Chapter 1

Agricultural Policy and Environmental Effects of Marginal Cropland Changes

Environmental groups, ecologists, economists, and others have expressed concern that agricultural programs that stimulate production can have unintended and undesired environmental consequences. This view is based on two ideas: first, that as more land is used in agricultural production, less land remains for wildlife or other environmental purposes; and second, that less productive agricultural lands are particularly susceptible to environmental damages. This report examines both ideas, but focuses mainly on the second one, in the context of agricultural production in the United States.

While the loss of forests and other areas to crop production may be critical in developing countries with expanding cropland areas, the amount of land used for U.S. crop production has remained relatively stable for the last 100 years. The use of particular lands in the United States has changed over time, however, with some cropland converted to urban, forest, and other uses, and some forests, pasture, and range switching to cropland. Little information exists on the environmental implications of these land-use transitions and the degree to which policies may be affecting them. If cropland that shifts in and out of production is less productive and more environmentally sensitive than other cropland, policy-induced changes in land use could have production effects that are smaller—and environmental impacts that are greater—than anticipated.

The view that economically marginal lands are environmentally fragile draws on basic economic and agronomic principles. For example, all else being the same, highly sloped lands are more erodible and may be more difficult to cultivate. Some also argue that poorer soils require greater nutrient applications if engaged in intensive agricultural uses, which may cause greater nutrient runoff depending on application methods and levels, rainfall runoff, soil erosion, and other factors. Thus, it makes sense that some environmentally fragile lands would be near the economic margin between cropland and less intensive agricultural uses, such as pasture. These marginal lands could be more likely to shift uses due to changes in governmental policies, commodity prices, or production costs. Thus, crop insurance subsidies, income support programs, and other government programs that may stimulate agricultural production could harm the environment more than the change in cropland acres would suggest. Conversely, large environmental benefits could be achieved at lower cost using targeted conservation programs because owners of low-quality and environmentally sensitive land might require less payment to remove land from production than would owners of higher quality land.

Although there is some logic to this view, little empirical evidence exists on the relationships between soil productivity and environmental sensitivity.

Moreover, there are surely exceptions. In southeast Washington, for example, deep fertile soil in the rolling (erodible) hills of the Palouse Country supports much of the State's wheat farming (Pimentel and Kounang, 1998). Even the broader environmental implications of erodibility are unclear. For example, if highly erodible lands lie farther from waterways, sediment and nutrient runoff from agricultural activities on these lands may cause less offsite damage.

Whether or not the link between land quality and environmental sensitivity is valid, it emphasizes the importance of examining economic and environmental factors jointly. The view that government farm policies that stimulate production are particularly damaging to the environment hinges on the following three logical premises:

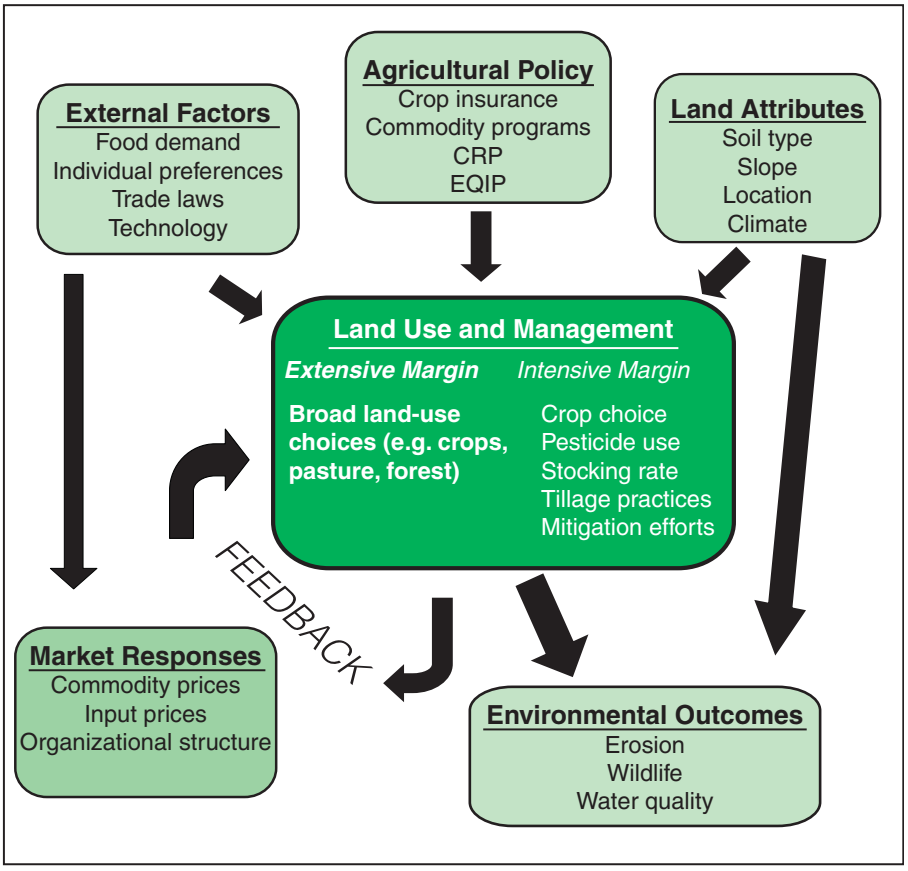
(1) Economic forces are likely to cause lower quality land to transition into and out of crop production.

