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The challenge of using survey research
to design and evaluate a water quality project:

A case study in Jackson County, Florida

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THE CHALLENGE OF USING SURVEY RESEARCH TO DESIGN AND EVALUATE A WATER QUALITY PROJECT:

A CASE STUDY IN JACKSON COUNTY, FLORIDA

The character of agriculture and of nonpoint pollution vary across regions. Under the national Water Quality Initiative, ninety grassroots pilot programs were established -- opportunities to devise targeted local education and technical assistance schemes. Data collection to support design and evaluation of one project is described, illustrating challenges and opportunities in water policy programming.

President Bush issued a challenging mandate when he announced his Water Quality Initiative in 1989: "Ultimately, farmers must be responsible for changing production practices to avoid contaminating ground and surface water" (Bush). Even though sound science is lacking to delineate exactly which and where farm practices need to be changed, or to specify what constitutes an acceptable level of water quality, there is political momentum behind implementation of policies targeting nonpoint water pollution from agriculture. Both the character of agriculture and the nature of non-point water pollution associated with farming vary considerably across the nation. Due to this intrinsic diversity, priorities concerning water quality policy for agriculture can be defined from the national level only in the most general terms. Perhaps the best guidance for targeting water quality programming was summarized in the term "source reduction," defined in the 1990 farm bill as "minimizing the generation, emission, or discharge of agricultural pollutants or wastes through modification of agricultural production systems and practices" (Cohen and coauthors). The notion that farmers can lower the risk of water pollution by reduction of pesticide and fertilizer usage, and by on-farm treatment of livestock wastes, is simple and intuitively appealing. Devising cost-effective and economically feasible ways to achieve source reduction, however, is a non-trivial challenge.

In an attempt to devise appropriate grassroots-based strategies to promote water quality, 90 pilot programs were funded by Congress in 1990 and 1991 under the President's Water Quality Initiative. Sites for these "demonstration projects" and "HUA projects" (Hydrologic Unit Area projects) were selected to represent the widest possible variety of farming areas considered prone to water quality problems associated with agriculture -- due to either large-volume livestock operations or cropping systems requiring significant agrichemical use, or both, coupled with topography vulnerable to groundwater contamination or to pollution from surface water runoff. Uncertainty concerning the nature of nonpoint source pollution itself, and, accordingly, uncertainty concerning the effectiveness of technologies farmers might adopt to try to reduce the threat of water quality externalities from their crop production or livestock operations, made it a challenge to hit the ground running with implementation of the Water Quality Initiative. In 1989, those coordinating the program design acknowledged that

> some appropriate technology is currently available to improve agricultural chemical management. But, much remains unknown about the magnitude and extent of agriculture's effects on water

quality, the specific nature of agricultural chemical fate and transport in water systems, and the economic and environmental tradeoffs among alternative production and agricultural chemical management systems. Thus, education and technical assistance, research, and database development and evaluation, the three major functional components of the USDA Water Quality Program, will get underway concurrently (USDA, p. 7).

The HUA and demonstration projects were the cornerstone of the Water Quality Initiative's strategy for achieving education and technical assistance goals.

There is a long tradition in farm policy of using voluntary, incentive-based voluntary programs to achieve environmental quality goals -- in particular, to achieve soil conservation objectives (Batie). The 90 pilot programs provide an opportunity to show that farmers' voluntary compliance, achieved through their participation in education and technical assistance programs, can make a difference in agriculture's attainment of water quality goals. At the same time, the implementation of this pilot programs will define the scope of what can be achieved to solve water pollution problems in agriculture without regulatory policies. The notion of using voluntary programs to accomplish changes in agricultural practices in order to achieve water quality standards has strong appeal, both to farmers and policy makers. For farmers, participation in education and technical assistance programs is an opportunity to retain property rights concerning their farm management, and autonomy in decision-making. For those designing and implementing farm programs, there are at least three pragmatic problems with implementing a regulatory approach. First, due to climatic and landscape variability in farming, it would be technically demanding to develop practical criteria for even-handed enforcement of regulations. Second, none of the local-level personnel in existing agencies who have grassroots support are equipped or willing to enforce regulations, or to levy fines against farmers who violate water quality standards. Finally, there is no guarantee that a regulatory approach would be cost-effective. In fact, the costs of transforming the agencies who implement farm policy to adopt a regulatory posture in an attempt to promote environmental quality priorities would impose high costs, both political and economic.

