

Appendix 1—Farm Level Case Studies on Profitability-Environment Tradeoffs

There are many sustainable agriculture success stories. Typically, these stories detail how shifting from a conventional to an alternative production system can provide economic and environmental benefits.

Several institutions have developed research programs in sustainable agriculture. In general, these institutions have targeted research projects that would otherwise be ignored by traditional institutions of agricultural research. We review some case study evidence on economic and environmental trade-offs developed by these institutions below.

National Research Council Interviews with Sustainable Farm Operators

The National Research Council conducted interviews with farm operators who adopted sustainable production practices. Anecdotal evidence obtained from those interviewed was then collated and published (National Research Council, 1989). We abstract some examples of National Research Council interviews below.

The Spray brothers' 720-acre Ohio farm includes 400 acres of cropland: 100 acres of corn, 88 acres of soybeans, 12 acres of adzuki beans, 100 acres of wheat and oats, and 100 acres of red clover, some of which receives premium prices as seed. The farm controls weeds with rotations, frequent cultivation, and by hand. Over half of the corn is fed to 32 dairy cows and 40 to 50 head of beef cattle. The farm does not participate in the feed grain program, but receives premium prices for oats, soybeans, and adzuki beans from health food stores because of its organic certification. No lime, fertilizer, or pesticides have been purchased since 1971.

The Kutztown farm in eastern Pennsylvania is 305 acres, with slopes reaching 25 percent. The farm finishes 250 to 290 beef cattle and 50 to 250 hogs, annually. Except for a small amount of starter fertilizer, fertilizer needs are satisfied with the livestock manure. The farm controls weeds with cultivation and crop rotation, with occasional herbicide applications on about half of the acreage. Most of the fields are contour-farmed in strips 100 to 200 feet wide. Although erosion exceeds the level needed for soil replacement, it is below the State average.

The Rodale Institute

The Rodale Institute began one of the earliest long-term studies in 1981 for examining the process of converting to low-input cropping systems (National Research Council, 1991b). The Institute compared a conventional rotation of corn and soybeans using typical levels of purchased inputs with two low-input systems. One of the alternative systems incorporated a 5-year rotation of corn, soybeans, small grains, legume hay and corn silage combined with cattle, and the other included a low-input cash grain system. During the transition period of 1981-84, a change in the equilibrium between plant growth and soil microorganisms was manifested in lower corn yields for both alternative systems. All systems have had similar yields since that time.

The Institute also found a higher level of microbiological activity and more microarthropods in the alternative systems, and attributed these to the variety of crops in the rotation, rather than simply the absence of pesticides (National Research Council, 1991b). A comparison of 9 years of data revealed that the cash grain rotation would have earned about 8 percent more profits than the conventional system, in the absence of government support payments. In addition, larger profits were subject to less annual variation.

Northwest Area Foundation

The Northwest Area Foundation (1994) reported on a 6-year \$4.5-million research project it funded to investigate the economic, environmental, and social impacts of sustainable agricultural systems in seven States. The report characterizes sustainable farms as: more diversified in crops and livestock than conventional farms; maintaining soil productivity with soil-building crop rotations, nutrient cycling, and tillage practices; and using a greater amount of labor, but in ways that spread it out over the year. Sustainable farms had fewer assets, although they tended to own more of their land. As a group, they tended to be less competitive than conventional farms, but the upper one-third performed competitively with conventional farms. Management appears to be the key to being competitive. Sustainable farmers were also younger than their conventional counterparts and adopted sustainable practices early in their careers, suggesting that education may encourage sustainable farming.

The Leopold Center

The Leopold Center funds studies on the feasibility and effectiveness of new resource management techniques for cattle and crops. Most of the studies are focused on specific aspects of the farm, rather than the total farm. The Center has funded research on the scale of swine operations in a loose housing arrangement, rotational grazing on highly erodible land, a simulation model of farm decisionmaking, manure management, reaction of a desired predator to a natural fertilizer, and educational videos about managed grazing. Some of the findings of these studies are: 1) small swine farmers can be more competitive with larger producers by using a computerized feeding, loose housing operation; 2) paddocks for cattle and interseeding grassy pastures are feasible alternatives to row cropping on land after removal from the Conservation Reserve Program (CRP); 3) late spring testing of soil, corn stalks, and manure provides more accurate information on the needs of crops at crucial times; 4) manure management reduces fertilizer costs; and 5) urea and fresh manure inhibit the effectiveness of biological control agents on black cutworms (Leopold Center for Sustainable Agriculture, 1996).

