



AgEcon SEARCH
RESEARCH IN AGRICULTURAL & APPLIED ECONOMICS

The World's Largest Open Access Agricultural & Applied Economics Digital Library

This document is discoverable and free to researchers across the globe due to the work of AgEcon Search.

Help ensure our sustainability.

Give to AgEcon Search

AgEcon Search

<http://ageconsearch.umn.edu>

aesearch@umn.edu

*Papers downloaded from **AgEcon Search** may be used for non-commercial purposes and personal study only. No other use, including posting to another Internet site, is permitted without permission from the copyright owner (not AgEcon Search), or as allowed under the provisions of Fair Use, U.S. Copyright Act, Title 17 U.S.C.*

Agricultural Economics and Interdisciplinary Work

Patricia Duffy

Before getting to the main substance of this paper, I'd like to express my gratitude to the Southern Agricultural Economics Association for the honor of receiving the Lifetime Achievement award. Throughout my career, I've enjoyed the support of the Association and would encourage all folks beginning their careers to stay connected to our professional organizations. In addition to outlets for research, the professional associations provide opportunities for informal information exchange, service, and networking.

I'd also like to thank colleagues both within the agricultural economics profession and outside it and my students past and present for making my career rewarding. I'd especially like to thank Dr. James Richardson, my one-time dissertation advisor and long-time mentor and friend, for giving me the foundation to conduct and publish applied research. Additionally, I would like to thank Dr. Ron Kay, from whom I learned a great deal about teaching during that long-ago year I spent as his teaching assistant. Teaching has proven to be one of the most rewarding and also one of the most challenging aspects of my career, and I was immensely thankful to have come to my job at Auburn having benefited from my association with a master teacher.

All Experience is an Arch

Or so said William Butler Yeats, in his poem *Ulysses*. My own experience, coming into the

agricultural economics profession, was not the standard one. My family did not own a farm, and although one of my first paying jobs was blueberry picking, I did not spend a lot of time involved in agriculture as a young person.

My youthful ignorance of the field of economics was also notable. I graduated from Boston College with a double major in English and French, and never took a single economics course while there. After graduating, I joined the Peace Corps. Having found it difficult to find people with an agricultural education who could speak French, the agency for a short time took volunteers who could speak French and trained them in agricultural sciences. After an intensive summer training at Michigan State University and armed with a box of reference books, I shipped out to Africa, where I spent two years teaching at a vocational high school. Along with basic agricultural classes, I was also assigned a course on rural construction, more specifically road building. By way of preparation, I was handed a copy of an old notebook and wished good luck by the school principal. I learned quite a bit from that notebook about the necessary steps in making long-lasting dirt roads, and only hope my students learned something too.

The country where I worked quickly provided me with a strong appreciation for a discipline I had not formally studied. In the United States, one goes to the store reasonably confident of finding everything one wants, or at least everything one needs, at a price quite similar to last week's price. This was not the case in Zaire in the late 1970s. Poor transportation, political upheavals, and government regulation of prices in stores led to shortages, intense price volatility,

Patricia Duffy is a professor in the Department of Agricultural Economics and Rural Sociology and assistant provost for undergraduate studies, Auburn University, Auburn, Alabama.

black marketing, and a host of other economic woes that are either historical footnotes or textbook abstractions in the United States. Having the experience of watching this economics laboratory in real life, I decided I wanted to be an economist, more specifically an agricultural economist, a field I had never even heard of before joining the Peace Corps.

There is much to recommend an undergraduate degree in English, especially in terms of an opportunity to master the art of persuasive writing. Returning to the United States, I fired off a volley of letters to selected agricultural economics departments, explaining why they should not only accept me as a graduate student – and me without a single course in economics or business to my credit – but also pay me an assistantship. I wish I still had a copy of that letter. It must have been one of my more effective efforts, because I was accepted into a graduate program on funding. Of course, that missile had to hit the right target, and I remain grateful to Mike Cook, Carl Shafer, and other members of that Texas A&M graduate committee in 1980 for taking a chance on the English major from Massachusetts.

