Proposal for 2008-2009
Northwest Columbia Plateau PM_{10} Project

Objective 5: **Wind Erosion and PM_{10} Emission Control Methods**

Title: ***Wind Erosion Control Research for Dryland Cropping Systems***

Personnel: **Principal investigator: William F. Schillinger, WSU;**
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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 11th and 12th 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.
5. Evaluate camelina as an alternative crop for the typical winter wheat – summer fallow production region.

Recent Accomplishments

The following are recent (i.e., 2006 - 2008) scientific journal articles from this project:

Schillinger, W.F., and R.I. Papendick. Then and now: 125 years of dryland wheat farming in the Inland Pacific Northwest. *Agronomy Journal* (in press).

Schillinger, W.F., T.A. Smith, and H.L. Schafer. 2008. Chaff and straw spreader for a plot combine. *Agronomy Journal* 100:398-399.
Schillinger, W.F. 2007. Ecology and control of Russian thistle (*Salsola iberica*) after spring wheat harvest. *Weed Science* 55:381-385.
Nail, E.L., D.L. Young, and W.F. Schillinger. 2007. Government subsidies and crop insurance effects on the economics of conservation farming systems in eastern Washington. *Agronomy Journal* 99:614-620.
Nail, E.L., D.L. Young, and W.F. Schillinger. 2007. Diesel and glyphosate price changes benefit the economics of conservation tillage versus traditional tillage. *Soil & Tillage Research* 94:321-327.
Schillinger, W.F., A.C. Kennedy, and D.L. Young. 2007. Eight years of annual no-till cropping in Washington's winter wheat – summer fallow region. *Agriculture, Ecosystems & Environment* 120:345-358.
Schillinger, W.F., and T.C. Paulitz. 2006. Reduction of Rhizoctonia bare patch in wheat with barley rotations. *Plant Disease* 90:302-306.
Kennedy, A.C., and W.F. Schillinger. 2006. Soil quality and water intake in traditional-till vs. no-till paired farms. *Soil Science Society of America Journal* 70:940-949.
Williams, J.D., S.B. Wuest, W.F. Schillinger, and H.T. Gollany. 2006. Rotary subsoiling newly planted winter wheat fields to improve infiltration in frozen soil. *Soil & Tillage* Research 86:141-151.
Paulitz, T.C., P.A. Okubara, and W.F. Schillinger. 2006. First report of damping-off of canola caused by *Rhizoctonia solani* AG 2-1 in Washington State. *Plant Disease* 90:829.

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 12th year of a long-term study to compare various no-till annual cropping systems at the Ron Jirava farm 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),
4. Winter wheat - summer fallow (tillage),
5. Winter wheat - spring wheat - spring wheat (no-till),
6. Winter wheat - spring wheat - chemical summer fallow (no-till), and
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 has been shown and discussed several times to an average of 200 people at the annual Lind Field Day in mid June as well as to several other visitors each 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 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. 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^{0}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 5. **Optimum Rodweeding Frequency to Maintain Seed-zone Moisture**. A 4-year study is underway 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 is assessed in September and grain harvested from plots the following July. Experimental design is 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 is sprayed with 18 oz./acre of glyphosate in mid March. In late March – early April, primary spring tillage is conducted to a depth of 5 inches with a Haybuster undercutter V-shaped sweep with attached 3-bar tine harrow. Aqua nitrogen fertilizer is 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 are conducted at the 4-inch depth with a Calkins center-drive rodweeder. The following rodweeding treatments are then established in a perpendicular direction to that of primary spring tillage:

1. No rodweeding (i.e., check). Weeds in this treatment are 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 rodweedings, 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 is a total of five rodweedings.

Soil volumetric moisture in the 6-foot soil profile is 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 is measured by collecting and weighing all above-ground dry matter within a 3-foot-diameter sample hoop randomly placed in each plot.

Surface soil cloddiness is 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) are avoided. All clods with diameters greater than 2 inches are sorted into 0.5-inch size increments and the mass of each size group determined. Subsurface soil cloddiness is 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 is then measured.

In late August-early September, the entire experiment area is 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 is perpendicular to that of the rodweeding operations. Winter wheat stand establishment is measured 21 days after planting. Grain yield is determined in July by harvesting a 5-ft-wide swath through each 200-ft-long plot with a Hege 140 plot combine.

Project 6. 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 6-year on-farm experiment is underway near Ritzville, WA. Seed-zone water content is adequate most years for establishment of winter wheat and winter canola. The experiment compares 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 is 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 is determined with a plot combine. After grain harvest, the entire experiment area is in summer fallow for the next 13 months, after which the entire experiment area is 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.

In addition to grain yield, soil volumetric water content is measured in all plots at time of planting in early September, in mid March, and again at grain harvest. During the winter following the harvest of winter wheat and winter canola, ponded water infiltration rate is 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 on different summer fallow fields for three consecutive years. Thus we plan to have six site years of data collection for this experiment.

Project 7: Camelina as an Alternative Crop in the Winter Wheat – Summer Fallow Region. Camelina is an ancient oilseed crop from Eastern Europe. Limited research from Montana in the past few years indicates that camelina is drought tolerant, does not require much nitrogen fertilizer, and does well on shallow or otherwise marginal soils. Several people feel that, if camelina has a fit in the Pacific Northwest, it will likely be in the low-precipitation region where winter wheat – summer fallow is the dominant crop rotation.

Four studies are proposed:

Study 1: Planting date. Location: Lind. Two planting methods: direct drilling and broadcast + packing. Six planting dates: (1) As soon as rains start in the fall (generally around mid October or later), (2) November dormant (Thanksgiving week), (3) Winter dormant (Jan. 15 – Feb. 1), (4) Early (mid February), (5) Mid (March 1), and (6) Late (March 15). There are four replications of each planting date and planting method. We will plant Calena variety at 5 lbs/acre with nitrogen @ 25 lbs/acre. Stand counts will be made using quadrant method. Assure II herbicide will be used to control downy brome. Grain yield will be determined with a plot combine. We will take samples from each treatment for oil content evaluation.

Study 2: Cultivar Evaluation. Location: Lind. We will evaluate 15 – 20 cultivars and numbered lines of camelina. There will be four replications with individual plots 5 x 20 ft. March 1 planting date. Nitrogen will be applied 25 lbs/acre. Grain yield will be determined with a plot combine.

Study 3: Fertilizer Rates. Location: Lind. Nitrogen rates are: 0, 10, 20, 30, 40, 50 lbs/acre. Sulfur will be applied to rates 2 and 4 (i.e., 10-0-0-8 and 30-0-0-8). We will use Calena variety @ 5 lbs/acre. March 1 planting date. Four replications.

Note: The three camelina studies (above) will be conducted for a duration of three years.

Study 4: Cropping systems. Location: Lind. A new 6-year study was initiated in fall 2007 with a WW-C-SF rotation compared to WW-SF. Experimental design is a randomized complete block with four replications. All phases of all treatments will appear each year. There are a total of 20 plots. Individual plot size is 30 x 250 ft. We are especially interested in finding out whether we can maintain adequate residue during fallow after camelina for adequate control of wind erosion.