Sustainable Horticulture: An Overview

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After World War II, the research, extension, and teaching programs of land-grant universities in the United States focused on reducing crop production costs by substituting other inputs for labor in horticultural production. Lower costs of producing the same or better-quality products was the most important goal. The switch from labor to other inputs resulted in tremendous efficiencies in production. In 1940, there were 6.3 million farms in the United States. By 1992, only 2.1 million farms were providing agricultural products to a much larger population (Table 1).

Advances in technologies, mass production systems, and varieties resulted in lower production costs and an abundant, low-cost supply of food in the United States. New horticultural production, marketing, and postharvest technologies have resulted in huge increases in production and year-round availability of fresh produce. The products also have eye appeal and a long shelf life.

This emphasis on lowering crop production costs has resulted in dependence on petrochemicals for controlling insects, diseases, weeds, plant growth, fruit set, and other physiological plant functions. Early varieties of poinsettias, for example, were very tall, and growers used labor to bend the stems over and tie them to make them shorter. Subsequently, labor, the largest input cost in greenhouse production, was replaced by chemical growth regulators. Technology and science also can be used to reduce dependence on chemicals. Breeders can work on breeding varieties of poinsettias that are short and do not require physical bending of the stems or application of chemical growth regulators. Advances also have been made in postharvest life of poinsettias by breeding new varieties that have a longer shelf life. This shift away from labor-intensive agriculture has resulted in tremendous efficiencies in production.

After the World War II era, environmental awareness slowly grew. This awareness accelerated after the energy crisis of the 1970s (Daberkow and Reichelderfer, 1988) and now is one of the major issues in the world, as evidenced by the United Nations Conference on Environment and Development held in Rio de Janeiro in June 1992.

Environmental issues

Environmental issues in agriculture, and especially horticulture, are many:

- Pests become resistant to chemicals because of heavy use. As a result, pesticide formulations must be changed continually, often at great expense. For example, in the 1950s, corn growers began using cyclodienes to control corn rootworms. Within a decade, corn rootworms developed resistance to cyclodienes (Ball and Weekmann, 1962).
- Groundwater in many areas has become contaminated by fertilizers and pesticides. By 1988, the U.S. Environmental Protection Agency (EPA) had detected 46 pesticides, including some carcinogens, in groundwater (GAO, 1991). The Kansas State Board of Agriculture created a Pesticide Management Area for Atrazine after tests showed high levels of the herbicide in certain drinking-water supplies (Studer, 1992).
- A survey by the U.S. Geological Survey found that 90% of the samples of surface water from 10 midwestern states contained agricultural chemicals (Hess, 1991). Cleaning up contamination of groundwater or surface water can be costly; however, if contamination is not cleaned up, costs will continue to rise.
- Farmers increasingly are concerned about applicator safety for themselves and their employees.
- Consumers increasingly are concerned with food safety and the chemicals in their food supply and environment.

Since the early 1970s, the public at large has been increasingly interested in costs to the environment, applicator health, and food safety. Pesticide companies have responded by attempting to replace extremely toxic chemical pesticides and herbicides with less-toxic alternatives (Darling, 1991).

Until recently, economists have viewed these environmental and other costs as externalities. Recently, however, many analysts have pointed out that these costs are not external to the system; they are a direct output of the system. We in agriculture have referred to some of the outputs as waste products. Now we need to calculate these costs and include them directly into production budgets.

Those in agriculture who focussed on consumers' concerns about the safety of chemicals in the food supply may have thought that these issues were the result of short-term hysteria, but concern about the global environment appears to be a long-term trend (Harris, 1987).

Sustainable agriculture defined

Sustainable agriculture is a philosophy that attempts to recognize that these costs are not externalities. It is based on human goals and on understanding the long-term impacts of our activities on the environment and other species. Using this philosophy guides our application of prior experience and the latest scientific advances to create integrated, resource-conserving, equitable farming systems. These systems reduce environmental degradation, maintain agricultural productivity, promote economic viability in the short and long term, and maintain stable rural communities and quality of life (Francis and Youngberg, 1990).

