*Chapter 2*

# The Extensive Margin of Cultivated Cropland

Lands at the extensive margin of cultivated crop production tend to move between annually cultivated crops, such as wheat or corn, and less intensively managed land uses such as for hay, grazing, or timber. In general, less intensive land management involves the use of fewer inputs, such as fertilizers or pesticides, less mechanical or manual cultivation, and less specialized machines per acre (Barlowe, 1958).

The amount of U.S. land in crop production has remained relatively constant over the past century, but its distribution and composition have varied. A great deal of land moves in and out of cultivation each year even as the *net* changes in cropland area are relatively small. Some cropland has moved into pasture/range, forest, recreational uses, and urban/suburban uses. Other land has moved into crop production, maintaining the constant level of cropland.

This chapter describes land-use changes over recent decades. We focus here on the movement of non-Federal land between cultivated crops and three other broad land-use categories: uncultivated crops (mainly hay); land enrolled in the Conservation Reserve Program (CRP); and grazing, forest, and other rural land. Cultivated crops and these other uses account for over 90 percent of the non-Federal land in the contiguous 48 States, and reallocations of land among them are relatively common. A shift from cultivated cropland to one of these other land uses generally represents a decrease in the intensity of land use.[1]

## Historical Changes in Total Cropland Used for Crops

Almost 100 years of data are available for U.S. area used for all crops (including cropland harvested, cropland failed, and cultivated summer fallow) from the USDA/ERS Major Land Uses data series.[2] U.S. cropland used for crops was 330 million acres in 1910 and 340 million acres in 2004, a difference of 3 percent. Of course, this masks land-use changes within regions and from year to year. For example, cropland used for crops peaked in 1982 at 383 million acres, falling to 331 million acres only 5 years later—a decline of roughly 13 percent.[3]

From 1945 to 2002, U.S. cropland used for crops declined by 23 million acres, or 6 percent. Over this period, cropland used for crops in the Corn Belt, Northern Plains, Pacific Northwest, and Mountain and Pacific regions increased by about 18 million acres (9 percent) while decreasing by 41 million acres (25 percent) in all other regions.[4] Thus, even as aggregate land-use patterns remained relatively stable, a larger land area shifted in and out of crop production, changing the particular lands cultivated across the country.

[1]Of course, there are exceptions. For example, some grazing is intensively managed through rotational grazing or other systems to increase forage output. Also, uncultivated cropland includes land devoted to horticultural crops which are often managed very intensively.

[2]The USDA/ERS Major Land Uses data are available at: www.ers.usda.gov/data/majorlanduses/. State-level data on total cropland (defined as the sum of cropland used for crops, cropland used for pasture, and cropland idled) are available at roughly 5-year intervals from 1945 to 2002.

[3]This rapid decline in cropland for crops coincided with an equally dramatic upswing in cropland acreage idled, most likely resulting from large annual acreage set-asides and the CRP, both initiated in the 1985 Food Security Act (the Omnibus Farm Bill) (Lubowski et al., 2006).

[4]Major Land Uses data are aggregated to the USDA Farm Production Regions (see fig. B-1 in Appendix B). ERS constructed a set of Farm Resource Regions (USDA/ERS, 2000) to be used, when possible, in place of the Farm Production Regions. Farm Resource Regions (used in the remainder of this report) require county-level data, which are not available for most land classes in the State-based Major Land Uses series.

## Land-Use Changes at the Extensive Margin of Cropland, 1982-97

Land-use dynamics can be more fully characterized using a land-use change matrix (table 2.1). The matrix is based on data and definitions from USDA's National Resources Inventory (NRI), which provides data on land use and land conditions at about 900,000 "points" of non-Federal land in the contiguous 48 States surveyed at 5-year intervals between 1982 and 1997 (see appendix A). Because this survey includes the same points of land over time, it can provide estimates of **gross** land-use change, as well as **net** changes. Because the land-use definitions in NRI do not match those used in the USDA/ERS Major Land Uses data series and because the NRI excludes Federal lands, results derived from the two data sources are not directly comparable, although they are complementary and lead to similar conclusions about net land-use trends (Lubowski et al., 2006).

Because the great majority of land tends to remain in the same use over any 5-year period, we examine changes over 15 years, the longest period for which the NRI data are available, so as to observe the largest possible amount of cropland transitions. The land-use change matrix in table 2.1 provides an estimate of every possible land-use change, given the land-use categories defined in the table. For example, the cell in the upper left corner represents land that was cultivated cropland in both 1982 and 1997. The next cell to the right represents land that was cultivated cropland in 1982 but was uncultivated cropland in 1997. These land-use changes do not account for changes that may have taken place during the years between 1982 and 1997. For example, some land may have moved from cropland to pasture and back to cropland again.

