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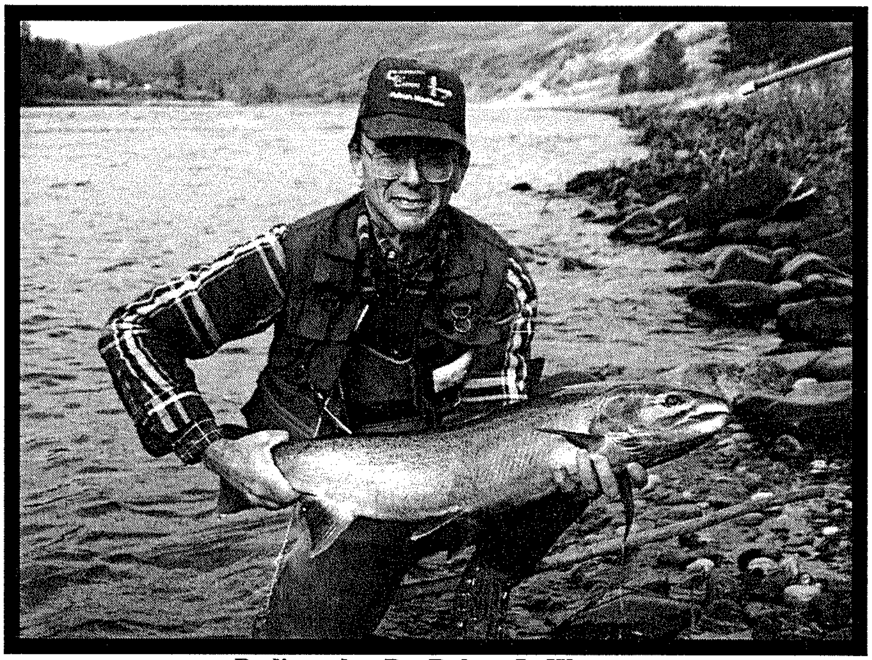

Dedicated to Dr. Robert L. Warner

2003 Field Day Abstracts: Highlights of Research Progress

Full articles on the Web at http://css.wsu.edu

WSU Dryland Research Station, Lind · June 12, 2003
WSU / USDA-ARS Cunningham Agronomy Farm, Pullman · June 26, 2003
WSU Wilke Farm, Davenport · July 2, 2003
WSU Spillman Agronomy Farm, Pullman · July 10, 2003

John Burns and Roger Veseth, Editors

Welcome to our 2003 Field Days!

As the Chair of the Department of Crop and Soil Sciences, I am proud to introduce the *2003 Field Day Abstracts: Highlights of Research Progress*. This publication has a simple purpose: to introduce you to over 35 research programs conducted in 2003 by WSU faculty and USDA/ARS research scientists working as part of or in cooperation with the Department of Crop and Soil Sciences.

The Department of Crop and Soil Sciences mission states that we will "discover and develop principles of crop and soil sciences through scientific investigation and apply these principles to the development of new crop varieties and new crop, soil and water management practices in agricultural, urban and natural environments; teach principles and applications to undergraduate and graduate students; and disseminate accumulated knowledge through resident instruction, continuing education, extension, publications, and professional contacts."

As you will see in the abstracts, we have exciting new and ongoing research activities. Our 2003 departmental sponsored field days are just one way for us to help you learn more about the latest developments in our research programs.

Sincerely,

Dr. William L. Pan, Chair
Dept. of Crop & Soil Sciences

DEDICATION TO ROBERT L.WARNER

Robert L. Warner, Plant and Seed Physiologist, WSU Department of Crop and Soil Sciences, retired on June 30, 2002 after 34 years of service with the WSU. Bob was known for conducting leading edge research in plant enzyme metabolism in plants, for his teaching skills in crop and seed physiology, and for his passion for fishing the rivers and streams of the PNW.

Bob was born and raised on a crop and livestock ranch in Redwood Falls, Minnesota. He attended Franklin High School and was active in FFA and all sports offered at the school. In 1956 he joined the U.S. Army and served as a wheeled vehicle mechanic with a Signal Corps unit at Ft. Huachuca, Arizona.

Bob left military service in 1958 and attended the University of Minnesota, where he received a B.S. degree in Agronomy in 1962, and a M.S. degree in Agronomy and Plant genetics in 1964. He obtained a PhD in agronomy/plant physiology from the University of Illinois in 1968. Bob joined the faculty of the WSU Department of Crop and Soil Sciences on July 1, 1968 with a research and teaching assignment. During his 34 years at WSU he taught over 375 students, received research and training grants in excess of $2 million, published over 50 refereed journal articles and was published in chapters of 11 books. He was also active on departmental and WSU committees having served on the Faculty Senate and 20 different search committees.

Bob and Karne (Kroll) met while he was attending graduate school in Minnesota and they were married in 1964. They have two children, Linda and Janet. Linda and her husband live in Issaquah, WA and gave birth to the first grandchild (Noah) for Bob and Karne in May 2003. Janet is single and currently works for Dr. Diter vonWettstein, R.A. Nilan Endowed Chair, Barley Genetics, WSU Dept. of Crop and Soil Sciences.

From 1996 until his retirement, Bob managed and operated the Seed Lab for the Department of Crop and Soil Sciences. During this time he worked closely with the Washington State Crop Improvement Association and the Washington certified seed industry to evaluate and identify causes of poor wheat seed vigor, primarily in newer varieties of spring wheat. His research contributed substantially to a better understanding by the seed industry of seed vigor and stress factors that cause poor germination and emergence. This work resulted in development of a publication on the performance of quality seed and was a fitting conclusion to a highly successful career as a crop and seed physiologist.

Bob and Karne continue to live in Pullman during his retirement, and he continues to be an avid fisherman and a friend of all faculty and staff in the Department of Crop and Soil Sciences.

2003 FIELD DAY ABSTRACTS: HIGHLIGHTS OF RESEARCH PROGRESS

* indicates full article available on the Web: http://css.wsu.edu

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COOPERATIVE PERSONNEL AND AREA OF ACTIVITY

V. Lane Rawlins	President, Washington State University
James J. Zuiches	Dean, College of Agriculture & Home Economics
Michael J. Tate	Dean and Director, Cooperative Extension
Ralph P. Cavalieri	Associate Dean and Director, Agricultural Research Center
William L. Pan	Chair, Crop and Soil Sciences

Cereal Breeding, Genetics and Physiology

Spring Wheat Breeding & Genetics

K.K. Kidwell .... *335-7247* .... *kidwell@mail.wsu.edu*
G.B. Shelton, V.L. DeMacon, M. McClendon

Winter Wheat Breeding, Genetics, & Cytology

S.S. Jones .... *335-6198* .... *joness@wsu.edu*
S.R. Lyon, K. Balow, M. Gollnick, D. Lammer

Wheat Genetics

K.G. Campbell, USDA .... *335- 0582* .... *kgcamp@wsu.edu*
R.E. Allan (Collaborator), USDA .... *335-1976* .... *allanre@mail.wsu.edu*
C. Steber, USDA .... *335-2887* .... *csteber@wsu.edu*
L.M. Little, J. Soule, J. Zale, E. Weir, B. Sakkarapope, N. Blake, L. Reddy, A. Del Blanco

Wheat Quality

B.P. Carter, Cereal Chemist .... *335-7203* .... *bpcarter@mail.wsu.edu*
T. Harris

Barley Breeding & Genetics

S.E. Ullrich .... *335-4936* .... *ullrich@wsu.edu*
V.A. Jitkov, J.A. Clancy, J.S. Cochran
D. von Wettstein .... *335-3635* .... *diter@wsu.edu*

Barley Genetics

A. Kleinhofs .... *335-4389* .... *andyk@wsu.edu*
T. Cavileer

Dryland Agronomy

W.F. Schillinger .... *509-235-1933* .... *schillw@wsu.edu*
H.L. Schafer

Cereal Physiology

P. Chevalier .... *335-3642* .... *chev@wsu.edu*

Seed Physiology

R.L. Warner .... *335-4666* .... *rwarner@wsu.edu*

Crop Diseases

Cereal Viruses, Foot Rots & Snow Molds

T.D. Murray .... *335-9541* .... *tim_murray@wsu.edu*

Root Diseases

R.J. Cook .... *335-3722* .... *rjcook@wsu.edu*
T. Peever .... *335-3754* .... *tpeever@wsu.edu*
T. Paulitz, USDA .... *335-7077* .... *paulitz@wsu.edu*
D. Weller, USDA .... *335-6210* .... *wellerd@mail.wsu.edu*

Rusts, Smuts, Foliar Diseases

R.F. Line, USDA .... *335-3755* .... *rline@wsu.edu*
X.M. Chen, USDA .... *335-8086* .... *xianming@mail.wsu.edu*
D.A. Wood, USDA; M.K. Moore

USDA Western Wheat Quality Lab:

C.F. Morris, Cereal Chemist/Director .... *335-4055* .... *morrisc@wsu.edu*
A.D. Bettge, M. Baldridge, D. Engle, R. Engle, B. Kelly, G.E. King