Background research in Jackson County, Florida -- the site for a 1991 HUA project -- made it clear that collecting ideas from farmers on what they think and what they do that affects water quality would be essential to the success of the county's new education and technical assistance project. For farmers in

Jackson County, Florida, groundwater contamination is a non-hypothetical issue: a soil fumigant, EDB (ethyldibromide), detected in 1983 in over 500 of the county's wells was one of the incidents which brought the issue of water quality and agriculture under public scrutiny at the national level (MacCallum and Anderson; Johnson; Sharlin). In Jackson County, some farmers acknowledge the relatively significant risk in their county of pesticides contaminating groundwater. Other Jackson County farmers believe that because they are careful handling and applying pesticides on their farm, the risk of potential water quality damages from their farm activities is negligible. Nobody, including those responsible for designing water quality programs, claims to know exactly how best to solve the potential problem in Jackson County -- or even how big it is.

The purpose of this paper is to describe the design of a multi-media survey research program to collect baseline data to support the design and evaluation of the HUA project underway in Jackson County, Florida. This case study illustrates challenges and opportunities common to the 90 water quality pilot programs. The first section of the paper outlines conceptual issues associated with evaluation research, relevant to the assessment of water quality programming. The second section provides a description of the survey research process followed in Jackson County and discusses the options envisioned for subsequent data collection in support of the Jackson County HUA project. The final section anticipates statistical and econometric issues relevant to data analysis for the evaluation of HUA projects.

DESIGNING SURVEYS TO COLLECT BASELINE DATA FOR EVALUATION

There are two ways of structuring a program evaluation: with controlled experimental designs and with longitudinal data analysis. In social science, the notion of collecting data from controlled experiments is somewhat foreign, because causes and effects of human behavior are tough to isolate, and because boundaries between participation and non-participation tend to be fuzzy. According to Rossi (1991), however "the impact of a program can be assessed only comparatively. ... In order to estimate the impact of a program, it must be compared to the absence of that program ... (through) the use of a comparison group. Randomized controlled experiments are the preferred means to make such comparisons, though they are frequently impractical" (p. 27). There are at least three procedural and substantive difficulties with a controlled experimental design approach to water quality program evaluation. The first objection is a pragmatic one: the difficulty of identifying a valid control group for a watershed-level education and technical assistance program. Many of the sites for pilot programs, including the HUA site in Jackson County, were chosen because they are vulnerable to nonpoint water pollution from farming. A companion site for an environmental control group -- truly comparable with respect to institutional setting, markets, and location -- may be less prone to water quality effects from agriculture. If farmers whose land is vulnerable to environmental damage are more aware and more open to water quality education and technical assistance than farmers whose land is less vulnerable, then that distinction itself invalidates the experimental design.[1] To find other farmers whose land is comparably prone to nonpoint water pollution is likely to introduce institutional or market differences, a different type of bias, in the experimental design.

A second consideration regarding studying a control group outside the project boundaries is project resource allocation. Although evaluation activities, including data collection, are a worthwhile expenditure of project funds, justification for collecting data on farmers outside a project's boundaries is difficult, especially when resources are scarce. It may be possible to collect baseline data on a random sample of farmers within the project boundaries at the beginning, and to devise an experimental design as the project evolves -- ex poste, designating those who participate as the experimental group and comparing them with those who do not participate (as the control group). It would be misleading, however, to represent this data as if it had been collected under a controlled experimental design.

The third, and perhaps the most fundamental, issue with respect to the evaluation of water quality programs is that documenting effectiveness requires clearly specified goals and objectives amenable to unambiguous measurement. Even the best econometric technique is only as good as the data being analyzed -- which is predicated on tracking clearly specified cause-and-effect relationships which can be measured. In the case of water quality education and technical assistance programming, the overall goal can be stated clearly and easily -- to reduce water quality damages from farming to acceptable levels. In the Jackson

[1]Regarding soil conservation program participation, there is abundant empirical evidence that farmers' perceptions make a difference in their responsiveness to incentive-based education and technical assistance programming (Ervin and Ervin; Norris and Batie).

County project design, there is no debate over the desired goals or outcomes of the project, as spelled out in the report summarizing the first year's activities (Graham): (1) to promote integrated crop management (ICM) and best management practice (BMP) adoption through the establishment of educational, technical and financial incentives; (2) to develop and implement conservation plans which ensure appropriate agrichemical use; (3) to produce site-specific maps of leaching, runoff, and erosion potential for various agrichemicals for each participant; and (4) to improve interagency cooperation. Nobody involved in implementation of the HUA project, however, can predict which measurable actions will cause changes in farmers' knowledge, attitudes and behavior -- which will, in turn, accomplish the project's goals. The local agency personnel involved in the Jackson County HUA are accustomed to submitting plans of action and reports of their agency's activities. They are less confident than those at higher levels in the bureaucracy, however, of causal linkages between these measured, reported statistics and actual changes in farmers' behavior, attitudes and knowledge.

