Wise use of biotechnology critical to sustainable future

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AS the Earth approaches its carrying capacity for human activity, we must adopt more sustainable ways to generate, distribute and consume resources. Considering the magnitude of the challenges we face, we should use all tools that can contribute to our long-term sustainability. The ability to adapt plants, animals and microbes using the traditional and new tools of biotechnology has already had an impact and will certainly play an increasing role in agriculture. Conservation of the Earth's biodiversity and its natural resources is similarly important for the future; it is our belief that the conservation of biodiversity and the judicious use of biotechnology are not mutually exclusive.

Agriculture faces many challenges including the protection of natural resources and the food supply. Just as society is concerned about the threat of emerging diseases such as avian flu and HIV to human health, we should also be concerned about the threat of diseases and pests to the sustainability of natural resources and the food supply. Those who live in California's coastal areas, and have watched the damage to oak stands by sudden oak death (SOD), can understand the vulnerability of more than just public health to emerging diseases. Scientists recently sequenced the genome for the SOD pathogen, a development that promises more rapid and conclusive diagnoses. Similarly, some scientists and growers believe that the best long-term answer to the bacterium responsible for Pierce's disease of grapevines is to develop vines that are genetically resistant to the microbe.

A number of ecological and socioeconomic crises now loom on the horizon. Global climate change may lead to changing local conditions and the need to adapt crop varieties. Changes in international and domestic farm policies, as well as world markets, pose continuing threats to many of the world's farmers.

Just as most oil production takes place abroad, ammonia-based fertilizers — a major part of the cost of agriculture — are increasingly purchased from foreign producers. Potassium and phosphorous supplies will likely be less stable in the future as well, and the production and application of all fertilizers are energy-intensive. All of these issues beg for biotechnical solutions to help farmers adapt and conserve precious resources.

Until the dawn of the industrial era, agriculture and forests provided the food, fiber and most of the energy necessary to sustain civilization. Given today's increasingly unsustainable consumption of energy resources, agriculture will once again be called upon to significantly contribute to civilization's energy needs. The world's population will likely increase by about 50% in the next 50 years, and the standard of living worldwide is increasing. These trends will result in heightened world demand for food, fiber and energy.

To meet this demand, U.S. agriculture is on the cusp of a transition equivalent to when plant breeding and synthetic fertilizers led to corn and soybeans becoming dominant crops. To meet this challenge, there will likely be a transition to genetically adapted crops with a variety of input and output traits; the new agriculture will also focus on yet-to-be-developed "energy crops" that can be used for biomass or the production of liquid fuels such as ethanol.

One of the questions that California must address is what role our agriculture will play in producing the new energy crops. Biotechnology offers appealing opportunities to develop energy crops that are markedly different from food and fiber crops. They will be drought-resistant, use nitrogen efficiently and, ideally, be harvestable during much of the year. While the cost of production in California may preclude the cultivation of crops grown more efficiently in the Midwest, biotechnology could lead to the creation of energy crops adapted specifically to regions of our state that currently struggle to be economically competitive.

Biotechnology has not yet had an impact on California's wide array of specialty crops, but research is being conducted to learn how to manipulate the genetics of these economically important crops (see *California Agriculture* 58[2]; "Fruits of biotechnology struggle to emerge"). These crops are the basis of California's competitive agricultural economy, and it is critical for UC to do the research that will keep this sector of our state's economy competitive in global markets. The potential exists to provide consumers with specialty crops enhanced by biotechnology, and managed with scientific understanding of the risks and benefits.

We are proud of the accomplishments of the faculty, staff and students at the campuses and county offices of the UC Agricultural Experiment Station and UC Cooperative Extension. Our scientists are leaders in the development and adoption of agricultural biotechnology. Ultimate decisions about how this important technology is used by our society will involve a full airing of the societal and political implications of these new crops. It is our hope that we always have faculty at the forefront of developing technology, and providing insights into its implications.

This edition of *California Agriculture* addresses a number of issues surrounding the risks and benefits of agricultural biotechnology, including transgenic plants, fish and animals (pages 116–139), and provides a glimpse of some of the important work being carried out in UC laboratories and field stations to address both.