Breeding and Culture of Legumes

Dry Peas, Lentils, Chickpeas

F.J. Muehlbauer, USDA .... *335-7647*........ *muehlbau@wsu.edu*
K.E. McPhee, USDA .... *335-9522*........ *kmcphee@mail.wsu,edu*
W. Chen, USDA .... *335-9178*........ *w-chen@mail.wsu.edu*
R. Short, S.L. McGrew, L. Burns

Dry Beans

A.Hang .... *509-786-9201*........ *ahang@tricity.wsu.edu*
P. Miklas, USDA .... *509-786-9258*........ *pmiklas@tricity.wsu.edu*
V. Prest, S. Swanson

Weed Management

F.L. Young, USDA .... *335-4196*........ *youngfl@wsu.edu*
R. Gallagher .... *335-2858*........ *gallagh@wsu.edu*
J. Yenish........ *335-2961*........ *yenish@wsu.edu*
P. Fuerst .... *335-7484*........ *pfuerst@wsu.edu*

Conservation Systems and Fertility Management

D. Huggins, USDA .... *335-3379*........ *dhuggins@wsu.edu*
D. McCool, USDA........ *335-1347*........ *dkmccool@wsu.edu*
J. Smith, USDA........ *335-7648*........ *jlsmith@mail.wsu.edu*
W.L. Pan .... *335-3611*........ *wlpan@wsu.edu*
R.J. Veseth .... *208-885-6386*........ *rveseth@uidaho.edu*
D. Pittmann .... *509-397-4636 X115*........ *pittmann@wsu.ed*
R.D. Roe, USDA........ *335-3491*........ *rdroe@wsu.edu*
D.J. Tonks .... *509-725-4171*........ *dtonks@wsu.edu*

Soil Microbiology

D.F. Bezdicek........ *335-3644*........ *bezdicek@wsu.edu*
A.C. Kennedy, USDA........ *335-1554*........ *akennedy@wsu.edu*

WSU Extension Uniform Variety Testing

J. Burns .... *335-5831*........ *burnsjw@wsu.edu*
P. Reisenauer, J. Kuehner, C. Crane

Agricultural Economics

D.L. Young .... *335-1400*........ *dlyoung@wsu.edu*

Food Science & Human Nutrition

B. Baik .... *335-8230*........ *bbaik@wsu.edu*

WSCIA Foundation Seed Service

G. Vollmer. .... *335-4365*........ *wscia@wsu.edu*

Plant Germplasm Introduction and Testing

R.C. Johnson, USDA .... *335-3771*........ *rcjohnson@wsu.edu*

Field Stations

Spillman Agronomy Farm

B. Pan........ *509-335-3475*........ *wlpan@wsu.edu*

Cunningham Farm

R.J. Cook .... *335-3722*........ *rjcook@wsu.edu*

WSU / USDA-ARS Palouse Conservation Field Station

D. Appel, Farm Manager .... *332-2753*........ *dpappel@wsu.edu*

Wilke Farm

D. Tonks .... *509-725-4171*.............................. *dtonks@wsu.edu*

Lind Dryland Research Unit

B.E. Sauer, Farm Manager...................................... *509-677-3671*.............................. *sauerbe@wsu.edu*

IAREC-Prosser, Othello

R. Stevens .... *509-786-9231*.............................. *stevensr@wsu.edu*

USDA Central Ferry (Pomeroy)

K. Tetrick, Manager... *335-1502*

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Contributors

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Columbia Grain Int'l.
Connell Grain Growers
Crites
DOW Agroscience
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Harvest States
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Monsanto Co.
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North Pine Ag Supply
Novartis
Nu Chem
Odessa Union Warehouse Co-op
Pioneer Seeds
Pomeroy Farm & Home Supply
Potash & Phosphate Institute
ProGene
Quincy Farm Chemicals, Inc.
Reardan Seed Co.
Ritzville Chemical
Ritzville Grain Growers
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Spectrum Crop Development
Spokane Seed
St. John Grain Growers
Syngenta
Tomco Seed
Valent USA Corp.
Wagner Seeds
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Washington Wheat Commission
Washington Barley Commission
Western Ag Innovations
Western Plant Breeders
Whitman Co. Grain Growers
Wilbur-Ellis
Wilhelm Seed
WSCIA Foundation Seed Service
WSCIA

Farmer Cooperators

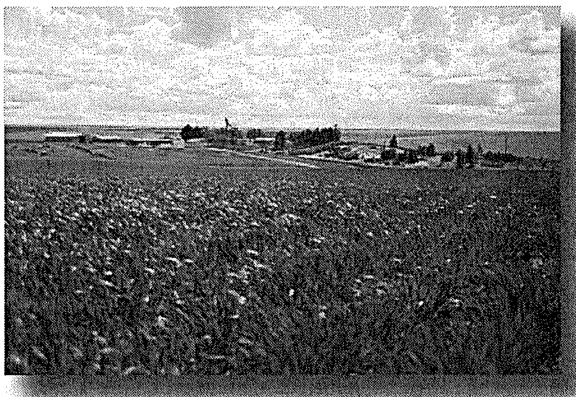
Aeschliman, John /Cory .... Colfax
Andenberg, Al .... Fairfield
Andrus, Jeff.................................. Lacrosse
Aune, Bud .... Lacrosee
Ausman, Lynn............................... Anatone
Bauermeister, Dale/Dan .... Connell
Bramhall, Cecil .... Dayton
Bruce, Albert/Doug...................... Farmington
Camp, Steve .... Dusty
CBARC... Pendleton, OR
Curtis, Al...................................... St. John
DeLong, Sara/Joe......................... St. John
Dietrich, Dale............................... Reardan
Dobbins, Glenn/Bryan .... Four Lakes
Druffel, Leroy .... Uniontown
Druffel, Mike/Ross .... Colton
Druffel, Norm/Sons...................... Pullman
Druffel, Ross .... Colton
Els, Jim... Harrington
Emtman, Randy/Jeff .... Rockford
Ericksen, Tracy .... St. John
Evans, Jim .... Genesee
Felgenhauer, Karl......................... Fairfield
Fleming, Chad.............................. Lacrosse
Fletcher, David............................. Dayton
Ford, Allen .... Walla Walla
Glasco, Paul .... Moses Lake
Gross, Paul/Jake........................... Deep Creek

Farmer Cooperators (cont'd)

Harlow, Dave	Palouse
Hennings, Curtis	Ralston
Hoffman, Dick	Pullman
Idaho, Univ. Kambitsch Farms	Genesee, ID
Jacobsen, Adelbert/Neil	Waterville
James, Randy	Dayton
Jirava, Ron	Ritzville
Johnson, Frank/Jeff	Asotin
Johnson, Hal	Davenport
Jorgensen, Keith/Owen	St. Andrews
Juris, Ron	Bickleton
Koller, Randy/Roger	Pomeroy
Kramer, Mark	Sprague
Kraus, Jerry	Creston
Kupers, Karl	Harrington
Laney, Chris	Sprague
Lange, Frank	Palouse
Lehn, Bernt/Roger	Farmington
Lyons, Rusty	Waitsburg
Mader, Steve	Pullman
Madison, Kent	Hermiston, OR
Matsen, Steve	Bickleton
McCaw, Guy	Waitsburg
McKay, Dan	Almira
McKinley, Dan	Dayton
Mills, Mac/Rod	St. John
Moore, Jim/Ann	Kahlotus
Moore, Steve/Dan	Dusty
Nelson, Bruce	Farmington
Niehenke, Norbert	Colton
Ostheller, David	Fairfield
Pittman, Jim/Jeff	Rosalia
Pottratz, Dennis	Fairfield
Rausch, Chris	Lexington, OR
Repp, Randy	Dusty
Roseberry, Dave	Prosser
Rowell, Doug	Horse Heaven Hills
Ruark, David/Paul	Pomeroy
Sauer, Bruce	Lind
Schmitt, Mike	Prosser
Schmitz, Joe	Rosalia
Schoesler, Mark	Ritzville
Stubbs, Jerry/Mike	Dusty
Swannack, Steve	Lamont
Talbot, Mike	Dayton
Tanneberg, Jason	Mansfield
Tanneberg, Larry	Coulee City
Tee, Larry	Latah
Thorn, Eric	Dayton
Tiegs, Brian	Fairfield
Torrey, Grant	Moses Lake
Wellsandt, Don/Doug	Ritzville
Wesselman, Roger	Mansfield
White, Dave/Gil	Lamont
Wilhelm, Edgar	Rosalia
Zenner, Russ	Genesee

HISTORY OF THE DRYLAND RESEARCH STATION

The Washington State University Dryland Research Station was created in 1915 to "promote the betterment of dryland farming" in the 8-to 12-inch rainfall area of eastern Washington. Adams County deeded 320 acres to WSU for this purpose. The Lind station has the lowest rainfall of any state or federal facility devoted to dryland research in the United States.



