Proposal for 2006-2007
Northwest Columbia Plateau PM₁₀ Project

Objective 5: Wind Erosion and PM₁₀ Emission Control Methods

Title: Wind Erosion Control Research for Dryland Cropping Systems

Personnel: Principal Investigator: William F. Schillinger;

Accomplishments
The main focus of this project is to test and develop dryland cropping systems to reduce wind erosion that are economically competitive with the traditional winter wheat – summer fallow system. We have two long-term cropping systems projects (now in their 9th and 10th year) where alternative crops and crop rotations are tested in large replicated plots using farm-size equipment. Economically viable alternatives to winter wheat – summer fallow have not yet been identified. However, our research has conclusively shown that wind erosion can be reduced by 50% or more, and farmers can make more money, if they use the undercutter method of summer fallow farming compared to their traditional tillage practices. This is a “win-win” situation for wheat farmers and the environment. In addition to cropping systems research, this project also works to enhance winter wheat seedling emergence and to predict when farmers should (or should not) plant spring wheat based on available soil moisture. Research results are presented each year in scientific journals and farmer publications as well as at winter meeting and summer field days.

Objectives
1. Continue long-term dryland cropping systems research at Ritzville and Lind to develop and test alternatives to winter wheat – summer fallow.
2. Investigate various ways to enhance emergence of winter wheat when sown deep into summer-fallowed soils.
3. Determine the soil physical processes involved in seed-zone moisture retention as affected by frequency of rodweeding operations during summer fallow.
4. Measure the rotational benefits of winter canola on soil characteristics and subsequent winter wheat performance.

Recent Accomplishments
The following are recent (i.e., 2005 and 2006) scientific journal articles from this project: Kennedy, A.C., and W.F. Schillinger. 2006. Soil quality and water intake in conventional-till vs. no-till paired farms. Soil Science Society of America Journal (in press).


**Planned Research**

Several new and ongoing studies in the 6- to 12-inch annual precipitation zone in eastern Washington will be funded by this project. These studies are:

**Project 1: Long-Term Dryland Cropping Systems Research at Ritzville.** We are now in the 10th year of a long-term study to compare various no-till annual cropping systems at the Ron Jirava near Ritzville, WA. In the first four years of the study (1997-2000) the crop rotations were: (i) a 4-year safflower/yellow mustard/wheat/wheat rotation; (ii) a 2-year wheat/barley rotation, and (iii); continuous wheat. During the second phase of the project (2001-2004), treatments were: i) a 4-year winter wheat/winter wheat/spring wheat/spring wheat rotation; ii) a 4-year winter wheat/spring barley/yellow mustard/spring wheat rotation; iii) a 2-year spring wheat/spring barley rotation; iv) a 2-year hard white spring wheat/spring barley rotation; v) continuous soft white spring wheat; and vi) continuous hard white spring wheat.

For phase three (2005-2008), field treatments are: i) a 4-year winter wheat/spring barley/spring wheat/chemical summer fallow rotation, ii) a 4-year winter wheat/spring barley/spring wheat/tilled summer fallow rotation, iii) a 2-year soft white spring wheat/spring barley rotation, iv) a 2-year hard white spring wheat/spring barley rotation, v) continuous annual soft white spring wheat, and vi) continuous annual hard white spring wheat. The experiment contains 56 plots, each 30 ft x 500 ft, covering 20 acres of land.

**Project 2: Long-Term Dryland No-till Research at Lind.** Annual cropping systems research using direct seeding has been ongoing at the WSU Lind Dryland Research Station since 1998. From 1998-2001, crop rotation treatments were: i) a 4-year rotation of spring wheat/spring wheat/safflower/spring oat, ii) a 3-year rotation of winter wheat/spring wheat/spring wheat, and iii) continuous annual spring wheat. All winter and spring wheat was in the soft white class.

A committee of growers and researchers met at the Lind Station in February 2002 to discuss and design the next phase of the experiment. Beginning in 2002 and continuing through 2008, the
crop rotations are the following:

1. Continuous annual soft white spring wheat (no-till).
2. Continuous annual hard red spring wheat (no-till).
3. Continuous annual hard white spring wheat (no-till).
5. Winter wheat - spring wheat - spring wheat (no-till).
6. Winter wheat - spring wheat - chemical summer fallow (no-till).
7. Winter wheat - spring wheat - summer fallow (tillage).

