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## 2005 Field Day Abstracts: Highlights of Research Progress

Special Edition, Celebrating 50 Years, Spillman Agronomy Farm

Department of Crop and Soil Sciences  
Technical Report 05-1

WSU Dryland Research Station, Lind – June 9, 2005

WSU / USDA-ARS Cunningham Agronomy Farm, Pullman – June 23, 2005

WSU Spillman Agronomy Farm, Pullman – July 7, 2005



## Welcome to our 2005 Field Days!

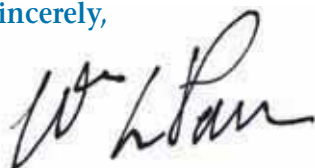
As Chair of the Department of Crop and Soil Sciences, I am proud to introduce the **2005 Field Day Abstracts: Highlights of Research Progress**. This publication has a simple purpose: to introduce you to over 35 research programs conducted in 2005 by WSU faculty and USDA/ARS research scientists working as part of or in cooperation with the Department of Crop and Soil Sciences.

This special edition celebrates the 50th anniversary of Spillman Agronomy Farm. I hope you enjoy the historical reflections herein. Many thanks to the hard work of the anniversary organizing committee, co-chaired by *Stephen Jones* and *John Burns*.

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 read in the abstracts, we have exciting new and ongoing research activities. Our 2005 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  
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### Spillman Agronomy Farm 50th Anniversary Organizing Committee

#### Co-Chairs

*Stephen Jones, Winter Wheat Breeder*  
*John Burns, Extension Agronomist*

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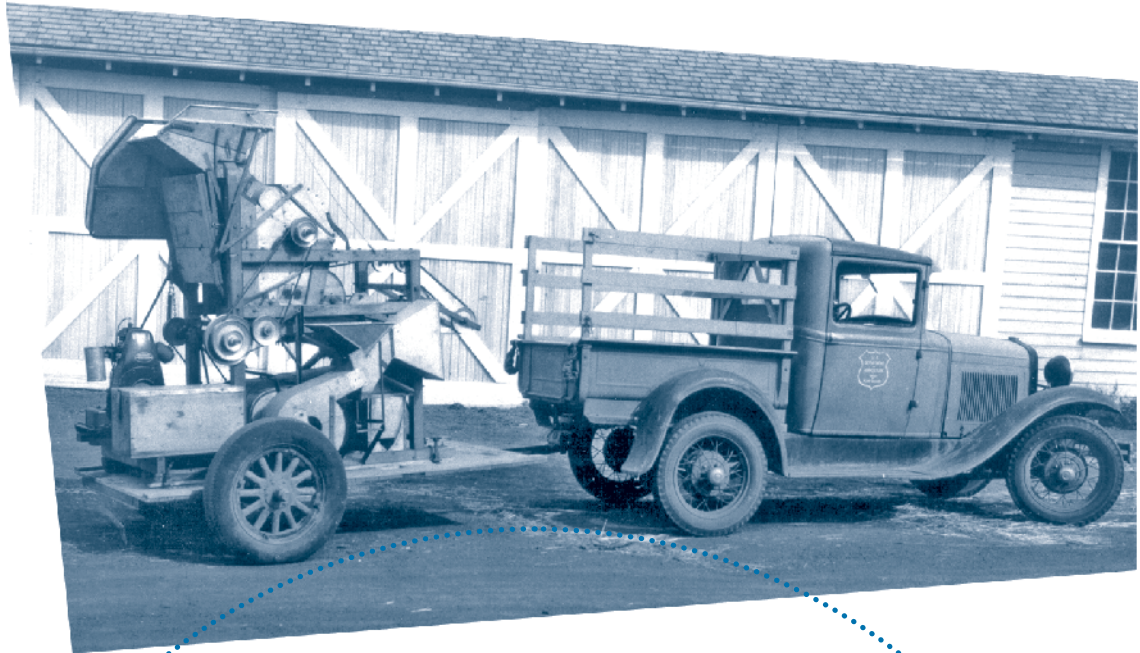
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*Vogel plot thresher (circa 1930's). Concurrent with Vogel's wheat breeding accomplishments was his invention of more than a dozen specialized types of research plot equipment. His most famous machine was the "Vogel nursery plot thresher," still used today around the world by wheat, oat, barley, rice, rye, flax, pea, bean and oilseed breeders.*

*In 1973, Nobel prize winner Norman Borlaug publicly stated, "Perhaps these inventions have contributed indirectly to expanding world food production even more than did the varieties he developed, which in themselves revolutionized wheat production."*





*Dr. Orville A. Vogel's (pictured) greatest impact locally and internationally, resulted from a introducing a dwarfing gene from Japanese spring wheat into standard height wheats shortly after World War II. This resulted in a substantial grain yield increase and also laid the foundation for what later became known as the Green Revolution.*

*Vogel's first commercially successful semi-dwarf wheat was released in 1961 and named 'Gaines' in honor of the second wheat breeder at WSU, Dr. Edward Gaines. It was a soft white winter wheat (foreground of picture) and produced incredibly high yields without falling over from the weight of the grain. Gaines, and the related variety Nugaines, added over \$100 million farm gate value per year during the decade of the 1960s for Washington farmers.*



*The impact of Gaines and Nugaines was so great that folklore associated with them still exists today. One of the most common tales was that Dr. Vogel could place his field notebook on a stand of Gaines and the heads were so thick and strong they would hold the book up. A more common (and repeatable) occurrence of the time would be that farmers would throw a hat on top of the wheat to see it be held up by the heads. Although this trick no longer seems dramatic, it was quite a display in the days of tall wispy wheats such as Omar and Brevor. The hat pictured here belonged to Dr. Vogel. It is being held up by a plot of Gaines at Spillman Agronomy Farm in August, 1960.*

## Respectfully Dedicated to Dr. Rod Bertramson



Rod Bertramson was born on a farm in western Nebraska, January 25, 1914. He passed away on March 23, 2005.

As a child and young adult he worked on the family farm until he graduated with a Bachelors degree in agronomy from the University of Nebraska in 1937 with honors. At the university, he was the lieutenant colonel of the newly activated ROTC field artillery unit. During his years at the university he lived in the campus dairy barn and worked his way through school, doing all manner of odd jobs.

Rod then went on to earn a M.S. degree in soil physics at the University of Nebraska and a Ph.D. at Oregon State University in soil chemistry. He then went on to employment with the Soil Conservation Service based in Rapid City, South Dakota, performing soil surveys. The next stop in his career was to join the agronomy faculty at Colorado State University as a soil scientist.

In the early years of World War II he joined the Army at the rank of first lieutenant. He trained at the Tank Destroyer Officer Candidate School at Camp Hood, Texas. In the post-war period he served in military government in occupied Germany.

In Germany he was appointed Chief of Food and Agriculture for Rheinland Provinz, and then Gross Hessen Provinz at Frankfurt. He was honorably discharged from the Army in 1946 at the rank of major.

Returning to the States, he then joined the faculty of the soils department at the University of Wisconsin. This was followed by a faculty position at Purdue University as a soil chemist. In 1949, he was offered a position at Washington State University as chairman of the agronomy department and served in that capacity for 18 years. After his tenure as chair he then served for 12 years as director of resident instruction in the College of Agriculture.

*(Continued on page 2)*

## *Reflections* — Dr. Bertramson

Rod had a way of making everyone that he came in contact with feel special. Usually a new faculty member or student's first knowledge of Rod occurred a few days after they had given a departmental seminar or had their name in the paper for something special that they had done. That's when a letter from Rod would show up in their mailbox. The letter would always praise the person for a "job well done". It was a real badge of honor to receive a letter from Rod. He designed them so that you couldn't help but feel that somebody out there cared and was proud for what you were contributing to WSU and the community. A few days before his passing Rod was there in the front row of the seminar room, listening, thinking, and asking questions of the speaker. Now, even when the room is full with over 50 people, there is an emptiness that is clearly felt.

The 50<sup>th</sup> anniversary celebration of Spillman Farm was exciting for Rod. He was an active member of the planning committee and added greatly to these proceedings and the structure of the event. The university, farming community, and general public will all miss Rod greatly. As a group, we wish that he had had the opportunity to be with us here today celebrating the 50 years of progress that is the result of the dedication and hard work of so many past and present WSU researchers. Rod was the connection between the past and future for many of us and we will miss him dearly.

It is with great honor that we dedicate this year's proceedings and field day to Dr. Rod Bertramson.

Stephen Jones and John Burns  
For the Organizing Committee

*(Continued from page 1)*

During his time as chair, the Department of Agronomy grew to become the largest in the University and one of the largest agronomy departments in the United States. During this time, the department was heavily involved in national programs in genetic and breeding mutation studies, which resulted in rapid expansion of personnel and prestige. The development of the Columbia Basin Irrigation Project and greater use of fertilizer in the state added further impetus to departmental growth. The development of Gaines wheat by Dr. Vogel and coworkers afforded national prestige to the department. Dr. Bertramson worked closely with industry leaders and family farmers of the Pacific Northwest in those times of great change and growth.

Dr. Bertramson was active in several professional and scientific societies and associations. He served as president of the American Society of Agronomy in 1961 and served in many official capacities over the years. During this time he was instrumental in approving reduced students fees so that more students could join the various professional societies. He also participated in the formation of the certification program of the society, which was incorporated in 1977 as the American Registry of Certified Professionals in Agronomy, Crops, and Soils. He served as the first chairman of ARCPACS.

He was active in local civic affairs—served on the City Council of Pullman, served on many civic organizations, was president of the Pullman Chamber of Commerce, and was active in the Pullman Kiwanis Club. He donated time and money to the local library system and he was an elder of the Pullman Presbyterian Church.

Rod was listed in many national registries. Notable in his resume in “Who’s Who in America” was his quotation: “Hearty approbation and generous praise of others’ efforts work magic in getting the job done. I’ve profited over the years from a friend’s advice, **‘Give bouquets to the living!’** ”



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 Connell Grain Growers  
 Crites  
 DOW Agrosience  
 DuPont  
 Empire, Inc.  
 FMC Corp.  
 Foundation for Agronomic Research  
 Genesee Union Warehouse  
 General Mills  
 GMG  
 Grant Co. Crop Improvement Assn.  
 Great Plains Mfg.  
 Great Western Malting  
 Gustafson, Inc.  
 Harvest States  
 Horsch Maschinen GmbH  
 Johnson Union Warehouse  
 Laughlin Trading Co.  
 Lincoln/Adams Crop Improvement Assn.  
 McGregor Co.  
 McKay Seeds  
 Merrill Lewis

Micro-Ag, Inc.  
 Monsanto Co.  
 Moore, Jim/Ann  
 North Pine Ag Supply  
 Nu Chem  
 Odessa Union Warehouse Co-op  
 Pioneer Seeds  
 Pomeroy Farm & Home Supply  
 Potash & Phosphate Institute  
 Primeland  
 ProGene  
 Quincy Farm Chemicals, Inc.  
 Reardan Seed Co.  
 Resource Seeds  
 Ritzville Grain Growers  
 Seedex  
 Spectrum Crop Development  
 Spokane Seed  
 St. John Grain Growers  
 Syngenta  
 Tomco Seed  
 Trigen Seeds, Inc.  
 USDPLC  
 Valent USA Corp.  
 W.F. Wilhelm & Son, Inc.  
 Wagner Seeds  
 Walter Implement Co.  
 Washington Assn. Wheat Growers  
 Washington Barley Commission  
 Washington Wheat Commission  
 Westbred, LLC  
 Western Ag Innovations  
 Western Farm Service  
 Whitman Co. Growers  
 Wilbur-Ellis Co.  
 WSCIA  
 WSCIA Foundation Seed Service



## 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 19th 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 20th 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.

## 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.

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.

## Palouse Conservation Field Station

The Palouse Conservation Field Station was established as one of 10 original erosion experiment stations throughout the United States during the period 1929 to 1933. The station consists of a number of buildings including offices, laboratories, machine shop, a greenhouse, and equipment buildings, as well as a 200-acre research farm. Scientists and engineers from the USDA/ARS and Washington State University utilize the Station to conduct research projects ranging from soil erosion by wind and water to field-scale cropping and tillage practices on the steep slopes common on the Palouse. Several persons are employed at the Station by both the federal and state cooperators. The Station has a full-time manager who lives on-site and maintains the busy flow of activities which characterize the farm. This includes the day-to-day routine items, farm upkeep, maintaining the



the complex planting and harvest schedule to meet the requirements of the various cropping research, and operating the machine shop which fabricates a majority of the equipment used in the research projects. There are also a number of part-time employees, many of whom are graduate students, working on individual projects. Along with the many research projects, a no-till project at the Palouse Conservation Farm was initiated on bulk ground in the fall of 1996. The objective of this project is to determine if it is technologically possible and economically feasible to grow crops in the eastern Palouse under no-till. The ARS Units at Pullman are focusing on technologies and research needed to make no-till farming possible in this region.

## 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 1890s.

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.



William J. Spillman, breeding plots at Pullman, 1900

## 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.

## 100 Years of Wheat from WSU

COMPILED BY STEVE LYON

**VARIETY ..... YEAR RELEASED ..... MARKET CLASS ... BACKGROUND / NAMED AFTER**

### SPILLMAN

Hybrid 60 .....	1905 .....	HWW Club .....	Lost
Hybrid 63 .....	1907 .....	SWS Club .....	Turkey/ Little Club; still grown at Spillman Farm
Hybrid 108 .....	1907 .....	SRS Club .....	Jones Fife/Little Club; lost
Hybrid 123 .....	1907 .....	SWS Club .....	Jones Fife/Little Club; still grown at Spillman Farm
Hybrid 128 .....	1907 .....	SWW Club .....	Jones Winter Fife/Little Club; still grown at Spillman Farm
Hybrid 143 .....	1907 .....	SWS Club .....	White Track/Little Club; still grown at Spillman Farm

### GAINES

Mayview .....	1915 .....	SRS .....	Selected from field of Fortyfold near Mayview
Triplet .....	1918 .....	SRW .....	Jones Fife/Little Club//Jones Fife/Turkey
Ridit .....	1923 .....	HRW .....	Turkey/Florence; first cultivar in USA released with smut resistance
Albit .....	1926 .....	SWW Club .....	Hybrid 128/White Odessa
Flomar .....	1933 .....	HWS .....	Florence/Marquis
Hymar .....	1935 .....	SWW Club .....	Hybrid 128/Martin

### VOGEL

Orfed .....	1943 .....	SWS .....	Oro/Federation
Marfed .....	1946 .....	SWS .....	Martin/Federation
Brevor .....	1947 .....	SWW .....	Brevon/ Oro
Orin .....	1949 .....	SWW .....	Orfed/Elgin
Omar .....	1955 .....	SWW Club .....	Oro and Elmar in pedigree
Burt .....	1956 .....	HWW .....	Burton Bayles, principal field crop agronomist for ARS
Gaines .....	1961 .....	SWW .....	EF Gaines (Vogel's professor) WSU Cerealist, 1913-1944
Nugaines .....	1965 .....	SWW .....	Sister line of Gaines (new Gaines)

### NELSON

McCall .....	1965 .....	HRW .....	M.A. McCall, first superintendent of Lind Station
Wanser .....	1965 .....	HRW .....	HM Wanser, early dryland agronomist

### ALLAN

Paha .....	1970 .....	SWW Club .....	Rail point (town) in Adams Co. between Lind and Ritzville
Coulee .....	1971 .....	HWW .....	Town in Grant Co.
Tyee .....	1979 .....	SWW Club .....	Rail point (town) in Clallam Co. between Beavor and Forks
Crew .....	1982 .....	SWW Club .....	Multiline with 10 components (crew of 10)
Tres .....	1984 .....	SWW Club .....	Spanish for three. Resistant to stripe rust, leaf rust and powdery mildew
Madsen .....	1988 .....	SWW Club .....	Louis Madsen, Dean of College of Agriculture at WSU, 1965-1973
Hyak .....	1988 .....	SWW Club .....	Rail point in Kittitas Co. east of Snoqualmie pass
Rely .....	1991 .....	SWW Club .....	Multiline with reliable resistance to stripe rust
Rulo .....	1994 .....	SWW Club .....	Rail point in Walla Walla Co.
Coda .....	2000 .....	SWW Club .....	The finale (of a symphony). R.E. Allan's last cultivar

### BRUEHL

Sprague .....	1972 .....	SWW .....	Rod Sprague, WSU plant pathologist. First snowmold resistant variety for WA
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### PETERSON

Luke .....	1970 .....	SWW .....	Name of Nez Perce Indian that saved Rev. H.H. Spalding's life near Lapwai, ID
Norco .....	1974 .....	SWW .....	Released as cultivar then recalled in 1975 due to susceptibility to new stripe rust race
Barbee .....	1976 .....	Club .....	Earl Barbee, WSU agronomist
Raeder .....	1976 .....	SWW .....	Plant pathologist JM Raeder, U. of ID professor of CJ Peterson
Daws .....	1976 .....	SWW .....	Dawson Moodie, chair, Dept. of Agronomy, WSU
Lewjain .....	1982 .....	SWW .....	Lew Jain, farmer friend of Peterson
Dusty .....	1985 .....	SWW .....	Town in Whitman Co.
Eltan .....	1990 .....	SWW .....	Elmo Tanneberg, Coulee City, WA wheat farmer/supporter
Kmor .....	1990 .....	SWW .....	Ken Morrison, WSU Ext. State Agronomist
Rod .....	1992 .....	SWW .....	Rod Betramson, chair, Dept of Agronomy, WSU
Hiller .....	1998 .....	SWW Club .....	Farmer/cooperator in Garfield Co.

**KONZAK**


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Wandell .....	1971 .....	Spring Durum .....	WA + ND (North Dakota) + ELL (?)
Wared .....	1974 .....	HRS .....	WA + red (HRS)
Urquie .....	1975 .....	SWS .....	Urqhart, a farmer near Lind, WA
Walladay .....	1979 .....	SWS .....	WA + Dayton (town in WA)
Wampum .....	1980 .....	HRS .....	WA + wampum (Native American term for money, medium of exchange)
Waid .....	1980 .....	Spring Durum .....	WA + ID, first WSU variety developed via induced mutation, also licensed in Europe
Waverly .....	1981 .....	SWS .....	Town in WA
Edwall .....	1984 .....	SWS .....	Town in WA
Penewawa .....	1985 .....	SWS .....	Old town area in WA
Spillman .....	1987 .....	HRS .....	WJ Spillman, first WSU wheat breeder
Wadual .....	1987 .....	SWS .....	WA + dual; dual quality, pastry and bread, new concept for SW wheat
Wakanz .....	1987 .....	SWS .....	WA + kan (KS -hessian fly testing) + nz (New Zealand - winter increase)
Calorwa .....	1994 .....	SWS Club .....	CA(California) + OR (Oregon) + WA
Alpowa .....	1994 .....	SWS .....	Town in WA
Wawawai .....	1994 .....	SWS .....	Area or old town in WA

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**DONALDSON**


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Hatton .....	1979 .....	HRW .....	Town in Adams Co.
Batum .....	1985 .....	HRW .....	Rail point in Grant Co.
Andrews .....	1987 .....	HRW .....	Old town in Douglas Co.
Buchanan .....	1990 .....	HRW .....	Historical family name near Lind
Finley .....	2000 .....	HRW .....	Town in Benton Co.