Buildings and grounds of the WSU Dryland Research Station at Lind.

Research efforts at Lind throughout the years have largely centered on wheat. Wheat breeding, variety adaptation, weed and disease control, soil fertility, erosion control, and residue management are the main research priorities. Wanser and McCall were the first of several varieties of wheat developed at the Lind Dryland Research Station by plant breeding. Twenty acres of land can be irrigated for research trials. The primary purpose of irrigation on the Dryland Research Station is not to aid in the development of wheats for higher rainfall and irrigated agriculture, but to speed up and aid in the development of better varieties for the low-rainfall dryland region.

Dr. M. A. McCall was the first superintendent at Lind. McCall was a gifted researcher given somewhat to philosophy in his early reports. In a 1920 report he outlined the fundamental reasons for an outlying experiment station. He stated: "A branch station, from the standpoint of efficiency of administration and use of equipment, is justified only by existence of a central station." The Lind station has followed the policy of studying the problems associated with the 8-to 12-inch rainfall area.

The facilities at Lind include a small elevator which was constructed in 1937 for grain storage. An office and attached greenhouse were built in 1949 after the old office quarters burned down. In 1960, a 40' x 80' metal shop was constructed with WSU general building funds. An addition to the greenhouse was built with Washington Wheat Commission funding in 1964. In 1966, a deep well was drilled, testing over 430 gallons per minute. A pump and irrigation system were installed in 1967. A new seed processing and storage building was completed in 1983 at a cost of $146,000. The Washington Wheat Commission contributed $80,000 toward the building, with the remaining $66,000 coming from the Washington State Department of Agriculture Hay and Grain Fund. A machine storage building was completed in 1985, at a cost of $65,000, funded by the Washington Wheat Commission.

Growers raised funds in 1996 to establish an endowment to support the WSU Dryland Research Station. The endowment is managed by a committee of growers and WSU faculty. Grower representatives from Adams, Franklin, Benton, Douglas, Lincoln, and Grant counties are appointed by their respective county wheat growers associations. Endowment funds support facility improvement, research projects, equipment purchase, and other identified needs. Also in 1996, the state of Washington transferred ownership of 1000 acres of adjoining land to the WSU Dryland Research Station.

Since 1916, an annual field day has been held to show growers and other interested people the research on the station. Visitors are welcome at any time, and your suggestions are appreciated.

CUNNINGHAM AGRONOMY FARM

In 1998, a team of Washington State University and USDA-ARS scientists launched a long-term direct-seed cropping systems research program on 140 acres of the WSU-own Cunningham Agronomy Farm located 7 miles NE of Pullman, WA. The goals are to:

- Play a leadership role through research, education and demonstration in helping growers in the high-precipitation areas of the Inland Northwest make the transition agronomically and economically to continuous direct-seeding (no-till farming) of land that has been tilled since farming began near the end of the 19^{th} century.
- Provide databases and understanding of the variable soil characteristics, pest pressures, and historic crop yield and quality attributes over a typical Palouse landscape as the foundation for the adoption and perfection of precision-agriculture technology in this region.

These two goals are intended to facilitate the greatest technological changes for Northwest agriculture since the introduction of mechanization early in the 20^{th} century. Growers and agribusinesses are recognizing both the need for and opportunities presented by these changes.

The past 3 years have been used to obtain site-specific data and develop physical maps of the 140-acre farm, with the greatest detail developed for a 90-acre watershed using 369 GPS-referenced sites on a nonaligned grid. Maps are available or being developed from archived samples for soil types and starting weed seed banks, populations of soilborne pathogens, and soil water and nitrogen supplies in the profile. This has been achieved while producing a crop of hard red spring wheat in 1999, spring barley in 2000, and initiating six direct-seed cropping systems (rotations) starting in the fall of 2001. Yield and protein maps were produced for the crops produced in 1999 and 2000.

The 90-acre portion of this farm is unquestionably the most intensively sampled and mapped field in the Inland Northwest. Some 20-25 scientists and engineers are now involved in various aspects of the work started or planned for this site. A 12-member advisory committee consisting of growers and representatives of agribusiness and government regulatory agencies provide advice on the long-term projects and the day-to-day farming operations, both of which must be cutting edge to compete scientifically and be accepted practically. This farm can become a showcase of new developments and new technologies while leading the way towards more profitable and environmentally friendly cropping systems based on direct seeding and precision farming.

WILKE RESEARCH AND EXTENSION FARM

The Wilke Research and Extension Farm is located on the east edge of Davenport, WA. The 320-acre farm was bequeathed to WSU in the 1980's by Beulah Wilson Wilke for use as an agricultural research facility. A local family has operated the farm for approximately 60 years. Funding for the work at the Wilke Farm comes from research and extension grants and through the proceeds of the crops grown. Goals for research at the Wilke Farm are centered around the need to develop cropping systems that are economically and environmentally sustainable. Focus is on systems that reduce soil erosion by wind and water, improve the efficiency and net return of farming operations, enhance soil quality, and reduce stubble burning.

The Wilke Farm is located in the intermediate rainfall zone (12-17 inches of annual precipitation) of eastern Washington in what has historically been a conventional tillage, 3-year rotation of winter wheat, spring cereal (wheat or barley), followed by summer fallow. Wheat is the most profitable crop in the rotation and the wheat-summer fallow rotation has been the most profitable system for a number of years.

The farm is split in half by State Highway 2. The north side has been in continuous winter or spring cereal production for approximately 10 years and being cropped without tillage for the past 5 years. Since 1998, the south side has been dedicated to the Wilke Research Project that is testing a direct seed, intensive cropping system. The south side of the Wilke Farm was divided into 21 separate plots that are 8 to 10 acres in size and farmed using full-scale equipment. There are three replications of a 4-year rotation (winter wheat, spring cereals, a broadleaf crop, and a warm season grass), and three replications of a 3-year rotation (winter wheat, spring cereals, and a broadleaf crop). Crops grown in the rotation have included barley, winter and spring wheat; canola, peas, safflower, sunflowers, and yellow mustard for broadleaf crops; and proso millet for the warm season grass. Data on soil quality, weed and insect populations, diseases, crop yield, and economics are being collected. The farm provides research, demonstration, education and extension activities to further the adoption of direct-seeding systems in the area. The Wilke Farm is a collaborative approach to develop direct seed systems that include local growers, WSU research and extension faculty, NRCS, agribusiness, Lincoln County Conservation District, and EPA. In addition, the Wilke Farm is used increasingly for small plot research by WSU faculty and private company researchers for small plot cropping systems research.

Due to its location and climate, the Wilke Farm complements other WSU dryland research stations in the Palouse area and at Lind and other locations in the region such as north central Oregon.

HISTORY OF SPILLMAN AGRONOMY FARM

In the fall of 1955, 222 acres of land were acquired from Mr. and Mrs. Bill Mennet at the arbitrated price of $420 per acre. The money for the original purchase came as the result of a fund drive which raised $85,000 from industry and wheat growers. In addition, $35,000 came from the Washington State University building fund, $11,000 from the State Department of Agriculture, and another $10,000 from the 1955-57 operating budget. The dedication of the new facility took place at the Cereal Field Day July 10, 1957. In 1961, the Agronomy Farm was named Spillman Farm after the distinguished geneticist and plant breeder at Washington State University in the late 1880s.

William J. Spillman, breeding plots at Pullman, 1900

Through the dedicated efforts of many local people and the initiative of Dr. Orville Vogel, arrangements were made to acquire an additional 160 acres north of the headquarters building in the fall of 1961. This purchase was financed jointly by the Wheat Commission and Washington State University. The newly acquired 160 acres were fenced and the wetland drained; it became an integral part of the Agronomy Farm, now consisting of 382 acres.

The headquarters building, which is 140 feet long and 40 feet wide, was completed in 1956. A 100- by 40 foot addition was built in 1981. In 1957, a well that produced 340 gallons per minute was developed. In 1968, the Washington Wheat Commission provided funds for a sheaf storage facility that was necessitated by the increased research program on the farm. At the same time the Washington Dry Pea and Lentil Commission provided $25,000 to build a similar facility for the pea and lentil materials. The facilities of the Spillman Agronomy Farm now range in value well over a half million dollars.

The Spillman Agronomy Farm was developed with proper land use in mind. A conservation farm plan which includes roads, terraces, steep slope plantings, and roadside seedings has been in use since the farm was purchased.

In addition to the original development of the farm utilizing conservation farming practices breeders are utilizing acreage to develop cropping systems that will include opportunities to include organic, perennial and biotechnological components in cereal and legume breeding programs.

WINTER WHEAT BREEDING, GENETICS, AND CYTOLOGY 2002 PROGRESS REPORT

S. Jones, S. Lyon, K. Balow, M. Gollnick, D. Lammer,
M. Arterburn, J. Chatelain, A. Greco, K. Murphy

WA007936 is an Eltan-type hard white winter variety developed through a backcross breeding program. It has superior dual purpose hard white quality and will be proposed for pre-release in the fall of 2003. Statewide Variety Testing summarized results for 2002 show WA007936 has yield, test weight, and all other agronomics similar to Eltan. Quality analyses of WA007936 show it has good bread and noodle quality.

