Natural Resource Management Sciences: A New Association of Academic Disciplines

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ABSTRACT

It is proposed that the traditional interdisciplinary nature of the agricultural sciences be extended and integrated with management sciences pertaining to other renewable natural resources. Current conflicts between agriculturalists and environmentalists demonstrate the need for professionals whose educational background gives them an understanding of the issues involved. Policy decisions regarding the activities of renewable resource industries, compatible with sustainable development and the maintenance of environmental quality, demand that those making the decisions be knowledgeable about the industries involved, as well as understand environmental impacts. Similarly, those whose principal concerns are for wilderness and interface areas should be better informed for the optimum management of those areas with an understanding of underlying agricultural principles of animal and plant production. It is for these reasons that there should be a consolidation of faculties of agriculture, forestry, and fisheries, together with the units that have developed on most campuses to address such areas as environmental studies, water conservation, wildlife management, waste management, land use planning, landscape architecture, and bioresource engineering.

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faculties of agriculture. The sections most likely to separate themselves are those that can be set up to bear titles that include currently fashionable words such as biotechnology, land-use planning, sustainable, management, environmental, and conservation. These areas are derived, in many cases, from the classical disciplines in agriculture and their separation from the agricultural sciences will result in mutual loss. Their removal from under the agriculture umbrella takes away many of the more contemporary areas for research and teaching, areas that are most attractive to students and faculty. What remains in association with agriculture may not be sufficiently comprehensive to warrant constitution as a faculty or college.

In recent years a great deal of thought has been given to ways of facilitating information transfer along the continuum from basic science through developmental technology to industrial application. The present trend of stripping away from faculties of agriculture (and from government departments of agriculture) everything that is not directly concerned with traditional production agriculture will, if continued, operate to the detriment of information transfer among areas that should be closely associated with the agricultural sciences.

The increases in efficiency and productivity of agriculture have been such that only 2 to 3% of the population in Canada and the USA is now engaged in on-the-farm agriculture. (Many more people are employed today in other agricultural industries and para-agricultural industries than in actual farming.) As a result, only a small proportion of the population has any knowledge, or even an awareness, of agricultural practices and the scientific basis for those practices, despite the fact that the activities associated with high technology agriculture are interwoven with all aspects of life on earth. It is regrettable that government policy decisions that affect production agriculture are being made today by thoroughly urbanized people who lack understanding of the techniques and requirements of food production and handling. A recent paper by Brown and Coffey (1992) describes an attempt to address this problem by a course at Western Kentucky University entitled The Science of Agriculture. This course is offered as part of a general education in science requirement for nonagriculture majors. The course is intended to give a broad view of agriculture and the role of science in it.

Gradually, during the past 50 yr, the image of agriculture for the increasing urban population has split so that, on the one side there is the nostalgic view of agriculture as an idyllic way of life, and on the other, of production systems dominated by chemicals, genetic engineering, factory farms, and enormous machines. Neither of these perceptions of agriculture is persuasive of bright, young people to educate themselves for careers in agriculture. Potential students have no way of knowing that agricultural sciences represent the integration of many disciplines including the basic sciences. They find it difficult to be excited about a discipline that appears to be directed only toward increased food production when they read about the problems of disposal of surplus products and payments to farmers for holding agricultural land out of production. They are not being informed about the exciting opportunities that exist for the management and integration of agriculture within the total ecological framework and the opportunities that exist for application of agricultural techniques to the management of the larger environment.

James H. Meyer, chancellor emeritus of the University of California at Davis, recently (1992) observed that the land-grant colleges of agriculture in the USA are "baffled" to identify and address the challenges they confront. He suggests that the original land-grant college model be altered to meet today's need for interdisciplinary, interdepartmental, and multidisciplinary research. Agriculturalists, having been so successful in achieving productive systems for food and fiber, should now be applying their knowledge and techniques to assure sustainability of agricultural production. Not only that, but knowledge gained regarding management of agricultural systems needs to be further developed and applied to the management of the larger ecosystems constituting the entire environment. Instead of assuming a leading and expanding role for the disciplines of agriculture in research, teaching, and management of natural resources, agriculturists have been slow to respond to these new opportunities. In fact, there seems to have been a notable lack of enthusiasm and imagination. As a result of the failure of agriculturists in academia and in government agencies to expand their mandates, the scope of professional agriculturists has been narrowing. Reflecting this phenomenon is a warning from Rep. Pat Roberts (1993) from Kansas and a member of the House Agriculture Committee. Roberts states that there is a danger that other agencies and departments will peel off functions now vested in the USDA for their own jurisdictions and that USDA may be restructured out of existence.

