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The Path to the Future:
Phase Seven

IOWA STATE UNIVERSITY
College of Agriculture
Department of Agronomy
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Introduction

Food and fiber production are so closely associated with human well being that few aspects of our daily lives are unaffected by agriculture. The production of food, feed, fiber, and other agricultural products has increased dramatically in the last century, but these gains have not been made without costs. As world population increases, the imprints of humankind on global ecology are more dramatically displayed. Efficient agricultural production that maintains environmental quality is critical for global well being.

The Agronomy Department was presented with an anonymous endowment in September 1999. The endowment was not meant to replace existing funding, but to be used in innovative ways that would help the department become the best—to be a world leader in charting the future of agriculture.

Our strategic endowment planning was initiated within this context. The major focus of this endowment plan is to prepare the Iowa State University Agronomy Department for the future—a future likely to hold more vertical integration, joint ventures and mergers in key agricultural industries; a future in which the scientific community and the public must communicate to establish a new understanding about emerging technologies and their impacts.

Although these and other issues make planning for the future difficult, our plan is built on the following expectations:

- Change will occur with increasing rapidity and the interval between scientific discovery and commercialization of the resulting agricultural technologies will be shorter.

- The globalization of agriculture and the effect of consumer preference on product development, production and marketing will increase.

- Unbiased, science-based information will be more important to the public as the complexity of agriculture increases.

Food and fiber production are so closely associated with human well being that few aspects of our daily lives are unaffected by agriculture.

Efficient agricultural production that maintains environmental quality is critical for global well being.
More interdisciplinary research will be required to solve problems and deploy technologies in service to the public.

New cropping systems must improve profits for producers without sacrificing environmental quality; adopting new systems will be difficult without appropriate policies.

Strong integrated efforts will be needed to reverse environmental degradation, and to conserve natural resources and biological and agricultural diversity.

These expectations and the Agronomy Department (1997–2002) strategic plan (http://www.agron.iastate.edu/agronomy/sp.html) were used to define the required operational characteristics of the Agronomy Department of the future and the context within which that department will function. Addressing these expectations is integral to the Agronomy Department's future leadership. Through all of this, the Agronomy Department will continue to address the needs of agriculture and thus support societal demands.

The Iowa State University Agronomy Department is a creation of the land-grant system, and our stated mission is to provide excellence in teaching, scholarship and engagement. The department has many research, extension, and teaching programs that are nationally and internationally respected.

We will build on our record of success by:

- expanding knowledge in crop, soil, and atmospheric sciences emphasizing interdisciplinary collaboration.

- developing information, products, services, and technologies for future agronomic practices.

- preparing students for successful careers in agronomic and related sciences, and providing opportunities for their continued education.

- improving crop production and soil management practices while enhancing environmental quality.

- anticipating and facilitating production of society's food, feed, fuel, and fiber needs.
Our success also will depend on:

Anticipating needs and adapting quickly. The ability to quickly shift emphases to answer emerging questions and meet new agricultural challenges is increasingly important. Moreover, to demonstrate world leadership the Agronomy Department must anticipate and understand the questions and foresee changes in world agriculture so that answers will be available for the future. The endowment will facilitate these changes.

Engaging the Department’s stakeholders. The Agronomy Department serves a global clientele that benefits from the results of agronomy research, teaching, and extension. This clientele includes special interest groups who are challenging current agricultural production models. Agronomy faculty and staff must interact with stakeholders frequently.

Ensuring the Department’s programs are multidisciplinary. Future scholarship, teaching, and engagement programs must increase the use of multidisciplinary and holistic approaches to solve agricultural and societal problems. We will rely more on team approaches to enhance scholarly activity, to leverage funding and to conduct innovative research that addresses agronomic issues from the molecular to landscape scales.

Future scholarship, teaching, and engagement programs must increase the use of multidisciplinary and holistic approaches to solve agricultural and societal problems.
An agriculture that serves all adequately and meets human needs sustainably will not happen on its own but must be created carefully, with the diverse needs and concerns of all in mind.

Initiatives

Institute for Global Innovation in Agricultural Science, Technology and Policy

Introduction
Agriculture is a multifaceted, global human endeavor to meet the world’s food and fiber needs. Because of its central importance to modern human existence, it is surrounded by cultural and ethnic traditions and concerns, and is regulated by governmental policies. Agriculture’s inseparable relationship to the human condition, its susceptibility to human manipulation, and its reliance and effects on natural resources create significant tensions. An agriculture that serves all adequately and meets human needs sustainably will not happen on its own but must be created carefully, with the diverse needs and concerns of all in mind. Therefore, considerations of the nature and future of agriculture must extend beyond its basis in biology to include its social, cultural, ethical, and economic dimensions.

Vision
The Institute for Global Innovation in Agricultural Science, Technology and Policy (GIAS) will be an international, broadly integrative arena for launching investigations of critical current, emerging, and future agricultural issues and their impacts on agriculture, natural resources, and societies. The Institute will consider issues of local and universal interest from multiple perspectives; provide suggestions as to how these issues might be addressed, and analyze the potential ramifications of these approaches.
**Goals and Objectives**

- Provide a basis for continuing innovation in research, teaching, and extension in support of agriculture and society.

- Foster interdisciplinary and interorganizational collaboration in the study of agricultural issues and the development of potential courses of action.

- Engage producers, consumers, policymakers, and the general public in developing and evaluating new agricultural paradigms.

