

***YIELD TRENDS IN A LONG-TERM CONTINUOUS DIRECT-SEED WINTER
WHEAT/SPRING CEREAL CROPPING SYSTEM**

R. James Cook, Tim Paulitz, Ron Sloat, and Ryan Davis

A study was undertaken the fall of 1987 on the Palouse Conservation Field Station near Pullman to evaluate yield trends and root diseases with continuous direct-seeded cereals. The 2002 planting of spring wheat represented the 21st consecutive year where the only tillage has been with the drill equipped to plant and fertilize as one-pass. The 2002 spring wheat represents the 19th cereal crop and the 18th wheat crop in 21 years. In addition to chem fallow in 1987 the plot was planted to spring barley in 1993 and spring peas in 1994. The study site has never been burned, yet the only crop residue present at the time of planting is that of the most recent crop.

The highest yield of winter wheat (Daws, at 128 bu/A in 1988) and spring wheat (Penawawa, at 99 bu/A in 1995) followed the chemical fallow and peas, respectively. This confirms the value in the Palouse of a break to either fallow or a broadleaf crop before planting wheat. The lowest yields of winter and spring wheat were in the second (Hill-81 at 57 bu/A in 1989) and third (Penawawa at 49 bu/A in 1990) years, respectively, due largely to root diseases. Over the past 5 years (17th to 21st consecutive years of direct seeding), the 2-year yield for one winter and one spring wheat year combined has averaged about 150 bu/A.

After years of chronic *Rhizoctonia* root rot, typical of the disease in the Palouse region, severe bare patches developed in this site for the first time in 2002. Approximately 15% of the site showed the bare patch form of this disease. In spite of the scattered patches Alpowa produced an average yield in four replicate plots of 69 bu/A. Undoubtedly this yield was still only about three-fourths of the potential yield for spring wheat at this site in 2002.

***ROOT DISEASES IN THE IRRIGATED CROP RESIDUE MANAGEMENT STUDY,
LIND, 2002**

Timothy C. Paulitz, William Schillinger, and R. James Cook

In 2000, an irrigated study was initiated at Lind to test alternative tillage and crop rotations for production of winter wheat under irrigation. The conventional treatment was continuous winter wheat, using moldboard plowing and stubble burning. The three direct-seeded treatments are 1) mechanical stubble removal, 2) burning residue and 3) standing residue left on surface. For each direct-seed treatment, there are three rotation crops- winter wheat, spring barley, and winter canola. Previous research has shown that tillage or lack of tillage, burning and crop rotation may affect root pathogens, including *Rhizoctonia* (caused of root rot and bare patch), *Gaeumannomyces graminis* var. *tritici* (cause of take-all), and *Fusarium pseudograminearum* and *F. culmorum* (cause of crown or dryland foot rot). Lesion nematode (*Pratylenchus neglectus*) can also damage cereal roots. In 2002, we measured both disease on roots and quantified pathogens with DNA tests. Overall, the disease levels on the cereals in 2002 were low. However, most of the winter canola direct seeded into standing barley stubble was killed in late Sept. by *R. solani*, probably 'greenbridged' from killing a heavy stand of barley volunteer within the crop two weeks previously. There was generally no effect of treatments on spring barley. On winter wheat, the risk of take-all and lesion nematodes were highest in the burn/plow treatment. This treatment also had the lowest yield in 2002. Conversely, the risk of *Rhizoctonia* was lower in the burn/plow, and the risk of *Fusarium* was highest in the standing stubble and mechanical

stubble removed treatment. However, in irrigated wheat, even though the pathogen is present, *Fusarium* may not cause much disease because of the adequate water and lack of plant water stress. Adequate water may also compensate for root damage caused by these pathogens.

RALSTON PROJECT CONTINUES ON!

Olivia Forté Gardner (WSU), Frank Young (WSU), Bill Pan (WSU),
Curtis Hennings (area grower)

The Integrated Spring Cropping Systems Project, better known as the 'The Ralston Project', began in the fall of 1995. The project, collectively conceived and designed by regional growers and scientists, aimed to reduce the risks associated with no-till, annual, and spring cropping systems in areas of low rainfall. Researchers from ten disciplines annually evaluated each cropping system on: a) weed population dynamics; b) soil fertility and nutrient cycling; c) varietal resistance to insects and disease; d) no-till and reduced tillage operation; e) stubble management for soil moisture and erosion control; f) pest populations and chemical inputs for control, and g) economic profitability and risk. Recently, investigators expanded and modified main plots and satellite studies to comply with the requests of interested growers and scientists. The major objectives however, remain consistent.

