IMPACTS OF NON-POINT SOURCE POLLUTION REGULATIONS ON MISSISSIPPI AGRICULTURE

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The Federal Water Pollution Control Act of 1972, PL92-500, established the goals of making the nation's streams and lakes swimmable and fishable by 1983 and eliminating both point and non-point pollution discharge by 1985. Implementation of this act, even if carried out uniformly and on the basis of scientifically determined information, could have far-reaching impacts on the agricultural sector.

The purpose of this article is to:

1. Review the requirements of the legislation.
2. Review selected research.
3. Estimate the potential economic impact of proposed regulations on agriculture in Mississippi.
4. Identify research needed to minimize the adverse economic impact of attaining the objectives of the regulations.

THE LEGISLATION AND PROPOSED REGULATIONS

The Environmental Protection Agency (EPA) was directed by PL92-500 to establish a regulatory program to reduce and eventually eliminate water pollution. Section 208 of the law provides the basis for the development of non-point water management plans for the rural sector and assigns certain responsibilities to the governors and to various state and regional agencies.

In 1977, Congress passed the Clean Water Act (PL95-217) which amends Section 208, PL92-500, to establish a Rural Clean Water Program (RCWP). RCWP provides for cost-sharing through 5 to 10 year contracts for the installation and maintenance of pollution control practices and measures [5]. Currently, a draft of the National Rural Clean Water Program Manual is being reviewed. This manual contains the regulations, policies, and procedures to carry out the RCWP [22].

The current legislation is nonspecific in the ultimate goal of elimination of both point and non-point pollution discharge by 1985. Considerable uncertainty and opportunity for misunderstanding and debate surround the issue of what constitutes swimmable and fishable waters (the interim goal), but the law is very clear on the ultimate goal of elimination of both point and non-point pollution discharge by 1985. Even though the act states clearly that achieving the 1985 target date is a goal and not national policy [3, p. 158], many questions are likely to be placed before the judiciary to decide. However, little if any latitude appears possible in the exercise of judicial wisdom except in the determination of what constitutes pollution and to what extent the national goal must be achieved.[1]

Water Quality vs. Conservation

The major focus of the cited legislation is on water quality and its improvement, whereas prior and current programs of the Department of Agriculture have emphasized the functional areas of erosion control, flood control, and watershed protection. At least 41 major laws have been passed by Congress authorizing land and water conservation programs in USDA which are translative into currently funded programs [29, p. 7]. The goals of these laws and of those directed toward improvement of water quality (PL92-500 and 95-217) may not be consistent because the categories of agriculturally related non-point pollution have been identified to include (1) sediments, (2) nutrients, and (3) pesticides. Thus, though efforts of one program area to reduce erosion will likely reduce sediments, they may result in increased levels of nutrients and pesticides entering the water.

[1]An excellent article by Schultze [18] addresses the issue of making economic decisions in the courtroom and the lack of technical assistance available to the courts.

REVIEW OF LITERATURE

A review of the literature suggests that certain inconsistencies do in fact exist. An Iowa State study [1] showed that without restrictions being placed on pesticide and nutrient use, the proposed decreases in soil loss could increase pesticide and nutrient use because less fertile or less desirable land would be brought into production (or substituted). Also best management practices (BMP's) would conceivably change production practices (no-till, etc.), increasing herbicide use [1, 3]. An EPA study [21] found that sediment yield from terraced watersheds was significantly less than from watersheds managed without terraces. However, except for paraquat, pesticide yields in runoff water **were not reduced in proportion to sediment reduction** because solution transport was the major mode of loss for soluble herbicides.

Menzel [10] states the need to recognize that reducing sediment loads in agricultural runoff will not reduce nutrient loads in proportion, and may even **increase the dissolved nutrient** load. Menzel emphasizes the need for more research on nutrient and pesticide management in reduced tillage systems and refers to an "enrichment factor" in runoff water.

Hall and Pawlus [7] found that greater soil and water losses were associated with higher herbicide rates (atrazine in this case) and raised the question of increased herbicide use and its effect on runoff and soil loss.

