Green Technologies for a More Sustainable Agriculture. By James Hrubovcak, Utpal Vasavada, and Joseph E. Aldy, with contributions from Linda Calvin, Jorge Fernandez-Cornejo, Dwight Gadsby, Ralph Heimlich, Wen Huang, Paul Johnston, and Dale Leuck. Resource Economics Division, Economic Research Service, U.S. Department of Agriculture, Agriculture Information Bulletin No. 752.

Abstract

For U.S. agriculture to continue along a sustainable path of economic development, further production increases must be generated by technologies that are both profitable and more environmentally benign. In this context, we assess the role of these “green” or sustainable technologies in steering agriculture along a more sustainable path. However, the lack of markets for the environmental attributes associated with green technologies can limit their development. In addition, simply making a technology available does not mean it will be adopted. Experience with green technologies such as conservation tillage, integrated pest management, enhanced nutrient management, and precision agriculture demonstrates that even when technologies are profitable, barriers to adopting new practices can limit their effectiveness.

Keywords: Sustainable agriculture, natural capital, nonrenewable resources, renewable resources, environmental services, green technology, integrated pest management, conservation tillage, enhanced nutrient management, precision agriculture

Acknowledgments

The authors thank Margot Anderson, William Anderson, Pierre Crosson, Dave Ervin, George Frisvold, and Michael Toman for their comments and participants of the ERS-Farm Foundation sponsored workshop for their insights on sustainable agriculture. Linda Calvin, Jorge Fernandez-Cornejo, Ralph Heimlich, Wen Huang provided the material on conservation tillage, integrated pest management, enhanced nutrient management, and precision agriculture. Paul Johnston and Dale Leuck provided the material for Appendix 1. Errors in interpretation are those of the authors.

1800 M Street, NW
Washington, DC 20036-5831

June 1999

Contents

Summary

For U.S. agriculture to continue along a sustainable path of economic development, further production increases must be generated by technologies that are both profitable and more environmentally benign. In this context, we assess the role of these "green" or sustainable technologies in steering agriculture along a more sustainable path. However, the lack of markets for the environmental attributes associated with green technologies can limit their development. In addition, simply making a technology available does not mean it will be adopted. Experience with green technologies such as conservation tillage, integrated pest management, enhanced nutrient management, and precision agriculture demonstrates that even when technologies are profitable, barriers to adopting new practices can limit their effectiveness.

Sustainability extends beyond the economic well-being of the current generation and reflects the ability of future generations to meet their needs. Sustainability recognizes that economic well-being relies on goods and services (like food and clothing) bought and sold in well-functioning markets, as well as goods and services (like those provided by the environment—e.g., recreation, safe drinking water, and scenery) not necessarily bought and sold in markets. Sustainability also requires investing in diverse forms of capital including both human-made capital (e.g., buildings and machinery) and natural capital (e.g., farmland, aquifers, lakes, rivers, estuaries, and wetlands).

Agriculture has a unique role to play in sustainability. Agriculture produces food and relies on natural capital for producing food. Agriculture also accounts for a majority of land and water use and is a major source of impairment of rivers, lakes, and estuarine waters. Because both food and natural capital are necessary for current and future generations, moving along a more sustainable path of economic development requires effective stewardship in agricultural production.

Because there is no single indicator of agricultural sustainability, we review trends in some existing indicators that are linked to sustainability. These indicators include: agricultural productivity, soil erosion, ground-water quantity, surface-water quality, ground-water quality, and wetland conversion rates. While there is overlap between the services these indicators represent, one can think of agricultural productivity, soil erosion, and ground-water quantity as indicators of our ability to provide food to current and future generations at reasonable costs to consumers. Surface-water quality, ground-water quality, and wetland conversion rates can be thought of as indicators of the environmental impacts associated with agricultural production. When taken as a whole, these indicators are consistent with a view of agricultural production in the United States where environmental problems exist, but where many of these problems can be addressed by thoughtful programs and policies.

Historically, the government has tried to correct many of the environmental problems associated with agricultural production through various conservation programs. For example, within USDA, the Conservation Reserve Program makes payments to farmers to remove highly erodible or environmentally sensitive land from production. Similarly, the Wetlands Reserve Program provides payments and cost-shares to landowners who permanently return prior convert-

ed or farmed wetlands to wetland conditions. These payments, albeit imperfectly, take the place of market prices and provide incentives for resource conservation.

Recently, “green” or more sustainable technologies are receiving a great deal of attention because they can potentially improve the environmental performance of agricultural production without reducing farm production or profits. However, the lack of markets for the environmental attributes associated with green technologies can limit their development. Market prices provide a signal about the scarcity of a resource. In general, research and development and the adoption and diffusion of new technologies will be directed to conserve those resources that are most scarce or highest priced; the so-called induced innovation hypothesis. Because the market prices of many environmental services and natural resources are less than their true value to society, there is less of an economic incentive to develop or adopt technologies that conserve those resources.

In addition, simply making a technology available does not mean it will be adopted. The adoption and diffusion of green technologies may be slow and gradual. Experience with green technologies such as conservation tillage, integrated pest management, enhanced nutrient management, and precision agriculture demonstrates that in addition to profitability, three critical factors affect adoption. First, structural barriers, including the lack of financial capital and limits on labor availability, may deter adoption. Second, a diverse natural resource base, including varied soil, water, and climatic resources, make it worthwhile to adopt these technologies only in some instances. Third, the economic risk of adopting new technologies may inhibit adoption. Barriers to the adoption and diffusion of green technologies have additional implications. Because the economic and environmental implications of green technologies vary by crop and region, there is no one technology that will be sustainable for every farmer in every part of the country. Because these barriers differ across the country, there is a premium on knowledge about regional adoption and diffusion constraints and an advantage to a decentralized approach to research and development and technology transfer.