

***Proposal for 2008-2009  
Northwest Columbia Plateau PM<sub>10</sub> Project***

**Objective 5:**            **Identify Alternative Cropping Systems that Reduce Wind Erosion**

**Title:**                    ***Developing Sustainable Intensive Cropping and Conservation Tillage Systems in North-Central Oregon and south-central Washington***

**Personnel:**            **Principal investigator: Stephen Machado, OSU;  
Cooperators: Larry Pritchett, Erling Jacobsen, Steve Petrie, Dick Smiley, Jason Sheedy, Sandra Easley, Dan Ball, and Larry Bennett, OSU; Stewart Wuest, Hero Gollany, John Williams, Ann Kennedy, David Myrold, and Steven Albrecht, USDA-ARS.**

**Objectives**

The ultimate objective of this project is to develop profitable and sustainable cropping systems for north-central Oregon and south-central Washington. Specific objectives include developing cropping systems that increase residue cover, reduce wind and water erosion, reduce soil water evaporation, increase soil available moisture, increase soil OM, and sustain soil productivity. Information to address these objectives, however, will be obtained after long-term experimentation. This proposal seeks to extend the on-going project consisting of long-term experiments at the Columbia Basin Agricultural Experiment Center (CBARC) at Moro, OR and Center of Sustainability (COS) at Heppner, OR.

**Recent Accomplishments**

The experiments are in their 4<sup>th</sup> year (2007-08) and some trends are beginning to show. Some of these results will be published in manuscripts we intend to submit starting in 2008.

***CBARC, Moro***

The project seeks to develop cropping systems that reduce wind erosion and have the potential to sustain soil productivity compared to the traditional winter wheat-fallow system. Different conservation tillage systems involving direct seeding are under evaluation (Table 1).

**Table 1. Cropping and tillage treatments for the long-term experiment at the CBARC, Sherman Experiment Station, Moro.**

Treatment No.	Description
1 (WW TF)	Conventional winter wheat/conventional tillage fallow
2 (WW CF)	Winter wheat/chemical fallow-direct seeding
3 (WW WW)	Continuous winter wheat-direct seeding
4 (SW SW)	Continuous spring wheat-direct seeding
5 (SB SB)	Continuous spring barley-direct seeding
6 (WW SB CF)	Winter wheat/spring barley/chemical fallow-direct seeding
7 (WW WP)	Winter wheat/winter pea-DS
8 (Flex)	Flex crop

Based on 3-year averages (2004-05, 2005-06, and 2006-07 crop-years) winter wheat following fallow in a 3-yr rotation with spring barley under direct seeding (Trt. 6) produced the highest yields although these yields were not significantly different from yields of wheat after conventional fallow (Trt. 1, Table 2). The high yield obtained from winter wheat in the 3-yr rotation with spring barley could have been partly attributed to low levels of root-lesion nematode (*Pratylenchus* spp) incidences. Yield from these two rotations was significantly higher than yield of winter wheat following chemical fallow (Trt. 2). Yields from annually cropped cultivars were strongly influenced by annual precipitation and were substantially higher when precipitation was high and low when precipitation low (Table 2). Continuous spring barley produced the highest yields followed by winter wheat after winter pea. Continuous winter wheat produced the lowest yields over the three crop-years. This was probably due to a combination of high downy brome (*Bromus tectorum*) infestation and high incidences of root lesion nematodes but not due a shortage of water as was expected in annual cropping. Grain yields of all the crops were negatively associated with root-lesion nematode incidences ( $r^2=0.86$ ;  $P=0.0008$ ). Soil moisture under plots grown to annual winter wheat was higher than in other rotations beginning May until harvest indicating that the crop was not able to utilize available soil moisture. Crop rotation that involved spring barley had very low incidences of the root lesion nematode.

The project is now in its fourth year and two more crop-years are required for all crop rotations to complete a full cycle. To this end, continued funding of the experiments to completion is vital to generate information required to determine whether the systems under evaluation control soil erosion and sustain soil productivity.