Best Management Practices

> Problems of environmental quality would be easier to solve if we knew more about what we were doing . . . we must make decisions without having a clear idea of the outcome of our actions [6, p. 46].

As currently identified, best management practices (BMP's) and the proposed management plans appear to focus almost entirely on erosion control, flood control, and watershed protection and only incidentally on water quality. Because of pollutant tradeoffs, the effects of currently proposed non-point pollution control measures are at best uncertain.

The RCWP rules and regulations specify the use of measures incorporating best management practices (BMP's) for the abatement of non-point pollution. The RCWP rules define a BMP as:

> A single practice or a system of practices included in the approved RCWP application that reduces or prevents agricultural non-point source pollution to improve water quality [5, 634.5,i].

No additional specifications are provided. The Mississippi Plan is more specific in that it provides a listing of cropping management systems and best management practices [11, Tables 23-27, pp. 125-155]. Cropping management systems range from continuous clean-tilled row cropping with residue management to crop-grass-legume rotations in conjunction with such practices as contour tillage, strip-cropping, subsoiling, and use of vegetated filter strips. Specified practices appear to consist largely of those traditionally recommended for erosion control, flood control, and watershed protection.

Both documents either prescribe or imply that the BMP's selected for a participant's water quality plan are site specific, yet **neither prescribes the criteria for the selection or the cost benefits expected in terms of yields, costs, and reduction in (1) sediments, (2) nutrients, and (3) pesticides or other factors affecting water quality.** Thus, no effective basis is available for the development of creditable estimates of the eventual impact of implementation of those rules.

Soil Loss Tolerance Levels vs. Water Quality

Though it was not developed to address the question of water quality directly, some information is available about specific BMP's in relation to erosion. A Soil Conservation Service (SCS) publication [24] provides data for predicting soil loss by use of the Universal Soil Loss Equation as well as soil loss tolerance values (T) by soil series for soils in the uplands of Mississippi.

Despite some debate about the parameters of the universal soil loss equation, it is generally agreed the the equation only predicts **erosion from a field and not the sediment, nutrients, or pesticides** entering the streams and, hence, the effect of erosion on water quality [31]. A USDA publication suggests that about 20 percent of the erosion specified moved completely off the field [32, p. 43]. How far it moved and to what extent water quality at various locations downstream was affected are not specified.

The soil loss tolerances (T's) and yields presented in the Mississippi publication [24] may be based on conventional wisdom rather than rigorous scientific investigation. Unfortunately, the potential impact of Section 208 could depend to a significant extent on the accuracy, acceptability, and/or use of these values. If the soil loss tolerances (T's) published are judged to be maximum permissible values, growth of row crops will be precluded on some of the land in the South and substantial changes in production practices will be required on the remainder. Estimates of the effects on farm in-

come also depend on the yields obtainable with the BMP's. The yield estimates published [24] appear to be somewhat gross and biased in favor of soil-conserving practices.

Concern also has been expressed about whether tolerances established to maintain soil productivity are sufficient for meeting pollution standards.

> Apparently, soil conservation practices adequate to maintain crop production may not be stringent enough to prevent offsite damages from potential pollutants. Furthermore, it may not be economically feasible to control all erosion of such stringent levels [12, p. 167].

Soil loss tolerances (T's) are stated in terms of tons per acre per year. The level has been established at 5 tons/acre/year for Mississippi. Soil losses have been estimated to average 9 tons/acre/year and to range up to 50 tons/acre/year for the U.S. [23]. Thus questions arise as to the feasibility of achieving a 5 ton per acre loss.

Benefits and Costs of Environmental Quality

> No price tag can be put on reaching environmental standards until all physical data are available or standards are set with some precision. There is no doubt that reaching environmental standards will be costly . . . . Two sources of revenue for meeting the costs . . . are taxes and higher prices: taxes when the costs are borne by government and higher prices when costs are borne by the private sector [6, p. 46].

Theoretically, the purpose of present environmental legislation and its ensuing laws is to guarantee that producers (farmers, industries, households, etc.) account for the full costs of production. In recent years society as a whole has been made aware of the fact that the "environment" has been regarded as a free good. Environmental inputs and outputs such as clean air and water, in addition to the more traditional inputs and outputs such as fertilizer, labor, corn, etc., are now being accounted for or at least recognized when economic decisions are made.

