TITLE: Developing chemical fallow systems for intermediate rainfall inland PNW environments.

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3rd INTERIM REPORT

PROJECT OBJECTIVES:

1) Compare the effects of fallowing method, including systems utilizing a sweep undercutter alone and in combination with rod weeding, chemical fallow, and conventional fallow; on seed-zone soil moisture, soil residue cover, weed control, and subsequent wheat crop growth response and grain yield in winter wheat/fallow environments in two intermediate rainfall locations.

2) Compare weed control effectiveness from various chemical fallow herbicide treatment regimes in intermediate rainfall PNW environments, and evaluate subsequent wheat crop response and yield.

3) Collect data to assess the economic viability of various reduced/no tillage fallow systems.

KEY WORDS: chemical fallow, WeedSeeker, spot treatment, undercutter, herbicides, weed control, rodweeder, Russian thistle.

STATEMENT OF PROBLEM: Growers in intermediate rainfall zones are trying chemical fallow systems to replace the more erosive dust-mulch fallow. Two primary problems associated with chemical fallow are the loss of seed-zone soil moisture due to evaporative loss in un-tilled soil, and weed problems associated with the elimination of tillage and subsequent reliance on herbicides. Currently, most growers rely on repeated broadcast applications of glyphosate for season-long weed control in chem-fallow. Often, control of these weeds with glyphosate alone or in tank-mixes has not been effective, or greater herbicide rates are necessary to effectively control weeds as dusty conditions reduce herbicide activity. Moreover, plants grown under moisture stress typically require greater herbicide rates to provide the same level of control compared to plants grown under adequate moisture. Another concern with repeated applications in chem-fallow is the development of herbicide resistant weed populations.

A concept for reducing repeated broadcast applications of glyphosate is through the use of optical sensor controlled spot-treatment utilizing “WeedSeeker®” technology. This technology has the potential to reduce herbicide costs through directed spot-treatment of weeds. It also may reduce the concern about dust inhibition of herbicide activity because it is possible to greatly increase the concentration of herbicide in the spot-treatment operation.

In addition, others have shown that properly timed sweep tillage operations followed by rod weeding may reduce evaporative losses of seed-zone soil moisture with relatively little loss of surface crop residue, and with possible enhancement of overall fallow weed control (Schillinger, 2001; Schillinger and Young, 2004). This previous work with sweep tillage utilizing an undercutter relied on rod weeding for weed control and seed-zone moisture retention.

Our project is investigating the potential for sweep tillage with chemical fallow (and no rod weeding) in comparison with several other fallow systems including: conventional fallow; sweep tillage plus rodweeding; or no-tillage, chemical fallow. We are evaluating the four systems for their impact on seed-zone soil moisture, surface residue and roughness, weed population dynamics, and response of the winter wheat crop following these fallow treatments.

ZONE OF INTEREST: Intermediate rainfall zones.

ABSTRACT OF RESEARCH FINDINGS: Research is being conducted near Davenport at the Wilke Research and Extension farm and on a commercial wheat farm near Helix, OR, both in intermediate rainfall production zones. Tumble pigweed, Russian thistle, wild oat, and downy brome were the main weed species at Davenport and prickly lettuce and Russian thistle at the Helix location in both fallow years. Treatment comparisons showed greater tumble pigweed density and biomass in non-rodweeded treatments compared to rodweeded treatments at Davenport, but no difference in density and biomass of Russian thistle or grasses. At Davenport, most weeds present in non-rodweeded treatments were in the tractor sprayer track path. At the Helix site, there were no differences in weed density among tillage treatments, but there were a greater number of Russian thistles in plots utilizing an optical sensor-controlled (OSC) sprayer for herbicidal weed control. At the Helix site, dust conditions appeared to impact weed control with the OSC sprayer, and rodweeding did provide slightly improved weed control. There were slight differences in soil moisture among treatments at both locations. Additional studies in WA and OR evaluated the efficacy of various herbicides using OSC sprayer in chemical fallow systems. Again, the dominant broadleaf weed species were tumble pigweed, Russian thistle, and prickly lettuce. Glyphosate alone at different rates and in combination with 2,4-D or pyrasulfatole plus bromoxynil, or paraquat provided greatest weed control at both Davenport and Pendleton sites. Carfentrazone plus dicamba, bromoxynil, or 2, 4-D 4 pt/acre alone proved to be the least efficient herbicides, mainly due to lack of grass weed control at Davenport or prickly lettuce at Pendleton.

