Incorporating Organic and Agroecological Approaches into the University Curricula: The Iowa State University Graduate Program in Sustainable Agriculture

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SUMMARY. Organic agriculture has expanded to a \$13 billion industry in the United States in 2005, continuing the nearly decade-long trend of 20% annual growth. Despite the growth in organic agriculture, our scientific knowledge of organic agriculture farming systems remains limited. Interest in sustainable and organic education at the university level has increased in recent years. To help address this need, the Iowa State University Graduate Program in Sustainable Agriculture (GPSA) was established in 2001 to meet three principal objectives: 1) provide students with the analytical and problem-solving skills required to meet the challenges confronting agriculture in the 21st century; 2) develop an innovative interdisciplinary and interdepartmental approach to graduate education; and 3) position Iowa State University at the forefront of institutions conducting research and extending knowledge about sustainable agricultural systems. As of 2004, more than 70 faculty from various departments and 29 students have participated in the program. Students have the opportunity to investigate organic issues within the context of the five new GPSA courses and to conduct organic agriculture farming systems research in thesis and dissertation studies. Producers and agricultural professionals are involved with GPSA students through the curriculum and on-farm research. Research questions involving optimizing crop or livestock production, plant protection, soil quality, and socioeconomic benefits of farming systems constitute typical theses.

The GPSA was established in 2001 as the first interdisciplinary agricultural degree program at Iowa State University (ISU) focusing on sustainable agriculture (SA) (ISU, 2006). This program offers master's and PhD degrees in the evaluation, analysis, design, and implementation of sustainable agricultural systems. Sustainable agriculture, as envisioned by this curriculum, considers three interrelated components: 1) ecological or environmental health benefits; 2) economic viability and a policy of resource use that does not compromise the lives of future generations; and 3) social benefits including social justice, human empowerment, and human health and safety (Madden and Chaplowe, 1997; Röling and Wagemakers,

1998). The GPSA was established to meet three principal objectives: 1) provide students with the analytical and problem-solving skills required to meet the challenges confronting agriculture in the 21st century; 2) develop an innovative interdisciplinary and interdepartmental approach to graduate education; and 3) position ISU at the forefront of institutions conducting research and extending knowledge about sustainable agricultural systems. The GPSA originated from a need for a broader examination of the ecological and social ramifications of U.S. agriculture, and a desire to teach students integrative analytical skills that could be applied to real-world problems. Based on an acknowledgment of the narrowness of postgraduate education (Einhellig and Marre, 1999; LaPidus, 1999), the GPSA was developed much along the lines of other interdisciplinary programs to meet the increasing demand for system scientists in the workplace.

Farming Systems Research (FSR), popularized by Hildebrand (1990), Dent (1993), and others, integrated

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the human component with the cropping system. The emphasis in early FSR included a more descriptive analysis of energy and input flows into the agroecosystem, compared with the more linear approach of traditional research on yield response to input levels (Bawden, 1990). Farmers' perceptions of research questions and results are also inherent in the systems process, as Chambers et al. (1989) recognized the importance of farmers as central to the research process, and advanced the concept of establishing research agendas based on farmer-identified problems.

The land grant universities (LGUs) are particularly suited for an interdisciplinary agricultural program because of their historical focus on practical research, teaching, and outreach [National Association of State Universities and Land Grant Colleges (NASULGC), 2000]. Because of the problems of reductionism that have developed over the last 30 years in many academic departments at LGUs, the Kellogg Commission recommended that LGUs return to their heritage and become more "engaged" with constituents in "contemporary multidisciplinary problems of the real world" (NASULGC, 1999). Altieri (1995) began offering formal courses in agroecology (AE) at a LGU in 1985, emphasizing the science of agroecosystem study, including the physical, biological, and cultural (socioeconomic) flows into and out of the agricultural system. The faculty who originally designed the GPSA were all connected through an interdisciplinary SA and AE background from the University of California (UC)–Berkeley (Altieri, 2006), UC–Davis (Parr and Van Horn, 2006), UC–Santa Cruz (Shennan and Miles, 2005), University of Maine (Sarrantonio, 2006), Evergreen State College (Rosemeyer, 2006), and Washington State University (Reganold, 2006).

