Radially organized teams

Addressing the challenges of sustainable agriculture research and extension at land-grant universities

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Abstract

Researchers at land-grant universities are under pressure to widen their research objectives, which requires them to expand their inquiry from a disciplinary base to a systems level, to include farmers and nonuniversity organizations as research collaborators, and to communicate with broader sectors of the public, such as consumers and policy makers. However, there are few rewards for scientists who undertake long-term, systems-based research. An approach that brings together multidisciplinary, multiprofession teams using a radial model of organization has successfully addressed these challenges in Wisconsin. A small "hub" manages the team, with the remaining participants linked to component task forces or "satellite" projects. This enables research to be done on both multidisciplinary and related single-discipline questions. Radially organized teams can attract diverse people with different time commitments and reward incentives. The research meets the criteria of public and academic audiences alike. For innovative research and extension efforts like radial teams to reach their full potential, larger institutional changes are needed within the land-grant system and professional agricultural societies.

Key Words: multidisciplinary team research, land-grant universities, alternative agriculture, integrated cropping systems

Introduction

In applied agricultural research, the land-grant universities face several major challenges through the 1990s and beyond:

<u>Challenge I:</u> To adopt systems oriented, agroecological approaches that examine both the biophysical and socioeconomic effects of alternative farming systems.

Voices inside and outside the land-grant system increasingly are calling on agricultural researchers to expand their inquiry from a discipline base to a systems level (Schuh, 1986; Buttel and Busch, 1988; National Research Council, 1989). Behind these calls is the need to identify, evaluate, and implement agricultural systems that are "economically sound, socially acceptable, and environmentally compatible" (Lacy, 1993, p. 41). Some writers have focused on systems analyses in the biophysical areas (Duvick, 1990; Francis et al., 1990), others on the connections between the biological and the social sciences (Heberlein, 1988; Lacy, 1992), and still others on matters of social justice (Allen et al., 1991).

Challenge II: To expand the circle of research and extension collaborators to include farmers and representatives of nonuniversity organizations.

Suggested additional participants include producers, and where applicable, suppliers, processors, nonprofit environmental and consumer organizations, and representatives of government agencies (Busch and Lacy, 1983; Schaller, 1991). Such calls have several bases: the historical citizen/university dialogue envisioned under the Morrow, Hatch, and Smith-Lever Acts (Danbom, 1986); a growing awareness among private U.S. corporations that listening to customers is crucial (Deming, 1982; Peters and Waterman, 1982); and the success of farmer involvement in applied research in international agriculture (Chambers et al., 1989). Reasons for expanding the circle of research and extension collaborators range from raising the quality and relevance of the knowledge generated (Suppe, 1987; Stevenson and Klemme, 1992), to restoring the image of the land-grant system (Buttel and Busch, 1988).

Challenge III: To communicate research results to broader audiences, including consumers and policy makers.

The range of citizen groups who are actual or potential constituencies for the land-grant university system has changed significantly since the system began in the late nineteenth century (Buttel and Busch, 1988). Consequently, land-grant scientists and educators should establish communication with these new groups (Debertin, 1992). Particularly important are consumers and policy makers (National Research Council, 1989; Clancy, 1992), two groups with whom land-grant institutions historically have not communicated well (Buttel and Busch, 1988; Lacy, 1993). Not giving attention to these communication channels will prove increasingly costly as the public becomes more concerned about agriculture's impact on the nation's natural resource base and the food system (National Research Council, 1989; Gussow, 1991).

Multidisciplinary, multiprofessional, radially organized teams can attract diverse groups of people to undertake various types of systems research and extension. In the next section, we outline the radial model of team organization, an approach that offers particular advantages for addressing the three challenges listed above. Next, we describe two team projects in Wisconsin that use this model. One is a case study; the other uses a traditional replicated research design to compare alternative production strategies. We then assess the radial model after three years of experience, and conclude by offering some thoughts on what else the land-grant universities must do to meet the challenges of the next decades.

Radially organized teams: the model

Little attention has been paid to the organizational dynamics of effective multidisciplinary, multiprofessional teams in university-based agricultural research. The radial approach to structuring applied research and extension teams was inspired by the work of several organizational theorists who emphasize participatory leadership and goal-setting (Deming, 1982; Wright and Morley, 1989; Miller et al., 1990), adaptive divisions of labor (Perrow, 1979; Kanter, 1983; MacRae et al., 1992), and multiple reward structures (Weisbord, 1976; Peters and Waterman, 1982). Many organizations, including research institutions, traditionally have divided labor either by specialty (discipline-based departments) or by multiskilled units (task forces) (Weisbord, 1976). Radially organized teams allow both.

