Toward More Effective Involvement of Agricultural Economists in Multidisciplinary Research and Extension Programs

Thomas L. Dobbs

Multidisciplinary research and extension involving agricultural economics and sister agricultural disciplines entail several tensions arising out of differences in perspective and methodology. Recognition of these differences is essential to the achievement of effective and productive working relationships in farming systems and other multidisciplinary research and extension endeavors. Problems and means of addressing differences are covered in this article.

Key words: agricultural economics extension, farming systems, farm management, multidiscipline, research.

Agricultural economics has a long history of involvement in multidisciplinary research and extension endeavors. A wealth of experience has been accumulated over the years in how to work with sister disciplines in the agricultural sciences. However, the increasingly specialized work taking place at many land grant universities (Schuh) tends to divert attention and resources away from multidisciplinary endeavors. Nevertheless, some segments of our profession are giving renewed attention to multidisciplinary "farming systems" research and extension work (e.g., Norman). For many years, Glenn Johnson (1957, 1971, 1981, 1984) has been stressing the importance of multidisciplinary research. The present need for agricultural economists to work effectively with other disciplines has also been emphasized in recent articles by King and Sonka and by Lacewell and McGrann. It is therefore timely to step back and reflect on how we might more effectively carry out multidisciplinary work.

Work cutting across discipline lines is especially subject to tensions. Discussion of several key problem areas constitutes the principal focus of this article. To set the stage for that discussion, some background on multidisciplinary dimensions of agricultural economics is first developed and a general framework for multidisciplinary research and extension involving agricultural economics is presented.

The ideas presented in this paper are intended to help facilitate more effective multidisciplinary research and extension efforts by members of the agricultural economics profession and their physical and biological science colleagues. Professional agricultural economists, professionals in other agricultural disciplines, and agricultural administrators in universities and government agencies constitute the principal audiences of this paper. Cooperation with professionals in other social

The author is a professor of economics, South Dakota State University.

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sciences and the humanities is left to other authors and papers.

Background

A brief review of the history of the agricultural economics profession may help readers to understand better where the profession has been and how it got where it presently is with respect to multidisciplinary activities. In this regard, a collection of symposium papers presented at the 1984 American Agricultural Economics Association meetings at Cornell University provides excellent background on the development and evolution of agricultural economics as an applied social science profession (Breimyer; King; Schertz; Stanton). A monograph by DeLoach, published several years ago for the Western Agricultural Economics Association, also provides valuable insights on the origins and development of agricultural economics. Johnson's writings (e.g., 1957, 1981) constitute another rich source of information on the evolution of agricultural economics.

It is clear from these historical accounts that agricultural economics emerged in the United States around the turn of the century as a hybrid discipline involving a joint consideration of agronomic and economic issues. Many of the original research and extension concerns of this new discipline were multidisciplinary by their very nature. Farm management concerns were at the forefront at such places as Cornell University (DeLoach). Questions of appropriate farm technology and management of farm resources were central to the orientation and thrust of early agricultural economists. Agronomy, animal husbandry, engineering, economics, and sociology had to be combined to conduct research and develop farmer education programs focused on these farm management concerns. Agricultural economists incorporated data and insights from these other disciplines in the process of systematically examining costs and returns associated with farm resource allocation alternatives. It is fair to say that agricultural economics was an integrating discipline in its early years.

Before long, the profession of agricultural economics began to take on more of an economics subdiscipline shape at some institutions, including the University of Wisconsin, Harvard University, and the U.S. Department of Agriculture. However, the farm management approach, with its heavy agronomy emphasis, prevailed through the 1920s at many land grant colleges and universities. By the 1920s, some institutions, such as the University of California, were also placing emphasis on agricultural marketing (DeLoach).

The "farm depression" of the early 1920s began to draw the attention of leading agricultural economists to policy concerns (Breimyer). Involvement in marketing and policy issues intensified during the general economic depression of the 1930s and the war and postwar periods of the 1940s. With an orientation extending beyond the farm and into the general economy, this work required greater strength in the discipline of economics. Multidisciplinary, farm management-oriented work continued, but disciplinary, policy-oriented work increased in relative importance.