“Becoming Interdisciplinary”

That’s the title of a book by Tanya Augsberg (2006) that I recently used while teaching the introductory course of Auburn’s new Interdisciplinary University Studies major. It’s an interesting book, and worth a look by anyone interested in interdisciplinary scholarship or even by those who want to have a better conceptual feel for disciplinary scholarship. I am not sure, however, that one actually becomes interdisciplinary, but rather that everyone starts out inclined toward the integrative thinking that interdisciplinary work requires and then, through the process of education and training, we instead become disciplinary. To some extent, becoming interdisciplinary may require a conscious reversion to a different way of thinking about the world.

In Chapter 1, Augsberg provides a brief history of the development of modern disciplines. She quotes Klein (1990) as tracing the modern concept of disciplinarily to the 19th

century, with the evolution of the natural sciences, technological advances, and other societal changes of that time period. The increasing division of knowledge into distinct disciplines continued through the early part of the 20th century.

Disciplines did not evolve without a reason. They arose in response to the need for highly specialized skills in many areas of study. Disciplinary boundaries may be broad or narrow, but within the boundaries there will be a set of problems that are viewed as the normal work of that field. Economists, for the most part, do not lay out designs for better rocket ships, and engineers, for the most part, do not write papers addressing the impact of new welfare laws on the unemployment rate. Specific disciplines are designed to address specific problems, generally problems that require a great deal of technical and specific expertise.

Although undergraduate educational programs usually contain a certain number of hours of core curriculum or general studies classes that expose students to an array of different disciplines, in graduate programs, the focus is almost exclusively on work within one discipline or field of study. The graduate student is increasingly trained in the tools of the discipline, as well as its vocabulary, methods of discourse, and standards of proof. The training is, of course, useful for addressing disciplinary problems. But immersion in one field may have the effect of limiting one’s perception of what is a relevant problem and how it should be addressed. As an analogy, I recall the effect of immersion in a foreign language. Upon my return to the United States after speaking French almost exclusively for two years, I sometimes struggled with sentence structure and vocabulary in my native tongue.

A Few Terms

Before discussing interdisciplinary work any further, it may be useful to define the term “interdisciplinary” as it is a word, like Humpty Dumpty’s “glory,” which can mean different things to different speakers. The words “interdisciplinary” and “multidisciplinary” are often used interchangeably. There are also conflicting

uses of the less commonly used terms “trans-disciplinary” and “cross-disciplinary.”

In this paper, I will rely heavily on the work of Julie Klein (1990) in defining these terms. To Klein, multidisciplinary work is work that involves a juxtaposition of disciplines, rather than an integration of concepts in a shared analysis. In a multidisciplinary approach to a problem, the various professionals will analyze the issue from their own disciplinary views, writing up separate sections of a report or giving different parts of a presentation, without much interaction across fields. Some research reports and many panel activities are thus multidisciplinary, not interdisciplinary, following this definition.

Interdisciplinary work, on the other hand, involves a deeper collaboration. It is a means of solving complex problems that do not yield well to the perspectives or approaches of any one discipline. In an interdisciplinary collaboration, participants begin by agreeing on the conceptual nature of the problem, the analytical approach, and the method of reporting results, including the standards of proof in testing hypotheses.

Salter and Hearn (1996) define “instrumental interdisciplinarity” as “borrowing methods and tools from across the disciplines in an effort to address needs dictated by the specific problem at hand” (p. 30). To those working in an applied field, faced with complex problems, borrowing methods and tools from other fields is often seen as an effective means to an end. The use of tools from statistics and management science is so common in agricultural economics, that these tools are usually seen as part of the arsenal of our own profession rather than imports from other fields. Indeed, a number of agricultural economists have contributed to the development of these tools, for example Earl Heady’s contributions to operations research and Frederick Waugh’s contribution to econometrics.