Two consecutive years of extreme drought hit several crop rotations in Phase II (2000-2002) hard, affecting their overall performance. Now in Phase III, investigators have split the plots to modify treatments and test new rotations. This allows researchers to test decisions related to crop selection, planting date, herbicide requirements, and marketing *based upon prevailing environmental and biological conditions*. These refined treatments include: 1) reduced-till winter wheat or winter canola – fallow; 2) no-till soft white spring wheat (flex crop) or chemical fallow – facultative spring wheat; 3) no-till hard red spring wheat with normal or reduced herbicide applications; 4) no-till spring oats (for forage or seed) – spring triticale, and 5) no-till hard white spring wheat – one-pass till spring barley or no-till spring barley.

In Phase II, an additional researcher conducted a survey to determine if and how the project's innovative research approach and design impacted visiting growers. The survey revealed that growers overwhelmingly viewed the project as a valuable learning tool to control soil moisture, reduce wind erosion, and manage the risk of converting to and sustaining alternative cropping systems. Growers' input from the survey along with researcher input and regional drought during Phase II contributed significantly to redesigning treatments in Phase III.

The field tour featuring Phase III is scheduled for Tuesday, June 1, 2004.

COMPARATIVE WATER USE BY SIX DRYLAND ALTERNATIVE CROPS

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Many growers in the low-precipitation (less than 12 inch annual) non-irrigated crop production region of the inland Pacific Northwest (PNW), want to diversify the wheat (*Triticum aestivum* L.) monoculture cropping system with alternative crops. In such dry environments the quantity of water used by alternative crops, and the soil depths from which water is extracted, is an important factor determining water availability for subsequent crops. A 2-year field study was conducted at 3 sites (5 site years) to determine water use and above-ground dry matter production (DMP) characteristics of six spring-planted alternative crops that may have agronomic and economic potential. Crops were dry field pea (*Pisum sativum* L.), flax (*Linum usitatissimum* L.), yellow mustard (*Brassica hirta*), foxtail millet (*Setaria italica* L.), safflower (*Carthamus tinctorius* L.), and sunflower (*Helianthus annuus* L.). Soil water content to a depth of six feet and DMP were measured at approximate 20-day intervals during the growing season. Crops fell into four water-use categories, from greatest to lowest: i) sunflower, safflower, millet, ii) yellow mustard, iii) flax, and iv) pea. Soil water use (minus precipitation) ranged from 4.8 inches for sunflower to 1.7 inches for pea. Each crop showed a unique extent and soil depth from where water was extracted. Average total DMP ranged from 8,125 lbs/acre for sunflower to 4,195 lbs/acre for pea. This is the first published report on comparative water use of alternative crops in the PNW dryland cropping region.

SEED PRIMING WINTER WHEAT FOR GERMINATION, EMERGENCE AND YIELD

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Insufficient stand establishment of winter wheat (*Triticum aestivum* L.) is a major problem in the low-precipitation (less than 12 inch annual) dryland summer fallow region of the inland Pacific Northwest. Low seed zone water potential, deep planting depths with six inches or more soil covering the seed, and soil crusting caused by rain before seedling emergence frequently impede winter wheat stands. A 2-year study involving laboratory, greenhouse, and field components was conducted to determine seed priming effects on winter wheat germination, emergence, and grain yield. Two varieties were used based on their strong (Edwin) and moderate (Madsen) emergence capabilities. Germination rate was measured in the laboratory using 44 treatment combinations (2 varieties x 3 priming durations x 7 priming media + 2 checks). Germination rate differed between varieties as well as by priming duration, priming media, and concentration of priming media. The most promising laboratory treatments were advanced to greenhouse and field experiments where emergence and grain yield (field only) were measured in 10 treatments (2 varieties x 4 priming media + 2 checks) from wheat planted deep with six inches of soil covering the seed. In the greenhouse, seed primed in potassium chloride (KCl), polyethylene glycol (PEG), and water led to enhanced emergence of Madsen, but not of Edwin, compared to checks. Rate and extent of seedling emergence was greater for Edwin compared to Madsen irrespective of priming media in three of four field plantings at Lind, Washington. None of the seed priming media benefited field emergence or subsequent grain yield in either variety compared to checks. Overall, results suggest that seed priming has limited practical application for enhancing emergence and yield of winter wheat planted deep into summer fallow.

