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SMALL GRAIN ACREAGE AND MANAGEMENT TRENDS FOR EASTERN OREGON AND WASHINGTON

Richard Smiley, Mark Siemens, Tom Gohlke, and Joel Poore

Abstract

Small grain acreage and management trends over the past 20 years were evaluated for counties and regions in eastern Oregon and Washington. Data were obtained from surveys conducted by the Conservation Technology Information Center (CTIC) and National Agricultural Statistics Service (NASS). Small grain acreages of dryland and irrigated winter wheat, spring wheat, and barley are reported as a percent of the total acreage in each region of each state. Also reported are trends for tillage practices, cropping frequency, and timing in terms of percent of total acreage. Winter wheat acreage has remained relatively constant over the last 20 years for most regions and comprised over 60 percent of the nearly 3.5 million acres planted to small grains in eastern Oregon and Washington. Acreage planted to barley has generally declined by 5 percent, with production shifting to spring wheat. Use of intensive tillage has decreased by over 50 percent in most regions, with production shifting to reduced tillage and no-till. No-till acreage for all wheat in Oregon increased from 1 percent in 1996 to 17 percent in 2004 and from 3 percent to 13 percent in Washington. For spring wheat, no-till acreage increased from 2 to 21 percent in Oregon and from 2 to 18 percent in Washington.

Key Words

Management trends, cropping practices, tillage practices, Oregon, Washington, agriculture statistics, small grain, wheat, barley, acreage

Introduction

Agricultural tillage and cropping practices in the inland Pacific Northwest have changed over the past 20 years. It is difficult, however, to find data that summarize the changes. The purpose of this study was to acquire, organize, and present acreage and management trends for selected small grain crops in dryland and irrigated agriculture for the primary regions where these crops are produced in Oregon and Washington.

Methods

Crops of interest for this study were winter wheat, spring wheat, barley, and oats from eastern Oregon and Washington. Acreage and crop management data for these crops from 1985 to 2004 were acquired from USDA-Natural Resource and Conservation Service (NRCS) personnel, using data supplied by NRCS and organized into a national database by the Conservation Technology Information Center (CTIC), West Lafayette, Indiana. County-level data for Oregon and Washington were acquired through cooperation of authors Tom Gohlke (NRCS, Oregon) and Joel Poore (NRCS, Washington).

Fall- and spring-planted small grains are not differentiated by crop species in the CTIC database. The crop species were determined by accessing data by the National Agricultural Statistics Service (NASS) for Oregon (NASS 2005a) and Washington (NASS 2005b). All years available in the databases were used in this summary, but databases differed in numbers of years

included for crop acreage and management data, resulting in data presented in this report covering intervals from 1985 to 2003, from 1990 to 2004, and from 1985 to 1995.

Data of interest included dryland and irrigated acreage planted to winter wheat, spring wheat and barley, crop rotation, and tillage practices. Tillage practices were classified by the NRCS into the following five categories depending on tillage intensity and residue cover.

1. *Intensive tillage* is also called conventional tillage, and is designated as full-width tillage that disturbs the entire soil surface, resulting in less than 15 percent residue cover after planting, or less than 500 lb/acre of small grain residue equivalent throughout the critical wind erosion period. Equipment used to meet this standard often includes tillage tools such as moldboard plows, disks, or chisels.

2. *Reduced tillage* is designated as full-width tillage that disturbs the entire soil surface, resulting in 15 to 30 percent residue cover after planting, or 500 to 1,000 lb/acre of small grain residue equivalent throughout the critical wind erosion period. Equipment used to meet this standard often includes tillage tools such as disks, chisels, or field cultivators.

3. *Mulch tillage* is designated as full-width tillage that disturbs the entire soil surface, resulting in 30 percent or more residue cover after planting, or more than 1,000 lb/acre of small grain residue equivalent throughout the critical wind erosion period. Equipment used to meet this standard often includes tillage tools such as disks, chisels, field cultivators, sweeps, or blades.

4. *No tillage* also includes strip tillage, in which the soil is left undisturbed from harvest to planting, except for strips up to one-third the row width. Other names include direct drilling, slot planting, zero-till, row tillage, and slot tillage. These practices result in 30 percent or more residue cover after planting, or more than 1,000 lb/acre of small grain residue equivalent throughout the critical wind erosion period. Equipment used to meet this standard includes no-till drills equipped with disk openers, hoe openers, or coulters.

5. *Conservation tillage* is the sum of acreage reported for mulch tillage and no tillage.

Unfortunately, the categorization scheme used by the NRCS may not accurately reflect the conservation practices used in the Pacific Northwest. The system limits no-till soil disturbance to no more than one-third the row width, which is difficult to achieve when common hoe-type drills are used to seed cereal crops planted in narrow rows. Because of this, many acres of wheat and barley seeded using no-till practices are categorized as mulch till rather than no-till.

The NASS groups multiple counties within each state into regions and summarizes data for each county and region. Three regions in eastern Oregon and four regions in eastern Washington were of interest in this study (Fig. 1). The NRCS collects data for each county. Consequently, data in this article are presented by region and county. A preferred classification method would be by agro-climatic zones as defined by Douglas et al. (1992) where regions are grouped by similar soil and climatic conditions. However, data were not available for groupings by agro-climatic zones. The NASS regions roughly define agro-climatic zones but in most regions and several large counties there are two or more different zones where typical cropping practices also differ. This information should be taken into account when analyzing the data presented. Data used for this study were for planted acres rather than harvested acres. Using data for

2000, the regions reported in this paper represented 96 and 98 percent of all wheat, and 98 and 99 percent of all barley planted in Oregon and Washington, respectively (Table 1). Total acreage and percentages of wheat and barley acres planted in the principal counties and regions are shown in Table 1.

The following discussion is organized by region in each state to allow readers to focus on the regions of interest. The discussion is also organized for irrigated and dryland crops reported and by the NASS and CTIC databanks utilized. Some discrepancies were noted between these databanks, likely due to the different process by which data were collected by each agency. The NASS databank was based on surveys of agricultural practices in each county. The CTIC databank was based on self-reporting by growers to their local USDA-NRCS office. Small discrepancies are expected when different methods are used to collect data of this type.

Results and Discussion

Oregon

***Northcentral region*:** There were 498,000 acres of wheat and 60,600 acres of barley planted in the region during 2000, representing 53 percent of wheat and 40 percent of barley acreage in Oregon (Table 1).

*Dryland acreage (NASS data)***:** Winter wheat dominated the small grains acreage, increasing from 70 percent in 1985 to 85 percent in 1995 (Fig. 2). For winter wheat, the rotation with summer fallow was by far the dominant production system, consisting of about 90 percent of acreage, and slightly increasing in proportion over the period 1985 to 1995 (Fig. 3). The 10 percent of winter wheat acreage planted in an annual crop sequence slightly decreased over that decade (Fig. 3). A 10 percent increase in the acreage of plantings to spring wheat occurred during that time interval (data not shown). Also, the proportion of barley following fallow decreased, from 20 percent to about 5 percent, and barley in annual cropping decreased, from 5 to 2 percent. Patterns and proportions were essentially identical for Gilliam, Morrow, Sherman, and Wasco counties.