Table 2.1
**Changes in land use between 1982 and 1997 (per 1,000 acres)**

| 1982 land use | 1997 land use | | | | | 1982 Total |
|---|---|---|---|---|---|---|
| | Cultivated cropland | Uncultivated cropland | CRP | Grazing, forest, and other rural land | Developed land, Federal land, and water | |
| Cultivated cropland | 297,124<br>78.9% | 18,352<br>4.9% | 29,366<br>7.8% | 24,741<br>6.6% | 6,867<br>1.8% | 376,450<br>100% |
| Uncultivated cropland | **11,685**<br>**26.3%** | 23,104<br>51.9% | 1,046<br>2.4% | 6,955<br>15.6% | 1,715<br>3.9% | 44,505<br>100% |
| Grazing, forest, and other rural land | **17,278**<br>**1.7%** | 8,462<br>0.80% | 2,280<br>0.20% | 948,322<br>94.7% | 25,389<br>2.5% | 1,001,731<br>100% |
| Developed, Federal, and water | 697<br>0.1% | 296<br>0% | 4<br>0% | 4,048<br>0.8% | 516,399<br>99% | 521,444<br>100% |
| 1997 Total | 326,784<br>16.8% | 50,214<br>2.6% | 32,696<br>1.7% | 984,066<br>50.6% | 550,370<br>28.3% | 1,944,130<br>100% |

Note: Rows represent 1982 land uses while columns represent 1997 land uses. The sum of an entire row is total land in a particular land use 1982. Likewise, the sum of each column is total land in a particular land-use in 1997. Percentages are of 1982 totals. Read right or left across a row to see how land in a particular land use in 1982 was later used in 1997. Read the table up and down a column to see how land in a particular land use in 1997 was previously used in 1982. The cells shaded in green and orange constitute the changes in extensive margin of both cultivated and uncultivated cropland as defined in this report. The numbers in bold are changes at the extensive margin of just cultivated cropland. The orange colored cells indicate land-use changes generally representing increases in land-use intensity, while green cells show changes that generally decrease land-use intensity (see fig. 2.1 for a schematic representation of these relationships).

Source: 1997 National Resources Inventory).

Changes at the extensive margin of cultivated and uncultivated cropland (the shaded cells in table 2.1) are much larger than would be suggested by net changes in cropland area. The amount of land-use change at the extensive margin of cultivated crop production is the total land area moving between cultivated cropland and less intensive land uses (uncultivated cropland, CRP, and grazing, forest, and other rural uses).[5] Changes at the extensive margin of cultivated cropland involved over 100 million acres between 1982 and 1997—or more than one-fourth of cultivated cropland area (376 million acres) in 1982.[6] This gross change in cultivated cropland compares with a net decline in cultivated cropland of less than 50 million acres (13 percent). Given that CRP has gradually enrolled lands since 1985 and requires land retirement under 10- to 15-year contracts, a small proportion of the land enrolled in the program shifted out of CRP as of 1997.[7] Shifts of cultivated cropland into and out of land uses other than CRP involved more than 72 million acres, or 3.6 times the **net** shift of 20 million acres from cultivated cropland to these non-CRP uses.

The difference between gross land-use flows and net changes in land area is greater with respect to changes in uncultivated cropland. While uncultivated cropland increased on net by 6 million acres (13 percent) between 1982 and 1997, more than 46 million acres shifted to and from uncultivated cropland and another agricultural or forest use—an area larger than the entire 44.5 million acres of uncultivated cropland in 1982 (table 2.1).

*The net movement of land among agricultural and forest uses from 1982 to 1997 decreased the intensity of land use*

From 1982 to 1997, there was a net change of 60 million acres from either cultivated or uncultivated cropland to our less intensive land-use categories (CRP and grazing, forest, and other rural uses). While 26 million acres shifted to cultivated or uncultivated cropland from a less intensive use between 1982 and 1997, and another 12 million shifted from uncultivated to cultivated cropland, shifts toward the less intensive land uses accounted for about 80 million acres (fig. 2.1).[8] About 90 percent of this total is movements of cultivated cropland into uncultivated cropland, CRP, and grazing, forest, and other rural uses.

*Reductions in the intensity of land use included net shifts from cultivated crops to uncultivated crops, CRP, pasture, and forest land uses*

CRP enrollment of roughly 30 million acres accounted for most of the 8-percent decline in cultivated cropland from 1982 to 1997. A net of 6.7 million acres (1.8 percent) shifted from cultivated to uncultivated cropland: 18.4 million acres were shifted from uncultivated to cultivated cropland while 11.7 million acres went the other way (fig. 2.1). There was also a large shift of pasture to cultivated cropland (9.4 million acres), with 14.7 million acres shifting the other way. More than 5.4 million acres (1.4 percent) of cultivated cropland in 1982 were converted to urban use by 1997. Changes to urban development are essentially one-way, with a negligible amount of land converting from urban use back to other land uses, including cultivated cropland.[9]

[5]Cultivated cropland includes land identified as being in row or close crops, summer fallow, aquaculture in crop rotation or other cropland not planted. Cultivated cropland includes cropland in short-term set-aside programs; double-cropped horticulture; and land in either hay or pasture which had at least one of the three previous years in row or close-grown crops. The NRI definition of uncultivated crops includes land in hay with no rotation and single-cropped horticulture. While lands used for single-cropped horticultural uses are often intensively managed, NRI definitions are used in this report as the land area in these uses is relatively minor, accounting for 15 percent (13 percent) of uncultivated cropland and 1.6 percent (1.7 percent) of total cropland in 1982 (1997).

[6]Specifically, from 1982 to 1997, the amounts of cultivated cropland converting to (from) uncultivated crops, CRP, and grazing, forest and other rural uses were 18.3 (11.7), 29.4 (0), and 24.7 (17.3) million acres, respectively. These land areas total 101.4 million acres, about 27 percent of the 376.4 million acres of cultivated cropland in 1982.

