

Executive Summary

Penn State's College of Agricultural Sciences (CAS) is dedicated to leadership and excellence in environmental research, education and outreach. To fulfill these aims, the CAS must be fully engaged in research, education, and outreach to enable society to address a range of historic environmental problems, as well as emerging and profoundly difficult challenges. Key recommendations by the *Sustainable Environments* Team (SET) are:

Research and Graduate Education

- Invest to enhance multi- and interdisciplinary capacity in existing and new initiatives and centers of excellence.
- Strategically fill research, teaching and extension positions to maintain and enhance the ability of CAS to form more complete interdisciplinary, multifunctional teams for addressing environmental issues.
- Reward interdisciplinary, multifunctional teams that address critical contemporary environmental issues.

Undergraduate Education

- Enhance the student-centered undergraduate education mission of the college by locating the ERM program and ENRI in one physical location.
- Integrate our strong undergraduate environment and natural resources program more closely with the research and extension missions of our college.
- Broaden undergraduate course offerings in topics of environmental sustainability to attract students to our programs.

Extension and Outreach

- Allocate resources to recruit, train, and empower extension personnel to meet the increasing needs related to legacy and emerging environmental problems.
- Allocate resources to teams that fully integrate Extension personnel into multifunctional, interdisciplinary activities that address environmental issues.
- Creatively build capacity of Extension to meet increasing demands in a period of diminishing resources.

Communications and Public Relations/Marketing

- Undertake a marketing effort around the areas of excellence to broadly communicate CAS leadership in research, education and extension involving issues of sustainable environments.
- Invest in more effective, issue-based web sites related to specific environmental problems.
- Provide incentives and rewards for interdisciplinary, multifunctional teams to create and deliver advanced information sources on resources management for diverse clientele.
- Offer and aggressively market high-profile topical *seminars, forums, conferences, and workshops* on broad issues with societal relevance, geared for the general public and other stakeholders.

Introduction

Penn State's College of Agricultural Sciences (CAS) is dedicated to leadership and excellence in environmental research, education and outreach. To fulfill these aims, the CAS must be fully engaged in research, education, and outreach to enable society to address a range of historic environmental problems, as well as emerging and profoundly difficult challenges. Perhaps foremost among these emerging challenges, driven by a complex web of global, regional, and local factors, is climate change and the risks it poses for biodiversity, vector-borne disease, water resources, natural hazards, and the productivity of bio-economic systems. Other important challenges of local, regional, and global importance include urbanization and renewable energy development.

The *Sustainable Environments* Team (SET) was charged with identifying gaps and opportunities in research, degree programs/courses, and extension education in the environmental domain. Our view of the environmental domain is expansive, encompassing natural and social sciences, engineering, and law relevant to understanding, measurement, and management of traditional air, water, and soil resources, but also living systems, biogeochemical cycles, landscapes, and human-environment interactions. We pursued our charge using information from prior CAS strategic planning initiatives, CAS surveys of stakeholder needs, reports of CAS study groups, expressed environmental research and education priorities of state, national, and international science, environmental, and agricultural agencies, and other sources.

A fundamental conclusion of the Team is that report of the 2004 CAS Natural Resources Study Group (NRSB) remains valid, salient, and cogent as a guide to excellence and leadership in environmental research, education, and extension. The Team notes and applauds accomplishments in line with recommendations of that report and the College Strategic Plan for the 2005-2008 planning cycle. These include:

- The Undergraduate Curriculum Review, leading to the changes in the administrative structure of the ERM program, an ERM curriculum review, and the creation of the Environmental Marketing Team.
- CAS investments in ENRI and the creation of the Biomass Energy and the Agriculture and Environment Science and Policy centers to foster integrated interdisciplinary research and education on high priority topics.
- CAS leadership and support for the development of a dual degree graduate program in Human Dimensions of Natural Resources and the Environment, and the creation of the new Community, Environment, and Development undergraduate major that includes an option focused on human dimensions of natural resources and the environment.

In noting these accomplishments, we are focusing on outcomes that flow from recent planning initiatives. The Team also identifies critical remaining gaps and opportunities that must be addressed for CAS to fully realize its potential for leadership and to fulfill its commitments as a Land Grant Institution.

