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department of agricultural economics
virginia polytechnic institute and state university
blacksburg, virginia 24061

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CHANGING DEMANDS ON AGRICULTURE IN TODAY'S SOCIETY AND THE ROLE OF THE LAND GRANT UNIVERSITY

SANDRA S. BATIE

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CHANGING DEMANDS ON AGRICULTURE IN TODAY'S SOCIETY AND THE ROLE OF THE LAND GRANT UNIVERSITY*

By

Sandra S. Batie**

The great experiment of the "people's" university began in 1862 with the formation of the land grant universities. These new universities reflected the then radical idea that the curriculum should emphasize applied disciplines in lieu of the classical languages and literature. In time, the state experiment stations were added to provide a research base on which the curriculum could be based. Ultimately, even the experiment stations were inadequate to guarantee that scientific knowledge would reach the general population; thus, in 1914 the Extension Service was added via the Smith-Lever Act. Extension existed to take the results of research to the people, mainly farm people, so they could apply it for a more productive economy. The Extension Service also developed a constituency that provided political support for state funding for the land grant universities.

When the land grant universities were established, 75 percent of the U.S. population was engaged in production agriculture; now there is only 2 percent. In the late 1800s, land grant universities could concentrate on teaching young, white, American males the disciplines of agriculture and military sciences. Now, these universities focus on whites, nonwhites, Americans and non-Americans, for

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** Sandra S. Batie is a Professor in the Department of Agricultural Economics, Virginia Polytechnic Institute and State University, Blacksburg, Virginia 24061-0401.

all types of careers. Through much of the land grant universities' history, research was closely linked with farm issues and with Extension. Now research is not necessarily related to on-farm agricultural problems, and, as a result, the research-extension link for farm issues has become more tenuous. When the land grant universities were new, and for most of their history, political support came from farmers and their representatives. Now, farmer constituency support appears to be diminishing in importance at the same time that non-farm elements of society are increasing their claims on agricultural colleges research, teaching, and Extension resources.

Initially, research could be directed to people's problems on farms and homes, and the land grant university could depend on state funding to address these problems. Now, while the state still pays large amounts, these monies tend to be allocated to salaries. Discretionary funds available for research and Extension frequently come from non-state sources. In Virginia, the level of state funding has become so low that my university refers to itself not as a "state-funded" university but rather as a "state-assisted" university. This funding directs the attention of the researcher and the Extension individual away from state problems, including farm problems.

Furthermore, the dependence on non-state funds has encouraged faculty toward more "disciplinary expanding" research at the expense of "problem-solving" research. Increasingly, "disciplinary expanding" research is also seen as being more prestigious.

Today we still hold some of the images of the land grant university of 130 years ago as a model of the way the university is and should be. However, such an image is increasingly inapplicable. If we are certain of anything right now, it is that the past is not a prologue for the future. As we attempt to predict the future for agriculture and for land grant universities, we find that our

images of the future are harder to form and are more likely to be in error than if we were in an era with less change. Still, it is essential that we try to predict the future, for it is only by identifying the forces that are pushing our future rather than those that have contained the past that we will possess the power to engage with our reality [Naisbitt and Aburdene 1990].

While there are many forces that are pushing our future, I am going to address only four:

- the declining uniqueness of narrowly focused agriculture and agricultural institutions;
- the rise of molecular biology and environmentalism;
- changing public perceptions on the role of science and agricultural science; and
- changing socioeconomic relationships: the information and global society.

Declining Uniqueness of Agriculture and Agricultural Institutions

In the last century, our country has had massive demographic changes. At one time our nation was heavily rural-based and our legislature was dominated by rural legislature's concern with rural issues. This description is no longer valid. Indeed, even in rural counties, only about 15 percent of the population is directly involved with production agriculture.

Our society is also quite diverse. For example, there are currently more nonwhite students in the California public school system than there are whites. These students frequently come from different cultures and hold different values than the traditional constituent or student of the land grant.

Furthermore, those of us who teach students know that there is no longer a collective experience with farming that forms a common social or ethical belief system. The vast majority of students, their parents, and even their grandparents do not have family connections to the agriculture sector.

Approximately a year ago, I was attending a meeting sponsored by the National Academy of Science and entitled "Investing in The Future: Professional Education for the Undergraduate." Many of us there were discussing a perceived problem of recruiting urban students who had "negative" images of colleges of agriculture. We felt these negative images were uninformed, but they were responsible for limiting our enrollment. There was a Houston school teacher participating in the conference. She interrupted us and stated that her students did not have a negative image of agriculture; they had NO image of agriculture.