Measuring effectiveness is an elusive concept in project evaluation, contingent on the definition of effectiveness. MacCallum (1991) suggests that at an early stage "it is helpful to differentiate between goals and objectives. Overall goals can then remain constant regardless of vested interests or program objectives" (p. 115). During program implementation, flexibility to modify short-run objectives in a manner consistent with long-run goals enhances the likelihood that a program will achieve measurable effectiveness. Particularly in education programming, allowing objectives to evolve makes sense. From the risk communication literature, a useful notion with respect to measuring effectiveness is "informed consent": providing individuals with access to the best information, but they make their own choices. An informed consent criterion "yields a different measure of effectiveness than an assessment based on individuals' following an agency's recommendations" (Desvousges, p. 119). In program planning, another helpful notion is the distinction between "formative evaluation" and "summative evaluation" (Herman, Morris, and Fitz-Gibbon). Formative evaluation means collecting preliminary data to guide the design of project activities and to suggest early short-run objectives, along with its role as baseline data. In contrast, summative evaluation is analysis conducted to assess the program's impact at the end.

Survey research can play a role in both formative and summative evaluation in support of the Water Quality Initiative's demonstration and HUA projects. Recognizing that what will constitute progress and success will differ for each pilot project, there is both challenge and opportunity built into in the task of data collection to support evaluation under these circumstances. At the least, having baseline data on farmers' knowledge, attitudes, and current farming practices will provide a useful starting place for summative evaluation. In 1990, the USDA collaborating agencies issued a memorandum detailing several specific parameters they would like to be able to measure at the duration of the pilot project: for example, "application of pesticide management practices," "reduction in nitrogen lost from root zone," "reduction in phosphorous lost from the edge of the field," "application of farmstead and wellhead protection practices" (Tidd, Ullery, and McCullen).

DESIGNING DATA COLLECTION TO FACILITATE EVALUATION: ANALYZING PANEL DATA

Due to the pragmatic obstacles to conducting evaluation using a "controlled experiment" paradigm, using longitudinal data to assess the impacts of water quality programming is an option worth considering. Analysis of panel data is a well-established (albeit technically demanding) econometric technique. If panel studies are rare, it is because longitudinal data is scarce -- largely because it is expensive to collect. Using panel data as the basis for project impact evaluation requires planning ahead. There is a rich literature describing how panel data has been used for evaluation purposes, particularly to fulfill requirements by the federal government on analyzing the impact of social programs in the 1970's.[2] More recently, the effectiveness of the EPA's risk communication campaigns on radon's risk has been evaluated by Smith and coauthors (1990a, 1990b, 1988a, 1988b) through analysis of panel data.

Evaluation based on panel data involves identifying a "cohort" of participants in a program, and surveying them periodically throughout the implementation period. The purpose is to collect data documenting changes in behavior, attitudes and knowledge -- in accordance with the program's objectives and goals -- and to analyze these data to identify which factors make a difference with respect to particular

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[2]For an introduction to this literature, please refer to Barrow, Cain and Goldberger; Maddala, 1983, p. 257-267; or Uncles.

participants' performance over time, and, in the aggregate, the success of the program overall.

There are numerous statistical problems associated with the selection of a cohort to follow. The most obvious, and the most discussed in the econometric literature, is self-selection bias (Maddala, 1983; 1988): there are likely to be fundamental differences between people inclined to participate in a particular program versus those not inclined to participate. Further, if a random sample has both participation and non-participation represented equally or appropriately, it is by luck rather than design, unless the sample is stratified -- when self-selectivity comes into play. Econometric techniques exist to correct for self-selection bias. Another problem is maintaining the representativeness of the chosen cohort, compared with the general population being described, over the life of the study. If the composition of the population being studied changes over the life of the project, it makes sense to update the composition of the cohort to account for these changes. There are numerous econometric techniques deemed valid for maintaining the integrity of longitudinal data (Uncles) -- such as, rotating randomly-chosen new members into the cohort at regular intervals, or using randomly-chosen replacements for cohort members who drop out of the panel study.