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**KIDWELL**


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Scarlet .....	1999 .....	HRS .....	Red seed color
Zak .....	2000 .....	SWS .....	Cal Konzak, WSU spring wheat breeder
Macon .....	2002 .....	HWS .....	Vic Demacon, WSU spring wheat researcher
Tara 2002 .....	2002 .....	HRS .....	"Gone with the Wind" theme
Eden .....	2003 .....	SWS Club .....	"Gone with the Wind" theme
Hollis .....	2003 .....	HRS .....	Grandfather of Gary Shelton, WSU spring wheat researcher
Louise .....	2004 .....	SWW .....	Nickname of the Breeder's neice
Otis .....	2004 .....	HWS .....	Nickname of the Breeder's nephew

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**JONES**


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Edwin .....	1999 .....	SWW Club .....	Edwin Donaldson, WSU Wheat Breeder
Bruehl .....	2001 .....	SWW Club .....	George (Bill) Bruehl, WSU Plant Pathologist
Masami .....	2004 .....	SWW Club .....	Masami (Dick) Nagamitsu, WSU wheat researcher
Bauermeister .....	2005 .....	HRW .....	Dale and Dan Bauermeister, Connell, WA wheat farmers/cooperators
MDM .....	2005 .....	HWW .....	Michael Dale Moore, Kahlottus area farmer/cooperator

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**CAMPBELL**


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Finch .....	2002 .....	SWW .....	WA bird
Chukar .....	2002 .....	SWW Club .....	WA bird

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## Historical Dry Pea, Lentil and Chickpea Varieties

FRED MUEHLBAUER, RICK SHORT AND KEVIN MCPHEE

The grain legume industry started in the early 1900s and progressed from using relatively old landraces to more advanced varieties produced by breeding programs. Initially, dry peas were produced from varieties that were commonly used for canning of fresh peas. Such varieties as 'Small Sieve Alaska', 'Alaska', 'First and Best' were commonly grown. These varieties gave way to 'Columbian', which is still the industry standard for color quality, and the so-called "stand-up varieties" such as 'Stirling'. Numerous varieties of the so-called stand-up peas have been developed and are in use for dry pea production. Lentil production began in the early 1920s on a small scale in the Farmington area and increased rapidly in the 1950s and 1960s. Varieties grown initially were described as "Persians" and "Chilean" types. The variety 'Brewer' released in 1984 quickly became the industry standard for the Chilean type. Other varieties such as 'Pardina', 'Redchief', 'Crimson' and 'Merrit' are currently important lentil varieties. Chickpea production began in the Palouse in the early 1980s and quickly expanded to become an important crop for the region. However, the devastating effects of *Ascochyta* blight reduced production in the area to a minimum until resistant varieties such as 'Sanford' and 'Dwelley' were developed and released in 1994 and more recently 'Sierra' in 2003.

The historical grain legume varieties show apparent changes made through breeding from the earlier types that were grown to the present day varieties. Varieties in the historical nursery include all three crops and are described as follows:

### DRY PEAS

**Small Sieve Alaska** – An old variety initially used for canning small green peas. It was used on a limited basis to produce dry peas with small seed size for specialty markets.

**Garfield** – Released in 1977 by USDA-ARS. The variety has long vines and larger seeds than other Alaska types.

**Tracer** – Released in 1977 by USDA-ARS. The variety was intended as a replacement for Small Sieve Alaska. It has a triple podding habit.

**Columbian** – Developed by the Campbell Soup Company for making split pea soup with good color. A green dry pea used by the industry because of excellent color qualities and good yields.

**Alaska-81** – Released in 1984 by USDA-ARS, seeds are dark green, round and smooth with green cotyledons. Immune to pea seed borne mosaic virus and resistant to *Fusarium* wilt race 1.

**Joel** – A medium-sized, green cotyledon dry pea released in 1997 by USDA-ARS. The variety has improved green pea color quality and has resistance to powdery mildew and *Fusarium* wilt race 1.

**Lifter** – A green cotyledon dry pea released in 2001 by USDA-ARS. The variety has multiple disease resistance, persistent green color of the seeds and yields are improved over Columbian and Joel. It has a dwarf plant habit with normal leaves.

**Franklin** – A green cotyledon dry pea released in 2001 by USDA-ARS. The variety is resistant to *Fusarium* wilt race 1, pea enation mosaic virus, and powdery mildew.

**Stirling** – A green cotyledon dry pea released in 2004 by USDA-ARS. It is a semi-leafless stand-up variety with resistance to *Fusarium* wilt race 1 and powdery mildew.

**First and Best** – Was one of the first yellow pea varieties grown in the Palouse region.

**Latah** – Released in 1977 by USDA-ARS. The variety was a pure line selection from First and Best.

**Umatilla** – Released in 1986 by USDA-ARS, 'Umatilla' is about 15 cm shorter and is higher yielding when compared to Latah. Resistant to *Fusarium* wilt race 1 and tolerant to pea root rot.

**Shawnee** – A large-seeded, yellow cotyledon dry pea released in 1997 by USDA-ARS. 'Shawnee' has large seed size, bright yellow seed color and resistance to powdery mildew.

**Fallon** – A large-seeded, yellow cotyledon dry pea released in 1997. The variety is resistant to powdery mildew and with a semi-leafless upright growth habit.

**Common Austrian Winter Pea** – The original Austrian Winter pea was grown extensively in the Palouse region for green manure plow down since the early 1900s. Improved types such as Melrose and more recently Granger have replaced the variety.

**Melrose** – An improved Austrian Winter pea released by the University of Idaho in 1978.

**Granger** – A semi-leafless Austrian winter-type pea released in 1996 by USDA-ARS.

**Specter** – A white flowered winter pea released by USDA-ARS in 2004 as a feed pea. The variety is semi-leafless and has yellow cotyledons.

**LENTILS**

Chilean – A large seeded yellow cotyledon variety introduced into the region in 1920.

Brewer – A large seeded yellow cotyledon lentil with larger and more uniform seeds, released in 1984 by USDA-ARS.

Merrit – A large seeded yellow cotyledon variety released by USDA-ARS in 2003. The variety has seed coat mottling and is expected to replace Brewer.

Tekoa – A large seeded yellow cotyledon variety released by USDA-ARS in 1969. The variety had an absence of seed coat mottling.

Palouse – Released by USDA-ARS in 1981. The variety has large seed size and an absence of seed coat mottling.

Pennell – A large seeded yellow cotyledon variety released by USDA-ARS in 2003. The variety has seed coat mottling and is expected to replace Brewer.

Mason – A large-seeded, yellow cotyledon lentil released in 1997 by USDA-ARS. 'Mason' has large seed size and no seed coat mottling.

Pardina – A small, yellow cotyledon-type cultivar with brown and speckled seed coats. It was introduced by the lentil industry from Spain and is now being produced extensively in the Palouse.

Richlea – Developed and released in Canada. The variety has medium sized seeds with yellow cotyledons and an absence of seed coat mottling. It is high yielding.

Eston – Developed and released in Canada. The variety has small seed size with yellow cotyledons.

Emerald – Released in 1986 by USDA-ARS, is a green-seeded lentil cultivar with distinctive green cotyledons.

Redchief – Released in 1980 by USDA-ARS, is a large-seeded red-cotyledon-type cultivar with seed coats that lack mottling.

Crimson – A small-seeded, red cotyledon-type lentil cultivar, released in 1990 by USDA-ARS. It originated as a pure line selection from 'Giza-9', a cultivar developed in Egypt and introduced into the U.S. by the ARS Grain Legume Program.

Morton – Morton is a small-seeded red-cotyledon winter-hardy lentil that was developed specifically for use in direct seed or minimum-tillage cropping systems. The variety was released in 2002.

**CHICKPEAS**

Burpee 5024 – A large seeded Kabuli variety distributed by the Burpee Seed Co. We use the variety extensively in our Ascochyta blight-screening nursery as a susceptible check.

Surutato 77 – A large seeded Kabuli variety developed and released in Mexico. The variety has very large seeds and was one of the first varieties of chickpea grown in the Palouse region. The variety is very susceptible to Ascochyta blight.

Tammany – Released by USDA-ARS in 1986. The variety is a large seeded Kabuli variety that is similar to Macarena from Mexico. The variety is very susceptible to Ascochyta blight.

UC-5 – A large seeded Kabuli variety developed and released in California. It was introduced into the Palouse in the late 1980s. The variety is very susceptible to Ascochyta blight.

UC-27 – A medium sized Kabuli variety developed and released in California. It was introduced into the Palouse in the late 1980s. The variety is very susceptible to Ascochyta blight.

Spanish White – Introduced from Spain into the Palouse in the mid 1980s as a large seeded Kabuli variety with white seeds. It is a specialty type in Spain. The variety is very susceptible to Ascochyta blight.

Blanco Lechoso – Similar to Spanish White. The variety has exceptionally large and white seeds. However, it is very susceptible to Ascochyta blight.

Sarah – Released by USDA-ARS in 1990. Sarah is a desi type and is susceptible to Ascochyta blight.

Dwelley – A large-seeded type-type chickpea released in 1994 by USDA-ARS. Dwelley has good resistance to Ascochyta blight and is a sister line to Sanford.

Evans – A large-seeded type-type chickpea released in 1997. Evans is earlier flowering and earlier to mature when compared with Sanford and Dwelley.

Sanford – A large-seeded type-type chickpea released in 1994. Sanford has a good resistance to Ascochyta blight and is a sister line to Dwelley.

Sierra – A large-seeded type-type chickpea released in 2003 by USDA-ARS. Sierra has improved resistance to Ascochyta blight when compared to Sanford and Dwelley.

Myles – A desi-type chickpea released in 1994. Myles has very good resistance to ascochyta blight.

## Barley Variety History

COMPILED BY STEVE ULLRICH

Name	Year	Market Class	Breeder	Comments
Olympia .....	1937	winter, 6-row, feed .....	Gaines .....	introduction from Germany collected in 1935
Rufflynn .....	1939	spring, 6-row, feed .....	Barbee .....	selection from Flynn ( Club Mariout / Lion)
Belford .....	1943	spring, 6-row, hay .....	Barbee .....	selection from Beldi Giant / Horsford
Velvon 17 .....	1947	spring, 6-row, feed .....	Gaines .....	selection from Velvon Composite 1 ( Colorado 3063 / Trebi )
Heines Hanna....	1957	spring, 2-row, malting .....	Gaines .....	introduction from Germany collected in 1925 (selected From a Czech landrace)
Luther .....	1966	winter, 6-row, feed .....	Nilan .....	induce mutant of Alpine (first induced mutant variety released in North America)
Vanguard .....	1971	spring, 2-row, malting .....	Nilan .....	selection from Betzes / Haisa II // Piroline
Kamiak .....	1971	winter, 6-row, feed .....	Nilan .....	selection from Bore / Hudson
Steptoe .....	1973	spring, 6-row, feed .....	Nilan .....	selection from WA 3564 (sel. From CC V) / Unitan
Blazer .....	1974	spring, 6-row, malting .....	Nilan .....	selection from Traill / WA1038 (induced mutant)
Boyer .....	1975	winter, 6-row, feed .....	Muir .....	selection from Luther / WA1255-60
Advance .....	1979	spring, 6-row, malting .....	Nilan .....	Foma/Triple Bearded Mariout// White Winter (WA6194-63)/3/Blazer
Andre .....	1983	spring, 2-row, malting .....	Nilan .....	selection from Klages / Zephyr
Showin .....	1985	winter, 6-row, feed .....	Ullrich .....	selection from 68-1448 / 2116-67
Coughbar .....	1985	spring, 6-row, feed .....	Ullrich .....	selection from Beacon // 7136-62 / 6773-71
Hundred .....	1989	winter, 6-row, feed .....	Ullrich .....	selection from WA2196-68 / WA2509-65
Crest .....	1992	spring, 2-row, malting .....	Ullrich .....	selection from Klages /2* WA8537-68
Bear .....	1997	spring, 2-row, hulless .....	Ullrich .....	selection from Scout / WA8893-78
Washford .....	1997	spring, 6-row, hay .....	Ullrich .....	selection from Columbia / Belford
Farmington .....	2001	spring, 2-row, feed .....	Ullrich .....	WA10698-76 // Piroline SD Mutant / Valticky SD Mutant /3/ Maresi
Bob .....	2002	spring, 2-row, feed .....	Ullrich .....	selection from A308 ( Lewis somaclonal line ) / Baronesse
Radiant .....	2003	spring, 2-row, feed .....	Wettstein .....	selection from Baronesse / Harrington proant mutant 29-667

## The Spillman Agronomy Farm Fund

"The importance of Spillman Farm will not diminish as time passes. Multimillion dollar structures on campus will not replace its (Spillman Agronomy Farm) vital role in crop improvement. I spoke at the Spillman Farm Field Day in July of 1996, the year I retired. I said then the farm was operating on a shoestring. Well, it is still being held together by the same shoestring. It is urgent after 50 years this facility receive the support it deserves." —Bob Allan, retired USDA/ARS Wheat Geneticist

The Spillman Agronomy Fund has been established to secure the future of cereal and pulse crop research and development by your tax deductible charitable gift. Please contact Patrick Kramer (509) 335-2243 [kramerp@wsu.edu](mailto:kramerp@wsu.edu) or Deb Marsh (509)335-2915 [marshdj@wsu.edu](mailto:marshdj@wsu.edu) for more information.

## WSU Spillman Agronomy Farm—Economic Impact

JOHN BURNS, DEPT. OF CROP AND SOIL SCIENCES, WSU, AND DOUG YOUNG, SCHOOL OF ECONOMIC SCIENCES, WSU

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Dr. Rod Bertramson, Chair, WSU Agronomy Department, 1949-1967, stated in the 1957 publication, Cereal Field Day and Dedication of New Agronomy Farm, State College of Washington, The Agronomy Farm Story, page 4; "...Here is a laboratory (field) that will benefit the present and future taxpayers of Washington and neighboring states. Here is the place where a thousand – to ten thousand-fold returns may be realized for every dollar spent on research..." How true he was. When the wheat industry initiated proposals in 1953 for voluntary assessment levies of ¼ cent per bushel on the 1953 wheat crop to provide funds to enable WSC to get more plotland and land suitable for foundation seed production the wheels were put in motion that resulted in the purchase of land to be called the Spillman Agronomy Farm.

The \$151,861 that was used to purchase 220 acres of the Mennet farm south of Pullman in 1955 is estimated to have a current (2005) day value of \$1,038,147 (Table 1). Even in today's dollars, that is a small price to pay for the return on investment from the agricultural research that has been developed at Spillman Farm during the past 50 years. Iowa State University and Yale University economists found that taxpayer investments in agricultural research and development at the nation's land-grant universities and the U.S. Department of Agriculture have yielded an approximate 50% annual rate of return on investment since 1970. This can be compared to an annual rate of return for government bonds of 3% above the inflation rate and the S&P 500's average rate of return of 8.5%. Agricultural research at Spillman has benefited agribusiness throughout the PNW and consumers world wide. Many of the higher yielding cereal and cool season legume varieties released over the past five decades came from research on Spillman Agronomy Farm. These varieties and other improved technology underlie the 50% return on research investment that reaches into the billions of dollars.

Most of the benefits have been transferred to the rest of society. Increased yields require increased use of fertilizer and other ag inputs, increased grain production requires storage that supports local grain cooperatives, increased machinery technology increases employment in research, fabrication, and raw materials supply. However, food consumers have traditionally reaped the lion's share of benefits from our research-driven ability to produce more food from fewer inputs. Americans enjoy one of the greatest bargains in food anywhere on the world. Increased food supplies have kept food prices down world wide. Efficient production ensures abundant food supplies for Washington exports of soft white wheat, peas, apples, and other commodities. If research at Spillman Farm reduced the annual food bill by only one dollar for each of the 6.5 billion people in the world, it would generate a \$6.5 billion annual dividend.

***Truly, a thousand to ten thousand- fold return has been realized for every dollar spent the investment in the Spillman Agronomy Farm.***

Table 1: Updating the Agronomy Farm Investment. A comparison in 1955 and 2005 dollars (based on the approximate 9-fold increase in price index for nonland items over the past 50 years)

EXPENDITURES	1955	2005
Land purchase: 220 acres @ \$420/ac, interest, legal fees	\$96,178	\$330,000
Development Costs: site preparation, engineering, fencing (2.5 miles), Fertilizing, seeding to grass and legumes	\$14,833	\$133,497
Headquarters Building: 40' x 140' including office, shop, work area, Machinery storage	\$23,263	\$209,367
Gas and Lubrication House: including fuel pumps, tanks	\$1,436	\$12,924
Drilling well, establishing domestic water: well is 400 feet deep, 8 inch diameter, water level 170 feet, 340 gpm	\$10,332	\$92,988
Miscellaneous development costs	\$2,819	\$25,371
<b>TOTAL EXPENDITURES</b>	<b>\$151,861</b>	<b>\$804,147</b>
<b>DEVELOPMENT ITEMS REQUIRING ADDED FUNDS</b>		
Development irrigation system for plots	\$6,000	\$54,000
Building residence for Farm Manager	\$20,000	\$180,000
<b>FUNDS NEEDED</b>	<b>\$26,000</b>	<b>\$234,000</b>

## WAWG Salutes WSU

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A MESSAGE FROM WAWG PRESIDENT JEFF EMTMAN



The Washington Association of Wheat Growers congratulates Washington State University (WSU) on its first 100 years of success in the development of wheat varieties. This occasion marks a huge milestone for the university and for the wheat industry of the Pacific Northwest. Your work has allowed area farmers to produce high yielding, high quality wheat that keeps us competitive in the world markets.

Over the years, WSU has been very fortunate to enlist the efforts of many world-class scientists to carry out innumerable wheat research and development projects. Farmers have enjoyed a close working relationship with the college and many of the scientists and feel quite fortunate to be the benefactors of much of their work.

Research stations and research farms have been the proving ground for many of the wheat varieties that were developed in the labs of WSU and related ARS facilities. They have proven invaluable in gathering information on variety performance in real field conditions. Because Washington State is so diverse, growing conditions vary dramatically from one research station to the other. These research stations and farms help the researchers determine which varieties do better in one part of the state than the other.

We have benefited greatly from the work done at the Spillman Agronomy Farm for the past 50 years. Thank you all so very much. We salute you!

## Spillman Agronomy Farm—Building Success

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A MESSAGE FROM THE WASHINGTON WHEAT COMMISSION



The Washington Wheat Commission (WWC) recognizes the tremendous contribution Spillman Agronomy Farm research has given to the state's wheat industry. The vast knowledge and experience flowing from the research plots at Spillman and other research stations have spread far beyond the borders of Washington. We compliment Washington State University (WSU) on the foresight of bolstering research by establishing the Spillman Agronomy Farm.

Now, more than ever, research is crucial to wheat producers who routinely face changing markets, unpredictable agronomic conditions, governmental policy changes, emerging diseases and ever rising input costs. A key factor to producers' profitability and competitiveness is research, wherein the Spillman Agronomy Farm has played an integral and active role for 50 years now.

Whether it is disease and pest control, crop management practices, or variety development, the significant work that takes place at research stations is applied research that affects a producer's bottom line and is the lifeblood of the wheat industry. Such outstanding performance at research stations enables researchers to attack learning curves first. In this way, success and failure occurs prior to a producer's adoption and implementation of farm practices and the planting of varieties, thus facilitating the effective transfer of technology to producers.

Since WSU's first variety was developed a century ago, the progress and accomplishments of the breeding programs, in concert with associated departments and disciplines, have been phenomenal. Continuing to augment those successes and expanding the institutional knowledge that Spillman has consistently provided will be vital to the health of the industry.