Integrated Research and Graduate Training

The complexity of contemporary environmental issues requires interdisciplinary efforts to reach creative and comprehensive solutions. The influential report of the National Academy of Sciences, “*Grand Challenges in the Environmental Sciences*,” articulates why collaboration of scholars from various fields is required to understand and solve complex problems that cut across traditional disciplines (NRC 2001). The essential need for interdisciplinary research and education as the path to leadership and excellence in environmental science, education, and problem solving is recognized by the CAS, and has been encouraged through various initiatives. A few examples are the creation of the Environment and Natural Resources Institute, the Environmental Resource Management undergraduate major, the College’s participation in the Ecology IDGP. Additional investments in faculty and in the organization of research and education are critical for the CAS to be a leader in environmental science and education, and the translation of knowledge to decisions makers on issues of current and emerging importance. Key actions recommended by the SET are:

Invest to enhance multi- and interdisciplinary capacity in existing and new centers of excellence.

The CAS currently supports college and university centers of excellence in several environmental domains. Examples are agriculture and environment science and policy, biomass energy, infectious disease population dynamics, chemical ecology, and toxicology and carcinogenesis. Strategic investments to produce more comprehensive and integrated teams in these areas should be considered to expand the scope of the College’s impacts.

The CAS should additionally develop new multi- and interdisciplinary, multifunctional centers and initiatives to strengthen intellectual capacity, provide recognition for CAS, and serve as catalysts for extramural funding initiatives in key areas. Potential topic domains include:

- *Water quantity and quality.* Issues of water quality and quantity variability issues are among the most pressing in the Commonwealth, nationally, and globally. Advancing interdisciplinary research, education, and extension on water science, engineering, policy, and management are areas of great need and opportunity. Programmatic areas encompassed here include:
 - Nutrient pollution and other causes of degradation
 - Land use and water
 - Climatic change and water
 - Energy and water
 - Policies for managing and protecting water
- *Air quality.* Land use dynamics and management approaches have important consequences for risks and consequences associated with atmospheric emissions

of environmental concern stemming from multiple sources. Programmatic areas include:

- Odors and particulates
 - Greenhouse gas emissions
 - Carbon sequestration in forests and agricultural soils
 - Risk assessment and decision-making
 - Policies for managing and protecting air
- *Sustainable Agriculture and Forestry.* Forest and agricultural lands dominate Pennsylvania's landscape, and their management imposes major environmental impacts, including the loss of wildlands, inefficient applications and management of pesticides and nutrients, and physical disturbance leading to declines in natural resource quality. Increasingly, our managed lands are being called upon to provide goods and services in addition to food, fiber, and energy production, from open space and recreational opportunities to environmental remediation, e.g., carbon sequestration and mitigation of greenhouse gases. Topic domains include:
 - Effective resource management
 - Enterprise and market strategies
 - Renewable energy and integration of energy, food and fiber production
 - Carbon sequestration in forest and agricultural systems
 - Policies and science for supporting agriculture and forests as multi-functional systems
 - *Biodiversity.* A growing population with rapidly changing quality of life expectations is placing ever-increasing stresses and demands on ecosystems to provide greater and more diverse services. CAS is well-placed to become a leader in understand how the changes in biodiversity from the molecular through population level impact the current and future function and productivity of managed and wild ecosystems, and the economic, social and policy issues associated with these changes. Topic domains include:
 - Biodiversity science
 - Policy to manage risks to biodiversity from invasive species, land use change, climate change
 - Markets for ecosystem services

Strategically invest in research, teaching and extension positions to maintain and enhance the ability of CAS to form more broad-based, interdisciplinary, multifunctional teams that can effectively address complex environmental issues.

The CAS should invest in personnel who will contribute to broad and interdisciplinary, multifunctional teams. Search committees for these positions should be diverse and cut across traditional disciplines and appointments.

Reward interdisciplinary, multifunctional teams that address critical contemporary environmental issues.

The CAS should provide incentives and rewards to interdisciplinary, multifunctional teams (and to individuals who participate in such teams) that confront critical environmental issues. A recent report of the National Academy of Sciences entitled “*Facilitating Interdisciplinary Research*” highlights the challenges that these research directions pose for academics with regard to meeting promotion and tenure criteria (NRC 2004). By their very nature, complex environmental problems require team-based investigation and collaboration that link information and methodologies from multiple disciplines. Evaluating and appropriately rewarding the contributions of an individual for the significance, creativity, and productivity of an interdisciplinary team may be difficult by traditional measures. For example, publications and other outputs from the team may be multi-authored, order of authorship may be decided by non-traditional criteria, and location of publication may not occur in traditional, disciplinary outlets. Approaches to address these concerns and to reward contributions to multi- and interdisciplinary activities that advance understanding of and solutions to complex environmental issues need to be developed.