- Improve the economic well being of plant and animal producers and define the underlying principles of sustainable agricultural systems.

- Provide educational opportunities to help people make informed decisions about the issues and their potential solutions.

- Elucidate agricultural technologies, systems, and policies that support family-based farming and strengthen relationships between agriculture, agriculturalists, and their local communities.

- Investigate the relationship between (1) agriculture and cultures, (2) global food supplies and food distribution systems, and (3) Iowa’s view of and participation in global agriculture.

**Strategies**

**Prioritizing programs**
The Institute will form a multidisciplinary advisory panel to identify priority issues. Issue analyses will include detailed reviews and integration of published information and indigenous knowledge. Additionally, the Institute will support symposia, seminars, conferences, and meetings where the world’s leading experts on topics related to the agricultural issues are invited to participate. The Institute also will conduct preliminary studies and surveys.

**Maintaining flexibility and expanding funding**
The Institute will locate and make use of human and other resources beyond those available through the endowment, thus leveraging endowment funding. Over time, the Institute may decide that certain core expertise to coordinate projects is required on a long-term basis. In these cases, the Institute would provide salary relief to the department or organization in which the individual normally works as long as the salary funds replaced remain in the department to which it was originally allocated.
Enhancing human resource base
The Institute will develop resident- and visiting-scholar programs to support leading experts to work, on a temporary basis, at Iowa State University. Alternatively, the Institute may support travel to institutions and organizations in the United States and abroad. This may be especially beneficial where the Institute perceives that enhancing Iowa State University's expertise in an area would be important. However, as with all Institute activities, this program will be flexible and responsive to the needs of the Institute, as deemed necessary by the advisory panel.

Building links with policymakers
The Institute will establish programs to give policymakers and analysts the opportunity to become knowledgeable about the scientific, social, and economic aspects of agricultural issues.

Engaging the public
One of the most important outcomes of Institute programs will be materials and activities that lead to the development of an informed public, one able to contribute to the evolution of agriculture. It is critical, therefore, that the Institute be an unbiased source of information for the public and that its work meets the highest standards of scholarship.

Potential Topics for GIASTP
- Intellectual property rights
- Transgenic organisms, agriculture, and food
- Water quality
- Land-use policies
- Global hunger: The role of production, distribution, and economics
- Organic production systems
- Salinization
- Carbon sequestration
- Sustainable agriculture
- Biodiversity
- Energy and renewable energy resources
- The future of the family farm
Excellence in Agronomic Education and Extension

Introduction

Current and projected changes in agriculture demand new approaches to meeting society's educational needs. Rapid changes in technology and discovery will require new educational relationships between the Iowa State University Agronomy Department and learners. We envision building new, long-term educational relationships with traditional and nontraditional students to serve their agronomic learning needs throughout their lives. Our new commitment to lifelong learning partnerships with students will require strong science-based information, new educational delivery systems, flexible learning environments, and programs that are responsive to the diverse and changing information needs of lifelong learners.

The large and diverse clientele served by the Iowa State University Agronomy Department includes resident undergraduate and graduate students, agricultural producers and their families, consumers, crop production professionals, the agricultural industry in general, and the greater scientific community. There is great potential to increase the number of people we serve by including students and faculty from Iowa's community colleges as well as elementary and secondary school teachers. There has been a large increase in the number of students who enroll in agronomy programs to prepare for careers in environmental
science and natural resource management. Furthermore, we anticipate that a growing pool of out-of-state students will be attracted to our strong resident education program.

All these people are learners to whom we should direct our teaching and extension efforts. It is imperative that our relationship with them be continuous and interactive. Results of cutting-edge research on learning theory must be incorporated into Agronomy's undergraduate, graduate, and extension programs. In addition, current programs and staff must be expanded and coordination must be increased between these new programs and existing off-campus instructional programs such as Agronomy Extension and the Master of Science in Agronomy program.

**Vision**

We have a unique opportunity to become the international leader in providing agronomic information. No other agronomy department in the nation has a comparable depth of resources, expertise, or opportunity. It is our vision to be recognized as the nation's premier institution in agronomic education and to develop life-long learning partnerships with our clientele. Our vision of premier agronomic education programs includes helping individuals to:

- obtain and apply sound agronomic information so they can manage natural resources wisely in the production of the nation's food, feed, and fiber.

- gain and use effective communication, critical-thinking, and problem-solving skills.

- acquire a solid foundation in agronomic sciences.

- learn the skills to adapt to and effectively use new technologies and information.

- develop professional and leadership skills that will serve them well in the agricultural industry and society in general.

- understand and adjust to the global environment and agriculture in which they live.

- obtain and maintain useful and science-based information through new and effective educational delivery systems, flexible learning environments, and programs that are responsive to the diverse and changing information needs of life-long learners.
Our vision for establishing a life-long learning commitment to traditional and nontraditional students and for others in agriculture includes providing premier agronomic extension programs that:

- give immediate access to agronomic knowledge utilizing modern technology that is readily accessible by all learners.

- engage both traditional and emerging agricultural industries to serve the public interest in efficient crop production and land stewardship.

- form and maintain a global perspective of agronomy, agriculture and the environment.

**Implementation Plan**

We propose the following new programs:

- A Scholar Exchange Program to bring the world's top scholars and innovators to our department and to send our faculty and staff to other public and private organizations. These exchanges will engage our faculty and staff with educators, researchers, producers, industrialists, and others as necessary and stimulate new ideas to continuously improve our educational programs, methods, and procedures.