The celebration of WSU's Spillman Agronomy Farm coincides with the establishment of the WWC in 1955. Research has long been a central priority for wheat producers and through a successful partnership, producers have contributed over \$20 million dollars to research funding at WSU over the years.

Looking toward the future, continued research will be essential for the entire industry and Spillman Farm will continue to play a principle role in the success of Washington farm families.



## Washington Barley Commission Commends Spillman Research Farm —*Fabulous at Fifty!*

### A MESSAGE FROM THE WASHINGTON BARLEY COMMISSION



Fifty years ago, barley grown in Washington State averaged 25 bushels per acre, the average farm size was 248 acres and WSU's Spillman Agronomy Farm was created. As we celebrate Spillman Farm's 50th year anniversary, we can reflect on how it has also served as the foundation for barley breeding programs which in turn have provided significant additional economic returns to Washington farmers over the past 50 years.

Started in 1985, Washington Barley Commission (WBC) is also celebrating an anniversary – proudly serving Washington barley growers for twenty years. Since its inception, the WBC has been a strong supporter of research at WSU, and Spillman Agronomy Farm and Field Day is no exception. Over the years, the WBC has contributed over 3.2 million dollars to WSU research – now that's dedication! It is very clear that the Washington barley industry has benefited from WSU's research and its relationship to Spillman Agronomy Farm.

The barley industry has seen its share of cycles, with the highest acres planted in Washington State being 1.2 million in 1985, to our present year's preliminary planted acres indicated at 200,000. As a comparison, in 1955, 775,000 acres of barley were planted.

As we celebrate Spillman Farm's 50th year, it was interesting to look back and see what has occurred in Washington State as it relates to agriculture.

<b>According to the</b>	<b>April 1, 1950 Census</b>	<b>2002 Census</b>
Farms in Washington State	69,820	35,939
Land in Farms (Acres)	17,369,245	15,318,008
Average Size of Farm (Acres)	248.8	426
Cropland Total (Acres)	7,720,502	8,038,469
Cropland Harvested (Acres)	4,236,705	4,894,634
Value of Land and Buildings		
Average per Farm	\$20,744	\$623,333
Value of Land and Buildings		
Average per Acre	\$86.78	\$1,486
Average Age of Washington Farmer (Years)	49.2	55.4
Farms Having a Telephone	40,198	
Farms Having Electricity	64,733	
Farms Having Tractors	40,247	29,941
Farms Having No Tractors, Just Horses or Mules	20,218	
Farms Having No Tractors, and only 1 Horse or Mule	3,210	
Farms Having No Tractors, and 2 or More Horses or Mules	6,146	
Farms Having Tractors and Horses or Mules	12,210	
Farms Having Tractors and No Horses or Mules	28,037	
Farms Having Automobiles	54,275	
Farms Having Computer Access (in 2003)	65%	
Farms Having Internet Access (in 2003)	54%	

Sources: Washington Agriculture Statistics Service and 2002 Census of Agriculture

## Spillman Farm—Site of 40 Years of Legume Varietal Development

USA DRY PEA AND LENTIL COUNCIL, WA & ID DRY PEA AND LENTIL COMMISSIONS  
TIM MCGREEVY, EXECUTIVE DIRECTOR & TODD SCHOLZ, DIRECTOR OF RESEARCH AND INFORMATION

As the USA Dry Pea and Lentil Council joins with WSU to celebrate 50 years of research contributions from the Spillman Farm, the Council is celebrating the 40th year of the formation of the WA and ID Dry Pea and Lentil Commissions. The WA & ID Commissions, along with the WA & ID Dry Pea & Lentil Association were created

with a vision of cooperation. The Spillman Farm, home for varietal development for Grain Legumes for the past 40 years has exemplified that vision.



Seated Left to Right: Harold Blain, James Stonecipher, Melvin Ensley, Gerald Miller. Standing Left to Right: Asa Clark, Leroy Mills, Hal Roffler, Kenneth Parks, Donald Olson, Harold Carter

Under the able direction of Harold Blain, producers like Asa Clark, Melvin Ensley, Gerald Miller, James Stonecipher, Leroy Mills, Hal Roffler, Ken Parks, Donald Olson, and Harold Carter, the original WA Dry Pea and Lentil Commission and the ID Pea and Lentil Commission made up of producers Bob Wittman, Rex Pardue, Eugene Thompson, Bill Hickman, Harry Graser, Iver Longeteig and John Hanley, united together with the Dry Pea and Lentil Processor and Exporter Association and the ID and WA Dry Pea and Lentil Growers Association to form what would become the USA Dry Pea and Lentil Council. Since 1965, the industry

has cooperated to direct and fund research, market development and education efforts to benefit processors, exporters, and end users in the PNW and across the nation. Spillman Farm and WSU Research played a significant role in the success of the dry pea, lentil, and chickpea industry in this country.

Present home to the breeding program of the USDA-ARS Grain Legume Genetics and Pathology Unit, what began as a small offshoot of an ARS program at Spillman Farm has grown to be a national development program of international renown. Under the leadership of Dr. Fred Muehlbauer, long standing lentil varieties such as Brewer, Red Chief, and Crimson were developed at Spillman Farm. More recently, lentil varieties such as Mason, Pennell, and Merritt have been released and are beginning to show their value. Chickpeas with *Ascochyta* resistance such as Evans, Dwelley, and Sanford were developed using a disease screening nursery on Spillman Farm. The cooperation fostered at Spillman between Dr. Walt Kaiser and Dr. Muehlbauer, ARS Scientists working on a WSU research farm, ultimately restored the viability of producing chickpeas in the PNW. These disease resistant varieties are planted throughout North America today. Screening nurseries for resistance to *Fusarium* wilt in peas have improved varieties such as Columbian and helped to develop varieties like Alaskan and Lifter green peas. The recent addition of a breeder, Dr. Kevin McPhee and a pathologist, Dr. Weidong Chen, have helped develop the recent release of Stirling green pea, a variety with powdery mildew resistance. Another recent development which improves the competitiveness of our industry is the advent of winter legumes like the Morton lentil and the Specter feed pea. With an increased yield potential and a fit in non traditional pulse growing regions, the fall-seeded, winter-hardy legumes are a prime example of the advancements being developed at Spillman Farm.

Research is a critical element to the pulse industry. The USA Dry Pea and Lentil Council, in cooperation with the WA and ID Dry Pea and Lentil Commissions will continue to rely on the facilities provided by the Spillman Farm, WSU Research, and the USDA-ARS GLGPU. The promise of a brighter future for the pulse industry will be built on the research provided by this cooperation today.

## Washington State Crop Improvement Association—Certified Seed Program

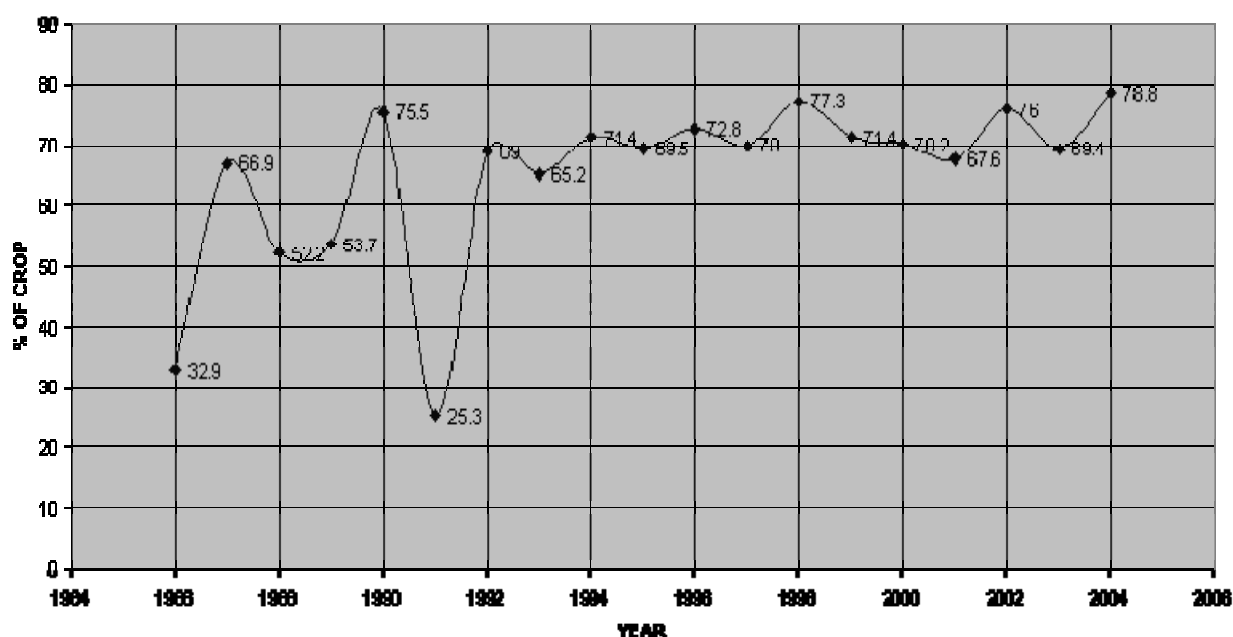
DOUG BOZE, SEED CERTIFICATION SUPERVISOR



Washington State Crop Improvement Association (WSCIA), is a non-profit organization working through agreements with Washington State University, Washington State Department of Agriculture, and Washington seed growers and conditioners to develop, produce and distribute certified seed in order to improve crop yields in Washington. WSCIA is delegated by the Washington State Department of Agriculture the responsibility for seed certification of buckwheat, chick peas, field peas, lentils, millet, soybeans, small grains, sorghum, and forest tree seeds. The majority of the certification program involves wheat and barley seed production.

The commercial grain industry has embraced the value of utilizing certified seed for planting Washington's wheat and barley crop. The chart below shows historical certified seed usage from 1986 through 2004. The five and ten year averages both exceed 72%. It is believed that the Washington cereal industry makes use of a higher percentage of certified seed than any other state in the nation.

**PERCENT OF WASHINGTON WHEAT & BARLEY CROP PLANTED WITH CERTIFIED SEED**



## Washington State Crop Improvement Association—Foundation Seed Service

JERRY ROBINSON, FOUNDATION SEED SERVICE MANAGER

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The Washington State Crop Improvement Association Foundation Seed Service (FSS), through a memorandum of agreement with Washington State University (WSU), has the authority and responsibility for producing and distributing breeder and foundation seed of publicly released WSU varieties. Foundation class seed is the first generation of seed available to the public and is the basis for the production of registered and certified seed.

*(Continued from page 21)*

### **BREEDER SEED PRODUCTION**

Seed heads selected by plant breeders are given to the FSS after the WSU Agricultural Research Center approves a pre-release increase of a promising selection. Each head is hand threshed and the resulting seed is placed in a separate ten foot long "headrow". About 1500 headrows are planted per acre and from one-half to two acres are planted for each breeder seed increase.

The breeder seed field is inspected several times. Rows that do not comply with the variety description are removed. These rows may differ in plant type, color or maturity or may contain plants that are not uniform in appearance within the row.

Breeder seed fields are harvested and conditioned using plot scale equipment that can be more easily and completely cleaned between varieties to prevent any chance of contamination.

### **FOUNDATION SEED PRODUCTION AND DISTRIBUTION**

Foundation seed is produced by selected seed farms and by the FSS on WSU research stations after a variety is released by WSU. The FSS provides the breeder seed and implements certain quality control procedures and inspections whether the crop is grown on the WSU research station or on a seed farm. Foundation seed is available to all growers and seed dealers for the production of registered and certified seed crops.



### **OTHER FOUNDATION SEED ACTIVITIES**

The FSS participates in a Tri-State (OR, WA, ID) Foundation Seed Program to support the Oregon State University cereal breeding program and provide foundation seed to Oregon producers. The FSS also produces foundation seed for other states, federal programs, and private companies.

### **SEED PRODUCTION AND DISTRIBUTION**

The FSS currently maintains over 80 varieties of wheat, barley, oats, lentils, chickpeas, dry peas, dry edible beans, grasses, alfalfa, red clover and other crops. An average of 1,000,100 lb. has been distributed annually during the last 15 years.



## Winter Wheat Improvement

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S. S. JONES AND S. R. LYON, DEPT. OF CROP AND SOIL SCIENCES, WSU

In 1957 Dr O.A. Vogel wrote a short 240 word progress report for his winter wheat breeding program. The brevity of the article was in direct contrast to the enormous influence his varieties would soon have on global wheat production.

*(In keeping the tradition of 240 words or less)* Our recently released varieties Masami (SWW), Bauermeister (HRW) and WA7936 (HWW) will have Foundation seed available for commercial production in the fall of 2005. A concentrated effort is underway to create a new high yielding SWW variety for the high rainfall production areas of Washington. Focus is on lines that have resistance to eyespot, Cephalosporium and stripe rust while maintaining high grain yield and test weight, winter hardiness, and excellent milling and baking qualities.

We are in our third year of developing varieties specifically for emergence from deep planting. Our goal is to eliminate emergence as an issue for Washington winter wheats. Five hundred thirty-nine crosses were made in 2004 specifically for the introgression of traits associated with superior emergence into our locally adapted cultivars. Among them were numerous crosses using historical varieties and unadapted breeding lines from various national and international wheat breeding programs.

We look forward to the next 50 years of progress in this program.

## A Brief Historical Perspective of Spring Wheat Variety Development

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K. KIDWELL, G. SHELTON, V. DEMACON, M. MCCLENDON AND J. BAILEY, DEPT. OF CROP AND SOIL SCIENCES, WSU

Throughout its 111-year history of wheat breeding, spring wheat varieties have been developed at Washington State's land grant university; however, the first person to officially serve as a dedicated spring wheat breeder was Dr. S.P. Swenson. Dr. Swenson served as Washington State College's spring wheat breeder from 1939 to 1947, at which time Dr. F. Elliot assumed responsibilities for the program. In 1957, Dr. C.F. Konzak was appointed to the spring wheat breeding position at WSC, which became Washington State University in 1959. Dr. Konzak dedicated his 37-year career to spring wheat breeding and genetics, and he released several important varieties during that period. Dr. Konzak's most notable varieties (followed by the year of release) included: Wared (1974), Urquie (1976), Walladay (1979), Wampum (1980), Waverly (1981), Edwall (1984), Penawawa (1985), Spillman (1987), Wakanz (1987), and Wadual (1987), Alpowa (1994), Wawawai (1994), and Calorwa (1994). Penawawa was produced on a majority of the spring wheat acreage in the Pacific Northwest for many years, and is still a major variety in the irrigated production region of southern Idaho. Following Dr. Konzak's retirement in 1994, Dr. Kim Kidwell assumed responsibility for the program with the charge of integrating molecular genetic technologies into the variety development process. The dedicated scientists who came before her created the germplasm base that the current spring wheat breeding program is built upon, and their legacies will live on forever through all future variety releases.

Since 1998, eight new spring wheat varieties have been released by WSU. Dr. Kidwell's first variety, Scarlet (1998) has been the primary hard red spring wheat variety, based on acreage, in commercial production in Washington State since 2002. Scarlet also is the first wheat variety to be patented through plant variety protection by WSU. Zak (2000) a soft white spring variety release, is the first WSU wheat variety for which an identity preserved (IP), local, domestic market has been created to capitalize on its exceptional baking quality. Since 2002, approximately 2 million bushels of locally grown Zak have been milled into flour at the ADM mill in Cheney, WA each year for use at the Nabisco plant in Portland, OR. Tara 2002 (2000) is a Hessian fly resistant hard red spring wheat variety, with exceptional bread making quality. Columbia Plateau Producers have capitalized on this attribute by selling locally grown Tara 2002, produced in sustainable cropping systems, in a high gluten flour blend called Shepherd's Grain, which is being used by local bakeries, as well as WSU's food service. Eden (2002) is the first adapted spring club variety with exceptional agronomic performance and end-use quality to be developed at WSU. The availability of a high quality, high yielding spring club variety guarantees that a consistent supply of club wheat is available on an annual basis from the PNW for exportation to Southeast Asia. Macon (2002) represents the first hard

white spring wheat variety to be developed at WSU. Macon has exceptional bread making quality for domestic use, as well as desirable noodle making properties for export markets. Louise (2004), a soft white spring variety, carries genes that confer durable, non-race specific high temperature adult plant resistance (HTAP) to stripe rust, a major foliar fungal pathogen of wheat. Louise was released as the Zak replacement based on its improved stripe rust resistance, eliminating the need for fungicide application. Otis (2004), a hard white spring variety, also carries HTAP resistance to stripe rust, as well as resistance to the Hessian fly.

## Barley Improvement: Then and Now

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S.E. ULLRICH, DEPT. OF CROP AND SOIL SCIENCES, WSU

A reflection 50 years after Bob Nilan's field day article of 1955: Eastern Washington has become an important barley producing area over the past 50 years. The top five barley producing counties in the state today in order are Whitman, Lincoln, Spokane, Garfield, and Columbia. As in 1955, barley varieties continue to require improvement to realize maximum returns per acre. Whereas current breeding objectives are somewhat similar, the priorities are different: 1) higher-yielding, stronger-strawed, two-rowed spring malting and feed barleys, 2) higher-yielding six-rowed spring malting (with Midwest quality) and feed barleys, 3) specialty food/feed barleys with hullless, waxy endosperm, and/or product color stability, and 4) winter barley with improved winter hardiness, yield, strength of straw, and malting and/or feed quality. To arrive at these objectives, we are testing introduced varieties, especially of winter types, and employing hybridization or crossing and selection, and in some cases chemical mutagenesis and selection.

### WINTER BARLEY

We primarily test new varieties and lines from Oregon and Idaho. We ended the crossing program in 1991 due to waning interest in winter barley and reduced budgets. We do however have one remnant line (WA1614-95) that shows variety release promise.

### SPRING BARLEY

Over the years, emphasis on production has shifted from predominantly six-rows to predominantly two-rows. This is reflected in our breeding priorities. The newest releases are the two-rows, 'Farmington' (2001), 'Bob' (2002), and 'Radiant' (2003). Several important varieties grown in 1955 were Gem, Atlas 46, Heines Hanna, Betzes, and Hannchen. Old and new varieties can be viewed in the Historical Nursery at the barley stop. Testing in 1955 included hullless and covered malting and feed types from North America and Europe, just as it is today. Fifty years ago there was interest in pearling barley for extending rice in East Asian countries and that interest remains today, but shifting from covered to hullless barley. Malt quality analysis has been conducted at the USDA Barley and Malt Laboratory, Madison, WI for over 50 years. Industry malt tests were conducted in 1955 by the Malt Research Institute, which merged with the Malting Barley Improvement Association in 1958, which evolved in 1982-1983 into the American Malting Barley Association of today. Malting barley production in the West was just gathering steam in 1955 attracting attention of Midwest-based maltsters and brewers. Mutation Breeding: Induced mutagenesis was an important barley improvement tool in 1955, as it still is today. The barley program did much important research on mutagenesis using radiation and chemical mutagens. In fact, the potent chemical mutagen of choice for barley, sodium azide, was discovered and extensively investigated at WSU by Bob Nilan, Andy Kleinhofs and others. We have used sodium azide over the years to select for semi-dwarf, proanthocyanidin-free, and currently herbicide resistance mutants. The semi-dwarf winter barley variety, 'Luther', released by WSU in 1966, was the first induced mutant variety released in North America. A number of WSU barley varieties carry induced mutant genes, e.g., Boyer, Hundred, Farmington, Bob and Radiant.