(2) Lower quality croplands are more environmentally sensitive.

(3) Agricultural policies affect land use on these low-quality and environmentally sensitive lands at the economic margin of crop production.

By exploring each of these assumptions, we begin to trace out the links between agricultural policy, land use, and its environmental consequences (fig. 1.1). External forces—such as food and fiber demand, technology, and indi-

Figure 1.1
Tracing the links between policy, land use, and the environment



vidual producer preferences—together with agricultural policy and land attributes directly affect incentives pertaining to land use and land management.

Land use and management influence the supply of agricultural commodities, and thus their prices and the organizational structure of U.S. agriculture. These market outcomes, in turn, influence land use. The land uses that culminate from these forces interact with land attributes to determine environmental outcomes. Our objective is to trace out some of these links.

Economics of Land-Use Change

Historical patterns of land-use change can be used to more firmly establish relationships between land quality and land use. Lands that have recently shifted into or out of cultivated cropland from other, less intensive uses are at the *extensive margin* of cultivated land, with land use evidently susceptible to economic or other forces (see box, "The Extensive and Intensive Margins of Cropland Use"). One may compare land attributes (such as yield potential, slope, and location) of transitioning lands and lands that have not shifted to a different land use to infer economic forces driving land-use change and whether transitioning lands are of lower quality.

There can be many extensive margins, including land straddling crop and pasture uses and land straddling crop and forest uses.[1] Although land moving from agricultural to urban uses is a prominent issue near some metropolitan areas, this is a small area nationally because urban areas comprise such a small share of total land use in the United States. Between 1982 and 1997, transitions from cultivated cropland to urban land occurred on just 1.5 percent of cultivated cropland.[2] By comparison, transitions to hay, Conservation Reserve Program (CRP), and "other" uses (pasture, range, and forest) occurred on over 24 percent of cultivated cropland. Lands that shifted into crop cultivation from these less intensive uses during 1982-97 constituted 9 percent of cultivated cropland in 1997 (USDA/NRCS, 2000). Because urban land uses are so valuable relative to agricultural uses on some lands, these transitions are driven by factors considerably different from those that drive transitions between intensive and less intensive agricultural uses. Agricultural-to-urban transitions are also less likely to be influenced by Federal agricultural policies.[3]

Environmental Characteristics of Transitioning Lands

Are lands of low agricultural value also more likely to move into and out of intensive agricultural uses, and are they more susceptible to environmental damages? Comparing various measures of environmental sensitivity (erosion, nutrient leaching/runoff, and encroachment on species habitat) on low-quality or recently transitioning lands versus higher quality or nontransitioning lands indicates whether the former are more prone to certain environmental damages. Quantifying these differences suggests the environmental consequences of the various economic forces that drive land-use change.

This report seeks to illustrate the environmental outcomes stemming from extensive margin choices. Intensive margin choices, however, are made

[1]In keeping with common usage in economics, we use the term "extensive margin" to refer generically to the economic margin between any two land-use alternatives. With respect to cropland uses, changes at the extensive margin can be defined in terms of broad land-use categories, as in this report, or more specifically in terms of specific crops (e.g., Wu, 1999). Other authors (Barlowe, 1958) use the term "extensive margin" to refer only to the economic margin beyond which all land uses cease to provide economic rents and land is left abandoned or unused.

[2]Urban land use is defined in accordance with the definition given by USDA's National Resources Inventory (NRI) as: "A land cover/use category consisting of residential, industrial, commercial, and institutional land; construction sites; public administrative sites; railroad yards; cemeteries; airports; golf courses; sanitary landfills; sewage treatment plants; water control structures and spillways; other land used for such purposes; small parks (less than 10 acres) within urban and built-up areas; and highways, railroads, and other transportation facilities if they are surrounded by urban areas. Also included are tracts of less than 10 acres that do not meet the above definition but are completely surrounded by urban and built-up land."

[3]With the exception of the USDA Farm and Ranch Lands Protection Program, which funds purchases of development rights on agricultural lands, Federal agricultural policies are unlikely to influence land-use change at the agricultural-urban fringe. Other researchers have examined local zoning laws and other factors affecting urbanization of agricultural land (Carrion-Flores and Irwin, 2004; Irwin et al., 2003; Heimlich and Anderson, 2001; Bockstael, 1996).