- An Innovation Incubator analogous to those available in business and research. These incubator programs are used in new fields of inquiry with breakthrough potential but high risk of failure. In these situations, the long-term potential is emphasized over the short-term costs. The innovation incubator will provide resources to bring together creative teams and provide release time for faculty and staff to design, test, and implement educational innovations. For example, in this incubator:
  - Cutting-edge research in educational and learning theory will be incorporated into agronomic education programs.
  - The latest educational applications of computer engineering, such as virtual reality and computer-assisted learning, will be optimized, developed, tested, and applied.
  - Faculty will design and develop new programs that link our department’s education efforts with those of community and private colleges, fostering seamless educational programs.
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- Curricular innovations, such as developing modular educational systems that provide flexible learning rates and tailor curricula to individual learning goals, will be developed.

- An Educational Technology Enhancement Laboratory that provides technological expertise and assistance to the department's faculty as they develop programs that appropriately harness emerging technologies and methods for improved student learning—and to implement new innovations into new and existing courses. This laboratory will be critical to the faculty's ability to incorporate successful ideas from the Innovation Incubator into our resident and extended-campus educational programs and to integrate interactive databases into teaching and extension activities.

- Interactive Databases and Websites will provide for interactive learning exercises that require the integration and summarization of large amounts of data to solve problems. Crop, soil, pest, and climatic data can be organized to allow for numerical and graphic analysis of points and trends on scales from local to global. The websites will provide access to developed educational modules and current research information in a searchable fashion, including links to appropriate experts. This will allow us to incorporate digital diagnostics and virtual decision-making programs into our teaching and extension programs.

- An Extended Learning Campus involving community colleges, crop production professionals, natural resource management professionals, farm organizations, government agencies, and agribusiness learners not directly reached by the university degree programs.

The endowment will provide new and unique opportunities for all educators to work cooperatively, thus enhancing efficiency, maintaining strong and dynamic curricula, and raising the quality of instruction delivered to resident and nonresident learners. By extensive cooperation with faculty and students at other educational institutions in Iowa, the United States, and the world, we will extend the benefits of the endowment to a broader range of constituents and enhance the widespread recognition of Iowa State University programs.
Integrated Approaches to Plant Improvement

Introduction
Advances in molecular biotechnologies are making the identification and quantification of the activity of plant genes easier. Combining the growing genetic information from major crops with improved computer programs will allow the isolation and manipulation of large groups of genes responsible for specific plant traits or associated with particular environmental cues. These technologies offer the possibility of achieving directed plant performance or plant products.

The development of insect-resistant and herbicide-resistant crops is a clear indication that the agricultural community will use products derived by single-gene manipulation. But the “single gene therapy” approach is inadequate to meet the long-term challenges of increased production per unit land area, greater value in agricultural products, and sustainable agricultural systems. The coordinated activity of many genes must be understood to modify even the simplest developmental trait.

The impact of gene manipulation must be assessed in the context of whole plant performance. And plant performance in an agricultural setting must be assessed in a system that incorporates whole plant communities, soils, cropping sequences, and environmental variables. The limited experience of the scientific community with crops transformed using molecular techniques indicates that transformants can and do exhibit unexpected phenotypes when placed under stressful conditions in the field. This initiative will integrate and coordinate the innovative research expertise in molecular biology, plant breeding, plant physiology, crop science, soil science, crop ecology, and climatology that currently exist in the Department of Agronomy, and related departments, to develop crops that will benefit the environment and future economy of Iowa.

Vision
The Initiative will generate knowledge and understanding of complex gene interactions within the context of agricultural ecosystems. This information will be used to design new crops that, when coupled with appropriate cropping systems, will result in the right genes in the right place, at the right time, and for the right reasons.
Goals
Our effort to develop appropriate crops and crop cultivars has the broad goals of increased profitability, product value, and yield stability. By building on our past strengths and more recently developed areas of expertise we will:

- develop genetic resources capable of greater production of food, feed or fiber per unit area and per unit input.

- design crop biomass and grain components for greater utility and increased market value.

- develop gene combinations to produce plants optimally suited for production in sustainable cropping systems.

This initiative has natural linkages to ongoing programs and research centers within Iowa State University, as well as to other national and international programs. Within ISU, this initiative area includes the Center for Plant Breeding, the Center for Designer Crops, the Seed Science Center, the Grain Quality Initiative, the Center for Plant Genomics, the Center for Plant Transformation and Gene Expression, and units of the United States Department of Agriculture, Agriculture Research Service, e.g., North Central Regional Plant Introduction Station. Outside the university, the initiative will be associated with international crop improvement centers, including the International Maize and Wheat Improvement Center (CIMMYT), the International Center for Tropical Agriculture (CIAT), International Rice Research Institute (IRRI), the Donald Danforth Center, and the National Oceanographic and Atmospheric Administration (NOAA).

Programs
We propose four major programs for the Integrated Approaches to Plant Improvement Initiative.

Understanding the genetic basis of yield per se and of heterosis
Heterosis, or hybrid vigor, has underpinned major yield gains in maize. Yields of other crops also have improved but without harnessing heterosis. The genetic basis of yield and various physiological processes related to yield remain obscure. A better understanding of how yield is improved through selection, what genes are involved in yield, and the processes that underlie heterosis will allow a more targeted approach to improving productivity. Drawing on the complementary strengths of the
Center for Plant Breeding, the study of yield and yield genetics across four major crops (maize, soybean, oat, and alfalfa) will produce substantial gains in our understanding of this vital topic.