Residue management (CTIC data): During 1990 to 2004, the proportion of acreage planted to spring grains increased by 10 percent and the proportion planted to winter cereals declined by 10 percent (Fig. 4). The shift was more pronounced in Gilliam and Morrow counties than in Sherman and Wasco counties. For spring-planted small grains, the proportion of intensive tillage declined from 40 to 10 percent over the 14-year time interval, with a 10 percent increase in reduced tillage, an increase in no-till from 0 to 30 percent, and a 10 percent reduction in mulch tillage (Fig. 5). There was a 30 percent increase in no-till between 1996 and 2004, and a 10 percent reduction in mulch tillage. For spring grains, the increase in no-till after 1996 appeared to represent a shift directly from intensive tillage. Before 1996, intensive tillage declined but no-till was still virtually absent. There was no increase in percentages of spring grains planted annually over the 1985 to 1995 time interval (Fig. 6). For fall-planted small grains, proportions of intensive tillage and mulch tillage declined slightly, with a concomitant increase in reduced tillage and no-till (Fig. 5). An increase from 0 to 20 percent in no-till occurred between 1996 and 2004, with a corresponding reduction in mulch tillage, indicating that production shifted from mulch tillage to no-till (Fig. 5). Region-wide, during 2004, no-till represented 30 percent of spring-planted small grain

acreage and 20 percent of fall-planted small grain acreage (Fig. 5). About 90 percent of both spring- and fall-planted small grains are now planted under mulch-till or no-till systems in Wasco and Gilliam counties.

Irrigated acreage (NASS data): Irrigated small grains acreage decreased from 9 percent in 1985 to 4 percent in 2003 (Fig. 7). The proportion of spring wheat and barley were consistently less than 2 percent of the total acreage for irrigated plus dryland acreage (Fig. 8). The proportion of irrigated winter wheat ranged from 6 to 7 percent of total small grains production from 1986 to 1996 but declined to 3 percent after the year 2000 (Fig. 8).

***Northeast region*:** There were 346,200 acres of wheat and 33,700 acres of barley planted in the region during 2000, representing 37 percent of wheat and 23 percent of barley acreage in Oregon (Table 1).

Dryland acreage (NASS data): Winter wheat dominated the small grains acreage, with 55 percent in 1985 and 75 percent in 1995 (Fig. 2). For winter wheat, the rotation with summer fallow was by far the dominant production system, consisting of about 60 percent of acreage over the decade (Fig. 3). The proportion of winter wheat in rotation with summer fallow decreased steadily, from 80 to 60 percent. Winter wheat planted in an annual crop sequence increased significantly over that time interval, increasing from 20 percent in 1985 to 35 percent in 1995 (Fig. 3). The increase in winter wheat matched a decrease in barley acreage. There was no increase in the acreage of plantings to spring wheat during that time interval, either in annual cropping or following fallow (data not shown). Spring wheat was planted on about 5 percent of the acreage during the decade. Acreage in barley decreased, from 20 percent to less than 5 percent following fallow, and from 10 percent to 5 percent in annual cropping (data not shown). Patterns for cropping practices in the northeast region were dominated by production in Umatilla County, which had 83 percent of the planted acres (Table 1).

In Union County, winter wheat increased from 20 to 40 percent following summer fallow, and remained relatively static at 35 percent for winter wheat in annual cropping (data not shown). Less than 10 percent of small grain acreage was planted to spring wheat or barley following fallow. More barley and spring wheat in Union County was planted in annual crop sequences than after summer fallow, owing mostly to a high proportion of irrigated fields and crop rotation practices in Union County. Barley in annual cropping sequences decreased in acreage from about 15 to 5 percent during the decade.

Barley was planted on more acreage in Wallowa County than in other counties in the northeast region (data not shown). In Wallowa County, barley acreage in annual cropping sequences decreased from 50 to 30 percent of total from 1985 to 1995. In contrast, winter wheat in rotation with summer fallow increased from 15 to 30 percent over the same decade. The proportion of spring wheat in annual cropping sequences increased over the decade, and reached a peak of 15 percent of the acreage at the end of the reporting period.

Residue management (CTIC data): During 1990 to 2004, the proportion of acreage planted to spring grains increased by 10 percent of total and the proportion of winter cereals declined by 10 percent (Fig. 4). The shift was more pronounced in Umatilla and Wallowa counties than in Union County. For spring-planted small grains, the proportion of intensive tillage declined from 65 to 20 percent over the 14-year time

interval, with significant increases in both reduced tillage and no-till systems (Fig. 5). Within the conservation tillage statistics for spring-planted small grains, there were increases of 10 percent in total acreage in both no-till and mulch tillage between 1994 and 2004. For spring grains, the increase in no-till appeared to mostly represent a shift directly from intensive tillage. Percentages of spring grains planted in annual crop sequences declined over the 1985 to 1995 time interval (Fig. 6). For fall-planted small grains, proportions of intensive tillage increased 10 percent while conservation tillage remained nearly steady, and reduced tillage declined from 40 to 20 percent (Fig. 5). Within the conservation tillage statistics for fall-planted small grains, there was an increase in no-till from 0 to 10 percent of total acreage between 1996 and 2004, and a corresponding reduction in mulch tillage. Region-wide, during 2004, no-till represented 15 percent of spring-planted small grain acreage and 10 percent of fall-planted small grain acreage (Fig. 5). These trends were reasonably similar for each of the counties in the northeast region.

*Irrigated acreage (NASS data)***:** Irrigated small grains in Oregon decreased from 20 percent of all small grains acreage in 1985 to 17 percent in 2003 (Fig. 7). The proportion of spring wheat and barley were consistently less than about 5 percent of the total acreage for irrigated plus non-irrigated acreage (Fig. 8). The trend was for a steady increase in spring wheat, reaching a peak of 5 percent in the early 2000's, and for a steady decrease in barley, reaching a minimum of less than 2 percent in the early 2000's (Fig. 8). The proportion of irrigated winter wheat reached a peak of about 15 percent of total small grains production in 1990, to a minimum of about 10 percent in the early 2000's (Fig. 8).

***Southeast region*:** There were 57,500 acres of wheat and 52,400 acres of barley planted in the region during 2000, representing 6 percent of wheat and 35 percent of barley acreage in Oregon (Table 1).

*Dryland acreage (NASS data)***:** Less than 20 percent of the southeast Oregon acreage was planted to non-irrigated small grains (Fig. 2). Winter wheat planted into annual crop sequences was highly variable, with up to 30 percent of the dryland acreage at the beginning and end of the 1985 to 1995 period, but with a low of less than 5 percent in about 1990 (Fig. 6). Plantings of dryland winter wheat, spring wheat, and barley were almost always higher in annual crop sequences than following summer fallow. Winter wheat and barley in annual cropping sequences shared the dominance of dryland plantings (data not shown). From 1985 to 1995 there was a decreasing amount of dryland winter wheat and a comparable increase of acreage planted to barley. Percentages of spring grains planted in annual crop sequences were highly variable during 1985 to 1995 (Fig. 6), but were generally dominated by spring barley.

*Residue management (CTIC data)***:** During 1990 to 2000, the proportion of acreage planted to spring cereals increased by 20 percent and the proportion of winter grains decreased by a comparable amount, but then returned to 1990 levels in 2004 (Fig. 4). For spring-planted small grains, the proportion of intensive tillage and reduced tillage were highly variable over the 14-year time interval, and almost no acreage was planted under mulch tillage or no-till (Fig. 5). For fall-planted small grains, proportions of intensive tillage increased from 40 to 90 percent at the expense of both mulch tillage and reduced tillage (Fig. 5). No-till is essentially absent for spring- and fall-planted small grains in the southeast region

(Fig. 5), possibly because more irrigated small grains acreage was managed in mixtures with livestock and forage enterprises in this region, compared to the north central and northeast regions.

*Irrigated acreage (NASS data)***:** Irrigated small grains were always more than 80 percent of all small grains planted in the southeast region (Fig. 7). Irrigated crops increased from 80 to 95 percent from 1985 to 1995, remained at 95 percent until 2001, suddenly decreased to 80 percent in 2003, and then returned to 88 percent in 2004. Barley was planted in higher proportions than winter wheat from 1985 to 2000 (Fig. 8). After 2000, the proportion of barley decreased markedly and winter wheat plantings increased in about the same proportion. About 15 to 20 percent of the acreage was planted to spring wheat from 1985 to 2003 (Fig. 8).

