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CHALLENGES CONFRONTING AGRICULTURAL RESEARCH AT LAND GRANT UNIVERSITIES

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INTRODUCTION

By creating the State Agricultural Experiment Station (SAES) system, the Hatch Act of 1887 (U.S. Congress, 1887) initiated a federal-state partnership supporting agricultural research.¹ This unique piece of legislation formalized a social contract for maintaining a strong agricultural industry and an affordable food and fiber supply. Over the past 107 years, this publicly supported agricultural research system has generated the technology and knowledge to ensure a moderately priced and stable supply of nutritious food and quality fiber for a rapidly developing nation. Public support continues today, with approximately 50% of fund-

ing coming from state, 31% from various federal agencies, and 19% from other sources (U.S. Department of Agriculture, 1992).

Although well-documented public-investment internal rates of return from agricultural research have been quite high—exceeding 40% (Huffman and Evenson, 1993),² recognition is widespread that the food and fiber sector is undergoing a paradigm shift with significant implications for the future of SAES mission-oriented research programs at Land Grant universities. Agricultural, corporate, scientific,

political, environmental, and social communities are asking the SAESs to identify and to pursue a broadened

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¹This paper did not attempt to delineate forestry issues although forestry research clearly is a vital research component of many SAESs. The authors believe, however, that some of the general trends

discussed are applicable to agricultural, forestry, and other natural resource industries. For a thorough discussion of forestry research, see "Forestry Research: A Mandate for Change" (National Research Council, 1990).

²This paper focuses only on the SAES system. For a thorough discussion of the role of U.S. Department of Agriculture (USDA)/Agricultural Research Service and private-sector research, see Huffman and Evenson (1993).

range of research priorities.

Many observers argue that to compete successfully in the future for limited tax based resources, Land Grant universities must forge a new social bond between the public and the agricultural research community. This bond should reflect among the latter a heightened concern for a sustainable agricultural system and among the former increased recognition of the importance of basic and mission-linked research (Meyer, 1993). The purposes of this paper will be to review certain critical societal changes to which Land Grant universities must respond and to identify specific challenges that must be met if SAES research is to continue to develop the knowledge base necessary for a sustainable, high-quality food and fiber system.

THE IMPACT OF SOCIAL CHANGE ON THE AGRICULTURAL RESEARCH AGENDA

During the formative years of the SAES system, especially during the first part of the twentieth century, publicly supported agricultural research accurately mirrored the mentality and philosophy of most U.S. citizens, who supported efforts to understand nature and to manage resources. Research emphasized solutions for farmers to natural problems such as droughts, floods, weeds, insects, and diseases and to human-generated problems such as those created by unregulated farming. Necessity drove the agenda, and public concerns about fertilizer fraud and infertile and degraded land in the nation's developed and settled areas focused scientific attention on improving agricultural productivity.

The visionary partnership proposed by the Hatch Act set the stage for unprecedented production and availability of food and fiber. The arguments supporting public investment in the agricultural industry were simple: Food was the basic necessity of life, and the agricultural community largely constituted society. All of society benefitted and properly shared the cost of this investment in national security and health. The public,

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composed primarily of farmers, realized a direct return on investment in agricultural research.

Achievement of such a national consensus about the aims of agricultural research is explained by the historical fact that the agricultural industry was the mainstay of economic and social infrastructures in thousands of rural communities. At the turn of the century, more than 75% of this country's gross

national product (GNP) and 85% of its employment opportunities were associated with agriculture. But as producers implemented new technologies and followed government agricultural policies, per-unit production capacity increased while farm numbers decreased. Today, 18% of GNP and 16% of employment opportunities are agricultural (Lipton and Edmonston, 1993). Although the number of farms and ranches has decreased, agricultural interest groups generally have dominated the rural policy and research agendas.

Today, research agendas are being established not only by farmers but also by consumers. Some initiators of change in the research agenda reflect the increased direct involvement of state and federal regulatory and service agencies, commodity and consumer organizations, advocacy groups, and industries associated with agriculture and forestry. Groups with diverse interests and persuasions participate actively in debates concerning sustainable agriculture, organic farming, genetically engineered foods, food production and processing, chemical and pesticide use, farm-animal welfare, and agriculture's environmental effects.