Each phase of all treatments appears every year. The experimental design is a randomized complete block with four replications, thus a total of 56 plots. Individual plot length is 225 ft with a 50 ft alley in the middle. All no-till plots are 15 ft wide, and tillage plots are 30 ft wide. Thus, all seven of the 2002-2008 treatments fit within the area of the original experiment. Grain harvest is with a plot combine equipped with chaff spreader. The entire experimental area is then "blanket harvested" with a commercial-scale combine to uniformly spread straw and chaff. Tillage (in treatments 4 and 7 above) is with a wide-blade undercutter sweep, both to control Russian thistle after harvest (if needed) and for primary spring tillage, followed by two rodweedings (i.e., minimum tillage). All other treatments are direct seeded and fertilized in one pass with a Cross-slot no-till drill or Anderson-opener no-till drill. This study will provide comprehensive information to growers in low-precipitation regions of the inland Pacific Northwest. The project is shown and discussed to an average of 190 people at the annual Lind Field Day in mid June as well as to several other visitors throughout the year.

**Project 3: Winter Wheat Seedling Emergence.** Growers in the low-precipitation regions need winter wheat varieties that can emerge from deep planting depth with marginal soil water potential. Since 1994, this project has annually evaluated the emergence of winter wheat varieties and numbered lines in replicated trials at Lind. We concurrently measure coleoptile and first leaf lengths of all entries. One hundred seeds of each variety or numbered line are sown in 17 ft-long rows with a 4-opener deep-furrow drill with a 15-inch spacing between rows. The drill delivered seed of individual entries to separate openers. Seeds were sown 6 inches below the summer fallow soil surface and an average of 5 inches of soil covered the seed. Winter wheat cultivars are compared for (i) seedling emergence percentage for every sampling date; and (ii) length of coleoptile and length of first leaf.

**Project 4: Winter Wheat Seedling Emergence as Affected by Soil Crusting.** Rain showers that occur after planting winter wheat into summer fallow cause surface soil crusting. The emerging coleoptile or first leaf often cannot penetrate such crusts. Information is needed on the interrelationship among quantity of rain on soil crusting and winter wheat emergence as affected by surface residue cover.

In this study, a portable rainfall simulator will be used to deliver rainfall at two different rates through two booms. We fitted the simulator to deliver 0.05 inch/hr of rain through one boom and 0.1 inch/hr through the second boom. The experimental design is a 5-factor laboratory pot experiment. Twenty five seeds each of Edwin and Eltan will be planted one-inch deep in pots containing 3 inches of wet (i.e., 15% soil moisture) soil. The wet soil will be covered with four inches of dry soil immediately after planting. Beginning one day after planting, the rainfall
simulator will be used to apply 0.05 inch/hr for 3 hours (total = 0.15 inch) or 0.10 mm/hr for 2.5 hours (total = 0.25 inch). Rainfall simulation will be repeated on the third and fifth days after planting. A total of 84 pots are required for each replication of the experiment. Factorial treatments for this experiment are as follows:
1. Two winter wheat varieties (Edwin and Eltan).
2. Two rainfall intensities and durations (as described above).
3. Three rainfall timings (1, 3, and 5 days after planting).
4. Three surface residue conditions (bare soil, 750 lb/ac of straw, and 1500 lb/ac of straw.
5. Two heat factors (50% of pots put under a heat lamp at 85°F air temperature for 9 hr/day, the remaining 50% of pots kept at room temperature with no additional heat).

**Project 5. Seed Priming Winter Wheat for Emergence and Yield.** A multiple-year field study was initiated at Lind in August 2004 to determine seed priming effects on winter wheat emergence and grain yield. Two wheat varieties were used based on their strong (Edwin) and moderate (Eltan) emergence capabilities. The three early phases of germination are: i) imbibition, ii) lag phase, and iii) protrusion of the radicle through the testa. Priming is a procedure that partially hydrates seed to initiate the germination process. The experiment has four treatments: Edwin and Eltan seed both primed and not primed (i.e., check). Primed seed was soaked in water for 12 hours, and then spread on a concrete platform for one hour at 60°F air temperature. Within the subsequent 3-hour time period, seed from all four treatments was treated with a fungicide and then planted into summer fallow with five inches of soil cover in 200-ft-long plots with a John Deere HZ deep furrow drill. Data collected are i) daily winter wheat seedling emergence beginning seven days after planting and continuing until 20 days after planting, ii) grain yield components at time of harvest, and iii) grain yield.

**Project 6. Optimum Rodweeding Frequency to Maintain Seed-zone Moisture.** A 3-year study will be conducted at the WSU Dryland Research Station at Lind to evaluate the frequency of rodweeding operations on (i) seed-zone moisture retention, (ii) surface residue retention, (iii) surface cloddiness, and (iv) subsurface cloddiness just before planting winter wheat in late August. After winter wheat is planted, stand establishment will be assessed in September and grain harvested from plots the following July. Experimental design will be a randomized complete block with four treatments. Each plot will be 30 by 200 feet, thus the experiment will cover 2.2 acres.