The term “cross-disciplinary” is often used as a synonym for “interdisciplinary;” however, another definition exists. Newell and Green (1982) define cross-disciplinary work, as distinct from interdisciplinary work, as involving an analysis that draws critically from one primary discipline so that the area of the second discipline becomes a passive subject matter. They cite the example of the “physics of music”

as being cross-disciplinary, rather than interdisciplinary. In this respect, much of the work of agricultural economists could be viewed as cross-disciplinary, with agriculture the passive subject.

Trans-disciplinary work, as defined by Klein, is work that transcends disciplinary boundaries. While interdisciplinary work is grounded in the disciplines, trans-disciplinary work by contrast relies on theories, concepts, and approaches outside the disciplines. Some examples provided by Klein include sociobiology, phenomenology, and general systems theory.

The Nature of Agricultural Economics

Recently, I had the opportunity to write a book chapter about agricultural economics for a reference handbook. In preparing to write the chapter, I researched the origin of the field and read or reread a large number of articles published by agricultural economists over many decades.

Agricultural economics came into being at the turn of the 20th century in response to the demand for professionals who could address the special economic and business concerns of the agricultural sector. In 1919, the *Journal of Farm Economics* was launched by the American Farm Economics Association. At that time, over 20% of the United States lived on farms. In 1967, the journal’s name was changed to the *American Journal of Agricultural Economics*, as agricultural issues beyond the farm gates became of increasing interest to the profession. The association that sponsors the journal changed its name twice, once to the American Agricultural Economics Association, and more recently to the Agricultural and Applied Economics Association, again reflecting the increasing scope of activities for its members. Whatever the name of the journal or the association, the focus of both has been and remains applied, real-world problems. The mix of problems studied and the array of tools used by agricultural economists have always been extensive, even at the outset of the discipline. Agricultural economists have long engaged in work ranging from farm-level cost accounting to price analysis to analyzing worldwide agricultural trade patterns and a host of

other real-world issues. As policies and markets evolved, agricultural economists investigated new problems, such as the consumer impact of food safety and nutrition labeling and the economic impacts of environmental regulations.

Gail Cramer (2011), in the introduction to his recently published, four-volume edited series of reprinted seminal papers in the field, referred to agricultural economics as “multi-disciplinary” because it uses principles from business, sociology, psychology, physics, and other fields (volume 1, page 1). He thus does not view agricultural economics as a sub-field of economics, but rather distinct from it in some ways. He notes that traditionally economics emphasized theory, rather than empirical testing of hypotheses through empirical work.

Undergraduate education in agricultural economics is, indeed, multidisciplinary, following Klein’s definition of the term. In my home department, our undergraduate majors are required to take courses in accounting, economics, production agriculture, statistics, and sociology. Our required departmental courses include agricultural marketing, agricultural finance, agricultural law, agribusiness, farm management, and agricultural policy. Whether undergraduate education in agricultural economics is interdisciplinary is an open question. Do we ask our undergraduate students to pull together the various concepts and tools from the different disciplines they study into a coherent, integrated approach to a problem? In many cases, I believe we do, especially in assignments in our upper-level courses in agricultural finance, management, marketing, law, trade, and policy.

Outreach programs in agriculture very commonly employ a team composed of agricultural production scientists (e.g., agronomists, horticulturalists, animal scientists, and plant pathologists) and economists. In some cases, the team takes a multi disciplinary approach, with each scientist approaching the problem from his or her perspective, and writing a multi-section report or giving a panel discussion. In other cases, the team may take a more integrated, interdisciplinary approach.