This model is so named because when viewed schematically it resembles a spoked wheel. The center or "hub" consists of a few systems-oriented collaborators. They are connected to "satellite" researchers who focus on specific, discipline-oriented problems. Within the hub is the "axle," the administrative center.

The responsibilities of the team's hub include focusing on overall project objectives, particularly the interdisciplinary or systems-level investigations, and helping the axle with day-to-day management. To accomplish these tasks, hub members must meet frequently to discuss developing situations. They also initiate new satellite activities, integrate the findings of the completed research, and direct the outreach components.

Other team members involved in satellite research have more narrowly defined objectives that fit comfortably into existing disciplinary approaches, such as monitoring weed management strategies, arthropod dynamics or farm economics. These activities can be either long- or short-term. The "spokes" or means of communication that connect the hub with the satellites include field visits, team meetings, progress reports, and telephone. The axle in this model consists of the principal investigators, who are responsible for helping the teams to function effectively and for dealing with external agencies, such as by soliciting funding and writing reports.

In summary, radially organized teams do the following:

- They foster effective coordination of research and extension activities on multidisciplinary and related single discipline questions on a wide range of topics.

- They enable research coordinators to attract a wide range of university and nonuniversity participants with differing motivations, time commitments, and reward requirements.

- They allow satellite studies related to the core scientific explorations to be done according to different schedules.

Projects that illustrate the radial model

Two Wisconsin projects currently employing the radial model of team organization are described in Tables 1 and 2. One project, the Krusenbaum study, is a whole-farm case study. Its objective is to monitor and assist a young farm couple as they convert a newly leased dairy farm from conventional to organic management. The other project, the Wisconsin Integrated Cropping Systems Trial, is a field-sized, replicated study that compares the productivity, profitability and environmental impact of six agricultural systems at two locations. Both projects began in 1989.

Forming teams and resolving conflicts over research design

With a general research hypothesis in mind (Tables 1 and 2), the principal investigators or axis members of each project began forming teams through ad hoc meetings to which they invited many potential team members. The primary tasks of these early meetings were to gauge people's interests and to choose the general research methods for each project (Tables 1 and 2).

Issues associated with alternative agricultural systems had been heavily politicized in recent years (National Resource Council, 1989; Council for Agricultural Science and Technology, 1990; Potash and Phosphate Institute, 1990). Therefore, both projects gave high priority to insuring that the teams represented a range of philosophies so that future audiences would consider them "honest brokers." As Table 3 shows, the result was that the teams included a significant range of university scientists and other agricultural professionals. Because of the applied nature of the research, the scientific cores of both projects were recruited from university extension researchers drawn from the biological, physical, and social sciences. Farmer members of the Krusenbaum case study were selected because of their experience with systems that use reduced levels of purchased inputs. Farmer members of the Cropping Systems Trial, on the other hand, were chosen to represent a range of production strategies that paralleled the cropping systems being evaluated in the field-sized experiment.

About half the scientists invited to the initial meetings joined one of the projects. The primary reasons of those who did not were lack of time or objections to the research methods. These objections involved three methodological issues. First, several scientists discounted the Krusenbaum project because confounding phenomena are inevitable when an entire farming system is being studied, and because it is difficult to generalize from a case study. Second, a serious debate erupted in the early meetings of the Cropping Systems Trial between ecologists and production scientists. Expressing boredom with the simplicity of most agricultural systems, the ecologists argued for including a wide diversity of crops in the trials. The production scientists, on the other hand, wanted to limit the comparisons to economically reasonable alternatives. The project's hub developed a compromise consisting of six rotations, all potentially competitive economically, but ranging in complexity from continuous corn to controlled livestock grazing.

The last conflict was over farmers' power within the teams. The university scientists all accepted the principle of farmer participation in decision making, but several objected strenuously to the principal investigator's commitment to submit all research protocols to farmer evaluation, with the possibility of farmer veto. Scientists who felt most strongly about this withdrew.

A related disagreement was over how fast to release information from the research projects. Farmers and extension agents were concerned about the slow publication timetables of the university scientists. This conflict was resolved by scientists agreeing to present preliminary results at field days and through university departmental papers.