GPSA and organic agriculture

On the issue of organic agriculture, the GPSA major provides an avenue for students interested in pursuing academic, non-governmental organization (NGO) and industry positions in organic agriculture. Expanding annually at 20% over the last decade, the organic agriculture industry was a \$13 billion industry in the U.S. in 2005 (Organic Trade Association, 2005). In

Iowa alone, organic production for all crops increased from 13,000 acres in 1995 to 150,000 acres in 2000 [Iowa Department of Agriculture and Land Stewardship (IDALS), 2001]. Iowa State University has one of the few faculty positions at an LGU entirely dedicated to organic agriculture research and education (Delate and DeWitt, 2004). Students in the GPSA program have the opportunity to investigate organic issues in all GPSA courses and to tackle organic farming systems research as thesis or dissertation topics. Organic farming systems, which have been described as complex (Norgaard and Sikor, 1995; Vogtmann, 1990) and in need of further understanding of mechanisms involved in such systems (Høgh-Jensen, 1998), provide ample research questions for GPSA students. With the organic industry gaining tremendous momentum in the U.S. and the world (U.S. Department of Agriculture–Economic Research Service, 2006), many students are interested in participating in this sector and require a new skill-set not previously taught at the traditional LGUs.

Faculty representation and curriculum

The ISU sustainable agriculture community coalesced around the idea that a formal multidisciplinary program in sustainable agriculture could address the concerns raised by the Kellogg Commission by connecting biological and socioeconomic fields of knowledge to develop sustainable solutions to agricultural problems. The GPSA was designed to complement existing departmental programs as a vehicle for faculty to form a learning community with an identity similar to their own departments (Comprone, 2001). Ten academic departments representing the social and biological sciences, liberal arts and humanities are included in the GPSA program. Major representation derives from the departments of agricultural and biosystems engineering, agricultural education and studies, agronomy, animal science, anthropology, entomology, forestry, horticulture, plant pathology, and sociology. There are 70 participating faculty members, with a core of 10 who have taught the five core courses, although any faculty member is able to initiate a course to add to the SA curriculum. The chair and co-chair are elected from among the GPSA faculty.

In addition, there is a 14-member coordinating committee that consists of one representative from each participating department. Together with local producers and other agricultural professionals, a sustainable agriculture "learning community" has been established, which meets weekly during the school year at the SA colloquium to share ideas, listen to visiting experts, and discuss current SA topics.

Five interdisciplinary courses and the colloquium make up the core curriculum (Table 1). To provide necessary information and a systems-oriented approach for studying agricultural sustainability, students follow an interdisciplinary core curriculum supplemented with coursework drawn from existing departmental curricula. The five new courses and colloquium that comprise the GPSA core curriculum are intended to create a common base of experience for students and faculty in the program, thereby fostering a group identity. The core courses: Agroecosystems Analysis; Integrated Crop and Livestock Production Systems; Ecologically Based Pest Management Strategies; Organizational Strategies for Diversified Farming Systems; and Society and Technology in Sustainable Food Systems are team-taught. Three of the five core courses are required for a master's degree and PhD students are required to complete all core courses. In addition to the core courses, at least three semesters of the colloquium are required for the master's degree and five semesters for the PhD. Students are encouraged to present their research proposals and defense seminars in the colloquium.

Students can take electives from various departments to round out their programs. Master's degree students must have previously obtained a bachelor's degree and a record of achievement in one of the natural sciences, social sciences, or engineering sciences, or a bachelor's degree and equivalent experience in these areas. PhD students must have a master's degree and either an undergraduate or master's degree in one of the majors in the College of Agriculture or its equivalent. The program stresses an integrated education in multiple areas of inquiry. Cross-disciplinary courses are taken to complement the main disciplinary "home." This "home" is declared during the first semester of study. The categories of cross-dis-

Table 1. Core courses in the Graduate Program in Sustainable Agriculture at Iowa State University.