RESULTS AND INTERPRETATION:

Objective 1 Summary: Research was conducted for a second year near Davenport, WA at the Wilke Research and Extension farm, and north of Helix, OR, on a commercial dryland wheat farm. Both areas are in winter wheat - summer fallow production areas and are considered to be in intermediate rainfall production zones. After the fallow treatments were performed in year one, plots were planted to winter wheat and taken to yield at both locations (Table 1). At both locations, treatments utilizing a rodweeder (treatments 5 and 6, Table 1) obtained the highest grain yield at the Davenport site ($p>5\%$), but not at a statistically significant level ($p>5\%$) at the Helix site. Fallow plots utilizing the WeedSeeker weed spraying tended to yield less than broadcast sprayed plots (Table 1). This may have been due to a slight reduction in weed control effectiveness at Helix during the 2007 fallow period (Table 2a). Differences in fallow weed control were not evident from weed counts made at Davenport in 2007(Table 2a). Tumble pigweed and Russian thistle were the main weed species at the Davenport site, while Russian thistle and prickly lettuce were predominant at the Helix site during the 2007 fallow period.

During the 2008 fallow period on adjacent plots at both Davenport and Helix, there were only slightly greater weed densities due to fallow tillage method (Table 2b). Weed density did not seem to be of a level of concern for the yield reductions observed (Table 1), but future wheat yield evaluations in 2009 may prove otherwise. It was interesting to note that at the Helix fallow site in 2008, there were significantly greater densities of Russian thistle in plots receiving an undercutter treatment, and significantly greater densities of prickly lettuce in no-till plots (Table 2b). This was likely due to difference in a surface soil condition after undercutter operation in the spring. At the Davenport site, tumble pigweed densities (AMAAL) were greater in plots that received an undercutter operation followed by a coil-packer. Again, the expression of this weed was likely due to a firmer surface soil condition favoring germination of that weed.

Analysis of total soil moisture content to a 5 foot depth at the end of the fallow period in 2008 were variable, depending on location and the prevailing precipitation pattern at each site. Slight differences in soil moisture were evident between treatments at any given depth (Figure 1). At the Helix site there appeared to be variable soil moisture at all depths making interpretation difficult (Figure 1). At the Davenport site there appeared to be slightly less soil moisture after conventional tillage in 2008, which is the opposite of that seen in 2007 where the no-till plots had less soil moisture throughout the profile (Figure 1). Definitive conclusions about soil moisture have not been drawn since statistical analysis of these data has not been completed at time of this report.

Table 1. Fallow tillage method influence on subsequent wheat yield and test weight. 2008.

				Helix, OR		Davenport, WA	
	PRIMARY TILLAGE OPERATION [1]	ROD WEEDER[2]	FOLLOW-UP OPERATIONS	Grain yield (bu/A)	Test weight (lb/bu)	Grain yield (bu/A)	Test weight (lb/bu)
1	Undercutter (coils on)	None	Broadcast glyphosate	57	60.3	38	57.5
2	No tillage	None	Broadcast glyphosate	54	60.7	39	57.9
3	Undercutter (coils on)	None	WeedSeeker	50	59.7	35	57.4
4	No tillage	None	WeedSeeker	53	59.8	36	57.3
5	Undercutter (coils off)	Yes	Rod weed	59	60.5	44	58.3
6	Chisel/Disk	Yes	Rod weed	59	60.5	43	58.1
	LSD(0.05)			ns	ns	6.3	ns

Table 2a. Weed population density response to fallow tillage/herbicide treatments. Helix, OR and Davenport, WA. 2007.

				Helix, OR		Davenport, WA	
	PRIMARY TILLAGE OPERATION [1]	ROD WEEDER[2]	FOLLOW-UP OPERATIONS	LACSE* plant count (7/16/07)	SASKR plant count (7/16/07)	AMAAL plant count (8/15/07)	SASKR plant count (8/15/07)
				number per 5 m^2			
1	Undercutter (coils on)	None	Broadcast glyphosate	0	0.4	10.2	<1
2	No tillage	None	Broadcast glyphosate	0.8	0.3	9.3	<1
3	Undercutter (coils on)	None	WeedSeeker	0.2	12.5	9.5	<1
4	No tillage	None	WeedSeeker	0.8	2.5	6.7	<1
5	Undercutter (coils off)	Yes	Rod weed	0	0.1	0	0
6	Chisel/Disk	Yes	Rod weed	0	0	0	0
	LSD(0.05)			ns	3.3	6.3	ns

Table 2b. Weed population density response to fallow tillage/herbicide treatments. Helix, OR and Davenport, WA. 2008.

