Resources & Environment

Incentives for Sustainable Agriculture

The concept of sustainable agriculture—which integrates technologies and practices that are as profitable as conventional farming methods but more environmentally responsible—has maintained its place at the policy table since the term became a catchphrase in the early 1990's. Three major goals are consistent with the range of strategies falling under the broad umbrella of sustainability: ensure the productivity and profitability of agriculture; conserve natural resources and the environment; and maintain economically viable rural communities.

Production agriculture is a major user of natural resources and environmental assets. A sustainable path of economic development for agriculture is one that will, at a minimum, balance use of these assets over time to meet the food and fiber needs of the present and all future generations and supply environmental services to a growing population (e.g., access to clean water, and reduced pesticides on food).

Historically, new technologies have served as an engine of output growth in U.S. agriculture, sometimes at the expense of eroding the environment and natural resource base. Today it is possible that the food and fiber needs of a growing population can be met by adopting new, output-enhancing, technologies that concurrently protect environmental quality and efficiently utilize natural resources.

Agricultural productivity growth in the U.S. has been impressive. During 1948-93, U.S. agricultural output grew at an annual average rate of 1.7 percent. A slight decline in input use accompanied this output growth, resulting in an annual productivity growth rate of 1.8 percent. By comparison, the annual productivity growth rate for the nonfarm sector was substantially smaller, at 1.1 percent over the same period.

For major U.S. field crops, yield growth paralleled this observed pattern of productivity growth. Yields for major field crops grew rapidly, ranging from 1 to 3 percent annually, with corn, sorghum, and potatoes exhibiting the most rapid growth. Since 1939, corn yields have grown at an impressive 3 percent per year while wheat yields have climbed approximately 1.8 percent. There is no strong evidence favoring the presumption of a plateau in overall field crop yields, although U.S. wheat yields have been relatively flat for 10-15 years.

Agricultural research and development (R&D) is perhaps the most important factor in the steady growth in U.S. agricultural productivity. Public research expenditures rose by 3-4 percent in real terms until approximately 1980; since then, growth has slowed to 0.7 percent per year. While Federal expenditures have remained flat since 1976, expenditures by the private sector have grown rapidly.

Most of the post-1980 growth has resulted from increased contributions from the private sector. The private sector now accounts for more than 50 percent of all agricultural research funds. A continuation of past patterns of R&D will contribute to an increased availability of food and fiber to future generations.

Environmental Damage Is Slowing

The inputs of agricultural commodity production include synthetic products (e.g., fertilizers and pesticides), natural resources (e.g., soil and water), and environmental assets (e.g., wetlands and water quality). Depleting environmental assets and natural resource inputs can reduce the availability of both food and fiber as well as environmental services to future generations. Data suggest that agriculture has made significant strides in reducing the rate of depletion of environmental assets.

Soil erosion has decreased substantially since the Dust Bowl period. Since 1938, soil erosion has declined by an estimated 40 percent, and most of the decline has occurred since 1982. This trend of reduced soil erosion resulted, in large part, from the 1985 Food Security Act, which established the Conservation Reserve Program and the conservation compliance provisions for farm program participants.

Due to this trend, threats of reduced farm productivity from excessive soil erosion do not appear to be significant. New programs place a greater emphasis on the off-site effects of soil erosion and seek to minimize the offsite damages to rivers, lakes, and estuaries. Given the time lag in sediment transport and biological

This article summarizes a workshop entitled “Economics of Sustainable Agriculture,” held in Washington, D.C. on October 21-22, 1996 and cosponsored by USDA’s Economic Research Service (ERS) and the Farm Foundation. The goal was to solicit input on the complex issue of sustainable agriculture from a diverse group of that included farmers, representatives of public interest organizations, academic and government economists, and current and former policy makers. A forthcoming ERS report, “Green Technologies for a More Sustainable Agriculture,” will provide a detailed overview of the workshop.

response, the benefits of any soil erosion reduction programs may start accruing well after implementation of the program.