**Table 2. Grain yield of winter wheat, spring wheat, spring barley, and winter peas under different cropping systems at CBARC, Moro, 2004-07.**

Rotation	Grain yield (bu/ac)			
	2004-05	2005-06	2006-07	3-yr average
<b>Annual cropping</b> †				
Continuous <i>winter wheat</i>	10.57c	18.41d	30.76ef	19.91e
Continuous <i>spring wheat</i>	10.10c	37.71bc	32.01e	26.61d
Continuous <i>spring barley</i>	11.61c	63.56a	39.31d	38.16c
<b>Two-year rotations</b>				
Conventional fallow- <i>Winter wheat</i>	57.99a	58.62a	63.95ab	60.19a
Chemfallow- <i>Winter wheat</i>	52.91ab	45.88b	59.18b	52.66b
Winter wheat- <i>winter pea</i>	9.13c	17.13d	9.49g	11.92f
Winter pea- <i>winter wheat</i>	40.52ab	32.76c	35.96de	36.41c
<b>Three-year rotations</b>				
Chemfallow- <i>winter wheat</i> -spring barley	63.24a	56.93a	65.04a	61.74a
Winter wheat- <i>spring barley</i> -chemfallow	12.76c	57.99a	35.81de	35.52c
Precipitation (mm)	7.88	16.92	11.06	11.95

†All plots are direct seeded except the conventional fallow treatments (1&2); Chem-chemical; CT-conventional tillage; Flex-crop-cropping system decided based on prevailing soil moisture conditions and grain price; SB-spring barley; SW-spring wheat; WP-winter pea; WW-winter wheat.

### ***Center of Sustainability, Heppner***

The experiment is located at the William Jepsen farm near Heppner, OR. In the past 3 years COS has evaluated cropping systems that are similar to the cropping systems at Moro (Table 3). The COS site receives similar crop year precipitation to Moro (12.05 inches), but it is shallower (2 ft deep) than the Moro site (>4 ft deep). This makes it possible to effectively determine the influence of soil depth on the alternate cropping systems. Procedures for data collection are the same as for Moro. But the experiment is not replicated. However, the experiment has very large plots that measure 80 ft by 900 ft and it may be possible to split the plots and add at least one replication. In the meantime, data will be analyzed using statistical methods for unreplicated studies (Perrett and Higgins, 2006).

**Table 3. Cropping and tillage systems under evaluation at the Center of Sustainability project at Bill Jepsen's farm in Heppner.**

Treatment/Rotation	Description
1	Conventional winter wheat/conventional tillage fallow
2	Winter wheat/chemical fallow-direct seeding
3	Continuous spring barley-direct seeding
4	Continuous spring wheat-direct seeding
5	Continuous spring DNS-direct seeding
6	Continuous winter wheat-direct seeding
7	Spring barley/mustard/spring wheat-direct seeding
8	Winter wheat/mustard/chemical fallow-direct seeding
9a,b	Flex crop

**Grain yield:** Based on the 3-yr average (2004-05 to 2006-07) annualized yields, continuous spring barley produced the highest yields followed by continuous winter wheat (Table 4). Continuous spring wheat produced the lowest yields. Winter wheat after either conventional fallow or chemical fallow produced much higher yields than continuous spring wheat even on an annualized basis. However, there were no differences between annualized yields of wheat-fallow treatments and continuous winter wheat treatments at this site. Data on pests are not yet available. Results from the 2006-07 crop-year indicated that populations of root-lesion nematodes (*P. neglectus*) in the continuous barley were much lower than in continuous spring wheat. This is probably why spring barley out yielded spring wheat. The experiments will run for two more crop-years for all rotations to complete a full cycle.

**Table 4. Grain yield (lbs/a) of winter wheat, spring wheat, and spring barley under different cropping systems at the Center of Sustainability, Heppner, Morrow.**

Rotation	Continuous cropping				Two-year rotations		Precip (in)
	3	4	5	6	1	2	
Year	Cont. S. Barley	Cont. S. Wheat	Cont. DNS	Cont. W. Wheat	W. Wheat after Conv. fallow	W. Wheat after Chem. fallow	Sept-June
2004-05	42	16	23	25	68	71	9.4
2005-06	52	29	28	34	47	56	14.5
2006-07	47	29	25	33	62	56	12.26
Mean†	<b>47</b>	<b>25</b>	<b>25</b>	<b>31</b>	<b>59</b>	<b>61</b>	<b>12.05</b>
Annual	<b>47</b>	<b>25</b>	<b>25</b>	<b>31</b>	<b>30</b>	<b>31</b>	

† 2003-04 to 2006-07 crop year mean.