				Helix, OR			Davenport, WA		
	PRIMARY TILLAGE OPERATION [1]	ROD WEEDER[2]	FOLLOW-UP OPERATIONS	SASKR plant count (7/17/08)	KCHSS plant count (7/17/08)	LACSE plant count * (7/17/08)	AVEFA plant count (8/19/08)	AMAAL plant count (8/19/08)	Other plant counts (8/19/08)
				number per 5 m^2					
1	Undercutter (coils on)	None	Broadcast glyphosate	1	0	0	0.03	0.72	0
2	No tillage	None	Broadcast glyphosate	0	0	4	0.01	0.21	0
3	Undercutter (coils on)	None	WeedSeeker	6	0	1	0.02	0.44	0.05
4	No tillage	None	WeedSeeker	2	0	7	0.02	0.18	0.02
5	Undercutter (coils off)	Yes	Rod weed	0	0	0	0	0	0
6	Chisel/Disk	Yes	Rod weed	0	0	0	0	0	0
	LSD(0.05)			3.6	NS	1.7	ns	0.26	ns

[1] Primary tillage operations to follow 1st glyphosate broadcast application. Conventional fallow (trt. 6) consisted of chiseling (Helix) or disking (Davenport) followed by rod weeding as needed.

[2] Rod weeding (secondary tillage) of selected treatments (trt. 5,6) was to firm soil and "set" moisture line.

* SASKR = Russian thistle; KCHSS=kochia; LACSE = prickly lettuce; AVEFA = wild oat; AMAAL = tumble pigweed.

Figure 1. Late summer fallow soil moisture after four fallow management methods. Davenport, WA and Helix, OR. 2007 and 2008.