This trend continued in the 1950s and intensified in the 1960s, as advances in computers made possible detailed modeling of agricultural economic problems. The tremendous advances in applications of econometrics and mathematical programming to agricultural problems during this period, described by King, contributed to this specialization trend. Most other disciplines in the field of agriculture were also becoming increasingly specialized during this time.

The 1970s and 1980s have witnessed a renewed interest within the agricultural economics profession in farm management-oriented work. The term often used for some of this work is "farming systems analysis," which has a connotation sometimes broader than, though similar to, farm management. Farming systems work involves the old fusion of economics with such sister agricultural disciplines as plant and animal science and agricultural engineering. However, it also frequently incorporates policy considerations and a broad range of social science dimensions into analyses of appropriate technology and management of agricultural resources. It must be acknowledged, however, that some U.S. farm management extension programs have been at least equally broad. Missouri's "Balanced Farming Program," established during the post-World War II years, is one such example (Johnson 1981).

Interest in farming systems-oriented work was kindled by U.S. and other agricultural

economists working in developing countries of Asia, Latin America, and Africa during the 1950s and 1960s. They faced questions similar to those of their farm management predecessors earlier in this century in the United States, dealing with the type of technology to introduce in order to improve agricultural productivity and income and how to introduce it. These questions in developing countries were compounded by cultural and policy considerations that, at least to the "outsider," were extremely complex. Agricultural research and extension work therefore called not only for economists and natural scientists but for sociologists, anthropologists, and political scientists, as well. As the Green Revolution in developing countries seemed to stall in the early 1970s, interest in farming systems research and extension methods spread substantially. Systems methods came to be viewed as means of untangling the complexities of farm productivity constraints and solutions.

This is not the place for an extensive discussion of similarities in and differences between farming systems research and extension (FSR/E), particularly as it is being promoted in developing countries, and farm management research and extension (FMR/E), as practiced over the course of this century in the United States. Considerable attention is devoted to that topic in recent papers by Johnson (1981) and by Aderogba et al. Strong similarities between the early FMR/E work in the United States and the new FSR/E are noted in those papers. Multidisciplinary orientations and systems approaches characterize both. Aderogba et al. note the increased specialization in farm management research which occurred over time, as economics, mathematical modeling, and use of secondary data attained dominance. On the other hand, they also note that systems approaches have made some very valuable contributions to FMR/E during the last two decades. They suggest that the strengths which have developed within both FMR/E and FSR/E might be drawn on in developing solutions to agricultural problems. Johnson (1981) feels that FSR/E work, at least as practiced in the International Agricultural Research Centers, could benefit by drawing more heavily on some of the rich traditions of American farm management. This would include giving greater attention in FSR/E to firm/household interrelationships and to institutional and human change.