In essence the current notion is that human activities are detrimental to the environment and that positive action should be taken to remedy these negative effects. Implicitly the environmental issue can be viewed in a benefit-cost framework. That is, economic activity and other societal action often decreases environmental quality in the process of producing the

goods and services required or desired by society. A trade-off occurs in that environmental quality is a good much like corn or automobiles. To produce more of it requires the use of scarce resources that could have produced something else. Therefore at some unknown optimal level of pollution the marginal costs of environmental use just equal the marginal benefits of goods and services produced by the environment.

The next section of this article addresses one aspect, the short-run equity implications for farmers, of this elementary benefit-cost paradigm. The short-run cost of enhanced environmental quality is assumed to be approximated by the change in production costs and farm income experienced by farmers in an effort to meet non-point water quality guidelines. The short-run case is emphasized because of the uncertainty surrounding the issue of implementing the law. Research has shown that in the long run farm producers may actually be better off than they were before environmental regulations were imposed. Taylor et al. [27, 28] conclude that restrictions on sediment loss and nitrogen fertilizer use would result in increases in producers' surplus and reductions in consumers' surplus given restrictions applied at the national level rather than at the individual farm or regional level. Admittedly, consumers will ultimately bear the cost. The real issue is: What will be the distributional effects of the change from present levels to the regulation-mandated level of pollution? Which farmers and how many will survive?

Neither the Mississippi Plan nor the RCWP proposes that all farmers simultaneously implement prescribed pollution abatement practices. Both propose that the problem be approached on a watershed basis. Hence, those farmers initially required to implement the prescribed measures will bear all of the costs and will receive very few of the benefits from higher prices. Their actions will have little if any effect on the aggregate supply function and, in fact, may be largely offset by expansions in production by other farmers. Can these farmers who are first required to implement the controls survive until all farmers have complied? How are the "windfall gains" of the "late" compliers to be distributed if a piecemeal program is implemented? Unless some procedures are developed to resolve these questions, a number of farmers are likely to be placed in untenable positions and "visible" farmer unrest will increase.

IMPACT ON MISSISSIPPI AGRICULTURE

During 1978 scientists in the Department of Agricultural Economics at Mississippi State

University conducted research to determine the short-run interim effect on net farm income of the replacement of current crop production practices with those BMP's that would result in soil losses less than or equal to the tolerance level published by SCS [24].

Individual farms were selected in each of the seven major land resource areas of the state and data on current practices, yields, costs, etc., were collected. Farms were selected and basic data were obtained with the assistance of local Cooperative Extension Service agents and SCS district and county conservationists. Published information from county soil surveys and other sources of primary data from individual farms were used in all of the analyses, except that some expected yields for selected BMP's were determined by a modified Delphi technique. Additional details of the procedures followed are given in the research reports.

Perhaps the most significant finding of the research was that even though masses of data were available describing best management practices, treatments, and expected soil loss, the data were insufficient to determine the resulting impact on water quality. Even though the effect of the imposition of water quality standards more stringent than current levels (except as they are interrelated) could not be considered, the findings imply either that established soil loss tolerances are physically unrealistic or that meeting the conservation-water quality goals can have a severe economic impact on agriculture in Mississippi and the South.

Parvin et al. [15] studied the impact in the 10 all Delta counties in Mississippi (LRA131) in the aggregate and then on two case farms. Only the two major crops, cotton and soybeans, were considered in estimating producer returns under current production systems versus those required to meet established soil loss tolerances. The analysis selected the crop-BMP for each major soil type-slope combination that yielded the highest net revenue while satisfying the erosion constraint.

The results indicate that satisfying the requirements would result in a 48 percent reduction in cotton acreage in the area and a $115 million decrease in producer returns. Such a loss in farm incomes would have a substantial impact on employment and income in the region's economy. Analysis of the impact on the two individual farms showed that net farm income would decrease by about $40 per acre.