Societal interest in the environmental impact of agricultural production practices has compelled agricultural scientists to focus beyond efficient, effective, and economical production and processing to the environment and health. Environmental concerns mounted during the 1960s with the publication of Rachel Carson's *Silent Spring* (Carson, 1962), a book challenging the conceptual approach that humans should control nature. Carson described for agricultural researchers an alter-

native vision in which understanding of the relationship between humanity and nature was sought. Since the publication of Carson's book, a healthy environment increasingly has been perceived by the public as a natural resource to be protected and enhanced. Likewise, because the agricultural sector is one of the primary users and beneficiaries of the natural resource base in the United States, environmental issues associated with agriculture have become of increasing concern.

Research in production technology may need to be shifted in emphasis while research to sustain natural resources, especially those used to produce food, may need to be increased. Such shifts are all the more urgent in the face of a predicted increase of five billion in world population over the next 40 years, an increase that will necessitate improved efficiency in food production if the need for expanding acreage devoted to crop production is to be alleviated (Council for Agricultural Science and Technology, 1994).

Expanding the scope of agricultural research inevitably will produce differences of opinion about priorities and competing demands for resources. In coming years, what farmers want from the system and what consumers want will need to be discussed and communicated thoughtfully. On the one hand, consumers want the food supply to be as free of contaminants and as safe as possible. As a result, many favor research on alternative production practices that are safer and more environmentally benign than current practices. One of the major sources of concern is pesticide use. Consumers tend to view new technology skeptically, and a growing number want food produced with minimal if any use of pesticides and chemical fertilizers. Farmers, on the other hand, are interested in cost-reducing technologies to increase profit and expect the university system to educate consumers about the safety of current production practices.

Universities will need to maintain farmer support while revising the agenda to accommodate consumers so as to gain their support. Moreover, because reliable

biological controls for many of the major pests of crops remain to be developed, the SAESs have a major responsibility of expanding this knowledge base. It is becoming increasingly evident that these controls must be developed for specific crop-environment conditions. If the private agricultural sector declines to develop such products, only the universities have the capacity to do so.

The agenda for agricultural research has by no means remained static in the face of social change. Indeed, congressional legislation concerning agriculture historically has demonstrated dynamic responsiveness to public needs. In 1925, the Purnell Act, by formally recognizing rural sociology and agricultural economics within the Land Grant system, authorized "economic and sociological investigations" for the development and the improvement of rural homes and lives. In 1955, the Hatch Act was amended to include human nutrition and home economics research "for the welfare of the consumer." With the 1990 Food, Agriculture, Conservation and Trade Act (U.S. Congress, 1990), Congress changed the priorities and purposes of the agricultural research

and extension system to incorporate explicit statements about satisfying human food and fiber needs; enhancing long-term viability and competitiveness of agriculture; expanding economic opportunities in rural America; and enhancing quality of life for farmers, rural citizens, and society as a whole. The 1990 Act further broadened the agenda for research and ex-

tension by focusing on the enhancement of human health, which depends on food quality, food safety, and nutrition, as well as on the detection and prevention of health and safety problems in rural areas. These are additions to the stated purposes of improving agricultural productivity and protecting the natural resource base, on which a sustainable agricultural economy depends.

With the establishment of the Agricultural Science and Technology Review Board in 1990 and, more recently, with the passage of Senate Bill 20, "Government Performance and Results Act of 1993" (U.S. Congress, 1993), Congress has called for the evaluation of research

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results’ “conforming to and compatible with the perceived needs of society.” Perhaps of greater concern to the traditional formula funding of agricultural research is the Clinton administration’s recently expressed interest in increasing funding primarily for research that would be subject to the competitive peer review process. The administration’s interest is of particular importance to agriculture, for less than 6% of federally funded agricultural research is allocated by that process.

The transformation of the national agricultural research agenda is illustrated most dramatically by changes surrounding the “farm bill,” which Congress legislates approximately every five years. Changes in the names of farm bills since 1970 reflect the shift from production agricultural issues in early years to consumer issues in recent ones (Table 1). The proposed title of the 1995 bill will relate to natural resources. In the 1930s and 1940s, the national farm bill was developed with input from about a dozen groups; in 1990, more than 260 groups were involved, and the number of groups debating the 1995 bill is even greater. In preparation for the 1995 bill, the SAES and Extension systems jointly developed 11 working groups to focus on priority issues in research and extension (Table 2) (National Association of State Universities and Land Grant Colleges, 1994).