**Improving grain and vegetative composition and value**
Grain and vegetative composition affects the market price paid for agricultural commodities and will become an increasingly important factor as markets evolve in response to consumer demand. In the short term, market demand will be met by identifying commercial genotypes that produce plant products with better-than-average composition. In the long term, however, meeting consumer demand for superior or unique combinations of plant components will require a much greater capacity to create genotypes with food, feed, fuel, and fiber characteristics uniquely tailored to specific end uses.

Transgenic transformations to introduce foreign genes hold promise. But modifying plant composition with transgenes is far more complicated than introducing a single gene for herbicide or insect resistance because of the greater potential for intra- and inter-plant genetic and environmental interactions. Also, end-use value usually depends on a combination of plant components, so many genes may need to be introduced or modified.

This program fosters new alliances between leading-edge research programs in molecular biology, molecular genetics, plant physiology, plant breeding, biochemistry, protein and oil chemistry and functionality, measurement technology, plant transformation, and crop modeling to explore innovative ways to improve product composition and value in the marketplace. Analysis of the effects of changing grain composition on seed performance in storage and in the field also will be part of this program.

**Improving yield stability across environments**
The productive ability of plants depends on the environmental conditions under which they are grown. Crop species and genotypes within species respond differently to environmental variability, but the genetic basis for this response is unclear. Ideally crops would maintain productivity as environmental conditions change. Evaluating genotype-by-environment interaction has been an integral component of plant-breeding programs. Combining this proven approach with biotechnological tools to identify and manipulate specific genes related to abiotic stresses will rapidly accelerate progress. Integrated work with molecular genetics, plant physiology, soil science, and crop ecology will identify the best gene combinations for crop stability across a wide range of...
environmental conditions. An integrated examination of genotype by environment interactions and yield stability will result in emergent solutions to this complex issue that would not be elucidated by individualized, discipline-based studies.

**Improving agroecosystem productivity and profitability**

The potential benefits (and pitfalls) of novel crop genotypes clearly need to be considered in the context of overall agricultural systems, whether on a single farm, within a common watershed, or in a region with similar geological or meteorological conditions. Working closely with the Integrated Studies of Agroecosystems Initiative, new crops containing novel gene combinations will be assessed within current and new agricultural systems.

This approach ensures that our crop improvement programs extend beyond the needs of individual commodities, and that we develop genetic resources best suited for profitable, environmentally sound agricultural systems.
Integrated Studies of Agroecosystems

Introduction
A primary objective of studying agroecosystems is to develop management strategies that optimize system performance, rather than maximizing throughput and production. Rich soils and a favorable crop production climate are the foundation of the Iowa economy. Decisions about how we manage our soils profoundly influence present and future productivity and profitability of Iowa's agriculture. They also influence the quality of our water and air—vital to Iowans' citizens. Objective information for guiding soil and landscape management decisions must be derived from basic knowledge generated in the soil, plant (crop and weed), atmospheric and other natural sciences, at the interfaces among these disciplines, and with consideration of the societal context. As a land-grant university, Iowa State University carries a unique responsibility to conduct basic and applied research to generate unbiased information needed for decisions concerning soil and crop management practices.

Iowa agriculture is rapidly changing, with advances in production technology and marketing in a global economy. Tillage practices, fertilization practices, plant genetics, cropping sequences, pest control strategies, and many other practices are evolving more rapidly than ever before. Some new practices offer great potential for improving agricultural landscape management, but these opportunities are not likely to be seized unless the state's land-grant institution rapidly generates reliable information about immediate and long-term impacts. New knowledge generates the need to focus applied research on
A new interdisciplinary program will focus on developing information needed to make wise, effective soil and landscape ecosystem management decisions with which to increase the profitability of Iowa agriculture and improve the quality of our natural resources. The program will include five integrated projects: fundamental studies in soil, crop, weed, and atmospheric sciences; soil and water stewardship; biogeochemical cycles in agroecosystems; temporal and spatial heterogeneity in agroecosystems; and biological-ecological interactions in agroecosystems. Two laboratories to support the research program also are planned. Necessary expertise in disciplines not currently represented in the department will be obtained through collaborations with other departments, short- and long-term exchanges with other institutions, and new hires into the department.

**Goals**

- Develop new and deeper understanding of basic soil, crop, weed, and atmospheric sciences and develop new basic sciences at their interface.

- Establish laboratories to monitor statewide agroecosystem characteristics and to integrate fundamental concepts of basic soil, crop, weed, and atmospheric sciences in developing strategies for managing agroecosystems on various landscapes.

- Provide assistance to agricultural producers, land managers, and policymakers in implementing agroecosystem management practices at locations across the State.

- Evaluate the role of agronomic systems in the wider context of local, regional, and global ecosystems as well as cultural, economic, and social systems through collaboration with the Institute for Global Innovation in Agricultural Science, Technology, and Policy and the Integrated Approaches to Plant Improvement Initiative.

