Adoption of Erosion Control Practices for Dryland and Irrigated Agriculture in the Inland Pacific Northwest

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Overview

Agriculture is practiced on 3,348,000 dryland hectares and 646,000 irrigated hectares in the Inland Pacific Northwest of the United States. Wind erosion is a major agricultural concern in the low-precipitation (<300 mm annual) dryland zone and the irrigated Columbia Basin and Yakima Basin where limited crop residue, excessive tillage, drought, poorly aggregated soils with low organic matter content, and high winds combine to cause dust storms that transport suspended soil particulates long distances. Water erosion from dryland farms in the intermediate (300-450 mm annual) and high (450-600 mm annual) zones has plagued the region since the inception of farming. Long-term average annual water erosion rates in the higher precipitation zone ranged between 22 to 67 Mg ha^{-1} (3 mm of topsoil) with traditional farming practices. At these rates some 25 Mg of topsoil are eroded for each Mg of wheat produced.

Advances in Conservation Agriculture

Dryland Agriculture

- Long-term cropping systems research in the low-precipitation zone showed that recrop spring cereals (wheat, barley, oat), spring oilseeds (canola, yellow mustard, safflower), and recrop winter wheat (i.e., no fallow), had highly variable grain yields, contained more weeds, and were generally less profitable than WW-SF. Grain yield of spring-sown crops ranged from near failure to low when May and June rainfall was not ample, whereas WW after SF better tolerated or otherwise buffered drought during these two critical months. These factors notwithstanding, spring cropping using no-till provides excellent wind erosion control and increased soil organic carbon to native soil levels within eight years (Fig. 1).
- A major advance was the development of the undercutter method for winter wheat - summer fallow (WW-SF) farming that uses wide V-blade sweeps to cut beneath soil with minimum surface lifting or disturbance and simultaneously deliver nitrogen during primary spring tillage (Fig. 2a) followed by as few as one non-inversion rodweeding operation (Fig. 2b) during the summer to control Russian thistle and other weeds. With the undercutter method, ample surface residue is retained during the 13-month fallow period and after planting of winter wheat (Fig. 2c) to reduce blowing dust emissions by up to 65% compared to traditional tillage fallow. There are no adverse effects on seed-zone water content or winter wheat grain yield with the undercutter system and it is more profitable compared to traditional tillage.
- There has been a rapid advancement since the mid 1990s in development of no-till grain drills that allow precise seed and fertilizer placement in one pass through the field (Fig. 3). The land area under no-till increases each year in the intermediate and high precipitation zones as farmers gain experience and confidence with this system, being yet further motivated by fuel savings and government farm programs that promote no-till farming.