**LONG-TERM NO-TILL ALTERNATIVE CROPPING SYSTEMS RESEARCH
AT THE RON JIRAVA FARM: YEAR 6**

Bill Schillinger, Ron Jirava, Harry Schafer, Jim Cook, Doug Young,
Tim Paulitz, and Ann Kennedy
Washington State University and USDA-ARS

We have completed six years of an ongoing cropping systems research project at the Ron Jirava farm near Ritzville, Washington. Annual precipitation was less than the long-term average in five of the six years. Over the years, annually cropped no-till soft white spring wheat (SW) averaged 35 bu/a with net returns of \$8.52 acre/year that was statistically equivalent to the traditional winter wheat - summer fallow system. This is the first economic "good news" for annual cropping in the low-precipitation zone. Spring planted barley, safflower, and yellow mustard showed negative net returns. Rhizoctonia root rot 'bare patch' disease first appeared in 1999 and is an ever-increasing problem. Phase II of the project, that began in the 2001 crop year, includes two 4-year rotations that contain recrop soft white winter wheat. Similar to spring-planted crops, recrop winter wheat failed during extreme drought in 2001. In 2002, recrop winter wheat yields were the same as spring wheat. Downy brome, which was not present for five and six years with continuous spring crops, heavily infested winter wheat in both 2001 and 2002. One referred journal article on disease was published, and two other journal articles (on economics and insects) were submitted in 2002. The long-term cropping systems research project at the Jirava farm will continue for the foreseeable future.

**SOIL QUALITY CHANGES WITH NO-TILL MANAGEMENT
ADOPTION FOR WIND EROSION CONTROL**

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USDA-ARS and Washington State University

We are characterizing the biological, physical and chemical soil quality parameters as affected by tillage, crop species and management systems. Research is being conducted in conjunction with the ongoing wind erosion projects initiated at various locations representing a range of time into no-till and several precipitation zones. Soil was sampled at sites near Genesee, ID, Colfax, WA, Ritzville, WA and Lind, WA from the 0 to 2 inch and 2 to 4 inch depths in early spring and mid-summer or fall to monitor soil quality changes over time. Soil quality and crop production data will be used to assess the influence of management practices on soil quality.

Organic matter in surface soils increased over time with long-term no-till. Changes in the microbial community and other soil quality parameters such as pH, electrical conductivity and microbial enzyme activity were variable in their response. Soil quality changes during the transition to no-till take longer, are less perceptible and are more variable in the low (150-to 300 mm annual) precipitation zones compared to the higher (300-to 550 mm annual) precipitation zones. The addition of irrigation water to Lind soils appears to shorten the transition time. In these plots, the continuous winter wheat burn plow treatment is showing signs of being degradative to soil quality. The lower disturbance with direct seed has more of an impact on soil quality measurements than surface residue management. Data from these long-term experiments will allow us to better assess the productivity and quality of soils in the dryland cropping region of the Inland Pacific Northwest to aid farmers in the transition to no-till cropping.

**WINTER WHEAT – SUMMER FALLOW VS. CONTINUOUS ANNUAL NO-TILL
HARD RED SPRING WHEAT IN THE HORSE HEAVEN HILLS**

Bill Schillinger, Harry Schafer, Doug Rowell, Doug Young, and Steve Schofstoll
Washington State University

Winter wheat - summer fallow is the predominant cropping system in the 300,000-acre Horse Heaven Hills region in south-central Washington. A 6-year study was conducted from 1997 to 2002 to compare the conventional soft white winter wheat - summer fallow rotation to continuous annual no-till hard red spring wheat (HRSW). Long-term annual precipitation at the experiment site is six inches, which we believe is the lowest for any non-irrigated wheat region of the world. Annual precipitation during the study ranged from 4.1 to 9.8 inches and averaged 5.9 inches. Six-year mean grain yield was 17.9 bu/a for winter wheat after fallow and 8.1 bu/a for annual HRSW (Fig. 1). Net economic returns for annual HRSW were always negative and lagged behind winter wheat - summer fallow by an average \$40 per acre per year. In the driest years, only one inch of soil water was stored and recharge occurred only to 12-to 18-inch soil depth. Although annual no-till cropping has clear environmental advantages, growers in the Horse Heaven Hills have advised that, even if annually cropped wheat should become more competitive after many years of no-till, they cannot afford to go through the transition period. This study is now completed. Two journal articles are planned.

