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FINAL REPORT: Final report.

PROJECT OBJECTIVES:

Objective I: Determine the impact of farming practices and systems on soil, air, and water quality. Assess the impacts of conservation practices on soil, water, and air quality and use this information to develop tools for improved conservation planning and resource management.

Objective II: Develop new technologies and increase efficiency of inputs that improve profitability of conservation farming systems. Develop profitable and environmentally sound conservation practices for pest and plant nutrient management. Identify crop plants and plant characteristics that enhance conservation farming systems for specific agronomic zones. Develop profitable conservation tillage and cropping systems for lands most vulnerable to resource degradation.

Objective IIa: Determine effectiveness of different herbicides for control of volunteer herbicide-resistant crops (HRC); Roundup Ready® spring wheat and canola, Clearfield® wheat and canola, and Liberty Link® canola.

Objective III: Assess the profitability of conservation tillage and cropping systems for lands most vulnerable to resource degradation. Estimate profitability, risk, and other economic impacts of conservation farming systems.

Objective IV: Accelerate grower evaluation and adaptation of profitable conservation systems.

KEY WORDS: Herbicide-resistant crops (HRC), Roundup (glyphosate), diffusion of technology, social influence, survey, adoption, adaptation.

STATEMENT OF PROBLEM: Weeds often pose the single greatest threat to successful adoption of direct-seed, conservation cropping systems. With current herbicide technology, weeds such as jointed goatgrass, feral rye, and downy brome are difficult or impossible to selectively control in winter wheat. In spring crops, especially broadleaf crops, Russian thistle is the major threat. Herbicide-resistant crop development is progressing rapidly and providing an opportunity to selectively control these and other weeds in direct-seed cropping system. However, there is little or no information on how to safely and effectively incorporate them into Pacific Northwest (PNW) direct-seed dry land winter wheat cropping systems. Important, unanswered questions include which HRC crops should or should not be used in a particular cropping system, and if used, how often. Many of the herbicides used on HRC are currently used or are closely related to herbicides used in PNW wheat production. Thus, how best to control volunteer herbicide resistant crops in these situations also requires study. Traditionally, growers
have relied on Roundup to control volunteer crops and weeds in no-till cropping systems. This poses a problem for control of volunteer HRC such as Roundup Ready wheat and canola.

**ZONE OF INTEREST:** winter wheat-fallow and annual crop in low, intermediate and high rainfall.

**ABSTRACT OF RESEARCH FINDINGS:** For the third consecutive year, rainfall has been below the long-term average of 11.5 inches. Rainfall was 4.3 and 1 inch(es) less than the average for the 2000-01, 2001-02, and 2002-03 growing seasons, respectively. This past spring was cold and very windy, which delayed seeding of spring crops because of untimely pre-plant herbicide applications for green bridge management. In the demonstration no-till rotation of late-planted winter wheat, spring triticale, and spring wheat, the no-till spring wheat was the highest yielder 2 out of 3 years. Spring mustard and spring canola did not produce enough seed to harvest all 3 years. In fact, spring canola failed to even germinate, emerge, and establish. Because of the extremely dry growing seasons of 2000-02, new main core rotations were established for the 2002-03 growing season based on the non-performance of rotations in 2000-02 and grower interests documented in a survey conducted in 2002. What made this survey unique was that it was the first time ever that a specific project was evaluated for its regional impact on interested growers. More than 60% of the growers used and more than 50% of the growers adopted technologies from the research project. A nine page final report on control of herbicide resistant volunteer crops was published in the 2002 STEEP progress reports and is, therefore not reproduced in this report.