This lack of a collective experience, coupled with the growth and diversity in rural America, is "slowly dampening the political and economic importance of production agriculture in rural America. Rural populations increasingly hold views different from those of farmers about acceptable, cultural practices and resource uses" [Johnston 1990, p. 1113].

Perhaps the most sobering implication for many of us of these societal changes is that over time those institutions that are uniquely, mainly, and narrowly identified with agriculture are destined to decline in power and influence. Such institutions include, to the extent that they remain identified as narrowly agricultural: the United States Department of Agriculture, agricultural colleges, rural cooperatives, 4-H Programs, the Extension Service, and congressional agricultural committees. The dynamics and interests of the previous decade that supported these institutions can no longer be maintained, particularly as America is increasingly governed by representatives of urban interests.

There are many additional implications to the land grant institutions. Most fundamentally, the land grant universities are like rural communities. They can no longer depend only on their farms alone; they must seek out alternate sources of growth and development [Hushak 1988].

In addition, these trends suggest that we must broaden the appeal of our agriculture colleges to people of all backgrounds. Universities, agencies, clientele and student bodies should increasingly reflect the diversity of society. Unless we broaden out appeal and create opportunities for those of many different backgrounds, what is relevant and worthwhile in our endeavors will be assimilated by others [Goodman 1991]. We should be seeking diversity and teaching appreciation for diversity in all our endeavors.

An additional implication is one that has been well articulated by a colleague, George McDowell [1988]. He argues that even though traditional groups appear to have declining capacity to deliver political support, they are nevertheless staking claims to existing resources in colleges of agriculture. However, unless these groups change their strategy, and unless they develop new clients and insist that new clients be served by land grant universities, he argues, land grant colleges will slip into mediocrity because of declining political support. Thus, land grant universities in addition to nurturing traditional agricultural constituents, should be assisting these same constituents to embrace new clients--just as the land grant universities should be embracing new clients themselves.

In addition, if the land grant university is to retain and rebuild state funding support, we need to find ways to influence the research agenda toward state issues. In my own institution, we were fortunate in garnering the support of our state legislature for a program called the Rural Economic Analysis Program. The program is a small amount of money, relative to our overall

operating needs. However, because of these monies, we are now able to address state problems in a meaningful manner. The funds enable us to reach both traditional as well as nontraditional constituencies and address rural issues--agriculture and nonagricultural. The existence of these funds in our department creates the obligation to address state issues. They have also reestablished prestige for this applied research. Such state-funded initiatives must be sought and then "delivered on" if state funding is to be directed at colleges of agriculture.

Rise of Molecular Biology and Environmentalism

Two simultaneous historic forces have combined in such a way as to provide a catalyst for major changes in traditional agricultural science. These two forces are the rise of environmentalism and the development of molecular biology.

The Environmental Movement:

The environmental movement first captured broad public attention in the 1970s and then accelerated through the 1980s and into the 1990s [Batie 1988; Batie 1990; Batie, Shabman, and Kramer 1986]. As we know, this movement has had rather profound influence on agricultural policy and science. The criticisms of agriculture with respect to the environment are numerous: chemical contamination of the environment and the food supply, groundwater and surface water depletion made possible by large irrigation systems, the vulnerability to disease of monocultural species of plants and animals, the destruction of wildlife habitat and the soil resource for the convenience of large machinery.

Even more fundamentally, many critics question the basic value structure underlying modern agriculture and agricultural research [Batie and Taylor 1992]. Many environmentalists go beyond the argument that the nation's drive for

material welfare is creating some undesirable side effects from an otherwise desirable industrial production system. Many of these critics raise basic questions about the system itself and the economic arrangements that have perpetuated it [Batie, Shabman, and Kramer 1986].

Among the economic arrangements of concern have been the structure and nature of agriculture, which had changed during the preceding decades. A large farm, monoculture, capital-dependent agriculture had emerged. The public image of agriculture's structure had become more akin to an industrial production process than to the praiseworthy yeoman of the soil laboring for the prosperity of society. Thus, the perceived flaws in the basic system include not only agriculture's inappropriate use of the environment and of soil and water resources, but also the exploitation of disadvantaged farm laborers, the payment of most of the farm program benefits to a handful of wealthy landholders, the use of unhealthy additives in food processing, the neglect of human nutrition, the demise of the rural community, and inhumane treatment of animals.