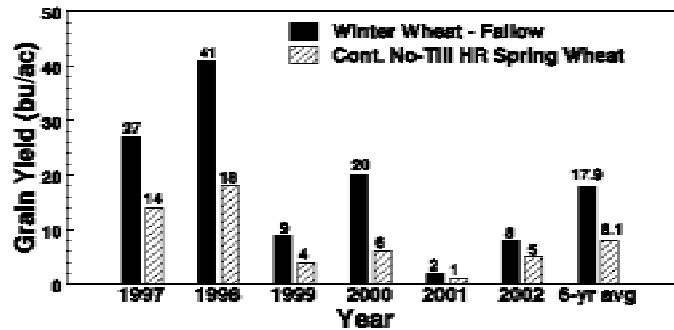


Figure 1. Grain yield of winter wheat after summer fallow compared to continuous annual hard red spring wheat during six years at the Doug Rowell farm, Horse Heaven Hills, Washington.

ALTERNATIVE TO BURNING

W.F. Schillinger, H.L. Schafer, B.E. Sauer, A.C. Kennedy, and T.C. Paulitz
Washington State University and USDA-Agricultural Research Service

A long-term irrigated cropping systems study was initiated in 1999 at Lind, WA, to evaluate a 3-yr rotation of winter wheat - spring barley - winter canola sown: i) directly into standing stubble, ii) after mechanical removal of stubble, and iii) after burning the stubble. The traditional practice of continuous annual winter wheat sown after burning and moldboard plowing is

Table 1. Grain yields of winter wheat, spring barley, and canola in 2001 and 2002 as affected by various stubble and soil management practices.

	Winter Wheat (bu/a)		Spring Barley (ton/a)		Winter Canola (lb/a)	
	2001	2002	2001	2002	2001 ^A	2002
Stubble burned	85	106	2.88	2.21	2574	2502
Stubble mechanically removed	67	110	3.03	2.33	2486	2226
Standing Stubble	69	107	2.88	2.26	2282	2188
Burn and Plow	75	97				
LSD (0.05)	NS	NS	NS	NS	NS	NS

NS = no significant differences at the 5% probability level.
A: spring canola instead of winter canola in 2001.

also included as a check. There are 40 plots (3 crops x 3 stubble management practices + check x 4 replications). Measurements include: grain yield, diseases, soil quality assessment, soil water dynamics and weeds. Excellent stands and yields of spring barley direct seeded into 10,000 lb/acre winter wheat stubble have been consistently achieved. Winter canola stands, weed pressure, and grain yield have been somewhat hampered by direct seeding into barley stubble compared to burning. Disease pressure has been low except for Pythium root rot of winter canola in all residue treatments. Differences in soil enzyme activity and microbial analyses between burn/plow and the direct seed treatments become more apparent each year. Farmers and urban dwellers are closely following this study because direct seeding into heavy residue with a diverse 3-yr crop rotation eliminates smoke emissions and air quality concerns created by stubble burning.

POLYMER SEED COATINGS FOR LATE FALL DORMANT PLANTING OF CEREALS

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Fall or dormant seeding is a management practice where spring crops are sown in the fall instead of March or April. The list of benefits of dormant seeding include faster spring growth to compete with Russian thistle and other broadleaf weeds, reduced heat and water stress, and higher yields. Dormant seeding is not without risks. Warm temperatures after late-fall seeding may result in emergence of spring wheat seedlings that may easily winter kill. In this study at Lind, we are evaluating hard red spring wheat (Scarlet), soft white spring wheat (Alpowa), spring barley (Baronesse), and soft white winter wheat (Eltan) planted in late November with and without polymer seed coating. The polymer "ExtenderTM" has been developed to prevent seed from imbibing water until soil temperatures begin to warm in late winter - early spring. The trial was planted in the last week of November in both 2001 and 2002 and again in mid March in 2002 and 2003 (planned). The four cereal entries are planted with and without the polymer coating into undisturbed spring wheat stubble with a Cross-slot drill equipped with a cone seed feeder. Planting rate for all entries is 70 lbs/acre and fertilizer rate is 40 lbs N, 10 lbs P, and 10 lbs S per acre. Experimental design is a randomized complete block with four replications.