Overall tillage trends for Oregon: Over the last 14 years, and particularly since 1996, no-till planting systems have increased dramatically in Oregon (Fig. 9). For the total wheat industry, no-till acreage went from 1 percent in 1996 to 17 percent (151,400 acres) in 2004, with gradual decreases in proportions of intensive tillage, reduced tillage, and mulch tillage (Fig. 9). No-till plantings increased for both winter wheat and spring wheat (Fig. 10). No-till acreage for winter wheat went from less than 1 percent in 1996 to 16 percent (102,000 acres) in 2004. No-till acreage for spring wheat went from 2 percent in 1994 to 21 percent (43,400 acres) in 2004.

Washington

Central region**:** There were 212,000 acres of wheat and 15,100 acres of barley planted in the region during 2000, representing 8 percent of wheat and 3 percent of barley acreage in Washington (Table 1).

*Dryland acreage (NASS data)***:** Winter wheat dominated the small grains acreage, increasing from 55 percent in 1985 to 65 percent in 1995, and then declining to 50 percent in 2004 (Fig. 2). For winter wheat, the rotation with summer fallow was by far the dominant production system, but it slowly declined from 95 percent of all wheat planted in 1985 to 90 percent in 1995 (Fig. 3). There was only a very slight increase in winter wheat planted in annual crop sequences, representing 5 percent of wheat acreage in 1985 and about 8 percent in 1995. Spring wheat was planted on up to 25 percent of the dryland acreage during 2 years, but was generally less than 10 percent of the acreage of small grain plantings (data not shown). Most spring wheat was planted following summer fallow, with very little planted in an annual crop sequence. The proportion of barley decreased from 15 percent in 1985 to less than 2 percent during 1995, and then remained at that level through 2004 (Fig. 2).

*Residue management (CTIC data)***:** During 1990 to 2004, the proportions of acreage planted to spring- and fall-planted cereals remained nearly constant in central Washington, with about 30 percent to spring cereals and 70 percent planted to winter cereals (Fig. 4). A far different trend occurred in Klickitat County, where fall-planted cereals declined steadily from 75 percent of the small grains crop in 1990 to 35 percent by 2000, and then remained constant through 2004 (data not shown). Also in Klickitat County, spring-planted cereals increased from 25 percent in 1990 to 65 percent in 2000, again stabilizing at that level through 2004. For spring-planted small grains, the proportion of intensive tillage declined from 80 to 40 percent of the total acreage over the 14-year time interval, with an increase from 10 to 40 percent in reduced tillage and an increase from 0 to 15 percent

in no-till (Fig. 11). Within the conservation tillage statistics for spring-planted small grains, there was no acreage planted until 1998, when up to 35 percent of the small grains were planted without tillage for several years; by 2004 the proportion of no-till spring grains declined to 15 percent of the acreage. Percentages of spring grains planted in annual crop sequences increased for wheat and declined for barley between 1985 and 1995, but both were generally under 5 percent (Fig. 6). Region-wide, for fall-planted small grains, proportions of intensive tillage declined from a maximum of 80 percent in 1994 to 30 percent in 2004, with a concomitant increase in reduced tillage (Fig. 11). Mulch tillage was at 15 percent at the beginning of that time interval but had disappeared by 1994 and then remained at less than 5 percent of the fall-planted acreage. Essentially none of the fall-planted cereal acreage in this region was categorized as no-till (Fig. 11).

*Irrigated acreage (NASS data)***:** Irrigated small grains varied from 12 to 25 percent of the total small grains acreage in central Washington from 1985 to 2003 (Fig. 7). There was a dramatic increase from 15 to 25 percent after the year 2000. The proportion of spring wheat and barley steadily declined over the 19-year interval and, during 2003, these crops represented less than 5 percent of the total small grains acreage in the region (Fig. 8). The proportion of irrigated winter wheat accounted for the increase in the proportion of irrigated small grains after 2000. Acreage of irrigated winter wheat increased from 6 percent of the total small grains acreage in 1999 to 20 percent of the acreage in 2003 (Fig. 8).

***East central region*:** There were 1,960,000 acres of wheat and 169,600 acres of barley planted in the region during 2000, representing 48 percent of wheat and 34 percent of barley acreage in Washington (Table 1).

*Dryland acreage (NASS data)***:** Trends were very similar to those in the central region. Winter wheat dominated the small grains acreage, increasing slowly from 60 percent in 1985 to 65 percent in 2004 (Fig. 2). For winter wheat, the rotation with summer fallow was by far the dominant production system, but it declined from 95 percent of all wheat planted in 1985 to 90 percent in 1995 (Fig. 3). There was only a slight increase in winter wheat planted in annual crop sequences: 5 percent of wheat acreage in 1985 and about 8 percent in 1994. Spring wheat was planted on 35 percent of the dryland acreage during 1989 but during other years was always less than 7 percent of the small grain acreage (Fig. 2). The strong but temporary shifts in proportions of winter and spring wheat during several years were caused by low-temperature damage to winter wheat. Spring wheat was planted following summer fallow in about the same proportion as in annual crop sequences (data not shown). The proportion of barley decreased from 25 percent in 1985 to less than 10 percent during 1995 (data not shown). Percentages of spring grains planted in annual crop sequences declined for barley and increased for wheat during 1985 to 1995 but were generally less than 10 percent of total acreage (Fig. 6). All of these trends were dominated by changes in production practices in Adams and Lincoln counties.

*Residue management (CTIC data)***:** During 1990 to 2004, the proportion of acreage planted to winter cereals gradually declined from 82 to 72 percent with concomitant increases in spring grains (Fig. 4). The shift was more pronounced in Lincoln County than in Adams County. For fall-planted small grains, the proportion of intensive tillage decreased from 45 to 10 percent but

was highly cyclic in pattern, with a resurgence of intensive tillage during 2000 and 2002, and then declining again in 2004 (Fig. 11). Reduced tillage was also highly cyclical but generally increasing, as was no-till. No-till acreage was always less than 5 percent of the total for fall-planted grains. For spring-planted small grains, the proportion of intensive tillage declined from 40 to 10 percent over the 14-year time interval, with concomitant increases in mulch till and no-till (Fig. 11). Within the conservation tillage statistics for spring-planted small grains, there was an increase from 0 to 10 percent in no-till and an increase from 20 to 35 percent in mulch tillage between 1990 and 2004. For spring grains, the increase in no-till and mulch tillage appeared to represent a shift directly from intensive tillage, with the acreage planted in reduced tillage remaining relatively constant at 45 percent.

*Irrigated acreage (NASS data)***:** Irrigated small grains in east-central Washington decreased from 20 percent of the acreage in 1985 to 15 percent in 2003 (Fig. 7), due mainly to a decrease in acreage of irrigated winter wheat, from 13 to 9 percent (Fig. 8). The proportion of spring wheat and barley were consistently less than 5 percent of the total small grains acreage, with both declining slightly over the 19-year interval.

Southeast and northeast regions: There were 1,060,000 acres of wheat and 312,000 acres of barley planted in these regions during 2000, representing 42 percent of wheat and 62 percent of barley acreage in Washington (Table 1).