The Lower Brown Loam area of the state (LRA134B and 134D) is very susceptible to erosion when row crops are grown. Since 1973, soybean acreage in this area has increased by 94 percent and acreage planted to row crops has increased by 83 percent. Most of this increase in row crops is on acreage formerly in pasture.

Hamill [8] analyzed the effect of meeting soil loss tolerances for two farms in this area. In general, soil loss tolerances could not be met on this soil on slopes greater than 2 percent. Thus, soybean acreage would decrease from one-third to one-half, resulting in a reduction in net farm income of about $41 to $67 per acre.

Kizer [9] studied a 1609-acre soybean operation in Clay County (LRA135). Six alternative crop program strategies were specified for the analysis, ranging from present practices to extensive use of contouring and reduced tillage. Only two of these most restrictive strategies analyzed would meet the tolerances established for soil loss. Excess soil movement of 19 tons per acre from 1223 of the 1609 acres in soybeans would occur with the present fall plowing, conventional production practices. Net operating income per acre would decline by about $22 per acre from strategy 1 to strategy 5 and would be reduced by more than 50 percent if strategy 6 were followed.

Rather than estimating expected yields for the BMP's selected for compliance, the studies of the farms in the other LRA's utilized break-even analysis, i.e., estimated the yield per acre that would have to be achieved to maintain the current level of net income per farm studied. Thus, the results obtained must be interpreted in relation to expectations of the attainability of the breakeven yields for the BMP's meeting the soil loss tolerances.

The farm selected by Simpson and Tyner [20] in Covington County (LRA133C) grew crops on 47 fields leased from 23 individuals. Soil losses of more than 23 tons per acre on the steepest slopes in crops were estimated for present practices. Contouring, terracing, and use of no-tillage practices would be required to meet the soil loss tolerances if soybeans were produced. Breakeven yields higher than current levels would be required for the contoured and terraced fields. Net returns could be maintained if no-tillage yields were approximately equal to current yields, but that outcome would be possible only for one to two years because of weed control problems.

Much of the land growing soybeans on the farm in Pontotoc County (LRA133B, Interior Flatwoods) had a drainage problem rather than an erosion problem. However, no-tillage practices would be required to reduce the present 43.1 ton per acre soil loss on 5-8 percent slope soils to the tolerance levels. Yields slightly higher than current levels would be required to maintain net farm income, again a suspect outcome [19].

A study farm selected by Eddleman and Henning [2] in Marshall County (LRA134C) is currently producing cotton, soybeans, corn for

silage, and hay. Soil loss tolerance levels on soils of more than 2 percent slope could not be met for producing soybeans on this farm without changing production practices and contouring, or installing parallel terraces. Substantial yield increases (up to 25 percent) would be required to maintain net income levels. Corn silage could not be produced unless parallel terraces were installed. A 50 percent increase in yields would be required to offset additional costs for this crop.

Reinschmiedt [16] selected a farm in Pontotoc County to represent the Upper Coastal Plains land resource area. The operator maintained crops on 49 separate fields leased from 14 individuals. The farmer could meet Section 208 soil loss requirements on 105 acres with little or no change in current practices. An additional 64 acres would require a no-till or a no-till double cropping system to satisfy soil loss restrictions. Contouring and terracing plus restricted crop management practices would be necessary on an additional 126 acres. The remaining 12 acres could not be brought within acceptable soil loss tolerances under any combination of cultural practices and crop management systems. Breakeven yields required under the alternative systems exceeded estimated current yields under these practices on all but 105 acres.

In summary, results of these analyses indicate that requirements to reduce erosion to established tolerance levels would have a severe economic impact on agriculture in the state. The impact of simultaneously meeting restrictive water quality standards could not be evaluated because of the nonavailability of data. Perhaps some of the practices chosen could result in a worsening of the water quality (toxic materials) or could improve it (particularly in sediment content). One might hypothesize, however, that the costs estimated are minimums and that adding water quality constraints to the analysis would yield substantially more severe impacts.

Several limitations of the analysis are worth noting. First, the research findings reported are based on case study farm analysis. Though efforts were made to select representative farms, the results should not be aggregated or applied to the state as a whole. It is hypothesized, however, that overall the impact of meeting requirements may be more severe than on the case farms selected.