### **Planned Research**

To fulfill the overall objectives, the long-term experiments at CBARC, Moro and COS, Heppner will continue in FY2008 with the same treatments shown in Table 1 and 3, respectively. The following data will be collected.

#### ***CBARC, Moro***

***Crop Productivity (Crop Growth, Grain Yield, and Yield Components) - Stephen Machado, Larry Pritchett, Erling Jacobsen***

Basic data on the timing of agronomic practices, dates of plant emergence, plant populations, flowering, and maturity, biomass, grain yield will be collected every year. Plants will be considered emerged when >50% of the plot has emerged plants. Plants will be counted 10 to 14 days after emergence on at least 10-3 ft row lengths in the sampling areas. The plot will be considered to have flowered or matured when >50% of the plants have flowered or matured. Bundle samples from at least 10-3 ft quadrats will be collected from the harvest areas for the determination of crop residue biomass and harvest index. Yield components will be determined from plants in bundle samples. Plants in the quadrat are cut as close as possible to the ground and weighed for total biomass. The spikes are then cut off and counted; spikelets from 10% of the spikes are counted and grain from these spikelets threshed, weighed and counted. From these data, spikes m<sup>-2</sup>, spikelets per spike, grains per spikelet, and kernel weight will be derived. The rest of the plot area will be harvested by a commercial size combine to obtain grain yield.

***Soil Erosion, Soil Physical Characteristics, Water Infiltration, Soil Available Moisture, - Stephen Machado, Stewart Wuest (ARS), Hero Gollany (ARS), and John Williams (ARS)***

Soil moisture data will be measured by dielectric methods (3 access tubes/plot) to about 36 inches every year. Erosion will be measured by a rill meter (McCool et al., 1976) during FY2008 crop year for the first time. The rill will be set up at least 4 locations in the plot and a digital photograph taken of the rill pins after seeding of fall crops or in January or February when the ground has settled. Another set of measurements will be taken on the same positions

after the erosion season in May or June. The difference in the data will be used to estimate soil erosion. Data on earthworm populations, bulk density, water infiltration and aggregate stability were measured at the start of the experiments in 2003 and will be measured every 5 years thereafter. The next measurements of these variables will be conducted during FY2008. Water infiltration will be measured using a double ring infiltrometer.

***Soil Biological Characteristics***-Ann Kennedy (ARS), David Myrold (OSU), Steven Albrecht (ARS)

Microbial community structure is crucial to major ecosystem processes, including the maintenance of fertile soils and the control of nutrient cycles. Soils from the different treatments will be analyzed for functional diversity, i.e., community-level-physiological profiles (CLPP) using the commercially available BIOLOG system to measure profiles of carbon-source utilization by mixed microbial communities extracted directly from soil (Garland and Mills, 1991; Boyle and Albrecht, 2002). The BIOLOG system simultaneously measures the ability of the community to metabolize any of 95 different carbon sources representing several groups of substrates (e.g. carbohydrates, amino acids, fatty acids). Data are analyzed using Principal Component Analysis to determine similarities or differences in the patterns of substrate utilization. Analysis will be conducted during the first year and every 3 years.

***Soil Organic Matter, Soil Chemical Characteristics, Soil Productivity***-Stephen Machado, Steve Petrie, Larry Pritchett, Erling Jacobsen

A representative soil sample will be collected at 12-inch intervals to 48 inches or to restricting layer using a Giddings® probe at 3 locations in each plot every year. In the first year (2003) and 5 years thereafter, samples will be analyzed for pH, OM, P, K, NO<sub>3</sub>, NH<sub>4</sub>, SO<sub>4</sub>, Zn, Soluble salts, in the 0 to 12 inch samples, NO<sub>3</sub> and SO<sub>4</sub> in the 12 to 24 inch samples, and NO<sub>3</sub> in the 24 to 48 inch samples. In other years the soil will be analyzed for NO<sub>3</sub>, NH<sub>4</sub>, and SO<sub>4</sub> in the first 12 inches and NO<sub>3</sub> in the 12 to 48 ft samples to determine fertilizer recommendations. Soil for SOM determination will be collected at 4-inch intervals in the top foot and at 12 inch intervals to a depth of 48 inches. The next comprehensive soil analysis will be conducted during the 2008-09 crop-year.