For the 2002 crop year, plant stand establishment for all cereal entries was significantly reduced when planted in late November compared to mid March regardless of whether or not seed was coated with the polymer (Fig. 1a). Scarlet was the only entry that had better emergence from November planting without the polymer compared to with the polymer. The polymer had no effect on stand establishment on any of the four cereal entries from the mid-March planting (Fig. 1b). Within cereal entries, Eltan planted in late November without the polymer had significantly greater grain yield than late November planting with the polymer as well as mid March planting (both with and without the polymer) (Fig. 1b). For the other entries, there were no within-cereal grain yield differences as affected by planting date or polymer coating for Scarlet, Alpowa, or Baronesse (Fig. 1b). This project is ongoing.

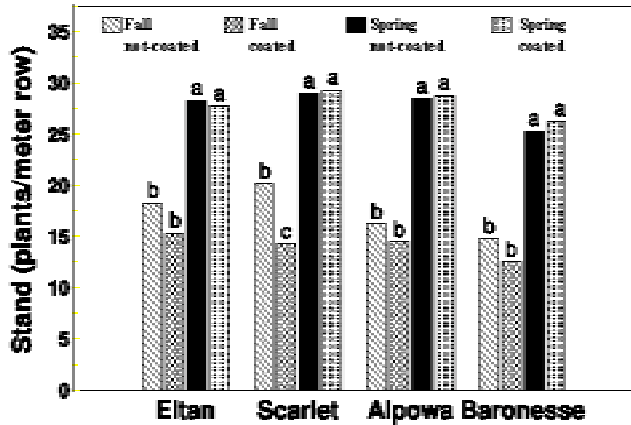


Figure 1a. Stand establishment of four cereal cultivars in 2002 with and without polymer seed coating planted in late fall (dormant seeding) and early spring.

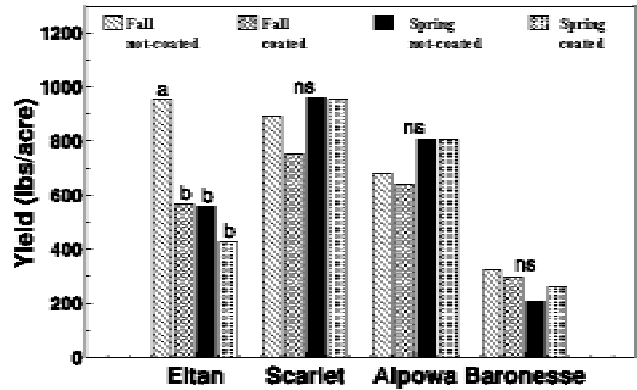


Figure 1b. Grain yield of four cereal cultivars in 2002 with and without polymer seed coating planted in late fall (dormant seeding) and early spring.

***FALL FERTILIZATION FOR SPRING WHEAT PRODUCTION IN DIRECT SEED ANNUAL CROP ROTATIONS**

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 Aaron Esser, WSU Extension On-Farm Testing Assoc., Ritzville

The objectives of this research are to evaluate the benefits of fall fertilization and the impact on nitrogen movement in soils and the impact on spring wheat establishment, yield, and quality. Two on-farm research projects were initiated in the fall of 2001, one, six miles north of Sprague WA, and the other, five miles south of Lamont, WA both located in the 10 to 12 inch rainfall area. Plot areas were fall fertilized using a low disturbance ‘Blue Jet’ coultter applicator. Treatments at both locations were fall fertilized with the low disturbance applicator (fall LD), spring fertilized with the low disturbance applicator (spring LD), fertilizer was dribbled on the soil surface (spring dribble), and spring fertilized with high disturbance one or two pass fertilizer/seed system (spring HD).

Nitrogen fertilizer applied in the fall with the LD applicator did not move past the first foot of soil by spring (Figure 1). Cooler soil conditions at fertilization, combined with less than normal precipitation limited nitrogen movement into the profile. There were no significant differences in wheat seedling establishment between the four treatments. At Sprague, wheat yield, test weight and protein were not significantly different between treatments. At Lamont, wheat yield for fall LD was significantly greater than spring LD or spring dribble but not spring HD. The spring HD treatment had significantly greater protein and lower test weight, and the spring

