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Why Economists Should Talk to Scientists and What They Should Ask: Discussion

Mary C. Ahearn

Although interest in cross-disciplinary research is not new, expressions of the importance of collaboration are increasing. A focus on agricultural sustainability issues, which explicitly recognizes the links among agricultural production activities, the environment, and communities, is an example of this interest. Among agricultural economists, a 1996 Council on Food, Agriculture, and Resource Economics (C-FARE) survey regarding professional priorities indicated that the profession overwhelmingly (92%) believes there is a need for more cross-disciplinary collaboration. This view is common across all sciences (physical and social), and not limited to the agricultural sciences.

A major reason for the increasing interest in cross-disciplinary work is because the beneficiaries and major financial sponsors—the general public—have demanded that science focus on "real-world" problem-solving research. Coupled with this pressure, and likely not unrelated, is increased competition for research dollars within and among our institutions. Solutions to real-world problems generally benefit through contributions from a variety of disciplines. Furthermore, there is a recognition that science and technology advances commonly include secondary, and unwanted, impacts. These secondary impacts are frequently the "domain" of disciplines other than the original science speciality, often times social science disciplines.

The author is a branch chief in the Economic Research Service, U.S. Department of Agriculture. The views are the author's and do not necessarily represent those of the Economic Research Service or the U.S. Department of Agriculture.

The recently developed goals of the USDA's Research, Extension, and Economics mission area provide an example of an effort, or at least a start, to respond to the public pressure to be more responsive to real-world problems. Those five goals are: (*a*) a highly competitive agricultural production system, (*b*) a safe and secure food supply, (*c*) a healthy and well-nourished population, (*d*) harmony between agriculture and the environment, and (*e*) enhanced economic opportunity and quality of life for all Americans. Although the agencies of the mission area—the Agricultural Research Service; the Economic Research Service; the Cooperative State Research, Extension, and Education Service (CSREES); and the National Agricultural Statistics Service—are relatively homogeneous within individual agencies in terms of the professional disciplines of internal staff, successfully supporting the goals will require cooperation across these agencies.

Rural development specialists in agricultural economics generally have been more problem-oriented and have a long history of collaboration with rural sociologists. For example, economists interested in understanding why individuals do not migrate to regions with greater job opportunities have employed sociological principles to help explain behavior that is seemingly irrational from a strictly economic perspective. In fact, there are numerous examples of where various subspecialities of agricultural economics have been linked to other disciplines. Young found that, out of a sample of 82 agricultural economists who had published cross-disciplinary articles over a 10-year period, 61% were production/farm management specialists and 20% were resource economists.

The three papers of this session are focused on agro-environmental issues, clearly a set of "real-world problems" of interest to the general public. A focus on the environment, in contrast to some traditional areas of agricultural economics (such as supply management), requires greater cross-disciplinary collaboration. Agriculture has a variety of negative impacts on the environment, many of the processes for which are not well understood by physical scientists, let alone quantified. Some of the most serious impacts include sheet and rill erosion, which is likely a serious problem on 25% of U.S. cropland, plus other soil quality factors (such as soil compaction and declining levels of organic matter) and surface and groundwater quality effects (such as sediments in waterways and agriculture as the major contributor to nonpoint sources of pollution) (National Research Council). While the session papers are focused on agro-environmental issues, many of the implications for cross-disciplinary collaboration are relevant to collaboration in other issue areas and for other activities, such as extension and teaching.

The Contribution of Economics

Perhaps the most significant contribution of economics in a cross-disciplinary effort is the overall assessment and integrative framework. Economics is the link from natural science to policy. For example, economics provides the benefit-cost analysis framework for integrated environmental assessments. The dollar as a unit offers the ability to quantify and aggregate over impacts, plus provides the link to the incentives of private agents in the marketplace. And while the central focus is on the market, economics provides concepts and tools that address nonmarket activity and market failures. The tools of economics are critical for designing policy mechanisms that are consistent with private incentives. On the other hand, in real-world situations, getting the natural science perfected may be more important in terms of solutions than further refinement of economic models. Or a social issue, such as inequality concerns, may be more important than maximizing economic surplus.

The motivation for this invited paper session was spawned by the 1995 Antle-Wagenet paper (jointly commissioned by the AAEA-ERS/USDA). That paper was directed toward the physical scientist audience and described what economics can contribute to a scientific project. (Their target audience likely explains why the paper's title implies that economists are not scientists.) They emphasized the contribution of economics in research administration, such as in setting research priorities and assessing returns to research investments, by translating physical relationships into the things people care about. Traditional collaboration from a physical scientist's perspective has been to consult with economists at the end of a physical science endeavor—for example, to determine the economic impact on farmers of a technology assuming it will be adopted, or of a potential regulation assuming it will be made into law [e.g., National Agricultural Pesticide Impact Assessment Program (NAPIAP) analysis]. There has been little interest in understanding potential social benefits and costs, or in identifying optimal policies for adoption of more sustainable practices, for example.

Critical Questions

The three studies in this session are excellent examples of useful cross-disciplinary collaboration addressing real-world, public policy issues. They differ in how they link the physical sciences with the social science of economics. All three of the presenters have not let their base of knowledge in economics prevent them from understanding what other disciplines have to contribute to the problem. They have clearly invested in learning from other disciplines.