IMAGINING A DIFFERENT FUTURE FOR AGRICULTURAL RESEARCH

As the number of stakeholders in the agricultural decision-making process has increased and the agricultural research agenda has expanded, urgent questions have arisen about the justification for continued public support of the SAESs. The viability of the agricultural system (teaching, research, and extension) at Land Grant

Table 1. Titles of farm bills since 1970

Year	Title
1970	Agricultural Act of 1970
1977	Food and Agricultural Act of 1977
1981	Agricultural and Food Act of 1981
1983	Reauthorized under same title for two years
1985	Food Security Act of 1985
1990	Food, Agriculture, Conservation and Trade Act of 1990
1995	???

Table 2. Titles of the Experiment Station and Extension 1995 Farm Bill Working Groups (National Association of State Universities and Land Grant Colleges, 1994)

Working group	Title
1	Sustainable agriculture
2	Agricultural chemicals and the environment
3	Water quality
4	Farm management
5	Natural resource management
6	Food safety and quality
7	Nutrition and diet
8	Rural and human resource development
9	Rural health care
10	Families and youth development
11	Impact of technology on agriculture

universities is being scrutinized, and there are repeated requests that the system be transformed to meet the changing needs of society.

The National Research Council’s Board on Agriculture of the National Academy of Sciences recently announced that it was undertaking a comprehensive three-year study of colleges of agriculture. To be entitled “Courage to Change: Land Grant Colleges of Agriculture at 130,” the study will evaluate the mission of the colleges of agriculture—teaching, research and extension—and delivery of services to the U.S. agricultural system and its clientele (Offutt, 1993).

The W. K. Kellogg Foundation, which also maintains a strong interest in the Land Grant university system, recently identified 12 “Food Systems Professions Education” projects in 22 states (Foster, 1993). The goal of this initiative is “to catalyze transformation and assist schools of agriculture, primarily those in land grant institutions, to visualize their future as programs responsible for preparing food systems professionals for the 21st century.” Opinions about the challenges facing the SAESs differ within the Land Grant community, but clearly, key parameters are being altered and the future of agricultural research at these institutions depends on their ability to respond.

The SAES system has not remained indifferent to the changing social climate, and it has taken a number of initiatives to plan and to prepare for necessary transitions. For the last decade and more, the SAES system has regularly established priorities for their own use and for recommendations to Congress for budget priorities.

These have, to a large degree, increasingly focused on issues of widespread, increasing national importance, such as the environment, food safety, nutrition, sustainable agriculture, water quality, and rural development. A summary of relevant reports and conferences can be found in *Investing in Research* (National Research Council, 1989) and in “Evaluating Agricultural Research and Productivity in an Era of Resource Scarcity” (North Central-208 Symposium, 1994). One of these areas, water quality, was accepted by Congress for special funding and a special initiative in recent years. In the early 1980s, the SAES system focused on biotechnology research for agriculture and food, and on the social, legal, and ethical issues related to it. Congress appropriated a major increase in the USDA competitive grants program to fund this important area.

A major step in conceiving of research for agriculture came in 1989–1990 with publication of the National Research Council/Board on Agriculture’s report *Investing in Research*, which recommended a major program in extramural research for agriculture, food, and the environment. The program encompassed six broad areas, including natural resources, environment, value-added products and processes, and markets, trade, and rural development, in addition to plant, animal, and food systems. Going further, it recommended that a significant portion of the research be multidisciplinary, in both basic and applied areas, and that it relate closely to extension as well. To fund this, it recommended a major increase in funding for the USDA’s competitive grants program. A key objective of these recommendations was to make it possible not only to increase funds for researchers in the SAES system, but also for all qualified researchers in private and public universities, research organizations, industry, the Agricultural Research Service of the USDA, and the Forest Service to become involved in high priority research areas. On the basis of endorsement of the main features of the National Research Council’s report by the USDA and recommen-

dations by the administration, Congress authorized funding for a new program entitled the National Research Initiative Competitive Grants Program. The initial funding for the program was \$73 million in 1991; this has increased over the past four years to \$105 million in

1994. However, the modest recent increases in appropriations have fallen far short of the original authorization of \$500 million. Nevertheless, this program represents the major significant increase in agricultural funding in over a decade and has provided support for approximately 3,000 research grants that have passed the rigorous screening of the peer review system. Almost as a companion

to this report, the National Research Council’s (1990) report *Forest Research: A Mandate for Change* recommended related changes for forestry research. Full funding of the National Research Initiatives would enhance the forestry research needs.