**RESULTS AND INTERPRETATION:**

**Objective 1:** Crop rotations that were examined in Phase II selected for the main core site include three rotations compared to the traditional tillage winter wheat fallow system. These rotations include a) no-till hard red spring wheat; b) no-till hard red spring wheat/spring barley; and c) no-till facultative spring wheat/no-till spring canola. Hard red spring wheat entailed using a variety (Tara) that has host-plant resistance to Hessian fly, a major pest of no-till spring wheat. Hard red spring wheat plots were split in half and compared grain production and quality of normal inputs with reduced inputs. Phase II cropping systems included: a) three-year crop rotation of no-till winter wheat, spring triticale, spring wheat; b) no-till hard white spring wheat, no-till spring canola; and c) no-till spring oats, spring mustard, spring canola. Because of poor growth performance by the spring broadleaf crops (mustard and canola), information was collected only from the 3-yr cereal rotation (item a) listed above.

This past growing season was again dry with only 10.5” of rain from October 1, 2002 to August 31, 2003. In the 3-yr rotation of no-till late-planted (November) winter wheat/spring triticale/spring wheat, yields were 19, 21, and 27 bu/A for winter wheat, spring triticale, and spring wheat, respectively. The 3-yr average was 16,13, and 19 bu/A for winter wheat, spring triticale, and spring wheat, respectively.

The project was requested again, by WSU administrators and the Washington Wheat Commission, to abandon Roundup® Ready® spring wheat experiments. Because of the turmoil and discontent surrounding the use of Roundup® Ready® spring wheat on growers fields and
failure to establish a canola stand, the separate long-term study evaluating a HRC rotation of Roundup® Ready® spring wheat and Liberty® Link® canola was discontinued.

**Objective II:** Other information presented in this report include disease management and carbon sequestration. Disease enhancement or suppression must be considered during the transition from winter wheat-summer fallow rotation to conservation-oriented systems such as annual spring cropping. Cereal root diseases have been monitored in the spring cropping study since 1995. Rhizoctonia root rot was identified as the most damaging disease in each of the annual spring cropping systems examined. Growers and advisory and regulatory personnel have shown keen interest in the successes and failures as crop management practices were adjusted to improve overall profitability for conservation systems in the winter wheat-summer fallow region in which most of the Pacific Northwest wheat is produced.

A laboratory incubation study for carbon sequestration was conducted using soil from four treatments at Ralston. Treatments included winter wheat/fallow; no-till spring wheat/no-till spring barley. Data from these soil incubation/microbiological studies indicated that no-till coupled with continuous cropping significantly increased soil C storage. It was also found that the frequency of crop residue additions were more important in retaining C than the effect of disturbance, such as light tillage. The final conclusion of the study was that fungi play an important role in retaining C in soils and promoting a greater fungal population will enhance soil C storage.

**Objective IIa:** A final 9-page report on managing herbicide resistant volunteer crops was published 2 years ago in the STEEP progress reports.

**Objective III:** Experiment 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 rotations systems: a) conventional/minimum tillage (SWWW)/fallow; b) no-till soft white spring wheat (SWSW)/ chemical fallow; c) continuous no-till hard red spring wheat (HRSW); and d) no-till HRSW/no-till spring barley (SB). No-till continuous spring grain rotations are clearly an environmental and agronomic 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 research 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.

**Objective IV:** The transfer of technology (TOT) from this project has always been a unique situation. In attempting to accelerate grower evaluation and the transfer of developed technologies, lead investigators solicited growers' input on proposed research objectives, design, and treatments during the onset of Phases I and II. This strategy was employed to increase the awareness of the project among growers, encourage on-going participation and evaluation, and to shorten the lag time occurring between technology development, transfer, and use/adoption. A survey study was conducted in May 2002 to determine the project's impact on interested growers and the influences affecting technology transfer. The overall impact of the Ralston Project was determined using growers' opinions on project funding and collaboration, experimental design, and growers' interest in production issues addressed in addition to the rate of use, adoption, and transfer of project technologies. All growers who attended the project’s field tours in 1996, 1998, or 2000 were mailed an 8-page, self-administered questionnaire. However, we limited survey eligibility to dryland growers who identified themselves as the primary production decision-maker(s) for their associated farming operation(s). One hundred one eligible growers answered and returned their questionnaire for a completion rate of 64%. A majority of growers first heard about the project through research/extension personnel as well as other growers and continued to receive information through the popular press, field tours, and grower meetings. Nearly half of the respondents passed on information they learned from their site visits to other growers.

