Objective 5: Wind Erosion and PM$_{10}$ Emission Control Methods

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Note: All references cited below are referred journal articles from the CP$_3$ Project

I. LONG-TERM CROPPING SYSTEMS RESEARCH

Maintaining stubble, clods, and roughness on the soil surface during summer fallow is critical for wind erosion control in the low-precipitation winter wheat – summer fallow region. In a 6-year experiment at Lind, we conclusively showed that:

- With minimum and delayed conservation tillage using a low-soil-disturbance undercutter sweep, 30% or more residue cover can be consistently achieved during fallow even when grain yield of the preceding wheat crop is as low as 25 bushels per acre. There were no differences in soil water in the 6-foot profile, seed-zone water, or wheat grain yield in the minimum tillage treatments compared to conventional tillage in any year or when combined over years (Schillinger, 2001).

- There are no economic disadvantages to practicing minimum or delayed minimum tillage compared to conventional high-soil-disturbance tillage during fallow (Janosky et al., 2002).

Findings from the above mentioned research project are considered one of the major achievements to date of the Columbia Plateau PM$_{10}$ Project.

Ib. No-Till and Alternative Cropping Systems in the Winter Wheat – Summer Fallow Region.
Two large-scale dryland cropping systems studies are ongoing at Ritzville and Lind. A large-scale irrigated cropping systems project is now in its 5$^{th}$ year at Lind. In addition, a 6-year cropping systems study in the Horse Heaven Hills was completed in 2002. Major published findings to date from these studies are:

- Continuous annual hard red or soft white spring wheat production using no-till is ideal for erosion control, but this practice is not agronomically or economically competitive with winter wheat – summer fallow in areas that receive less than 10 inches of annual precipitation (Schillinger and Young, 2004).

- Continuous annual soft white spring wheat using no-till is economically competitive to winter wheat – summer fallow in an 11-inch annual precipitation zone. This is the first economic ‘good news’ for continuous annual cropping using no-till in the low-precipitation region of the Pacific Northwest. However, when soft white spring wheat is grown in various
rotations with barley, yellow mustard, or safflower, the crop rotation it is not economically competitive with winter wheat – summer fallow (Juergens et al., 2004).

- The soil-born fungus *Rhizoctonia solani* AG8, commonly called Rhizoctonia bare patch disease, cannot be controlled by crop rotation in low-disturbance no-till systems. Bare patches appeared during year 4 of long-term dryland no-till experiments at both Ritzville and Lind and continue to expand in size as documented by annual mapping of bare patches using GPS technology (Cook et al., 2002).

- Recrop (i.e., no fallow) winter wheat will generally produce significantly higher grain yield compared to recrop spring wheat in the low-precipitation region of the inland PNW as long as downy brome is not a major problem. Recrop spring wheat sown directly into the stubble of the previous crop has good yield potential when five inches or more available water is stored in the soil during the winter (Schillinger et al., 1999).

- Soil quality is increasing with continuous annual dryland cropping using no-till at Ritzville and Lind, but several decades of continued no-till farming are likely required for soil quality to return to anything comparable to the native soil (Stubbs et al., 2004).

- In the irrigated cropping systems study at Lind, there were no differences in grain yield of winter wheat, spring barley, and spring canola grown in a 3-year rotation where the stubble is left standing, mechanically removed, or burned. A major decline in soil quality has occurred in the check treatment where stubble is first burned and soil then moldboard plowed prior to sowing continuous annual winter wheat (Kennedy et al., 2004).

II. SINGLE-COMPONENT RESEARCH TO CONTROL EROSION IN SUMMER-FALLOWED FIELDS

IIa. Winter Wheat Seedling Emergence.

Farmers in the winter wheat – summer fallow region of the inland Pacific Northwest need varieties that emerge through six inches or more of dry soil cover. When adequate winter wheat plant stands are not achieved, farmers are forced to replant their fields. Such replanting further pulverizes soil clods, buries residue, is a major cause of wind erosion in late summer and early fall. Studies to enhance winter wheat seedling emergence and plant stand establishment have been ongoing at Lind since the inception of the CP3 in 1993. Major published findings since 1998 are:

- Under conditions of both high and low soil water potential, advanced numbered lines and varieties with long coleoptile length consistently emerged from the soil fastest and achieved the best final stand compared to those that contained *Rht1* or *Rht2* reduced-height genes. Coleoptile length accounted for 70% of the variability in emergence among entries (Schillinger et al., 1998).