In the past several years, a series of “futuring conferences” was initiated. The first was convened by extension leaders nationwide and examined those needs for the 1990s and beyond. In 1993, the Experiment Station Committee on Organization and Policy (ESCOP) of the National Association of State Universities and Land Grant Colleges sponsored a Futuring Conference to examine paradigmatic trends in agriculture and other sciences. The conference had four objectives:

- to identify paradigm shifts and new approaches confronting SAESs;
- to reassess mission, structure, and research agendas;
- to understand internal and external forces affecting SAESs; and
- to commit to a strategic plan.

Speakers, including academicians, businesspeople, farmers, members of public-interest groups, and members of Congress, premised that research on humanity’s social, physical, and biological interactions with

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nature and on quality of life will continue to be supported publicly. There also was considerable agreement among participants, however, that the SAES system would require fundamental reorientation if public support was to continue and to remain vigorous.

Issues of sustainability, environment, and quality of life received major emphasis. Research and development need to focus on sustainable growth, environmental quality, and quality of life (Crow, 1993). Research focus should be broadened, for a too-narrow focus on production agriculture and commodities eventually could marginalize and possibly lead to the demise of the SAES system.

A focus on bioregions is needed to promote an ecologically-centered vision balancing human needs and ecosystem health. In this focus, the ecological and social sciences have key roles (Stauber, 1993). The farming community, which includes not only large agribusinesses and diversified farms but also part-time farmers and organic farmers, needs a research agenda serving all of them (Bird, 1993).

These views, and others similar to them, helped the conference define new directions for agricultural research and identify an expanded client base that the system must be able to serve.

To bring further coherence to these futuring studies, a third futuring conference will be convened during 1995 to extend the major themes of agriculture and natural resource programs involving research, extension, and teaching.

Research priorities for the SAES, developed in 1994 by the ESCOP, demonstrate the system's responsiveness to the changing constituencies' needs and its dynamic commitment to meeting the challenges identified at the Futuring Conference. The priorities listed in Table 3 represent not only the agenda for U.S. agriculture but also the agendas of consumer, environmental, and other organizations with interests in advancing human well-being. Reflecting responses from hundreds of groups called on to identify their research needs, ESCOP's 1994 priorities indicate that future agricultural research must target four areas, namely,

- the environment;
- sustainable production systems;
- economies of rural communities; and
- consumer interests, e.g., food safety and quality.

Although many SAESs are establishing scientifically credible research in such broadly defined areas, there still exists a perception that these areas are beyond the traditional scope of experiment stations. So to address the needs for research in these four areas, the SAES system must display the initiative and the imagination to develop innovative approaches to increasingly complex research problems. In this endeavor, the system faces numerous challenges.

PUBLIC PERCEPTION OF THE ACCOMPLISHMENTS OF SAESs WILL DETERMINE THE LEVEL OF PUBLIC INVESTMENT IN THE SYSTEM.

THE CHALLENGES OF NEW PRIORITIES

As the SAES research agenda has expanded, it has become evident that the insular nature of the agricultural

Table 3. The 1994 priorities listed in order of importance for the State Agricultural Research System (Experiment Station Committee on Organization and Policy, 1994)

Priorities
Conserve and enhance air, soil, and water resources
Increase use of integrated and sustainable production systems
Enhance food safety
Protect plants for sustained productivity
Enhance agricultural and rural economies
Manage ecosystems to conserve and enhance biodiversity
Enhance animal genetic diversity and biological performance
Develop alternative plant management systems
Understand fundamental plant processes
Recover and use waste resources through agricultural and forestry systems
Use genetics to improve plants for the 21st century
Convert processing by-products to beneficial uses
Enhance food quality and value
Develop resource management decision systems
Increase the quality of animal-food products
Enhance the health and well-being of food animals
Target optimal nutrition for individual human health
Develop new or improved nonfood products
Strengthen social communities
Design foods for healthy human diets
Empower people for economic and social viability
Promote healthy food choices

research community may be an obstacle to meaningful change. In fact, the ability of the SAES to respond to an increasingly diverse and complex research agenda will depend on its ability to forge links and new partnerships with groups traditionally outside the system. The process of determining current and future research priorities in agriculture must include an expanded customer base and hence an enhanced entrepreneurial spirit among faculty members. It should be noted that the system does not function in isolation within the Land Grant university. Integrated, synergistic involvement of academic programs and extension is required.