In research, however, I would argue that despite the need to understand natural systems and the problem-oriented nature of the field,

much of the work in agricultural economics is not interdisciplinary or even multidisciplinary. Instead, it is disciplinary work in economics, albeit applied economics. It may be cross-disciplinary, in terms of applying economic concepts to a problem in agriculture or another natural science, but the home discipline is economics. To do effective applied work, an agricultural economist must have a good understanding of agriculture, a solid grounding in statistics, and often, depending on the sub-field, familiarity with the tools and techniques of other business disciplines including marketing, finance, accounting, or management science. Agricultural economists may also draw heavily on biologically-based disciplines outside agriculture, engineering, or ecology. However, it is not all that common to find, in our premier journals, articles co-authored with those outside the economics discipline. In a recent volume of the *American Journal of Agricultural Economics*, for example, of 16 full-length articles, only two had co-authors who were not economists. And even in these articles, the fundamental theories and concepts were from the economics discipline.

Although it is not common to find papers in our top journals co-authored with those outside the field, this is not to say that agricultural economists don’t frequently co-author papers with those in other disciplines. When they do so, however, those articles may be more likely to find a home in a different kind of journal.

Interdisciplinary Collaboration, Barriers, and Incentive

Much has been written on the topic of barriers to and incentives for interdisciplinary work. Bradbeer (1999), for example, in an article focused on interdisciplinary student learning, lists four barriers: differences in disciplinary epistemologies, differences in disciplinary discourses, differences in disciplinary traditions of teaching and learning, and differences in students’ preferred learning approaches and styles. Over a decade ago, I co-authored a paper on the topic of barriers to interdisciplinary research with two scientists in biologically-based agricultural fields

(Duffy, Guertal, and Muntifering, 1997). Barriers discussed in that article were reward structures, poor timing, unrealistic expectations, and mutual ignorance. The category of "mutual ignorance" covers many of the same issues raised by Bradbeer.

For interdisciplinary work to be successful, barriers must be surmounted. Reward structure is an external barrier, and one that differs from institution to institution. Petrie (1976) pointed out that the institutional setting matters and the more administrative support and peer recognition afforded to interdisciplinary work, the more likely it is to be successful. He further noted that a need for achievement is an important psychological motivator that comes into play in interdisciplinary projects. A young agricultural economist, who wishes to be well-thought-of by his colleagues and to earn tenure and promotion through the ranks, will pay attention to signals concerning what is and what is not rewarded.

Perusal of author affiliations in a table of contents may send a subtle, but powerful, signal that our "best" journals are focused on research at the more disciplinary end of the spectrum. Further, almost all academic units are organized by discipline, and expectations for disciplinary contributions may be explicitly communicated, in writing or in oral comments, to the newer members of the department.

The following passage from Auburn University's *Faculty Handbook* illustrates the importance of disciplinary work in tenure and promotion decisions, not just for a single department, but university-wide.

A faculty member engaged in research/creative work has an obligation to contribute to his or her discipline through applied and/or basic research, through creative endeavors, or through interpretive scholarship. To a large extent, each discipline and each department must determine how much and what quality of research/creative work is appropriate for promotion (and/or tenure) and judge its candidates accordingly. In appraising the candidate's work, faculty members should consider the quality and significance of the work, the quality of the outlet for publication or exhibition, and, in cases of collaborative work, the role of the candidate (Chapter 3).

The identical passage was quoted in our 1997 paper (Duffy, Guertal, and Muntifering, 1997). Despite a growing campus-wide awareness of the importance of interdisciplinary work to solve complex problems, no change has subsequently been made to this language.

Senior faculty can work a positive influence in changing institutional culture. The first step may be the recognition that good interdisciplinary work relies on team members starting with a solid grounding in their home discipline. In this respect, it is not a bad thing that agricultural economists are expected to prove themselves competent in their home discipline. Successful interdisciplinary work should not be discounted as "second rate" or "sloppy science." Without a good basis in the home discipline, there may not be much one can contribute to an interdisciplinary team.

If interdisciplinary work is going to be attractive to competent professionals, it will need to offer similar levels of reward to disciplinary work and those rewards must be clearly communicated. With grants increasingly targeted toward interdisciplinary teams and the emergence of new, well-regarded journals friendly to interdisciplinary work, there are clearly ways for researchers to enjoy significant, measurable achievement in interdisciplinary work.