An important difference in the viewpoint of these environmentalists from traditional agriculturalists is the environmentalists' skepticism about the social value of new technologies. Many environmentalists tend to reject scientific management of natural systems. The guiding environmental concepts are ecological. Environmental limits to growth are not those of resource productivity; rather, they are those that are imposed by the environment and its capacity to assimilate the waste residuals of human activities. Nature is seen as something humans are a part of, not something to which they are superior, nor of which they are the managers [Batie 1989]. Thus, technology is frequently seen as imposing human domination on nature and as creating at least as many, or more, problems than it solves.

Increasingly, despite lingering and contradicting images of "Farmer Brown" or "Green Acres," agriculture is perceived as a highly industrialized sector of the economy with many social flaws. As a result, "the envelope of good will that has surrounded and protected agriculture since the 1930s, establishing the context for protective farm legislation, has dissolved" [Libby 1991, p. 16].

The agricultural system is no longer an isolated component of either U.S. society or its political system [Buttel 1986, p. 91]. Environmentalists, consumer groups, federal and state policymakers, foundations, agricultural input firms, GATT (General Agreement on Tariffs and Trade) negotiators, and university administrators all see it as their business to scrutinize and criticize various facets of agricultural science and technology.

Molecular Biology:

The second major historical force was the rise of the new science of molecular biology. Duvick [as quoted in Goodman 1992] notes that the rise of molecular biology was led mainly by laboratory-based medical researchers. It was imposed on an agricultural science that, by the 1970s, saw biology as a servant of agriculture, which had become virtually subservient to chemical aids. For example, "entomology in agronomy was largely a science of insecticides and their interactions with crop growth and weather patterns. Weed science was a science of herbicides" [as quoted in Goodman 1992, p. 7]. The new molecular biologists began a search for substitutes for chemical production aids [Goodman 1992, p. 9].

Many observers see a great potential in the merging of environmental interests with molecular biology research: "the new biology in service of agriculture . . . will present us with a sounder agriculture, grounded in ecological principles and deepened with new genetic insights" [Duvick as quoted in Goodman 1992]. Perhaps the vision of directing molecular biology toward developing an environmentally enhancing agriculture will become reality. . . but

right now the tension between environmental interests and molecular biology science is extreme. Today, the public is questioning science in general and agricultural science and biotechnology in particular.

Society has a right to question, since the course of science and technology greatly influences the society's future. The stinging reality is that "those who control technology control the future" [Wenk 1986, p. 200]. Naisbitt and Aburdene [1991] in their new bestseller, *Megatrends 2000: Ten New Directions for the 1990s*, makes this prediction: "The ethical problems of surrogacy, biotechnology and other biomedical issues will only increase as we approach the millennium. We must try to anticipate the future of biotechnology to prepare us for the spiritual dilemmas we will face. These ethical questions are related to our need to understand what it means to be human, especially as we reject the notion that science and technology have all the answers. In the 1990's we will witness, if not a showdown with science, certainly a decade of debate about what scientists are doing" [p. 289].

These forces combine to provide what I call "new critics" and "new clients." There is a tension between these that creates both problems and opportunities. For an example of opportunities, some of our new constituents are members of the environmental community. We need to find a way to better service this community and also to get credit for that service. George McDowell [1988] saliently argues that researchers and Extension personnel in the land grant university have been less than successful in obtaining credit for such important environmentally enhancing technology as integrated pest management. In neglecting to claim this credit, land grant universities have foregone needed political support.

There are potential conflicts as well brought by our new agendas. For example, Buttel [1986] has described how new developments in biotechnology could

have a detrimental affect on the relationships between land grant universities and their historical clientele, and might exacerbate conflicts between universities and state legislatures. Buttel and his colleagues claim that biotechnology research might drive a wedge between universities and farmers as the primary clients for land grant universities' plant breeding research. The new clients are seed and chemical companies and processors, not the traditional farming sector. The interests of the new and old clients can no longer be assumed to be identical. Busch and his colleagues [1991] observed that few researchers and administrators appear to be aware of the potential for conflict between these interests of farmers and those of agribusiness.

Kline [1988] notes that there is also an undeniable tension between agricultural science and rural welfare that poses another serious challenge to land-grant institutions. Agricultural science appears to be destined to increase productivity and agricultural supplies, but surplus production is an important source of rural decline. Kline muses: "Abandoning biotechnology is antiscientific or even worse Luddite. These are serious charges in our culture. On the other hand, abandoning rural welfare is politically suicidal. . . . Land-grant institutions will need a science policy that promotes both biotechnology and rural welfare" [p. 33]. One solution to this desire for two incompatible goods is to emphasize new crops and new uses for old crops, soil and environment-concerning practices, and research addressing human and animal health. Some yield-increasing research may need to be deemphasized, at least for domestically-oriented research. However, "the difficulty is that the research agenda outlined will not be particularly attractive to business" [p. 36]. Thus, there is a need for new sources of support.