*Dryland acreage (NASS data)***:** Winter wheat dominated the small grains acreage; increasing from 60 percent in 1985 to 70 percent in 1995 and then returning to 60 percent in 2004 (Fig. 2). For winter wheat, the rotation with summer fallow was by far the dominant production system, but it declined slightly from 70 percent of all wheat planted in 1985 to 60 percent in 1995 (Fig. 3). Winter wheat planted in annual crop sequences increased, representing 20 percent of wheat acreage in 1985 and about 35 percent in 1994 (data not shown). The proportion of barley decreased from 40 percent in 1985 to 15 percent during 1995 (Fig. 2). Barley planted into annual crop sequences dominated the barley production, declining from 25 percent in 1985 to 15 percent during 1995 (Fig. 6). The proportion of barley following summer fallow decreased from 15 percent in 1985 to 0 in 1995 (data not shown). Over these two regions, spring wheat was planted on 20 and 35 percent of the non-irrigated acreage during 1989 and 1991, respectively, but during other years was always less than 15 percent of the acreage of small grain plantings (data not shown). The proportion of acreage planted to spring wheat increased steadily in Spokane County, from 2 percent in 1985 to 10 percent in 1995 for spring wheat in annual crop sequences. Less than 5 percent of the acreage was planted to spring wheat after summer fallow in Spokane County. In the five southeast counties, spring wheat was planted following summer fallow (data not shown) in about the same proportion as in annual crop sequences (Fig. 6).

*Residue management (CTIC data)***:** During the 1990 to 2004 time interval the proportion of southeast and northeast Washington acreage planted to winter cereals declined from 82 percent to 68 percent and the proportion of spring grains increased by a comparable amount (Fig. 4). In several counties (Asotin, Columbia and Spokane) the trends were greater from 1990 to 2002, but then there was a reversion back toward a greater proportion of fall-planted

cereals in 2004. Whether this trend back towards fall-planted production continues won't be known until the expanded survey is repeated during 2006. For fall-planted small grains, proportions of intensive tillage decreased from 65 percent to 15 percent with concomitant increases in reduced tillage from 15 percent to 40 percent, mulch tillage from 15 percent to 20 percent, and no-till from 5 percent to 15 percent (Fig. 11). In Spokane County the conversion from intensive tillage to reduced tillage, mulch tillage and no-till was even greater at 65 percent. For spring-planted small grains, the proportions of intensive tillage and reduced tillage were highly cyclic over the 14-year time interval (Fig. 11), a pattern dominated mostly by highly cyclic tillage practices in counties such as Columbia County and Whitman County. Trends were more uniform in Walla Walla County and Spokane County. Region-wide, intensive tillage of spring-planted small grains reached low points of 13 percent in 1992 and 2004, but increased as high as 40 percent during the intervening years. In contrast, in Spokane County, intensive tillage of spring grains decreased from 80 percent in 1990 to 12 percent in 1996, and remained at about 15 percent through 2004. A comparable immediate drop and then stabilization at a low level occurred for intensively tilled spring grains in Walla Walla County. Region-wide, mulch tillage sporadically increased from 12 percent in 1990 to nearly 22 percent in 2004, and no-till increased steadily from 3 percent in 1990 to 20 percent in 2004.

*Irrigated acreage (NASS data)***:** Irrigated small grains were always less than 3 percent of all small grains planted in the southeast and northeast regions (Fig. 7). None of the individual crop species occupied more than 2 percent of the total small grains acreage (Fig. 8).

***Overall tillage trends for Washington*:** Over the past 14 years, intensive tillage has declined dramatically and each of the three conservation tillage systems has increased steadily in Washington (Fig. 9). Reduced tillage and no-till increased more rapidly than mulch tillage. For the total wheat industry, no-till acreage went from 3 percent in 1990 to 13 percent in 2004 (322,100 acres). No-till plantings increased for both winter wheat and spring wheat (Fig. 10). No-till acreage for winter wheat went from 3 percent in 1990 to 11 percent (182,900 acres) in 2004. No-till acreage for spring wheat went from 2 percent in 1990 to 18 percent in 2000, where it remained steady through 2004 (139,200 acres).

***Forces driving evolutions in crops and management*:** Proportions of small grain species and crop management systems have clearly changed over time in Oregon and Washington. Forces driving these changes are complex and presumably due to a number of factors including economics, farm programs, and new technologies. An analysis of these factors in each region is well beyond the intent of this report. Nevertheless, it seems worthwhile to conclude by listing some of the interactive forces that are influencing changes in agricultural systems in these states.

Economics is clearly a principal driving force. For wheat and barley, government programs such as deficiency payments and crop insurance have significant influences on growers' decisions on cropping practices. The Federal Crop Insurance Program, for instance, played a strong role in helping growers convert to no-till during recent drought years. Conservation districts and the USDA-NRCS also became more aggressive in promoting no-till and provided more technical assistance and funding for cost-share through sources such as U.S.

Environmental Protection Agency grants and the EQIP program (USDA-NRCS Environmental Quality Incentives Program, a component of the Federal "Farm Bill" that provides incentive payments for farmers and ranchers to implement conservation practices that promote agricultural production and environmental quality). Additional emphasis was placed on off-farm costs associated with soil erosion from water and wind, including passage of air quality legislation that led to additional monitoring of air quality.

During the past 15 years, farmers also gained better understandings of commercial and public sector research that improved their capabilities for managing weeds, diseases, and insects. Recognition and implementation of the green bridge concept led to immediate yield improvements for spring wheat and barley in annual cropping systems. Strong advances have been made in breeding spring wheat varieties with higher levels of resistance to Hessian fly. Also, great advances have been made in commercially produced no-till drills and fertilizer application technologies, and costs were reduced for some widely used herbicide technologies, particularly associated with no-till systems. New herbicides for controlling grass weeds in crops have also been introduced, reducing the dependence on tillage for weed control. A deepening commitment to more conservation-friendly farming systems was reflected by formation of the Pacific Northwest Direct-Seed Growers Association and by transforming the annual STEEP Conference (USDA-CSREES special PNW-regional grant "Solutions to Environmental and Economic Problems") into the annual Northwest Direct-Seed Cropping Systems Conference.

There are undoubtedly many other economic, sociological, environmental, and biological factors associated with the trends summarized in this paper. It would, for instance, be interesting to understand factors that limit or promote adoption of conservation technologies in various regions. For example, in areas of comparable rainfall (11 to 12 inches) and temperature, the transition from winter wheat rotated with mulch-tilled summer fallow to no-till winter wheat rotated with chemical fallow has seemingly been effective in Wasco County, Oregon, but the same system in adjacent Sherman County appears to have failed due to heavy infestations of Russian thistle, which has forced growers to retain the fallow system with mulch tillage. An analysis of factors associated with contrasting experiences in such counties and regions would be enlightening.

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Table 1. Proportions of all wheat and barley produced in counties and regions[1] of Oregon and Washington during 2000.

State and region	County	Total wheat planted	Proportion of all wheat planted in each:		Proportion of all barley planted in each state
			region	state	
Oregon		*acres*	*%*	*%*	*%*
Northcentral region					
	Gilliam	107,500	22	12	13
	Morrow	206,200	39	21	3
	Sherman	105,900	24	13	17
	Wasco	78,400	14	7	8
	total	498,000	-	53	40
Northeast region					
	Umatilla	285,500	83	31	10
	Union	36,800	11	4	5
	Wallowa	18,400	5	2	6
	total	346,200	-	37	23
Southeast region					
	Crook	3,900	6	<1	<1
	Jefferson	14,100	23	1	1
	Klamath	6,600	12	1	26
	Malheur	31,400	57	4	5
	total	57,500	-	6	35
Oregon State total		965,000		96	98
Washington					
Central region					
	Benton	114,900	55	5	-
	Klickitat	46,500	22	2	2
	Yakima	36,400	18	1	<1
	total	212,000	-	8	3
East Central region					
	Adams	321,200	27	13	2
	Douglas	199,800	17	8	-
	Franklin	110,700	9	4	-
	Grant	196,700	16	8	2
	Lincoln	367,600	31	15	27
	total	1,196,000	-	48	34
Southeast region					
	Columbia	84,400	9	3	4
	Garfield	78,100	8	3	8
	Walla Walla	239,400	26	10	5
	Whitman	498,100	54	20	34
	total	926,000	-	37	52
Northeast region					
	Spokane	125,200	94	5	9
	Stevens	8,300	6	trace	1
	total	134,000	-	5	10
Washington State total		2,475,000		98	99

[1] Listings are for selected regions that collectively represented more than 95 percent of all wheat planted in each state, and for counties that collectively represented more than 90 percent of all wheat planted in each region. Figures for regional and state totals represent actual planting data and may therefore differ slightly from the sums of acreages and percentages shown for the selected counties shown in this table.