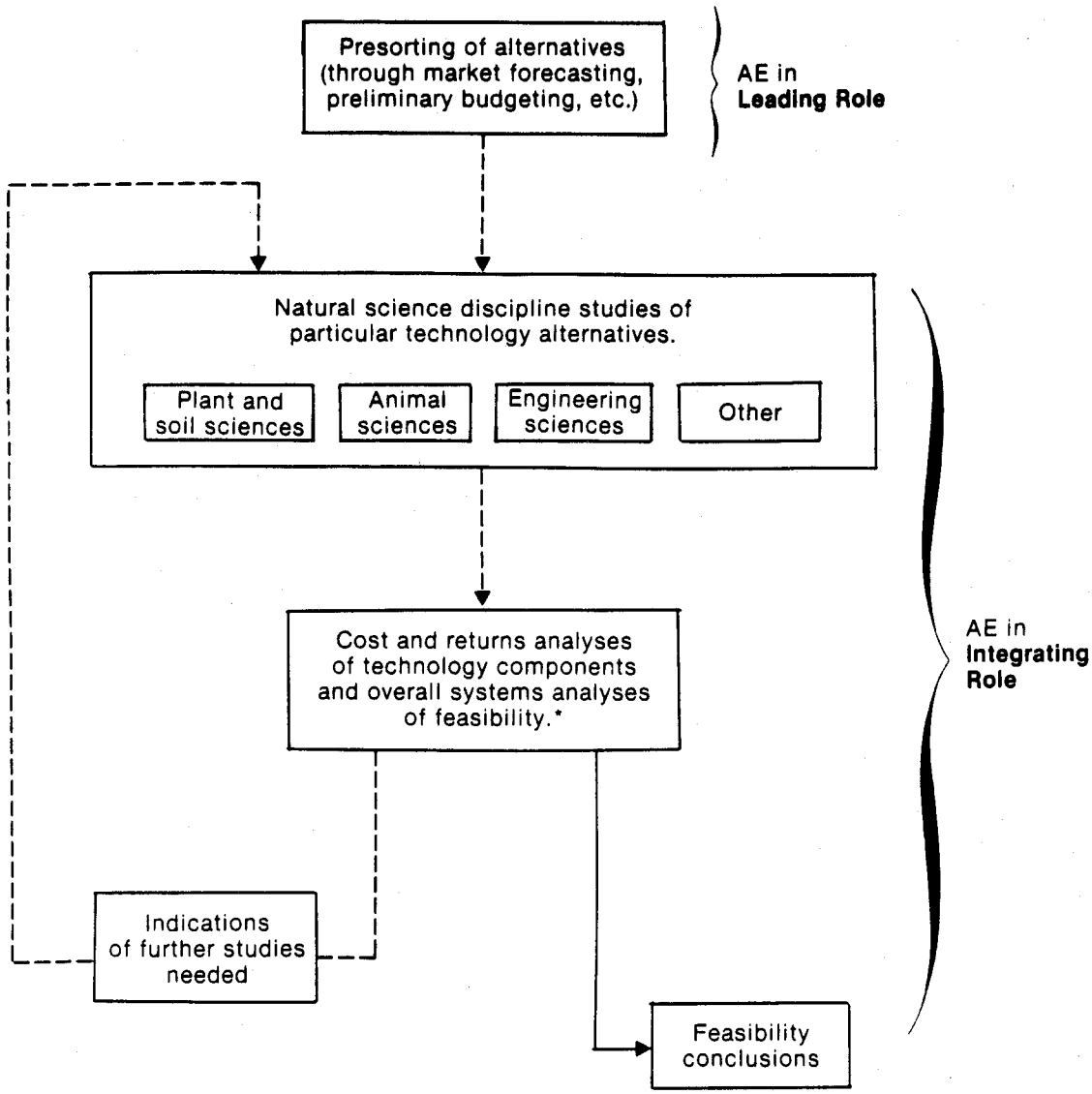
General Framework for Multidisciplinary Research and Extension

Various organizational and analytical frameworks have been utilized in recent years for multidisciplinary research and extension in the United States and overseas.[1] Multidisciplinary research frameworks in some of the international agricultural research centers funded by the Consultative Group for International Agricultural Research are described by Flinn and Denning. In a domestic application, the approach used in multidisciplinary fuel alcohol research and extension over the past several years at South Dakota State University is described in some detail by Dobbs. The general framework illustrated by figure 1, however, is sufficiently broad to capture a number of organizational and analytical issues giving rise to tensions identified in this paper. An integrating role is stressed in this framework. Leading and following roles are also encompassed in the framework, however.

An emphasis on the integrating role is consistent with Swanson's statement that the influence of agricultural economics "as an integrating discipline for the applied natural sciences in agriculture has been pervasive" (Swanson, p. 849). This emphasis should not be misconstrued as a proposed dominance by agricultural economics in multidisciplinary endeavors. Johnson's writings (e.g., 1957, 1971, 1981) wisely emphasize a healthy balance of disciplines in multidisciplinary investigations—with the roles of each respective discipline depending on the problem or subject at hand. Nevertheless, it does seem that there are many instances in which agricultural economists are especially well suited to play either integrating or leading roles, or both.