The decision to study a panel of program participants, however, solves only a subset of the problems associated with collecting baseline data to evaluate the impact of a program. There remains the non-trivial problem, at the outset, of determining what measured outcomes to establish as benchmarks for progress. In addition, decisions on the pragmatic issue of what proportion of program resources should be devoted to survey research come along with the design of a panel study -- both at the beginning and throughout the life of the water quality program. For local personnel implementing the Jackson County HUA project, uncertainty concerning the level and flow of funds to the projects complicated such decisions. In planning evaluation activities in Jackson County, Rossi's first two general laws of evaluation applied: (1) "there is no such thing as a free evaluation," yet (2) "evaluations should not cost more than the program being evaluated" (1991, p. 26). In the early stages of project implementation, it required some cajoling for those involved to agree that significant manpower and energy devoted to collecting baseline data was worthwhile, as opposed to jumping right into designing research station demonstration plots or starting to work with farmers.

SURVEY RESEARCH IN JACKSON COUNTY, FLORIDA: A FRAMEWORK FOR EVALUATION

Lessons from Jackson County represent an attempt at designing a flexible framework for survey research to help both refine immediate, second-year program objectives while, at the same time, establishing baseline data for an impact assessment of the water quality program. During the initial year, a Design Team, with leadership from the University, was organized to discuss whether it was a good idea to conduct a survey. Survey research was recommended both as necessary to establish baseline data in order to later evaluate the impact of the project, and also as a useful strategy for developing and fine-tuning education messages and technical assistance strategies (Regan and Desvousges). The Design Team included two Extension economists stationed in north Florida, the local Extension director and two Extension agents, the SCS district conservationist and water quality coordinator, and two water quality specialists from Florida Department of Environmental Regulation.

At its first meeting, the Design Team decided it was worthwhile to conduct in-person interviews with a random sample of farmers in the HUA boundaries. They valued this information for its usefulness in their programming, and were less worried about collecting a baseline for valid evaluation criteria at the end of the project. Agreeing on a sampling frame was a non-trivial task. The local ASCS provided their mailing list of over 2000 farmers in the HUA. The Extension and SCS personnel who scrutinized this list pared it down to 276 farmers active in the HUA -- many of whom are not currently participating in Extension or SCS programs, but who are farming.[3] The Design team agreed that 75 farmers (27 percent) would be interviewed. Over two months of survey design, the Design Team's primary activity was to brainstorm about the content of the questionnaire -- what knowledge, attitudes and behavior to measure, how to phrase the questions to minimize ambiguity, whether certain issues were too sensitive to probe (such as which pesticides are being applied and pesticide loading and mixing practices), and how to keep the questionnaire to a manageable length. This process required three three-hour meetings of the Design Team, plus several iterations by FAX. Close to the end of this process, five leaders from the farm community, members of the

[3]When interviewing began, the Design Team discovered that even this closely scrutinized mailing list was not without problems. There were still farmers listed who had retired from farming or who had moved out of the area. Most of the farmers contacted agreed to be interviewed.

HUA project's Farmer Advisory Group, were also asked to review the survey instrument. Four interviews with farmers to pre-test an evolving version of the survey instrument also played a vital role in the tightening process.

The same week local interviewers were going into the field to begin conducting in-person interviews, the Extension Service holds an annual Peanut Short Course to discuss the latest University research with farmers and pass on new production techniques (especially pest and disease control). Peanuts are the main crop in Jackson County and the Short Course draws, on average, over one-third of the farmers in the county who grow peanuts, and the majority of large farmers. Attendance in 1992 was above average. The Design Team decided to collect information of Peanut Short Course participants' perceptions of the water quality problem. Baseline data collected from a mail survey of this group of farmers will offer another option for evaluating the HUA project activities, either to track progress or to evaluate the impact of the project when it ends. This flexibility makes sense to those involved with the HUA project and concerned about its evaluation. They are unsure about how much of their budget and effort they will want to allocate to evaluation down the road; that depends partly on how the program evolves and on what types of accountability for funds are required. Members of the Design Team, local Extension personnel familiar with farming and farmers in Jackson County, were surprised by some of the attitudes and knowledge gaps documented in only four pre-tests of the questionnaire. They were, therefore, anxious for the results of the 75 in-person interviews. They were more enthusiastic about the survey research project after the interactive process of design and pretesting than when the effort was initiated. However, the expense of conducting these in-person interviews represents a significant commitment of project resources: approximately $3000 (this figure does not include survey design costs). It may not be feasible to re-visit this cohort of 75 to track progress; at the end of the program, it is likely that $3000 will have high opportunity costs, compared with on-going education and technical assistance programming.