### NEWER DEVELOPMENTS

Pest resistance has become a priority due to the emergence of the Russian wheat aphid and barley stripe rust. Soil diseases have become important due to reduced tillage, e.g., direct seeding. Molecular genetics research and breeding have emerged as major aspects of the program, hardly imagined in 1955. Breeding focus is on marker-assisted selection for yield and malting quality in Harrington/Baronesse backcrosses and for stripe rust resistance. Much of the credit for molecular breeding advances is due to the North American Barley Genome Mapping Project, partially conceived at WSU and first coordinated by Bob Nilan.

## WSU Variety Testing Program—50 Years (1955-2005)

J. BURNS, P. REISENAUER, J. KUEHNER, DEPT. OF CROP AND SOIL SCIENCES, WSU

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The WSU Cereal Variety Testing Program has over a 50 year existence that has embodied the same goal during all these years: to further test new varieties and crosses with old standard varieties. The Variety Testing Program was established as WSU Ag Research Project Number 0175, Adaptation of Cereal Varieties in Washington. The program has been a leader in adopting new technologies; passing technologies back to breeding programs and disseminating data on a local to world-wide basis with the use of modern electronic communications. There have been very few changes in the objectives of the program:

### ORIGINAL OBJECTIVES LISTED IN 1955

- 1) To further test new varieties and crosses with the old standard varieties.
- 2) Tests are carried on in several locations in the State to sample the different rainfall and weather conditions to find out the locations the varieties will be most suitable in.]
- 3) Tests are carried on with winter wheat, sp wheat, winter barley, sp barley and oats to find out these agronomic differences.

### WHAT IS DIFFERENT TODAY COMPARED TO 1955?

- 1) Proprietary varieties included in trials
- 2) Emphasis on electronic data dissemination and publication
- 3) Greater focus on integrating evaluation of varieties with biotechnological novel traits
- 4) No testing of oats
- 5) Variety Testing Program web site: <http://variety.wsu.edu>

Variety Testing Program off-station nurseries were established at only five locations in 1955 (St John, Dusty, Lamont, Pomeroy and Walla Walla). Some notable comparisons in the WSU Variety Testing program in 50 years are:

WSU CEREAL VARIETY TESTING PROGRAM		1955	2005
Number of Winter Wheat Nurseries			
	Soft White Wheat	5	20
	Hard Winter Wheat	0	8
	Irrigated Soft White	0	1
	Irrigated Hard	0	1
Number of Winter Barley Nurseries		5	2
Number of Spring Barley Nurseries			
	Dryland Spring Barley	5	14
	Irrigated Spring Barley	0	1
Number of Spring Oat Nurseries		5	0
Number of Spring Wheat Nurseries			
	Soft White	1	18
	Hard White	0	18
	Hard Red	0	18
Number of Irrigated Spring Wheat Nurseries		0	1
TOTAL NURSERIES		21	102
Size of plot			
	Harvested rows	2-rows x 8ft	7-rows x 16 ft
	Average harvested area (sq ft)	16	64
Distance to furthest nursery location		65 miles	230 miles
Percent of cereal varieties from private breeding programs		0%	25%-30%
Number full-time employees		1	2
Type of harvest/machine value		Hand/Vogel thresher (\$1K)	Wintersteiger plot combine (\$100K)
Data entry. Analysis, dissemination		By hand	Bar code, computer, Web page, electronic
Estimated number of individual plots		1820	9500
Project budget (including wages)		\$3,135	\$166,000



## Perspectives on Wheat Fertility—Present and Future

RICHARD T. KOENIG, ASSOCIATE SOIL SCIENTIST AND EXTENSION SOIL FERTILITY SPECIALIST, DEPT. OF CROP AND SOIL SCIENCES, WSU; DAVID R. HUGGINS, USDA-ARS, PULLMAN, WA; WILLIAM L. PAN, PROFESSOR AND CHAIR, DEPT. OF CROP AND SOIL SCIENCES, WSU



In his 1957 Spillman Farm field day abstract Dr. Glen E. Leggett stated that most eastern Washington farmers were using nitrogen (N) fertilizer for wheat; few were using N ten years prior to when he wrote the abstract. Research conducted by Harley Jacquot and Tom Jackson was well underway to demonstrate responses to N fertilizers. This research established baseline data for Leggett's N fertility modeling that still serves as the basis for today's N management guidelines.

The 1950s represented the beginning of widespread synthetic N fertilizer use. World N fertilizer use increased exponentially, from approximately 5.5 million tons to 88 million tons, between the mid-1950s and mid-1980s. Adoption of synthetic N fertilizers

helped to fuel the Green Revolution, and we realized unprecedented yield increases that were also driven in the Palouse by the adoption of semi-dwarf wheats. Farmers became increasingly aware of the need to replenish soil nutrients that were removed with grain harvest, rather than continuing to "mine the soil". However, on the downside, increased use of N coupled with the inherent inefficiencies of N use in agricultural systems has contributed to air and water quality problems throughout the world. Eastern Washington is not immune to these problems.

In 1957 Dr. Leggett reported that three pounds of N were required to produce one bushel of wheat. Today, N recommendations for wheat grown in eastern Washington are based on market class, ranging from 2.7 lb N/bushel for soft white winter to 3.6 lb N/bushel for hard red spring. Uniform N recommendations as well as management, however, are quickly becoming obsolete. Research conducted over 10 years ago showed that N requirements for wheat vary spatially over the complex landscapes characteristic of eastern Washington. Soft white winter wheat, for example, may require as little as 1.8 lb N/bushel to more than 3.9 lb N/bushel depending on landscape position. Recent research also shows that altering the timing of N availability through the use of split applications and other technologies can improve efficiency and reduced N requirements. Although we understand that N management should vary spatially and even temporally across the landscape, the ability to apply this knowledge to site-specific management has been limited by our ability to accurately predict this variation as well as by equipment and other technologies necessary to variably manage nutrient inputs for wheat. Through research and other advancements these limitations are quickly disappearing. Several large-scale research and on-farm projects in precision N management are in progress or will be initiated in 2005.

In his 1957 abstract Dr. Leggett also reported that S had been shown to limit yields in certain areas, but that P had not resulted in yield increases in research. Subsequent studies by Guettinger and Koehler in the 1960's demonstrated that P deficiencies and P fertilizer responses were more apparent in eroded slope positions where topsoil and soil organic matter had been lost. Current research clearly shows that, when soil residual levels are low, applications of both S and P are necessary. Research demonstrating the impact of these nutrients on yield has been enhanced by our understanding of the various roles of S in protein quality and the baking characteristics of hard wheat, and of P in imparting cold and drought tolerance. Research, industry and grower experiences are also providing more evidence of a diversity of roles for chloride in alleviating physiologic leaf spot and improving disease tolerance in wheat.

The future holds many opportunities disguised as challenges. Continued emphasis on the impact of N on water and air quality is a given. National and even international efforts to regulate nutrient – primarily N and P – use

will occur. Increased emphasis on the role of cropping systems in improving nutrient efficiency, the development of more efficient fertilizer forms, and precision agriculture (in both space and time) techniques show great promise to meet present and future environmental challenges. Solutions will come from a combination of genetics and variety development, improved understanding of cropping system management and function, new technology in the area of fertilizer manufacture, and new technology and understanding of precision nutrient management. An analogy might be drawn to the automobile industry: when new challenges such as air quality regulations or higher fuel prices emerge, research and technology advances have markedly enhanced efficiency and overcome these challenges while maintaining and even improving performance. A similar response to environmental opportunities in agriculture can be expected. Research is the key and continued collaboration among university researchers, private industry, progressive growers and environmental agencies is essential. Results of such collaboration can be seen in the recently revised dryland winter wheat nutrient management guide for eastern Washington, which was widely

## Part I. Breeding, Genetic Improvement, and Variety Evaluation

### Winter Wheat Breeding, Genetics and Cytology

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S.S. JONES, S.R. LYON, K.A. BALOW, M.A. GOLLNICK, D.L. LAMMER, M.K. ARTERBURN, K.M. MURPHY, J.C. DAWSON AND J.L. PIASKOWSKI

**Masami** (WA007916), a soft white common winter wheat, received full release approval in February 2004. It was released for its excellent grain yield, cold hardiness, end-use quality and disease resistance. Masami is named in honor of Masami “Dick” Nagamitsu, a retired WSU wheat researcher. Masami is targeted to replace Eltan and Madsen in all precipitation zones of eastern WA as it consistently produces higher grain yields, especially in those areas where foot rot is a problem for Eltan and cold hardiness is a problem for Madsen. It should replace Rod in low and intermediate precipitation zones and may work well as a mix with Rod due to its higher test weight and excellent foot rot resistance. Foundation seed will be available in Fall 2005.

**MDM** (WA7936) is a hard white winter variety that received approval for full release in the spring of 2005. Results from statewide Variety Testing trials indicate WA7936 has yield, test weight, and all other agronomics similar to Eltan. USDA-ARS Western Wheat Quality Lab analyses show it has good bread and noodle quality. It was evaluated by the Pacific Northwest Quality Council and found to have acceptable quality for domestic hard white winter wheat uses. Foundation seed will be available in Fall 2005.

**Bauermeister** (WA7939) is a hard red winter variety with good bread and noodle quality that received approval for full release in the spring of 2005. Bauermeister is named in honor of Dale and Dan Bauermeister, long time cooperators from Connell, WA. Summarized results from statewide Variety Testing trials indicate it consistently outperforms Finley and has phenotypic and agronomic characteristics very similar to Eltan. Evaluations by the Pacific Northwest Quality Council determined Bauermeister has acceptable quality for domestic hard red winter wheat uses. Foundation seed will be available in Fall 2005.

**WA7934 and WA7935** are foot rot resistant lines in an Eltan background developed through marker-assisted selection. Both lines perform well in Variety Testing trials, have good soft white winter wheat quality, and have all other agronomics similar to Eltan. The better of these two lines will be selected for pre-release following this year’s results.

### Perennial Wheat as a Sustainable Alternative Cropping System

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STEPHEN JONES AND TIM MURRAY, DEPARTMENTS OF CROP AND SOIL SCIENCE AND PLANT PATHOLOGY, WSU

Soil erosion associated with the cropping of annual small grains is probably the greatest impediment to long-term sustainability of agricultural ecosystems worldwide. Perennial wheat offers a new solution to the long-standing problems of soil erosion and reduced soil quality associated with conventional annual wheat cropping systems.

These problems are particularly severe in the low rainfall areas of the Pacific Northwest. By retaining constant ground cover over multiple years, wind and water erosion can be dramatically curtailed. Other potential benefits of perennial wheat include improved wildlife habitat, more efficient use of available water, the provision of a potent carbon sink, and the potential for integrating straw retrieval and marketing into a small grains cropping system in a more sustainable way than is possible in annual cropping systems.

Our research has focused on three broad goals: 1) Continued development of Wheatgrass-Wheat hybrids and partial hybrids using parents adapted to the PNW to produce long-lived and vigorous perennial wheat varieties; 2) To identify effective sources of disease resistance and transfer it to perennial parents for diseases that present the greatest risk to production of perennial wheat in the PNW; and, 3) To characterize genes and developmental and physiological events that condition perennial habit by identifying chromosomes carrying genes for these traits from perennial species.

Initial screening of perennial wheat for resistance to eyespot, *Cephalosporium* stripe, and Wheat Streak Mosaic (WSM) has been completed and additional perennial wheat germplasm is currently being evaluated for resistance to these diseases. Genetic studies to understand the genetic control of these sources of resistance are in progress. Likewise, field plots were established in fall 2004 to study the impact of WSM on yield and its spread in perennial wheat.

## Identification and Deployment of Genes to Reduce Production Risks and Improve Quality in Club and Soft White Winter Wheat

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The goal of the breeding and genetics program is to develop wheat germplasm and cultivars with increased resistance to production risks and improved end-use quality. Soft white club wheat, is grown mainly in the Pacific Northwest and is a major export crop with 70-80% exported annually. Targeted traits improve resistance to stripe and leaf rust, cold tolerance, *Cephalosporium* stripe and Fusarium crown rot and resistance to strawbreaker foot rot. We plant, manage, evaluate and harvest advanced replicated nurseries at 11 locations for club and soft white wheat in Eastern Washington, NE Oregon, and North Idaho. We evaluate end use quality in early generations on 1500 F4 and F5 head row selections for micro milling flour yield and break flour yield, micro solvent retention capacity, test weight, kernel weight and morphology. We conduct laboratory, greenhouse and growth chamber evaluations of coleoptile length and seedling leaf breath. We use molecular marker assisted selection to incorporate genes for resistance to Strawbreaker foot rot, Stripe rust, Barley Yellow Dwarf Virus, Hessian fly, and preharvest sprouting. Marker assisted selection for foot rot has been conducted on a routine basis in our laboratory since 1989. We are now in the third year of our marker assisted selection efforts for the other traits listed above. We will have BC2F2 populations to plant in the field in 2005. The populations that are segregating for BYDV resistance derived from the wild wheat relative *Thinopyrum intermedium* will be planted at Central Ferry, WA. Populations containing new sources of resistance to Hessian fly will be planted at Pendleton. Other populations will be planted at Pullman. Six club wheat breeding lines ARS97135, ARS97173, ARS00235, ARS00127, ARSC96059-1 and ARSX960411-2, have been entered into the 2005 WA state variety trials. All are mid season to early maturing, stripe rust and foot rot resistant with the quality characteristics desired for club wheat.

## Improving Spring Wheat Varieties Through Precision Breeding

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Molecular genetic techniques are routinely used, along with traditional breeding methods, to incorporate important genes into wheat varieties to facilitate the rapid transition of improved breeding lines from the lab to the greenhouse, and from the greenhouse to the field. Since 2002, stripe rust has been endemic throughout the primary spring wheat production regions in the Pacific Northwest. Seedling resistance genes *Yr5* and *Yr15* are effective against all races of stripe rust identified thus far in the U.S., and tightly linked molecular markers for these genes have been developed. We employed a DNA marker-assisted backcross breeding (MABB) strategy to simultaneously incorporate *Yr5* and *Yr15* into three cultivars, 'Alpowa' (SWS), 'Scarlet' (HRS), 'Zak' (SWS) and one

advanced breeding line, 'WA7900' (HWS). Backcross derivatives containing the targeted chromosomal regions associated with *Yr5* and *Yr15* demonstrated high levels of resistance to stripe rust in controlled environment assays. These lines will be evaluated for agronomic characteristics and disease response under inoculated field conditions at WSU's Spillman farm in 2005. High temperature adult plant (HTAP) resistance genes for stripe rust also are being transferred into experimental germplasm using traditional breeding methods.

A genetic source of high grain protein concentration (GPC) was detected in a wild relative of wheat, and the corresponding chromosome segment was transferred, by MABB, into Scarlet, 'Tara 2002' and an advanced hard red winter breeding line, 'WA7869'. Additionally, a HTAP gene (*Yr36*) also is located on this chromosomal segment, and durable stripe rust resistance was inadvertently transferred into backcross derivatives during the high GPC gene introgression process. Eleven backcross derivatives from Scarlet and Tara 2002 will be evaluated at three locations in 2005 to assess expression levels of the high-GPC region and stripe rust resistance. Four of these lines (WA7994, WA7995, WA7997 and WA7998) with excellent variety release potential also will be evaluated at 18 locations in the 2005 WSU Spring Wheat Variety Testing Trial. Less advanced material also will be evaluated in a replicated field trial at Spillman Farm. Twenty backcross derivatives of WA7869 were planted in replicated field trials at Kahlotus and Lind in fall 2004. Additionally, one line with excellent yield, superior grain protein content and end-use quality, designated as WA7975, was entered into the 2004-2005 Hard Winter Wheat Variety Testing Trial.

The Hessian fly is one of the most destructive insect pests of spring wheat in the US. Several HF resistance genes have been identified, however, most varieties grown in the PNW carry the *H3* gene. The risk of new biotypes overcoming the *H3* gene concerning, therefore, we initiated efforts to incorporate several Hessian fly (HF) resistance genes into adapted germplasm. We are introducing novel HF resistance genes (*H9*, *H13*, *H25*) into adapted germplasm using conventional breeding and MABB.

In cooperation with Drs. Steber and Okubara (USDA-ARS), we are screening for tolerance to the herbicide Roundup™ and Rhizoctonia root rot in chemically mutagenized Scarlet, Zak, Tara 2002, 'Hollis', 'Macon' and 'Louise'. A Scarlet mutant with high levels of tolerance to *R. solani* has been identified. We are in the process of genetically characterizing the inheritance of this tolerance, and hope to rapidly introgress it into advanced breeding lines.

## Barley Improvement Research

S.E. ULLRICH, V.A. JITKOV, J.A. CLANCY, J.S. COCHRAN, AND H.-J. LEE

COLLABORATORS: A. KLEINHOF, D. VON WETTSTEIN, J.W. BURNS, X. CHEN, T.C. PAULITZ, AND B.-K. BAIK WITH RESEARCH ASSOCIATES, TECHNICIANS AND/OR GRADUATE STUDENTS

**More on the Web**

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 in collaboration with D. v. Wettstein). Bob and Radiant have yields similar to Baroness across eastern Washington, while Farmington yields best in med.-high rainfall zones. Based on results from the Extension State Uniform Spring Barley Nursery and others across eastern Washington, Farmington (107 loc-yr), Bob (73 loc-yr), and Radiant (69 loc-yr) yielded 94, 98, and 98% of Baroness, respectively. Overall and for most individual nurseries, the yields of these cultivars were statistically equal or greater than Baroness. All produce relatively high test weights and Bob high kernel plumpness. Farmington and Bob have partial resistance to barley stripe rust. Several new breeding lines have performed well agronomically including the two-rows WA15279-00, WA8569-99, and WA10701-99. WA10701-99 has high malting quality as well. Current collaboration in the U.S. Barley Genome Project involves mapping dormancy, preharvest sprouting, 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 Baroness and high malting quality of Harrington using molecular marker assisted selection has yielded several promising breeding lines. 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, Russian wheat aphid, and Hessian fly. Work on screening for resistance to soil borne pathogens is in progress.

## Rapid Introgression of Useful Genes into PNW Wheat Varieties using Marker-Assisted Backcrossing

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The resistance of a variety to different diseases and insects may be rendered ineffective due to changes in ever-evolving pest populations caused by mutations, population shifts, or migration. The spring wheat variety 'Zak' is a good example that became susceptible to stripe rust during first year of production, resulting in significant yield losses. This susceptible reaction was probably due to a new stripe rust race. In addition to the dynamic nature of the pests, other challenges wheat breeders face including preference-driven changes in the market demands and breeding cultivars that are adapted to changing cultural practices. For these reasons, many 'good' varieties sometime become unfit for production mainly because of the lack of a single trait. This problem can usually be solved by adding the desired gene(s) to the deficient variety by the backcross breeding method. The conventional method, however, requires more than six backcrosses in order to recover genotype of the original variety along with the improved trait. Because of the time and effort involved, and the competition from new varieties that would be available by the time the old variety is improved, this conventional method is not very efficient.