WA007939 and **WA007940** are Eltan-type hard red winter sister lines with good bread quality. They consistently outperform Finley and have agronomic characteristics and phenotypes very similar to Eltan. One will be proposed for pre-release in the fall of 2003.

WA007916 is a soft white common winter wheat that is approved for pre-release. It is adapted to a broad range of production areas and consistently ranks among the top cultivars in all agronomic categories. When compared to Madsen, Eltan, and Rod, extensive data indicate that WA007916 is equal or superior in grain yield, cold hardiness, end-use quality, and resistance to various diseases. WA007916 will have a strong positive impact on overall agronomic performance and end-use quality of soft white winter wheat grown in Washington State.

Otto and Doris Amen Dryland Research Endowment: An intensive breeding effort developing winter wheats specifically for emergence from deep planting was initiated this year. The breeding lines produced from this study, using long coleoptiles as the primary breeding objective, will be specifically identified and continually screened for their emergence capabilities as they are advanced through the breeding program to full release.

*STRAWBREAKER FOOT ROT, CEPHALOSPORIUM STRIPE, AND SNOW MOLD DISEASES OF WINTER WHEAT

Tim Murray, Leila Vasquez, Hongjie Li, and Hongyan Sheng,
Dept. of Plant Pathology, WSU

Strawbreaker foot rot, aka Eyespot, and Cephalosporium stripe are two of the most important diseases of winter wheat in the Inland Pacific Northwest. These diseases are most common in areas with more than 18" annual precipitation, but can cause significant losses in the lower rainfall areas too. Early-seeded winter wheat has the greatest risk of being affected by these diseases, especially when planted following summer fallow. Grain yield in fields where either of these diseases is severe may be half or less than that of fields where these diseases are not serious. The snow mold diseases are limited to the northernmost wheat-producing areas of Lincoln, Douglas, and Grant Counties and southern Okanogan County, where snow cover frequently persists for 100 days or more. Left uncontrolled, all plants in a field can be killed when snow mold is severe.

Foliar fungicides have been used to control strawbreaker, however, TiltPlus®, the only product currently registered, is being discontinued by its manufacturer. Disease-resistant varieties are the most desirable control measure for these three diseases, and varieties with resistance to strawbreaker and the snow molds are available. Varieties with true resistance to Cephalosporium stripe are not available.

In cooperation with the WSU Winter Wheat Breeding and Extension Variety Testing programs, studies to screen winter wheat cultivars and breeding lines for resistance to Cephalosporium stripe and strawbreaker have been conducted at the Spillman Agronomy Farm and for snow molds in Douglas County since 1998. As a result, potential new varieties with effective resistance to these diseases have been identified and released (e.g., Bruehl) or are in the final stages of testing. This work is part of our long-term goals to improve the resistance of commercial varieties to these important diseases and reduce losses and external inputs for Washington State wheat growers.

*SPRING WHEAT BREEDING AND GENETICS

K. Kidwell, G. Shelton, V. DeMacon, M. McClendon, J. Baley and R. Higginbotham.

The hard red spring wheat variety WA7859, named Hollis, was approved for release in 2003. Hollis is a tall, Hessian fly resistant variety with excellent stripe rust resistance and outstanding end-use quality. WA7921 (SWS) and WA7931 (HWS) were approved for pre-release. WA7921 had moderate resistance to stripe rust in 2002 and is resistant to the Hessian fly. The grain yield of WA7921 was equal to or better than Zak, Alpowa and Wawawai in field trials conducted from 1999 to 2002. Grain yields of WA7931 equaled or exceeded Idaho 377s and Macon across production zones in 2002. WA7931 is moderately resistant to stripe rust and is Hessian fly resistant. A chromosomal region conferring a grain protein content increase of 1-2% has been introgressed into Scarlet and Tara 2002 through marker-assisted backcross breeding. BC_5F_4 lines containing the high protein segment with superior agronomic performance and improved grain protein content will be evaluated in replicated fertility trials in 2003. Local isolates of *Pythium,* a prevalent disease in direct seeded spring wheat, were tested for pathogenicity on a diverse array of wheat cultivars. Preliminary growth chamber evaluation results indicate that experimental breeding line from WSU is tolerant to *Phythium.* Near isogenic lines (NILs), with and without Roundup tolerance, were evaluated under direct seed conditions at three locations in 2002. Inoculum of Rhizcotonia root rot or take all were direct seeded into the field plots prior to planting to simulate greenbridge volunteer. A no greenbridge control also was included. NILs from three treatments (RoundUp, Buctril/Harmony Extra, and a no spray, hand weeded control) were evaluated for disease severity as well as agronomic performance. Regardless of disease treatment, glyphosate treated RoundUp Ready spring wheat, produced significantly more grain than entries treated with Buctril/Harmony Extra or in the no spray control.

*CONTROL OF WHEAT AND BARLEY RUSTS
2002 PROGRESS REPORT

X.M. Chen, M.K. Moore, D.A. Wood, G.P. Yan, R.F. Line, P. Ling, and V. Pahalawatta

OVERVIEW: Stripe rust, leaf rust, and stem rust affect all classes and types of wheat and occur in all agronomic zones. Without resistance, all winter and spring wheat in the Pacific Northwest (PNW) can be infected. The rusts are most destructive in the high rainfall and irrigated zones. **Stripe rust** is the most important disease of wheat in the PNW and has become increasingly important in the central and southeastern states. The PNW environment is highly favorable for severe stripe rust (losses in excess of 20%) in at least three out of four years and every year in western Washington. In the PNW, stripe rust reduced wheat yields by more than 50% in the early 1960's and by more than 20% in 1981. Without resistant cultivars and effective fungicides, losses would often exceed 80%. The destructiveness of **leaf rust** occurs in at least two out of every four years and every year in fields with overhead irrigation. Losses of 10 to 50% caused by leaf rust have occurred in many years since 1974. Leaf rust is more severe when the weather is most favorable for high yields. **Stem rust** is less common because it develops late in the growing season when the weather is often unfavorable for the rust. When precipitation is frequent in June and July, it can cause severe epidemic. Except a few winter wheat cultivars and some spring wheat cultivars, wheat cultivars grown in the PNW are generally susceptible to stem rust. **Barley stripe rust** is a relatively new disease that can cause widespread damage to barley. Barley stripe rust and wheat stripe rust are similar; however, they are two different diseases. Wheat stripe rust can attack some barley cultivars, but it has never severely damaged the barley crop. In contrast, barley stripe rust has reduced barley yields by 30 to 100 percent and reduced grain quality. The environment in the PNW is highly favorable for barley stripe rust. If not controlled, it can be highly destructive whenever the weather is favorable for epidemics.

*WASHINGTON STATE UNIVERSITY WHEAT QUALITY PROGRAM

Brady Carter, Cereal Chemist. Tracy Harris, Laboratory Technician
Cooperators: Steve Jones, Kim Kidwell, Kim Campbell, and Craig Morris

The goal of the Washington State University Wheat Quality Program (WSUWQP) is to increase the competitiveness of Washington wheat in the global market by developing and promoting varieties that are superior for both agronomics and end-use quality. This goal is primarily accomplished by the annual testing of over 4000 breeder lines for end-use quality. Testing thousands of lines for quality is very time consuming and labor intensive and can only be accomplished efficiently through the cooperative efforts of the WSUWQP and the Western Wheat Quality Lab.

The strategies and methods used to test breeder lines for quality are continually modified and updated. For instance, this year the WSUWQP developed a system to easily access historical data for any breeding line using statistical analyses and the SAS program. In addition, a TGA 601 thermogravimetric ash analyzer from LECO is now being used to analyze all flour samples for ash. Other procedures being considered for addition to the standard set of quality tests are: micro-farinograph, micro-extensigraph, water activity, and wheat ash.

The WSUWQP has established lines of communication with wheat markets, both domestic and foreign, through meetings and personal visits. Exposure from these meetings has resulted in a high level of interest by the industry in several new WSU varieties. In addition, the WSUWQP has worked hard to establish lines of communication with growers of the state by giving talks at grower meetings and field days. In the global market, wheat buyers have imposed tighter quality specifications and are demanding wheat varieties that possess flour functionality characteristics that ideally suit them for use in specific products. The future success of the wheat industry in Washington depends on cooperation by the researcher, grower, and end-user to produce a wheat crop that requires less input and possesses superior, consistent end-use quality.

PROTEIN AND STARCH CHARACTERISTICS OF WHEAT REQUIRED FOR MAKING WHITE SALTED NOODLES AND BREAD WITH IMPROVED QUALITY

Byung-Kee Baik
Department of Food Science & Human Nutrition and IMPACT, WSU

Information regarding the influences of protein content and quality as well as of amylose content on processing characteristics and quality parameters of Asian noodles is greatly helpful for developing wheat varieties suitable for making white salted and instant fried noodles and expanding overseas wheat export in noodle wheat markets in Japan and Korea. We also determined the suitability of using waxy and partial-waxy wheat for production of high quality white salted noodles and bread.