Additional barriers cited in our earlier article (Duffy, Guertal, and Muntifering, 1997) included the related problems of unrealistic expectations and poor timing. For economists, poor timing means we are often brought into a project too late, after the primary data have been collected. Dobbs (1987) opined that some natural scientists may view agricultural economists as "clerks," if they take directions from the natural scientists, or "parasites," if they pursue their own ideas using data collected by others.

The problem of unrealistic expectations is often the result of poor timing. If data collected are not suitable for a solid economic analysis, little can be done after the fact. Further, natural scientists may not understand the amount of time and effort that can go into developing a suitable economic model or that sixth authorship on a paper in a production-science journal will do little to nothing to further the

economist's hopes for tenure and promotion. To a large extent, these related barriers can be circumvented by open discourse, working together on grant proposals, and ongoing collaborations.

Mutual ignorance may be the most significant barrier to successful collaboration. Petrie (1976) points out that disciplines vary in what he refers to as their "cognitive maps," which he explains as being their basic concepts, methods of inquiry, problem definition, way of organizing or categorizing information, standards of proof, and general ideas. Swanson (1979), for example, noted that agricultural economists and natural scientists may ascribe to different paradigms. Economists tend to look for uni-directional causality, while biologically-based disciplines may look for mutual causality, with feedback loops, a fundamental difference in approach.

Axel Leijonhufvud (1973) in his humorous article, "Life Among the Econ," summed up the status relationship in economics using the following words: "The dominant feature, which makes status relations among the Econ of unique interest to the serious student, is the way that status is tied to the manufacture of certain types of implements, called 'modls' (sic)." For an applied economist, status can also extend to original applications as well as construction of models. However, the highly stylized, mathematical derivations of behavior most favored by economists are not always well-understood or appreciated by those without formal training in the discipline.

A major source of tension for an agricultural economist interested in interdisciplinary work thus may stem from the need, on the one hand, for any successful economist to embrace the central tenets of the home discipline of economics while, on the other hand, being willing to learn other ways of thinking about a problem. The type of professional discourse preferred by economists (e.g., stylized mathematical models of behavior) may pose a significant barrier to communicating with those outside the field what it is we truly value about our disciplinary models. The very same "modeling" that increases the likelihood of disciplinary reward may be a barrier to interdisciplinary collaboration by increasing mutual ignorance.

Zilberman (1994), discussing particular barriers that may be faced by agricultural economists addressing innately interdisciplinary environmental and resource problems, noted that members of other disciplines do not always accept the assumptions of profit or utility maximization, while this framework for self-interested behavior is the dominant idea in economics. As an example, he discusses the field of public health, and gives the specific example of the Delaney amendment. While economists are trained to assess costs and benefits and maximize overall welfare under constraints when recommending policy aimed at reducing health risk, those in other fields may view any risk as unacceptable. He points out that an economist who ignores other professionals and aggressively advocates policies contrary to the central tenets of other professions risks alienating its members and cutting off communication. Instead, he advocates "dialogue, mutual exchange, and acceptance."

Stripping away the mathematics we often so generously apply to twice-differentiable functions, we can come down to the basic notion that incentives matter. In 1994, Zilberman said that convincing others that incentives work is best accomplished by case studies and actual data, rather than regression results. It has been my observation, however, that in the span of nearly two decades since Zilberman wrote his article, the notion that incentives work has gained greater traction in the world at large, and that this basic premise can now often be a starting point for agreement on how to approach a problem rather than a point of debate.

Even if the institutional environment encourages interdisciplinary collaboration and mutual ignorance can be overcome, the personalities of the potential teammates can be critically important. So another question that must be answered is how much satisfaction an individual will derive from interdisciplinary work? Petrie posits that a critical personality trait for the successful member of an interdisciplinary team is a taste for new adventure. Within our disciplinary boundaries, the conventions are well known and one has already built up a great deal of human capital. Interdisciplinary work often involves different types of risk, risk that the

project will fail, risk that it will be far more time consuming than a disciplinary project, and risk of various types of conflict with other team members.

