benefit curves. Scenarios involving different P treatments reflect costs to the ecosystem at a corresponding P use. Phosphorus use results in marginal benefits to crops depending on crop, soil type, and other management practices. Within each year, weather patterns and cropping patterns will influence the curves. Running multiple simulations can give an indication if an optimum P application exists for crop and environmental concerns. The resulting equilibrium P figure could assist in developing optimal farm subsidy programs and BMPs.

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