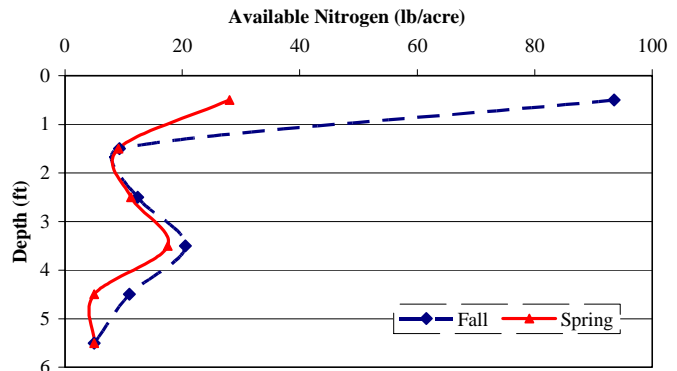


Figure 1. Available nitrogen fertilizer in the spring of the year after fall fertilization and prior to spring fertilization in an on-farm trial near Lamont, WA.

dribble treatment had the lowest protein and highest test weight. Protein and test weight for fall and spring LD treatments significantly different.

Results from these two experiments showed that fall fertilization can be a benefit in a direct seed annual cropping system. Given the dry winter in 2001-2002, nitrogen movement into the soil profile was minimal. This is the first year of an on-going project that will be conducted through two more growing seasons to evaluate how this system works under different moisture and temperature regimes.

***WEED DYNAMICS IN AN INTENSIVE DRYLAND CROP ROTATION STUDY**

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Objectives of this project were to diversify crop rotations grown in the intermediate rainfall area of the PNW, promote natural resource stewardship through reduction of wind and water erosion, monitor changes in soil quality parameters, implement of integrated pest management practices and monitor changes in pest populations.

Two crop rotations were initiated in the spring of 1998 at the WSU Wilke Research and Extension Farm near Davenport, WA and on five cooperator's fields within a 30-mile radius of Davenport. The 3-year rotation was winter wheat/spring cereal/broadleaf. The 4-year rotation was spring cereal/winter wheat/warm season grass/broadleaf. Plot size ranged from 8 to 10 acres on the Wilke Farm and from 10 to 100+ acres on cooperator farms. All field operations were performed using grower's equipment. Small grain crops grown in the study included winter wheat, spring wheat and barley; broadleaf crops included yellow mustard, canola, peas, sunflowers, flax, safflower, buckwheat; and warm season grasses included proso millet and corn.

Weed management has been one of the major concerns and costs in transitioning to direct seeding. In the three-year rotation, prickly lettuce, prostate knotweed, and wild oat populations decreased. In the four-year rotation, the downy brome population increased and Canada thistle increased in both rotations. Wild oat populations decreased in both rotations, but the decrease was more rapid in the three-year rotation. Averaged over years, the wild oat population was greatest in the spring cereal crop and lowest in winter wheat and the broadleaf crop. Averaged over years, the wild oat population was greatest in the warm season grass. Downy brome populations remained static in the four-year rotation but increased in the three-year rotation.

***OVERVIEW OF THE SPOKANE COUNTY AND NORTHWEST CROPS DIRECT SEEDING PROJECTS**

Diana Roberts, Dennis Roe, Dennis Pittmann, Herb Hinman, Roger Veseth

WSU Cooperative Extension teams with growers from Whitman and Spokane counties on two grower-driven direct seeding projects that are funded by USDA-SARE (Sustainable Agriculture, Research and Education). The NRCS, Spokane County Conservation District, Palouse-Rock Lake Conservation District, Palouse Conservation District, Whitman Conservation District, and Pine Creek Conservation District are also partners on these projects.

Northwest Crops Project 2003 is the 6th year of the Northwest Crops Project. The farmer cooperators are comparing a four-year direct seed rotation; winter wheat – warm season grass (corn) – broadleaf - spring wheat with a three-year rotation; winter wheat – spring barley – chem. fallow. The 4-yr rotation includes a warm season grass to provide different windows for

weed management and a broadleaf to help break disease cycles. The trials are set up in on-farm testing strips with each plot/crop being at least 30 ft by 500 to 700 ft.

Spokane County Direct Seeding Project 2003 is the third and final year for the Spokane County Direct Seeding Project. Participating growers identified specific questions they wanted answered, and designed their own trials to solve them. Most of the trials questions relate to residue management, which is a primary challenge to successfully adopting direct seeding in the annual cropping zone (18 to 22 inches precipitation).