In the 1990 farm bill, the U.S. Congress defined sustainable agriculture as "an unintegrated system of plant and animal production practices having a site-specific application that will, over the long term: satisfy human food and fiber needs; enhance environmental quality and the natural resource base upon which the agricultural economy depends; make the most efficient use of nonrenewable resources and on-farm resources and integrate, where appropriate, natural biological cycles and controls; sustain the economic viability of farm operations; and enhance the quality of life for farmers and society as a whole."

Early discussions of low-input sustainable agriculture (LISA) focused on the differences between the conventional agriculture paradigm and ecologically sustainable agriculture (Beus and Dunlap, 1990). Some discussions were highly polarized; however, most researchers and farmers now recognize that today's agriculture can be improved by incorporating techniques designed to make farming more environmentally safe and less economically risky. The farm crisis of the 1980s made people realize that the definition of sustainable agriculture should include an economic component (O'Connell, 1991).

In the 1990 farm bill, the United States Congress renamed the LISA program. In recogni-

Table 1. Changes in U.S. farms, 1940-90.²

	1940	1990
U.S. population	132,164,569	248,709,873
Total workers	51,742,000	117,491,000
Farm workers	8,995,000	2,848,000
Farm workers as % of workers	17	2
Farm workers as % of total	6.8	1.1
Number of farms (million)	6.3	2.1
Average farm size (acres)	168	467

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²Source: U.S. Bureau of Census and USDA.

tion of the fact that the goals of sustainable agriculture will be met by a wide range of old and new techniques and strategies, the program is now called sustainable agriculture research and education (SARE). This change in terminology is a good one; it reflects the fact that the changes we are witnessing are not necessarily a shift to lower inputs, rather to different inputs.

Attitudes of advocates of sustainable agriculture

In general, advocates of sustainable development envision a society that does not jeopardize the prospects of future generations as it satisfies its own needs (Brown et al., 1990). Advocates of sustainable agriculture, therefore, believe in appropriate scientific and technological progress. Appropriate technology applied to development problems is not harmful to the environment, but fits in the biophysical and socioeconomic parameters of the environment on which it is imposed (Batie, 1988).

Many advocates of sustainable agriculture believe that the biosphere imposes limits on and provides opportunities for economic growth. The environment's ability to assimilate pollution from peoples' activities is the ultimate limit to economic growth (Batie, 1989). Because the extinction of species is an irreversible change that results in less-diverse ecosystems, it leads to a lower quality of life for humans (Ehrlich, 1988). Wild biodiversity can provide plants that are useful to humans (Ilitis, 1988).

Most advocates of sustainable agriculture are reluctant to accept environmental risks and believe that actions taken must not harm people or nature. They advocate environmental justice and egalitarian ethics. They believe that all people must be given equal access to natural resources and a quality environment. They seek to limit population growth and to invest in human capital.

The scientific and regulatory communities have identified three major goals of sustainable agriculture: to improve farm-level profitability, to improve the international competitiveness, and to reduce environmental damage by farming practices (Harsch, 1991).

Environmental organizations had a much bigger say in drafting the farm bills passed since 1985 (Table 2). Those bills were confined primarily to program crops, except for the funding for research on alternative farming for all of agriculture in the 1985 farm bill. The 1985 farm bill made participation in programs such as commodity price supports, crop insurance, and certain loans contingent on compliance with environmental objectives. For example, the Highly Erodible Land program gave farmers until 1990 to develop a conservation plan and until 1995 to implement it. Legislation may include horticulture in the future, and, if legislation does not encourage horticulturists to move toward more sustainable systems, the marketplace will.

The Federal Agricultural Improvement and Reform Act of 1996 (FAIR) has been called the greenest farm bill ever. It establishes several new environmental initiative such as the Environmental Quality Incentives Program (EQIP), which provides cost-share and technical assistance to help agricultural producers meet environmental challenges. The Conservation Farm Option and Farms for the Future programs offer producers voluntary, incentive-based conservation partnerships. FAIR also continues the Conservation Reserve and Wetlands Reserve programs. By changing the crops subsidy programs, FAIR will give farmers more flexibility to use sustainable agriculture practices such as crop rotation and the use of fewer synthetic fertilizers and pesticides.

Sustainable agriculture is NOT

- a break with modern agriculture,

- another name for organic farming,
- only for small farms,
- only for livestock,
- a step backwards,
- a panacea for all environmental problems,
- a complete solution to farm profitability problems, or
- a budget-buster for USDA.