In addition, some institutional problems of Section 208 compliance will further complicate meeting water quality standards—for example, the fact that much of the cultivated land in Mississippi and the South in general is rented. Furthermore, many of these rental tracts are very small. What are the implications of these facts in terms of the owner entering into RCWP contracts or other BMP practices? It is hypothesized that the owners will allow much of this land to revert to pasture or woodland to avoid these complications. What will be the impact of these changes on the structure of agriculture?

RESEARCH NEEDS

Ultimately, the question of what constitutes acceptable levels of erosion control and water quality will be the overriding issue facing agriculture and society. Resolution of this issue will require substantial increases in both technical and economic research. Technical research is needed to provide more and better information about the physical parameters of the water quality-agricultural production relationship. Economic research is needed to provide more and better information about benefits-costs and their distribution among the various segments of society and over time. The penchant of agricultural economists is to address the aggregative, longer term, broad, general policy type issues regardless of the quality of technical information available. Thus, for this article, attention is directed toward identifying the kind of research needed to provide quality technical information and to determine the impact of compliance over time on individual farm businesses. Though the major part of this research must be conducted by physical and biological scientists, agricultural economists do have a substantial role and indeed an obligation to work with other scientists in identifying critical information needs and appropriate research approaches and designs.

More specifically, the overall objective of the research (which is also the farmer's objective) can be stated as:

Objective: Find that set of crop production/ erosion-pollution control systems that will maximize the present value of net farm income.

Subject to: Regulatory constraints on (1) erosion, (2) sediment, (3) nutrients, (4) pesticides and other toxic substances at appropriate spatial and temporal points.

Many specific tasks and questions must be identified prior to designing and conducting the research. One of the first tasks is to specify in detail the practices and activities included in each **crop production/erosion-pollution control system**. For example, the following items must be specified:

—each tillage practice and its timing,
—each pesticide application and its timing,
—each fertilizer application and its timing,

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—harvesting procedures and residue management, and

—other erosion-pollution-production practices affecting the variables of interest.

Ideally, a set of systems would be specified spanning the range of alternatives available.

Theoretically, the number of crop production/erosion-pollution control systems in the complete set would be very large and many of the systems would differ only with respect to one of the variables. For example, Systems 1, 2, ... k might be the same except for reflecting k different levels of fertilizer application or k different timings of a given tillage practice. Practically, the number of systems should be reducible to a manageable size on the basis of the available knowledge, best estimates, or professional judgments of scientists.

Once a practical set of alternative systems has been identified the research must be designed to address certain questions about each system in the set. Some of these questions are:

1. What are the expected yields and costs per acre and their variability and distribution over time?
2. What is the expected erosion, what is its distribution within a year and over years, and what is its relationship to water quality?
3. What is the expected sediment, nutrient, pesticide, and toxic chemical content of runoff and its distribution spatially and temporally?
4. How would the answers to the preceding questions differ for alternative soil-slope-rainfall situations?
5. What are the relationships among the variables identified (interaction)?

Given that these questions represent some of the relevant researchable issues, what is the most efficient research design (approach) for answering these questions? Regardless of the research design chosen, inclusion of the complete set of crop production/erosion-pollution control systems in one experiment or even at one experiment station probably will not be feasible. Thus, some systematic procedure must be used to select a manageable subset from the complete set of systems. For the subset selected, the research design must provide for measurement of the parameters implied in the questions along with appropriate interactions so that economic, erosion, and water quality effects for the farm, watershed, and higher levels of aggregation can be evaluated.

Traditionally, three alternative approaches to research have been used, involving (1) small plots, (2) experimental farms, and (3) cooperating farmers. The extent of their use by the various disciplines in experiment stations ranges from heavy reliance on plot work by the physical and biological scientists to widespread use of observations from individual farmers by agricultural economists. Each approach has advantages and disadvantages and the approach selected should depend on the objectives of the research rather than the comfort and convenience of the researchers. Each approach, if well managed, is an accepted scientific method and can produce scientifically and statistically valid results.