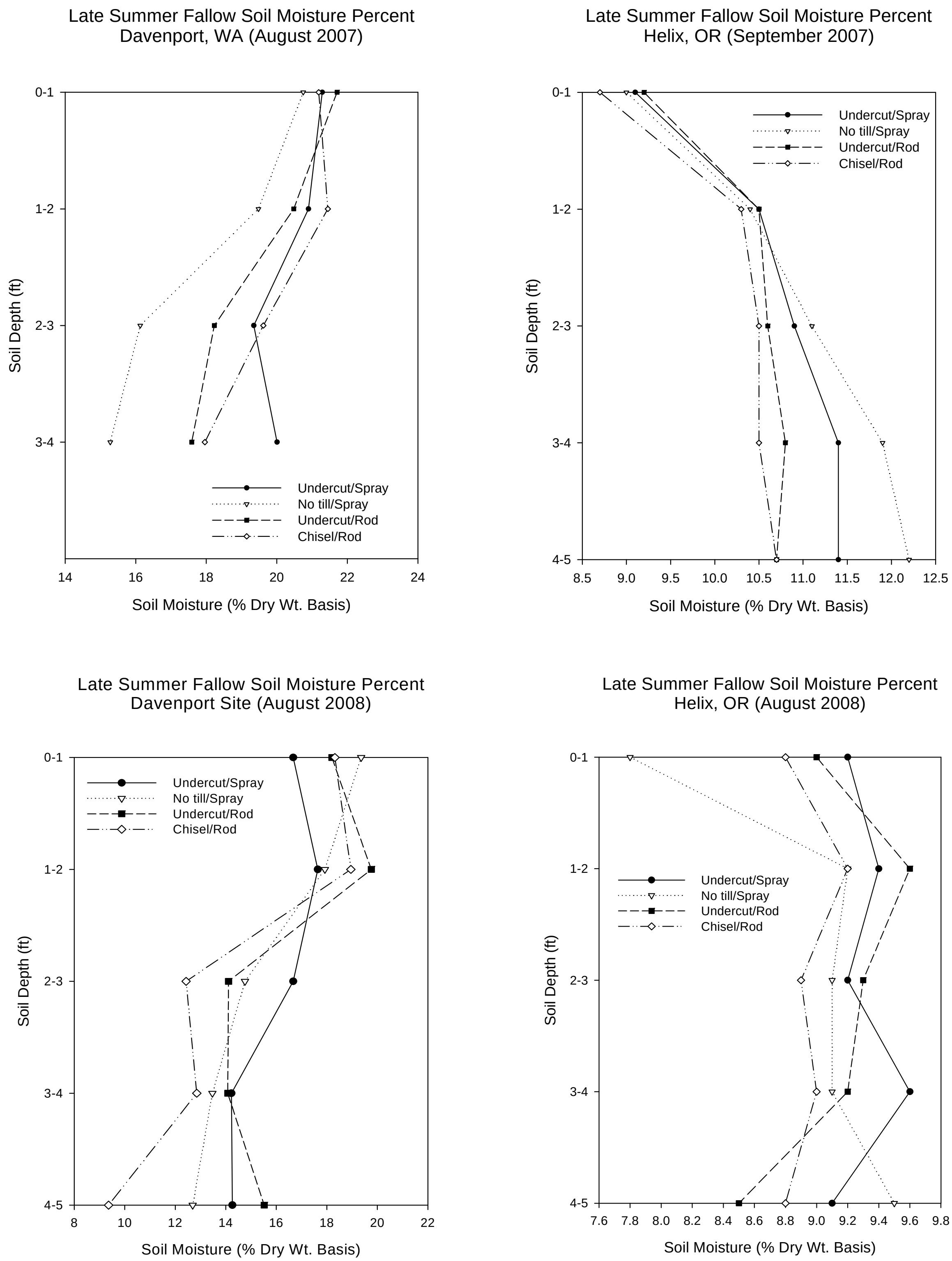
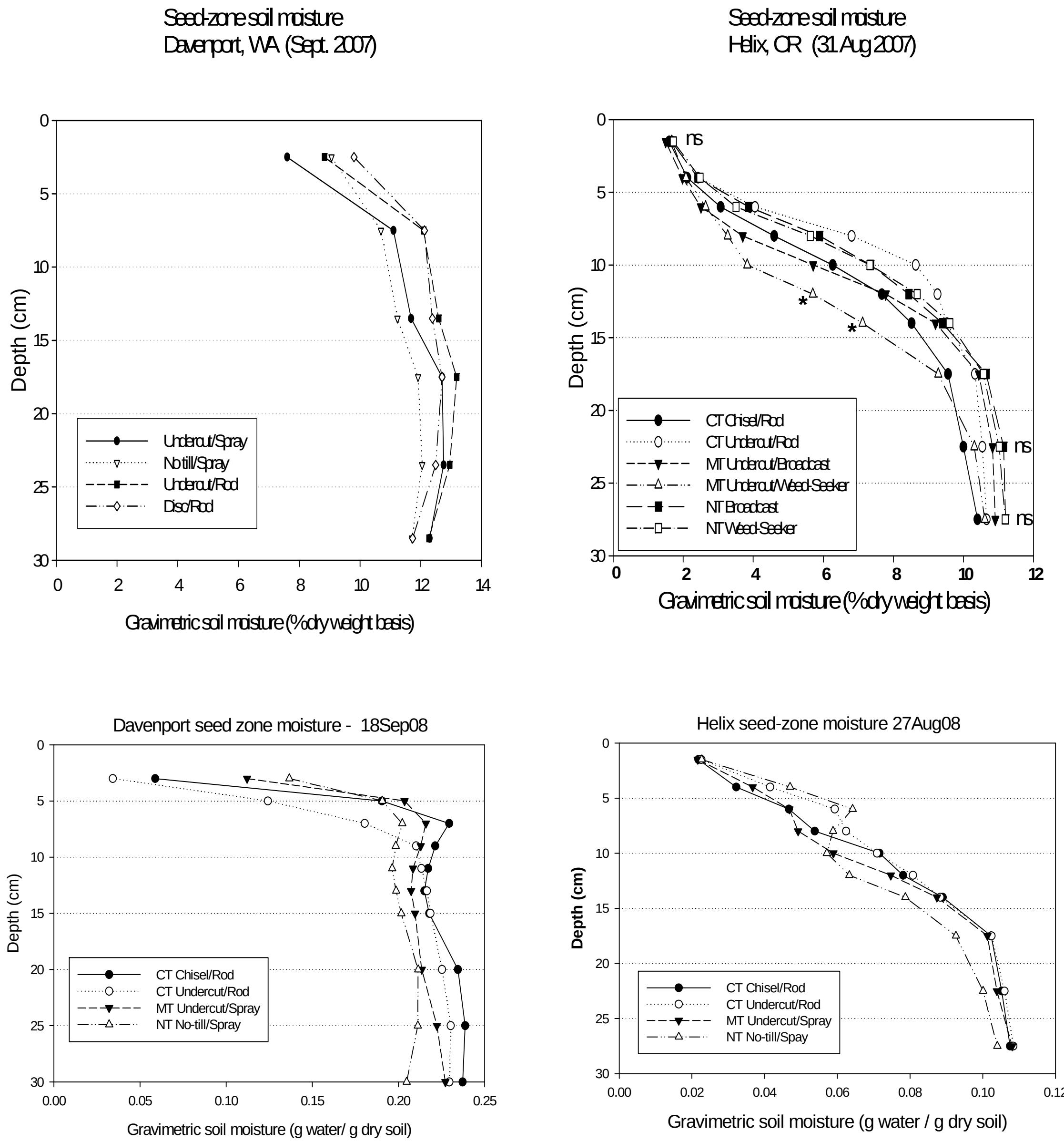