Agricultural economists can play a leading role when they pre-sort technology, commod-

[1] The term "discipline" is used in this paper in a manner similar to that of Swanson (p. 849), in which the term "simply refers to a specialized field of knowledge." In this sense, a discipline and a profession are more or less synonymous. Agricultural economics and animal science, for example, are both considered disciplines for purposes of this paper. Johnson (e.g., 1971) uses the term discipline in much the same way in some of his earlier writings. However, his later papers (e.g., Johnson 1983, 1984) suggest a more narrow definition of discipline. In the latter, such fields as chemistry, economics, physics, and biology are considered disciplines. Agronomy, animal science, agricultural engineering, and agricultural economics, on the other hand, are considered subject matter groupings of relevant disciplines. Departments containing those fields, says Johnson (1984, p. 3) "are more like institutes than traditional disciplines."



*AE is in **Following Role** if only brought in to do cost and returns analyses after natural science studies are nearly completed.

Figure 1. Framework for multidisciplinary research and extension involving agricultural economics. Source: Dobbs, p. 7

ity, management, or other economic alternatives. Already-available technical and economic data are drawn on for preliminary analyses at this stage. This sorting on the basis of available information, prior to any additional physical or biological experimentation, narrows down the alternatives for the technology or production-oriented work by natural science disciplines. Subsequent to that preliminary sorting, natural science discipline studies of particular alternatives can provide hard data on physical and biological relationships, to be used in detailed feasibility assessments by agricultural economists.

It must be acknowledged, however, that economists frequently are not in this leading

role in multidisciplinary endeavors. The nature of local institutions and the problem at hand strongly influence which discipline is appropriate for the lead role. Moreover, agricultural economists have fewer opportunities than their natural science counterparts to specialize over long periods of time on particular commodities and agricultural processes. Consequently, physical or biological scientists who have long-standing familiarity with the subject commodities or technologies often play the leading roles. Indeed, Johnson (1971, p. 738) has stressed the importance of agricultural economists being willing "to be Indians as well as chiefs . . . and to recognize that the chief may very advantageously be from a different discipline . . . ."

Agricultural economists can play an integrating role in these feasibility assessments by (*a*) providing a broad systems framework to guide the natural science studies and (*b*) combining the physical and biological data from different discipline-oriented studies with economic data to reach management and policy conclusions. Economics, rooted in the concept of trade-offs, is often better suited to integrating all the various positive (benefit) and negative (cost) features of particular technologies or enterprises than are the natural science disciplines.

Systems frameworks and the ability to integrate diverse elements of multidiscipline studies are by no means the exclusive domains of agricultural economists. Each discipline has particular theories and analytic frameworks to contribute in multidiscipline investigations. However, a sizable number of agricultural economists are inclined toward the kind of "holistic" perspective traced by Johnson (1987) in much of the early U.S. farm management research and extension work. These agricultural economists, who operate with conceptual frameworks which are both broad and capable of incorporating dynamic considerations, are often well suited to playing integrating roles.

Sometimes neither leading nor integrating roles for agricultural economics are present in particular multidisciplinary research and extension projects. For example, agricultural economists may be brought into the process late, only to do cost or market analyses on agricultural technologies already developed or being introduced by natural science research and extension specialists. This following role of agricultural economics may be necessary and appropriate in some instances. However, it often has severe limitations, to which we will return later in this article.

Tensions Facing Agricultural Economists in Multidisciplinary Work

Those who have ever been involved in multidisciplinary research or extension programs know that perfect harmony does not always prevail. Tensions between and among different disciplines are inevitable. Some stresses are healthy, but others can be counterproductive if not well understood and handled.