The Extensive and Intensive Margins of Cropland Use

Lands near the economic margin of two or more competing uses lie on the *extensive margin* of the higher value use. Changes in broad categories of land use, including movements of land into and out of crop production, are termed extensive margin choices. *Intensive margin* choices refer to the particular crop choices (e.g., corn versus soybeans) and crop-specific application rates of inputs such as pesticides, water, and fertilizer. In other words, the difference between extensive and intensive choices refers to the difference between how the land is used in a general sense and how it is managed more specifically. This report focuses on the economics and environmental implications of changes in the use of land for crop cultivation versus other less intensive uses and on the role of agricultural policies in influencing these extensive margin choices. Other research has examined policy impacts on crop choices and input use and the associated environmental consequences (Babcock and Hennessy, 1996; Smith and Goodwin, 1996; Wu and Brorsen, 1995; Wu and Segerson, 1995; Horowitz and Lichtenberg, 1993; Quiggin et al., 1993).

simultaneously with extensive margin choices (see box, "The Extensive and Intensive Margins of Cropland Use"). Ideally, we would consider both sets of choices simultaneously, but the complexity of the modeling and data requirements make such an analysis infeasible. Because the environmental effects of broad land-use changes induced by policy have received little empirical attention, we focus on extensive margin changes, while drawing on assumptions about intensive margin choices that are based on more aggregated data and pre-existing models.[4]

Impacts of Federal Agricultural Policies: Crop Insurance and the Conservation Reserve Program

In addition to broadly examining relationships between soil productivity, environmental sensitivity, and land-use change, this report examines environmental outcomes stemming from land-use conversion caused by specific agricultural programs that may have particular relevance for lower quality land. Researchers have noted the potential for farm programs to generate unintended negative environmental consequences by increasing the amount of cultivated cropland (e.g., Goodwin and Smith, 2003; Wu, 1999; Plantinga, 1996). Many agricultural policies have been cited as encouraging producers to cultivate additional land or retain land in cultivation when it would not otherwise be profitable to do so. These studies include land-use effects of commodity programs (e.g., Plantinga, 1996; Wu and Segerson, 1995; Wu and Brorsen, 1995), acreage effects of crop insurance subsidies (Goodwin et al., 2004; Deal, 2004; Goodwin et al., 1999; Griffin, 1996; Keeton et al., 1999; Wu, 1999; Young et al., 1999), and disaster payments (Gardner and Kramer, 1986). A few studies have also analyzed the environmental effects of these changes (Deal, 2004; Goodwin and Smith, 2003; Wu, 1999; Plantinga, 1996). These studies, however, have mainly examined environmental outcomes for particular regions, not for the Nation as a whole.

[4]We generate environmental indicators for nutrient runoff and leaching using the Environmental Policy Integrated Climate Model (EPIC), a crop biophysical simulation model that estimates the impact of management practices on crop yields, soil quality, and various environmental emissions at the field level (Mitchell et al., 1998).

Environmental outcomes depend on the magnitude of land-use changes induced by policies and on land attributes of affected versus nonaffected parcels. We focus on two major Federal farm programs: crop insurance subsidies and the CRP.[5] Crop insurance subsidies may lead to unintended environmental damages by inducing the conversion of land from pasture, range, and other uses into crops. The CRP, established by the Food Security Act of 1985, is a major Federal program that does just the opposite—it offers incentives to convert cultivated cropland to grasslands or tree cover for environmental gains.

Crop insurance subsidies, which have grown markedly since the Crop Insurance and Reform Act of 1994, may encourage farmers to plant crops on land that would not be economically viable without subsidized insurance. There has been particular concern over the environmental characteristics of those lands that could be brought into production due to risk-reducing farm programs such as crop insurance subsidies (e.g., Goodwin and Smith, 2003; Wu, 1999; Environmental Defense, 1999). The concern is that cultivation induced in areas where farming is economically risky may coincide with areas where cropping is particularly harmful to the environment.

The CRP has been estimated to be the most important driver of cropland change from 1982 to 1997, and may have offset the increase in agricultural output associated with other direct Federal farm payments (Lubowski et al., 2003).[6] It provides annual rental payments to farmers who voluntarily remove environmentally sensitive cropland from production under 10- to 15-year contracts. The contracts are allocated through a competitive bidding process based on an index that includes several environmental indicators, plus a cost component. Land enrolled in CRP is generally lower quality than other cropland (Sullivan et al., 2004). This is a natural consequence of the competitive bidding process because farmers wish to retain their higher quality lands for crop production. But CRP lands differ from extensive margin lands as a whole, as well as from land that has remained in cultivated crops. This is the first study to examine, on a national scale, the economic characteristics and environmental impacts of lands affected by crop insurance and the CRP.

[5]The Federal crop insurance program cost over $15 billion from 1981 to 1999, and roughly $3 billion per year since 2001 (Glauber and Collins, 2002). The CRP currently pays about $1.8 billion per year and has disbursed over $27 billion since its start in 1985 (USDA/FSA, 2004a and 2004b).

[6]Land-use definitions in this report are based on the National Resources Inventory (NRI). In the NRI, cropland includes cultivated plus uncultivated cropland while CRP is a distinct land-use category. In contrast, in the ERS Major Land Uses data series, cropland idled under government programs, such as CRP, is considered part of "total cropland" (see appendix A for more details).