Opportunities, problems, and questions that the SAESs will face in forming coalitions follow.

Cultivating New Funding Sources

A degree of public support for agricultural research will continue to be provided by traditionally supportive public agencies such as the USDA and state legislatures. The priorities of the expanded research agenda require enhanced funding for the USDA's National Research Initiative, a mission oriented and merit based competitive grants program, as well as support from other public sources such as the Environmental Protection Agency, the Department of Energy (DOE), the Department of Health and Human Services, the Food and Drug Administration, the National Science Foundation (NSF), and the National Institutes of Health. An example of a recent successful tri-agency funding program is that of the DOE-NSF-USDA/National Research Initiative Competitive Grants Program's plant science interdisciplinary research training grants.

Recognizing the need for continued agricultural production research, many agricultural commodity organizations have developed marketing orders permitting collection of fees for research. One of the fastest growing funding mechanisms for agricultural production research, these check-off fees support technology development and transfer by making research results available to every member of the commodity organization.

Future funding sources for research will include public agencies and private sources and, increasingly, partnerships between multiple funding sources, with

each source contributing to research elements in which it has a target interest. Corporations, universities, and state colleges should form consortia to jointly fund basic and applied research in areas of science such as food, animal, plant, environmental, and natural resources, for the benefit of all.

Forming Multidisciplinary Teams

Not only is the cost of conducting research escalating, but the complexity of science needed for SAES research is increasing. Research in fields ranging from molecular biology to computer-based decision support systems requires not only specialized equipment and facilities but also highly trained technical support, and the professional expertise needed may well be available elsewhere than in colleges of agriculture. Increasingly, multidisciplinary teams of scientists will be required to address the complex issues facing agriculture.

For example, a study to determine the environmental impact of an agricultural watershed requires a range of experts including hydrologists, chemists, toxicologists, agronomists, soil physicists, and ecologists (including wildlife ecologists). Such multidisciplinary team research requires a new understanding of relationships for scientists and new methods of rewarding faculty on such research

teams. New skills in group dynamics, research marketing, and communication may be required.

Multidisciplinary collaboration within and among universities will become the mode of operation. Successful funding initiatives at state and national levels may require the development of programmatic research initiatives by multidisciplinary teams cutting across department, college, and state lines. A number of universities have formed institutes and/or centers as mechanisms to assemble expertise from various disciplines.

Such collaborative initiatives in the SAES system, however, confront the immediate obstacle with which the system has evolved: that of disciplinary departments forming the base units of management and funding. The incentive and reward system for faculty in these units traditionally has been focused on scholarly activity judged by disciplinary peers. As research becomes in-

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creasingly interdisciplinary, how should the SAES reward system be changed to accept the broadened mandate while maintaining research quality? Will the academic reward system accommodate the need for expanded faculty efforts? How will, or should, the allocation of resources, traditionally driven by block and formula funding to units, be adapted to multidisciplinary initiatives? The need to compete for limited resources could lead to a continued sense of detachment from other researchers as well as from end users of the research. Who will provide the leadership and guidance to help colleges implement such fundamental changes? These are questions that evolving Land Grant universities, disciplinary societies, and professional associations must address.

In addition to managing on-campus research programs, some institutions are forging links with other Land Grant universities across state lines. Thus, cooperation within environmental bioregions and research programs is aided, and synergism grows. These links are driven not only by budgetary restrictions imposed on individual SAESs, but also by the increasing costs of research. Insects, diseases, and environmental conditions ignore state lines. Administrative barriers limiting cooperation across state lines must be minimized.

Linking With Agribusiness

As agricultural corporations grow through mergers and buyouts, they often develop economies of scale and increasing scientific sophistication to deal effectively with research questions. In the past two decades, the number of major companies in the agricultural chemical industry in the United States has decreased from more than 25 to 7. The cost of developing a product for market (from research laboratory to field laboratory) has escalated from \$20 million 10 to 15 years ago to more than \$50 million.³ As the technology associated with agricul-

ture grows ever more sophisticated, so must agribusiness. But cost and complexity are barriers for new as well as for existing small companies. Likewise, the farm machinery industry has come to consist of five corporations meeting the nation's farm equipment needs and conducting the majority of research for production agriculture machinery, e.g., tractors and combines.