We decided to use a previously untested method of 'marker-assisted background selection' for selecting desirable backcross progeny. We standardized this method on transferring a stripe rust resistance gene *Yr15* into the susceptible variety 'Zak'. A stripe rust resistant gene *Yr15* is very effective against this new race along with most other prevalent stripe rust races. Our target was to develop a system to transfer any trait with simple inheritance into any spring wheat variety within a two-year period. During our first attempt, we have successfully accomplished this by transferring *Yr15* gene into 'Zak'. The same method is being used to transfer 'Clearfield Technology' herbicide resistance genes to PNW winter wheat varieties although it will take longer because of the growing habit. This approach will significantly extend the life of a good variety by targeted "variety fixing." It makes wheat breeding more efficient and cost effective, which in turn will allow wheat growers in the PNW to maintain their competitive edge in the international markets.

## The USDA-ARS Western Regional Small Grain Genotyping Laboratory

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P. LING, L.M. LITTLE, K. GARLAND CAMPBELL. ALL AUTHORS: USDA- ARS WHEAT GENETICS, QUALITY, PHYSIOLOGY AND DISEASE RESEARCH UNIT. PULLMAN WA

The Western Regional Small Grain Genotyping Laboratory is offering collaborative genotyping services to assist marker assisted selection efforts for wheat and barley cultivar development in Western region. The genotyping laboratory uses both conventional and high-throughput methods to extract DNA and facilitate marker genotyping. The laboratory mainly uses SSR markers and other user-friendly molecular markers to generate genotype information. Currently, the services we are able to provide including genotyping of advance breeding lines; marker assisted selection of backcross populations; marker data for mapping populations; polymorphism assays of parental lines for mapping populations and DNA fingerprints for varieties differentiation. The marker types we are able to perform including SSRs, RAPDs, AFLPs, RFLPs, CAPs, RGAPs, TRAPs and isozymes. Besides routine genotyping services, the laboratory also conducts research projects on stripe rust resistance gene (*Yr8* and *Yr15*) mapping and marker revalidation use RGAP, SSR and TRAP markers. Cloning of the stripe rust resistance gene *Yr5* is in progress. The development of new genomic technologies and marker genotype database are high priorities in coordination with the other three regional genotyping laboratories at Fargo, ND, Manhattan, KS, and Raleigh, NC. Molecular marker genotyping will increasingly provide more efficient information to wheat and barley breeders so that marker-assisted selection can be used in breeding programs to more incorporate valuable traits. This will increase the efficiency of the breeding effort.

## Marker-Assisted Breeding for Disease and Pest Resistance End Use Quality in Wheat

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We have used a molecular breeding approach to develop wheat cultivars with resistance to disease and pest and improved end use quality. We are introgressing the following important genes in different wheat cultivars adapted to in Pacific Northwest region of the U.S. (1) Stripe rust resistance genes: Yr5, Yr15 and HTAP resistance to stripe rust; (2) Hessian fly resistance genes: H9, H13, H25, H3; (3) Foot rot resistance gene: Pch1; (4) Barley yellow dwarf virus resistance gene: Bdv2; and (5) Pre-harvest sprouting resistance gene. BC2 and BC3 genotypes carrying the target genes have been identified using DNA markers linked to the genes. Populations segregating for resistance to stripe rust have been planted at Spillman Agronomy Farm in 2005. Populations segregating for resistance to BYDV will be evaluated at Central Ferry, WA in 2006. Populations segregating for resistance to Hessian fly will be evaluated in Pendleton, OR in 2006. Populations segregating for resistance to preharvest sprouting and to strawbreaker foot rot will be evaluated at Spillman Farm in 2006. This is an effective method of simultaneously incorporating single gene sources of resistance into valuable breeding populations.

## Optimizing Plant Genetics and Soil Fertility to Achieve High Grain Protein Content in Hard Red Spring Wheat

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High grain protein concentration (GPC) is an essential trait for bread wheat cultivars, and producers receive financial incentives for hard red spring (HRS) grain with GPC equal to or exceeding 14%. A chromosomal region from *Triticum turgidum* ssp. *dicoccoides*, reported to confer a 1 to 2 % increase in GPC, was recently transferred to hexaploid wheat. The responses of this chromosomal region to nitrogen rate and genetic background have not been determined. The objectives of this research were to: 1) introgress this region into two adapted HRS cultivars, 'Scarlet' and 'Tara 2002' using marker-assisted backcross breeding; and (2) assess nitrogen response differences among backcross derivatives of Scarlet and Tara 2002 with and without the high GPC region at varying nitrogen levels. Five DNA markers spanning the high-GPC region on chromosome 6BS were used to monitor for the presence of the region. Based on DNA marker profiles, BC<sub>6</sub>F<sub>5</sub> and BC<sub>5</sub>F<sub>5</sub> derivatives of Scarlet and Tara 2002, respectively, with (2 per recurrent parent) and without (1 per recurrent parent) the GPC region, along with the recurrent parents themselves, were evaluated in a directed seeded field trial in Dusty, WA in 2004. Four replicates of each of the eight genotypes were evaluated with 5 nitrogen fertility rates: 0, 20, 40, 80, 120 and 160 lb/A with 40 lbs N/A applied during the previous fall and the remainder deep- band applied below the seed row. Grain was harvested with a Winterstiger small-plot combine, and GPC was measured with a Zeltex protein analyzer. Two, 3-ft rows of plant material were hand harvested at physiological maturity. Plant samples were evaluated for total nitrogen, with the above ground biomass and grain analyzed separately using a LECO CHNS analyzer to characterize nitrogen and sulfur content, as well as partitioning among grain and stover fractions. Nitrogen rate significantly impacted every variable tested including grain yield and GPC. Predetermined yield goals of 40 bu/acre were achieved with the addition of 120 lb N/acre, and grain protein goals of >14% were achieved when grain yields plateaued. This demonstrates the principle that yield potential must be satisfied before grain protein can be elevated to desirable levels. The nitrogen supply required to reach 14% protein was 4.1 lb N/bu. Tara 2002 produced more grain than Scarlet and its derivatives, particularly at low N regimes; however, derivatives with the high-GPC regions were not distinguishable from Tara 2002 or Scarlet for grain yield or for GPC at any fertility rate. Significant differences in sulfur translocation were detected between varieties. Tara 2002 and its derivatives translocated more sulfur to the grain than Scarlet and its derivatives, which may be related to the superior protein quality of Tara 2002 compared to Scarlet. Significant differences were not detected between the backcross derivatives and their recurrent parents for GPC in this trial. However, test weights of grain harvested from all entries were extremely low suggesting that plants may have subjected to high levels of abiotic stress. A severe cheat grass infestations early in the season and lack of precipitation may have influenced these results. This field trial will be repeated in 2005.

## Artificial Freeze Testing of Regional Breeding Lines and Cultivars of Wheat, Barley, Peas and Lentils

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Winter injury is one of the most common risk factors to winter wheat production in the Pacific Northwest. In the Wheat Plant Growth Center at WSU, we conduct artificial freeze tests in the large walk-in growth chambers. The experiments use cold rooms, vernalization rooms, cold boxes, and greenhouse space to determine the cold tolerance values for each genotype of wheat, barley, pea and lentil we currently test. These values are expressed in the form of death and survival percentages at each of several specific temperatures applied mechanically through refrigeration. These are called Lethal Temperature at 50% (LT-50) values. These LT-50 values are then examined and compared with the LT-50 values of other cultivars with similar traits, to single out genes within the plant that are contributing to the resistance of cold, disease, or other factors that attack wheat, barley, peas and lentils. The LT-50 values have shown good correlation with winter survival over the past three years of observations in the WSU winter wheat variety trials at Spillman Agronomy Farm and other locations throughout WA. Most of these plants being tested are already segregated into regional spring and winter lines, elite lines, and genetic (significant in relation) mapping populations. By doing this, it makes it easier to see the relationships of the LT-50 values, apply their possible significance, and discover the genetic material that will be responsible for future crop improvement. The ultimate goal of these investigations, therefore; is to increase and stabilize our yields through resistance to cold, disease, and other crop loss.

## The Effect of Wheat ABA Response Mutants on Grain Dormancy and Drought Tolerance

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Drought is a yearly yield limiting factor for wheat production in the Pacific Northwest. We have isolated wheat mutant lines that are hypersensitive to the phytohormone abscisic acid (ABA) in germination. These mutants will be used to identify agronomically useful genes with the goal of using them to develop wheat germplasm with improved tolerance to preharvest sprouting and to drought. Twenty-nine ABA hypersensitive (ABH) mutants were identified in fast-neutron mutagenized Chinese Spring and EMS mutagenized cv. Zak by screening for failure of afterripened grain to germinate on 5 uM ABA. Dose-response curves were employed to characterize the grain dormancy and germination of mutants. Studies in progress will test the hypothesis that mutants identified for altered ABA sensitivity in germination may also show altered vegetative ABA response and drought tolerance. Four methods will be used as a screen for altered drought responses in ABAH mutants compared to wild type:(1) transpiration rate to determine if altered ABA response in germination is associated with altered transpiration rate under controlled greenhouse drought conditions; (2) mutants showing altered transpiration rate will be examined for altered ABA response using stomatal closure assays; (3) an infrared camera will be used to determine canopy temperature, an increased canopy temperature due to closed stomates is an indication that plant is under drought stress (mutants may show increased surface temperatures); and (4) a field test will be performed under dry conditions to determine if mutants show drought tolerance in terms of higher harvest index and total plant yield. This research will identify genotypes with altered response to drought and to sprouting that can be used in the USDA-ARS wheat breeding program. We will also develop and test new methods of screening germplasm for drought tolerance in the field. The mutants have been planted at Spillman Farm in both summer fallow and annual cropping systems in 2005.

## Evaluating Germplasm from the Caucasus Region for Resistance to Stripe Rust

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Stripe rust is one of the major foliar diseases of wheat in the Pacific Northwest and worldwide, causing significant yield and quality losses. This disease has occurred in Washington since the early 1900s, and stripe rust became a major disease of wheat in the late 1950s. The use of resistant cultivars, developed through crosses involving resistant sources, has become the major means of controlling stripe rust. It is believed that resistance genes originate from the centers of origin of crops, where they historically evolve along with the pathogens. The Caucasus Region is considered to be one of the centers of origin of both wheat and stripe rust. It was proposed that the sources of resistance to stripe rust could be identified in the historical wheat germplasm of this region. This research is being conducted to identify stripe rust resistance genes within a population of 175 historical wheat varieties and wheat relatives originating from Georgia and held at the USDA-ARS National Small Grains Collection at Aberdeen ID. The accessions were obtained, increased and are being screened at the WSU Wheat Plant Growth Center for seedling resistance to the new race of stripe rust, PST 100. In addition, the accessions have been planted at Spillman Agronomy Farm and for evaluation of resistance to field races of stripe rust in 2005 and 2006. Molecular marker analysis is being conducted on this germplasm to determine genetic relationships so that breeders can prioritize new sources of resistance based on genetic relationships.

## Western Regional Uniform Wheat Nurseries

L. M. LITTLE, K. GARLAND CAMPBELL, C. MORRIS, X. CHEN AND OTHER COOPERATORS IN THE WESTERN REGION

The goals of the Western Regional Nurseries are to evaluate wheat germplasm for production, disease, and quality characteristics in several environments throughout the Western Region. The nurseries also functions as an important vehicle for exchange of advanced breeding lines among breeders. Lynn Little oversees basic administration, collation, and yearly production of the Western Regional Uniform Cooperative Wheat Nurseries Report. This involves 4 individual nurseries (Hard Winter, Soft Winter, Hard Spring, and Soft Spring) grown in 23 locations over 5 states by 12 cooperators. The report also includes disease screening and quality analysis information. This is a cooperative project used to observe developing lines prior to possible release in the commercial wheat market and to share germplasm among breeding programs in the Western Region. The data can be accessed through the web site: <http://www.wsu.edu:8080/~wheaties/nurseries.html>

## WSU Variety Testing Program: 50 Year “Golden” Locations—a Snapshot of Cereal Variety Improvement

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**More on the Web** Fifty years ago (1955) the WSU Variety Testing Program managed nurseries at three off-station locations at Lamont, St John and Dusty, Washington. Today (2005) the WSU Variety Testing Program continues to have winter and spring nurseries at two of the same locations in Lamont and St John. Both of these locations could easily be considered the “Golden” locations for the WSU Variety Testing Program representing a combined 100 years of cereal variety evaluation on basically the same piece of ground. Nearly as significant, the Dusty, WA location in 2005 is within 5 miles of the 1955 nursery location. In 1955, all three locations had winter barley, winter wheat, spring wheat, spring oats and spring barley trials in them. 2005 nurseries include winter wheat, spring wheat, and spring barley.

**LAMONT:** The 1955 Lamont nurseries were established on the Roy Cook farm. When Roy retired, his daughter, Lorraine, and husband Curt White took over farming and maintained variety testing nurseries. When Curt retired in the early 1990's his sons David and Gil, took over the farm and are the current cooperators. The variety testing nurseries continue on the White (Cook) farm.



**ST JOHN:** The 1955 St John nursery were established on the George Mills farm in St John. When George retired from farming, his son Woody took over the farm. When Woody retired from farming, his son Mac took over the farm and is farming with his son Rod. The variety testing nurseries continue on the Mill's farm.

**DUSTY:** The 1955 Dusty nurseries were established on the Fred Stueckle farm. Fred's son David continues to farm. The current (2005) Dusty Variety Testing locations are within five miles of the 1955 nursery and could easily be classified as one of our "Golden" locations. The winter variety testing nursery is currently on the Chad Fleming farm and the spring nursery is on the Gerald and Mike Stubbs farm.

Variety testing yield data at these locations illustrate the impact of the winter wheat and spring barley breeding programs at WSU during the past 50 years. Winter wheat yields of adapted varieties have increased an average of 167% and spring barley yields have increased an average of 117% across these three locations. These substantial yield increases have also been enhanced by the use of nitrogen fertilizers, improved selective herbicides and other crop management chemicals as well as improved cropping systems that include extensive use of crop rotations.

## Grain Legume Breeding

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F.J. MUEHLBAUER, K.E. MCPHEE, W. CHEN, R.W. SHORT, C.D. HOAGLAND AND S.L. MCGREW, USDA-ARS, PULLMAN

The grain legume breeding and genetics program is focused on producing new improved cultivars of dry pea, lentil, chickpea and fall-sown winter-hardy pea and lentil. Emphasis has been placed on development of edible types of winter peas and winter lentils that can be direct-seeded in the fall into cereal stubble or reduced tillage situations. All types of edible grain legumes must be environmentally adapted, high yielding and market acceptable. The breeding efforts directed at each of the individual legume crops are described below.

**Dry peas:** The goal of the dry pea breeding program is to develop improved cultivars of green and yellow spring and winter peas as well as marrowfat types adapted to all suitable US production regions. The project addresses production constraints including disease resistance, harvestability, agronomic adaptation, yield and quality. 'Stirling' (selection PS610152), released in February 2003 for its upright, lodging resistant growth habit and resistance to seed bleach and powdery mildew, is in production and has shown improved yield potential compared to other available cultivars. 'Specter' (selection PS9830F009) was released in 2005 and is the first white-flowered, clear-seeded winter feed pea cultivar. Breeder seed is being increased during the 2005 crop year and Foundation seed is expected to be available to producers in the fall of 2006.

**Lentils:** The U.S. lentil industry competes in the world market and must have cultivars with acceptable quality for a variety of market classes. Until very recently, the Palouse region produced only one type of lentil, the so-called Chilean type ('Brewer') with large, yellow cotyledons. The trend has been toward several additional types including: Spanish Brown, Turkish Red, Eston and Richlea. 'Pennell', a large, yellow cotyledon lentil with uniformly green seed coats, was released to the industry and has good standing ability and higher yields when compared to Brewer. 'Merrit', another large-seeded yellow lentil, was also released and is expected to be a replacement for Brewer. A new large green (yellow cotyledon) lentil selection, LC860616L, has performed well in field trials and has been approved for increase of breeder seed with release expected in 2006. The release of 'Morton', a red cotyledon, winter-hardy lentil, is the first of its kind and has provided improved yields when compared to commonly grown spring cultivars and offers producers a viable fall-sown legume rotation crop for use in direct seed situations.

**Chickpea:** Ascochyta blight is a devastating disease of chickpea in the Palouse area and has caused serious crop loss. Several blight resistant cultivars have been released, but most recently, 'Sierra' was released with greater resistance to Ascochyta blight, larger seeds and improved yields and quality. 'Dylan' (CA9990I604C), a Café type chickpea with fern leaf morphology and improved blight resistance, was released in 2005. Seed of Dylan will be available to producers in spring 2006. CA9990I875W, a large-seeded Spanish White type chickpea with fern leaf morphology and improved resistance to Ascochyta blight, was approved for increase of breeder seed in 2005 and limited amounts of seed should be available to producers in 2006. Full release of CA9990I875W is expected in 2006 pending results from 2005 field trials.

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

## 2004 Dry Bean Performance Evaluation in Washington

AN N. HANG, DEPT. OF CROP AND SOIL SCIENCES, WSU-PROSSER

WSU-Prosser has been coordinating Dry Bean Nursery Program as part of W-150 Multiple State project: Genetic Improvement of Dry Bean (*Phaseolus vulgaris* L.) for Yield and Disease Resistance, and Food Value during the last 3 years. In 2004, there were 28 entries of all market classes (black, navy, great northern, pinto, small red, soldier, yellow, Flor de mayo, light red kidney and white kidney) including 5 commercial cultivars using as check. The nursery was planted on Shano silt loam soil at Othello Research Farm, WSU on May 26, 2004. Fertilizers were adjusted to 100 lbs N and 80 lbs P per acre. Eptam (2 qt/a) and Sonalan (1qt/a) were preplant incorporated into the top 4 inches to control weed. All lines grew well under central Washington environment. Seedling vigor was high. Days to maturity varies from 85 (cv. Cal Early, a light red kidney) to 103 days (cvs. T-39, a black and OAC Rex, a navy bean). Black and navy bean are normally considered as full season bean and required 100+ days from planting to harvest. All other market classes may reach maturity from 85 to 95 days. No insects nor diseases were observed in the field and therefore no pesticides were applied during the growing season. Ten plants from each plots were cut, dry and thrashed for harvest index, biomass yield and seed yield efficiency. Yield ranged from 1510 lb a<sup>-1</sup> (cv. Red Coat Soldier) to highest of 4525 lb a<sup>-1</sup> (USRM 20 a new line developed by P.N. Miklas- USDA-ARS Prosser. The overall yield was 3565 lb a<sup>-1</sup>. The growing condition in Othello was favorable to great northern and pinto lines and their yields were above 4000 lb a<sup>-1</sup>.

## 'Quincy' New Pinto Bean Variety for Washington

<sup>1</sup> AN N. HANG, <sup>2</sup> P.N. MIKLAS, <sup>2</sup> M.J. SILBERNAGEL AND <sup>3</sup>G.L. HOSFIELD

<sup>1</sup>DEPT. OF CROP AND SOIL SCIENCES, WSU-PROSSER, <sup>2</sup>USDA-ARS, PROSSER AND <sup>3</sup>EAST LANSING, MI

'Quincy' was released in September 2004 by Washington State University in cooperation with USDA-ARS Prosser, WA and East Lansing, MI. This new release was developed to bring a virus resistant pinto cultivar for the Northwestern states bean growing areas and was the first pinto cultivars released by WSU/USDA-ARS to possess dominant *I* gene resistance to seed borne bean common mosaic virus (BCMV) and high tolerance to beet curly top virus (BCTV). It also exhibits a high level of tolerance to root rot caused by *Fusarium solani* (Mart.) Sacc. f. sp. *phaseoli* (Burkholder) W.C. Snyder & H.N. Hans. Quincy is susceptible to bean rust caused by *Uromyces appendiculatus* (pers.:Pers) Unger which is not a problem in the Pacific Northwest where the weather is unfavorable for rust epidemiology. Quincy has a semi upright Type III plant growth habit Quincy produced high yield comparable to 'Othello' and averaged 3810 lbs per acre in 7 years from 1996 to 2003. Quincy is a medium to late maturity pinto, it requires 90 to 96 days to mature and about 3 to 6 days longer than Othello.. Quincy yielded 14 % higher than Othello in 1999, 2002 and 2004 in Roza, WA, under multiple stress conditions of low residual soil nitrogen (~ 25 lbs /a) with no fertilizer applied, low soil moisture (irrigation water applied at ~ 50% of water used requirements based on evapo-transpiration schedules) and heavy root rot pressure soil due mainly to *Fusarium solani* Seed of Quincy (1000 seeds per lbs) is slightly larger than Othello (1100 seed per lb).