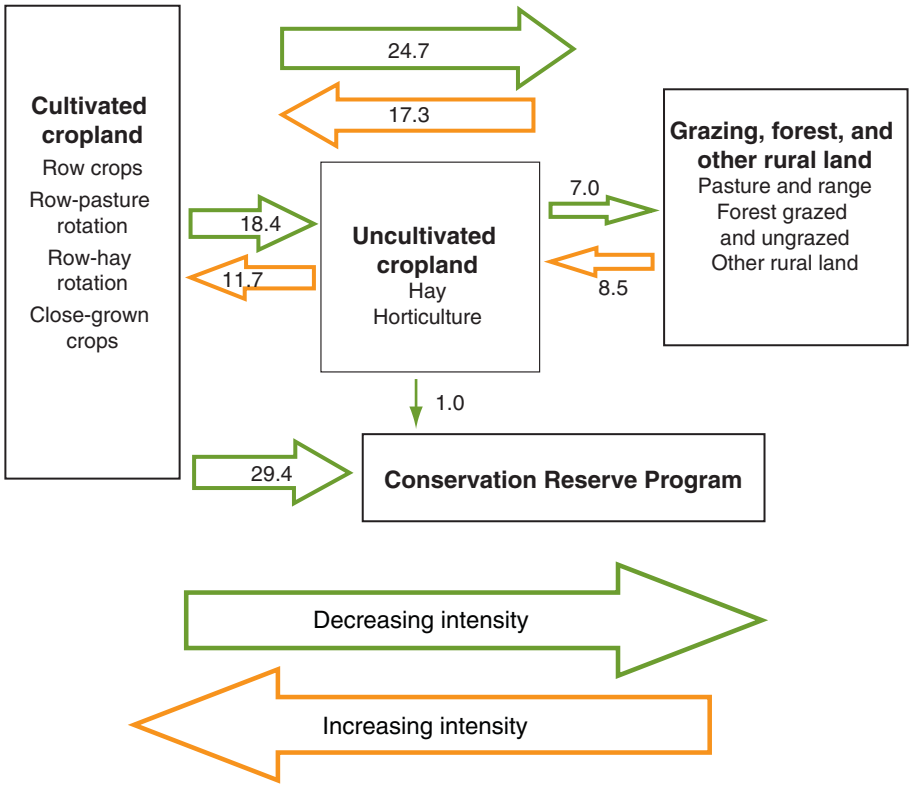
[7]Approximately 11 percent of the 34 million acres enrolled in CRP as of 1992 dropped out of the program in 1997, the year the first contracts began to expire. Approximately, 63 percent of the acres that dropped out returned to cultivated or uncultivated crop production in 1997 (Sullivan et al., 2004).

[8]While ground cover in CRP and uncultivated cropland may often be similar, we consider CRP as a less intensive use than uncultivated cropland given contractual restrictions on grazing and haying on CRP lands. Shifts from uncultivated cropland to CRP were only 1 percent of changes between cultivated or uncultivated cropland and the "less intensive" land-use categories.

[9]Changes to CRP are also one-way from 1982 to 1997 since the program was established in 1985 and requires land owners (or operators) to retire land from crop production under 10- to 15-year contracts. Data from the 1992 and 1997 NRI surveys, when the first CRP contracts began to expire, show land shifting out of CRP and into other land uses (Sullivan et al., 2004).

Figure 2.1

**The extensive margin of cropland with respect to other agricultural and forest uses, 1982-97 (million acres)**




Note: The green (orange) colored arrows indicate land-use changes constituting a decrease (increase) in the relative intensity of use. The width of the arrows is roughly proportional to the size of land-use movements.

Source: 1997 National Resources Inventory.

Most of the change in uncultivated cropland was movement of land between cultivated and uncultivated cropland (fig. 2.2). Movement between uncultivated cropland and grazing, forest, or other rural uses was also significant, with over 16 million acres shifting one way or the other. Total land movement into and out of uncultivated cropland (16.5 million acres) by 1997 was about 37 percent of all uncultivated cropland in 1982 (44.5 million acres).

While cultivated crop area declined by 50 million acres from 1982 to 1997, uncultivated cropland increased by 5.7 million acres (12.8 percent), chiefly due to the net shifts of 6.7 million acres from cultivated crops (fig. 2.3). Pasture and range also contributed acreage. On the other hand, uncultivated cropland lost almost 1.5 million acres (3.3 percent) to urban development, 1 million acres to CRP, and about 450,000 acres to forest uses.

*Land-use changes between 1982 and 1997 mask some changes occurring within that time period*

Because our data discussed to now are based on a snapshot at two points in time, they do not reveal shifts in land-use intensity during an interim period between 1982 and 1997. While we lack information on all land-use changes