In many countries, a publicly supported agricultural research and extension system does not exist although farmers certainly have a need for technical assistance. Global corporations therefore have established their own research, education, and technical transfer systems and are able to provide direct technical assistance abroad as well as in the United States.

The challenge and the opportunity for publicly supported agricultural research are not in duplicating the private sector's research agenda but in building unique private/public partnerships or perhaps even jointly supported consortia for agricultural research. Links should be forged between SAESs and corporations to provide efficiency and effectiveness in the overall agricultural research system.

Increasingly, agricultural research will be conducted in partnerships among industries and other entities. But will the Land Grant universities and the private sector find new and creative ways of working together? In forming such alliances, the SAES system must recognize that developing too close a relationship with the private sector could cause Land Grant universities to lose their credibility with society (U.S. Congress, 1992). Thus, the SAES system must grapple with the problem of how to form close, productive relationships with the private sector without restimulating the kind of public concern about "corporate driven" agricultural research agendas at public institutions that was evident in the 1970s.

At the same time, private-sector scientists and technologists need opportunities for noncompetitive dialogue and interchange with academic and regulatory contemporaries, and vice versa. Opportunities exist to provide advanced degrees and continuing education.

EACH SAES MUST ESTABLISH A BROAD
 BASED ADVISORY COMMITTEE TO
 INCLUDE REPRESENTATIVES OF
 CONSUMER AND ENVIRONMENTAL

³The South Carolina Agricultural Experiment Station (SCAES) Advisory Board is a group of 22 individuals representing industry, government, agribusiness, farmers, and consumer interest groups. This statement is the result of a 1992 meeting of the board at which discussions about defining SCAES customers were held.

Transferring Technology

The continued development and transfer of technology will be instrumental in the definition and conduct of future research. Historically, through licensing of protected intellectual property, the SAES has played a major role in delivering technology to corporations, which then are able to transfer that technology to farmers and livestock producers. Certain industries and corporations owe their development over the years to the results of SAES research. The hybrid corn business is a classic example: the technology of corn variety development, initiated in both the SAES and the USDA/ARS systems, now is primarily in the hands of major seed companies. This flow of responsibility for technological development from public to private sector needs to continue. But the recent strengthening of intellectual property rights may require development of new relationships.

Changes have been made in patent law, and universities now are allowed to retain title rights on publicly funded inventions that they develop. New laws also were passed recently to facilitate technology transfer between federal laboratories and industries. One challenge is simply keeping up with these changes and fitting them into the SAES research environment. Another more vexing challenge is the degree of “proprietaryness” that is emerging in contemporary research. It is caused by a number of factors: these changes in law and regulation; increasing interest in (exclusive) licensing by private sector entities; increasing vertical integration of the agricultural inputs industry; closer relationships in ownership, research, and business practice to the chemical industry where proprietary knowledge has been more prevalent than in agriculture; and the exceptional commercial (and scientific) power of biotechnology.

Universities now own pieces of, or otherwise are involved in, new ventures that invest in and commercialize the technologies that they develop. The many advantages to this change include improved cooperation between public institutions and private companies, and facilitation of technology transfer. Additionally, facul-

ty can more easily see the relevance and applicability of their research. Nonetheless, incentives to privatize the benefits of university innovations, which generate income for the public university, may conflict with its mission. Indeed, the use of public funds for private gain raises many ethical issues. Allowing individual scientists to share the profits of their work, even if publicly funded (as allowed under the new law), and encouraging universities to produce consumer products open doors to potential abuse (U.S. Congress, 1992). Should Land Grant universities be planning to sell intellectual property to the highest bidder?

The challenge for an SAES is to decide not only when to allow a technology to be privatized, but also how privatization should be accomplished. At times, the technology might best be transferred in limited partnerships, such as foundation seed associations. Will the SAESs take the lead in developing the innovative private/public corporations needed to transfer technology that cannot be transferred by either type of corporation alone? How can

public and private sectors cooperate to enhance social welfare? Should the SAESs play an augmented role in evaluating new technologies and providing their unbiased assessments to society? Has the recent strengthening of intellectual property rights changed the type of research that SAESs should undertake?

This set of issues will continue to require close attention and needs to be resolved in the years ahead.