Undergraduate Education

The College of Agricultural Sciences has significant strengths in undergraduate environmental education, with students in department-based and interdisciplinary programs comprising over 25% of our college enrollments at UP. Interest and enrollment in environmental programs is projected to remain high for the foreseeable future, and the College is uniquely positioned to offer a wide array of programs. The college has recently implemented several initiatives to increase enrollment in undergraduate environmental and natural resource majors, including the administrative alignment of the ERM program with ENRI, development of the CED major, discussions regarding program restructuring, and development of the Environmental Marketing Team. Looking to the future, it is imperative that our undergraduate programs continue to address historic or "legacy" environmental problems *and* also expose students to contemporary and emerging issues of statewide, regional and global significance such as adaptations to climate change, water quality and quantity, habitat fragmentation, and invasive species ecology and control. Key actions recommended by the SET are:

Enhance the student-centered undergraduate education mission of the college by locating the ERM program and ENRI in one physical location.

One opportunity to improve communications among students and within the *disciplinary community* that comprises our environmental and natural resource programs is to centralize cooperation and communications among departmental and interdepartmental programs within ENRI. The student-centered mission of our undergraduate programs will be well served by locating ERM and ENRI in one centralized location. ENRI should also continue to be the portal for disseminating information about our environmental and natural resource programs.

Integrate our strong undergraduate environment and natural resources program more closely with the research and extension missions of our college.

The integration of our undergraduate programs with the research and outreach missions is an opportunity that our College should encourage. For example, internships for undergraduates in extension offices could benefit both students and outreach within our college by exposing students to the College's land grant mission and stakeholder issues around the Commonwealth. Extension educators could also interact with students in the classroom on these same issues. Over one-half of the environmental research at Penn State is conducted within the College, and improving undergraduate student connections to environmental research would serve to integrate undergraduates into the research mission. Our current model of departmental faculty appointments is an obstacle to mentoring students from other curricula. A consistent message needs to be directed to units that interdisciplinary research and the mentoring of students from multiple disciplines is valued and encouraged. Monetary or other incentives for mentoring students from environmental and natural resources disciplines, regardless of departmental affiliation, is one way to accomplish this.

Broaden undergraduate course offerings in topics of environmental sustainability to attract students to our programs.

Opportunities exist to strengthen and broaden our environmental and natural resource course offerings. The pervasive notion that faculty and units only receive credit for unit-based courses has hindered course offerings for students with cross-departmental interests. In keeping with our efforts to foster interdisciplinary research among faculty across departments, we must support a culture of environmental course offerings that transcend departmental boundaries. Examples of subject areas for these courses include watershed management science, GIS and spatial analysis, agroecology, invasive species ecology and management, and landscape ecology. Interest in our undergraduate programs from students outside the college (e.g., DUS) could be further cultivated by the development and offering of issues-related general education courses related to sustainable environments. These courses should be taught by senior faculty conducting research in these areas. Faculty and departmental incentives like salary supplements and teaching assistant support would serve as incentives for these course offerings. In addition, we should further explore opportunities for cooperation between programs, such as concurrent degrees between ERM and AEE that offer opportunities for environmental science and education combined with teacher's certification. Other opportunities include the development of options and minors in areas of strength like aquatic resource management and emerging areas like biomass and renewable energy issues, and adaptations to climate change.

Extension and Outreach

Building, sustaining, and expanding the capacity of Extension is paramount to the CAS mission. Extension offers broad experience in coordinating applied research, an infrastructure for outreach, and a strong tradition of service to society. Extension enables the University to have a far-reaching impact, bringing research to bear on the challenges and opportunities faced by Pennsylvanians. Effective outreach is possible through an

extensive, functional network of Extension faculty and educators threaded throughout all levels of Pennsylvania communities – strategically connecting the counties to the research and intellectual capacities availed by the Penn State system. Extension’s reach can be facilitated through the creative use of technology and development of strategic partnerships and alliances.