Quincy is an acceptable canner. Quincy has been released as a non exclusive public variety without plant variety protection. Breeder and foundation seed will be maintained by Washington State Crop Improvement Association, Inc. Department of Crop and Soil Sciences, WSU Seed House, Pullman.

## 'Silver Cloud' New White Kidney for Washington

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Silver Cloud was developed by WSU and USDA-ARS Prosser and was released in February 2005. It is a high yielding , upright bush, mid season maturity, disease resistant white kidney adapted to the US Pacific Northwest. Silver Cloud has an upright Type I growth habit and is resistant to lodging. It has dominant *I* gene resistance to bean Common mosaic virus and complete resistance to curly top virus. Silver Cloud is more tolerant to bean rust

[*Uromyces appendiculatus* (pers:Pers) Unger] than other white kidney. Silver Cloud is classified as medium to late maturity group averaging 96 days from planting to harvest, and 8 days later than "Lassen". Silver Cloud outyielded Lassen by 6 to 19% in 1996 and 1997, respectively. Silver Cloud has unusually attractive, large and shiny white seed that are 850 seeds per lb compared to 925 seeds for Lassen. Under multiple stress conditions of low residual soil nitrogen (~ 20 lb/a) with no fertilizer applied, low soil moisture (irrigation water applied at ~ 50% of water used requirements based on evapo-transpiration schedules), and heavy root rot pressure, due mainly to *Fusarium solani* Silver Cloud produced 19 and 59% higher yield than Lassen and 'Beluga'. Silver Cloud averaged 2225 lbs per acre in 12 locations in the US and Canada. Canning trials performed by USDA-ARS and Michigan Agricultural Experiment Station and by New York Agricultural Experiment Station showed that Silver Cloud had improved canning quality compared to Beluga, Lassen and White Kidney for overall appearance and size. Silver Cloud has been released as a non-exclusive variety without plant variety protection. Breeder seed and foundation seed will be maintained by Washington State Crop Improvement Association, Inc. Department of Crop and Soil Sciences, WSU Seed House, Pullman.

## Edamame Research Report

AN N. HANG, GAVIN SILLS AND THOMAS A. LUMPKIN, DEPT. OF CROP AND SOIL SCIENCES, WSU-PROSSER

Edamame is a type of soybean, but it is higher in flavor, less fat or oil content, high nutritional value and milder taste than soy bean. Edamame is served as cooked fresh green seed in pod, high nutritional snack food. Edamame seed is also used for many years in oriental cooking in stir fry or mixed with rice in the same way the green pea is used or in soup. In part of the East Asian Crop Research program, WSU released 2 lines of edamame this February. These lines were selected from 50 lines from the crosses made in 1990. These lines have shown adapted to the Columbia Basin growing conditions. These selection criteria are:

- 1) adapted to the 150 days growing season of central Washington
- 2) produced high yield of 2-, 3- and 4-seed pods
- 3) no or low percentage of seed shatter
- 4) large seed size and
- 5) high soluble solid

Edamame is grown like soybean and is harvested at the green pod stage (fully developed pods but before they turn yellow) and the seed is still green and soft for fast cooking (5 min. in boiling water). Edamame can be commercialized in fresh or frozen pods or in frozen seed like green pea.

The edamame research at WSU is an ongoing project to further select new lines with larger seed with less branching, more upright and higher percentage of pod set at higher internodes which will facilitate mechanical harvesting and reduce seed loss. Agronomist is also seeking cooperation with food scientist in studying various cooking method for edamame before serving as snack food. Agronomist at WSU is also seeking lines with early, mid and late maturing lines to prolong fresh market span.

## Part 2. Pathology and Entomology

### Strawbreaker Foot Rot, Cephalosporium Stripe, and Snow Mold Diseases of Winter Wheat

TIM MURRAY, SCOTT McDONALD, AND HONGYAN SHENG, DEPT. OF PLANT PATHOLOGY, WSU

Strawbreaker foot rot (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. 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 can persist for 100 days or more.

Application of TiltPlus® fungicide in the spring prior to jointing and/or planting a resistant variety like Madsen, have been the main control measures for eyespot. Production of TiltPlus has been discontinued, leaving Tilt and Topsin-M, the two components of TiltPlus, as the only fungicides registered for eyespot. Disease-resistant varieties remain the most desirable method for controlling eyespot and several varieties with resistance are available. Likewise, snow mold-resistant varieties and early seeding are the best control methods. Several resistant varieties such as Bruehl and Eltan are available. Varieties with true resistance to *Cephalosporium* stripe are not available. Collaborative research in our program and Dr. Stephen Jones' winter wheat breeding program has resulted in transfer of resistance from wheatgrass into wheat; varieties with very effective resistance to *Cephalosporium* stripe and eyespot should be available in the next few years.

In cooperation with the WSU winter wheat breeding program, we screen winter wheat cultivars and breeding lines for resistance to *Cephalosporium* stripe and eyespot every year at the Spillman Agronomy Farm or Palouse Conservation Field Station, and for snow mold resistance in Douglas County. 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 goal to improve the resistance of winter wheat varieties to these important diseases and thereby reduce yield losses and external inputs for Washington State wheat growers.

## Develop a Modified Assay Method for the Endopeptidase Marker and Compare the Utility of this with the DNA Marker for Strawbreaker Foot Rot Resistance in Wheat

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The most effective resistance gene (Pch1) has been used to develop Strawbreaker foot rot (also known as foot rot or eyespot) disease resistant wheat cultivars world wide during past 20 years. An endopeptidase isozyme marker had been used as indirect selection tool to identify plants carrying Pch1 in developing foot rot resistant wheat cultivars because of close association of this marker and Pch1. The objectives of this project were to: (1) develop an efficient assay method for endopeptidase marker in wheat; and (2) compare the utility of endopeptidase and recently reported DNA marker for predicting disease response. We developed a faster and improved method of assaying endopeptidase marker and identified six distinct endopeptidase banding patterns among 38 wheat cultivars and breeding lines tested for the marker. The endopeptidase marker was 100% accurate for predicting foot rot disease response, whereas the DNA marker predicted the correct phenotype with approximately 90% accuracy. The improved method for Pch1 linked endopeptidase marker assay will help wheat breeders to identify resistant plant at early generation in their breeding program which will lead to develop foot rot resistant wheat cultivars quicker and more efficiently. A recombinant inbred population of Brundage/Coda that is segregating for foot rot resistance has been planted in our foot rot inoculated nursery at Spillman Agronomy Farm for evaluation in 2005.

## Management of Root Diseases of Wheat and Barley

TIMOTHY C. PAULITZ, USDA-ARS ROOT DISEASE & BIOLOGICAL CONTROL RESEARCH UNIT, PULLMAN, WA

Since 2000, my program has focused on developing an understanding of root pathogens, namely *Rhizoctonia*, *Pythium*, *Gaeumannomyces*, and *Fusarium*, in order to identify and implement strategies for their control. As the work of my predecessor, R. J. Cook, has demonstrated, soilborne pathogens can result in significant yield loss, and they are difficult to quantify and diagnose. In collaboration with Dr. Patricia Okubara, I am defining the genotypic and pathogenic diversity of these pathogens, so quick methods of detection and quantification can be developed based on DNA extraction from soil. This information is also useful for developing techniques to screen germplasm for resistance or tolerance to pathogens, especially *Pythium* and *Rhizoctonia*. This work has led to several promising lines which are now being genetically characterized in collaboration with Dr. Kimberlee Kidwell

and other plant breeders. It is also important to understand the epidemiology of these pathogens: how they spread in time and space and how cultural practices influence disease. My program has examined disease dynamics in direct seed (no-till) systems, which can increase diseases such as *Rhizoctonia* root rot. *Rhizoctonia* can become yield limiting during the 3<sup>rd</sup> and 4<sup>th</sup> year of the transition from conventional tillage, but is not a major problem in long-term direct seed systems (>12 years). In collaboration with Dr. Dave Huggins, we have used GPS to study the spatial distribution of *Rhizoctonia* on the Cunningham Agronomy Farm, to create maps which can be used with precision agriculture/variable rate technology. The knowledge from all these studies is then translated into cultural practices that can be tested under field conditions including residue management, greenbridge control, chemical fallow, reduced mechanical tillage, and variable N application. Collaborators: R. James Cook, Kurtis Schroeder, Patricia Okubara, Kimberlee Kidwell, David Huggins, and William Schillinger.

## Strategies for Detection and Control of Root Diseases of Wheat

PATRICIA OKUBARA, USDA-ARS ROOT DISEASE & BIOLOGICAL CONTROL RESEARCH UNIT, PULLMAN, WA

**More on the Web** All Pacific Northwest varieties of wheat and barley are affected by root diseases, including *Rhizoctonia* root rot, *Pythium* root rot, *Fusarium* crown rot, and take-all. Genes conferring effective resistance against the fungal pathogens that cause these diseases have not been identified, and therefore breeding for resistance to root diseases has not been undertaken. The research in my laboratory is aimed at controlling root pathogens by identifying and deploying genes and factors in the plant that directly combat them, or that support durable interactions with biocontrol agents that suppress disease.

As root diseases are not readily distinguished on the basis of symptoms, and current diagnostic methods require up to 14 days, rapid molecular (PCR) assays to detect and quantify the major soilborne pathogen of wheat and barley are being developed. Such assays will be used to screen breeding lines for pathogen tolerance, and establish risk thresholds and disease management strategies for growers.

Soil bacteria of the genus *Pseudomonas* confer biological control of a number of soilborne pathogens, including *Rhizoctonia*, *Pythium*, and the take-all pathogen, *Gaeumannomyces*, in part due to production of antifungal metabolites and plant hormones that stimulate root growth. Our research in this area indicates that Pacific Northwest wheat cultivars have genetic variation in their ability to support high populations of the biocontrol bacteria and to accumulate the antifungal metabolite on their roots. Current research focuses on determining mechanisms of disease tolerance in wheat roots, and identifying wheat genes that are involved in sustaining successful biocontrol interactions and pathogen defense. Among the latter are genes for stress adaptation, jasmonate (hormone) signaling, and inhibition of cell death in the root. Collaborators: Timothy Paulitz, Daniel Skinner, Kurtis Schroeder, Camille Steber, Kimberlee Kidwell.

## Genetic Characterization of *Pythium* Root Rot Resistance in Cultivated Wheat

E. SNYDER, T. PAULITZ, R. HIGGINBOTHAM AND K. KIDWELL, DEPT. OF CROP AND SOIL SCIENCES, WSU

Genetic resistance is a common control measure for many pests and diseases that plague spring and winter wheat. *Pythium* spp. are prominent in soils in all wheat producing regions in Washington State, and severe infections can lead to 25% yield losses. For economic and environmental reasons, more growers are moving toward direct seeded wheat production systems, and *Pythium* root rot can be exacerbated under these conditions. Control of *Pythium* has proven difficult due to its wide host range and lack of effective chemical control methods. In addition, no tolerant or resistance cultivars have been developed. Genetic resistance is a viable option for controlling this disease thereby reducing grower risk. However, sources of resistance or tolerance must first be identified for use in variety improvement. The objectives of this research are to: 1) verify resistance reactions of several wheat varieties previously identified as having high levels of tolerance to *Pythium* root rot; 2) genetically characterize the *Pythium* tolerance identified in these varieties; and 3) identify DNA tags for *Pythium* tolerance for use in marker-assisted selection. Disease responses to *Pythium* were determined in controlled growth chamber assays by screening against two common species, *P. ultimum* and *P. debaryanum*. Fourteen days after planting, root and plant measurements were recorded for inoculated and non-inoculated seedlings to assess disease damage. The hard red winter line KS93U104 and the Australian hard white variety 'Sunco' were rated as moderate to highly resistant, whereas the

hard white winter line OR942504 and the hard white spring variety 'Macon' highly susceptible, which confirmed previous results. Segregating populations were developed by crossing resistant to susceptible genotypes. These populations will be used to determine whether the resistance is heritable (i.e. transmitted from parent to offspring) and for DNA marker analysis in conjunction with disease screening. Two genetic mapping populations are being constructed: 1) KS93U104 X OR942504 (winter types); and 2) Sunco X Macon (spring types). A double haploid population (250 individuals) will be created for the winter population, whereas recombinant inbred lines (250 F<sub>5</sub> developed using single seed descent) will be developed for the spring population. Both populations will be used for disease assessment and DNA marker analysis. KS93U104 also was crossed to Sunco to determine if the sources of tolerance in each genotype differ. If the tolerance to *Pythium* root rot identified in these genotypes is genetic in nature, we will identify and utilize DNA markers associated with resistance to rapidly incorporate this trait into adapted spring and winter wheat varieties.

## Reduction of Rhizoctonia Bare Patch in Wheat with Barley Rotations

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*Rhizoctonia* bare patch caused by *Rhizoctonia solani* AG-8 is a major fungal root disease in no-till cropping systems. In an 8-year dryland no-till cropping systems experiment near Ritzville, Washington, *Rhizoctonia* bare patch first appeared in year 3 and continued unabated through year 8. Crop rotation had no effect on bare patch during the first 5 years. But from years 6 to 8, both soft white (SW) and hard white (HW) classes of spring wheat grown in a 2-year rotation with spring barley (SB) had an average of only 6.6% of total land area with bare patches compared to 15% in continuous annual SW or HW (i.e., monoculture wheat). Monoculture HW in patches was damaged or killed by *Rhizoctonia* before seedling emergence as evidenced by a 40% reduction in plant stand compared to monoculture SW and HW or SW in rotation with SB. In years 6 to 8, average grain yield of both SW and HW were greater ( $P < 0.001$ ) when grown in rotation with SB than in monoculture. Although both classes of wheat had less bare patch area and greater grain yield when grown in rotation with SB, monoculture HW was more severely affected by *Rhizoctonia* than SW. Soil water levels were higher in bare patches, indicating that roots of healthy cereals do not grow into/underneath bare patch areas. This is the first documentation of suppression of *Rhizoctonia* bare patch disease in low-disturbance no-till systems with rotation of cereal crops.



Fig. 1. *Rhizoctonia* bare patches, seen here in barley, were mapped using a backpack-mounted global positioning unit.

## Control of Stripe Rusts of Wheat and Barley

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Stripe rusts of wheat and barley were accurately forecasted in 2004. Wheat stripe rust was severe while barley stripe rust was generally light. Fungicide application was implemented to control stripe rust on both winter and spring wheat crops, which prevented major losses. In Washington State, yield losses were reduced to 1.5% for winter wheat and 3% for spring wheat. High-temperature, adult-plant (HTAP) resistance to stripe rust, which is in most winter wheat and the major spring wheat and barley cultivars, continued to be the most effective and durable type of stripe rust resistance. In 2004, 28 races of the wheat

stripe rust pathogen and 15 races of the barley stripe rust pathogen were detected, of which six and three races were new for the wheat and barley stripe rust pathogens, respectively. PST-100 was the most predominant race of the wheat stripe rust pathogen throughout the country. More than 13,000 wheat and 5,000 barley entries were evaluated for stripe rust resistance, from which new germplasms and advanced breeding lines with stripe rust resistance were identified. The information was provided to breeding programs for developing and releasing new cultivars with adequate resistance. To more efficiently incorporate stripe rust resistance into commercial cultivars and to understand mechanisms of resistance, crosses were made to identify genes, develop molecular markers for genes, and use the markers to transfer genes for resistance. Molecular markers were identified for several genes in wheat and barley for resistance to stripe rust and other diseases. A bacterial artificial chromosomal (BAC) library was constructed for wheat to clone rust resistance genes. BAC and cDNA libraries were constructed for the wheat stripe rust pathogen to study its genome and functional genomics. More than 30 genes of the rust fungus were identified and primers were designed based on selected genes to study populations of the stripe rust and to determine relationships of the wheat stripe rust to other rusts. Foliar applications of Folicur, Tilt, Quadris, Quilt, Headline, and Stratego were effective for controlling stripe rust when sprayed at the right time. Profitability of fungicide application on various cultivars of wheat and barley without and with different level of stripe rust resistance was determined.

## Mapping Genes for High Temperature Adult Plant Resistance to Stripe Rust in Wheat

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High-temperature, adult-plant (HTAP) resistance to stripe rust in wheat is governed by multiple genes, and is race non-specific and durable. We utilized molecular marker technology to (1) identify and map genes for HTAP resistance to stripe rust in winter wheat cultivar 'Stephens' which has provided significant level of resistance to stripe rust for the last 26 years in Pacific Northwest region of the U.S.; and (2) develop DNA markers for use in marker-assisted breeding. Two genes associated with HTAP resistance were identified and mapped. One gene was mapped within a 23.1 cM region flanked by DNA markers Xgwm88.2 and Xucw71 on the short arm of wheat chromosome 6B, whereas second gene was mapped within a 14.9 cM region flanked by DNA markers Xgwm508.2 and Xgwm132 on the same chromosome. These DNA markers linked to the genes for HTAP resistance to stripe rust can be used in marker assisted breeding for durable stripe rust resistance in wheat. The mapping population is planted at Spillman Agronomy Farm, at Mt. Vernon, WA, and at Davis CA for stripe rust evaluation in 2005.

## Grain Legume Pathology

W. CHEN, K.E. MCPHEE, F.J. MUEHLBAUER, T. CHEN, AND R. SHORT, GRAIN LEGUME GENETIC AND PHYSIOLOGY RESEARCH UNIT, USDA-ARS, WSU-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. Our research program is working on several important diseases of grain legumes.

**Ascochyta blight of chickpea:** Ascochyta blight of chickpea is caused by the fungal pathogen *Ascochyta rabiei*, and is a devastating disease. Management of Ascochyta blight is mainly through use of resistant cultivars and judicious application of fungicides. Identifying resistance sources and determining pathogenic variation of the pathogen is important in developing new resistant cultivars. The pathogen population can be divided into two pathotypes, and currently the dominant pathotype in the Palouse region is pathotype II which is pathogenic on resistant cultivars. Greenhouse and field evaluations have identified four chickpea germplasm lines that are highly resistant to the pathotype II and will provide new materials for resistance breeding. Fungicide trials conducted at Pullman and Genesee from 2002 to 2004 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 the trials. Resistant cultivars

such as 'Dwelley' and the recently released 'Sierra' are tolerant to *Ascochyta* blight. That means they can still yield comparably even with certain levels of disease infection.