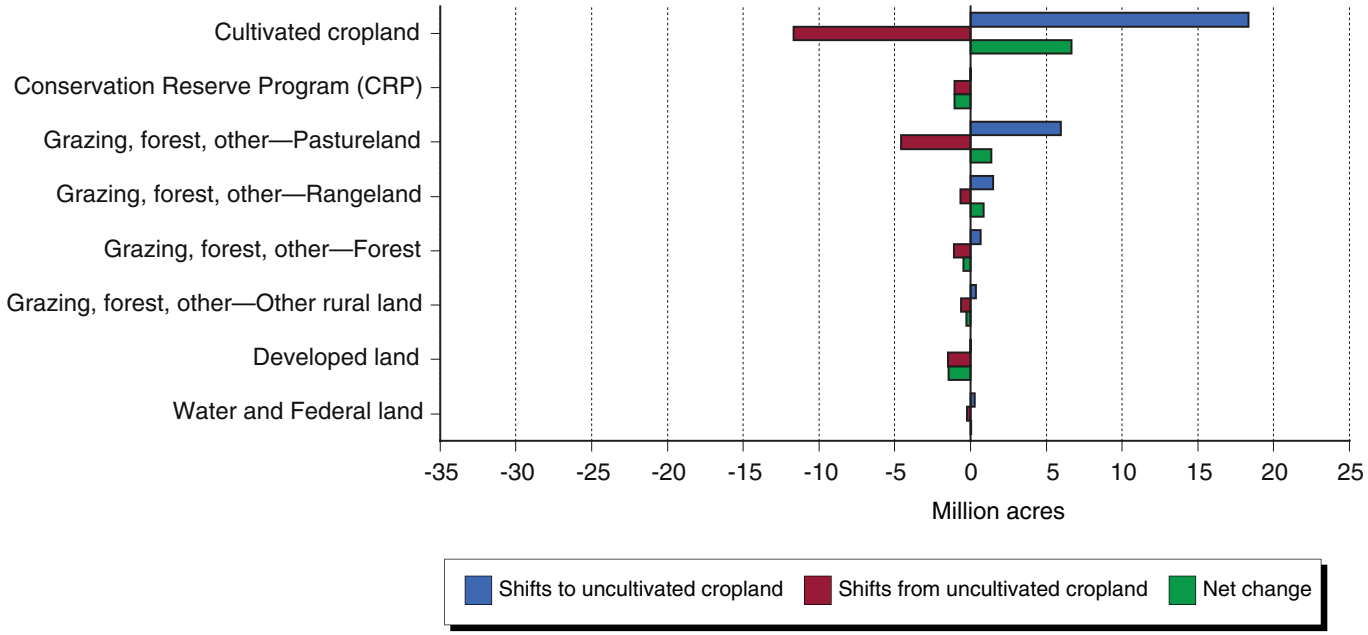
Figure 2.2

**Shifts to and from cultivated cropland, 1982–97**

Source: 1997 National Resources Inventory.

Figure 2.3

**Shifts to and from uncultivated cropland, 1982–97**




Source: 1997 National Resources Inventory.

that occurred between 1982 and 1997, we can identify some additional changes that took place based on data from the 1987 and 1992 NRI surveys. For example, a land parcel may have been cultivated in both 1982 and 1997, but used for pasture in 1987 and/or 1992.

Of the 297 million acres that were in cultivated cropland in both 1982 and 1997, 13.9 million acres (4.6 percent) were in a less intensive use in either 1987, 1992, or both years. Of this total, about 10 million acres (72 percent) shifted to uncultivated crops, 2.2 million acres (16 percent) to pasture or range, and 1.6 million acres (12 percent) to CRP. Another 12.1 million acres shifted into cultivated crops from a less intensive land use and then shifted back out of cultivation over 1982-97. In total, 26 million acres shifted between cultivated cropland and a less intensive use between 1982 and 1987 and/or 1992 (though not between 1982 and 1997). This is in addition to the 100 million acres of land at the extensive margin of cultivated cropland captured by the 1982-97 span. Taken all together, this area (127 million acres) is equal to a third of U.S. cultivated cropland in 1982 and about three times the net shift in cultivated cropland to less intensive agricultural and forest uses during 1982-97.[10]

## The Extensive Margin of Cultivated Cropland Is Not Equally Active in All Regions

The location of land-use change depends on the land use involved. Figure 2.4 shows land entering and exiting cultivated crop production from 1982 to 1997. Figure 2.5 shows land shifting from cultivated crops to another use, by land use, while figure 2.6 shows land shifting into cultivated crops. Transitions to and from uncultivated cropland were more common in the North, while transitions between cultivated crops and grazing are more evenly distributed. The margin between cultivated cropland and forest was active only in the Southeast. CRP enrollments were concentrated in the Plains States.