The increasing needs for extension and outreach stemming from the pressures of legacy and emerging environmental problems are in sharp contrast with decreasing support for extension activities. Extension’s diminishing capacity is primarily due to the attrition from career-end retirements of valuable Extension specialists – both faculty and educator – and is coupled with a lack of commitment to allocate financial resources to fill these vacancies.

Extension work in the environmental arena is often for the “common good” with little or no profit motive. Consequently, it is unlikely that private enterprise would provide leadership to provide unbiased, science-based applied education and technical assistance in the absence of Extension. As evidenced by countries which have privatized extension, the “common good” functions have not been protected, a strong indicator of the need to ensure, build, and maintain a strong extension presence in the environmental arena. Key actions recommended by the SET are:

Allocate resources to recruit, train, and empower extension personnel and incorporate extension appointments into UP faculty positions to meet the increasing needs related to legacy and emerging environmental problems.

Investments in extension are needed to meet the Commonwealth’s current and emerging environmental challenges. Extension educators should be present in every region of the state to meet the educational needs of that region in conjunction with statewide environmental program goals. As agriculture and natural resource extension specialist and educator positions become vacant, it is essential that personnel are recruited, cultivated, and empowered to carry out the essential mission of improving understanding and management of living systems, landscapes, and human-environment interactions. The CAS should invest in personnel who will contribute to broad and interdisciplinary, multifunctional teams. Search committees for these positions should be diverse and cut across traditional disciplines and appointments.

Areas of particular need include: human, animal, and environmental health risk assessment and communication; ecosystem structure – function relationships; adaptation of agriculture and natural resource management to conditions created by climate change; and economic and social impacts of environmental systems management related to water, air, land and alternative energies.

Allocate resources to teams that fully integrate Extension personnel into multifunctional, interdisciplinary activities.

As outlined in the section on research and graduate training above, legacy and emerging environmental challenges are complex and require an interdisciplinary approach to create and communicate solutions. The CAS should provide incentives and rewards to include Extension in interdisciplinary, multifunctional teams (and to individuals who participate in such teams) that confront critical environmental issues.

Build capacity of Extension to meet increasing demands in a period of diminishing resources.

The increasing needs for outreach stemming from the pressures of legacy and emerging environmental problems are in sharp contrast to decreasing support for extension activities. CAS should build capacity of Extension to meet increasing demands in a period of diminishing resources by providing incentives and rewards for creative use of technology to expand delivery of programs (e.g., eXtension) and for development of productive partnerships with educational institutions, governmental and non-governmental agencies, and organizations that have educational programs that address areas of critical needs of traditional and new clientele (e.g., NRCS, Chesapeake Bay Foundation, Pennsylvania Certified Organic).

Communications and Public Relations/Marketing

Undertake a marketing effort around the areas of excellence to broadly communicate CAS leadership in research, education and extension involving issues of sustainable environments.

CAS should invest further in synthesis, communications and marketing activities to develop a more solid reputation for excellence and leadership in environmental research, education, and extension. This is essential for both raising the profile of ongoing efforts, and for better serving the multiple and diverse audiences. Such eminence would allow the college to attract and retain research funds, top-notch faculty and the best students. The college should “own the franchise” and be nationally recognized for issues of sustainable environments in Pennsylvania. Potential strategies for enhancing impact of CAS activities include:

Invest in more effective, issue-based web sites related to specific environmental problems.

Many stakeholders’ first experience with the University and CAS is through the World Wide Web. CAS must improve its web presence to reflect that its environmental research and extension efforts are substantial and cut across disciplines and departments to address pressing environmental issues with societal relevance. Accordingly, the SAC should invest in more effective web sites, and offer new sites related to specific environmental problems rather than administrative units.

Provide incentives and rewards for interdisciplinary, multifunctional teams to create, synthesize and deliver advanced information sources on resources management for diverse clientele.

The CAS should actively foster the creation of materials that market and promote interdisciplinary, multifunctional work that addresses environmental issues. Incentives and rewards in the form of small grants for multifunctional teams to come together to combine data and results with the goal of synthesizing and creating advanced information materials on key environmental issues. Products could include fact sheets, white papers, and presentation materials that distill complex information into key points for the public and for policy makers, and for use by CAS and other media outlets.

Offer and effectively market high-profile topical seminars, forums, conferences, and workshops on broad issues with societal relevance, geared for the general public and diverse stakeholders.