***Surface Crop Residue Cover***- Stephen Machado, Larry Pritchett, Erling Jacobsen

Surface residue cover (%) in each plot will be estimated by taking digital photographs of surface residues in at least 10, one meter quadrats in each plot after harvest and at seeding. The images will be analyzed to determine percent surface cover using Sigma Scan Pro 5.0 (SPSS Inc.) software. The amount of total residues produced will be derived from bundle samples obtained at harvest.

***Diseases***-Dick Smiley, Jason Sheedy, and Sandra Easley

Diseases will be monitored at least twice annually in each planted plot. All procedures are routinely performed in on-going disease-management research with wheat and rotational crops (Smiley et al., 1996). Plots will be sampled for disease assessments during early winter (late November or early December) and late spring (May), and whiteheads, if present, will be quantified during mid- to late-June. Winter and spring samples involves removing 20 to 40 plants per plot, washing soil from roots, and scoring each plant individually for presence and

severity of diseases such as Fusarium foot rot, take-all, Rhizoctonia root rot, strawbreaker foot rot, or Cephalosporium stripe. If present, the incidence and/or damage by insect pests is also quantified.

***Weeds-Dan Ball and Larry Bennett***

Evaluations will be made on changes in density and species composition of weed populations. Emphasis will be placed on downy brome and jointed goatgrass, two weeds of primary importance in this agronomic zone. Weed density and species composition estimates will be made twice during the growing season. One count will be made in late January before crop canopy closure by counting all weeds in 5 randomly placed 2.68 ft<sup>2</sup> quadrats per plot. A second count will be made in mid April after application of appropriate herbicide treatments. Weed counts will be made in three large 9.8 ft by 16.4 ft quadrats suspended above the crop canopy to assess mid-season weed populations after herbicide treatment.

***Profitability of Cropping Systems-Steve Petrie, Stephen Machado, Larry Pritchett, Erling Jacobsen***

The inputs and outputs of each cropping system will be tracked and recorded for economic analyses to determine the most economic system. We will enlist the collaboration of an agricultural economist from OSU, WSU, or UI to assist in the economic analysis. An annual partial net economic analysis will be performed by subtracting the variable input costs from the gross crop value for each treatment or rotation. This procedure does not generate an enterprise comparison but does permit comparisons between various treatments. Variable input costs for herbicides, fertilizer, and seed will be based on the average of retail price quotes from three local input suppliers. Tillage, herbicide application, and seeding costs will be based on the Oregon State University Enterprise Budget for Wheat (Macnab 2003) adjusted to reflect the increased fuel costs. The costs of flailing and seeding using a direct-seed drill will be estimated. Costs will be broken into crop inputs (planting through harvest, about 10 months) and fallow phase (harvest through seeding, about 14 months). The current wheat price will be used. The costs in the analysis do not include Counter-Cyclical Payments, Loan Deficiency Payments, crop insurance, or fixed costs such as cash rent or taxes. If appropriate, the potential payments for conservation practices were determined based on the Natural Resources Conservation Service (NRCS) worksheets used in the Conservation Security Program.

***Sustainability-Stephen Machado, Steve Petrie, Dick Smiley, Dan Ball***

Data obtained from all the above activities will be used to assess the productivity and sustainability of the cropping systems under evaluation.

***Center of Sustainability, Heppner***

The COS project will continue for two more years. The procedures will be similar to procedures at Moro. Bill Jepsen will continue to manage the plots. He will seed, control weeds, take records and harvest the crops. We will help him in all the operations and in addition we will sample soils every year for fertilizer recommendation purposes and in the 5<sup>th</sup> year for a comprehensive analysis of cropping systems effects on soil quality. Data on soil physical, chemical, hydrological, and biological characteristics, soil erosion, pests, and crop productivity will be monitored.

### **Expected outcomes and anticipated impacts for research and extension:**

The two experiments are expected to generate data on cropping systems effects on soil erosion, soil quality, and soil productivity. Using this information, the sustainability and profitability of different cropping systems will be determined and necessary adjustments will be made to improve potential cropping systems. Furthermore, data from the CBARC, Moro will provide information for deep soils while data from COS, Heppner will provide information for shallow soils. Information obtained from these experiments will go a long way to influence growers to adopt sustainable cropping practices that reduce wind erosion.

### **References**

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