Economics as the Dismal Science

One potential conflict is between the apparent pessimism of economics and the equally apparent optimism of many of the natural sciences. Economics involves the allocation of scarce resources among competing wants or needs. The emphasis on limitations and the pessimism seemingly implied in economics are deeply rooted. Economics' reputation as the "dismal science" goes back to the writings of Thomas Malthus on population growth and the food supply. Simply stated, Malthus' *Essay on the Principle of Population as it Affects the Future Improvement of Society* (published in 1798) envisioned population constantly pressing against the means of subsistence.

The task of most natural science disciplines is to produce basic scientific breakthroughs or applications of science which will forestall the dismal kind of human prospect envisioned by Malthus. In fact, an intrinsic optimism propels good applied natural science research, in which technical means of improving human well-being are sought. If there were no hope involved in pursuing the uncertain or unknown, what purpose would there be in most natural science research?

There is no essential contradiction between the underlying philosophy of economics, with its emphasis on resource limitations and trade-offs, and that of the natural sciences, with their emphasis on technical solutions to resource limitation problems. There is often tension, however, when agricultural economics and the natural science disciplines are brought together in the context of technology adoption recommendations. For example, the engineer may

see new irrigation systems as a partial solution to food problems in a particular developing country, and the agronomist may see substantially increasing fertilizer application rates as a partial solution. Both may envision major benefits relative to costs resulting from their respective schemes.

However, numerous factors beyond the scope of individual natural science disciplines may temper the suitability of a technology. Farmers, for all kinds of very rational reasons, may not increase fertilizer application rates as much or as quickly as expected. The new irrigation structures may not be accompanied by adequate institutional arrangements for management and maintenance and may therefore fail to deliver as much water to farmers' fields as expected. The agricultural economist, with his charge to advise on allocation of scarce resources, realizes that budget limitations may not permit full-scale, immediate adoption of both the agronomist's and the engineer's schemes. Moreover, the costs of some scheme elements may exceed the expected benefits related thereto. Perhaps one or the other scheme will have to wait or, more likely, both may have to be modified in objective or approach in order to fit budget realities.

While the agronomist and the engineer both rightly view their respective schemes in positive terms, the economist's view may be perceived to be negative when he contends that some components of the schemes' costs are too high. Also, it can be unsettling to the physical and biological scientists when economists add macroimplications to microanalyses of technology adoption prospects. Those scientists who are developing new technologies often do not want attention focused on the dampening effect that technology adoption can have on commodity prices. This is more of a problem in countries with agricultural surpluses than in developing countries which are still striving to meet basic nutritional needs. Many issues pertaining to feasibility studies result in controversy and pressures for the economists involved. Economists' results are often unpopular, not only with their natural science colleagues but with "state legislators, state agency officials, farm organizations, and lay public" (Lacewell and McGrann, p. 70).

Economists and other social scientists involved in *ex ante* technology evaluation studies frequently find themselves recommending further research, modification, and evaluation prior to "extending" the technology to potential users. This seemingly "go slow" advice of economists often leads to tension.

A recognition and acceptance of this tension can result in constructive, rather than destructive, interaction. Social scientists, as well as natural scientists, are obviously for human progress. There must be a strong dose of optimism in all of us, especially when we work in the field of agricultural and rural development. At the same time, however, that optimism must be leavened with realism—a recognition that every technology in which there is hope cannot, and should not necessarily, be applied immediately. If both agricultural economists and their natural science colleagues on multidisciplinary teams recognize that they share the same goals but play different roles in pursuit of these goals, this philosophical tension can be healthy. The natural scientists can help expand people's horizons in terms of what is possible. And agricultural economists can help determine which of the possibilities are feasible and recommendable. Mutual respect for the respective roles of each discipline is a critical ingredient for multidisciplinary endeavors.

Perceived Parasites

Another type of tension has great potential for destructiveness. That tension occurs when either agricultural economists or their natural science colleagues, or both, perceive the other group to be parasitic. In applied, multidisciplinary research or extension work, this perception sometimes develops out of the way in which data are obtained.