Wetlands supply critical environmental services, such as wildlife habitat, flood control, and water filtration. The lower 48 states have lost almost one-half of all wetlands since 1780, but the rate of wetland losses associated with agricultural production has decreased significantly. The rates of wetland loss from agriculture since 1980 are dramatically lower than in earlier decades.

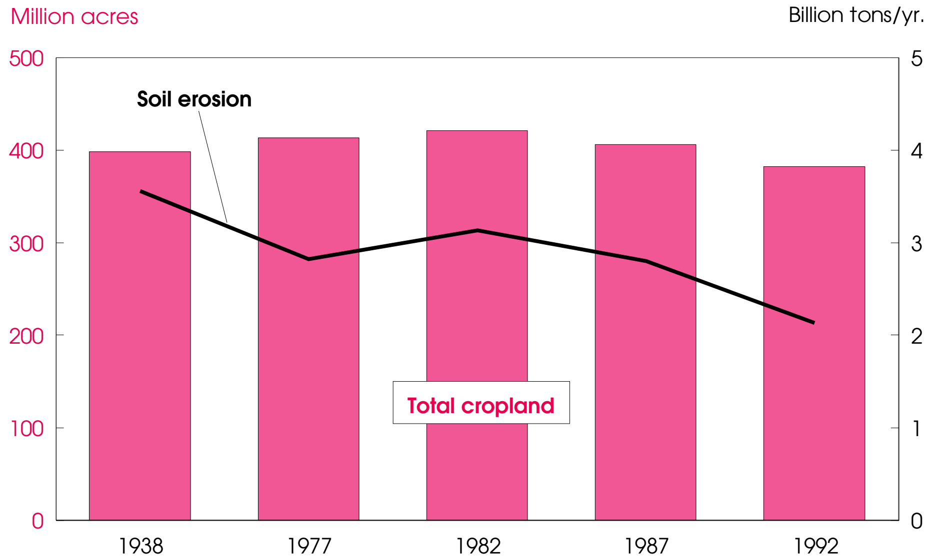
Improvements in the agricultural sector's environmental performance can be attributed partially to activities of environmental interest groups and partially to a willingness of farmers to address food safety and environmental concerns. While agricultural production has improved its environmental performance without major effects on output, continued growth in the demand for food and fiber as well as for environmental goods and services will likely place additional competing pressures on environmental protection.

Demand for environmental services (e.g., access to pesticide-free food and clean water) can be inferred from a number of recent patterns. First, a small portion of the market enables some individuals to pay price premiums in exchange for organic products free of pesticide residue. The willingness to pay more for such products demonstrates demand for foods that are perceived to reduce health risks and/or even provide greater water quality protection.

Second, many individuals express their value of the environment by contributing to nonprofit environmental organizations. Since 1987, the percentage of U.S. households contributing to such organizations has fluctuated from 11 to 16 percent. Average annual contributions have ranged between $87 and $99 per household.

Such studies typically provide some indication of demand for many environmental services affected by agriculture, including the protection of ground water quality, wetlands, surface water quality, wildlife habitat, and open space.

Soil Erosion Is Down Sharply Since the 1930's



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Technology & Sustainability

New technologies have the potential to reduce the loss of environmental and natural resource assets as well as improve agricultural productivity. Two key issues are the availability of new technologies (which depends on the extent and quality of investment) and their adoption in the market.

Underinvestment in sustainable technology can occur for two reasons. First, firms cannot fully capture the benefits of developing and implementing a new technique, given that competitors can often mimic a successful new technology. Second, new technology development, while addressing issues of cost and yield, is less concerned with objectives that are commonly associated with more sustainable practices (e.g., environmental quality and food safety).

Private-sector R&D usually focuses on practices that conserve scarce production inputs and that push down costs or improve returns by capturing a market niche. For example, if labor in agriculture is scarce, and hence a relatively expensive input, private-sector R&D will focus on practices that are labor saving. Similarly, because fertilizer has a market price, the private sector has some incentive to conduct R&D to reduce use of fertilizer and thus reduce costs.

On the other hand, the private sector has had little economic incentive to conduct R&D on practices that produce improved habitat for wildlife, or a more scenic landscape, because these goods have usually lacked market prices or other mechanisms to provide returns. The private sector will invest in R&D on the efficient use of natural resources only to the extent that it is profitable.