Protein characteristics of wheat flours were evaluated to determine the effects of protein content and quality on processing and textural properties of white salted noodles, as well as to identify protein quality required for making white salted noodles. SDS sedimentation volume based on constant protein weight, mixograph time and proportions of salt and alcohol soluble protein of commercial flours for making white salted noodles were more comparable to those of hard wheat flours than those of soft wheat flours. Protein quality of flour protein should be considered in the selection of wheat for making white salted noodles. Wheat protein slightly softer than that of the typical bread wheat, but much stronger than that of soft wheat, is desirable for making white salted noodles.

Double null partial waxy wheat flours were used for preparation of white salted noodles and pan bread. Double null partial waxy wheat flours produced softer, more cohesive and less adhesive noodles than soft white wheat flours, indicating that partial waxy starches of low amylose content are responsible for the improvement of cooked white salted noodle texture. Partial waxy wheat flours with more than 15.1% protein produced bread of larger loaf volume and softer crumb of bread even after storage than the hard red spring wheat flour of 15.3% protein. Bread baked from double null partial waxy wheat flours exhibited a slower firming rate during storage than bread baked from HRS wheat flour. These results indicate that white salted noodles with excellent textural properties as well as bread with extended shelf-life can be produced from wheat of reduced starch amylose content.

*BARLEY IMPROVEMENT RESEARCH

S.E. Ullrich, V.A. Jitkov, J.A. Clancy, and Judy Cochran
Collaborators: A. Kleinhofs, D. von Wettstein, J.W. Burns, R.J. Cook, X. Chen, and B.-K. Baik
with Research Associates, Technicians and Graduate Students

The overall goal of the WSU Barley Improvement Program is to make barley a more profitable crop. Specific objectives are to improve agronomic and grain quality factors and pest (disease and insect) resistance for dryland and irrigated production. The emphasis is on spring hulled barley with additional efforts on spring hulless and/or waxy, and winter types. One new two-row spring cultivar each was released in 2001 (Farmington), 2002 (Bob), and 2003 (Radiant tested as 98NZ223 in collaboration with D. v. Wettstein). See v. Wettstein in this document for more detail. All of these new cultivars have yields similar to Baronesse across eastern Washington. Based on results from the Extension State Uniform Spring Barley Nursery across 41 locations and 3 yr. (2000-2002), Farmington, Bob and Radiant yielded 97, 98, and 99% of Baronesse, respectively. Overall and for most individual nurseries, the yields of these cultivars were statistically equal or greater than Baronesse. All produce relatively high test weights and Bob high kernel plumpness. Farmington and Bob have partial resistance to barley stripe rust. These new cultivars have potential for malting designation as well. Malting quality testing is underway in association with the American Malting Barley Association. Current collaboration in the North American Barley Genome Project involves fine mapping dormancy and malting quality genes and molecular breeding for malting barley improvement. Molecular breeding of two-row and six-row spring types is underway. Combining the high yield of Baronesse and high malting quality of Harrington using molecular marker assisted selection has yielded several promising breeding lines, which is reported in detail by Schmierer et al. in this document. Collaborative projects in evaluating barley for food use and pest resistance are also underway. New breeding lines have been identified with resistance to barley stripe rust and Russian wheat aphid. Work on screening for resistance to soil borne pathogens and Hessian fly is in progress.

*GENETICALLY ENGINEERED STEM RUST RESISTANCE IN BARLEY

Andris Kleinhofs and Diter von Wettstein
Department of Crop and Soil Sciences, School of Molecular Biosciences
and Center of Integrated Biotechnology

In a joint project the research groups of Andris Kleinhofs and Diter von Wettstein have converted the highly stem-rust susceptible barley cultivar Golden Promise into a highly resistant cultivar by transformation with the barley Rpg1 gene. After infection tests by Brian Steffenson in growth chambers at the University of Minnesota limited field tests are being conducted with the transformants by the University of Minnesota and WSU. The tests are performed by permission from APHIS [USDA, Animal and Plant Health Inspection Service].

The Rpg1 gene has protected barley cultivars from significant stem rust losses for more than 60 years. The Rpg1 provides resistance to the stem rust fungus Puccinia graminis f.sp.tritici and was cloned by the efforts of Robert Brueggeman, Nils Rostoks, David Kudrna, Andris Kilian and Arnis Druka. The isolation of the gene from the cultivar Morex was by map-based cloning, which requires high resolution genetic and physical mapping of the relevant chromosome region, but no prior knowledge of the structure or function of the gene. The cloned gene was inserted into a plasmid used for barley transformation, transferred into a disarmed Agrobacterium strain and then by co-cultivation with zygotic embryos into Golden Promise. Henriette Horvath, Nils Rostok and Robert Brueggeman obtained 42 transgenic lines carrying one or several copies of the gene.

These lines were characterized for their seedling infection response to the rust fungus. A single copy of the gene was sufficient to confer resistance. The remarkable aspects about the transformants is that they exhibit a higher level of resistance than the original sources of the gene, that is the varieties Chevron and Morex. The results demonstrate that rust susceptible cultivars with valuable agronomic or quality traits can be made more resistant by genetic transformation with a functional resistance gene rather than by hybridization with existing resistant cultivars.

*HIGH ENERGY BARLEY BROILER DIETS WITH TRANSGENIC GRAIN

Diter von Wettstein
R.A. Nilan Professorship, Department of Crop and Soil Sciences
and School of Molecular Biosciences

Barley is an unacceptable component in broiler chicken feed, because of its low metabolizable energy. Feeding barley to poultry results in a limited uptake of nutrients, slow initial growth, and unhygienic sticky droppings adhering to the cloaca and down of the chicken as well as to the floors of the production pens. The reason is that birds lack in their intestine an enzyme that can efficiently degrade the major cell wall component of the mature barley grain. This component is (1,3-1,4)-beta-glucan and it is absent in the cell walls of corn grain making corn a favored feed for broilers and hogs. The highly viscous beta-glucan trouble-makers interfere with the diffusion of digestive enzymes and the transport of nutrients through the unstirred water layer adjacent to the mucosal surface of the intestine. They are also responsible for sticky droppings. When corn is not available or expensive, barley is used as animal feed, but it has to be supplied with microbial enzymes manufactured in fermenters. We have investigated, if one can breed a barley grain that can provide the enzyme as a feed addition to normal barley grown on the farms in the Palouse. We have synthesized a gene that produces a thermotolerant, stable beta-glucan depolymerizing enzyme and have transferred it into barley plants with the regulatory gene components that restrict its synthesis to the maturing grain. This grain produces so much highly active enzyme, that an addition of 0.2g per kg of normal barley (0.02%) is sufficient to achieve equal weight gain of broilers in feeding trials as obtained with corn diet. Also the sticky droppings could be eliminated with this small addition of transgenic [popularly called GM or GMO] grain. This small amount makes the ingredient comparable to trace minerals that have to be added to standard diets.

*RADIANT, A QUALITY BARLEY MATCHING BARONESSE IN YIELD

Diter von Wettstein
R.A. Nilan Professorship, Department of Crop and Soil Sciences
and School of Molecular Biosciences

'Radiant' (98NZ223) is a proanthocyanidin-free two-rowed spring malting and feed barley released by the Washington State (WSU) Agricultural Research Center. The average yield in replicated trials of the State Uniform Nursery across 41sites at 15 locations in the three years 2000 to 2002 was 4327 LBS/A or 99% of Baronesse (4367LBS/A). Plant Height, kernel plumpness and test weight of Radiant is similar to Baronesse and Harrington. Radiant has a tendency to head 2 to 5 days later than Baronesse. In the Cunningham Direct Seeding Spring Barley trial with 4 replications in 2002 Radiant yielded 4666 LBS/A, Baronesse 4040 LBS/A. Proanthocyanidin-free barley is a quality improved raw material for the malting and brewing industry because it insures an excellent haze stability of beer, but it is also excellent as feed barley, as shown by broiler chicken trials and with diets for finishing beef cattle. Proanthocyanidins, also known as condensed tannins, are polyphenolic compounds that bind strongly to proteins and carbohydrates. They survive the malting process, are dissolved during the mashing procedure in the wort and land up in the beer produced by fermentation with yeast. There they precipitate proteins and carbohydrates especially under low temperature conditions.

This is known to brewers as permanent and chill haze. Therefore any brewery that wishes to serve and sell brilliant clear beer with good shelve-life has to remove the proanthocyanidins by technical procedures prior to bottling or canning of the beer. Full scale brewing with proanthocyanidin-free barley produces beer without permanent or chill haze, thus making the technical stabilization procedures superfluous. Porridge and pastes for breakfast cereals made from barley flour display an unattractive grey color especially, when fortified with iron for health-care reasons. With flour from Radiant grains the grey color is avoided and the products can be as attractive as those from oats.