Figure 2. Seed-zone soil moisture content in late summer after four fallow management methods. Davenport, WA and Helix, OR. 2007 and 2008.



Objective 2 Summary: In the second year of studies conducted at the Davenport, WA (described above) and at the Columbia Basin Agricultural Research Center near Pendleton, OR, evaluations of herbicide efficacy using an optical sensor controlled (OSC) spot sprayer (WeedSeeker™) in chemical fallow systems are summarized (Table 4). At both the Pendleton and Davenport sites in 2008 the dominant broadleaf weed species were tumble pigweed and prickly lettuce. At both locations, most treatments with the exception of bromoxynil (Buctril) or BAS 800H applied alone, provided acceptable weed control through the OSC sprayer. At this time, alternatives to glyphosate for fallow weed control with an OSC sprayer appear to exist for the broadleaf weeds encountered at these sites.

Table 4. Visible weed control in chemical fallow at (14 DAT) with an optical sensor , spot sprayer. Pendleton, OR, and Davenport, WA. 2008.

	Treatment [1]	Rate	Application method [2]	Pendleton, OR site		Davenport, WA site	
				LACSE* control	AMAAL control	LACSE control	AMAAL control
		-- amount/a --		------------------------ % ----------------------			
1	glyphosate	1.5 lb ae	A	100	100	30	100
2	glyphosate	3.0 lb ae	B	100	100	91	99
3	glyphosate	1.5 lb ae	B	99	99	95	100
4	glyphosate	0.75 lb ae	B	93	96	95	99
5	glyphosate + Unison	1.5 lb ae + 4 pt	B	94	100	88	100
6	Unison (2,4-D)	4 pt prod.	B	91	100	83	82
7	glyphosate + Huskie	0.75 lb ae +15 fl oz	B	86	98	99	99
8	Huskie	15 fl oz prod.	B	90	99	100	97
9	glyphosate + Buctril	0.75 lb ae + 0.5 lb ai	B	87	98	85	93
10	Buctril	0.5 lb ai	B	30	48	20	27
11	glyphosate + Aim EW + Clarity	0.75 lb ae + 0.031 lb ai + 0.25 lb ai	B	94	100	97	98
12	Aim EW + Clarity	0.031 lb ai + 0.25 lb ai	B	85	89	100	89
13	Gramoxone Inteon	3 pt prod.	B	79	76	99	97
14	Glyphosate + BAS 800H	0.75 lb ae + 2 fl oz	B	96	99	96	86
15	BAS 800H	2 fl oz	B	49	38	100	51
16	Untreated control	--	--	0	0	0	0
	LSD (0.05)			17.8	12.6	-	-

[1] All treatments except the untreated control received Bronc Max at 1 % v/v and NIS at 0.5 % v/v.
[2] A = broadcast spray; B = optical sensor (WeedSeeker) spray.
* LACSE = prickly lettuce; AMAAL = tumble pigweed.

Table 5. Weed biomass and density in chemical fallow with a optical sensor spot sprayer. Pendleton, OR and Davenport, WA. 2008.

Treatment [1]		Rate	Application method [2]	Pendleton, OR[3] Total weed biomass	Davenport, WA Total weed biomass
				g/m^2	g/m^2
1	glyphosate	1.5 lb ae	A	0	4
2	glyphosate	3.0 lb ae	B	1	0
3	glyphosate	1.5 lb ae	B	0	0
4	glyphosate	0.75 lb ae	B	0	0
5	glyphosate + Unison	0.75 lb ae + 4 pt	B	3	1
6	Unison (2,4-D)	4 pt prod.	B	2	4
7	glyphosate + Huskie	0.75 lb ae +15 fl oz	B	2	1
8	Huskie	15 fl oz prod.	B	16	6
9	glyphosate + Buctril	0.75 lb ae + 0.5 lb ai	B	27	1
10	Buctril	0.5 lb ai	B	144	93
11	glyphosate + Aim EW + Clarity	0.75 lb ae + 0.031 lb ai + 0.25 lb ai	B	4	1
12	Aim EW + Clarity	0.031 lb ai + 0.25 lb ai	B	98	9
13	Gramoxone Inteon	3 pt prod.	B	19	1
14	Glyphosate + BAS 800H	0.75 lb ae + 2 fl oz	B	0	21
15	BAS 800H	2 fl oz	B	123	96
16	Untreated control	--	--	331	302
	LSD (0.05)			93.8	-