A parasitic view of economists tends to arise, for instance, when economists are brought into multidisciplinary programs late in the game, as followers. They are expected in those situations to pick up and sort through accumulated physical and biological data and to do an economic analysis of the technology or intervention which has been under study. The natural scientists then sometimes view the economists as either mere clerks or, if the economists author their findings themselves, as parasites who are getting professional mileage out of data someone else has worked hard to generate.

Agricultural economists sometimes have similar views toward natural scientists. It is not unusual to find natural scientists tacking on their own economic analyses at the end of

their studies. Becoming an economist is considered by some to be "as easy as falling off of a log." This view of economics implies that "I can do my own economics as well as the economist, so why bother with him." However, the economist observing this process often sees things differently. He may see the natural scientist as arrogant, irresponsible, and incorrect in use of theory and method and, yes, parasitic. The parasitic view often results from the fact that, for the natural scientist to do his own economic analysis, he may have to spend a great deal of time in some economist's office obtaining data and having assumptions and estimation methods explained to him. In effect, he may lean on the economist quite heavily for assistance but not consider the economist a real partner in the process. Economists in this situation, like the natural scientists in the previous paragraph, may feel used.

This tension is greatly reduced when agricultural economists and natural scientists work together as a team from the outset of a research or extension program. Mutual appreciation of respective roles is more likely to be engendered when this takes place than when agricultural economists are brought in at the tail end. Multidiscipline authorship of publications, another means of mitigating this tension, is also more likely to occur when the various discipline representatives work together on a project from its inception. In fact, how reporting and authorship of research findings are to be shared should be discussed up front in all multidiscipline projects.

It should be fully recognized, however, that resources will not permit a multidisciplinary approach to every agricultural research problem or extension information need. Natural scientists will often have to work alone and to borrow information from agricultural economists for a limited treatment of economic dimensions. Likewise, agricultural economists frequently will not have the luxury of formal collaboration with natural scientists; they must then consult natural science literature and specialists in attempts to ensure that physical and biological data used in their economic analyses are the best available. When either natural scientists or agricultural economists must "go it alone"—and often they must—there needs to be a good deal of care and humility in use of the data and assumptions borrowed from other disciplines. If that care and humility are exercised and if due credit is given for assistance provided, then parasitic perceptions can be mitigated.

Discipline Chauvinism

Another type of tension is more "internal" than "between disciplines," but it can be debilitating, nevertheless. That tension relates to the lower esteem sometimes held by one's discipline peers for multidisciplinary research.[2] This lower esteem may be attributable to the frequent necessity of using relatively unsophisticated economic methodologies and data collection procedures in multidisciplinary research; discipline purists often react quite negatively to such compromises. These compromises are accepted better in extension than in research circles.

In judging the multidisciplinary work of one's agricultural economics peers, whether in research or in extension, there is need to exert greater effort to distinguish between pragmatic and simply "sloppy" methodologies. Shifting agricultural economists' professional focus from the heavy disciplinary orientation of the post-World War II years toward a more "problem-solving" orientation (King and Sonka, pp. 13–15) would help the profession to do that. A heavy disciplinary focus tends to emphasize either new and different methodologies or fine-tuning of particular methods or models. This disciplinary focus has received priority in the agricultural economics profession's journals, as well as in its professional reward systems generally, for the past twenty-five years. Problem-solving and subject matter foci, on the other hand, place greater emphasis on decision makers' needs (Johnson, 1987). The latter focus, more so than the disciplinary focus, accounts for a broad range of information needs as well as for the fact that the decision-making value of additional or better information in each area must be balanced against the incremental cost of acquiring that information. A multidiscipline team at Michigan State Uni-

[2] Johnson (1983, 1984) describes this attitude as a type of chauvinism which elevates disciplinary accomplishments while denigrating academic activities, often multidisciplinary by nature, which are focused on "subject matter" and "problem solving." Johnson (1984, p. 3) describes problem solving research or activities as those "designed to solve a particular problem for a decision maker who faces that particular problem in the world beyond academia" and subject matter research or activities as those "designed to produce multidisciplinary information on a subject important to a fairly well-defined group of important decision makers facing a fairly well-defined set of important problems."

versity, in discussing peer recognition and related issues of research and publication emphasis, has stated that, "unfortunately, work that is too carefully done is sometimes irrelevant for practical decision making" (Black, Waller, and Brook, p. 9).