Kline concludes, "The upshot is that if the land-grant label is to be taken seriously, those institutions should begin allocating considerable resources to

anticipating the social consequences of the technologies they sponsor, honestly inform the public of those consequences and encourage the kind of creative programs that will offset the downside of biotechnology in rural communities. It is likely that these programs will have little to do with the traditional emphasis on agricultural productivity" [p. 33].

There is an additional implication of the rise of molecular biology that is not well-recognized. The social problems surrounding science demonstrates that there is probably no single problem of society that can be understood exclusively from any single discipline [Wenk 1986, p. 4]. As even a beginning student of economics can attest, specialization can yield large returns. This generalization is true in science as well as trade and industry. Thus, specialization in disciplines provides high returns in advancing knowledge. But specialization comes at a price of being isolated from the broader ramifications surrounding science and its products [Wenk 1986].

Just as specialization in industry will yield no extra returns unless trade takes place with others, in science there must be trading of ideas and concepts between disciplines to obtain the benefits of specialization. If knowledge and learning are too compartmentalized, they will not translate into more understanding [Wenk 1986]. Colleges of agriculture need to encourage knowledge-sharing in research through funding and recognition for multidisciplinary research and the creation of multidisciplinary mechanisms as task forces (e.g., agroforestry or sustainable development task forces).

Students need to be exposed to a broad set of disciplines. We need to remove arrogance and chauvinism toward other disciplines from our teaching and to encourage students to consider alternative ways of learning and the contributions from other disciplines in problem solving. We know that science cannot solve ethical and value questions. The solutions to these debates lie in

social and not technical innovations. We need to encourage our students to think about ethical and value questions and to consider social issues as well as technical ones as they pursue their career. There will be a hybrid vigor reflected in our efforts if we will include the humanistic and social sciences with the physical and technical ones in our curriculum and in our research.

Changing Perceptions on Science and Agricultural Science[1]

To understand the current debate about science's role in society, we must understand that the debate challenges the positivistic heritage of science. This positivistic heritage provides the basis for a common perception that all real knowledge is scientific, and that scientific knowledge is objective and value-free in its conception and value-neutral in its impacts. As a result, positivistic science can ignore politics, human nature, and human institutions. Indeed, in the positivistic extreme, scientific knowledge is seen as potentially replacing politics [Torgerson 1986].

Reductionism science was borne of this viewpoint. Essentially, reductionism is based on the belief that the whole is better understood by examining its parts and that the behavior of the whole can be predicted by the behavior of the parts.

A corollary of this positivistic view of science is that science provides the necessary knowledge for technological advance; technological advance leads to progress and improved human welfare. By the 18th century, Enlightenment visionaries saw objective knowledge as leading to "[a] smooth, efficient industrial civilization, established and managed not by the dictates of political

[1] This section of the paper draws heavily on Batie 1992.

interests but by the dictates of genuine knowledge: the findings of the modern natural and social sciences. . . . For it was through providing precise and reliable knowledge of lawful regularities that science could promote the progress of human civilization through the early turmoil of industrialization toward the ideal of a mature and harmonious industrial order" [Torgerson 1986, p. 36]. We see this influence, for example, in agricultural history during the first half of this century with the Taylorists' pursuit of scientific management of the workplace, home, and school, and with the progressive conservationists' pursuit of scientific forestry management [Busch and Lacy 1983]. It is not accidental that the Extension Service was born during this time period.

In the first half of the century, the use of science to resolve conflicts was seen as not just possible, but ideal. "Confusing objectivity with political consensus, . . . [researchers] saw science as the supreme mediator among competing classes and interest" [Busch and Lacy 1983, p. 15]. Science was a trustworthy guide to human activities.

Because positivistic science is detached from societal values and politics, positivistic scientists as experts are also detached from the citizenry. However, citizens are expected to value and have faith in the wisdom of both science and scientists. In agriculture, for example, the researcher was assumed to have the right question and the right answer to a farmer's problem(s), and any failure to adopt technologies resulting from the research could be ascribed to a farmer's stubbornness or ignorance [Busch, Lacy, Burkhardt, Lacy 1991]. Indeed, the conviction that researchers had the right answer was so strong that the high-yielding varieties borne of the Green Revolution were diffused by convincing some farmers to adopt practices so that their "fields more closely resembled the experimental fields of the researchers" [Busch, Lacy, Burkhardt, Lacy 1991, p. 50-51].