**White mold of lentils and peas:** White mold is caused by the fungal pathogen *Sclerotinia sclerotiorum*. White mold can be a serious disease under conducive conditions (cold and moist weather). Research is being conducted to identify resistance/tolerance sources in the pea and lentil germplasm lines. Several lines of lentils showed tolerance to the disease and pea cultivars also showed differential response to white mold. These tolerance sources are being used to map and identify tolerance genes or quantitative trait loci that will help resistance breeding. The pathogen population in a lentil field near Colton was extensively sampled and studied for genetic variation through mycelial compatibility groups and presence of double stranded RNA. Considerable genetic variation was found in the pathogen populations, which has implications in developing screening procedures in breeding programs.

Recent funding from the Cool Season Food Legume Research Program will allow us

to study **powdery mildew of pea**. Research will focus on management practices and genetics of resistance aiming at developing resistant pea cultivars adapted for US production.

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

		<u>Mean percent RWA infested tillers 48 DAPE</u>
Treatment/formulation	Rate fl/oz cwt	
Poncho 600 (5 lb/gal)	0.20	0.25c
Poncho 600	0.10	0.50c
Gaucho 480	0.32	1.00c
Cruiser	0.19	2.50b
Gaucho 480	0.16	2.50b
UTC	-----	18.50a

Means followed by same letter are NSD. ANOVA; LSD  $p = 0.05$ .

		<u>Bu wheat per acre yield</u>
Treatment/formulation	Rate fl/oz cwt	
Poncho 600	0.20	79.75a
Poncho 600	0.10	79.70a
Gaucho 480	0.32	75.83b
Cruiser	0.19	69.73c
Gaucho 480	0.16	67.88c
UTC	-----	67.40d

Means followed by same letter are NSD. ANOVA; LSD  $p = 0.05$ .

		<u>Mean plants/18 inches of row 10 DAPE</u>
Treatment/formulation	Rate fl/oz cwt	
Poncho 600	0.20	16.00a
Poncho 600	0.10	15.50a
Gaucho 480	0.32	14.00a
Gaucho 480	0.16	11.00c
Cruiser	0.19	10.75c
UTC	-----	9.00d

Means followed by same letter are NSD. ANOVA; LSD  $p = 0.05$ .

## Seed Treatment Insect Control in Spring Wheat, 2004

DAVID BRAGG, CATHLIN DONOHUE, WSU, EXTENSION ENTOMOLOGY, AND KURT TETRICK, USDA-ARS WREPMIC CENTRAL FERRY, WA 99347

**Pacific Coast Wireworm (WW):** *Limoniuss canus* LeConte  
**Russian wheat aphid (RWA):** *Diuraphis noxia* (Mordvilko)

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A seed treatment experiment of a RCB by plot drill was established at USDA-ARS WREPMIC. Seeding was into failed winter wheat on sweet corn ground for wireworm presence. Wireworm damage was evaluated by mean plant stand counts per 18 inches of row. Mean grain heads per plant were counted prior to harvest for plant vigor. Differences in plant stand varied between treatments -two rates of Poncho and Gaucho 480 0.32 fl/oz cwt SD to other treatments and UTC. Heads per plant were SD for two rates of Poncho compared to other treatments and UTC. Differences in plant stand are attributed to wireworm injury to seedling plants.



RWA appeared at just prior to anthesis, and RWA infested tillers were counted. Yield data in bu per acre were collected by small plot combine. All 5 seed treatments improved control of RWA compared to the UTC. Poncho™ 600 provided slightly better yields compared to the 0.32 fl oz/cwt Gaucho 480 treatment. These 3 treatments were SD to other treatments, and UTC.

## Establishing Cereal Leaf Beetle Biocontrols in Washington State

DIANA ROBERTS (WSU EXTENSION, SPOKANE), TERRY MILLER (NORTHWEST BIOLOGICAL CONTROL INSECTARY/QUARANTINE [NWBIC], PULLMAN), KEITH PIKE (WSU ENTOMOLOGY, PROSSER), STEVE MILLER (USDA-APHIS, SPOKANE)

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The cereal leaf beetle (*Oulema melanopus*) was first discovered in Washington state in 1999. It has a wide host range in the grass family and may cause yield losses up to 75%. Introduced biocontrol species have successfully kept the cereal leaf beetle (CLB) at subeconomic levels in most midwestern and eastern states.

The WSDA initiated a bicontrol program in 2000, and WSU Extension took the lead in 2003. By the end of 2004 we had established 4 field insectaries and a small tent insectary at the NWBIQ in Pullman. The 2 primary biocontrol species are *Tetrastichus julis* (larval parasitoid) and *Anaphes flavipes* (egg parasitoid). Both are tiny wasps that are specific to CLB and they do not harm people, pets, livestock, or plants

The total number of parasitoids released in 2004 at these insectaries were:

- 7,028 *T. julis* (larval parasitoid) as parasitized CLB larvae
- 125 *L. curtis* (larval parasitoid) as parasitized CLB larvae
- 10,038 *A. flavipes* (egg parasitoid) as parasitized CLB eggs

In 2003, a prerelease survey at Nine Mile Falls found 5 *T. julis* larvae in one (1) of 130 CLB larvae sampled. **Note:** surveys of pest insects and biocontrols assume that for every insect caught, there are many in the field that are not caught. In 2004, prerelease surveys at the four field insectaries found a total of **191 *T. julis*** larvae or adults, up to 7 per CLB larva. **Note:** *T. julis* appeared at Deep Creek and in a field at Wilbur prior to ever being released there. We expect it had moved on its own from Nine Mile.

A 2004 prerelease survey also found one *A. flavipes* adult at Nine Mile and at Colville, the very first season after it was released in Washington. **Note:** *A. flavipes* has typically been hard to establish in the dry, western states. It is an important component of CLB biocontrol as it kills the CLB before it can cause damage, unlike the larval parasitoids that allow CLB larvae to damage the plants before they die in the pupal stage.

In 2004 the progression of CLB across the state was somewhat anomalous. While one can find it at low levels in dryland fields in the higher rainfall areas, it is concentrating in irrigated regions. New hotspots showed up in irrigated fields at Connell, Walla Walla, Ritzville, Warden, Moses Lake, and in Clark County.

COOPERATORS:

KIT CUTLER (NINE MILE FALLS), RICHARD SEITTERS (COLVILLE), WALTER KNAPP (PEONE PRAIRIE), PAUL GROSS (DEEP CREEK).

## Part 3. Quality Evaluation

### Washington State University Wheat Quality Program

BYUNG-KEE BAIK, CEREAL CHEMIST; TRACY HARRIS, LABORATORY TECHNICIAN  
COOPERATORS: STEVE JONES, KIM KIDWELL, KIM CAMPBELL AND CRAIG MORRIS

The Washington State University Wheat Quality Program (WSUWQP) provides end-use quality testing of early and advanced generation breeding lines for the wheat breeders at WSU. The goal of WSUWQP is to increase the competitiveness of Washington wheat in the global market by promoting end-use quality of wheat through extensive testing of breeding lines to ensure the development of superior wheat varieties.

For the crop harvested in 2003, WSUWQP tested approximately 2300 samples from the spring and winter wheat breeding programs. The test results were analyzed, summarized and reported to the WSU wheat breeders. The end-use quality evaluation data have been used by the breeders in making selections of their breeding lines for the next growing season.

Wheat quality testing included both early generation and advanced breeding lines of spring and winter wheat. End-use quality evaluation of breeding lines was conducted largely based on milling performance and functional properties (processing and baking quality) of wheat grains. Soft white (spring, winter and club) wheat lines were tested for their grain quality for making cookies and sponge cake; hard red wheat lines for making bread; and hard white wheat lines for both bread and noodles.

All samples were tested for test weight, single kernel hardness, wheat and flour protein content, milling quality, flour ash and protein content. Soft white wheat was tested for mixograph absorption, microsolvent retention capacities, flour swelling volume, sponge cake volume and cookie diameter. Club wheat was tested for mixograph absorption, Brookfield viscosity, sponge cake volume and cookie diameter. Hard red and hard white wheat were tested for mixograph absorption and bread loaf volume. Hard white wheat samples were also tested for alkaline noodle color.

This work is an integral part of the wheat breeding process for the development of wheat variety with superior end-use quality.

## Starch Quality Assessment of Dual Purpose Hard White Wheat

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C. WALKER (WSU), B. CARTER (DECAGON), K. HUBER (U OF I), AND K. KIDWELL (WSU)

Developing dual-purpose varieties suitable for both noodle and bread production is essential to creating a viable hard white wheat (HWW) market. To develop breeding strategies for selecting dual purpose types among experimental breeding lines, the ideal combination of protein quality, protein content, and starch type for a dual-purpose HWW must be determined. The two starch types most often associated with noodle production are partial waxy starch and normal starch. Partial waxy starch occurs when there is a lower than normal level of amylose compared to amylopectin in the endosperm of the grain, which is caused by the absence of one or more of the genes that code for the enzyme responsible for the production of amylose. Flour from partial waxy wheat exhibits high starch pasting and swelling characteristics, which results in soft textured noodles; however, this type of wheat is unsuitable for making hard bite noodles. HWW varieties with strong gluten and normal starch type are predicted to be ideal for bread and noodle making; however, partial waxy types with strong gluten also are useful for bread and noodle making.

Originally, our intention was to create a unique set of wheat samples in a common protein quality background that vary only for their starch pasting characteristics to test the impact of normal vs. partial waxy starch on product quality. In spring 2003, headrows of Otis, a hard white spring variety thought to be a mixture of normal and partial waxy starch types, were planted in Moses Lake, WA for seed increase. Two hundred headrows were randomly selected for harvest, and flour milled from resulting grain was analyzed to identify individuals varying in their starch pasting characteristics. Results suggested that Otis might not be a mixture of normal and partial waxy starch types, which was confirmed through DNA marker analysis. Even though Otis is 100% partial waxy, the average starch pasting viscosities of this variety have been consistently lower than Idaho377s, another partial waxy wheat and the bread baking quality of Otis is superior to that of Idaho377s.

The objectives of this research are to: 1) explore possible physiochemical attributes that cause Otis to exhibit different starch pasting and quality characteristics than other hard white varieties with partial waxy starch types; 2) determine the differences in end product performance, specifically in the production of Asian noodles and bread, of four hard white spring wheat varieties with varying starch and protein quality attributes when analyzed at different grain protein contents. Determine how the attributes identified in objective 1 impact differences in product performance among these four varieties; and 3) Based on the results of objective 2, determine which combination of physiochemical traits provides the widest product utility range for a dual-purpose hard white wheat. Results will give breeders, quality specialists, and end-users clear indications of the ideal type of hard white wheat to produce in the PNW. It may or may not be possible to fulfill the needs of a majority of our hard white wheat users with one type of wheat. Unfortunately, the US wheat marketing system is unable to segregate wheat based on quality. However, wheat can be segregated based on grain protein content, creating the possibility of

identifying grain lots suitable for specific markets based on protein content level. This study will provide insights into the potential for providing customers with hard white wheat that suits their specific quality needs by creating grain lots with the ideal combination of starch type, protein content, and protein quality for their targeted end product.

## Converting Barley from a Low to a High Energy Feed

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DITER VON WETTSTEIN, DEPARTMENT OF CROP AND SOIL SCIENCES, SCHOOL OF MOLECULAR BIOSCIENCES & CENTER OF INTEGRATED BIOTECHNOLOGY, WSU

Indeed supplementation with enzymes is now the rule, if barley is used as animal feed. Enzyme solutions are produced in fermenters, transferred to mixers with starch carrier material in the form of barley or wheat flour in order to stabilize the enzyme. After mixing, the material is dried in warm air and the pellets milled, homogenised and packaged for shipping. But barley acreage continues to decline because low-priced GMO corn with higher nutritional quality remains a strong competitor of barley even in areas where grain corn cannot mature.

Low nutritional value of barley is due to the absence in birds of an intestinal enzyme for efficient depolymerization of (1,3-1,4)- $\beta$ -glucan, the major carbohydrate of the endosperm cell walls. It leads to high viscosity in the intestine, limited nutrient uptake, decreased growth rate, and unhygienic sticky droppings adhering to chickens and floors of the production cages. We have performed broiler chicken trials to investigate, if transgenic grain containing a protein-engineered thermostable (1,3-1,4)- $\beta$ -glucanase in the endosperm can increase the nutritive value of barley-based diets to that of maize. Equal weight gain, feed consumption and feed efficiency was obtained. The frequency of chicks with sticky droppings was reduced to the level observed with maize diet. A barley-soybean diet containing 620g non-transgenic barley/kg needs only 0.2g (0.02%) transgenic grain/kg to achieve the high nutritive value, while commercial Avizyme 1100<sup>®</sup> is added at a concentration of 1g/kg diet. The addition of transgenic grain compares to the amount of trace minerals added to standard diets. The transgene has been bred into modern barley varieties, providing a yield that compares favorably with that of Baroness. The lines produce constant amounts of enzyme.

Small amounts of transgenic grain containing (1,3-1,4)- $\beta$ -glucanase as feed additive can boost the production of non-transgenic barley in areas where grain maize cannot mature. Feeding 40 million broiler chicks in Washington with barley instead of imported maize will require 280 000 ton of **non-transgenic** barley but only 56 ton of transgenic barley, which could be produced on 25 acres of farmland. The barley feed with added transgenic grain provides an environmentally friendly alternative to enzyme additives, as it uses the sun for its production and thus avoids use of non-renewable energy for fermentations.

## Part 4. Agronomics, Alternate Crops and Systems

### Evaluating Chemical Fallow Systems for Weed Control Efficacy

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JOSEPH P. YENISH, AARON ESSER AND DENNIS TONKS, WASHINGTON STATE UNIVERSITY AND FRANK YOUNG, USDA-ARS

Research was conducted near Lind and Pullman, WA in the low and high rainfall production zones, respectively, to determine the efficacy of various herbicides in a chemical fallow system. Predominant species at Lind and Pullman were Russian thistle and mayweed chamomile, respectively. Weed density and biomass were measured on July 15 and August 4 at the same respective locations. At Lind, broadleaf weed populations and biomass tended to be greatest with glyphosate regardless of number or timing of applications. The lowest weed density and biomass were with 0.064 lbs. isoxaflutole plus 0.141 lbs. sulfentrazone/acre applied March 10 followed by 0.375 lbs glyphosate/acre applied April 12. Isoxaflutole plus sulfentrazone reduced broadleaf density and biomass 97

and 91%, respectively, greater than glyphosate applications. Treatments with weed density or biomass that not greater than isoxaflutole plus sulfentrazone included 0.188 and 0.141 lbs sulfentrazone/acre, 0.064 lbs flumioxazin/acre, 0.080 lbs isoxaflutole/acre, and 0.064 lbs flumioxazin plus 0.141 lbs sulfentrazone/acre. None of the treatments containing dicamba, metribuzin, or paraquat plus diuron differed from glyphosate treatments for weed density or biomass. At Pullman, greatest weed density and biomass tended to be with glyphosate only treatments applied April 28 or earlier. However, an additional glyphosate application made June 22 reduced plant density and biomass 97 and 100%, respectively, than earlier glyphosate applications. Tankmix combination of 0.064 lbs flumioxazin plus 0.141 lbs sulfentrazone/acre and 0.064 lbs isoxaflutole plus 0.141 lbs sulfentrazone/acre and sequential applications of 0.5 lbs paraquat plus 0.25 lbs diuron/acre also reduced weed density and biomass 90% or better compared to early applied glyphosate. The efficacy of treatments varied between locations due to different weed species. While glyphosate remains a critical component of chemical fallow systems, it is possible to achieve good weed control with fewer glyphosate applications when combined with residual herbicides.

## Mechanical Weed Management in Conservation Tillage Systems

SUZANNE KOPAN AND ROBERT GALLAGHER, DEPT. OF CROP AND SOIL SCIENCES, WASHINGTON STATE UNIVERSITY

Soils in much of the Pacific Northwest are highly prone to wind and water erosion under conventional farming practices. Conservation tillage systems help mitigate these effects but tend to favor the development of certain soil-borne fungal pathogens (i.e. *Rhizoctonia* spp., *Pythium* spp., and *Fusarium*) and depend on herbicides for weed control, leading to the development of herbicide resistant weed populations. This project is evaluating a Phoenix® rotary harrow prototype and a high-residue rotary hoe for mechanical weed control in conservation tillage wheat and pea production systems. We hypothesize that a pre-plant rotary harrow operation coupled with multiple rotary hoe operations will provide non-selective control of weeds, reduce soil-borne diseases, and help deplete soil weed seed bank populations. In addition, the rotary harrow and hoe provide minimal soil disturbance within the top 2 inches of soil while leaving a majority of the crop residues on the soil surface to protect against erosion. Preliminary data suggest that problem weeds, such as prickly lettuce and wild oat, can be controlled in wheat by this integrated mechanical approach without causing reductions in crop stands. Mechanical management of these weeds in spring peas appears to be more problematic.

## Determining Best Crop Rotation for Effective Jointed Goatgrass Control Using Imidazolinone Resistant Wheat

FRANK L. YOUNG, USDA-ARS, JOSEPH P. YENISH, AND JOHN BURNS, WASHINGTON STATE UNIVERSITY

Researchers collected data during the fourth year of a long term study in eastern Washington to determine the frequency and time to use a herbicide-resistant winter wheat crop to manage jointed goatgrass (*Aegilops cylindrica*). Research activities continued at two locations: a) 18-22 inch (high) rainfall zone with a winter wheat/spring cereal/grain legume rotation, located near Pullman, WA, and b) 9-11 inch (low) rainfall zone with a winter wheat/summer fallow rotation, located near Pasco, WA. At Pullman, imidazolinone-resistant winter wheat (ClearFirst®) planted in the fall of 2003 was treated in April 2004 with imazamox herbicide at the rate of 6 oz/A imidazolinone + 2.5% UAN (v/v) + 0.25% surfactant (v/v). Control of jointed goatgrass in imidazolinone-resistant winter wheat plots was nearly 100%. The conventional winter wheat at Pullman averaged 420 spikelets yd<sup>-2</sup> of jointed goatgrass and was treated with a tank mix of herbicides for broad-spectrum weed control. Average yields (clean grain) at Pullman were 106 bu/A for the imidazolinone-resistant winter wheat and 113 bu/A for the conventional winter wheat. At the Pasco north site, imidazolinone-resistant winter wheat (ORCF101) planted in the fall of 2003 was treated in March 2004 with imazamox herbicide at a rate of 5 oz/A + 2.5% Sol 32 (v/v) + 0.25% surfactant (v/v). Control of jointed goatgrass was good, with imidazolinone-resistant winter wheat plots averaging 68 spikelets yd<sup>-2</sup>, compared to 1286 spikelets yd<sup>-2</sup> in conventional winter wheat plots. Average crop yields (clean grain) were 50 bu/A for the imidazolinone-resistant winter wheat and 67 bu/A for the conventional winter wheat. The Pasco south site was fallow in the 2004 growing season and was seeded with Clearfield® (ID587) and Stephens winter wheat in September 2004.