A Personal Perspective

As a person working in the area of farm management, collaboration with natural scientists, particularly agronomists in my case, came with the job description. My motivation to pursue interdisciplinary work more aggressively, and to branch out beyond collaborations addressing farm management problems, arose thanks to some policy changes that took place shortly after I was promoted to full professor. In the early part of my career, I enjoyed a long period of analyzing the impacts of changing farm bills on planting decisions on crop farms, using a variety of operations research tools. In 1996, when farm program benefits were largely decoupled from plantings, that particular line of research was no longer especially relevant. Around the same time, Congress passed the “Personal Responsibility and Work Opportunity Reconciliation Act of 1996,” better known as welfare reform. I had a long-standing interest in the problems of poverty, and elected to make a change in research focus. The shift was not easy, as I had no background to draw on, but the work proved interesting. I’m not sure I would have been willing to risk a shift of this kind before I had received a promotion, but the timing was good. I was fortunate to have colleagues in sociology and social work willing to collaborate on this effort, as these other social sciences bring rich insights to the problems of poverty and food insecurity. Our team was also fortunate to receive funding from the Southern Rural Development Center, which greatly enhanced our ability to complete an interdisciplinary project.

My personal experience is that it is usually fairly easy to collaborate with other agricultural scientists, despite differences in paradigms and some mutual ignorance. Zilberman also reported on the relative ease of this type of collaboration. Being in the same college, we share a common culture and an interest in common problems. Further, agricultural scientists do not,

for the most part, have a dominant, central theory explaining human behavior, but instead have complementary skills and often useful, primary data from well-conducted experiments. Many of their journals welcome articles co-authored by economists. Their style of reporting research is typically logical and succinct and thus not hard for an economist to learn if he or she is willing to work at it a little.

Collaboration with social scientists from other fields can be more challenging. Often, they do have a competing paradigm to explain human behavior, or even several competing paradigms. These paradigms are rarely recorded in mathematical notation, which can make it difficult for economists used to such modeling to extract the central ideas of these other disciplines. Further, as in our field, writing research results for publication often requires knowledge of specialized vocabulary, and it is important to have a thorough background in the relevant literature. In collaborating with other social scientists it is therefore important to establish from the start what the target journal will be and who is responsible for which part of writing the paper. Even so, the background reading needed for a successful collaboration with other social scientists can be time consuming and arduous. Departments such as my own, which have both economists and sociologists on the faculty, are useful in facilitating this sort of interdisciplinary collaboration because of the day-to-day interaction that leads one to wonder what these other folks are up to and also a history (one hopes) of good will and comradeship among the faculty.

In terms of working with agricultural scientists, I have especially enjoyed a long-standing collaboration with a faculty member in agronomy. Speaking from my own perspective, we work together well and have complementary skills. This faculty member has some formal academic training in business and economics, and no doubt that made the initial collaboration fairly easy. We have continued to work together on various problems through the years and have seen success in terms of publications, grants, and graduate students who have completed degrees. Continued collaboration with the same individual or team of individuals is an approach I would recommend.

I have more recently partnered successfully with a faculty member in nutrition science. Much like my agronomy colleague, she also has a good understanding of social sciences, which facilitated this partnership. This field does, in general, have tighter “standards of proof” (e.g., lower accepted alpha levels for probability tests) than agricultural economics. Also, the style of presenting results can be quite different, relying more on graphs and figures than on tables full of numbers. Writing styles for the journals are also different and took me some effort, a lot of reading, and a good deal of explanation from my colleague, to grasp.