Involving a wide range of university and nonuniversity participants in the design phase resulted in a team of self-selected people for each project who felt comfortable working together and who agreed upon a common set of objectives (Tables 1 and 2). However, it quickly became clear that few participants in either project had the time to administer or coordinate the proposed research and outreach. The radial model of organization helped to resolve this impasse by accommodating team members' varying time commitments and research preferences. Table 3 describes the axle, hub, and satellite structures that eventually emerged for the two projects.

Using the radial model

Although the two projects have very different designs, their objectives are similar (Tables 1 and 2). Both emphasize understanding the biophysical and socioeconomic dynamics of the farming systems under study. Identifying and evaluating alternative production strategies figure strongly in both projects, and each team has made substantial commitments to educational and outreach activities.

As a result, there are many parallels between the two projects' hub activities (Tables 1 and 2). The first task of both hubs was to design the basic crop rotations. Other tasks included establishing data collection and measurement protocols for the performance of the crops and livestock and for economic and management indicators. Both projects hold winter meetings at which all members review plans for the coming season. Hub members meet regularly in the spring and early summer to implement timely changes in cropping plans. Additional hub activities include organizing field days, site visits and other educational programs, and annual team meetings to review project and team performance. Less coordinated effort is required for the satellite activities, which are component-specific and often shorter term. As described in Tables 1 and 2, these parallel explorations include agronomic, animal, physical, and farm management studies.

An assessment of the radial model

Three years' of experience with the two Wisconsin projects is enough to allow an initial assessment of the radial team model. The assessment focuses first on how well these radial teams have addressed the three challenges to the land-grant system posed earlier, and second on how well radially structured teams solve organizational problems generic to all team efforts.

The three land-grant challenges:

- To adopt systems level research

Both Wisconsin projects meet this challenge, with qualifications. Each focuses on an important system--an entire farm in one case, and a series of alternative cropping systems in the other. However, nearly all the analyses so far have been done in parallel rather than interactively. Agronomists compare nutrient cycling or weed ecology in the various cropping systems. Soil scientists focus on the systems' impacts on soil erosion or groundwater quality. Social scientists monitor the farms' labor use, management decisions, and profit margins. Helped by hub members and team meetings, such investigations result in important multidisciplinary as distinct from interdisciplinary research.

Some systems-level problem solving of an interdisciplinary nature has been undertaken in each project. The Krusenbaum team has worked interactively to generate dairy forage systems that comply with environmental standards, meet the herd's nutrient needs, and are suited to the farm family's labor and financial resources. As the literature suggests, truly interdisciplinary analysis is both required and facilitated by systems level problem solving (Birnbaum, 1982). Interdisciplinary efforts, however, require commitments of time and resources that only a few participants could make.

- To expand the circle of research and extension collaborators

Both Wisconsin teams have done well in responding to this challenge. As Table 3 reveals, both have farmers, county extension agents, scientists from non-profit organizations, and professional agricultural consultants as active members. Also, the Cropping Systems Trial includes a high school teacher and the superintendents of the institutional farms hosting the investigations.

A greater challenge than recruiting these nontraditional research participants has been to obtain more than token involvement. As indicated above, the issue of farmers' power drove several prospective university scientists away when the teams were being formed. Both proactive and reactive organizational mechanisms have been used to give the nonscientists on the teams a sense that they are "owners" of the projects and exert real authority. First, the farmers, extension agents and research station superintendents were involved from the outset in setting the objectives and designs of both projects. This resulted in placing high priority on farmers' concerns regarding the financial, labor, and management implications of the farming systems being studied and on the extension agents' concerns about the educational components. Second, nonscientists in both teams are empowered to veto project ideas that they collectively judge to be off the target.

- To communicate results to broader audiences, including consumers and policy makers

As with the other two challenges, the Wisconsin teams have had qualified success in meeting this outreach challenge. A large number and good variety of people attended traditional field days sponsored by the two projects. Also encouraging has been the response to several innovative outreach activities generated by team members. These include elementary and high school curriculum units developed by the teams' county extension agents and public school teachers (Cunningham, 1992) and twilight meetings, cohosted with the Audubon Society, on the interactions between agriculture and wildlife. Attempts to communicate with state policy makers, on the other hand, have been only partially successful.

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Organizational evaluation

Besides having to meet these three challenges facing land-grant universities, the radial teams at Wisconsin had to address organizational challenges that are generic to all team efforts, but are particularly important to these teams because of the mix of disciplines, professions, and political outlooks. To function well, radial teams must develop effective leadership and goal setting procedures, foster successful communication and conflict resolution, and insure that the necessary resources are obtained to reward and motivate team members (Weisbord, 1976).