This program has natural linkages to ongoing programs in the department and within Iowa State University, as well as to other national and international programs.
Programs

**Fundamental Studies in Soil, Crop, Weed, and Atmospheric Sciences**

A holistic understanding of agronomic systems cannot be accomplished without a strong foundation of the sciences that are the core of agronomic systems, particularly soil, crop, weed, and atmospheric sciences. Examples of fundamental areas that must be addressed include: (1) the chemical reactions responsible for the long-term behavior and fate of nutrients and pollutants in soils; (2) the rates and mechanisms that control movement of water, solutes, gas, and colloidal particles in soils; (3) identification and improvement of the soil physical, chemical, and biological properties that are most suitable for growth and development of future crop plants; (4) interactions of soil biota with each other and plants at various trophic levels; (5) mechanisms controlling fluxes of atmospheric gases into and from terrestrial ecosystems; (6) impact of climate variability and climate change on soil processes and cropping strategies; (7) crop responses to soil and atmospheric conditions and pests; and (8) biotic and abiotic factors determining weed survival, emergence, growth, competitive ability, reproductive output, and dispersal. This project will foster new alliances between cutting-edge research programs in physical, biological, and chemical sciences, ecology, and molecular biology to improve our basic understanding of agronomic systems.

**Soil and Water Stewardship**

Soil and water are two of our most precious natural resources. This project will foster a comprehensive understanding of soil and water interactions to improve decisions about use of soil and water for crop production and to encourage long-term stewardship of soil and water resources. Many fundamental aspects of the complex physical, chemical, and biological interactions of the soil-water-plant system remain unknown or poorly understood. Water quantity issues (such as the effects of flood and drought on soil processes and crop production) as well as water quality issues (such as the fate of agricultural chemicals, industrial chemicals, animal wastes, pathogens, and eroded sediments) demand decision-making models that are informed by fundamental scientific knowledge. This project seeks ways to balance crop production needs with the need to preserve soil and water quality and to maintain natural landscapes. The project will be linked closely with the Temporal and Spatial Heterogeneity project and the Iowa Agroecosystem Long-Term Research Facility.
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Biogeochemical Cycles in Agroecosystems
The cycling of carbon, nitrogen, phosphorus, and sulfur in all ecosystems occurs through complex biotic transformations in soils, water, and the atmosphere. Besides their essential role in soil fertility and crop production, these transformations are essential to the beneficial ecosystem services that sustain the planet. The objective of this project is to understand the mechanisms underlying biogeochemical cycles, how agronomic activities affect these cycles, and how human activities can be changed to alter the net effect of these cycles. Carbon, nitrogen, and other elements do not move in and out of the soil independently, instead, cycles involving these elements are intricately linked to one another, and to microbial activities, hydrologic cycles, energy balance, and plant physiology. Integrated approaches involving soil, plant, and atmospheric scientists and collaboration with economists are essential. For example, innovations emerging from fundamental soil science (biology, chemistry, physics, and pedology), soil management, and genetic manipulation of root structure and plant biochemistry hold promise for enhancing carbon sequestration and reducing nitrogen losses from soils. The Iowa Agroecosystem Research Laboratories (described later) will be invaluable to the project on temporal and spatial heterogeneity and will provide the means for understanding and manipulating biogeochemical cycles.

Temporal and Spatial Heterogeneity in Agroecosystems
The inherent temporal and spatial heterogeneity of agroecosystems has an enormous impact on soil management, on crop yields, and on the variability of ecosystem services. Heterogeneity is present in the physical, chemical, and biological properties of soil as well as in the animal, plant, insect, and microbial populations within ecosystems. Documenting and predicting these heterogeneities are critical for improved crop management strategies that include risk assessments and uncertainty analyses. Modern technologies (e.g., ground-penetrating radar, remote sensing, geographic information systems) allow us to quantify and improve predictions of heterogeneity at scales ranging from a few meters to a county. In conjunction with the project on soil and water stewardship, knowledge generated by this project will facilitate development of site-specific management strategies to maximize agroecosystem products and services within the context of the entire ecosystem. The project will be closely allied with the Biogeochemical Cycles in Agroecosystems project to facilitate a better understanding of the variability in soil-carbon-enhancement strategies for different types of soils and crops and for different locations in the field, landscape, and watershed. Initiative participants will work closely with the Integrated Approaches for Plant Improvement Initiative to assess
the interactions between crop genotype and temporal and spatial heterogeneity on crop performance. Numerical models and simulations will be developed in the Iowa Agroecosystems Analysis and Simulation Laboratory.

**Biological-Ecological Interactions in Agroecosystems**

Agronomic systems exhibit properties that depend not only on the activities within component parts, but also on the interactions that occur among these components and the environment. Plant (crop and weed)/animal/insect/microbe/environmental interactions affect crop productivity, biogeochemical cycles, and ecosystem services. The goal of this project is to assess processes at the cell, organism, community, and ecosystem levels of agronomic systems. For example, cropping and tillage strategies are frequently used unsuccessfully to control plant (weed) or insect pathogen populations, because little is known about the complex interactions in the soils that contribute to pathogen suppression. Similarly, the complex interactions between roots and microorganisms as they affect plant health, nutrient cycling, and weed suppressive soils are only beginning to be understood. Development of management practices that exploit these processes will greatly enhance agroecosystems. This project will interface closely with the Temporal and Spatial Heterogeneity project, the Iowa Agroecosystem Long-Term Research Facility, the Integrated Approaches to Plant Improvement Initiative, and the Plant Sciences Institute.

**Facilities/Laboratories**

We propose to establish two laboratories essential to meeting the goals of integrated studies of agroecosystems.