Seventy-seven percent of growers found one or more project technologies particularly useful to their own production operation(s). The issues that received the highest amount of the interest during field tours included: 1) the economic analysis for each crop system; 2) using no-till drills for spring planting and fertilizing operations; 3) using spring crops as an alternative to fallowing; 4) and managing crop stubble to increase soil moisture. When asked if they had tried out anything of interest from the project in their own farm operation, 61% growers answered yes and over 1/3 cited independent trials using multiple technologies. Thirty-two growers reported making more or less permanent adoptions from their independent trials. These adoptions included 11 conversions to no-till/direct seeding; 9 conversions to annual/continuous spring cereals; 7 conversions to lower-impact tillage operations, either by use of low-impact equipment or fewer tillage operations; and 2 conversions to annual/continuous spring cropping of cereal and broomleaf crops. These latest adoptions came in addition to adoptions made by 57 of the growers prior to their first visit to the project site. For approximately half of the population, there were particular technologies used in the project that they were either not able or unwilling to incorporate into their own production operations. Individuals largely attributed their decision to regional drought conditions and poor economics and the high risk currently associated with spring cropping. Nevertheless, the high rate of both use and adoption of complex technologies demonstrated the impact of investigators’ extension efforts to help growers overcome persisting hurdles in integrated crop management of conservation cropping systems.

Growers’ overall opinion of the Ralston Project was influenced by both the experimental design and research approach taken by primary investigators. Elements that substantially improved individuals’ opinions included integrated/multiple component research (91%), plot size (90%), project duration (82%), grower input (81%), and growers’ collaboration with researchers (79%)
from several universities (78%). The credibility of the project hinged mainly on: a) investigators’ designation of entire cropping systems as individual treatments; b) a plot design that accommodated commercial-size equipment, and c) the use of a grower advisory panel. However, a small number of individuals felt that the project’s credibility was weakened because investigators selected a site that they considered unrepresentative of regional topography and by the poor economic performance of the crop rotations tested.

Funding sources did not have as great an impact on growers’ opinion as did project design. Fifty-eight percent of individuals surveyed cited that the involvement of Washington, Oregon, and Idaho State Universities improved their opinion of the Ralston Project. This may be attributed to the long-standing relationship between agricultural producers and land grant universities. Federal conservation programs (i.e. STEEP and PM(10)) left just 7% of growers with a worse opinion of the project. This adversity to federally mandated research programs, likely results from the environmental regulation that some believe created it. In concluding remarks, a substantial number of growers supported the project’s continuance citing the value of developing more long-term production trends for no-till and spring cropping systems, especially in the semi-arid region. The long-term study of higher risk management options coupled with a collaborative, large-scale, systems approach to research design have therefore, proved effective technology transfer strategies for the researchers of the Ralston Project.

INTERACTION WITH OTHER SCIENTISTS CONDUCTING RELATED RESEARCH:
Dan Ball, OSU Weed Scientist, Pendleton, OR and Joe Yenish, WSU Extension Weed Scientist, Pullman, WA have also conducted studies to evaluate the effectiveness of different herbicides for control of volunteer Roundup® Ready® spring wheat in no-till cropping systems.

PUBLICATIONS, REPORTS, AND PRESENTATIONS:

Presentations
Annual STEEP review (January, 2003); annal PM-10 review (December 2002).

Publications

Young, D.L., T.J. Kwon, E.G. Smith, and F.L. Young. 2003. Site specific herbicide decision model to maximize profit in winter wheat. Precision Agriculture. 4: 227-238.