- **Leadership**

Effective leadership is critical in managing the varied activities of multiprofession radial teams. It requires the teams' axle and hub members to make a substantial commitment and to be competent both in scientific judgment and human relations skills (Anbar, 1973; Rossini and Porter, 1979). Commitment is required because leadership and coordinating duties often are frustrating and time consuming (Heberlein, 1988). As shown in Table 1, radial teams need substantial monitoring and adjusting. This attention is particularly necessary in agriculture, where participating professionals like university scientists and family farmers are accustomed to working independently.

Pivotal to the successes of both Wisconsin teams has been the leadership of an axle person who not only has a background in farming systems research but also has a mandate from the college to facilitate applied, multidisciplinary projects. Such job descriptions are rare in land-grant institutions. Also, both teams have profited from the inclusion of a social scientist interested in small group dynamics, another nontraditional area for agricultural researchers.

- **Internal communication and conflict resolution**

These areas clearly show the importance of leadership and a center of team accountability. After experimenting unsuccessfully with more complex communication structures, both teams decided to transmit all significant information through one axle faculty person. Agendas for planning and communication are prepared by this team leader and carried out in several ways. The hub of the Cropping Systems Trial meets four times a year, while the Krusenbaum team hub has averaged over six meetings per year. The full teams meet twice a year, once before planting and once after harvest. Annual reports summarizing the various satellite studies also are important in communication.

Conflict resolution also is handled in various ways. Whenever possible, compromises are forged at team meetings, such as the compromise mentioned earlier between the ecological and production groups in the Cropping Systems Trial. When such resolution is not possible, the satellite studies and on-farm trials offer opportunities for conflicting sides to try out their preferences, such as testing the effectiveness of various soil additives.

As mentioned, veto power is important for both projects. An agreement was reached early in the Krusenbaum project that whenever the farm couple chose not to follow advice offered by the team, they would tell the hub why in writing. The Krusenbaums kept a decision diary that shows such veto power was exercised primarily when the couple believed that following the advice would require too much labor or would significantly set back the farm's transition to organic certification (Stevenson, 1993). The veto power exercised by the county committees of the Cropping Systems Trial was less aggressive, and usually involved recommending modifications of the satellite research experiments proposed by university scientists.

- **Obtaining resources**

The marginal status of long-term, systems research is revealed by the difficulties that both teams have had in securing funding. One problem has to do with the research objectives. Since neither study focuses primarily on agricultural inputs, it is difficult to go to some traditional sources that fund applied research. On the other hand, neither study is sufficiently process-oriented to have access to funding sources for basic biological research. Timing is another problem. Neither long-term rotations nor farms in transition are in equilibrium during the early years, so that few conclusions can be drawn with short-term funding.

Finally, academic prejudices appear to play a role. The Research Committee of the Graduate School at the University of Wisconsin, for example, rejected funding for the Cropping Systems Trial with the justification that the school "should not fund projects that do not potentially help faculty to develop research programs fundable by federal agencies like NIH, USDA, NSF, etc." The committee twisted the knife deeper by commenting to the principal investigator that its funds "should go to projects with clearly stated hypotheses and methodologies used in creative ways" (!) (memo to Joshua Posner, December 12, 1991).

On the positive side, support for the two projects has been secured from nontraditional funding sources, including the University of Wisconsin's Center for Integrated Agricultural Systems (Stevenson and Klemme, 1992), the Wisconsin Department of Agriculture, Trade, and Consumer Protection, the Wisconsin Department of Natural Resources, USDA's Sustainable Agriculture Research and Education program, and the Kellogg Foundation.

Summary

Our experience shows that radially organized teams of scientists, farmers, and other agricultural professionals can make important contributions to sustainable agriculture research and extension. Areas identified for further work and development include:

- Doing truly interdisciplinary research to complement multidisciplinary and single discipline investigations.

- Broadening the acceptance of the contributions that nonscientists make to multiprofessional research teams.

- Developing creative outreach strategies to communicate with wider sectors of the agricultural community, particularly policy makers.

- Generating new sources of funding and support for long-term, systems-oriented agroecological studies.

To address these challenges successfully, significant institutional changes will be needed within the land-grant system and professional agricultural societies. These changes include:

- Broadening the public research agenda beyond the traditional orientation toward agricultural production issues and the recent emphasis on the molecular and cellular levels (Bonnen, 1986; Buttel and Busch, 1988). This will mean seriously upgrading the attention given to such topics as ecological systems, whole farm and community analyses, and matters of class, race, gender, and intergenerational equity in agricultural and food systems (Allen et al., 1991).