*MOLECULAR MARKER-ASSISTED SELECTION FOR ENHANCED YIELD OF TRADITIONAL MALTING BARLEY CULTIVARS

Deric Schmierer, Nejdet Kandemir, David Kudrna, Berne Jones, Steven Ullrich, and Andris Kleinhofs

Quantitative trait loci (QTL) conferring high yield on barley chromosomes 2HL and 3HL from cv. Baronesse have been targeted for introgression into cv. Harrington. In 2002, five H/B isolines showing Baronesse-like yield and Harrington-like malting quality were planted in the Washington Spring Barley State Uniform Nursery (SUN) at 15 locations, while lines NZDK7 and 00-140 were included in the Preliminary State Uniform Nurseries (PSUN) planted at three locations. Line 00-106 contains a putative Baronesse yield QTL on 2HL, 00-140, 00-146, 00-165, and 00-170 have a putative Baronesse yield QTL on 3HL, and 00-123 is suspected as containing the 3HL region, but also contains two independent regions on 2HL. Line 00-170 yielded less than Baronesse but greater than Harrington based on the all location SUN average, and equal to Baronesse and greater than Harrington when considering only nine high-production malting barley growing environments at $P \leq 0.10$. Interestingly, NZDK7 contains no Baronesse alleles in the 2HL and 3HL target regions, but consistently yields equal to Baronesse and greater than Harrington with poor malting quality. The all location PSUN average showed that NZDK7 and 00-140 yielded equal to both Baronesse and Harrington at $P \leq 0.10$.

Experiments are currently being conducted to develop new lines with all possible combinations of the putative yield QTL. Molecular markers will be used to screen and select lines for desirable genotypes. We also plan to cross 00-170 with NZDK7, the goal being to combine the best yielding lines while recovering acceptable malting quality. Six H/B isolines have been included in the SUN in 2003, including 00-170 and NZDK7. Another eight lines have been included in the PSUN, including the remaining four lines from the 2002 SUN.

WSU EXTENSION CEREAL VARIETY TESTING PROGRAM – 2002

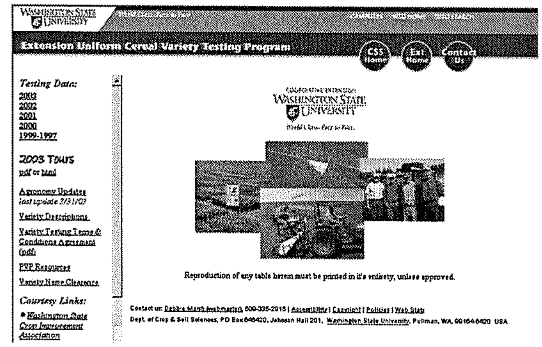
J. Burns, P. Reisenauer, J. Kuehner, C. Crane, D. Marsh

The goal of the WSU Extension Cereal Variety Testing Program is to provide comprehensive, objective and readily available information on the performance of public and private cereal varieties to Washington growers.

The diverse growing condition characteristic of Eastern Washington necessitates using a large number of testing locations. There were 20 -soft white winter wheat, 6- hard (red & white) winter wheat, 16-spring wheat and 15-spring barley nurseries grown in 2002. Included in these nurseries were 65 winter wheat, 48 spring wheat and 40 spring barley varieties/experimental lines. Approximately 25% 35% of all entries were from private breeding programs.

Components of the Variety Testing Program that enhance value to plant breeders and producers are:

1. Harvest data is provided within 3-days after harvest. Extensive use of information technology is used to provide data on both an E-mail server list as well as the Variety Testing Web site: http://variety.wsu.edu



2. Sub-samples from variety testing nurseries are utilized for Genotype by Environment wheat quality evaluations by USDA and WSU cereal chemists in the USDA/ARS Western Wheat Quality Lab, Pullman, WA.
3. Formal agreements are in place with the Federal Grain Inspection Service to provide market class grade evaluations of all new lines of winter and spring wheat entered in the Variety Testing Program. Over 950 samples of winter and spring wheat were evaluated in 2002.
4. The Variety Testing Program provides other research programs with variety seed procurement for satellite varietal evaluations. An example is providing complete soft white winter wheat nursery sets for Cephalosporium stripe and an Eyespot (Strawbreaker) foot rot disease trials..
5. Crop season variety evaluations are an integral component of the program. Data is collected on emergence, winter regrowth, heading, and unique seasonal conditions (such as disease outbreaks) and provided to plant breeders and producers.
6. The Washington State Crop Improvement Association (WSCIA) and the WSCIA Foundation Seed Service are key partners in the program. All data entered in the Variety Testing Program for two consecutive years is automatically included in the WSCIA Seed Buying Guide.

PLANT PATHOLOGY RESEARCH OF GRAIN LEGUME CROPS

Weidong Chen, Tony Chen, Rick Short, Kevin McPhee and Fred Muehlbauer,
Grain Legume Genetic and Physiology Research Unit, USDA-ARS,
Washington State University, Pullman

Grain legumes (dry peas, chickpeas and lentils) are important rotation crops in cereal based production systems in the Palouse region. Production of grain legumes is also expanding to other northern tier states. Diseases of grain legumes have been a major constraint to the yield and quality, and consequently to the profitability of grain legume production. One of the important diseases is Ascochyta blight of chickpea caused by *Ascochyta rabiei*. Ascochyta blight has been the major focus of the pathology program of the USDA-ARS Grain Legume Genetics and Physiology Research Unit.

Fungicide trails conducted at Pullman and Genesee in 2002 showed that Bravo, Headline and Quadris are effective in reducing disease severity of Ascochyta blight. Applications of these fungicides increased yield significantly on susceptible cultivars, but their effect on yield of resistant cultivars was not evident in 2002 trials. Resistant cultivars such as Dwelley are tolerant to Ascochyta blight which allows them to produce a crop under moderate disease pressure.

Field plots have been established at five locations in the Palouse region to determine the relationship of Ascochyta blight severity with yield on various cultivars in order to establish a guideline for fungicide application. Two new fungicides are being compared to Bravo, Headline and Quadris to determine their efficacy in controlling Ascochyta blight. The aim of this research is to develop alternate spraying schemes to manage potential fungicide resistance.

Greenhouse and growth chamber experiments were conducted to develop a standard set of chickpea differentials for determining variations of the pathogen, *Ascochyta rabiei,* and to determine the prevalent pathotypes in the Palouse region.

Research on white mold caused by *Sclerotinia sclerotiorum* focuses on screening commercial cultivars and core germplasm collections to identify resistance sources of peas, chickpeas and lentils.

For more information, please refer to the Grain Legume Research Unit website at: http://pwa.ars.usda.gov/pullman/glgp/

NEW DIRECTIONS OF THE GRAIN LEGUME BREEDING PROGRAM

Fred Muehlbauer, Kevin McPhee, Weidong Chen, Rick Short, Tony Chen, Sheri Babb
and Sheri McGrew; Grain Legume Genetic and Physiology Research Unit,
USDA-ARS, Washington State University, Pullman

The grain legume breeding program is focused on producing new improved cultivars of spring-sown dry pea, lentil, chickpea and winterhardy pea and lentil. Emphasis has been placed on the development of edible types of winter peas and winter lentils that can be direct-seeded in the fall into cereal stubble. All types of edible grain legumes must be environmentally adapted, high yielding and market acceptable. Promising selections are often increased during the winter months in Arizona to shorten the time from variety release to commercial field production. The breeding efforts directed at each of these crops are described below.

Dry peas: The USDA-ARS dry pea breeding program is focused on developing improved cultivars of green and yellow cotyledon spring and winter peas as well as marrowfat peas that are adapted to US production regions. Goals of the project include disease resistance, improved yields, lodging resistance, harvestability, and quality. Two green pea cultivars, 'Lifter' and 'Franklin', were released in 2000 with superior yield potential to 'Joel' and 'Columbian' and with resistance to seed bleaching. In February 2003, 'Sterling' (PS610152) was released as the first lodging resistant green pea from the USDA program. It has excellent seed quality and superior yield potential. Foundation seed will be increased during the summer of 2003 and seed will be available to producers in the spring of 2004.

Lentils: The lentil industry of the U.S. competes in the world market and must have cultivars that produce acceptable quality of the various market classes. Until very recently, the Palouse region produced only one type of lentil, the so-called Chilean type ('Brewer') with large, yellow cotyledons. Indications now are that several types can be produced and sold in various markets both domestically and worldwide. A large yellow cotyledon lentil with uniformly green seed coats was recently released the industry. The new large seeded lentil, 'Pennell' has good standing ability, large non-mottled seeds and higher yields when compared to Brewer. Another large-seeded yellow lentil 'Merrit' was also released and is expected to be a replacement for 'Brewer.' A winter hardy lentil was released this past year and is designed for direct seed systems. The release of 'Morton', a red cotyledon lentil with winter hardiness is the first of its kind and has provided improved yields when compared to commonly grown spring varieties. Samples taken to India reportedly have acceptable quality for that market.

