

PROPOSAL TITLE: Using the undercutter sweep in a reduced tillage fallow system in eastern Oregon

SUBMITTED TO: Agricultural Research Foundation for the Oregon Wheat Commission

SUBMITTED BY:

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Date: \_\_\_\_\_

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Agricultural Research Foundation

Date: \_\_\_\_\_

## **Research Proposal for the Agricultural Research Foundation and the Oregon Wheat Commission**

**Title:** Using the undercutter sweep in a reduced tillage fallow system in eastern Oregon

**Investigator:** Steve Petrie, OSU Soil Scientist and Superintendent, CBARC, Pendleton.

**Cooperators:** Stewart Wuest, USDA-ARS soil scientist, Columbia Plateau Conservation Research Center, Pendleton.

**Funding History:** Petrie received \$15,730 in 2008 and \$20,140 in 2009 for N management research and \$22,228 with Stephen Machado for work on C sequestration in 2009.

**Abstract:** Currently, the predominant dryland cropping system in north-central and northeastern Oregon is winter wheat followed by tillage-based summer fallow. Winter wheat is grown on about 900,000 acres in the region with the majority using this system. Summer fallow is practiced to store moisture in the fallow phase which results in larger and more consistent yields as rainfall from two years is used to produce one crop. Summer fallow also releases nutrients from the soil organic matter reducing the reliance on purchased fertilizer inputs. Finally, tillage-based summer fallow systems create a dust mulch that retards soil moisture loss and permits timely fall seeding resulting in increased yields. However, tillage-based summer fallow leaves the soil surface open and vulnerable to water and wind erosion and degrades the soil organic matter. The long-term economic and agronomic sustainability of tillage-based summer fallow has been questioned because of excessive soil erosion and loss of soil organic matter. No-till summer fallow using herbicides to control weeds is an option but often results in excessive soil surface moisture loss resulting in delayed fall seeding. Development of a system that incorporates the positive attributes of the tillage-based and the chemical fallow systems would reduce tillage thereby reducing the loss of soil surface organic matter, lowering the potential for soil erosion and increasing water infiltration into the soil while permitting timely seeding in the fall. One such system that has been proposed uses a subsurface ‘undercutter’ sweep in the early summer. The undercutter sweep breaks the capillary connection between the soil and surface there by reducing evaporative water loss while still retaining essentially all the crop residue on the soil surface to reduce erosion. Weed control in the fallow phase can be accomplished by using herbicides or fewer rodweeding operations. The objectives of this proposed research are to compare a typical tillage-based fallow system and the effects of time of undercutter operation and undercutter operation followed by rodweeding on surface residue, seed zone moisture, stand establishment, and crop yield.

**Objective:** The general objective of this research is to develop a crop fallow system that relies on less tillage and leaves more crop residue on the soil surface to reduce erosion. The specific objectives of this research are to:

1. Measure the effects of using the undercutter sweep, in conjunction with various summer fallow tillage operations, on soil surface residue at seeding
2. Measure the effects of using the undercutter sweep, in conjunction with various summer fallow tillage operations, on seed-zone moisture at seeding

- Determine the effects of using the undercutter sweep, in conjunction with various summer fallow tillage operations, on stand establishment and crop yield.

**Procedures:** This trial will be established at the Sherman Station of the Columbia Basin Agricultural Research Center. The Sherman Station receives about 11 inches of precipitation annually with more than 75% of this occurring between October 1 and May 1. This rainfall amount and distribution is representative of the majority of the dryland cropping area in eastern Oregon. This trial will be established following a uniform crop of winter wheat. Glyphosate will be used to control weeds prior to the imposition of the various treatments. The treatments to be used are shown in Table 1. The treatments will be arranged in a randomized complete block design with four replications. The tillage intensity treatments range from a system that would be typical for the area (Treatment 1) to a pure no-till or chemical fallow (Treatment 7). This study will also investigate the optimum time for the initial undercutter application. In the context of this study, “typical” refers to the usual date of initial tillage operation and “early” and “late” refer to the earliest date to use the undercutter sweep without adverse effects on soil physical properties while “late” would be at the end of time period of initial tillage. It is likely that the seed zone moisture and soil surface residue in late August will vary between the different treatments which may require the use of different grain drills on different treatments to achieve optimum seed placement and crop stands. Furthermore, the depth of moisture will likely vary as well and this may require that different seeding dates be used for different treatments. There are various grain drills at the Sherman Station which will permit different treatments to be seeded with the appropriate drill at the appropriate time. Fertilizer will be applied at seeding based on the results of soil tests. Weeds will be controlled by uniform application of herbicides.

Table 1. Tillage treatments to be used.

Treatment	Primary tillage		Secondary tillage	Fallow tillage	# of times
	Implement	Timing			
1	Chisel plow	Typical	Cultivator	Rodweeding	As needed
2	Undercutter	Early	None	None	N/A
3	Undercutter	Typical	None	None	N/A
4	Undercutter	Late	None	None	N/A
5	Undercutter	Typical	None	Rodweeding	1
6	Undercutter	Typical	None	Rodweeding	2
7	None	None	None	None	N/A

**Objective 1:** Surface residue at the end of the fallow cycle will be measured using two techniques. First, by collecting and weighing all above-ground dry matter within a 3-foot-diameter sample hoop randomly placed in each plot. Second, by estimating the soil surface area covered by residue using the string intercept method.

**Objective 2:** Soil volumetric moisture in the soil profile will be measured prior to primary tillage in the spring 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.