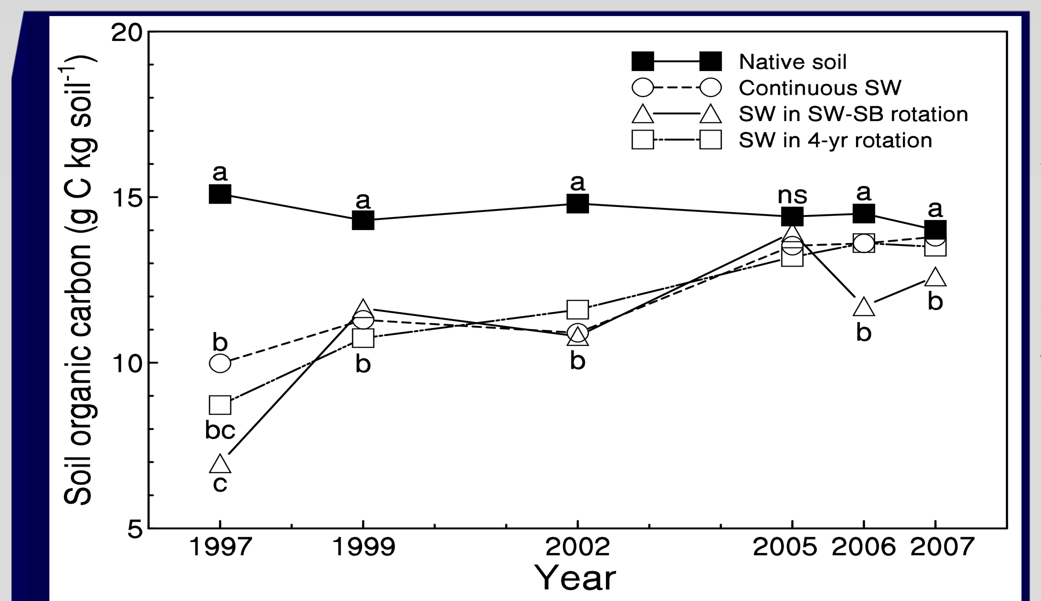

Fig. 1. Soil organic carbon in the surface 0-5 cm from a long-term annual no-till dryland cropping systems experiment near Ritzville, WA. Average annual precipitation at the site is 290 mm. Prior to 1997, the field had been in a tillage-based winter wheat – summer fallow rotation for 110 years. Soil cores were obtained at intervals from 1997 to 2008 from native soil (i.e., never disturbed), continuous spring wheat (sw), a 2-year spring wheat – spring barley (sb) rotation, and 4-year rotation that included broadleaf crops. Soil organic carbon increased to that found in undisturbed native soil by the eighth year of the experiment. Data from A.C. Kennedy, USDA-ARS.

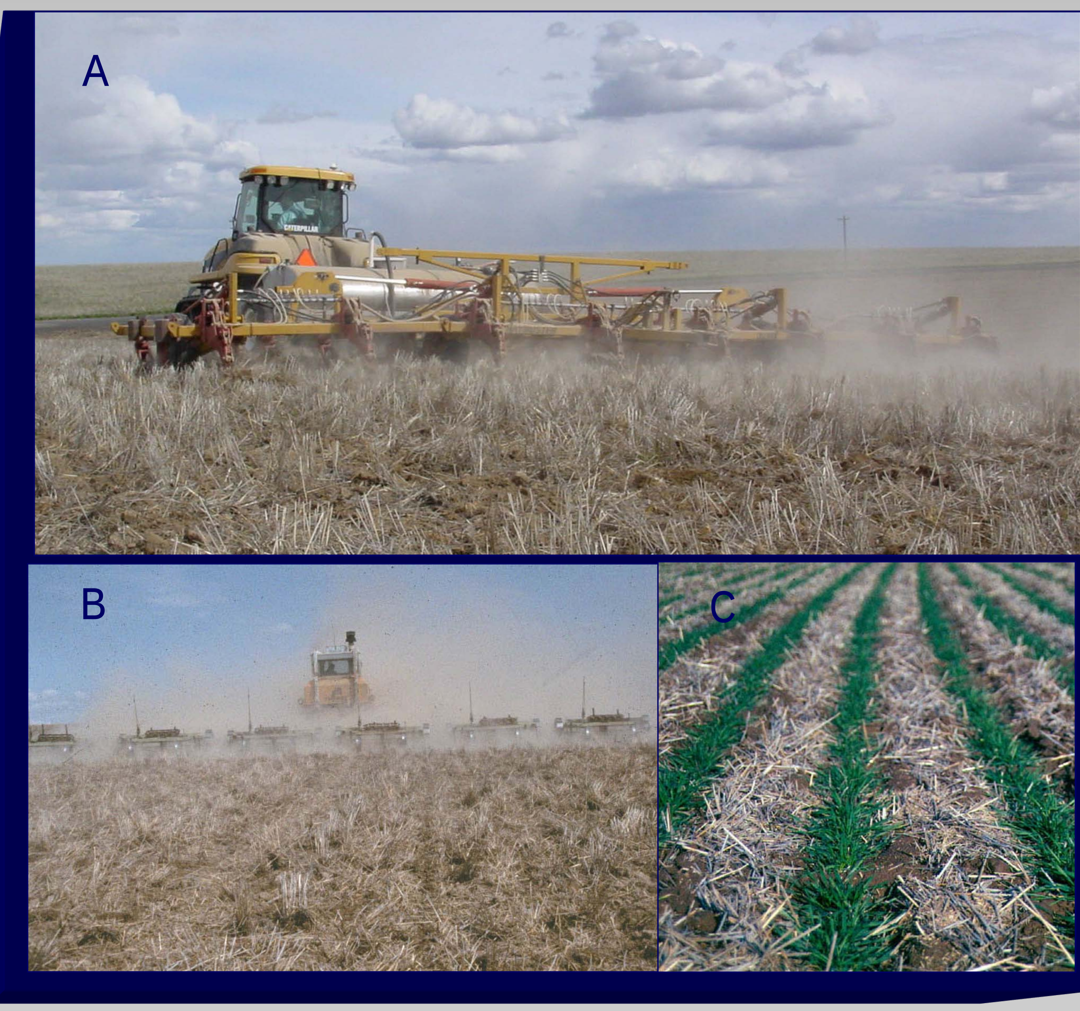

Fig. 2. The undercutter method for winter wheat – summer fallow conservation farming. (A) Primary spring tillage plus aqua NH_3-N injection with a Haybuster undercutter V-sweep implement. The narrow-pitched and overlapping 80-cm-wide V blades slice beneath the soil at 13 cm depth to sever soil capillary channels to halt the upward movement of liquid water to retain seed-zone water for late-summer planting of winter wheat. Most residue is left standing for control of wind erosion. (B) A rotating rodweeder is operated 7-to 10-cm below the soil surface to control Russian thistle and other broadleaf weeds during the late spring and summer. (C) Thirty percent or more residue cover at time of planting winter wheat is achieved using the undercutter method. Photos by W.F. Schillinger, WSU.