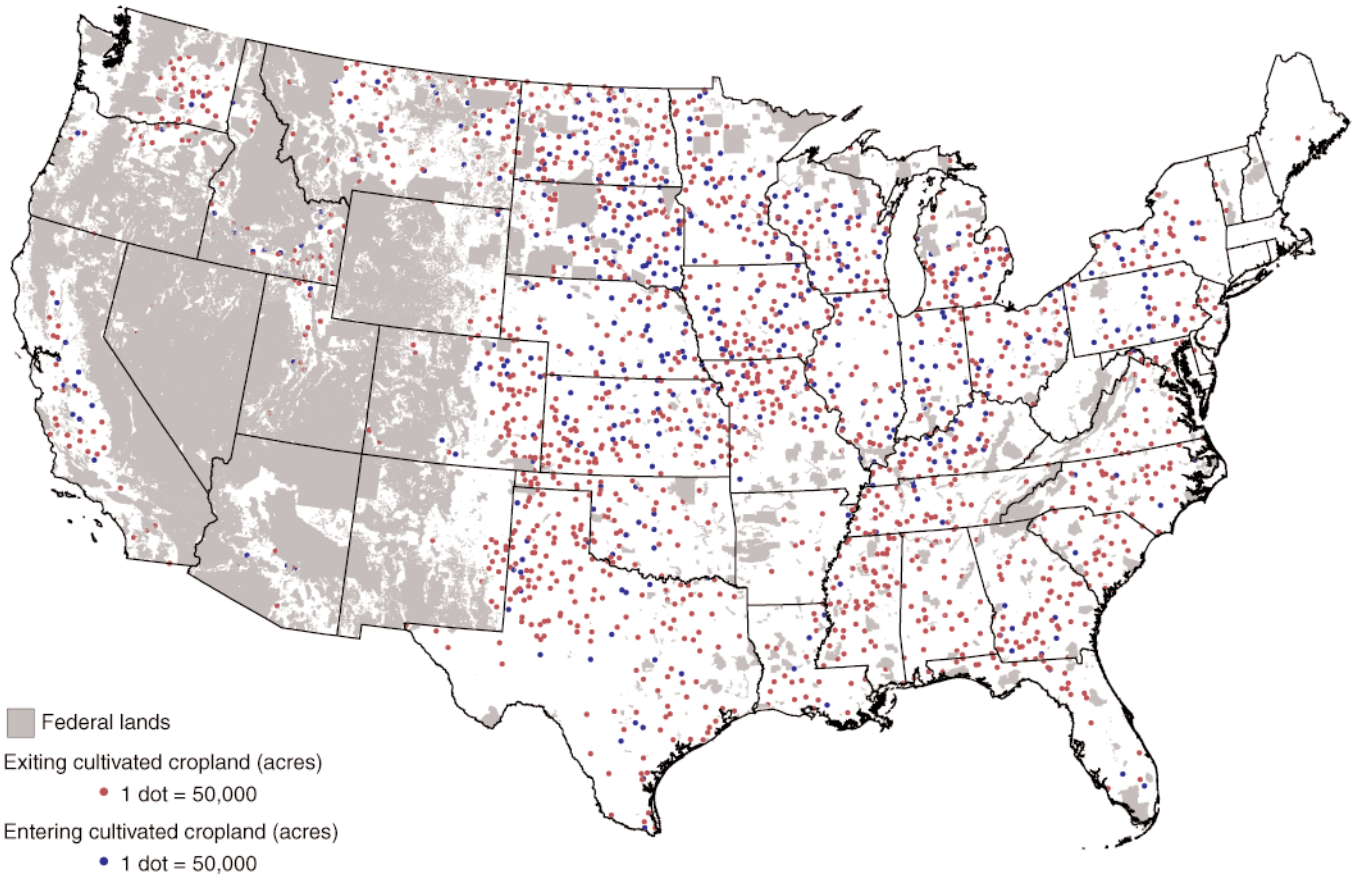
Regions that have more acreage of cultivated cropland also tend to have relatively large movement of land both into and out of cultivated crop production. The Heartland, Northern Great Plains, and Prairie Gateway account for about 70 percent of U.S. cultivated cropland, and have the most land transitioning into and out of cultivated crop production (fig. 2.7). In all three regions, CRP was a major factor in land transitioning out of cultivated cropland (fig. 2.8).

Regions that started with a lot of cultivated cropland in 1982 also tended to have large net reductions in cultivated cropland (fig. 2.7). The reduction in cultivated cropland was particularly large in the Prairie Gateway (10.9 million acres), where CRP enrollment was also high (9.6 million acres). Although the Southern Seaboard started with less cultivated cropland acreage, the net reduction from 1982 to 1997 was large, especially shifts to grazing and forests; 1.4 million acres, or 8 percent, of the cultivated cropland in 1982 shifted to pasture and a similar amount shifted to forests by 1997. In the Northern Crescent, the extensive margin of crop production was active in both directions, despite a relatively small base of cultivated cropland and relatively little CRP enrollment.

[10]There were 5.3 million acres in uncultivated crops in both 1982 and 1997 that moved to a less intensive use in 1987 or 1992 (with 4.6 million and 0.5 million shifting to grazing and CRP). Some 1.8 million acres of land not in uncultivated crops in either 1982 or 1997 shifted to uncultivated cropland from a less intensive use in 1987 or 1992. In total, at least 7.1 million acres changed use at the extensive margin of uncultivated cropland, in addition to the 16.5 million acres million acres described earlier. The total movement of land at the extensive margin of uncultivated crops thus exceeds 23.6 million acres, more than half of the 44.5 million acres of uncultivated crops in 1982.

Figure 2.4

**Land entering and exiting cultivated cropland, 1982-97**




Note: Size of dots is not proportional to actual land area.