Long-Term Trials

Long-term crop trials attempt to measure the effect of selected treatments on a small number of variables such as crop yield or profitability. Chase and Duffy (1991) reported on a 12-year comparison of crop rotations carried out at the Northeast Research Center of Iowa State University. The three rotations were continuous corn (C-C), corn-soybeans (C-Sb), and corn-oats-meadow (C-O-M). Chase and Duffy noted that monoculture and limited rotations are viewed as increasing soil erosion and reducing soil productivity that must be made up by increases in fertilization. Conventional pesticide and fertilizer applications were made on the C-C and C-Sb rotations. For the C-O-M system, manure was used as the nutrient source and pesticides were applied only as pests exceeded threshold levels, as determined by the farm manager. The meadow was an alfalfa hay with oats as a companion crop. The alfalfa was harvested in the year after the oats and was plowed under after the last cutting in preparation for the following year's corn crop. Labor costs were the highest for the C-O-M rotation because labor was used as a substitute for machinery, chemicals, and other nonfarm inputs. Excluding labor, the C-O-M rotation had average production costs of \$96

per acre, compared with \$159 per acre for C-Sb and \$207 per acre for C-C. Returns to land, labor, and management were similar for the C-C rotation and the C-O-M rotation, but nearly 60 percent higher for the C-Sb rotation. No assessment of the effects on environmental quality was made, but appropriate pricing of reduced chemical residues would raise the relative return to C-O-M.

Luna and others (1994) reported on a systems-wide trial begun in 1987 by a team of seven researchers representing six departments at Virginia Polytechnic Institute and State University, intended to last 10 years. The object was to compare a crop-livestock system using integrated pest management (IPM) with an alternative system intended to maintain or improve profitability and soil productivity while reducing soil erosion and chemical use. Preliminary conclusions suggest that similar levels of productivity can be achieved on both systems, and the need for nitrogen fertilizer and pesticides can be decreased by using managed grazing and an alfalfa rotation. Manure from feeding of corn silage provides most of the nutrients for the following year's corn crop. Luna and others noted it is difficult to draw inferences that can be extended much beyond the specific systems compared, and even those inferences are location specific as well. Furthermore, it is difficult to assign cause and effect in such trials because many factors are operating simultaneously and over time.

In the livestock sector, operators have also employed more environmentally benign practices. Rotational grazing, for example, involves managing livestock on a series of pastures. Farmers effectively rotate herds across this series of pastures through the year to maximize profits. A key component to the success of rotational grazing is the planting of forage crops that mature at different times through the year. This allows for farmers to rotate their herds to pastures with sufficient forage throughout the year. Both dairy and beef cattle farmers have used rotational grazing.

Through rotational grazing, some farmers have gained significant cost savings by reducing the amount of supplemental feed necessary for their herds. By moving herds to fields with forage at its optimal growth stage, farmers can ensure their herds consume both high-quality and high-quantity forage. In some cases, dairy cattle have been found to graze 50 percent more forage on productive fields than expected. In addition, rotational grazing can decrease labor require-

ments for herd management. These economic benefits have yielded substantial profit increases for dairy farmers in Vermont and South Carolina and beef farmers in Iowa.

A well-managed rotational pasture system allows a farmer to substitute natural resource inputs (forage) for capital inputs (feed). Given that the farmer moves the herd from field to field, this substitution is sustainable because 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 environmentally sensitive lands covered by soon-to-expire Conservation Reserve Program (CRP) contracts. They have found that rotational grazing ensures soil cover and yields, and in some locations, greater profits than row crops. In these cases, CRP land can return to active agricultural pro-

ductivity without losing the environmental benefits associated with the program (USDA, Sustainable Agriculture Research and Education Program, 1995). Similar economic considerations apply for explaining the barriers to the adoption and availability of more environmentally benign production practices in the livestock sector.

The literature reviewed above indicates there may be some potential for achieving sustainability goals by increasing the availability of green technologies. This, however, may be easier said than done because the success of these technologies on a particular farm may not be easily replicated to all farm resource situations. Significant impediments may exist in replicating the success of a particular technology on a large scale.