[1] All treatments except the untreated control received Bronc Max at 1 % v/v and NIS at 0.5 % v/v.
[2] A = broadcast spray; B = optical sensor (WeedSeeker) spray.
[3] Treatments evaluated ~14 days after treatment (DAT).

IMPACTS OF RESEARCH: Justification: (including benefits to growers): The development of a chemical fallow system, or a modified chemical fallow system utilizing an undercutter sweep could offer an effective method for managing weeds and conserving seed-zone soil moisture that is critical for early wheat crop establishment in intermediate-rainfall environments. The utilization of a sweep tillage operation has the potential to facilitate weed control and reduce evaporative soil moisture loss, thereby preserving seed-zone moisture for optimal seeding conditions. Systems need to be developed which rely less on multiple glyphosate applications given the potential for the development of herbicide-resistant weed populations. Preservation of seed-zone moisture and retention of crop residue to minimize soil erosion is a desirable outcome from limited sweep tillage operation(s). Moreover, an evaluation of the economics of these alternative fallow management systems is needed to determine their feasibility for reducing overall cost of fallow, as well as the impact on subsequent crop yield and return on investment throughout the crop cycle within the intermediate rainfall production area.

The proposed research is also timely from an economic perspective. Adoption rates for conservation tillage are low in the PNW wheat-fallow region. This remains true despite some promising previous research at Lind which showed reduced tillage wheat-fallow systems to be equally profitable as conventional tillage wheat-fallow. Nail, Young, and Schillinger (2005) have recently updated the economics of the Lind research (Janosky, Young, and Schillinger, 2002) to reflect the currently higher diesel prices and lower glyphosate herbicide prices relative to 1998. This update shows the reduced tillage wheat-fallow systems to be statistically more profitable than the conventional tillage systems. Further research at other sites would be useful to hopefully confirm these results and to make a convincing case to farmers. With the current and likely future elevated prices for fuel, the timing could not be better for testing promising reduced tillage wheat-fallow systems.

Expected outcomes and anticipated impacts for research and extension: Expected outcomes from this research include the identification of the economic and agronomic feasibility of several techniques related to fallow operations. Techniques to be evaluated include the effectiveness of sweep tillage at maintaining seed-zone soil moisture with and without subsequent rod weeding; the effectiveness of a residual herbicide program and the feasibility and effectiveness of WeedSeeker® technology on overall weed control and subsequent crop response. All of the tillage/herbicide combinations will be compared and evaluated as possible replacements for conventional tillage. Information generated from this study will provide a basis for cost/yield comparisons between sweep and chem-fallow, and provide information on the potential for fuel, labor, and herbicide savings during the fallow period.

INTERACTION WITH OTHER SCIENTISTS CONDUCTING RELATED ACTIVITY: The project is being coordinated across two locations at Pendleton, OR and Davenport, WA. All aspects of these studies are being coordinated by the principal investigators. In addition, soil moisture sampling were coordinated and directed by Stewart Wuest, USDA-ARS, Pendleton, and Don Wysocki, Oregon State University, Pendleton. Undercutter treatments were designed and conducted at both locations after review of previously conducted research and published results from Bill Schillinger, WSU, Lind, WA.

PUBLICATIONS AND PRESENTATIONS: The following presentations have been made related to this project:

Corp, M. K. & Lutcher, L. "Evaluation of Wheat-Fallow Methods in the Pacific Northwest". Seminar. Western Australia Department of Agriculture and Food - Dryland Research Institute; Merredin, Western Australia. September 13, 2007.

Corp, M. K. and S. Wuest. Evaluation of fallow methods study: no-till, reduced tillage, and traditional fallow. Presented at 2008 ASA annual conference. Houston, TX.

Ball, D. A. and L. H. Bennett. 2008. Light-activated sensor sprayer for reduced herbicide use in no-till fallow. Pg 15-19 in: 2008 Dryland Agric. Res. Annual Rpt. Oregon State Univ. Spec. Rpt. 1083.