It is not surprising, therefore, that during much of this century, agricultural scientists, like other scientists, have seen the products of our science as "undiluted good things" [Busch and Lacy 1983, p. 35]. With this view, science ensures the emergence of truth and social progress. Thus, when science and its products came under scrutiny, there appeared to be a widespread feeling by agricultural and other scientists of being misunderstood and perhaps even betrayed.

The view of science and technology as leading to unquestionable progress is no longer a widely held belief. We have gone from the Sputnik triumph to the Challenger disaster; the Manhattan Project to Hiroshima, Three-Mile Island, and Chernobyl; from Better-Living-Through-Chemistry to Bhopal. As Wenk [1986, p. 1] notes, there is an unease caused by the difference between the tangible fruits of science and technology and their inadvertent threats to life, liberty, and the pursuit of happiness; the unease can lead to feelings of alienation, vulnerability, and impotence.

Our economic and political democratic institutions seem to lag behind our technology and science so that the negative impacts of technology and science appear to be ignored and neglected. Since the people who are negatively affected by science and its products are, ostensibly, the same people who are meant to be the beneficiaries, they, too, can feel misunderstood and perhaps betrayed. Such alienation from science is quite worrisome. "As political theorist C. Wright Mills once observed, the stability of democracies is threatened when citizens feel that they 'live in a time of big decisions; [and] they know they are not making any'" [Hiskes and Hiskes 1986, p. 72].

The scrutiny and criticism of science and technology are visible in agriculture. These concerns underlie much of the call, for example, for sustainable agriculture or sustainable development [Batie and Taylor 1990a and

1990b; Batie 1989]. The social and environmental impacts of technical innovation are increasingly being scrutinized. In agriculture, these reexaminations frequently focus on the environmental and community impacts of agriculture practices both domestically and globally. For example, the green revolution is criticized as introducing plants that lack pest immunities and that requires the use of environmentally damaging chemicals, of requiring the excessive use of fertilizers and irrigation water that are both expensive and harm the environment, of dehumanizing the farmer by requiring reliance on experts, and by producing inequitable growth. These criticisms reflect disillusionment that technological advances (when separated from social and political consideration) have indeed meant progress toward improved human well-being.

More fundamentally, this skepticism also reflects a growing public belief that not all is knowable. "Rather all systems--ecological, physical or social--might be subject to sudden, drastic, and unpredictable changes. It is not just that science does not predict these system breaks; rather these system breaks are not predictable" [Boulding 1984]. Thus, the science and technology products may be accompanied by negative, unforeseen, and undesirable impacts.

In addition, the claim of science to objectivity is frequently rejected [Busch and Lacy 1983]. There probably is no such thing as a value-free science or even totally objective facts. Indeed, Donald Kennedy, former president of Stanford, worries that someday the words "scientific objectivity" may become an oxymoron, a self-contradiction like "express mail," "easy credit," "bureaucratic efficiency," or "metro schedule" [Kennedy 1982].

It is now widely recognized that different disciplines have embedded values that affect the choice and investigation of problems to be studied. Listen carefully to the following quote from Chuck Hassebrook, policy analyst for the Center for Rural Affairs in Walthill, Nebraska. He reflects his perception that

in land-grant universities, the choice of problem to be studied validates selected social values:

> "We have to recognize that publicly funded agriculture research and extension programs are a form of social planning. The decisions we make, on what types of agriculture technologies we develop, shape rural life. . . . We're not saying that some answers are better than others. We're saying that certain questions are more important than others. The system has always set priorities. We're saying that a publicly funded system needs to be responsive to the public" [Jaschir 1991, p. A-24].

In much of agricultural research, for example, values of a modern industrialized society are evident. These values are that natural resources are a source of a nation's material welfare, increased production is desirable, expanding foreign markets are to be pursued, and materialistic and profit orientations are appropriate. Included are the beliefs that humans should dominate over nature [Andrews 1985; Coleman 1982] and that science and technology are linked to progress [Kaufman 1985; Dahlberg 1985]. Quite simply, the conventional view of the undergirding modern agricultural research is that economic growth is synonymous with desirable progress. Thus, agricultural research emphasis on increasing productivity, the use of natural resources as inputs into production processes, and consolidation of farms for efficiency gains are perceived as necessary and appropriate ways to progress.