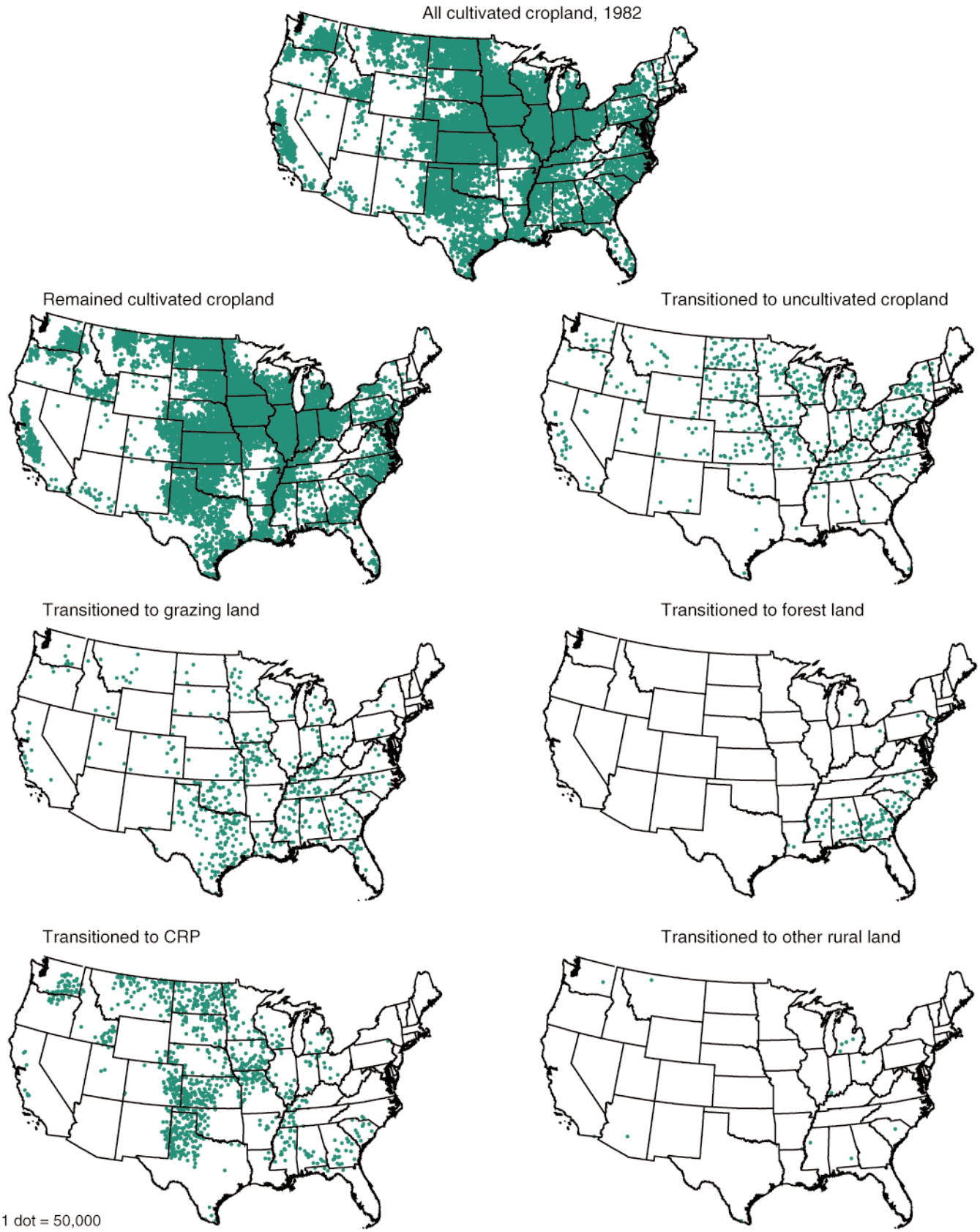
Source: 1997 National Resources Inventory.

The fact that larger declines occurred in regions with more cultivated cropland does not necessarily indicate that crop production is shifting toward regions with less initial cropland acreage. In fact, the four regions with the largest cultivated cropland acreages (Heartland, Prairie Gateway, Northern Great Plains, and Northern Crescent) experienced the smallest percentage reductions in cultivated cropland area (fig. 2.9). On the other end of the scale, the Eastern Uplands region, which has the smallest acreage of cultivated cropland, experienced the smallest net decline in absolute terms but the largest decline in percentage terms. Reduction in cultivated cropland exceeded 20 percent in three regions: the Eastern Uplands, Southern Seaboard, and Basin and Range. A region's tendency to maintain cultivated cropland (at the margin) likely reflects differences in soil quality, the scale of production, government programs, and other factors affecting the relative profitability of growing crops.

So, the extensive margin of crop production is significantly larger than the net change in land used for cultivated crops. Between 1982 and 1997, cultivated cropland declined by 50 million acres, while more than 100 million acres were shifted into or out of cultivated crops. These shifts (either gross or net) are not evenly distributed across regions, with absolute changes larger in regions with the most cultivated cropland and percentage changes greater in regions with relatively little cultivated cropland.

