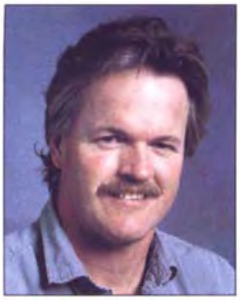

Can 'sustainable' be defined? . . .

New directions in research needed

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Agriculture first developed, flourished and faltered in a Mediterranean ecosystem. The great rivers of the Middle East spawned irrigated systems that supported the dominant early civilizations, but eventually suffered extensive degradation. In Europe, intensive production systems evolved in the context of the industrial revolution and land limitations. Only in North America have the fruits of the industrial revolution combined with extensive land resources to provide a high-input extensive agriculture. In California we have come full circle, coupling advanced technology, high inputs and extensive land with a Mediterranean ecosystem. The California experiment is young and the future of the state's irrigated agriculture is facing major challenges.

One of the major concerns of irrigated agriculture is its long-term productivity or "sustainability," perhaps the most overused, least understood word in agriculture today. The goals of sustainability — environmentally sound, socially acceptable, economically viable agriculture — are unimpeachable, but the term cannot be permanently defined. Social, economic and environmental pressures change rapidly and what is sustainable today may well be unsustainable tomorrow. Yet the debate about the appropriate agriculture of the future has often confused practices with goals. In California, for instance, sustainable agriculture has been widely equated with both organic and low-input agriculture.

It is critical to the future of agriculture that solutions are not narrowed to a particular set of techniques. For example, high tech approaches to agriculture that employ computers, image sensing, and satellite global positioning systems show great potential to reduce farm inputs such as pesticides and fertilizers. For example, agricultural engineers are developing imaging technology that can identify weeds in the field and selectively apply herbicides, dramatically reducing their use. Such technology also increases efficiency, lowers environmental effects and enhances competitiveness.

How then do we identify the practices that achieve long-term goals for the future agriculture of the state? First, we must develop indicators through which we can measure sustainability. We must be able to walk out to the field, take the temperature of the system and determine its health. Second, we must develop quantitative links between these indicators and system performance. This relationship allows us to understand the tradeoffs between competing goals.

To develop objective measures of sustainability we must conduct research that is long-term, large-scale and integrative — a major challenge in the present agricultural research environment. The cost of performing this kind of research is roughly 10 times greater than the typical funding commitment from agencies and research institutions. Large-scale research, the kind required to capture the variability that often characterizes soil and hydrological processes, means large costs for relatively simple experiments.

Integrative research is a particular challenge to the land-grant system. Since the end of the World War II, agricultural scientists have concentrated on the need to increase short-term productivity. With a relatively constant set of production constraints, agricultural researchers focused downward on lower level processes, often working at the molecular level. This reductionist approach assumed that understanding lower-level phenomena would improve production; and it did. However the environmental questions now being raised require that specific findings be integrated into our understanding of the total farming system and its impact upon the environment.

Integrative research is not as well represented in land-grant institutions today as it was 50 years ago, when most research was performed in the field and was easily linked to growers' problems. The emphasis on reductionism without a commitment to integration has left major gaps between our vast knowledge of lower-level processes and its application to the system problems of today. Furthermore the early retirement of many older faculty has meant a loss of scientists who understood the broad functioning of agricultural systems.

How do we overcome these obstacles? First, if long-term, large-scale research is required for problems as critical as food production and environmental protection, we must call upon funding agencies and universities to change their focus — currently the driving force behind short-term, reductionist research. Likewise commodity groups have to broaden their perspectives. Often critical of university research as not relevant or applied, industry could not find a more relevant issue than agriculture's long-term impact on the environment.

Second, land grant universities need to become catalysts for integrative research. An example is the Long-Term Research on Agricultural Systems (LTRAS) project at UC Davis, which addresses the critical, broad questions facing agriculture (see p. 5). The project is a 100-year commitment by UC Davis, the College of Agricultural and Environmental Sciences at Davis, and the UC Division of Agriculture and Natural Resources to study the performance of Mediterranean agricultural systems, particularly as they vary in level and nature of input. Within the context of this experiment (10 cropping systems replicated 6 times), reductionist scientists can focus on lower level processes yet interpret their findings in the context of how the entire cropping system performs. Such an environment can link the power of reductionist science to global questions of long-term function and environmental impact.

California agriculture represents one of the great food production systems of the world. Its remarkable combination of natural and developed systems is a resource that should be protected for the future. The challenge for agriculture in this state is to support a research mechanism which can objectively define our system's performance and identify the practices that maintain and enhance this unique resource.