**Iowa Agroecosystem Analysis and Simulation Laboratory**

The Iowa Agroecosystem Analysis and Simulation Laboratory will provide a computational facility and statewide network for measuring environmental factors essential to understanding agronomic systems. The computational facility will provide data archive, analysis and simulation capabilities for studying agroecosystems. The measurement network will acquire and disseminate real-time data for research and outreach activities that are time-sensitive and are of potential environmental and human importance. This will provide an unparalleled opportunity to develop comprehensive data sets from which generalized concepts will be built to link climate, climate change and climate variation to plant growth, soil processes, and agroecosystem interactions at various scales.
Iowa Agroecosystem Long-Term Research Facility

The Iowa Agroecosystem Long-Term Research Facility will provide a resource to focus on the dynamic interactions within agroecosystems, including human effects on these systems, and between these systems and the physical environment. Unlike other experimental farms, this facility will be dedicated to long-term ecosystem research to couple investigations on fundamental agronomic sciences, agricultural productivity, and essential ecosystem services.
Agronomic Leadership Program

The endowment funds are not meant to replace existing funding from state, federal, or university sources. The Agronomic Leadership Program supplements those resources by creating a mechanism for the Agronomy Department to enhance department-wide activities and programs. The Agronomy Leadership fund will be managed by the head of the Agronomy Department who will be responsible for making reports to the Department of Agronomy, Dean of the College of Agriculture, and the Endowment Advisory Panel regarding program fund balances and expenditures.

Program activities shall include undergraduate and graduate scholarships, the Continuous Improvement and Assessment Unit (described later), equipment purchases, faculty and staff development (including recruitment and retention), infrastructure issues, and enhancing the department's World Wide Web (WWW) site. Additional staff and resources for accounting and purchasing as may be required to support increased activities resulting from endowment initiatives, programs and projects also may be administered through this program.

Expanding and improving the department's WWW presence is critical to presenting research outcomes; providing a common gateway to resident, distance, and extension programs; aid recruiting undergraduate and graduate students to agronomy and agronomy-related programs. Therefore, a WWW-development committee will be formed. This committee will be composed of faculty and staff with visionary ideas about what the WWW should do and how it should be organized. Membership will include a representative from each of the four endow-
ment initiatives, and from the Department's computer committee. The head of the Agronomy Department may appoint other members as necessary to create a WWW site that will serve the diverse needs of our department and our clientele.

Special expenditures from the funds set aside for the Agronomic Leadership Program may be made to supplement usual endowment initiative funding in order to speed initiative development, at the discretion of the Agronomy Department head. An example of such an activity would be a one-time expenditure of funds to purchase computers and, if necessary, remodel space to house the computer analysis laboratory proposed by the Agroecosystem Initiative.

**Agronomy Undergraduate Fellowships**

To be the premier undergraduate agronomy program we must attract the brightest students to Iowa State University and develop them into future leaders. To achieve our goal, we propose establishing the Agronomy Undergraduate Fellowship Program in three areas.

The Agronomy Academic Fellowship Program will recruit top undergraduate students with interests in sciences related to crops, soils, and the environment. They will be offered awards equal to tuition, room, and board, which will be renewable for eight semesters. We envision supporting four students per year for four years, or a total of 16 students by year four of the program.

The Agronomy Travel Fellowship Program will encourage our students to learn more about another part of the world through an agronomy-organized or other approved work, travel, or study program. We envision that this program would support travel for 50 students per year, with the goal of 100 percent student participation by graduation. To shape our students into skilled professionals, the Agronomy Professional Development Fellowship Program will provide students with an opportunity to gain structured experience in research, teaching, or outreach. Students will work with faculty mentors who will provide guidance and one-half of the students' stipends. The goal is to support 20 students per year.

**Agronomy Graduate Fellowships**

The Department of Agronomy has a long and distinguished history of training graduate students who have become leaders. But the demographics of graduate education are changing. With the strong economy and outstanding career opportunities available, fewer students are choosing to pursue a graduate education and research career.
We can no longer rely only on our reputation to attract the best and brightest students. We must proactively identify and compete for the best students.

The Graduate Fellowship Program will attract the very best students to our graduate programs. To be eligible (draft criteria), applicants must have a B.S. or M.S. degree in agronomy or a related biological or chemical discipline; rank in the first quartile of their graduating class; and have GRE scores of >580 (verbal), >680 (quantitative), and >660 (analytical). The fellowship will pay a stipend of $20,000 per year and full tuition. Students accepted into the program will have the option of choosing their major professors, but must work with an agronomy graduate faculty member and be enrolled in an agronomy graduate program. Students enrolling in interdepartmental majors will not be qualified.

The program will initially fund 10 fellowships. Four fellowships will be funded in the first year, four in the second year, and two in the third year. The number available in subsequent years will depend on openings made available by graduating students.

**Continuous Improvement and Assessment Unit**

A critical component of success is to accomplish goals and objectives. However, especially in the arenas of education, extension, and research, goal-based evaluations are probably less meaningful than contextual analyses of programs. A simple list of goals will not appropriately characterize successes or progress. It is critical that sound protocols be developed for assessing and improving the performance of endowment initiatives, documenting the impacts of initiative activities, and articulating this information to Iowans and other clientele. Improvement and assessment efforts and development/adjustment of project directions will be a continuous exercise that utilizes inputs from clientele.