A mail survey of Peanut Short Course participants within the county, conducted according to the Total Design Method (Dillman), will cost only $300 to implement; 140 farmers will be surveyed. Feedback on the content of the Short Course will be valuable in its own right. For the HUA project Design Team over the long run, however, the most important selling point of the mail survey is cost-effectiveness. If the response rate is acceptable (above 60 percent), then it is a lower-cost option for both tracking progress and impact evaluation than the alternative -- collecting panel data from the cohort of 75 farmers. This strategy broadens the Design Team's options over the life of the project. In addition, collecting this baseline data provides at least three further dimensions and possibilities for future evaluation activities. First, Peanut Short Course participants include farmers both from the HUA and from the western part of the county. With this survey data, those implementing the HUA program can get an indication of whether those farming cropland which is more prone to water quality damages have different attitudes or behave differently than those farming less vulnerable acreage. Second, this group of Short Course participants represents a set of progressive farmers. If the program has an impact anywhere, it is likely that the impact could be documented and measured among the population of Short Course participants. Third, it might be possible to qualitatively compare this group of Short Course participants with a group of farmers from the random sample from the HUA area (those interviewed in person) and contrast their knowledge, attitudes, and behavior. Hopefully, further decisions about data collection in conjunction with this HUA project will not be constrained by inadequate baseline data.

SURVEY DATA ANALYSIS IN SUPPORT OF AN HUA PROJECT: CONCLUDING REMARKS

From a researcher's perspective, analyzing panel data to try to explain farmers' behavior and attitudes in conjunction with an education and technical assistance program would be an unusual but pleasant luxury. Ervin and Ervin (1982) expressed frustration with ambiguous results from cross-sectional analysis; summarizing attempts to explain farmers' complex decision processes concerning adoption of soil conservation practices, they noted that "perhaps attempts to explain the dynamic process of conservation practice use with static reduced form models will always fall short. However, the required longitudinal data usually preclude a dynamic approach" (p. 290). Uncles (1988) remarked on the advantages of analyzing panel data: "because it is possible to test or relax the assumptions implicit in cross-section models, panel studies offer the most effective way to relate the incidence of events with consumer [or producer] variability. In particular, spurious statistical effects can be isolated from real behavioral effects. Overall, this is the most reliable way to collect information about the sequencing of events, repetition, habit, and dynamics at the microlevel" (p. 5).

In analyzing panel data, there are two possible econometric strategies: fitting models to test inferences about **fixed effects** or using systems of simultaneous equations to sort out **random effects** (Maddala, 1987). Fitting a fixed effects model involves pooling observations and testing inferences comparing the coefficients of intercept parameters across the groups of observations. With panel data, observations from one time period can be compared with data collected in an earlier or a subsequent period. If pooled analysis shows no statistically important differences in the intercepts, then the factor which distinguished the pooled observations had no identifiable effect on the dependent variable, for the data fitted. Differences in the shift parameter estimates across groups indicate statistically significant impacts on the dependent variable from membership in one group or another. A helpful example is analysis by Rosenzweig (1990), who made the most of available cross-sectional data by fitting a fixed effects model.

There is a danger of over-simplifying the process being modeled by using fixed effects models to analyze panel data. For example, if data are pooled by time period and statistical tests comparing intercepts are conducted to pick up differences between one time period and another, then a maintained hypothesis is that all differences between the two panel observations are explained by the timing difference. The model has no built-in capacity to describe and test for structural differences other than temporal differences.

The advantage of random effects models is the capacity to test for endogeneity across time periods and to model structural change in a dynamic model. Appropriate specification of systems of simultaneous equations to test for random effects is technically demanding (Maddala, 1987; Heckman and Singer, 1982; Chamberlain, 1984) and requires a sophisticated understanding of factors influencing the behavior being modeled -- plus adequate data measuring those behavior factors. Smith (1990a) described fitting systems of simultaneous equations using panel data to model the process consumers follow in their learning about radon's risk, and their decision on how much to spend to mitigate against radon exposure. As Smith's modeling demonstrates, implicit in random effects modeling is the opportunity to test causal relationship and to test for the occurrence of endogeneity across causal factors in dynamic decision processes.

The issue of what data collection activities and, in turn, data analysis procedures, will be appropriate for the on-going evaluation of the progress of the Jackson County HUA project and, ultimately, for an impact evaluation of the project when it ends are issues which will resolve as the project progresses. This paper documents the process followed as an attempt to establish a baseline for evaluation and to collect information for the design of program activities and education messages. The example of the Jackson County case study was an opportunity to spotlight some issues relevant to evaluation of USDA's other demonstration and HUA projects under the Water Quality Initiative.

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