Figure 2.5

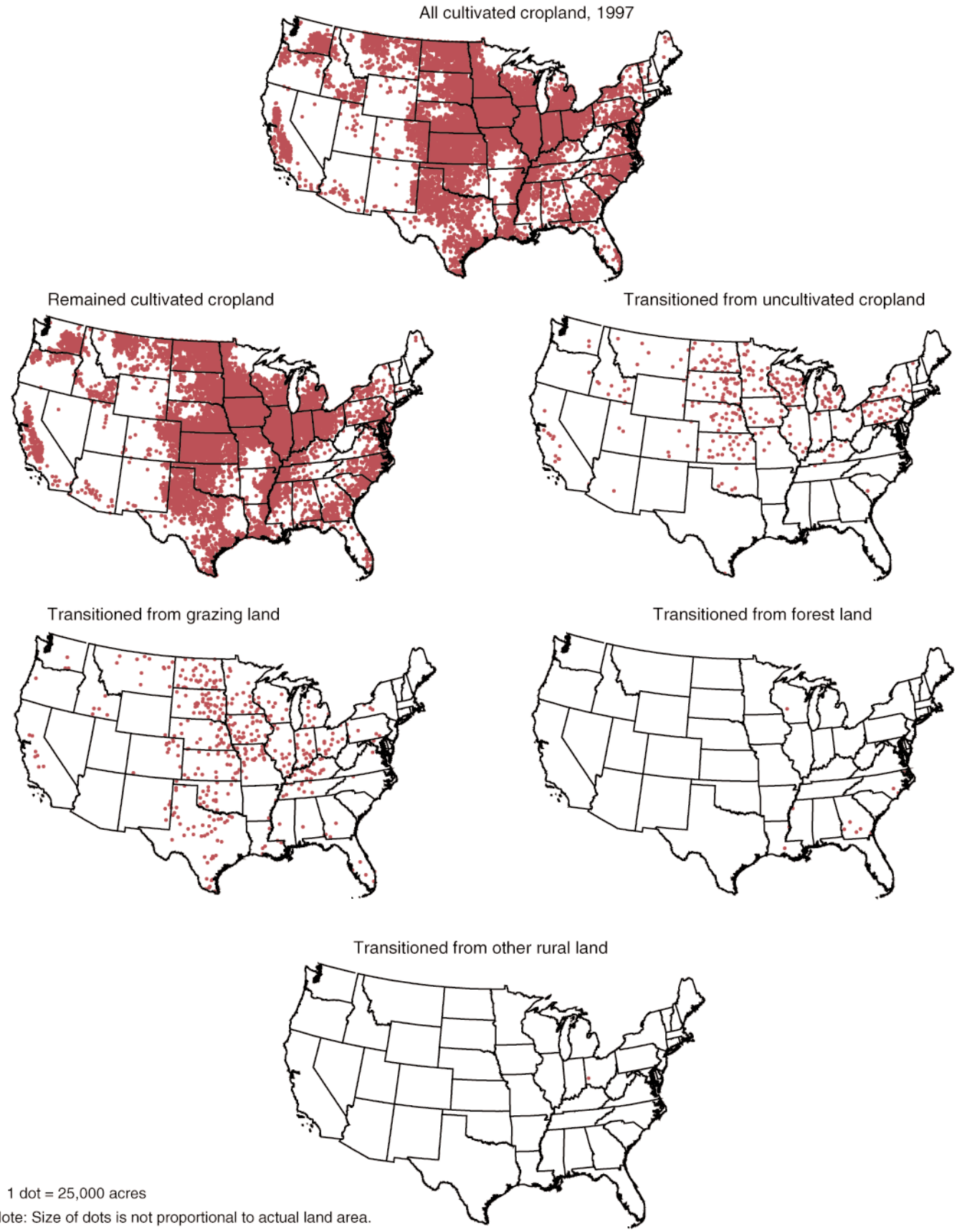
**Location of land exiting cultivated cropland, 1982-97**




Note: Size of dots is not proportional to actual land area.
Source: 1997 National Resources Inventory.

Figure 2.6

**Location of land entering cultivated cropland, 1982-97**



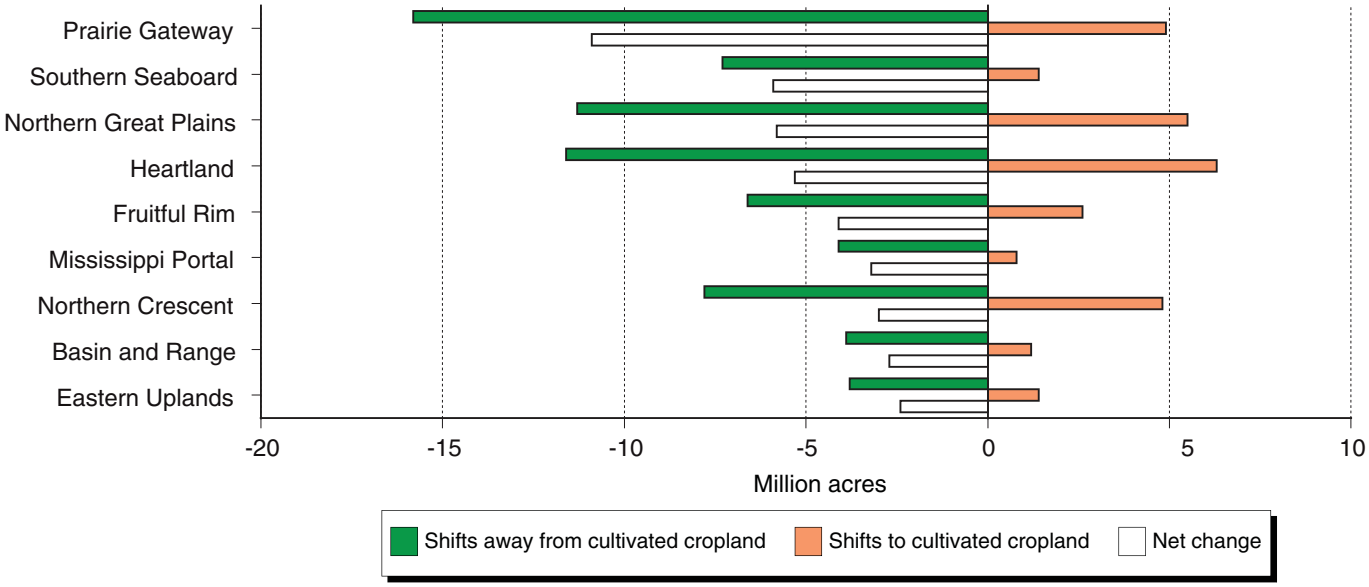

• 1 dot = 25,000 acres

Note: Size of dots is not proportional to actual land area.

Source: 1997 National Resources Inventory.