Extension is an important part of all three projects, and we host workshops and field tours so that growers can learn from the trials. The Spokane Project tour will be June 24, 2003. You may obtain annual reports of the projects or details on events from the project contacts: Diana Roberts (phone 509-477-2167, e-mail robertsd@wsu.edu); Dennis Pittmann (phone 509-397-4636 ext 115, e-mail pittmann@wsu.edu); Dennis Roe (phone 509-397-4636 ext 117, e-mail rdroe@coopext.cahe.wsu.edu or go to <http://www.spokane-county.wsu.edu/> and click on the farming icon then the direct seeding link.

***ALTERNATIVE STRATEGIES TO ACHIEVE ECOLOGICAL AND ECONOMIC GOALS DURING THE TRANSITION PHASE FOR ORGANIC GRAIN PRODUCTION IN THE PALOUSE**

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As demand for organically grown commodities continues to grow at over 20% annually, crop producers have the opportunity to increase the economic profitability and environmental sustainability of their operations by transitioning to an organic production system. Organic certification requires a three-year transition phase, where a cropping system must be free of non-approved fertilizers and pesticides, and organic price premiums cannot be collected. As the agroecosystem adjusts to these changing conditions, a farmer may be vulnerable to economic losses due to weed infestations, inadequate soil fertility, and dockage penalties due to poor crop quality. This can be compounded by the necessity to build biologically robust soils that are capable of sustaining crop production during certified organic production.

The goal of this research project is to develop strategies that ease the burden of this transition period while achieving the necessary biological and economic goals associated with soil and pest management. This will be accomplished by evaluating various crop combinations during the transition period to better understand the trade-offs among weed management, soil quality and economics. These alternative cropping systems include combinations of cash grains, perennial and annual forages, and legume, brassica and green manure crops. A system of measurements have been designed to evaluate each cropping systems effect on reducing weed populations, improving the quality of the soil and competitive ability of the crops, and the most optimal economic scenario for the transition phase and on into certified organic production.

III. Profitability and Risk Management

***ECONOMICS OF WIND EROSION CONTROL CROPPING SYSTEMS AT THE RALSTON PROJECT**

Douglas Young and Frank Young

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These experimental trials were initiated in August 1995 on a farm near Ralston in an 11.5-inch annual rainfall zone. The main trials at the site evaluated four tillage/crop rotation systems: a) conventional/minimum tillage SWWW/fallow; b) no-till soft white spring wheat (SWSW)/chemical fallow; c) continuous no-till HRSW; and d) no-till HRSW/no-till spring barley (SB).

No-till continuous spring grain rotations are clearly an environmental success. Research has shown that these systems can reduce predicted dust emissions by 94% during severe wind events compared to conventional wheat-fallow. But seven years experimental results at Ralston have shown that the continuous no-till spring grain systems tested have not been economically competitive with a minimum tillage winter wheat/fallow system. The 1996-2000 average disadvantage of \$42/acre/year for continuous HRSW versus SWWW/fallow grew to a \$53/acre/year average disadvantage over 1996-2002. Furthermore, the spring cropping systems exhibited significantly more economic risk in dry years. Of course, more yield enhancing research and public support for these soil and air quality conserving spring cropping systems, possibly using different wheat classes, might make them more competitive. Researchers should also investigate other soil conserving systems. Minimum tillage SWWW-fallow systems tested at Lind and at Ralston employed substantially less tillage during the fallow operation than was typical on most area farms. These “minimum tillage” SWWW-fallow systems, which are predicted to cut dust emissions in severe events by 54 percent relative to conventional systems, might provide a cost effective intermediate cropping system for the region.

Results from farmer surveys and Cooperative Extension farmer panels have indicated that farmers may be able to trim the cost of production for HRSW. If possible, this would improve their competitiveness with winter wheat-fallow. Other research has shown significant public valuation for higher levels of air quality which are provided by soil conserving cropping systems.

***ECONOMICS OF ALTERNATIVE CONTROL PRACTICES FOR JOINTED GOATGRASS IN WINTER WHEAT IN THE PACIFIC NORTHWEST**

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Jointed goatgrass control field experiments were established in 1996-2002 near LaCrosse, WA in a 14-inch annual rainfall zone. Main plot treatments included stubble burn and stubble no burn. Subplots included three crop rotations: a) WW/fallow; b) SW/fallow/WW/fallow; c) WW/SB/fallow. Subsubplots included growers’ “conventional” practices for fertilizing and planting winter wheat versus “integrated” practices for fertilizing and planting winter wheat. Integrated practice included larger seed size, higher planting density, deep banded fertilizer at