Once the values embedded in science are exposed, it is a small step for some in society to perceive scientists as identified with and supporting various power relationships or sectors of the economy. We see this in agriculture, for example, with the accusation that agricultural scientists are "handmaidens of" or "held hostage" to agricultural industry interests. Such accusations have been

pivotal in the recent bST (Bovine Somatotropin) controversy. This perception also underlies much of the criticism of reductionist, traditional agricultural research in addressing sustainable agricultural problems [Batie and Taylor 1992].

Even without the accusation of scientists serving special interests, scientists are increasingly seen as fallible. At least in America, the public has always had little faith in experts. "As Harry Truman said, 'An expert is someone who doesn't want to learn anything new, because then he wouldn't be an expert'" [as quoted by McCloskey 1990, p. 111]. Still, the lack of public trust of scientists as experts appears to be greater today than before. This lack of faith in experts is the natural accompaniment to the public ambivalence about the social value of undirected scientific research [Hiskes and Hiskes 1986].

There is also a fairly pervasive decline in the belief that there is a unique universal logic of science. That is, more people are now rejecting the idea that there is one way to discover all knowledge. It is now argued that "knowledge of certain aspects of the world must be developed at the expense of knowledge of others. Many separate sciences could develop out of many cultural systems. These sciences would not produce contradictory results, but would deal with different aspects of the natural world" [Busch and Lacy 1983, p. 206]. We can see this perception particularly manifested in various concepts of sustainable development and calls for more pluralistic methods of resolving conflict, discovering knowledge, analyzing problems, or designing institutions.

Agricultural science and its products, including those of biotechnology, are subject to these same changing perceptions with respect to the role of science in society. In addition, ethical issues are increasingly framing the debate with respect to the value of agricultural science and its products.

Ethics and Research

For decades, because of the positivistic tradition, scientific inquiry has been dominated by the question of "can we do it?" [Wenk 1986]. In agriculture, this question has been directed toward the objectives of increasing agricultural productivity and efficiency. Wenk [1986] notes that, for most technologies, society began to ask the more difficult question of "ought we do it" around the 1960s. It is my impression, however, that such reorientation has not been widespread in agriculture science until fairly recently. Wenk continues that additional questions of the 1980s with respect to technology have been "Can we manage it?" and "Can we afford it?". Wenk believes that only by asking such fundamental questions can we transform our information age to an age of understanding. For agricultural science products, this sort of inquiry can translate into questions of "why is this product desirable?" and "To whom and for whom is it desirable?" For science and technology in general, such inquiry is the key societal issue of "What comprises a good society?". Thus, science and technology are a means to a good society and not an end in themselves.

Fundamentally, we need to recognize that the quality of science is not the debated issue. The debate about science and technology is a debate about values and ethics, not a debate about scientific methods or facts per se. Few people would believe that the nuclear energy debate, for example, is about the efficiency of nuclear power in meeting our energy needs. The debate has to do with acceptable risks, the ethics of imposing radioactive wastes on future generations, and many other value-laden and ethical questions.

Because debates are over ethics and values, there is a need for considerable more analysis of the potential impacts of technologies and scientific products on human health, on safety, on rural and urban communities, on the environment, on species diversity, and on the quality of life. This need

suggests an enhanced role for the social and humanistic sciences. It is important that tradeoffs be identified and clarified so that informed choices can be made.

Our increasing command over genetics, for example, will not be without social constraints. The potential of agricultural science and biotechnology will have to be successfully defended before any of its rewards can be captured; profitability will not be the main criterion by which science and technologies will be judged. For example, if a biotechnology--say the engineering of a cocoa butter substitute--means the collapse of another country's export-based economy, then the profitability of the production for U.S. firms will not be the debated point.

There is a need to involve the broader public in science "agenda-setting." "It is critical that public involvement be incorporated into the process for setting the research agenda, that the involvement be informed by careful analysis and conducted in good faith on all sides, and that it not be limited to the after-the-fact criticism or before-the-fact conjecture that have typified the interactions between researchers and the public in recent years" [Handelsman and Goodman 1991, p. 2]. There has been limited involvement of the broader public in agricultural sciences.

For example, the agenda for biotechnology in agriculture has largely been set by agricultural industry--who are valuable and important stakeholders in the process [Kenney 1986]. But, industry representatives are not the only valuable and important stakeholders and, as a result, to date the research agenda tends to have a built-in bias [Handelsman and Goodman 1991].