(The following discusses background considerations for a consolidation of academic disciplines dealing with the understanding and management of global and local ecosystems to achieve the sustainability of productivity and environmental quality.)

**AGRICULTURE**

Agriculturists have been so obsessed with attaining maximum levels of production and efficiency in the short term that the longer-term costs have been neglected. Any practice that lowers future productivity or results in environmental pollution has to be considered as a cost of production. Stated in terms of environmental accounting, depletion of resources represents loss of capital and consequent reduction of future income. Sustainability cannot be maintained under circumstances where there is loss of the resources that constitute capital. Sustainability of the specific resources directly associated with agricultural productivity requires a detailed understanding of the nutrients (including water) needed for plant and animal production, of the physical environments required by particular plants and animals, and of energy flow through the production systems, knowledge that has traditionally constituted the core of programs in colleges and faculties of agricultural sciences.
The quantity of food produced is no longer a matter of major concern to the average citizen in North America. The means of production are, on the other hand, reaching the consciousness of the public. Quite apart from the so-called natural or organic food question, there is a developing view of agriculture and related activities as polluting industries. Urban dwellers who leave the cities for rural communities are quick to complain about the odors emanating from neighboring farms. There are frequent newspaper and magazine articles written about air pollution from the spraying of crops and the belching of cows, and water pollution from the runoff of fertilizers and animal wastes. It is well-documented that soil losses under commonly used cultivation methods are a serious threat to sustained productivity. The Science Council of Canada (1986) identified soil degradation, from a variety of causes, as a serious problem resulting in reduced crop yields and financial losses. The Council recommended the development of a national soils policy, but pointed out at the same time that a lack of soil specialists hindered attempts to overcome the problem of soil degradation. The impact of agricultural activities on water quality is becoming a serious problem (Braden and Lovejoy, 1990). The disposal of wastes from different types of food processing plants is more complicated and costly than it once was because of the increased density of our populations and industries.

The public is becoming aware of these production and environmental problems and, in some instances, vocal in their demands for immediate solutions. What has not been made fully clear to the public is that the solutions will be accompanied by increases in the cost of food. The following statement is made in a report from the Science Council of Canada (1977):

In a conserver society, the pricing mechanism should reflect, not just the private cost, but as much as possible the total cost to society, including energy and materials used, ecological impact and social considerations. This will permit the market system to allocate resources in a manner that more closely reflects societal needs, both immediate and long term.

The application of this concept has a number of dictates for the agricultural industry. The cost of food must increasingly include the cost of disposal of wastes associated with production of the food. Furthermore, as some of our most productive agricultural lands is being taken out of production by urbanization, land that is less productive must be brought under cultivation. The cost of food produced on less fertile land is higher because of lower yields and the necessity of higher inputs to achieve acceptable production levels. The maintenance of soil fertility, and even more dramatically, the maintenance of the very soil itself, has to be considered as part of the cost of production. A new direction for research must be to determine the means whereby soil and soil fertility can be maintained at the lowest long-term cost.

The customary measures of national income, such as gross national product, although useful as indicators of economic activity, are not measures of true or sustainable income. Depletion and degradation of natural resources are ignored for short-term accounting purposes. True income is sustainable income. It is estimated as the maximum amount of resources that can be consumed in a given period without reducing the amount of resources available for consumption in a future period (El Serafy and Lutz, 1989).

A current concern in decisions regarding free trade is that dislocations in marketing of agricultural and other products may be expected if imports are freely allowed from countries in which land is exploited for maximum returns on a short-term basis, without thought for sustainability or environmental degradation. Policy-makers with a solid understanding of the long-term implications of these practices for agriculture in all of the countries involved are needed. The policy issues that relate to the interactions between commodity pricing and husbandry vs. exploitation of natural resources require delicate handling in international negotiations. To prevent decisions with disastrous consequences for the environment and for sustainability of agricultural productivity in the countries concerned, the issues must be subject to informed analysis. Colleges and faculties of agricultural sciences have to provide knowledge of agricultural and natural environmental systems based on similar principles within their curricula. More difficult, but just as necessary, curricula must provide education and appreciation of the relationships between the two systems, as well as of the fact that few, if any, natural ecosystems remain independent of human management, whether direct or indirect. Management of the agricultural and the so-called natural ecosystems can no longer be considered as separate disciplines. Neither should education for management in the two areas be academically separated. The education of those responsible for the planning and management of resources must be directed toward the achievement of an overall steady state, within which framework a great variety of constantly changing environmental and industrial activities can be accommodated without dislocation of the overall equilibrium.