Figure 2.7

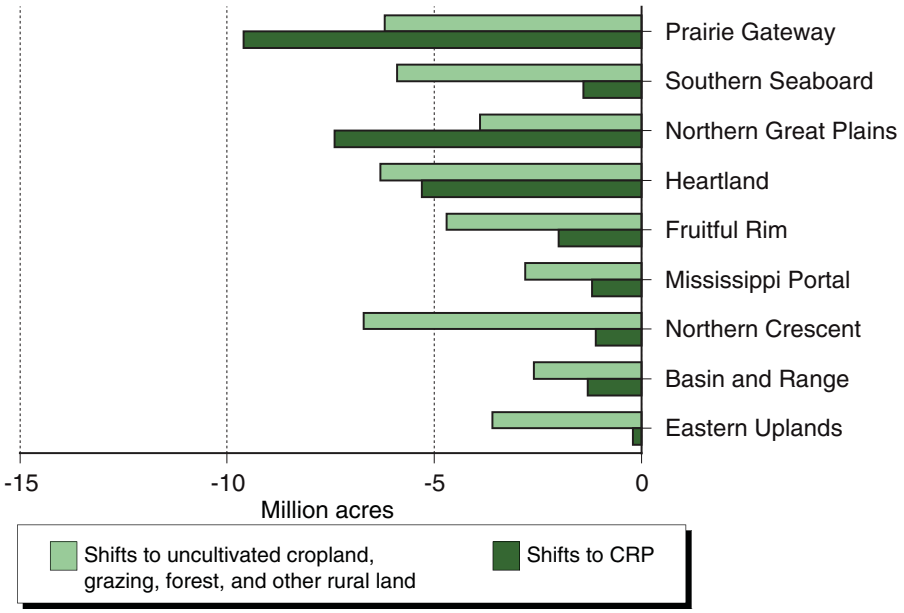
**Shifts to and from cultivated cropland (all land uses), by region, 1982-97**




Source: 1997 National Resources Inventory.

Figure 2.8

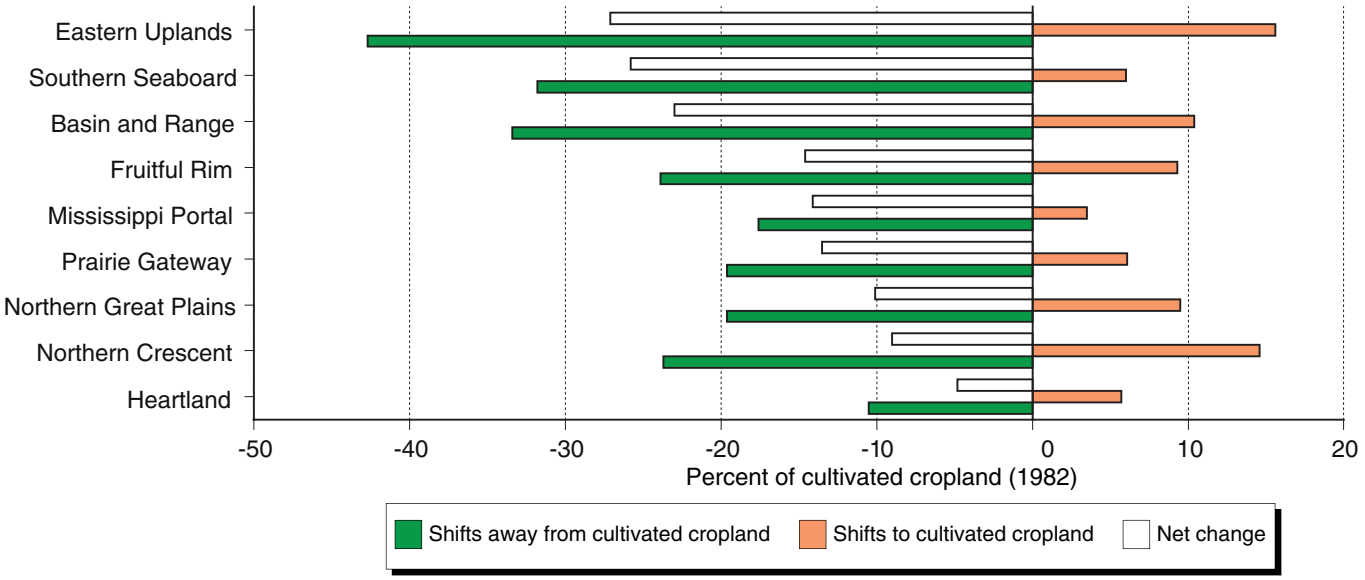
**Shifts from cultivated cropland to CRP and other agricultural and forest uses, by region, 1982-97**




Source: 1997 National Resources Inventory.

Figure 2.9

**Percentage shifts to and from cultivated cropland (all land uses), by region, 1982-97**




Source: 1997 National Resources Inventory.

Even if the amount of land used for crop production is relatively stable, the specific land being used for crops is changing. So, have the economic and environmental characteristics of cultivated cropland been changing even while cropland acreage remains constant? And is cultivated cropland at the extensive margin more or less vulnerable to environmental damage than the land that persists in cultivated crop production?

Finally, agricultural policy may affect the environmental characteristics of cultivated cropland through its impact on the extensive margin of crop production. CRP enrollment is critical, given its role in shifting land from crop production in the three regions with most cultivated cropland. How does CRP land compare environmentally with land converted to cultivated crops? Crop insurance may also have affected the extensive margin of crop production, but its effects are more difficult to quantify.