**Objective 3:** Winter wheat stand establishment will be measured by taking stand counts 21 days after planting. The plots will be harvested with a small plot combine to determine yield. Test weight, kernel weight and grain protein will be measured.

**Timeline:** The initial primary tillage will be performed when soil moisture conditions are appropriate in the spring of 2010 or 2011. The tillage and/or chemical weed control practices will be performed during the summer based on growing conditions. Data on soil surface residue and seed zone moisture will be collected in late August. The treatments will be seeded when conditions are appropriate for seeding within each plot area which may range from late August to early November, depending on soil surface moisture conditions and the occurrence of fall rains. The plots will be harvested in July of 2011 or 2012. A report will be available for the OWC by December of 2011 or 2012.

**Justification:** Currently, the predominant dryland cropping system in north-central and northeastern Oregon is winter wheat followed by tillage-based summer fallow. Winter wheat is grown on about 900,000 acres in the region with the majority using this system (Smiley et al. 2005). Summer fallow is practiced to store moisture in the fallow phase which results in larger and more consistent yields as rainfall from two years is used to produce one crop. Summer fallow also releases nutrients from the soil organic matter reducing the reliance on purchased fertilizer inputs. Tillage-based summer fallow leaves the soil surface open and vulnerable to water and wind erosion and degrades the soil organic matter. The long-term economic and agronomic sustainability of tillage-based summer fallow has been questioned because of the excessive soil erosion and loss of soil organic matter (Duff et al. 1995, Rasmussen et al. 1995)

There are a range of production practices used by dryland growers in the fallow phase of the cropping system depending on their equipment, soil characteristics, rainfall, and historical practices in their region. A typical sequence of fallow practices would include primary tillage, such as chiseling, after the winter wheat crop, followed by secondary tillage such as cultivating. The field is then tilled using a rodweeder during the summer at a depth of 4-5 inches below the soil surface. Rod-weeding controls weeds that germinate during the summer and greatly reduces soil water loss during the summer months by creating a 'dust mulch' that retards evaporation. The rodweeder also creates a discrete boundary between the dust mulch and the moist soil which is located 4-5 inches deep in the soil. This discrete boundary disrupts the capillary continuity in the soil and greatly reduces evaporative loss of water from the below the boundary. Winter wheat seeding can be reliably accomplished in late summer because the seeds can be placed into moisture using deep furrow grain drills. Earlier seeding often results in higher yields (Flowers et al. 2008) especially when seed bed moisture conditions result in rapid germination and emergence.

The adverse effects of tillage-based summer fallow are well known and include greater potential soil erosion, increased loss of soil organic matter at the soil surface, and reduced water infiltration. Scientists and growers in the region have been conducting field research on chemical or 'no-till' fallow which relies on the use of herbicides to control weeds. The soil is not tilled in chemical fallow which results in more crop residue on the surface and less potential soil loss due to wind and water erosion. Chemical fallow does not create a 'dust mulch' so

evaporation losses occur throughout the summer (Schillinger and Bolton 1992) and the soil at 4-5 inches, where the seed is placed, is often too dry to seed at the optimum time in the fall. Growers cannot seed until fall rains have wet the surface soil and this often delays seeding beyond the optimum seeding date leading to reduced yield (Flowers et al. 2008)

Development of a system that incorporates the positive attributes of the tillage-based and the chemical fallow systems would reduce tillage thereby reducing the loss of soil surface organic matter, lowering the potential for soil erosion and increasing water infiltration into the soil while permitting timely seeding in the fall. One such system that has been proposed uses a subsurface 'undercutter' sweep in the early summer. The undercutter sweep breaks the capillary connection between the soil and surface there by reducing evaporative water loss while still retaining essentially all of the crop residue on the soil surface to reduce erosion. Weed control in the fallow phase can be accomplished by using herbicides or fewer rodweeding operations. There is limited information available on the effects of using the undercutter sweep in the low rainfall dryland areas of eastern Oregon. Petrie (2009) evaluated the use of the undercutter sweep at the Sherman Station and found that the undercutter sweep effectively set a moisture line at about 5 inches deep. His study focused on the timing and number of rodweeding operations and did not compare a 'typical' fallow tillage system with systems using the undercutter sweep. The objectives of this proposed research are to compare the surface residue, seed zone moisture, stand establishment, and crop yield and quality in a typical tillage fallow system and different systems using the undercutter sweep.

#### **Literature cited:**

Duff, B., P.E. Rasmussen, and R.W. Smiley. 1995. Wheat/fallow systems in the semi-arid regions of Pacific NW America. pp. 85-111. *In. Agricultural Sustainability: Economic, Environmental and Statistical Considerations* (V. Barnett, R. Payne and R. Steiner, Eds.). John Wiley & Sons, London. 266 p.

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Schillinger, W.F, and F. Bolton. 1992. Summer fallow water storage of no-till versus conventional tillage in the Pacific Northwest. *Oregon Agric. Exp. Stn. Spec. Rept.* 894:28-31.

Smiley, R., M. Siemens, T. Gohlke, and J. Poole. 2005. Small grain acreage and management trends for eastern Oregon and Washington. *Oregon Agric. Exp. Stn. Spec. Rept.* 1061:30-50.

Budget:

Item	Amount
Salaries	
Faculty	N/A
Graduate students	N/A
Other students	\$9,600
Other labor	N/A
OPE for all categories	\$960
Equipment	N/A
Travel	
6 trips to Sherman Station	\$780
Supplies and Materials: land laboratory fee, plot stakes, sample bags and cans, soil analysis, combine use fee, etc.	4,600
Total	15,940