However, it is designed to develop a full range of options for all farmers and not to impose limitations on any farmer.

Sustainable agriculture practices

Farmers use various combinations of the following practices to farm sustainably: crop rotations; pest-control strategies that do not harm nontarget species, farm workers, neighbors of farms, or con-

Table 2. Farm legislation affecting sustainability, 1862–85.

Farm Act	Key public concerns	Provisions affecting sustainability
1862 1935	Building a nation Drought, wind erosion, farm bankruptcies, conservation	Homestead Act subsidized, sodbusting USDA Soil Conservation Service (SCS) created
1936	Conservation and crop surpluses	Direct payments by SCS to farmers to subsidize conservation practices
1949	Surpluses, low prices, and erosion	USDA price supports link production control with conservation programs
1956	Surpluses, low prices, and erosion	Long-term Soil Bank and Great Plains Conservation programs launched to idle erodible land for up to 10 years
1965	Meeting export demand	Acreage reduction programs replaced by fencerow-to-fencerow planting (early 1970s)
1977	Cost effectiveness; paying farmers not to produce	Cost-sharing assistance limited to identified conservation needs
1981	Meeting global food demand	Conservation cost-sharing rules tightened to separate conservation from production control
1985	Surpluses, conflict between price support programs and conservation	Conservation Reserve Program, Sodbuster, Swampbuster programs; research on alternative farming
1990	Impact of agriculture on the environment, food safety	Flexibility in planting, crop use, crop rotation and marketing; incentives to change resource use; greater research and technical assistance
1996	Allowing market forces to work, removing government restrictions	Reform of subsidy programs linked to specific crops, incentives for environmental protection

sumers; mechanical and biological weed control; soil and water conservation practices; animal and green manures; and agricultural chemicals that do not pose significant threats to humans, animals, or the environment (O'Connell, 1991).

Key questions for researchers and farmers may include the following: What management factors affect sustainability? What crops can be grown using sustainable agriculture practices? How can inputs best be manipulated? Must farmers accept lower profits for doing the right thing? What new technologies and practices will assist farmers in moving toward sustainable farming?

This colloquium was convened to address what is happening in the United States to make horticulture more sustainable. The following papers are presented by university researchers and others who have been involved in sustainable programs and by national project directors who develop guidelines for sustainable university programs.

These papers provide an overview of SARE, a discussion of waste streams in greenhouse production, a description of a multi-state project that evaluates the feasibility (biologic and economic) of using sustainable agriculture practices for small fruit, a description of a computer model (PLANETOR) that allows farmers to evaluate alternative resource management strategies, and a discussion of sustainable landscaping.

We in the horticulture community have a difficult task to address environmental issues. The market is now global. Land prices in many states are now too expensive to practice labor-intensive farming. We face many restraints as we work for solutions. We need to find systems that are not only environmentally sustainable, but also economically viable for the producers.

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Welcome to Reality: An Overview of a Low-input Sustainable Agriculture (LISA) Project in Small Fruit

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ADDITIONAL INDEX WORDS. extension education, integrated pest management, raspberry trellising, small fruit pest complexes, raspberry, strawberry, cover crops, floating rowcovers

SUMMARY. An in-the-trenches researcher/coordinator viewpoint of a northeast regional LISA grant funded from 1989-93 is presented. The specifics of the logistics of coordinating a multi-state grant in a fledgling granting program is emphasized, as well as the evolution of the content and focus of the research directions for the grant Evaluation of Alternative Strategies for Small Fruit Production (Univ. of Vermont Agreement 92-08-01). This was a project in which five states in the northeastern United States proposed to cooperate on a multi-disciplinary project exploring the biological and economic feasibility of selected production practices for small fruit. These practices were selected because they showed potential for increasing net profit by reducing purchased inputs or maximizing yield. Information transfer, before, during, and after the studies was emphasized, using such diverse means as grower experimental plots, the participation of growers in integrated pest management programs, the development and publication of economic data relevant to the projects, the development of a LISA small fruit newsletter, as well as more traditional means of information dissemination such as grower meetings, and trade and scientific publications.

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