Chickpeas: Ascochyta blight is a devastating disease of chickpea in the Palouse area and has caused serious problems with crop production. Releases of 'Dwelley' and 'Sanford' made it possible to grow the crop with some assurance that the disease would not be devastating. In 1997, 'Evans' was released as an earlier flowering and maturing variety with blight resistance. Recently, we released an improved variety 'Sierra' that has better resistance to Ascochyta blight, larger seeds, improved yields and quality. Two additional selections in the program may be released this coming winter based on performance in trials this summer. One of the lines is a Spanish White type and the other is a café type with fern type leaves.

For more information, please refer to the Grain Legume Research Unit website at: http://pwa.ars.usda.gov/pullman/glgp/

*2002 DRY BEAN PERFORMANCE EVALUATION

An N. Hang and Virginia I. Prest
Washington State University - Prosser

Washington does not rank top in the nation in bean production and it was grown only in 34,000 acres. Washington weather and other environmental factors are favorable for bean production in the Northwest. Bean grown in Washington is not for local consumption but for seed market nationwide and internationally. Bean testing and evaluation become very crucial to growers in Washington and the Pacific Northwest. Washington State University - IAREC is coordinating the bean testing program nation wide and also one of the 13 test sites in North America. New potential bean lines produced by public or private institutions were tested along with commercial varieties. Agronomic traits, disease resistant level and quality will be collected to support new variety development.

*YIELD, AGRONOMIC CHARACTERISTICS AND QUALITY OF WSU EDAMAME LINES GROWN IN OTHELLO, 2002

An N. Hang
Washington State University - Prosser

Columbia Basin can produce high quality edamame for the fresh market; however the seeds are very expensive and not readily available for various harvesting schedules for optimum fresh market demand. A breeding program has initiated at WSU during mid 1990's to cross for seed shattering resistance using imported varieties and the seed shattering resistant lines from US soy bean. During recent years, WSU researchers have crossed and selected more than 50 promising lines. Selection criteria are high yield, high percent of 3- and 4-seed pods, resistance to shattering, seed size and seed color.

*CUNNINGHAM AGRONOMY FARM—SERVING NW AGRICULTURE THROUGH DIRECT-SEED AND PRECISION-AGRICULTURE TECHNOLOGIES

R. James Cook, Ryan Davis, Bruce Frazier, Rob Gallagher, Dave Huggins,
Armen Kemanian, Eric Page, Tim Paulitz, Fran Pierce, Dave Uberuaga,
Shawn Wetterau, Joe Yenish, and Doug Young

The "Cunningham Agronomy Farm," a.k.a. the Direct-Seed/Precision-Ag Research Farm, is devoted to a long-term direct-seed and precision-agriculture cropping systems research using a "whole farm, data-driven" approach to integrating farming and science. The farming is done with commercial scale equipment and the data are collected over time and space at multiple GPS-referenced sites representing the landscape.

A 92-A portion of the farm is now in six different 3-year crop rotations, each consisting of winter wheat/alternative crop/spring wheat. The six alternative crops are winter and spring barley, winter and spring pea and winter and spring canola. The combined yields of spring and winter wheat were 150 and 146 by/A in 2001 and 2002, respectively. Getting good stands of winter canola and winter peas has been limited by the dry falls but not the winter wheat stubble. Winter barley like winter wheat has done modestly well "dusted" into standing cereal stubble.

The yield and grain protein field maps suggest that, regardless of N application rates, certain areas of the field will fail to meet protein goals while other portions of the field readily respond to N fertilizer and are more suited to efficient HRS production. Preliminary analyses indicate higher grain yields are associated with higher soil organic matter (soil carbon content).

Data on the effects and interactions of landscape position, crop residue cover, seed burial depth, and seed age on wild oat emergence will be used to develop a wild oat emergence model that will help farmers better predict the most efficient time to employ wild oat management strategies. This project also includes research on management strategies for Italian rye.

Fusarium crown rot caused by *Fusarium psuedograminearum* has become the dominant disease of the spring wheat in this study. It was more severe in direct response to adding nitrogen to make grain protein in the hard red spring wheat, whether the nitrogen was split applied between fall and spring or all applied in the spring.

*PERFORMANCE OF ADVANCED LINES AND VARIETIES OF SPRING AND WINTER BARLEY SEEDED DIRECTLY INTO WHEAT OR BARLEY STUBBLE

R. James Cook, John Burns, Steve Ullrich, Diter von Wettstein,
Yongchun Wu, and William Schillinger

Spring barley IS well-suited to direct seeding into cereal stubble; Rhizoctonia root rot has been the most apparent hazard, but tools such as greenbridge management and fertilizer placement are helping greatly to reduce the risk of this disease.

Research is now underway on: 1) Evaluation of varieties and advanced lines to determine their adaptation to direct seeding, and 2) identification/development of barley germplasm with resistance or tolerance to Rhizoctonia root rot.

The variety studies are conducted near Ritzville and Pullman, representing the low- and high-precipitation areas, respectively. These tests are done with excellent greenbridge management and a one-pass system that seeds and places fertilizer and loosens the soil directly beneath the seed. The five-year average for the multiple tests and eight to ten varieties per test at the Ritzville location is about 1850 lbs/A. This includes 2001 when yields averaged about 600 lbs/A because of drought. Yields at Pullman are averaging slightly above 4000 lbs/A for the varieties of spring barley and 5,800 lbs/A for the varieties of winter barley. To emphasize, these yields are with direct seeding and continuous cereals. No one variety stands out as either well adapted or poorly adapted to direct seeding. As in with conventional seeding, Baronesse has been at or near the highest yielding spring barley in these tests.

The identification or development of barley germplasm with resistance or tolerance to Rhizoctonia root rot includes 1) evaluation of existing barley germ plasm in a special field test for ability to yield in spite of disease (tolerance); and 2) tranfer of resistance into barley by genetic engineering. Several lines of the barley transformed to express a gene for production of an endochitinase enzyme from the fungus *Trichoderma harzianum* have shown modest but distinct resistance to both species of *Rhizoctonia* responsible for root rot in the PNW. If confirmed, these lines will be available for use in the barley breeding program.

*PERFORMANCE OF ADVANCED LINES AND VARIETIES OF SPRING AND WINTER WHEATS SEEDED DIRECTLY INTO CEREAL STUBBLE

R. James Cook, John Burns, Kim Campbell, Steve Jones, and Kim Kidwell

Efforts have been underway for several years to evaluate the performance of advanced lines and varieties of spring and winter wheat under direct-seed conditions with no fallow and no broadleaf crops in the rotations. All tests have been done with greenbridge management, without burning the stubble, and with all fertilizer placed below the seed at the time of planting.

With the exception of spring wheat varieties resistant to Hessian fly, no one variety stands out based on yield as either well-adapted or poorly-adapted to direct-seeding. In spite of the hazards encountered in these systems, the yields produced with good greenbridge management and fertilizer placement for root disease control are quite respectable.

At Bickleton, continuous direct-seeding has produced a 5-year average of 25.9 bu/A for spring wheat varieties and 36.5 bu for winter wheat varieties, for a combined yield of 62.4 bu every 2 years. Separate studies indicate that an average yield of 60-65 bu/A every 2 years is still only about 85% of potential.

Plots at the Colfax site have been in a field direct-seeded for more than 10 years prior to these tests. Yields of about 35 varieties and advanced lines of spring wheat have averaged 57 bu/A over the past 5 years. Fusarium crown rot caused by *Fusarium psuedograminearum* has been evident in each of the past 3 years at this site. The HRS wheats, as a group, have proven more susceptible to Fusarium crown rot than SWS as a group in these tests.

The yields on the Palouse Conservation Field Station during 5 years representing the 17th - 21st consecutive years of direct seeding and the 14th - 18th cereal crops have averaged a combined 150 bu/A every 2 years for alternating spring and winter wheat varieties. Yields on the Cunningham Agronomy Farm have averaged about 80 bu/A for the winter wheat varieties and 70 bu/A for spring wheat varieties, again producing a combined 2-year average of 150 bu/A. Winter wheat varieties in a 2002 test on Spillman Farm following 4 consecutive years of direct-seeded spring cereals all yielded in the range of 100 bu/A.

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

R. James Cook, Tim Paulitz, Ron Sloot, 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 tillagehas 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: 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

Bill Schillinger, Chad Shelton, Harry Schafer, and Steve Schofstoll
Washington State University and Western Farm Service

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

Ghana Giri and Bill Schillinger
Department of Crop and Soil Sciences, Washington State University

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

Ann C. Kennedy, Tami L. Stubbs, William F. Schillinger, and Jeremy C. Hansen
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.