What did we learn from the experiences of the three sets of authors about the cross-disciplinary process, and in particular, about the questions that an economist should address in planning cross-disciplinary research? First, economists should be clear on several questions about the objectives of the research: How will economic processes affect environmental externalities? How important is precision in physical results to the overall results? What is the appropriate scale and spatial disaggregation of the project, e.g., farm-level, a geopolitical boundary, or an ecological-relevant boundary, such as a watershed?

Questions economists should ask natural scientists include: How advanced is the state of the science? Is the science sufficiently developed to contribute to the objective of the research? Can the science be generalized to meet the scale and spatial disaggregation of the project? Will the assumptions employed withstand scrutiny from other natural scientist peers, i.e., how controversial is the science to be integrated? Is a particular method for developing environmental indicators accepted by peers? When is a complex model necessary to develop environmental indicators and when will approximations be acceptable? How do environmental indicators (loadings or fate and transport/process models results or objective environmental monitoring) translate into things people care about?

The Level of Scientific Integration

The three session papers offer an interesting contrast in the degree to which physical science and social science are integrated to address issues. The objectives of the research will dictate the appropriate level of scientific integration. While the term "multidisciplinary research" is commonly used to characterize all research efforts involving more than one discipline, a set of terms has evolved which makes distinctions among the research based on the extent of the integration of the disciplines. These terms are multidisciplinary, interdisciplinary, and transdisciplinary. In this new terminology, *multidisciplinary* research is used to characterize separate, parallel research. The Kellogg-Goss paper is an example of multidisciplinary research. The Kellogg-Goss paper describes a physical science effort to use the GLEAMS model to develop pesticide mass loss indicators. The indicators will be useful, aside from economic analysis, for example, in targeting vulnerable areas. For application in adjusting the U.S. agricultural productivity measures, the results will be used as a data set from which shadow values for the externality will be measured based on economic theory. The relative lack of integration across disciplines in this study is appropriate because the goal was not to predict producer behavior as a result of a change in policy or other stimulant to the system. It was simply to estimate the environmental effects of known historical pesticide use.

The Ribaudo-Hurley paper is an example of *interdisciplinary* research. In this example, integration of the disciplines and discussion of the goals are necessary from the outset, but distinct frameworks of disciplines are maintained. The purpose of this analysis was to measure the adjustments of producers to regulation, and the ensuing environmental quality effects. Therefore, it was essential that economic optimization be integrated with the physical process models.

Transdisciplinary research implies a synergistic alliance between and across disciplinary boundaries; it is more participatory; it focuses on stakeholders; and it uses an inductive approach, which is orientated to learning rather than predicting (Constanza, Daly, and Bartholomew). This means that details of cause and effect will remain unknown, but the uncertainty is acknowledged. An important conceptual tool is a system picture of possible causes and effects. The Milon-Kiker-Lee paper is an example of transdisciplinary research. Their paper describes how social scientists can contribute in this highly participatory process of restoring a unique ecosystem—what they call adaptive management. Economics will not, nor will any other discipline, dominate the analysis.

Barriers and Facilitators to Collaboration

In reviewing barriers to cross-disciplinary collaboration, Zilberman includes technical disciplinary journals as a barrier. The technical approach makes it difficult for scientists in other disciplines to comprehend the disciplinary journals. Other barriers to cross-disciplinary collaboration commonly identified include the reward system of research institutions and competition among scientists. In the case of cross-disciplinary work, it is likely very important to have an institutional structure that allows for bottom-up, as well as top-down direction. The "bottom-up" approach is important because, whether or not collaboration is critical (and if so, how that collaboration should be structured) is a technical issue that must be evaluated by technical subject matter experts. The "top-down" approach is important because incentives and resources must be provided to facilitate collaboration.

A significant barrier to cross-disciplinary collaboration in the agro-environmental arena is the extent of scientific uncertainty in the physical sciences. The USDA-Land Grant System has invested in fate and transport models of the physical process of agricultural production, such as transport of pesticides and nutrients, and soil erosion. Two of the papers in this session employed these types of models, i.e., GLEAMS and EPIC. But the science of how these physical processes relate to ecological health is very undeveloped. Many of the ecological impacts are, at this stage, limited to conceptual ideas, and have yet to be validated. A review of ecological concepts by Saterson includes the following: (*a*) ecosystems change abruptly, not smoothly; (*b*) the processes that influence ecosystem structure do so at different scales; (*c*) feedback cycles exist; (*d*) changes are often irreversible; and (*e*) diversity buffers and provides resilience. However, these concepts are often too general to be useful in applied cross-disciplinary collaboration.

Several institutional incentives exist to foster cross-disciplinary collaboration. First of all, the basic organizational structures of Colleges of Agriculture and the Research, Extension, and Economics mission area of the USDA offer an umbrella organization for agricultural sciences that helps to lower the transactions costs of cross-disciplinary efforts by providing the information infrastructure within which scientists interact. A very recent competitive grants initiative includes funds to foster cross-disciplinary collaboration, the Fund for Rural America. The Fund for Rural America gives priority to studies that include a systems-based approach (which takes a broad rather than a reductionist view), and to inter- or cross-disciplinary approaches (USDA/CSREES). Another recent institutional initiative that may foster cross-disciplinary collaboration is the Government Performance and Results Act which requires accountability for public dollars spent. The accountability incentive likely will lead to an increase in the demand for the contributions of economists.

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