- Hydration of winter wheat seed up to, but not exceeding, the lag phase of germination with several priming media increased the rate and extent of germination and emergence of two varieties in laboratory and greenhouse studies. Seed soaked in water for 12 hours germinated and emerged as well or better than any other priming media tested. However none of the seed priming treatments benefited field emergence or subsequent grain yield compared to checks (Giri and Schillinger, 2003). Research on winter wheat seed priming with water is ongoing at Lind and in collaboration with scientists in Turkey.
IIb. Planting Date Effects on Straw Production.
- Planting date markedly affected straw production of winter wheat planted on summer fallow. Winter wheat planted at Lind in late August produced 3.0 ton/acre of straw compared with 2.1 and 1.2 ton/acre from mid-September and mid-October plantings, respectively. In addition, late-August planting resulted in the highest grain yield in most years. For cropland susceptible to wind erosion in east-central Washington, early planting of winter wheat is a best management practice (Donaldson et al., 2001).

IIc. Rotary Subsoiling Newly Planted Winter Wheat on Summer Fallow.
- A 6-year study was conducted to determine the effect of rotary subsoiling in newly planted winter wheat on intensively tilled summer fallow. The rotary ‘shark’s tooth’ subsoiler created one 16-inch-deep pit with 1-gallon capacity every 8 ft². Rotary subsoiling improved net over-winter water storage compared to the check in 2 of 6 years, but wheat grain yield was not affected. In February 2003, we simulated rainfall on partially frozen soils for 3 hr and a rate of 18 mm/hr. Rotary subsoiling increased infiltration two fold compared to the check and also significantly reduced runoff. The benefit of rotary subsoiling for increasing wheat grain yield has not yet been proven (Williams et al., 2005).

III. WEED ECOLOGY
Russian thistle is the major broadleaf weed of spring-sown crops in the low-precipitation farming region of the inland Pacific Northwest. Russian thistle is a C₄ plant with a deep and aggressive rooting system and prolific seed production that presents a formidable obstacle to spring wheat. Spring wheat has slow early growth and canopy closure compared to winter wheat that grows vigorously in early spring. Two experiments on Russian thistle ecology have been concluded since 1998 and another long-term study is presently in its 6th year at Lind.

IIIa. Soil Water Use and Growth of Russian Thistle After Wheat Harvest.
- Individual Russian thistle plants grown in a grid pattern without competition from other weeds used 20 gallons of soil water while growing with the spring wheat crop and an additional 27 gallons of water after wheat harvest. Individual Russian thistle plants produced an average of 46,000 seeds by time of killing frost in October (Schillinger and Young, 2000).

IIIb. Post Harvest Management of Russian Thistle.
- When wheat grain yields are low, it is difficult to maintain adequate surface residue for erosion control during the ensuing fallow year. Russian thistle often produces a greater quantity of dry matter by grain harvest that the wheat crop it infests. In a multiple-year experiment, dead Russian thistle plants that were controlled after wheat harvest (before seed production) with herbicide were preserved as an important source of surface cover during fallow. In contrast, when post-harvest control was with tillage, Russian thistle plants were wind-blown from the field. Results show the value of conserving dead Russian thistle plants for erosion control in low crop residue situations when this weed is likely to be present in large amounts (Schillinger et al., 1999).
IV. EXTENSION AND OUTREACH
Since 1998, Schillinger and colleagues have produced the following outputs for this project:
  Book chapters – 2
  Referred journal articles – 13
  Pacific Northwest extension bulletins – 12
  Conference proceedings papers – 10
  Abstracts from professional meetings – 31
  Experiment station research and extension reports – 66
  Popular publications for farmers in Wheat Life – 14
  An average of 15 oral presentations by the PI each year to about 1300 people.