Reaching Nontraditional Constituencies

As emphasized throughout this paper, the agenda for agricultural research is being set by increasingly diverse constituencies. The SAESs need to build coalitions with consumer groups, regulatory groups, environmental groups, and others with backgrounds different from its own and that are involved in decision making. Approaches to developing such coalitions are for each SAES to establish a broad based advisory committee or to expand its existing advisory committee to include representatives of consumer and environmental interests as

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well as farmers or agricultural industry personnel. These groups would be charged with generating recommendations regarding SAES leadership and the development of a shared vision and strategic plan.

Educating the Public

A clientele or even the general public may perceive some part of the public agricultural-research effort as useless. And as the private sector begins to shoulder a large part of the responsibility for applied research, it will become increasingly difficult for the general public to assess the merit of SAES research. Tension or debate always has existed between advancing the science of agriculture and solving the immediate problems of applied agriculture. A fundamental challenge facing the SAES system is to develop strategies and mechanisms for educating the public and elected officials not only about the social benefits of scientific research but also about the need to recognize and to support the range of basic and “mission linked” research as an investment in a long-term, cumulative process generating solutions to practical problems. Professional societies should assist in relating to the public contemporary success stories, e.g., Integrated Pest Management programs, increased food safety, decreased environmental contamination. And the public must be able to connect these success stories with the strategic investment of tax dollars in the SAESs.

CONCLUSIONS AND RECOMMENDATIONS

Experiment station scientists have demonstrated that mission oriented research at institutions of higher learning can be accomplished and that adjustments in priorities can attract clientele. But the decreasing numbers of agricultural production units and the societal focus on other types of research have fostered the misconception that agricultural sciences’ needs have dwindled. Admittedly, there have been significant social changes since the inception of the SAES system, but they do not diminish the critical importance of agriculture’s contribution to national health and security. Statistics about agriculture’s reduced contribution to the GNP do

not indicate a decreased need for the research conducted by SAESs at Land Grant universities: the essential role of research in supplying a safe and stable supply of food and fiber has not changed. The challenge facing the SAESs is to alter this widespread misconception, to maintain close links with agriculture and forestry groups, and to continue to influence policies and practices through credible science.

Many more groups are interested in agriculture and wish to participate in policy making than currently are doing so. To continue to produce agricultural research benefiting all society, SAES administrators, scientists, and farm and forestry groups must forge links with these other groups. Land Grant universities will need to develop a strategy and an infrastructure to realize the vision of an evolving society, as they have done in the past. The general public, however, increasingly will hold SAESs accountable for conducting research that it perceives as relevant. Ultimately, public perception (including the perceptions of farmers, foresters, livestock producers, and members of related industries) of the accomplishments of SAESs will determine the level of public investment in the system. Public support for agricultural research will continue at Land Grant universities if institutions adjust to the new agenda being set by their expanded client base.

To address the kinds of challenges identified in this paper, the ESCOP Futuring Conference outlined for the SAESs and Land Grant Universities a series of recommendations:

- Develop a shared vision after broad based advisory input.
- Create a strategic plan based on mission/vision and links to cooperating agencies.
- Fund problem-driven issues using a team approach and links with the private sector.
- Expect programs to be outcome oriented.
- Create a reward system for team efforts and linkage creators.
- Restructure organizations based on the strategic plan, e.g., interdisciplinary centers and institutes.

SHOULD LAND GRANT UNIVERSITIES BE PLANNING TO SELL INTELLECTUAL PROPERTY TO THE HIGHEST BIDDER?

- Link basic, disciplinary, multidisciplinary, and integrative sciences to applied and adaptive efforts.
- Expand research on community development, economic development, natural resources, and the environment.
- Integrate conventional and sustainable agricultural systems.
- Reduce the number of Hatch and regional research projects and enlarge participation.
- Develop a grant program to fund new facilities competitively.

These recommendations reflect a consensus about creating a system incorporating a broad based, multidisciplinary approach to solving problems identified by system constituents. A shared vision is needed, as well as a strategic plan acknowledging the multiple stakeholders in the issues at hand. Organizations will need to be restructured based on the strategic plan; they will need to create a reward system recognizing innovators and problem solvers; they will need to develop mechanisms for funding research and for improving facilities. These recommendations are the product of an institutional effort to anticipate the future and to develop a set of organizational processes to maintain and to strengthen the research enterprise. Although SAES leadership has taken the initial steps to develop a shared vision and a strategic plan (Experiment Station Committee on Organization and Policy, 1993, 1994), much remains to be done to implement these recommendations.

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