Small plots, as used for much of the agronomic and other physical science research, supposedly provide for close control by the experimenter. Results can be analyzed by analysis of variance or similar widely used statistical algorithms familiar to most researchers. Experimental designs involving small plots have been used to establish the effect of several levels of a few factors on an outcome such as yield.

Traditional designs do not provide for analysis as complex as that needed to answer the broader questions or to ascertain the magnitude of interactive effects associated with Section 208 compliance. Analyses of the pollution-erosion abatement/revenue maximization problem involve determining the simultaneous effect on such outcomes as (1) yields, (2) costs, (3) erosion, (4) sediment, (5) nutrients, (6) pesticides, and (7) other toxic materials in the water transport systems of varying such factors as (1) tillage practices and timing, (2) fertility rates, incorporation techniques, and timing, (3) planting rates, practices, and timing, (4) pesticide rates, application techniques, and timing, and (5) any other production and conservation practices affecting the variables of interest. Partitioning the problem is not likely to be helpful because of the importance of the interactions among the variables. Furthermore, there may not be zero covariance among the factors at practical levels.

Another problem with the use of plots of the traditional size is the inability to include conservation treatments such as terraces, contours, grass strips, etc. within the experiment. Small research plots can be used to examine very small subsets of the overall problem to establish some causal relationships between certain variables. Unfortunately, answers to the larger set of questions must be provided within an inconveniently short period of time. Even if there were time to "discover" the causal relationships, could the results be transferred to solve a single individual farmer's problem in an acceptable fashion when so many different circumstances prevail in any one field on the farm?

The experimental farms (or fields) approach supposedly permits less experimental control than the use of small plots. Also, it could be

more expensive to conduct per system evaluated than research by either the small plot or cooperating farmer approach. Fewer systems can be evaluated at any one time than with the cooperating farmer or perhaps the small plot approach. The causal relationships and the simultaneous effects of varying the levels of the independent variables cannot be determined.

In spite of these negative factors, the experimental farm approach would allow many of the questions stated heretofore to be answered for the conditions prevailing at the time for the particular systems studied. Some advantages of using field-size treatments are (1) conservation treatments can be installed, (2) differences in production costs and yields can be ascertained, and (3) problems with weed-control equipment, management, and other disturbances can be identified. However, unless the treatments can be replicated (increasing costs and complexity) or other statistical procedures for estimating variance identified, acceptance of the results may be hampered. The experimental farms approach does have considerable intuitive appeal.

The question of responsibility for conduct of the experiments must be resolved. To what extent should agricultural economists be involved in the day-to-day decisions about plowing, planting, weed control, and so on and in the performance of these operations? Can these matters be left to the agronomist, agricultural engineer, or other physical scientist or will agricultural economists need to become more involved in fieldwork than has been traditional?

A third alternative, the use of cooperating farmers, merits consideration if sufficient observations can be obtained for an adequately large number of systems from a well-designed sample of farmer cooperators. Statistical techniques are available for analyzing data obtained in such fashion and inferences can be made from observed relationships to answer the questions posed for the broader population. Though providing more answers at a lower cost per system, this approach may involve a greater total cost than the experimental farm approach, largely because of the cost of instrumentation of the fields, farms, and watersheds. The logistical problem of installation of instrumentation and of data collection (as well as the expense) may render this approach infeasible. Nevertheless, it should be given very careful consideration because the researcher may attain greater validity, due to the larger sample size despite having less control over each "experiment."

SUMMARY

The questions that must be answered if agriculture is to withstand the impending erosion-pollution abatement regulations are formidable. The magnitude of the problem must somehow be recognized and addressed by the most capable scientists. Solutions will be difficult and researchers will often become frustrated in their efforts. The authors have demonstrated by their analysis, using incomplete and otherwise gross data, that appropriate and accepted methods employing statistical and econometric techniques are available for answering the questions about the impact of compliance with Section 208 if acceptable data can be generated. The crucial question is whether the resources required for instrumentation, operation, and data generation will be committed to this research to answer the questions raised or whether incomplete, piecemeal, and misleading analyses of small segments of the overall problems will prevail. The challenge is to develop and improve upon research approaches and to find ways to satisfy the multiple objectives of increased farm income, conservation, and zero discharge of pollutants by 1985.

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