The lack of market incentives can also slow adoption of more sustainable practices by farmers. Until farmers have an economic incentive for more sustainable practices, the agricultural sector will not provide a mix of food and environmental services which reflects public preferences. The lack of private market incentives both for the development of more sustainable practices (the supply side) and for the adoption of more sustainable practices (the demand side) suggests a positive role for government.

A number of management practices often considered to be more sustainable than many conventional agricultural practices are already *available* to producers. These practices include, among others, conservation tillage (*AO* August 1996), preci-

A Selection of Sustainable Agricultural Practices

Enhanced nutrient management involves the efficient use of plant nutrients from commercial fertilizers, animal wastes, and municipal wastes. The primary goal is to sustain an increase in agricultural production and to minimize the environmental damage from residual nutrients. Enhanced nutrient management includes a broad set of agricultural practices.

Farmers can more effectively manage the nutrients on their farms by developing a better understanding of nutrient inputs, outputs, storage, and crop uptake. For example, with a better understanding of a field's nutrient requirements through soil testing, a farmer can match fertilizer and manure applications to the crops' needs and decrease the amount of residual nutrients lost to the environment. Further, matching the timing of applications to particular stages in the growing season decreases nutrient escape. More efficient and location-specific applications of nutrients can reduce farmers' fertilizer costs as well.

Better management of nutrients serves to ensure the quality of downstream waters and to prevent the mining of nutrients in the field. For the farmer, improved applications can decrease the time and energy expended on crop management by reducing the number of trips across fields.
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Integrated pest management (IPM) includes an assortment of techniques designed to maintain pest infestation at an economically acceptable level rather than attempting to completely eradicate all pests. IPM monitoring methods include scouting or regular and systematic field sampling to estimate pest infestation levels; soil testing for pests such as nematodes; the use of pheromone odors and visual stimuli to attract target pests to traps; and recording environmental data (e.g., temperature and rainfall) associated with the development of some pests. Pest management practices include biological controls such as natural enemies and biopesticides; cultural controls such as hand hoeing, mulching, and crop rotation; strategic controls such as planting dates and timing of application and harvest; and use of crops developed to be resistant to certain pests.

While IPM does not exclude the use of synthetic pesticides, the pesticides used in IPM often differ from those used on a preventative or routine schedule. Where possible, IPM uses pesticides that target specific pests and are less toxic to beneficial organisms. To the extent IPM decreases pesticide use, reduces toxicity, and optimizes timing, gains in environmental benefits can occur in terms of improved water quality, decreased probability of wildlife poisonings, and decreased probability of negative health effects on applicators.

In some cases, IPM increases crop yields. But even when yields remain unchanged, farmers can still profit if a decrease in pesticide expenditures is larger than the increase in expenditures on other inputs (e.g., labor).
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Rotational grazing involves the management of livestock on a series of pastures. Farmers effectively rotate herds across these pastures throughout the year to maximize production. A key component to the success of rotational grazing is planting forage crops that mature at different times throughout the year. Both dairy and beef cattle farmers have employed rotational grazing.

Pastures that are on rotational grazing tend to have rapid regrowth and recovery potential, generally higher quality forage, decreased weed and erosion problems, and more uniform soil fertility levels. A well-managed rotational pasture system allows a farmer to reduce labor and purchased feeds by substituting forage crops for feed. Assuming the farmer moves the herd from field to field, this substitution can be sustainable if grazing does not exceed a field's rate of regrowth. Several researchers have experimented with rotational grazing as an alternative to row-crop agriculture on erosion-prone land, finding that rotational grazing ensures soil cover and that in some locations, it yields greater profits than row crops. In this way, erosion-prone land could return to active agricultural production while providing environmental benefits of erosion control.
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sion agriculture (*AO* May 1995), integrated pest management (*AO* May 1994), enhanced nutrient management, and rotational grazing. However, barriers exist that slow the *adoption* of available technologies.

Risks associated with alternative production technology can be a primary deterrent. A more sustainable technology that carries higher risks than a conventional technology may not be adopted because farmers often take actions to minimize these risks.