The involvement of a broader public is necessary if the political pressures influencing science and technology are to be informed. Scientific research is not just a social process, it is a public process as well. Thus in a democratic

society, not only should those affected by a decision have a say in the decision, the more important the decision, the more they will attempt to influence it through politics. In the extreme, and in contrast to the positivistic view, we have seen that politics can dominate knowledge [Torgerson 1986]. There are some observers, for example, who feel "policies dominating knowledge" has been the case in some agricultural conflicts such as that surrounding the use of Alar on apples.

Because of the politicalization of science and biotechnology issues, the scientist cannot be an aloof observer, rather he or she must become a participant. As Hiskes and Hiskes [1986] note ". . . two hard lessons for scientists to learn after the heady rush of the Manhattan Project have been that they are not the philosopher kings of the modern age and that informing political decisions is not the same thing as forming them" [p. 41].

Rather than thinking of the public as unschooled or in need of education, the public should be admitted as full partners to the decision-making process. However, by calling for more scientific participation in public debate, I do not mean to imply that there is a need "to educate the public." Such a paternalistic, "we are the experts, and our values count" approach is precisely what is being indicted. Instead of a one-way lecture from researchers to the public, there needs to be unbiased dialogue. It is important that such a dialogue focus on definition of goals and the design of desired outcomes rather than on the rejection of technologies or regulation of research [Handelsman and Goodman 1991].

For example, stakeholders in addition to agriculturalists should be invited to participate in decision-making with respect to agriculture's future. Such groups as deans' advisory groups, national planning groups, curriculum planning committees, agency advisory groups, user groups, or grant review teams need to

find linkages with those not necessarily representing agricultural philosophies. It will be less comfortable in the short-run, but the decisions reached are more likely to be viable ones in the long-run.

Another implication of the call for broader participation is for our curriculum. Since our students will be participants, we should be teaching appreciation for alternative ways of thinking. We must insist that our students problem-solve, and develop the skills of rhetoric, negotiation, mediation, and compromise.

The Information and Global Society[2]

The final force pushing our future that I will discuss is that of changing socio-economic relationships. The American economy is in transition and as a result, our economy is stressed. In general, we are moving from an industrial, manufacturing-based economy to one based on information and services. It is exceptionally difficult for us to think and talk about alternative images of a future based on information. We continually slip into old habits and beliefs better suited for the industrial society--an industrial society that now appears to be moving to developing nations. The American economy needs to improve productivity per worker if we are to maintain or improve standards of living. However, many observers believe that these productivity increases will come from better problem-solving, better planning and decision-making, better communication, better educated citizens, and by rearranging and democraticizing our current hierarchal management systems [Snyder and Edwards 1990]. "Increasingly, educated brainpower--along with roads, airports, computers, and fiber-optic

[2] This section of the paper draws heavily from Batie 1991.

cables connecting it up--determines a nation's standard of living" [Reich 1991, p. 36].

These transitions are already well on their way. "Today, over half of us are information workers, while only 17 percent to 18 percent of America's labor force is still employed in industry. What is more, information work is the source of most of the total value-added by the overall U.S. economy" [Snyder and Edwards 1990, p. 8]. The transition has been a wrenching turbulent one with millions of blue collar workers and mid-mangers now unemployed [Doering et al. 1991]; and it is by no means obvious that our society will make the necessary choices to become a highly productive nation based on information. Yet the trend is clear.

Increasingly, it is specialized knowledge firms "whose solutions define new horizons of possibility" that are the high earning firms [Reich 1991]. "Whether the industry is old or new, mature or high-tech, specialized knowledge is accounting for a larger and larger portion of its revenues. . . The leading textile businesses depend on the knowledge needed to produce specially coated and finished fabrics for automobiles, office furniture, rain gear, and wall coverings . . . As computers with standard operating systems become virtually identical, the high profits come from devising software to meet particular user needs. . . The fastest-growing telecommunications services involve specialized knowledge: voice, video, and information processing; the development of 'smart buildings', "to connect office telephone, computers, and facsimile machines. . . . The fastest-growing trucking, rail, and airfreight businesses meet shippers' needs for specialized pickups and deliveries, unique containers, and worldwide integration of different modes of transportation" [Reich 1991, p. 37].

It is not just the usually thought of consumer services that underlie the information society, but also producer services: " . . . planning, R&D,

recruitment, employee training, sales and marketing, product design, advertising, logistics and distribution" [Snyder and Edwards 1990, p. 9]. In the United States, it will be the information-based firms that out-compete the low cost labor-based competitors throughout the world.