Figure 1. Counties and regions in which most small grains are produced in eastern Oregon and Washington.

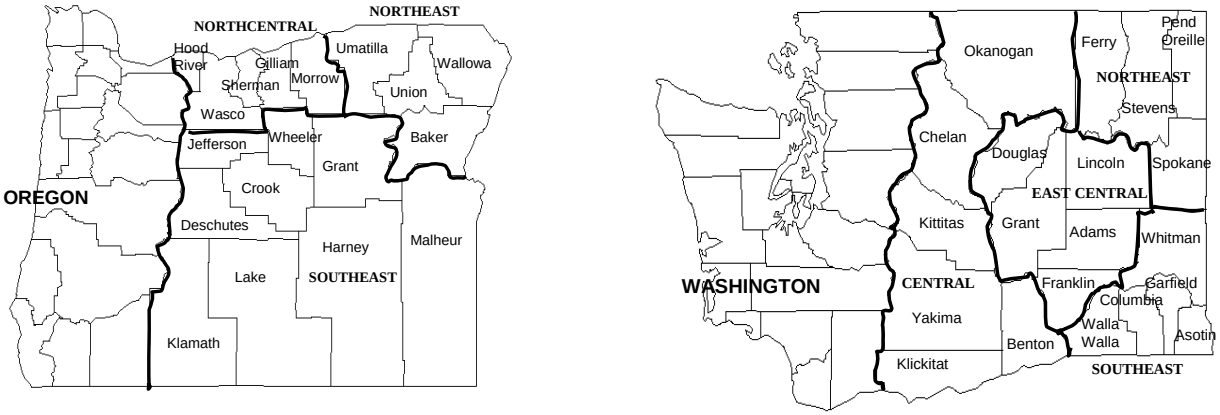


Figure 2. Proportions of dryland winter wheat, spring wheat, or barley planted from 1985 to 2003, expressed as a percentage of the total small grains acreage planted in each region; data are for three regions of eastern Oregon and four regions of eastern Washington.

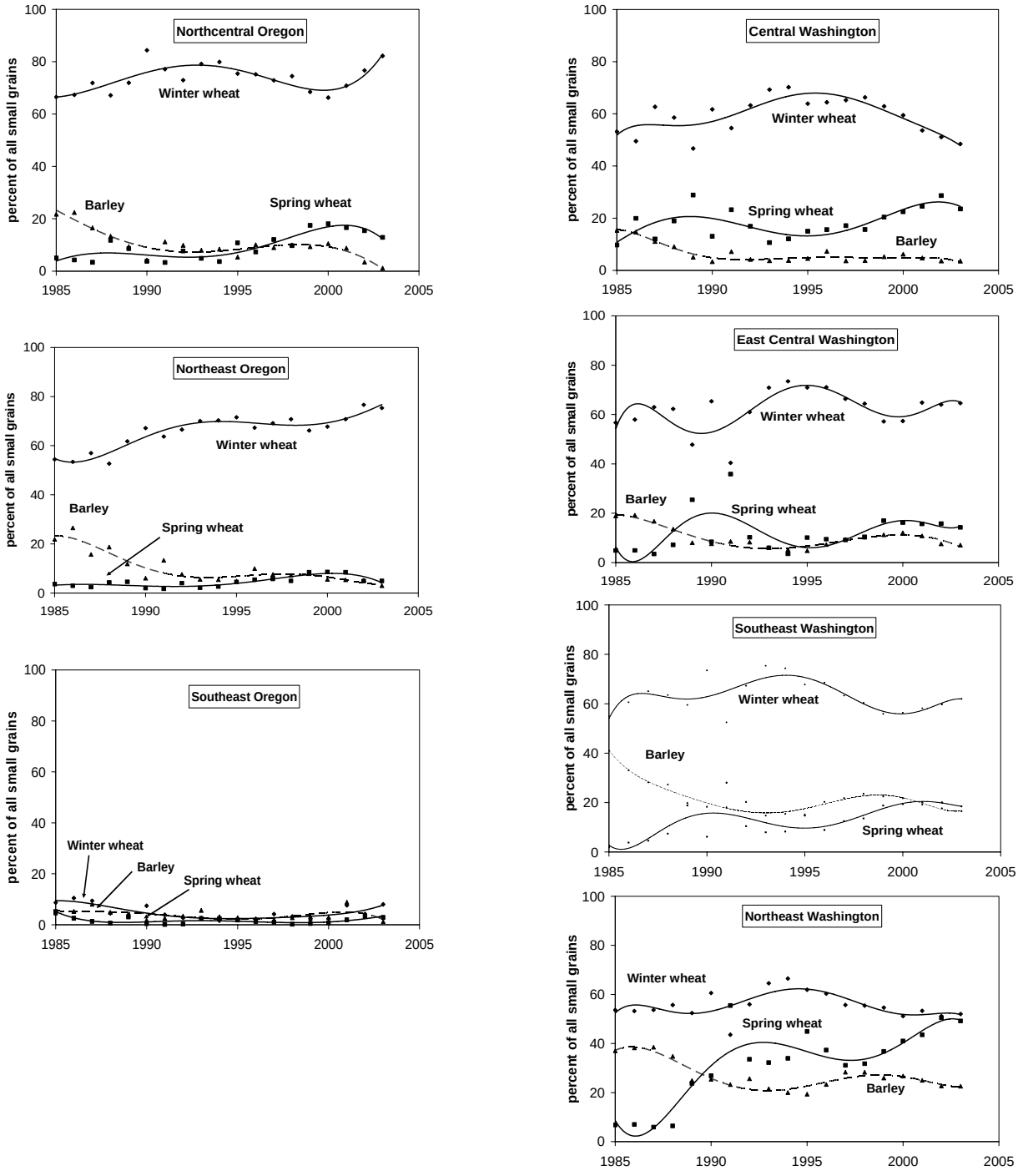


Figure 3. Proportions of dryland winter wheat planted after summer fallow and annual crop sequences in three regions of eastern Oregon and in four regions of eastern Washington; data are presented as a percentage of total winter wheat acreage in each region.