If economics is the study of the production, distribution, and consumption of monetary wealth in human society, ecology might be regarded as the study of the production, distribution, and consumption of the biological components in the overall environment. Natural resource economics is, of course, a special branch of economics that should be closely associated academically with the agricultural, forestry, and related resource management sciences. Neither general economics nor ecology is regarded as a predictive science. On the other hand, when we consider that knowledge in agricultural and forestry sciences is applicable for the management of natural resources with controlled or understood inputs toward well-defined goals, resource economics, in its application to managed resources, may indeed approach predictability.

WILDERNESS MANAGEMENT

The areas that we describe as wilderness areas are rural lands, of limited access, that are not utilized intensively for agriculture or forestry. They are, nevertheless, managed, albeit unintentionally in many cases. In 1973 it was written that we must develop new attitudes toward achiev-
ing a civilization that balances the two ecologies, natural and man-made (Walters, 1973). Twenty years later we recognize that our responsibility is for management of the entire ecological system because there is no longer a natural ecology beyond the impact of human activities. Considering the fact that our activities impinge even on wilderness areas, it is important that we understand the possible effects lest we inadvertently disturb a desirable ecological balance. That rationale indicates the importance of utilizing knowledge derived from agricultural research and experience.

The proportions of different organisms within a given area may be cyclical or, less frequently, in equilibrium. In cases where we have relatively small pockets of wilderness located in the midst of agricultural, industrial, or urban areas, it may not be possible to allow for the natural cycles of the populations of the various plants and animals. Efficient production of agricultural animals depends on a knowledge of the physiological energetics of the animals in question. Energy flows or transformations within an ecosystem represent the sum total of the energy transformations occurring in the individual organisms contained within that ecosystem. Without an understanding of the physical, chemical, and biological processes that take place in an area, the results of attempts at management to maintain the system in any sort of steady state are bound to be disappointing. Agriculturalists are missing an opportunity to extend the teaching and application of their knowledge for the management of areas beyond rangelands. More formal arrangements among university personnel in agriculture, forestry, and ecological sciences should be designed for teaching and research. This would broaden the knowledge and perspectives of our students who leave the universities to become the professionals in government and industry where decisions regarding planning and management of land resources are made.

LAND USE: THE AESTHETICS AND THE PRACTICALITY

The pressures of organization on agricultural land, and particularly on prime agricultural land, are becoming increasingly severe. Difficult though they may be, decisions on land use must be made. The political determination of policy and the establishment of priorities for land use of specific sites constitute areas that should involve professionals with agricultural expertise.

All animals impact the environment in some manner, depending on species and concentration. The effects brought about by humans are now of a dimension that exceeds anything that could have been imagined by futurists. For example, depletion of the ozone layer, attributed to human activity, was first documented in a natural setting, the Antarctic. Our power has begun to frighten some who visualize the loss of much of the natural landscape. There is fear that some landscapes will be altered irreversibly if the area and scale of destructiveness are such that the resilience of the environment for recovery is overwhelmed. There is a positive aspect to landscape alteration, however, in that deliberate management can provide us with visual pleasures designed in accordance with our wishes. Landscape architects play an increasingly important role in the provision or maintenance of environmental elements that are conducive to our emotional well-being within an overall environment that is sometimes unpleasant or even threatening. Working landscapes will not evolve into acceptable forms unless by conscious design.

THE NEED FOR GREATER DIVERSITY IN STUDIES ASSOCIATED WITH THE TRADITIONAL AGRICULTURAL SCIENCES

Unless the study of agricultural sciences expands its applications to cover the increasing number of areas where management requires the knowledge and technology already residing in institutions under a heading of agriculture, the institutions will find themselves limited to activities pertaining only to production agriculture. The limitation will be to the detriment of the public and private institutions defined as agricultural, as well as to others needing the expertise of personnel trained in the agricultural sciences. Earlier writers who addressed ecological concepts considered that ecology might, in the future, have a commanding position in the curriculum of agriculture and science courses in agricultural colleges and presaged that knowledge of ecological principles would become the base for applied sciences such as agriculture, horticulture, and forestry (Arthur, 1895).