Moreover, by its very nature, multidisciplinary research often requires more time than does disciplinary research to reach the fruition stage. Personnel evaluation processes must recognize and account for that, especially in discipline-oriented university reward systems.

"Top-down" versus "Bottom-up" Direction

To some, "top-down" direction may be another source of tension. Nevertheless, university administrators above the department level have a crucial role to play in determining the multidisciplinary research and extension agenda for agricultural economics and its sister agricultural disciplines (Dobbs). Strong leadership at the top is often essential if multidisciplinary programs involving several disciplines are to be undertaken successfully. Research and extension efforts involving only two agricultural disciplines, or perhaps even three, can frequently emerge as "bottom-up" efforts resulting from the shared interests and personal compatibilities of individuals. In contrast, the success of research and extension programs which involve more than two or three disciplines often depends upon "top-down" initiatives. University and college-level priorities must be clearly conveyed—through resource allocations, removal of administrative bottlenecks, and professional rewards—if multidisciplinary efforts are to be carried out in a timely and productive manner.

A healthy balance between "bottom-up" input and "top-down" priority setting and direction is both possible and necessary for multidisciplinary research and extension to flourish in departmentalized university settings.

Other Tensions

Only a few of several possible tensions associated with multidisciplinary research and extension have been discussed here. Lack of appreciation for other disciplines' methodologies can create special tensions in multidisciplinary work; data collection and analysis procedures most appropriate for one discipline may not be the most appropriate for another. Problems also arise if time is not spent and patience is not exercised to learn the vocabulary and something of the substance of the cooperating disciplines other than one's own. These potential tensions need not be debilitating to multidisciplinary research and extension programs, however, if mutual empathy exists among agricultural economists and their natural science colleagues.

Concluding Thoughts on the Place of Multidisciplinary Work

The focus of this paper has been on multidisciplinary research and extension involving agricultural economics. Multidisciplinary dimensions to work in the agricultural economics profession have existed since the turn of the century. Although relative emphases on disciplinary versus multidisciplinary work in agricultural economics have varied over time, the multidisciplinary dimensions remain valid today.

It is important to recognize, however, that every profession needs ongoing, strong discipline efforts if it is to maintain intellectual vitality and, indeed, to make major contributions to multidisciplinary efforts. Agricultural economics is no exception. Strong, discipline-oriented research and extension programs in marketing and price analysis, economic development, firm decision making, and resource economics, for example, are extremely important in university academic departments which house agricultural economists. Agricultural economists who are pursuing and extending new knowledge in their discipline tend to keep current on theoretical and methodological developments and on recent management and policy findings. New theory, methodology, and findings have valuable applications in discipline-oriented advice and assistance provided by agricultural economists. This knowledge is also critical if agricultural economists are to bring fresh insights to their multidisciplinary work with natural scientists and other social scientists. Academic units that do not carry on strong discipline-oriented work can expect difficulty over time in maintaining full partnership status in multidisciplinary programs.

The optimal combination of disciplinary and multidisciplinary research and extension in a

university department of agricultural economics will depend on the resources and missions of the particular university and department at a given time. It will also depend on the backgrounds and personal inclinations of available staff. For reasons put forth in the previous paragraph, however, a strong program of discipline-oriented work is essential to the vitality of any agricultural economics department.

At the same time, major commitment to selected multidisciplinary activities of high priority in terms of the university's mission can enrich an agricultural economics department's research and extension program and enable its staff to address certain real-world problems in more complete contexts than would be possible in disciplinary work alone. In any particular department of agricultural economics, some staff may be involved only in disciplinary work, some may carry on only multidisciplinary work, and some may have a hand in both. If there is strong interaction among the collection of agricultural economists, the strengths of both disciplinary and multidisciplinary work will reinforce each other.