Irrigated Agriculture

- Winter cover crops improve nitrogen cycling and reduce soil nitrate levels in potato-based crop rotations. In a study in the Columbia Basin, cereal and *brassica* cover crops planted in late August after harvest of corn accumulated between 112 to 142 kg nitrogen ha-1. Over-wintering cover crops significantly reduced soil nitrate levels compared to fallow. Cover crops are a practical means to control wind erosion after harvest of high soil disturbance crops such as potatoes. Winter wheat makes a good cover crop because seed costs are reasonable, it emerges quickly and produces rapid ground cover, is not killed by low temperatures, and withstands sand blasting during windstorms.
- Historically, winter cover crops have been incorporated into the soil prior to planting the spring crop with the disadvantage being that soil is left vulnerable to wind erosion between spring tillage and crop establishment. Strip-till is a relatively new conservation farming technique where the tillage is confined to narrow strips where seed will be planted. Strip-till is gaining in popularity with irrigated farmers and is practiced in several crop-rotation scenarios. Corn, beans, and other crops can be strip-tilled into alfalfa in mid-to-late spring after the farmer obtains a first cutting of alfalfa hay. Glyphosate herbicide is used to burn down the alfalfa and a strip-till cultivator and planter are pulled in tandem with a high horsepower tractor to till, fertilize, and plant in one pass (Fig. 4).
- Farmers are experimenting with white mustard and oriental mustard as a biofumigant green manure that provides an alternative to chemicals to control soil-borne pests in potato-based cropping systems. A Columbia Basin farmer developed a wheat/mustard – potato cropping system that allows production of potatoes every other year where traditionally potatoes are grown only once every four years. In this system, mustard is planted no-till or broadcast into newly harvested wheat stubble in mid August and irrigation provided. In on-farm tests, mustard produced an average 5730 kg ha-1 of dry biomass by late October before first being flail chopped then incorporated into the soil with a tandem disk (Fig. 5). Where mustard was used as a green manure water infiltration rates more than doubled compared to the control. Results further showed that mustard green manure suppressed the soil-borne fungus *Verticillium dahliae* sufficiently to produce potato yields similar to those following application of metam sodium, a commonly used chemical soil fumigant.

Fig. 3a. No-till planting of spring wheat into standing stubble of the previous winter wheat crop in the Palouse region of Washington. The residue is left standing and undisturbed to protect the soil from water erosion during the winter. Farming is conducted on slopes as steep as 45% or more. This 450 hp tractor is equipped with crab steering and a self-leveling cab for operating on steep slopes.

Fig. 3b. The 12-m-wide modified Greats Plains model 3010 air drill has a notched coulter in front of each seed opener to cut through residue and 2-cm-wide shanks to band liquid aqua NH_3-nitrogen plus thiosulfate-sulfur about 8 cm below the soil surface. Liquid "starter" fertilizer from a separate tank delivers phosphorus close to the seed that is planted with double-disc openers on 20 cm row spacing. This field has been in continuous no-till for 30 years. Photos by John Aeschliman, Colfax, WA.

Fig. 4. One-pass planting with a strip-till cultivator in tandem with a corn planter through alfalfa that has been sprayed with glyphosate herbicide. Liquid fertilizer is delivered via the tanks mounted on the tractor. Photo by A.M. McGuire, WSU.

Fig. 5. Mustard green manure is flail-chopped and then incorporated into the soil with a tandem disk with attached packer in late October in the Columbia Basin. Mustard and other *brassica* crops suppress nematodes, soil fungal pathogens, and weeds to offer farmers effective and less expensive alternatives to chemicals for controlling these pests in potato-based crop rotations. Photo by A.M. McGuire, WSU

Further Reading

Kok, H., R.I. Papendick, and K.E. Saxton. 2009. STEEP: Impact of long-term conservation farming research and education in Pacific Northwest wheatlands. J. Soil Water Conserv. 64:253-264.
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