Interdisciplinary Work and “Wicked Problems”

Sandra Batie (2008), in her fellows address for the Agricultural and Applied Economics Association, discussed “wicked problems” or dynamic and complex problems that are often intractable or even elusive. Horn and Weber (2007) refer to “wicked problems” as social messes and give several examples including the AIDS epidemic, global climate change, terrorism, and nuclear waste. They propose using a “mess map” to conceptualize the problem. The map is designed to help the task force members form a stable, common mental model of the “wicked problem.” Among other advantages, they note that the “mess map” increases the likelihood that group participants will “talk to, and not past each other.”

To remain relevant, she suggests that agricultural economists will need to work on these sorts of issues, stepping outside disciplinary bounds to do so. Energy and obesity are, in my view, two important “wicked problems” that will require interdisciplinary approaches. Pollution, resource depletion, crime, and poverty are others. Agricultural economists are well positioned to work on these problems, now and in the future.

The typical academic career spans three decades or more. During the first decade, the astute agricultural economist will maximize his or her chances to achieve professional goals,

such as tenure and promotion to full professor, for example. In the process, he or she will become increasingly competent in the home discipline.

After promotion to full professor, the next stage of the career involves figuring out what kind of work will keep one happy and productive for the next 20 years. Most academics I know work, on average, a good bit more than a 40-hour week. If putting in such long hours is drudgery, physical and mental health problems are sure to arise. Hence there is a need to find work that is personally rewarding and interesting for the long run. Many meaningful problems can be effectively addressed by one discipline, and thus I would by no means advocate that disciplines should be relegated to the “dustbins of history.” However, some complex problems (i.e., the “wicked problems”) may not yield well to disciplinary solutions. I would also maintain that interdisciplinary collaboration, beyond being useful as a means to an end, can be rewarding and interesting in its own right as a way of learning new things and broadening perspectives.

References

- Augsburg, T. *Becoming Interdisciplinary*, 2nd ed. Dubuque, IA: Kendall/Hunt, 2006.
- Batie, S.S. “Wicked Problems and Applied Economics.” *American Journal of Agricultural Economics* 90(2008):1176–91.
- Bradbeer, J. “Barriers to Interdisciplinarity: Disciplinary Discourse and Student Learning.” *Journal of Geography in Higher Education* 23,3(1999):381–96.
- Cramer, G. “Introduction.” *Agricultural Economics: Critical Concepts in Economics, Volume 1. Production Economics*. G. Cramer, Ed. London and New York: Routledge, 2011.
- Dobbs, T.L. “Toward More Effective Involvement of Agricultural Economists in Multidisciplinary Research and Extension Programs.” *Western Journal of Agricultural Economics* 1(1987):8–16.
- Duffy, P., E. Guertal, and R. Muntifering. “The Pleasures and Pitfalls of Interdisciplinary Work in Agriculture.” *Journal of Agribusiness* 15,2(1997):139–59.
- Horn, R.E., and R.P. Weber. *New Tools for Resolving Wicked Problems: Mess Mapping and*

- Resolution Mapping Processes*. Watertown, MA: Strategy Kinetics, LLC, 2007.
- Klein, J. *Interdisciplinarity: History, Theory, and Practice*. Detroit, MI: Wayne State University Press, 1990.
- Leijonhufvud, A. "Life Among the Econ." *Western Economic Journal* 11,3(1973):327-37.
- Newell, W.H. and W.J. Green. "Defining and Teaching Interdisciplinary Studies." *Improving College and University Teaching* 30,1(1982):23-30.
- Petrie, H.G. "Do You See What I See? The Epistemology of Interdisciplinary Inquiry." *Journal of Aesthetic Education* 10(1976): 29-43.
- Salter, L., and A. Hearn. *Outside the Lines: Issues in Interdisciplinary Research*. Montreal, Canada: McGill-Queen's University Press, 1996.
- Swanson, E. "Working with Other Disciplines." *American Journal of Agricultural Economics* 61(1979):849-59.
- Zilberman, D. "Economics And Interdisciplinary Collaborative Efforts." *Journal of Agricultural and Applied Economics* 26,1(1994): 35-41.