The Continuous Improvement and Assessment Unit (CIAU) will be responsible for working with initiative coordinators to develop plans to assess performance and impacts. Further, CIAU will facilitate engagement activities between clientele, interest groups, and the agricultural community for the endowment initiatives. The CIAU must have the expertise to quantify the information obtained from listening meetings and initiative activities and develop recommendations for improvement. The CIAU also will work with individual endowment-funded projects and document progress and successes. The work of the CIAU is viewed as a visionary activity in its own right, providing a new model for an innovative, evolutionary Agronomy Department.
This program should become a model that others will emulate not only for purposes of accountability but also as a mechanism for continuous improvement of programs and their resultant impacts.

A faculty member will lead the CIAU. Support could include a P&S position and graduate students. The lead faculty position should have expertise in social sciences, statistics, and qualitative evaluation techniques. Thus, the CIAU leader may be appointed from another department with collaboration and responsibilities in the Agronomy Department.
General Procedures for Executing Initiatives

The power of these endowment funds is derived from the fact that they are not to replace existing funding. Thus, they do not replace existing activities but permit new ones or enhance those already in place. They provide a unique mechanism for the department to pursue innovative initiatives, including high-risk, what-if kinds of research, and maintain flexibility to enhance its leadership into the future. Thus, the procedures developed for these initiatives, in so far as possible, are aimed at preventing the establishment of programs or structures that, in time, might become obsolete.

In accordance with the original endowment Memorandum of Agreement with Iowa State University, final decisions regarding funding of endowment initiatives will be made by the head of the Agronomy Department and the dean of the College of Agriculture, but each initiative shall receive adequate funding in order to make appropriate progress. Endowment initiatives in the initial funding cycle are: the Institute for Global Innovation in Agricultural, Science, Technology, and Policy; the Excellence in Agronomic Education and Extension Initiative; the Integrated Approaches to Plant Improvement Initiative; the Integrated Studies of Agronomic Systems Initiative; and the Agronomic Leadership Program. Initially, each of the first four initiatives will receive equal base funding. The proportion of endowment funding will be 60 to 70% to the first four initiatives and 30 to 40% to the Agronomic Leadership Program.
Any faculty or staff member can belong to any initiative. There are no restrictions on the number of initiatives that a staff member can be involved in. The only requirement is that the member actively participates in the initiative activities and becomes a contributing member of the initiative. Participating in an initiative does not imply funding of a staff member's program. Actively participating in the research, education, and extension activities of the initiatives could result in funding.

**Initiative Coordinators**

Each of the four variable initiatives will be under the direction of an initiative coordinator. This person will be a member of the Agronomy Department faculty or staff. The head of the Agronomy Department will appoint the initiative coordinator (IC) for a five-year term, with potential for reappointment. Each IC shall have at least a full-time BS- or MS-level initiative assistant to assist in all phases of the program's activities, but especially in maintaining and encouraging communications within and outside the program. It will be the IC's responsibility to:

1. Seek a consensus among faculty and clientele about projects or initiatives to pursue.

2. Recommend projects for funding.

3. Establish strong cooperative working relations with the leader of the continuous improvement and assessment unit.

4. Encourage or ensure, where appropriate, cross-disciplinary extension, teaching, or research.

5. Establish, review, and evaluate the process to ensure that only the highest quality projects and proposals are funded. This review and evaluation process shall include external peer review, clientele analysis, and be appropriate for the kind of project or activity under review.

6. Monitor progress of initiatives and ongoing projects and programs.

7. Assure the consideration of additional external funding where possible.

8. Represent initiative programs and projects to others.

9. Take the lead in establishing initiative goals, objectives, and priorities.
10. Consult with and advise the head of the Agronomy Department regarding faculty and staff contributions to initiative activities.

11. Develop, in cooperation with the other initiative coordinators, an annual report presented to the head of the Agronomy Department who will share it with others as defined in the endowment memorandum of agreement.

It is recommended that IC's establish a means to regularly obtain advice from clientele, colleagues, and others as necessary to ensure that the initiatives remain innovative, creative, and engaged.

The department shall use endowment funding to establish structures necessary to support activities expanded due to endowed initiatives. Of necessity, those filling the positions will be employees of the Agronomy Department. No permanent positions will be assigned to initiatives for the first 10 years of initiative existence to ensure that initiatives remain flexible and adapt to developing needs and issues.

General Proposal Criteria

As projects and programs are developed within the initiatives, requests for proposals to identify projects that would permit the initiative unit to fulfill its goals may be made. Each proposal for endowment support shall be evaluated by a common set of criteria to ensure that the project is consistent with the Agronomy Department's core values and our desire for efficient utilization of resources. These criteria include:

1. Who are the clientele?

2. Why is this an important issue to agriculture, the State of Iowa, Iowa State University, or the Agronomy Department?

3. What is the important commodity, direction, or need and justification?

4. How is the project or program critical to our mission?

5. How will agriculture in the future be impacted by the results of the project?

6. How does the program or project take us above and beyond what is currently being done?
7. Does the program or project clearly create or refine linkages with existing or developing programs to utilize university resources efficiently?

8. Does it create or refine linkages with external institutions that will strengthen our department and university?

9. Does it clearly specify how university funds, grants, gifts and other resources will enhance funds provided by the endowment?

**Project Types**

Because each initiative is unique and is responsible for innovation and for communicating results to clients, several types of programs and projects will develop within an initiative. As a guide to organizing initiative activities, the following examples of project types are suggested:

**Short-term Projects**
- 1 to 2 year, possibly high-risk, projects that need seed money for testing of ideas
- ≤ 3-page proposal
- All initiative participants (IP) may be from Agronomy Department.
- No IP can be awarded more than one project every three years.
- Reviews will be sought (may be all on-campus reviewers).