Winter wheat stubble in the experiment area will be sprayed with 18 oz./acre of glyphosate in mid March. In late March – early April, primary spring tillage will be conducted to a depth of 5 inches with a Haybuster undercutter V-shaped sweep with attached 3-bar tine harrow. Aqua nitrogen fertilizer will be injected into the soil at a rate of approximately 45 lbs/acre with the undercutter during the one-pass primary tillage. All subsequent rodweeding operations will be conducted at the 4-inch depth with a Calkins center-drive rodweeder. The following rodweeding treatments will then be established in a perpendicular direction to that of primary spring tillage:
1. No rodweeding (i.e., check). Weeds in this treatment will be controlled with a high rate of glyphosate with a backpack sprayer as needed to maintain weed-free plots.
2. Rodweed only when required to control weeds (this will range from 1 to 3 rodweitings, depending on the year).
3. Rodweed immediately after primary spring tillage, but thereafter only as required to control weeds (as per treatment no. 2, above).
4. Rodweed immediately after primary spring tillage and then at one-month intervals until late July-early August. This will be a total of five rodweedings.

Soil volumetric moisture in the 6-foot soil profile will be measured prior to primary tillage and again in late August before planting. Additionally, in late August, volumetric water content in the seed zone will be determined in each plot in 1-inch increments to a depth of 10 inches using an incremental soil sampler.

Surface residue at the end of the fallow cycle will be measured by collecting and weighing all above-ground drymatter within a 3-foot-diameter sample hoop randomly placed in each plot. Surface soil cloddiness will be determined at the end of the fallow cycle by measuring the diameter of individual soil clods within a 3-foot-diameter sampling hoop randomly positioned in each plot. Wheel tracks (and foot tracks for the check treatment) will be avoided. All clods with diameters greater than 2 inches will be sorted into 0.5-inch size increments and the mass of each size group determined. Subsurface soil cloddiness will be measured before planting by gently sieving 0.01 m$^3$ of soil from the 0-to 4-inch dry mulch layer through stacked 2 inch$^2$, 1 inch$^2$, and 0.5 inch$^2$ mesh screens. Mass of clods not passing through each of the three mesh screens will then be measured.

In late August-early September, the entire experiment area will be planted to soft white winter wheat with a John Deere HZ drill with 16-inch row spacing (or an International 150 drill with 18-inch row spacing if surface residue levels are high). Planting direction will be perpendicular to that of the rodweeding operations. Winter wheat stand establishment will be measured 21 days after planting. Grain yield will be determined in July by harvesting a 5-ft-wide swath through each 200-ft-long plot with a Hege 140 plot combine.

**Project 7. Rotational Benefits of Winter Canola on Subsequent Winter Wheat.** Winter canola is one of the few crops that can compete economically with winter wheat in the low-precipitation zone. Spring canola, yellow mustard, and other oilseeds are not agronomically or economically viable in the low-precipitation zone with current technology. In addition to economically viable grain yield from winter canola, several farmers have reported that the winter wheat crop following winter canola (with a year of summer fallow between crops) often has considerably higher grain yield compared to monoculture winter wheat (i.e., a 2-year winter wheat – summer fallow rotation). However, this rotational benefit of winter canola on winter wheat has never been documented, nor have soil physical or biological factors that may account for the wheat yield increases been measured, in winter wheat – summer fallow region.

A 3-year on-farm experiment will be conducted at two sites near Ritzville and Harrington, WA. Seed-zone water content at these locations is adequate most years for establishment of winter wheat and winter canola. The experiment will compare the 2-year winter wheat – summer fallow rotation to a 4-year winter wheat – summer fallow – winter canola – summer fallow rotation. In late August, winter wheat and winter canola will be planted into summer fallow in 16 by 200 foot plots with a John Deere HZ deep-furrow drill. Seeding rate for winter canola is 3 lbs/acre and for winter wheat 45 lbs/acre. Experimental design is a randomized complete
block with 6 replications. Grain yield of winter wheat and winter canola will be determined with a plot combine. After grain harvest, the entire experiment area will be in summer fallow for the next 13 months, after which the entire experiment area will be planted to winter wheat. Grain yield of winter wheat, which two years earlier was planted to either winter wheat or winter canola, will be determined by plot combine. Metal disc blades will be buried at each corner of the experiment so that, using a metal detector, the precise location of all plots can be determined after the 13 months of summer fallow.

In addition to grain yield, soil volumetric water content will be measured in all plots at time of planting in early September, in mid March, and again at grain harvest. During the fall following the harvest of winter wheat and winter canola, ponded water infiltration rate will be determined within a 2-foot-diameter infiltrometer ring, and soil biological analysis will be conducted by A.C. Kennedy to compare dehydrogenase enzyme activity, whole-soil fatty acid methyl esters, and phospholipid fatty methyl esters between the treatments.

The study will be established at both the Ritzville and Harrington on-farm sites on different summer fallow fields for three consecutive years. Thus we plan to have six site years of data collection for this experiment.