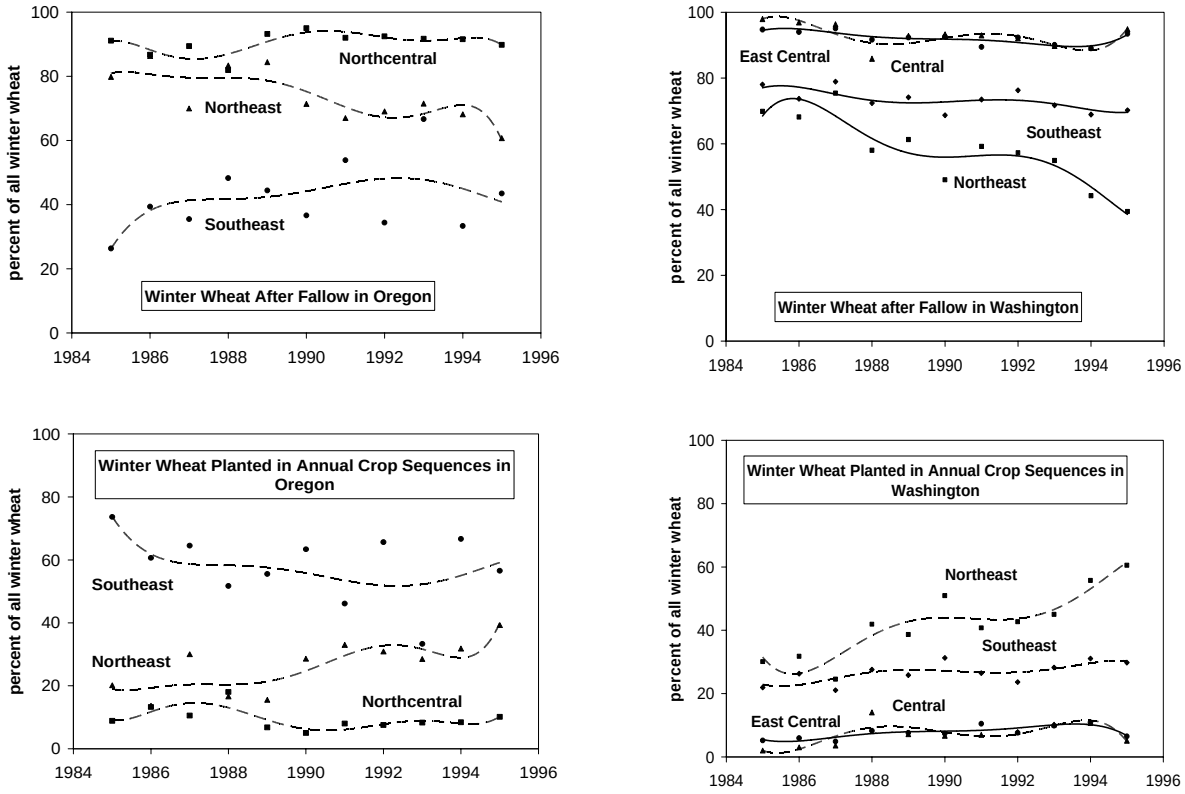


Figure 4. Proportions of all small grains (wheat, barley, and oats) planted during the fall and spring in three regions of eastern Oregon and in three regions of eastern Washington; data are presented as a percentage of the total small grains acreage planted in each region.

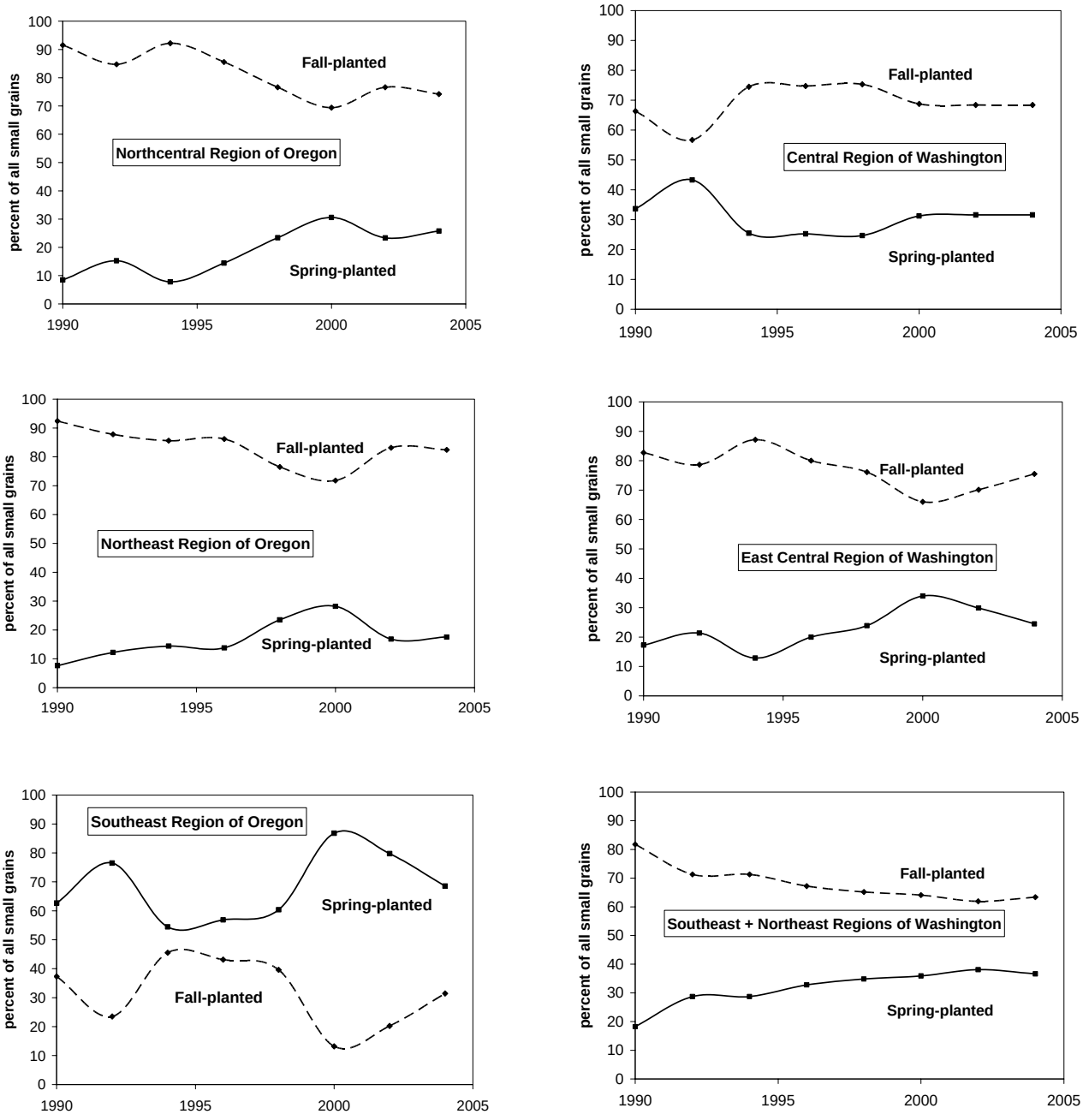


Figure 5. Proportions of spring- and fall-planted small grains managed under four types of tillage practices (intensive, reduced, mulch, no-till) in Oregon; data are presented as a percentage of the total small grains acreage planted in each region.