The agricultural industry should be lobbying for research funding in areas where information is needed to push technology for production methods that do not deplete or degrade our land, water, and air resources. These are not attractive areas for government funding because the results of the research are not dramatic in the way that the discovery of a cure for cancer is or the development of a featherless chicken.

Rep. Charles Stenholm from Texas and chairman of the House subcommittee of nutrition and the operation of the USDA, recently observed that the rules affecting food production are being formulated more and more outside congressional agricultural units and USDA by people who are either opposed to, or misunderstand, production agriculture (Stenholm, 1993). This situation does not bode well for the future of food agriculture. The situation is bound to worsen, unfortunately, unless graduates in agriculture are more broadly educated with a knowledge of agriculture that is firmly based in the broader ecological framework. Those occupying the decision-making positions with regard to food production increasingly need an education that imparts an understanding of the inputs necessary for efficient agricultural production and food processing without sacrificing sustainability and the quality of the environment.

According to the National Association of State Universities and Land-Grant Colleges, “A major issue confronting our society is the declining quality of students who are preparing for scientific and professional careers in food, agricultural, and natural resource disciplines. The availability of food, agricultural, and natural resources expertise is in serious jeopardy.” Concern for the future availability of an adequate supply of doctoral scientists with suitable backgrounds for research in agriculture lead
to the establishment of a committee of the National Research Council (USA) to study the question. The committee published their report in 1988 entitled "Educating the Next Generation of Agricultural Scientists" (NRC, 1988). In the report it was stated that the large number of currently employed agricultural scientists trained outside traditional applied agricultural disciplines has important implications. Students considering a career within a university should be confident that they will have the opportunity to undertake research of a general and long-term nature and not be restricted to the solution of specific short-term problems that have been flagged for attention by industry or government (Science Council of Canada, 1979).

Agricultural and other natural resource sciences have a distinct advantage for teaching and research in agriculture, when they are located within a multi-university where there can be interaction with other disciplines in the physical, medical, and social sciences. The library facilities, the breadth of research activity, the opportunity for contact with specialists in other fields, and the variety of visiting lecturers are only some of the factors contributing to the intellectual ambience offered to both faculty and students within the multi-university. Wherever their location, however, faculties or colleges of agriculture undoubtedly owe some of their current problems to isolating themselves from the mainstream of intellectual activity with the result that their activities are no longer regarded as relevant to society's needs, and their status has accordingly declined.

The broad approach needed to address the complex and interdependent problems of sustaining environmental quality and the productivity of our renewable resources cannot be achieved if the involved disciplines operate in isolation from one another. Strengthening the associations will have a number of advantages at the academic level through integration and broader application of course subject matter, and realignment of courses to provide programs for graduates. Graduates need to have in-depth knowledge in specific areas, but should also possess a holistic view of the factors essential for sustainable environmental quality.

Established academicians, as well as professional graduates of earlier programs, may feel threatened by the administrative, curriculum, and name changes that will be necessary to implement redesigned courses of study with new alignments of options. More recent entrants to university faculties and institutes may likewise feel threatened by new alignments of courses. They will be expected to acquire a greater breadth of knowledge than if they were exposed to a narrowly based program of studies. Resistance may be expected to changes in the current titles of programs and courses. Some changes will be necessary, however, to reflect altered emphasis and objectives. Academic options related to the management of the environment, sustained productivity of the natural resource sector, and research opportunities in these areas will be attractive to students. Subject matter covered, as described under the current course labels, often seems of little relevance to students who feel that they are facing a different world than that experienced by their professors. The perception of irrelevance may not be entirely correct, but there is some truth in it. Lest the changes envisaged in the above be viewed merely as academic tinkering, let me cite an opinion put forth by Senator Conrad M. Burns (1994) of Montana with regard to the lack of political power presently enjoyed by the agricultural industry. Senator Burns is convinced that agriculture must put forward a new organization—a kind of environmental or natural resources organization, that will be perceived publicly as critical to the public interest.

SUMMARY

Consideration should be given to consolidation of faculties of agriculture, forestry, and fisheries, together with smaller units that have grown up on most university campuses to deal with such topics as water conservation, wildlife management, waste management, land use planning, landscape architecture, bioresource engineering, environmental protection, natural resource conservation, and resource economics, in an interdisciplinary faculty with a name such as Resource Management Science.

REFERENCES


