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ANALYSIS

Economic and environmental implications of alternative landscape designs in the Walnut Creek Watershed of Iowa

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Abstract

This paper evaluates the economic and environmental impacts of three alternative landscape scenarios created by a team of landscape architects, following input from an interdisciplinary team of researchers. In the first scenario, the main objective was to increase production and profitability of commercial agriculture with environmental objectives given secondary weight. In the second scenario, water quality improvements were the main objective with secondary objectives being financial health of the agricultural sector and maintenance and restoration of biodiversity. In the third scenario, maintenance and restoration of native biodiversity was the main objective with secondary weight given to the financial health of the agricultural sector and water quality. We evaluate the degree to which the economic and environmental objectives can be achieved together or involve tradeoffs. We found that some changes in land use or agricultural practices result in environmental improvements on certain dimensions in addition to making economic sense. But most changes in land use or agricultural practice do not bring uniform environmental improvement. There may be difficult tradeoffs between different components of environmental quality in addition to tradeoffs between economic and environmental objectives. © 2001 Elsevier Science B.V. All rights reserved.

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1. Introduction

Land use and land management decisions in agricultural systems not only produce marketed agricultural goods but also change the level of nonmarketed ecosystem services as well. Choosing among land use/land management options to produce desired combinations of agricultural goods and ecosystem services requires integrating input from a number of different disciplines including agronomy, hydrology, ecology and economics. To study land use/land management issues in the context of Midwest agricultural watersheds, an interdisciplinary team of researchers was assem-

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bled to investigate water quality, biodiversity and returns to farmers for sample watersheds. This paper reports on results generated by this interdisciplinary investigation for environmental and economic returns for the Walnut Creek Watershed southwest of Ames, Iowa, USA Walnut Creek is a fairly typical watershed in the Des Moines Lobe region of Iowa, which is characterized by flat terrain and highly productive soils.

The task for the interdisciplinary team was to investigate what might be the economic and environmental consequences of alternative futures for the watershed. Three landscape scenarios were created by a team of landscape architects to capture essential features of three quite different future alternatives for the watershed, following input from the interdisciplinary team of researchers (for details, see Nassauer et al., 1999). In each of the three scenarios priority was given to different objectives. In the first scenario, the main objective was to increase production and profitability of commercial agriculture with environmental objectives given secondary weight. In the second scenario, water quality improvements were the main objective with secondary objectives being financial health of the agricultural sector and maintenance and restoration of biodiversity. In the third scenario, maintenance and restoration of native biodiversity was the main objective with secondary weight given to the financial health of the agricultural sector and water quality. The three scenarios are described in greater detail in Section 2.

In this paper, we examine the economic and environmental implications of the three alternative scenarios compared to a status quo baseline (current farm practices and land use) in the Walnut Creek Watershed. The environmental effects we analyze are nitrate–N (NO_3-N) runoff and leaching, wind and water erosion. The economic effect we analyze is total return to land (total revenue minus total cost except land cost). To estimate return to land under various alternative land use/crop management practices, we first estimate yields for various crops under the alternatives. Combining estimated yields with output prices and production costs then determines total return to land. Both yield and environmental effects are derived using a computer simulation model known as the Interactive Environmental Policy Integrated Climate (i_EPIC; formerly the Erosion Productivity Impact Calculator) (Williams et al., 1988; Sharpley and Williams, 1990). We describe the simulation model and data in Section 3.

The end result of the analysis shows how economic and environmental objectives may be affected by choosing alternative scenarios, which represent different possible futures for the watershed. The research also sheds light on the degree to which economic and environmental objectives are complementary or involve tradeoffs. The results of the analysis are described in Section 4.

Most prior related research has focused on the impact of specific agricultural practices on water quality (Hallberg, 1989; Gren, 1993; Kronvang et al., 1995; Gren et al., 1997; Byström, 1998). In particular, the impact of tillage practice on farm income and water quality has received a lot of attention in the literature. Conventional tillage systems using a disc to turn over soil have advantages for weed control, disruption of pest life cycles, and breaking up of soil layers that may impede water filtration and plant growth. Disadvantages of conventional tillage include higher soil erosion rates, loss of soil porosity, and soil compaction. The National Research Council (1989) estimated that no-till systems could reduce soil erosion by as much as 94%. In addition, Martin et al. (1991) found that overall no-till is cheaper then conventional tillage. Wiersink et al. (1992) found no-till had a higher variable cost, but conventional tillage had a higher fixed cost. The increased variable costs are associated with increased herbicide use for weed control in no-till (Martin et al., 1991).

With the move to conservation tillage practices such as no-till, there has been concern over the fate of nutrients in the soil and their possible effects on water quality. The primary concern has been focused on NO_3-N runoff and leaching since NO_3-N is the most commonly detected pollutant in groundwater. For example, the US Geological Survey (USGS) found that NO_3-N concentrations in 21% of samples collected beneath agricultural land exceeded the 10 mg/l max-