Course no.	Course title	Credits (no.)	Cross-listings	Content brief
SusAg 509	Agroecosystem Analysis	3	Agron 509, Soc 509, Anthr 509 ^z	Farming systems field study
SusAg 515	Integrated Crop and Livestock Production Systems	3	AE 515, Agron 515, and AnSci 515	Crop and livestock production within landscapes and watersheds
SusAg 530	Ecologically Based Pest Management Strategies	3	Agron 530, Ent 530, and Pl P 530	Integrated pest management with emphasis on underlying ecological processes
SusAg 546	Organizational Strategies for Diversified Farming Systems	3	Soc 546, Hort 546, and Agron 546	Social relations of alternative marketing, including relational marketing
SusAg 610	Society and Technology in Sustainable Food Systems	3	Soc 610, AE 610, Anthr 610	Social and technological dimensions of sustainability in food systems
SusAg 600	Sustainable Agriculture Colloquium	1		Weekly seminar
SusAg 599	Creative Component	Variable		Advanced topic for creative component report in lieu of thesis
SusAg 699	Research in Sustainable Agriculture	Variable		MS and PhD thesis and dissertation research

^zAgron = Agronomy; Soc = Sociology; Anthr = Anthropology; AnSci = Animal Science; AE = Agricultural and Biosystems Engineering; Ent = Entomology; Pl P = Plant Pathology; Hort = Horticulture; SusAg = Sustainable Agriculture.

ciplinary courses are social sciences, biological and physical sciences, or engineering.

Master's students must take six credits in the category outside of their disciplinary "home," while Ph.D students take 12 credits outside of their discipline. A minimum of six research or creative component (a detailed treatise in lieu of a thesis—required for a Master of Agriculture degree) credits is required for master's students, while 18 research credits are required for the GPSA PhD. The balance of course requirements (MS, nine credits; PhD, 21 credits) will be electives approved by the Plan of Study (POS) Committee, for a total of 34 credit hours for the MS and 72 credit hours for the PhD. In all cases, the student's graduate committee must include a member of the Sustainable Agriculture faculty whose subject area will be tested at the student's final oral examination.

Student numbers and graduate profile

As of Dec. 2004, there were 29 GPSA majors and three students with GPSA as a minor program. Within the GPSA portfolio, eight were PhD students and 24 were pursuing a MS degree. In 3 years of the program, there were 12 graduates.

The most recent GPSA student with an organic research focus matriculated with required GPSA courses plus 15 credits in agronomy, ecology, statistics, sociology, economics, and biosystems engineering and graduated with a MS degree in 2005. Her organic

farming research thesis involved an examination of the multifunctionality of an organic cow-calf operation (Wiltshire, 2005).

In looking at the graduate profile of 2004, four former GPSA students had been hired in interdisciplinary employment, including sustainable agriculture NGOs. Outcomes that have been established for the GPSA program include the following:

1. Students are able to frame problems and ask critical questions concerning the sustainability of agriculture;

2. Students have knowledge of biophysical and socioeconomic aspects of sustainable agriculture;

3. Each student develops an expertise in sustainable agriculture that transcends disciplinary boundaries, and includes intellectual history;

4. Students become professionals who are interdependent and collaborative;

5. Students will be able to "deal with" complex agricultural problems by using systems thinking or other approaches. Students will be able to critique the different approaches; and

6. Recognize and display visionary leadership with moral and ethical integrity.

However, concern about the depth of training GPSA students receive to prepare them for traditional agricultural fields (crop advisors, crop consultants, academic technical support, industry) has been raised by some recent graduates. In a UC-Davis study of sustainable agriculture academics,

disciplinary, as well as interdisciplinary, knowledge was considered critical for a successful SA program. Practical experience, field trips, and internships were also considered important elements of the major (Khanna et al., 2006). In order to address this issue, POS committees must work closely with students to help determine curricula that match students' career goals. In addition, participatory learning with professional agriculturalists through internships, on-farm research, and/or lab rotations may help alleviate the problem.

Conclusions

With increasing interest in developing more sustainable methods of agricultural production from prospective students across the country, and continued support from faculty members and College of Agriculture administrators, the GPSA is well positioned to take advantage of the demand for sustainable and organic agriculture educational opportunities. Many challenges remain, however, including the need for increased logistical and fiscal support for faculty members teaching in GPSA, and greater public support through engagement with the sustainable and organic farming community. By networking with other university sustainable and organic agricultural programs across the U.S., we hope to share the lessons we have learned in establishing this interdisciplinary graduate program and use the knowledge we gain from others to enhance our program.

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