- Modifying institutional structures to give a clear mandate for integrating high quality science with systems-oriented applied research and outreach programs. Encouraging efforts to do so are occurring at centers of integrated or sustainable agricultural systems on several land-grant campuses across the country (Lacy, 1992). Such efforts, however, need to be institutionally structured at higher levels of organizational authority and integration (Weiss and Robb, 1989; Beattie, 1991).

- Altering the flow of resources and rewards to create incentives for interdisciplinary research and outreach efforts. Examples include devising ways to credit multiple authorship fully (Friedhoff, 1988), securing space in prestigious journals for reporting high quality, systems oriented research (Heberlein, 1988), and revising job descriptions and tenure evaluations for new faculty hired to provide leadership to effective multidisciplinary and multiprofession teams.

Table 1. The Krusenbaum Farm: a case study and model in the establishment of an organic dairy

Hypothesis: A low-input, sustainable agriculture approach is suitable for entry-level dairy farmers.

Research methods: A multidisciplinary case study of a family farm and its transition to organic farming.

Research objectives:

1. To describe the biological, physical, and financial effects of adopting low-input production practices.
2. To chronicle the evolution of a set of coherent farm strategies to deal with issues of animal husbandry, debt management, and labor use.
3. To develop tools that will permit generalizing from a case study to help others evaluate alternative production strategies.

Hub activities: Conceptualize and evaluate an overall transition plan

1. Design crop rotations to meet economic and organic objectives
2. Develop and annually review the dairy herd feeding strategy
3. Annually review compliance with ASCS and SCS regulations
4. Annually review nutrient management and weed control program
5. Maintain farm records (e.g. agronomic, climatic, sales and purchases)
6. Organize field days

Satellite activities: Redesign field boundaries to minimize erosion

1. Weed monitoring and control strategies
2. Evaluate milk production and herd health
3. Analyze financial records
4. Maintain decision diary
5. Analyze building and machinery needs g
6. Monitor soil biological and physical characteristics
7. Maintain labor diary

Table 2: The Wisconsin Integrated Cropping Systems Trial Hypothesis: Increasing crop rotation diversity can maintain system productivity and profitability while reducing the need for chemical inputs.

Research methods: A randomized complete block design comparing six rotations at two locations. Individual plots are approximately 0.75 acres

Research objectives:

1. To describe the biological, chemical, and physical impact of alternative crop rotations at the field level. This work will help promote an agroecological focus on farming.
2. To quantify the short- and long-term economic implications of adopting alternative crop rotations.
3. To expand the range of alternative technologies being presented to farmers.
4. To build functioning "learning centers" that will involve diverse groups in community learning about agriculture.

Hub Activities: Design the initial set of treatments

1. Supervise the agronomic activities on the plots
2. Modify treatments as the growing season progresses
3. Develop the Learning Centers educational programs and field days
4. Conduct site visits
5. Edit an annual technical report

Satellite activities: Monitor earthworm numbers

1. Study the evolution of weed seed numbers
2. Build phosphorous and potassium nutrient budgets
3. Measure fall soil nitrate levels
4. Describe changes in soil health
5. Screen litter dwelling arthropods
6. Take census of nematode populations
7. Characterize corn root health
8. Conduct economic analysis

Table 3. Team make-up of two Wisconsin projects employing the Radial Model of Organization.

Krusenbaum Project

- **Axle:** Host farmer, MFAI agronomist, UW agronomist

- **Hub:** Host farmer, MFAI agronomist, crop consultant, UW-agronomist, UW-sociologist, UW-economist

- **Satellite activities:** 2 farmers crop consultant, MFAI agronomist, 8 UW-Ext. Specialists, 2 UW-researchers

WICST Project

- **Axle:** 2 extension agents, 2 farm superintendents, MFAI agronomist, 2 UW agronomists

- **Hub:** 6 farmers, 2 vo ag instructors, 2 extension agents, 2 farm superintendents, MFAI agronomist, 2 UW-agronomists

- **Satellite activities:** 2 farmers, 2 MFAI agronomists, master gardener, land conservationist, SCS soil scientist, 9 UW-ext. specialists, 7 UW-researchers

MFAI = Michael Fields Agricultural Institute
UW = University of Wisconsin-Madison Staff
VoAg = High School Vocational Instructors in Agriculture,

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