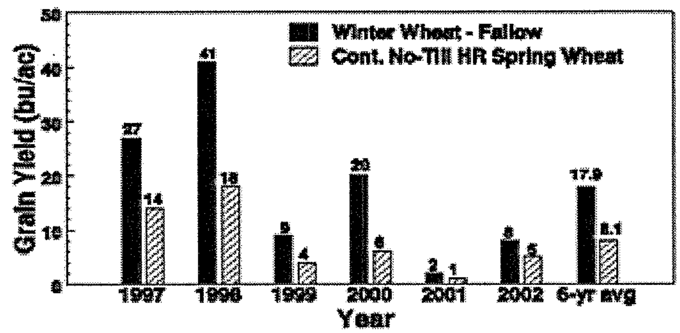


Figure 1. Grain yield of winter wheat after summer fallow compared to continuous annual hard red spring wheat during six years at the Doug Rowell farm, Horse Heaven Hills, Washington.

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

Bill Schillinger, Harry Schafer, Bruce Sauer, and Steve Schofstoll
Department of Crop and Soil Sciences, Washington State University

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 "Extender™" 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.

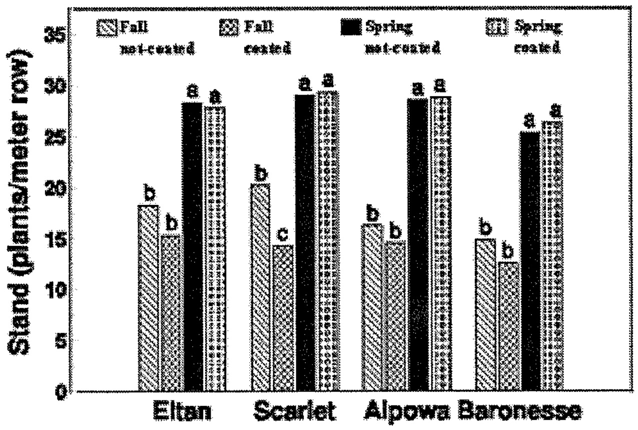


Figure 1a. Stand establishment of four cereal cultivars in 2002 with and without polymer seed coating planted in late fall (dormant seeding) and early spring.

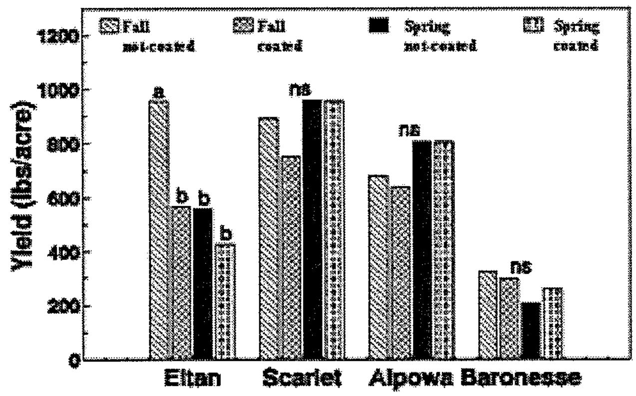


Figure 1b. Grain yield of four cereal cultivars in 2002 with and without polymer seed coating planted in late fall (dormant seeding) and early spring.

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

Dennis Tonks, WSU, Extension Dryland Farming Systems Specialist, Davenport,
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' coulter 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

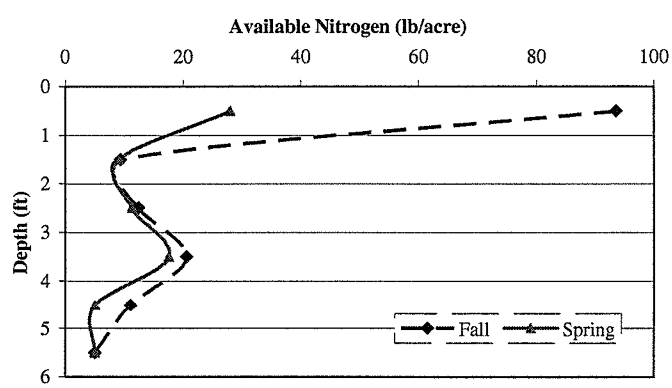


Figure 1. Available nitrogen fertilizer in the spring of the year after fall fertilization and prior to spring fertilization in an on-farm trial near Lamont, WA.

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

Dennis J. Tonks and Darla J. Rugel, Cooperative Extension, Davenport

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

R. Gallagher, D. Bezdicek, S. Higgins, M. Fauci, and L. Hoagland-WSU Crop & Soil Sciences, and H. Hinman-WSU Agricultural Economics

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.

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

Douglas Young and Frank Young
Department of Agricultural and Resource Economics, WSU and USDA-ARS, Pullman, WA

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

Cory G. Walters, Douglas L. Young, and Frank L. Young
Department of Agricultural and Resource Economics, WSU
and USDA-ARS, Pullman, WA

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 time of planting, and starter fertilizer placed with the seed.

Grain prices were marketing year averages for Washington from 1997 to 2001: SWWW and SWSW was $2.90/bu and spring barley was $1.90/bu. Low wheat yields in 1999 and 2001 were a result of poor rainfall during fall planting. Standard enterprise budgeting procedures were used to track the costs of the variable inputs and machine operations used in the different treatments within the experiment. All net returns are expressed per rotational acre to permit consistent comparisons across rotations. Net returns also include estimated payments under the 2002 Farm Bill.

The four-year rotation (SW/fallow/WW/fallow), no-burn, conventional seeding and fertilizing gave the highest net return of $27.42 per rotational acre. This treatment is followed by the three-year rotation (WW/SB/fallow), burn, conventional at $24.10 per rotational acre. SWWW/fallow had negative net returns ranging from -$11.23 to -$31.86 in three treatments but this traditional rotation had a positive return of $14.63 per rotational acre for the burn conventional treatment. Over all three rotations and over both burn and non-burn plots, conventional seeding and fertilizing performed better economically than integrated seeding and fertilizing.

*HOW SPEEDS OF ADOPTION AND ALTERNATIVE DRILL ACQUIRING METHODS MIGHT AFFECT RISKS OF FAILURE FOR A BEGINNING NO-TILL FARMER IN EASTERN WASHINGTON

Bharat M. Upadhyay and Douglas L. Young
Department of Agricultural and Resource Economics
Washington State University

Farmers attempting no-till need to decide on a speed of adoption and on method(s) of acquiring the no-till drill. Three speeds of adoption (gradual, moderate and immediate) and thirteen sequences of drill acquisition permit 39 transition strategies in this study. The objective of the study is to evaluate how the farmer's choice among speeds of adoption and drill acquiring sequences affects risk of no-till transition failure. Four E. Palouse representative farms involving two sizes (3000 acres and 800 acres) combined with two equity levels (80% and 20% land owned) were included in the experiment.

Data and Simulation

Historic price and yield risk patterns were used to simulate a farm's annual net after-tax cash flows for 500 "risky runs" for each of the years of a six-year transition to no-till farming. The farm received government payments, as eligible in the 2002 Farm Bill. Expenditures included cash crop production costs, debt repayments, property and income taxes, insurance, overhead, and family living withdrawals.

The probability of "transition failure" was calculated with two different failure criteria: 1) two consecutive years of negative cash flow and 2) negative cumulative cash flow balance at the end of the six-year transition period.

Results

Regardless of farm type, speed of adoption had a larger effect on navigating the no-till transition successfully than did the drill acquisition method. Higher equity farmers have a better probability of no-till transition success. For large farmers, rapid purchase of a no-till drill had a reasonable chance of success; however, gradual or moderate acreage expansion is recommended until any yield penalty is eliminated. Small low equity farmers were at greatest risk. Custom and rental drill acquisition during the early years of the transition is recommended for small farmers.

*COMPARING THE COST OF PURCHASING AND RENTING A NO-TILL DRILL FOR A SAMPLE OF SUCCESSFUL NO-TILL FARMERS IN THE PALOUSE

Bharat M. Upadhyay and Douglas L. Young
Department of Agricultural and Resource Economics
Washington State University

Farm machinery constitutes a substantial portion of total capital investment for most farmers in eastern Washington and northern Idaho. The objectives of this research are (1) to examine the cost associated with no-till drills purchased by long term no-till farmers compared to renting drills and (2) to identify characteristics associated with efficient purchasers of no-till drills.

Data and Method

A sample of ten "successful" long term no-till farmers included six farmers growing wheat, barley, lentils, and peas in a 19-22 inch precipitation region and four farmers growing wheat and barley in a 8-13 inch precipitation region.

Capacity and cost efficiencies for surveyed farms were calculated based on the average annual net present value of after tax cash flows associated with actual purchased drills and hypothetical rented drills. Percentage efficiencies in purchasing over renting were calculated for nine sample farmers.

Results

The sample of long-term no-till farmers saved money by purchasing no-till drills. The efficiency index for purchasing versus renting ranged from 20% to 90% with a mean of 47%. Savings from purchasing increased as acreage increased indicating economies of size in no-till drill ownership. Farms in a low precipitation region no-tilled more acreage, spent less on drills, and generated higher efficiency than farms in a high precipitation region. The more efficient farms incurred smaller annual drilling cost per acre due to purchase of cheaper drills, achieving lower per acre repair costs, and using their drills on larger acreages.

*indicates full article available on the Web: http://css.wsu.edu