We can already see this force's impact on agriculture. Agricultural production is becoming information-intensive; indeed, in some areas of the nation such as California, the term "prescription agriculture" is used to describe the high information, high service nature of the production practices. Production agriculture as an information-intensive sector is following the lead already set by "beyond the farm gate" marketing. George Hoffman, vice-president of Burger King, cautions us that it is a mistake to view consumers as the customers of farmers. Instead, analysts should focus on the "food chain"; agricultural products are become less and less important factors in the "food chain" as more and more value is added by the marketing sector through improvements in producer and consumer services. As you purchase your groceries, the scanner records your purchases, which can then be matched with your social security number. The social security number makes it possible for stores to analyze their customers purchasing habits as correlated with census and income information obtained from other data banks. Thus, the retail grocers can better target their purchases, inventory control, and services to their market. (This information gathering is not without controversy--issues of information needs versus privacy rights are also increasingly entering the public agenda.)

The rise of the information society puts new pressures on researchers, agency personnel, Extension, teachers, farmers, and businesspeople to become better informed. The need to collect data in a manner that it can be used as knowledge-creating information is as difficult and as important an assignment as so-called "bench science." The information society also requires a work force

of highly and broadly educated, flexible people who can communicate well. Since the information-intensive society has much less need for hierarchal, compartmentalized governance than does labor-intensive industrial societies, the new work force must be self-starters, problem solvers, independent leaders and thinkers. In this new environment, experience-based and long-life learning assumes precedence [Snyder and Edwards 1990].

The information society has major implications for agriculture in a global economy characterized by international interdependencies. We are living in a global, interdependent world. There is a now classic sociology 1915 study of the identification of trading patterns of communities. Sociologist Charles Galpin studied wheel tracks in rural dirt road intersections to identify community boundaries and trade centers. An analogous study today of trade-produced "indentations" would find the globe crosshatched in such a dense, extensive manner that any pattern would probably be indecipherable.

Reich [1991] notes that today it is difficult to identify many products by where they were produced since they are a composite of global service from many nations. A product may be designed in one nation, prototyped in another, and constructed in a third from parts imported from several nations. Furthermore, Reich continues, ". . . the value of a nation's work force adds to the world economy is no longer measurable in terms of products shipped across borders. Increasingly, a nation's key exports are the skills involved in solving, identifying, and brokering new problems" [p. 40]. Thus, we find that the keys to expanding agricultural markets to, say, Eastern Europe lies not in production nor even distribution as much as it lies in cultivating, protecting, and rewarding entrepreneurial talent.

There are several implications of these changes. One is simply the need to recognize the interdependencies. To truly understand these interdependencies

requires a good grounding in a global macroeconomic framework. It is a sad commentary that principles of economics textbooks are just now beginning to include truly globally integrated models despite the obvious relevance years ago of such an approach. Our students also must acquire a level of cultural, social, and political knowledge of world affairs that is presently atypical. In addition, our contributions in the international development arena will increasingly tend to be that of "know-how," that is, information-intensive, educational efforts. Our domestic extension rural development strategies should be that of education and not industrial development per se. Our rural communities' competitive advantages are emanating from highly educated work forces combined with world class infrastructures--not low wage, low regulation, or low tax economies.

Conclusions

At a National Academy of Science Forum on the Future of the Land Grant University, a provocative question was posed: "Assume that in 2020, there are only 20 land grant universities. Who will they be and what are their characteristics?" The answer is not easy, but the truly excellent land grant universities of the future will be those who identified correctly the forces pushing their future and who skillfully used that information as criteria for informed decision-making and resource allocation.

It is clear we are in turbulent and changing times. The land grant university must embrace, predict, and harness these changes if it is to be viable into the next century. As we try to take advantage of the opportunities presented by these changes, we are going to find ourselves heavily criticized. For example, research that leads to technological displacement of labor instead

of viable employment, research that leads to increasing use of chemicals, research that is not eco-protecting and community-enhancing will be challenged. However, research that is labor, environmental, and community protecting will also be challenged. There are no easy answers for research, for teaching, or for Extension. However, "just as plants and animals must adapt to changes in their physical environment in order to survive and thrive in the long run, so too must institutions and entire societies adapt themselves to changes in their economic and technological environment if they are to remain viable from generation to generation" [Snyder and Edwards 1990, p. 1].

What is clear is we cannot preserve a hundred year old land grant university focus on traditional agriculture. We should not abandon all of the old to embrace the new, but we do need to ask the help and assistance of traditional constituencies to address the concerns of new constituents so that we can gain a new generation of support for the people's university.

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