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References

Aderogba, K., et al. "Farming Systems Research vs. Farm Management/Marketing: A Potential Dilemma for Economists." Poster presentation at fourth annual farming system research symposium, Kansas State University, Oct. 1984.

Black, J. R., J. Waller, and R. Brook. *The Development of Software for Agricultural Decision-Making.* Agr. Econ. Staff Pap. No. 80-24, Michigan State University 1980 (review draft cited with permission of senior author).

Breimyer, H. F. "Farm Depression and the Role-of-Government Debate." Paper presented at AAEA annual meeting, Cornell University, 7 Aug. 1984.

DeLoach, D. B. *The Western Agricultural Economics Association: Aspirations and Achievements.* A Western Agricultural Economics Association monograph, no date.

Dobbs, T. L. *Agricultural Economics in Multidiscipline Research and Extension: Leading, Following, Integrating.* Dep. Econ. Staff Pap. No. 84-2, South Dakota State University, 1984.

Flinn, J. C., and G. L. Denning. *Interdisciplinary Challenges and Opportunities in International Agricultural Research.* Los Banos, Philippines: International Rice Research Institute Pap. Ser. No. 82, 1982.

Johnson, G. L. *Academia Needs a New Covenant for Serving Agriculture.* Mississippi Agr. and Forestry Exp. Sta. Special Publ., July 1984.

———. "Agricultural Economics, Production Economics, and the Field of Farm Management." *J. Farm Econ.* 39(1957):441–50.

———. "Ethical Dilemmas Posed by Recent and Prospective Developments with Respect to Agricultural Research." Paper presented at annual meeting of the American Association for the Advancement of Science, Detroit MI, 27 May 1983.

———. "Holistic Modeling of Multidisciplinary Subject Matter and Problematic Domains." *Systems Economics: Concepts, Models, and Multidisciplinary Perspectives,* pp. 85–109, eds., K. A. Fox and D. G. Miles. Ames: Iowa State University Press, 1987.

———. "Small Farms in a Changing World." Prepared for first annual farming systems research symposium, Kansas State University, Nov. 1981.

———. "The Quest for Relevance in Agricultural Economics." *Amer. J. Agr. Econ.* 53(1971):728–39.

King, G. A. "Analytical Tools and the Development of Quantitative Methods (1920–1984)." Paper presented at AAEA annual meeting, Cornell University, 7 Aug. 1984.

King, R. P., and S. T. Sonka. "Management Problems of Farms and Agricultural Firms." Paper presented at AAEA special conference on "Agriculture and Rural Areas Approaching the 21st Century: Challenges for Agricultural Economics," Iowa State University, 8 Aug. 1985.

Lacewell, R. D., and J. M. McGrann. "Research and Extension Issues in Production Economics." *S. J. Agr. Econ.* 14(July 1982):65–74.

Malthus, T. R. *On Population,* ed., Gertrude Himmelfarb. New York: Modern Library, 1960.

Norman, D. W. *The Farming Systems Approach: Relevancy for the Small Farmer.* Michigan State University Rural Develop. Pap. No. 5, 1980.

Schertz, L. P. "Contributions of Agricultural Economists to Policy Making: 1945–1984." Paper presented at AAEA annual meeting, Cornell University, 7 Aug. 1984.

Schuh, G. E. "Revitalizing the Land Grant University." Paper presented at colloquium, Strategic Management Research Center, University of Minnesota, 28 Sep. 1984.

Stanton, B. F. "Diverse Beginnings: Agricultural Economics, 1880–1920." Paper presented at AAEA annual meeting, Cornell University, 7 Aug. 1984.

Swanson, E. R. "Working with Other Disciplines." *Amer. J. Agr. Econ.* 61(1979):849–59.