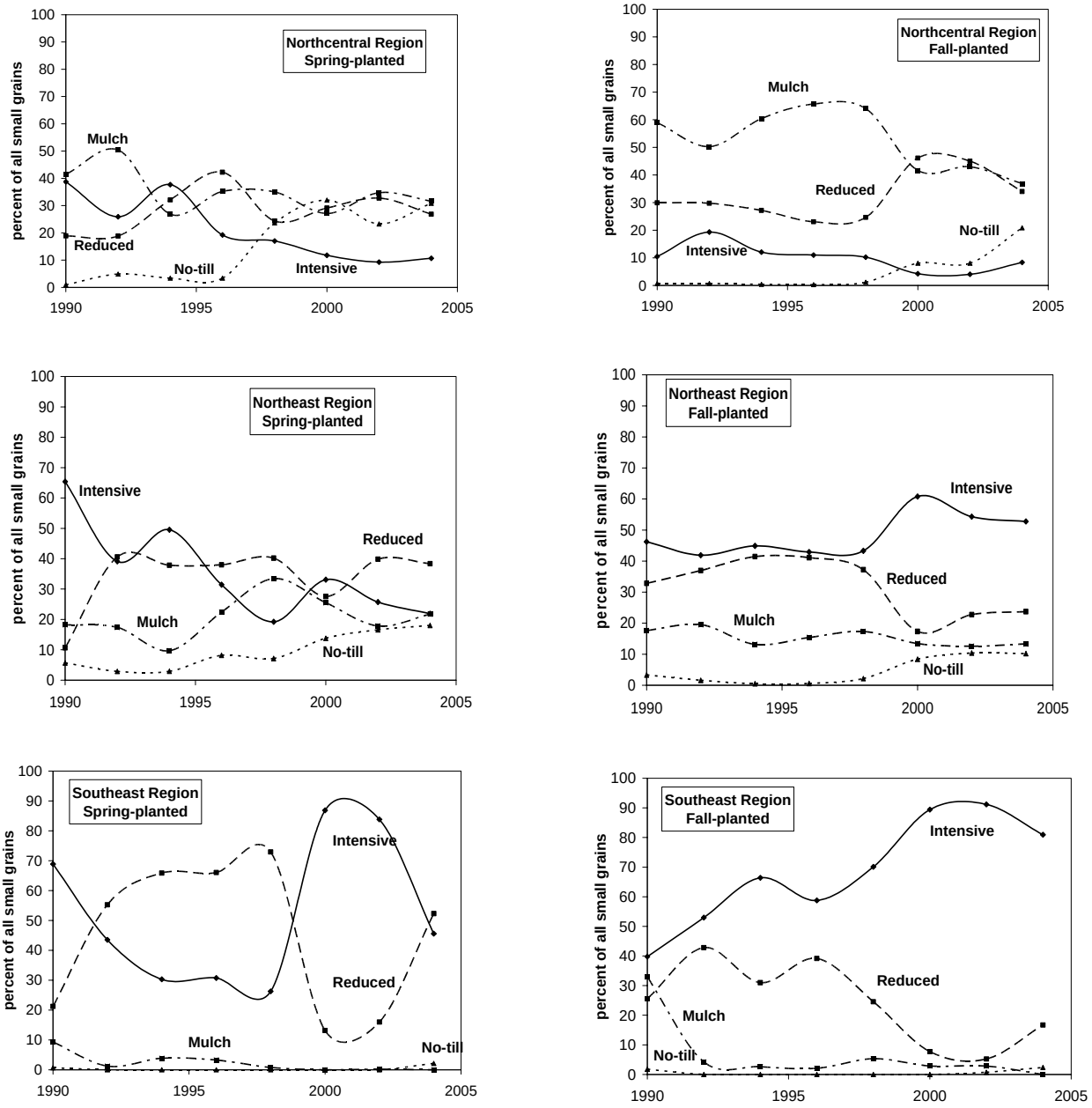


Figure 6. Proportions of dryland spring wheat and spring barley planted in annual crop sequences as a percentage of the total dryland small grains acreage in three regions of eastern Oregon and in three regions of eastern Washington.

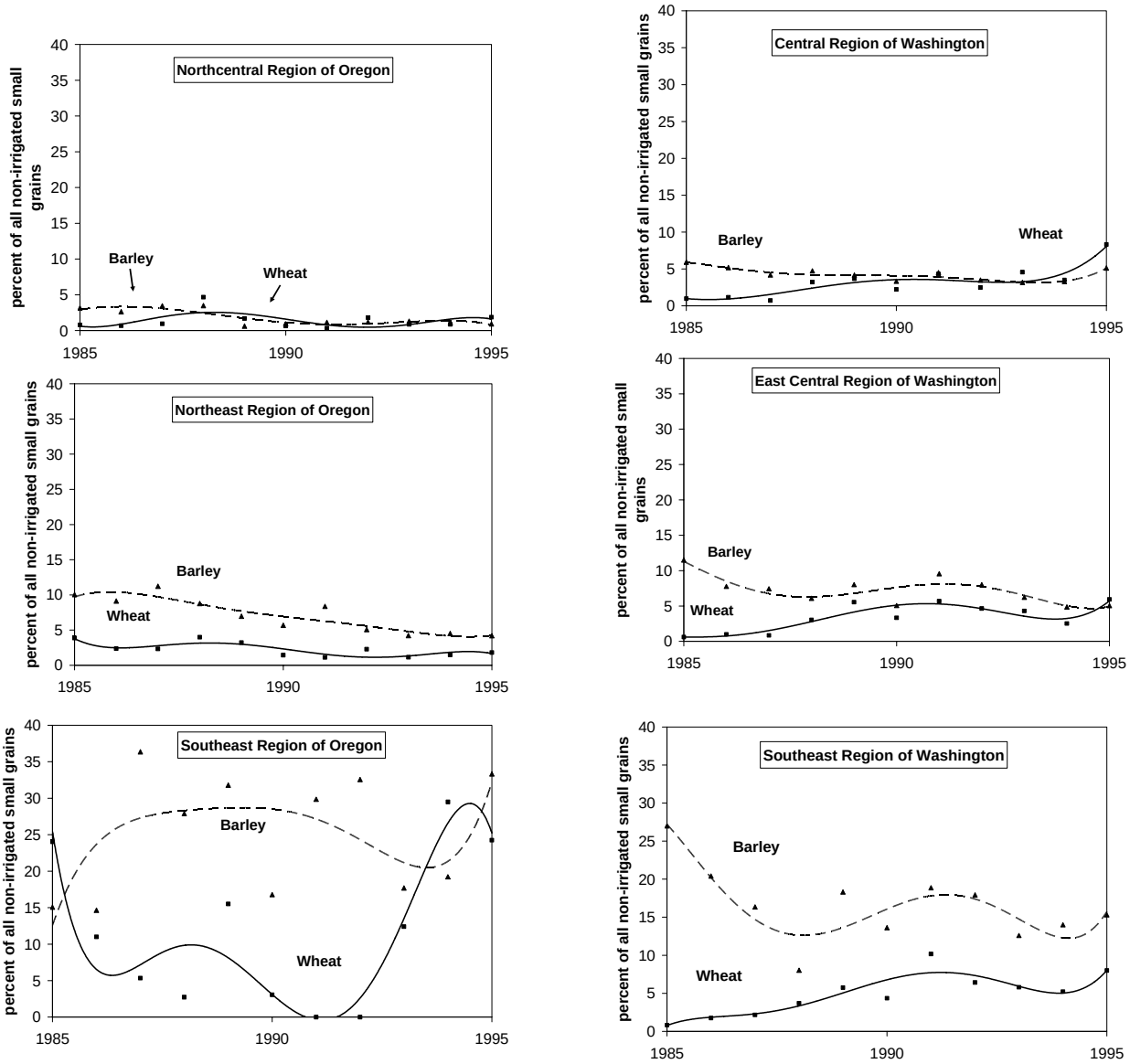
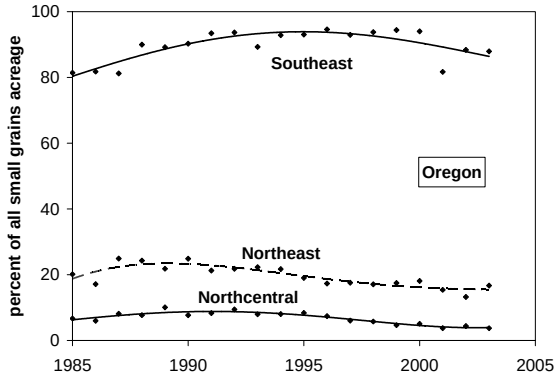


Figure 7. Proportions of irrigated small grains as a percentage of the total small grains acreage planted in three regions of eastern Oregon and in four regions of eastern Washington.



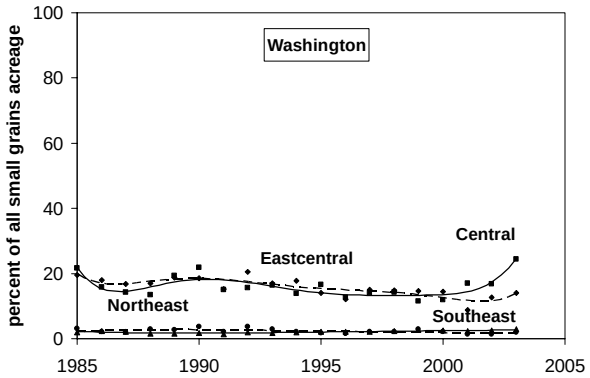


Figure 8. Irrigated winter wheat, spring wheat, and barley plantings as a percentage of the total planted small grain acreage from 1985 to 2003 in three regions of eastern Oregon and three regions of eastern Washington.