**Regular Projects**
- 2- to 3-year duration
- ≤ 10-page proposals
- At least one team member must come from outside the department to ensure that projects are conducted from multiple perspectives.
- Proposals may originate from outside the department but must involve Agronomy IPs.
- Reviews solicited from external, off-campus reviewers (2 to 3)
**Long-term Projects**
- 3- to 5-year duration, with possibility of renewal
- ≤15-page proposals

- At least one team member must come from outside the department to ensure that projects are evaluated from multiple perspectives.

- Proposals may originate from outside the department but must involve Agronomy IPs.

- Reviews solicited from external, off-campus reviewers (2 to 3)

**Small Grants**
- ≤$5K

- 1-page proposal

- Funded at discretion of IC

**Initiative Activity Sequence**
It is not possible to predict exactly what each initiative must do in order to function at maximum efficiency. Further, each initiative has been defined to foster integration of multiple disciplines and perspectives. However, in so far as possible, each initiative shall operate within the following guidelines:

1. IC meets with any potential initiative participants (IP) to define and loosely rank initial program and project ideas.

2. IC organizes and conducts clientele meeting where these ideas are presented. The IC and the IPs then listen to the clientele, documenting client ideas and suggestions.

3. As a group, the IC and the IPs work to develop a consensus about program priorities.

4. Proposals are solicited with guidelines that are based on the agreed-to priorities.

5. ICs of the variable initiatives meet with one another to talk about their program priorities and the likely proposals that will be put forward by IPs. The ICs may identify overlap among projects in
different programs. These may result in linkages between projects or IPs in different programs. They will also consider whether or not other sources of funding are more appropriate for given programs and projects.

6. Where it is determined that proposals or programs are more suitably funded from external sources or that funds might be available from external sources, the IC will work with IPs to develop outstanding proposals that could be submitted to external funding agencies.

7. Proposals are sent to internal and external reviewers as appropriate.

8. Reviews are received and the IC ranks proposals in close consultation with at least two other ICs (quorum). It is expected that internal reviews, external reviews, current and pending support, adherence to program priorities, etc. will be considered by the ICs, working together. This probably will require help from the initiative assistants of each of the ICs, but the ICs will be responsible for ranking projects.

9. The IC might go back to IPs for clarification or suggest slight reorganization of an otherwise worthy proposal.

10. The IC of the initiative will make initial decisions about level of funding of highly ranked proposals. Proposals may be funded at levels lower than requested.

11. ICs make recommendations to the head of the Agronomy Department for projects to be funded, justifying them in terms of client input and initiative priorities. The head of the Agronomy Department seeks consensus among all four ICs about which projects are funded.

12. The ICs will send a report to client groups describing the projects that received recommendations for funding.

13. Head of the Agronomy Department and the dean of the College of Agriculture make final decisions about initiative funding based on the reports generated by the ICs.

14. The Endowment Advisory Council shall advise the department on the visionary aspects of endowment initiatives.

15. The IC monitors progress of projects during the year by regular meetings with IPs.
16. At a suitable time, the IC discusses the results of the projects and programs with the IPs and the leader of the Continuous Improvement and Assessment Unit and considers courses of action for the coming year.

17. IC sends a progress report on initiative activities including data and information provided by the Continuous Improvement and Assessment Unit to client groups and sets a date for next annual listening meeting.
Judging Initiative Successes

Each initiative and program will, in collaboration with the Continuous Improvement and Assessment Unit, develop improvement and assessment criteria and documentation. Listed below are some general criteria that reflect the overall goals we have in establishing these initiatives and programs. They are measures of success expected to emerge from the activities of these initiatives.

Long-term expectations include:

- Improved agricultural diversification strategies that support producer profitability.

- Increased demand for our degree programs.

- Increased satisfaction of employers with Iowa State University Agronomy Department Graduates.

- More students receiving awards, participating in honors programs and belonging to honor societies.

- More students participating in study abroad programs.

- More faculty receiving awards, fellowships, and advisory roles in professional associations and clientele groups.

- Increased consumer awareness of the crop-based products upon which they rely.

- Fewer negative agricultural impacts on the environment.

- Enhanced knowledge on the part of policymakers and the general public about agricultural issues.

- Increased external interest in funding endowed chairs in research and educational activities supported by endowment monies.

- Increased interest in coming to Iowa State University for professional development leaves, especially relating to the initiatives.

- Better public understanding of the interactions between agriculture and the environment, including the positive roles that agriculture can play in land stewardship.
- Greater numbers and quality of interdisciplinary, interdepartmental, and interorganizational programs and activities.

- Greater numbers of engagement activities in which true two-way dialogues occur among scientists, educators and clientele.

- Greater numbers of grants and other funds in support of interdepartmental and interorganizational activities. The goal is, on average, to reach a dollar for dollar match between external funds obtained and endowment dollars spent.

- Increased numbers of graduate students receiving awards.

- More publications involving authors and collaborators from different disciplines and institutions.

- Increased recognition and rewards, on- and off-campus, for collaborative groups rather than for individual successes.

- Greater interest in our educational programs, both on- and off-campus.

- Increased involvement in research teams by faculty members with primarily teaching or extension responsibilities.

- Increased recognition by our colleagues within the college and across the university that the Agronomy Department is prepared to address complex agricultural issues in a collaborative fashion.