For example, a farmer may find it economically optimal to "over-apply" nitrogen prior to planting, a practice which increases as it becomes more likely that inclement weather will preclude access to the field during the growing season. Nitrogen applied in advance of the growing season is more susceptible to runoff and poses a more serious environmental threat than when applied during the growing season. In cases like these, farmers may not realize the profit and environmental quality gains expected for a sustainable technology.

Site specificity of many environmental problems, as well as the diversity of the resource base, has implications for technology adoption—and for policy implementation. Research results from USDA's Economic Research Service indicate that for vegetable growers, for example, farm location—a proxy for climate and soils—has a significant effect on pesticide demand, yields, and farm profits. Soil fertility, rainfall, and temperature also influence profitability among farms. The physical environment of the farm may affect profitability directly through greater fertility, and indirectly through its effect on pests.

All else being equal, a farm located in a dry, infertile area is less likely to adopt IPM than one located in an adequately wet, fertile area. Similarly, conservation tillage practices may not perform well in areas with poorly drained soils, short growing seasons, and high rainfall. As soil becomes finer and denser, adoption of no-till may decrease. Although many areas of commonality do exist, there is clearly no "one-size-fits-all" solution to the issue of sustainability, and policies must be flexible enough to recognize the diversity of the natural resource base as well as region-specific environmental issues.

Restructuring Incentives For Sustainability

The 1996 Farm Act created new programs that advance the goals of sustainability, such as the Environmental Quality Incentives Program, the Wildlife Habitat Incentives Program, and the Farmland Protection Program (*AO* November 1996). The act also extended programs such as the Conservation Reserve and Wetlands Reserve Programs. A number of other policy options, are in various stages of adoption, that would further promote agricultural sustainability.

Insurance could encourage the adoption of sustainable practices. An impediment to adoption of more sustainable practices (e.g., integrated pest management) is the risk associated with switching from time-tested conventional modes of production. Further analysis of the feasibility of providing insurance against such risks is needed.

Access to credit can also be a factor in farmers' willingness to adopt sustainable production practices. Policy could be restructured so that farmers could finance the costs of switching to a new technology regime (e.g., precision agriculture).

Market development for more environmentally safe crop production is a key to moving towards a more sustainable agriculture. The development of nationally accepted organic standards, for example, will spur markets for fruits and vegetables produced using techniques that optimize agro-ecosystem health. By developing markets, especially for specialty products, producers who utilize sustainable production practices can obtain a premium for choosing to exercise environmental stewardship.

Local flexibility in the implementation of Federal programs is needed to target specific environmental problems, because the nation's natural resource base is so diverse. A "one-size-fits-all" approach to sustainability will not work, because there is a need to customize programs to match locally diverse needs. The 1996 Farm Act, which allowed greater planting flexibility to farmers, sets an example for tailoring programs to the real needs of farmers.

Research and development could focus on problems faced by producers who adopt sustainable technologies. Greater emphasis could be placed on interdisciplinary research and on evaluating tradeoffs between environmental quality and profitability in both conventional and alternative technologies.

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March Releases—USDA's Agricultural Statistics Board

The following reports are issued electronically at 3 p.m. (ET) unless otherwise indicated.

March

4	*Dairy Procucts*
	Egg Products
	Poultry Slaughter
5	*Broiler Hatchery*
11	*Crop Production (8:30 a.m.)*
12	*Broiler Hatchery*
14	*Cattle on Feed*
	Livestock Slaughter, Annual
	Milk Production
	Potato Stocks
	Turkey Hatchery
19	*Broiler Hatchery*
21	*Chickens & Eggs*
	Cold Storage
	Livestock Slaughter
24	*Catfish Processing*
25	*Cotton Ginnings (8:30 a.m.)*
	Hop Stocks
26	*Broiler Hatchery*
	Wool & Mohair
27	*Agricultural Prices*
	Hogs & Pigs
31	*Grain Stocks (8:30 am)*
	Prospective Plantings (8:30 am)
	Rice Stocks (8:30 am)
	Peanut Stocks & Processing