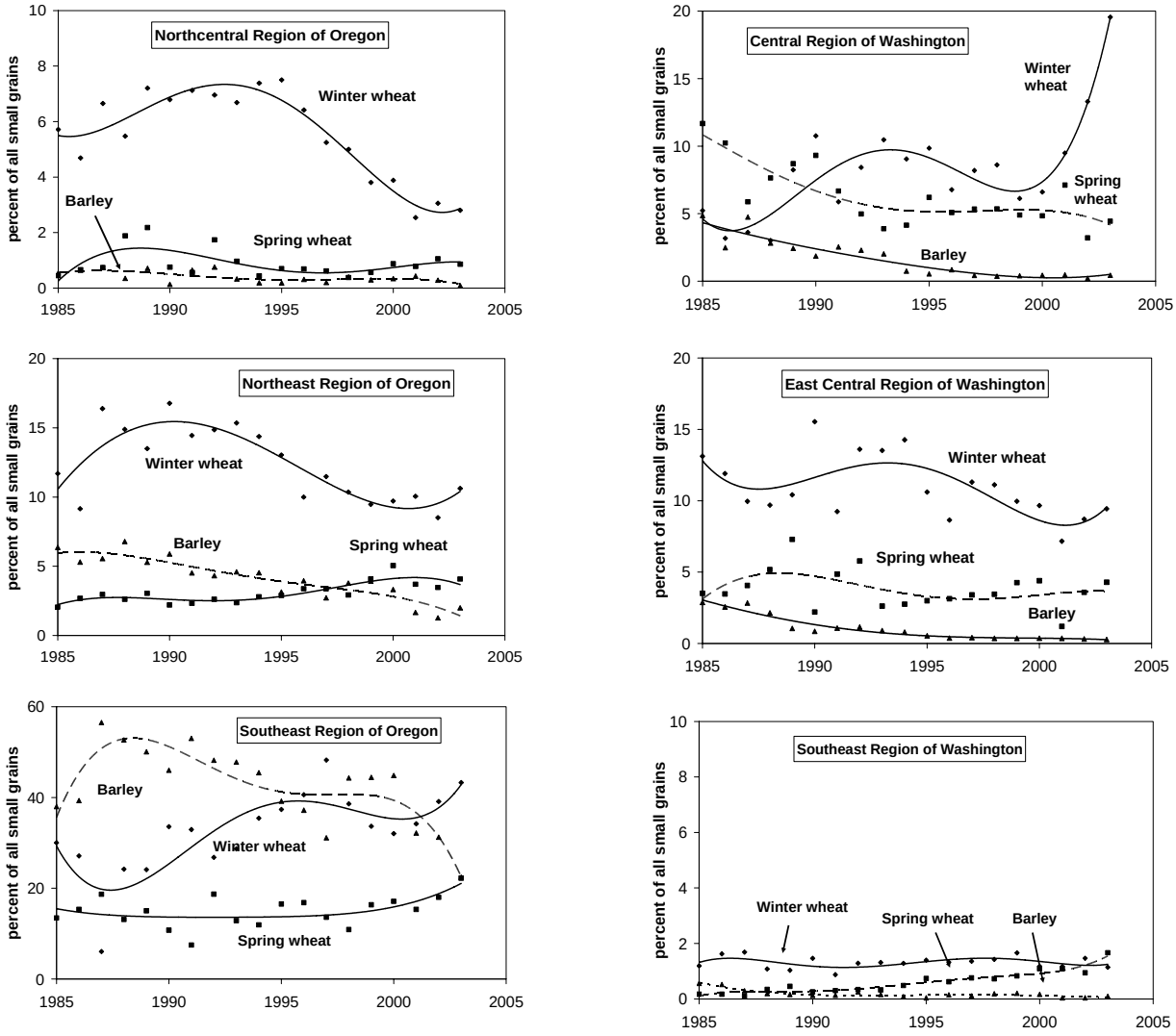


Figure 9. Trends in tillage practices for all small grains in Oregon and Washington; data are expressed as a percentage of the total acreage planted to winter wheat, spring wheat, and barley in each state, including irrigated and dryland production systems.

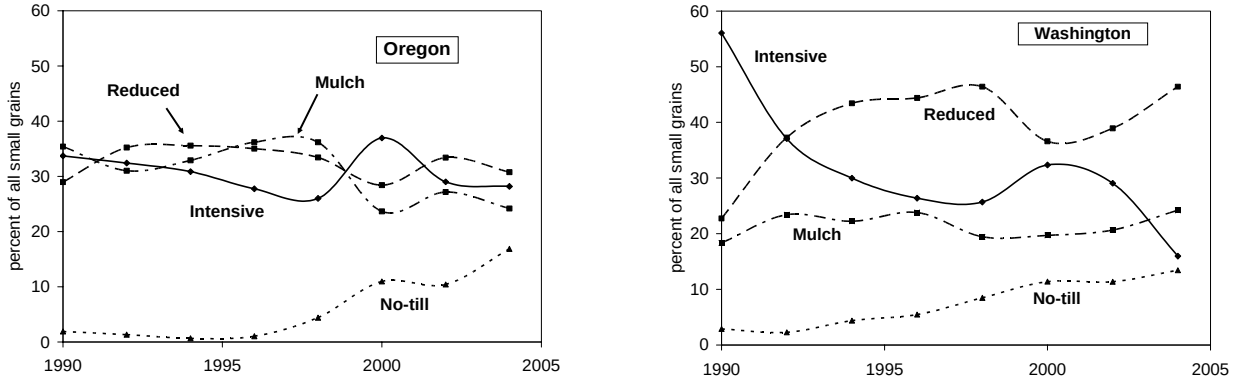


Figure 10. Proportions of statewide no-till wheat acreages in Oregon and Washington; data are expressed as a percentage of the total acreage planted to small grains in each state.

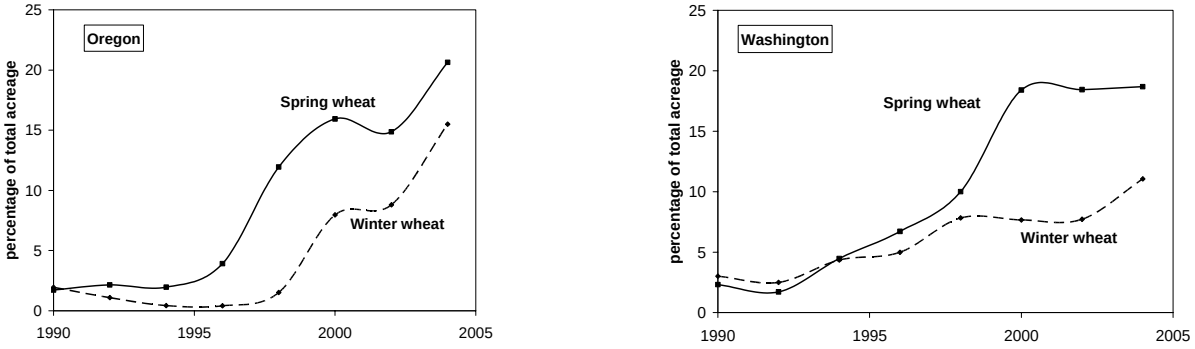


Figure 11. Proportions of spring- and fall-planted small grains managed under four types of primary tillage (intensive, reduced, mulch, no-till) in Washington.