## Post-Harvest Control and Ecology of Russian Thistle in Continuous Annual Spring Wheat

W.F. SCHILLINGER, H.L. SCHAFER, S.E. SCHOFSTOLL, AND B.E. SAUER, DEPT. OF CROP AND SOIL SCIENCES, WSU

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A 5-year experiment was conducted at the WSU Dryland Research Station at Lind on post-harvest management of Russian thistle in continuous annual spring wheat. The post-harvest Russian thistle control treatments were: i) paraquat + diuron herbicide applied 7 days after wheat harvest; ii) tillage with overlapping adjustable-pitch 32-inch-wide V-blade undercutter sweeps conducted 7 days after wheat harvest, and; iii) check (do nothing, let Russian thistle grow). Use of the undercutter V-sweep resulted in a complete kill of all Russian thistle plants with absolutely no subsequent seed production. With contact herbicide, some Russian thistle grew back and/or escapes occurred and seed production averaged 490 seeds per square yard. The check treatment produced a 5-year average of 7910 Russian thistle seeds per square yard. The undercutter V-sweep treatment had significantly more water in the 6-ft soil profile at time of wheat harvest, after killing frost in October, and in mid-March compared to the herbicide and check treatments. Spring wheat grain yield was significantly less in the check compared to the herbicide and undercutter V-sweep treatments. Results show that tillage with a low-disturbance undercutter V-sweep is more effective than contact herbicide for post-harvest control of Russian thistle.

## Winter Wheat Seedling Emergence after Rainfall Simulation

W.F. SCHILLINGER, H.L. SCHAFER, S.E. SCHOFSTOLL, AND J.R. ALLDREDGE, DEPT. OF CROP AND SOIL SCIENCES AND DEPT. OF STATISTICS, WSU

Stand establishment of winter wheat planted into summer fallow is hindered when rain showers after planting crust the soil. In a laboratory experiment conducted at Lind, a rainfall simulator was used to deliver rainfall at two different rates onto newly-planted winter wheat in pots. The experimental design was a 5-factor factorial in a randomized complete block. Thirty seeds each of Edwin and Eltan were planted 1-inch deep in pots containing 3 inches of wet (i.e., 13% soil moisture) soil. The wet soil was covered with 5 inches of dry soil immediately after planting. Beginning one day after planting, the rainfall simulator was used to apply 0.05 inch/hr for 3 hours (total = 0.15 inch) or 0.10 mm/hr for 2.5 hours (total = 0.25 inch). Rainfall simulation was repeated three and five days after planting. Factorial treatments for this experiment are as follows:

1. Two winter wheat varieties (Edwin and Eltan).
2. Two rainfall intensities and durations (as described above).
3. Three rainfall timings (1,3, and 5 days after planting + a check, i.e., no rain).
4. Three surface residue conditions (bare soil, 750 lb/ac of straw, and 1500 lb/ac of straw).
5. Two heat factors (50% of pots put under a sun lamp at 85°F air temperature at the soil surface for 9 hr/day, the remaining 50% of pots kept at room temperature without the sun lamp).

There were 96 pots for each run (i.e., replication) and we conducted three runs. By far the most important factor affecting winter wheat seedling emergence ( $P < 0.0001$ ) was timing of rainfall after planting. Rainfall 5 days after planting impeded emergence much more than rainfall 3 days after planting. Similarly, rainfall 3 days after planting impeded emergence more than rainfall 1 day after planting. The pots with 750 lb/ac and 1500 lb/ac of straw on the surface had better winter wheat seedling emergence than pots with a bare soil surface, presumably because the straw intercepted rain drops to reduce crusting. There were no differences in seedling emergence as affected by the 0.15 inch and 0.25 inch simulated rainfall. We were surprised to find that seedling emergence was greater in pots placed under the sun lamp for 9 hr/day compared to pots left at room temperature. Seedling emergence was apparently enhanced by warming of the soil by the sun lamp; not adversely affected by soil crusting as we thought would occur. Averaged across all factors, Edwin emergence was significantly greater than that of Eltan. We plan to continue and expand this experiment in 2005 and 2006.

## Soaking Winter Wheat Seed in Water to Enhance Emergence

W.F. SCHILLINGER, H.L. SCHAFER, S.E. SCHOFSTOLL, AND B.E. SAUER, DEPT. OF CROP AND SOIL SCIENCES, WSU

Insufficient stand establishment of winter wheat is a major problem in the low-precipitation (< 12 inch annual) dryland summer fallow region of the inland Pacific Northwest. Low seed zone water potential, deep planting depths with 5 inches or more soil covering the seed, and soil crusting caused by rain before seedling emergence frequently impede winter wheat stands. A multiple-year field study was initiated at Lind in early September 2004 to determine seed priming effects on winter wheat emergence and grain yield. Two wheat varieties were used based on their strong (Edwin) and moderate (Eltan) emergence capabilities. The three early phases of germination are: i) imbibition, ii) lag phase, and iii) protrusion of the radicle through the testa. Priming is a procedure that partially hydrates seed to initiate the germination process. The experiment has four treatments: Edwin and Eltan seed both primed and not primed (i.e., check). Primed seed was soaked in water for 12 hours, and then spread on a concrete platform for 15 minutes at 60°F air temperature under cloudy conditions. Within the subsequent 3-hr time period, seed from all four treatments was then planted into summer fallow with 5 inches of soil cover in 200-ft-long plots with a John Deere HZ deep furrow drill.

After 12 hours of soaking in water, wheat seeds were “glumped” together. But, after just 15 minutes of removal from the water, individual kernels separated easily. Primed seed was soft and kernels were easily destroyed by pinching between fingernails. We were concerned that primed wheat kernels would be damaged when passing through the flutes of the grain drill, but this did not occur. Less than one percent of primed wheat kernels were damaged passing through the grain drill. Primed seed of both varieties emerged significantly better than their checks (Fig. 1). Emergence of Eltan increased dramatically with priming whereas priming had much less effect on Edwin (Fig. 1). In a related study, we found a similar trend between the varieties Edwin and Madsen that were soaked in several priming media (G.S. Giri and W.F. Schillinger, *Crop Science*, 2003). Grain yield and yield components will be measured in July 2005. We plan to continue this experiment for several years.

## Tillage Method and Sowing Rate Relations for Dryland Spring Wheat, Barley, and Oat

BILL SCHILLINGER, DON WELLSANDT, HARRY SCHAFER, STEVE SCHOFSTOLL, AND STEVE DOFING, DEPT. OF CROP AND SOIL SCIENCES, WSU

No-till (NT) sowing of spring cereals directly into undisturbed stubble of the preceding crop has gained popularity in the inland Pacific Northwest (PNW). But some farmers report lower grain yield of spring cereals with NT compared to sowing after conservation tillage (CT) of the soil. A 4-yr field study was conducted in a 12 inch annual precipitation zone on the Don Wellsandt farm in Adams County, WA to determine sowing rate effects on seed-zone water content, seed-zone temperature, plant stand establishment, grain yield, grain yield components, and straw production for three spring-sown cereal species using both NT and CT. All factors other than tillage method (i.e., drill, fertilizer rate, sowing depth, sowing date) were held constant. Soft white wheat (*Triticum aestivum* L.), barley (*Hordeum vulgare* L.), and oat (*Avena sativa* L.) were sown at three rates: 120, 200, and 280 seeds per square yard (roughly 30, 60, and 90 lbs/acre, respectively). A split-plot design was used, with NT and CT as main plots and sowing rate x cereal species combinations as subplots. Residue cover measured just before planting was 87 and 46% for NT and CT, respectively. There were no differences in plant stand between NT and CT, but grain yield was reduced in NT in part due to less water in the seed zone (2-to 6-inch soil depth) compared to CT during early plant development. Likely, disruption of capillary continuity with CT restricted upward movement of water that resulted in greater retention of water in the seed zone underlying the depth of tillage. With NT, soils retained less water in the seed zone but remained wetter near the surface due to greater upward movement and higher residue cover that slowed evaporative loss during the early weeks after sowing. Grain yield was not affected by sowing rate for any crop species because increased number of heads per unit area and kernels per head consistently compensated for reduced plant stand density. Tillage method x crop species and tillage method x sowing rate interactions did not occur for grain yield or any grain yield component. Results show that grain yield of NT across crops was significantly reduced by 90 lbs per acre per year (or 5%) compared to CT.

## Fall Fertilization for Spring Wheat Production in Direct Seed Annual Crop Rotations in the Intermediate Rainfall Area of Washington

DENNIS TONKS AND AARON ESSER

GROWER COOPERATORS: CHRIS LANEY AND STEVE SWANNACK

Fertilization in the fall prior to spring wheat production has many possible benefits such as improving grain yield and end use quality, and spreading the grower's workload and improving efficacy at spring seeding. The objectives of this research were to look at the movement of fall-applied nitrogen in the spring prior to seeding, and to examine the impacts of fall applied nitrogen on spring wheat establishment, yield and grain quality. On-farm tests were initiated in the fall of 2001 and carried out over 3 years near Sprague and Lamont, WA. At each location both fall and spring fertilizer treatments were aqua ammonia fertilizer applied with a low disturbance 'BLU-JET®' rolling coulter applicator, and the trials were seeded with each of the grower's direct seed drills. Fall nitrogen treatments were applied late after soil temperatures were below 50°F to slow conversion of ammonium to nitrate and restrict the movement to allow snowmelt or early spring precipitation to distribute the fertilizer throughout the root zone. Nearly 100% of the nitrogen applied in the fall was still in the first foot with very little movement into the second foot relative to the soon to be applied spring treatment plots. Ammonium conversion to nitrate was also low, by spring soil sampling 69% of the total N in the first foot was still in the ammonium form. Wheat seedling populations and tiller numbers differed by location and year but were not significantly different among treatments. Wheat yield, grain protein and test weight also differed by location and year but were not significantly different among treatments. In conclusion, fall applied fertilizer had no negative impact on spring wheat production compared to spring applied fertilizer. Economically growers were able to purchase fertilizer late in the fall cheaper than they could in the spring in some situations. Late fall applied nitrogen failed to increase grain protein which is advantageous as soft white wheat is grown where low protein is desired. Fertilizer needs to be applied earlier in the fall to increase movement into the soil profile and potentially increase grain protein for hard red and hard white spring wheat production.

## Chloride Response of Pacific Northwest Spring and Winter Wheat Cultivars

RICHARD KOENIG<sup>1</sup>, MONICA ALLEN<sup>1</sup>, WILLIAM PAN<sup>1</sup>, KIM GARLAND CAMPBELL<sup>2</sup>, RON BOLTON<sup>1</sup>, KIMBERLEE KIDWELL<sup>1</sup>, JOHN BURNS<sup>1</sup> AND BRADY CARTER<sup>1</sup>

<sup>1</sup>DEPARTMENT OF CROP AND SOIL SCIENCES, WASHINGTON STATE UNIVERSITY, PULLMAN

<sup>2</sup>USDA-ARS WHEAT GENETICS, QUALITY, PHYSIOLOGY AND DISEASE RESEARCH UNIT

**More on the Web** Chloride (Cl) deficiency symptoms are exhibited by certain spring and winter wheat cultivars grown in the inland Pacific Northwest. To assess responses to Cl, spring and winter wheat cultivar by chloride rate trials were conducted at multiple eastern Washington locations during the 2001 to 2004 growing seasons. Whole plant samples were collected at early head emergence for Cl determination, and grain yield was measured at maturity. In addition, winter wheat flag leaves were imaged with a flatbed scanner to quantify percent leaf spot severity, and spring and winter wheat grain samples were analyzed for a suite of end-use quality parameters. Chloride application produced higher tissue Cl concentration at early head emergence in all winter and spring cultivars. At most locations, 320 lb Cl/acre was required to increase tissue Cl concentrations above the critical value of 0.15%. Spring wheat yields responded to Cl applications in only one out of five site-years. There were interactions between winter wheat cultivar and Cl rate for leaf spot reduction. The cultivars Eltan, Finch and Coda showed few leaf spot symptoms regardless of Cl level. The cultivars Madsen, Weatherford and Beamer showed more severe leaf spot symptoms and symptoms were alleviated with Cl application. Importantly, cultivars responded to Cl whether they showed leaf spot symptoms or not. Small (2.0 to 3.2% above the control treatment; average 2.7 bushels/acre) but statistically significant winter wheat grain yield responses were detected to Cl application. The effects of Cl on milling and flour quality of spring and winter wheat were not consistent. In eastern Washington, winter wheat yield appears to respond to Cl more than spring wheat. While differences exist in winter wheat cultivar leaf spot responses to Cl, yield responses were not cultivar-dependent.

## Application of Potassium Chloride to Alleviate Leaf Spotting

K. GARLAND CAMPBELL<sup>1</sup>, J. BURNS<sup>2</sup>, E. HARWOOD<sup>2</sup>, R. KOENIG<sup>2</sup>,

<sup>1</sup>. USDA- ARS WHEAT GENETICS, QUALITY, PHYSIOLOGY AND DISEASE RESEARCH UNIT. PULLMAN WA. <sup>2</sup>. DEPT. OF CROPS AND SOIL SCIENCES, WSU, PULLMAN WA.

Our objective has been to determine if fall application of KCl to winter wheat has positive impacts on yield, test weight, and end use quality. A fall winter wheat nursery was planted and harvested at Pullman WA and treated with either 0 or 20lb/acre chloride as KCl. This was the third year of that trial and the results of the research are now being summarized. Application of KCl at 20lb/acre resulted in a small but consistent increase in yield (3-5%) and test weight (1%) over the three environments evaluated. Similar nurseries are planted at Spillman Agronomy Farm and other locations in WA and OR in 2005.

## Assessing Stratified Soil Acidity in Inland Northwest Direct-Seed Cropping Systems

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Declining soil pH is detrimental to cereal and grain legume production in the Inland Pacific Northwest (IPNW). Soil acidification reduces crop yields and rotation options by altering nutrient availability, biological activity, and increasing aluminum (Al) phytotoxicity. Direct-seed (DS) systems are characterized by the development of stratified soil acidity at the depth of fertilizer placement. It has yet to be determined how acidity moves through the soil profile or how broadcast or subsurface-banded lime strategies influence soil acidification, spatial variability of soil pH, Al chemistry, and crop response in DS systems of the IPNW. This study is focused on characterizing the stratification of acidity and Al chemistry in the seed-zone environment of DS systems, as well as crop tolerance to soil acidity. A 1:1 water extract was used to assess the spatial variability of soil acidity and Al speciation modeling under treatments of banded fertilizer (150 to 206 lbs N ac<sup>-1</sup>) with subsurface-banded lime (200 lbs lime ac<sup>-1</sup>), broadcast lime (6250 lbs ac<sup>-1</sup>) or broadcast sulfur (890 lbs ac<sup>-1</sup>). The zone of greatest acidification (5 to 10 cm) correlated to the depth of fertilizer placement for all treatments. Acidification of the upper 20 cm of the soil indicates that soil acidity is moving vertically with repeated application. Current pH's are at or below 5.0, compared to the 1985 regional average of 5.7, indicating that soils in the IPNW continue to acidify. Yield limiting pH's are developing in the surface 20 cm of the soils tested, suggesting that liming programs will be necessary to maintain crop yields and soil quality. Root emergence of 20 pre-1950 and 20 currently grown cultivars of wheat, grown in acidified and limed soil, will be used to determine if Al tolerant cultivars may have been inadvertently selected by breeding programs. Wheat response to stratified and uniform acidity will also be assessed using a greenhouse pot study.

## Direct Seeding Results from Spokane and Whitman Counties

DIANA ROBERTS (WSU EXTENSION, SPOKANE COUNTY), DENNIS ROE (NRCS, PULLMAN), ROGER VESETH (DECEASED WSU/UI CONSERVATION TILLAGE SPECIALIST), TIMOTHY PAULTZ (USDA-ARS), HERB HINMAN, (WSU AG ECON DEPT), AND DENNIS PITTMANN (WSU CROPS AND SOILS DEPT, FORMERLY WSU EXTENSION)

**More on the Web** The renewed interest in direct seeding that occurred across the Pacific Northwest after the 1996 Freedom to Farm Bill spawned several research projects in eastern Washington. These included two on-farm testing projects to research and demonstrate the transition to direct seeding; the Spokane County Direct Seeding Project, and the Northwest Crops Project in Whitman and Garfield Counties.

**The Northwest Crops Project** was a 6-year on-farm testing project in the intermediate rainfall area (14 to 18 inches annual precipitation) of eastern Washington. It compared a low-risk 3-year crop rotation with a high-risk 4-year rotation, all under direct seeding without irrigation or field burning from 1998 to 2003. The 4-year rotation was spring wheat - winter wheat - warm season grass (corn) - broadleaf crop (cooperator's choice). The 3-year



rotation was winter wheat - spring barley - chemical fallow or broadleaf crop (cooperators' choice). The second rotation was similar to a conventional rotation for the area, substituting chemical fallow for tillage fallow. The cooperators used crop varieties that best suited their farm conditions.

The variables considered were crop yield and net economic return (gross revenue minus the sum of fixed and variable costs, from grower data). In comparisons of 3 sites with the most consistent data, we did not see significant differences in performance between crop rotations. This confirmed current farmer decision-making strategies that are based on current commodity prices, climatic conditions, and local farm situations.

We did see statistical differences between some crop sequences within the rotations. Broadleaf crops and chemical

Note: Full reports for the Northwest Crops Project and the Spokane County Direct Seeding Project will be available on the STEEP website under the On-Farm Testing section at <http://pnwsteep.wsu.edu/index.htm>

We will also post Microsoft Excel spreadsheets to this website that show the rotation management costs that Northwest Crops Project cooperators provided. You may use these spreadsheets to calculate the economics of various direct seed rotations on your own farm.

fallow in a rotation benefited the subsequent wheat crop. Dryland corn provided residue management benefits but tended to lose more money than did barley in rotation.

A quantitative analysis of soilborne pathogens showed that including a warm-season grass in the rotation did not affect the level of *Rhizoctonia* and *Fusarium* species.

In the **Spokane County Direct Seeding Project**, the cooperating farmers decided to identify specific questions they wanted answered in their transition to direct seeding, and they designed their own trials to solve them. Many of the questions related to residue management as most of these growers farmed in the annual cropping region (18 to 22 inches precipitation) where residue management is a hindrance to successfully adopting direct seeding. Seeding through heavy residue can be tough in the fall, and especially in the spring when thick winter wheat residue tends to keep the soil cold and wet. They also tested a commercial residue digester and the effect of fall fertilization on Kentucky bluegrass fields direct seeded to spring oats.

Each of the six trials was laid out in replicated on-farm testing strips and was repeated for three years (2001 to 2003). The farmers used all their own equipment for managing the plots. The data for each trial was analyzed separately, and often showed that the highest inputs were not cost effective.

#### **Project Sponsors and Cooperators**

WSU EXTENSION, USDA-SARE (SUSTAINABLE AGRICULTURE RESEARCH AND EDUCATION), NRCS, USDA-ARS. THE SPOKANE COUNTY CONSERVATION DISTRICT, AND THE PALOUSE, PALOUSE-ROCK LAKE, PINE CREEK, AND WHITMAN CONSERVATION DISTRICTS IN WHITMAN COUNTY. THE NORTHWEST CROP PROJECT GROWER COOPERATORS WERE JOHN AND CORY AESCHLIMAN (COLFAX), LEE DRUFFEL (COLTON), TRACY AND KYE ERIKSEN (ST. JOHN), RON KILE (PINE CITY), STEVE AND DAN MOORE (LACROSSE), RANDY AND AARON REPP (DUSTY), DAVID AND PAUL RUARK (POMEROY), AND STEVE AND ANN SWANNACK (LAMONT). THE SPOKANE COUNTY DIRECT SEEDING PROJECT FARMER COOPERATORS WERE GLENN AND BRYAN DOBBINS (FOUR LAKES), RANDY AND JEFF EMTMAN (VALLEYFORD), PAUL GROSS AND STEVE BENNING (DEEP CREEK), DAVID OSTHELLER (FAIRFIELD), AND LARRY TEE (LATAH). PROJECT STATISTICIAN: J. RICHARD ALLDREDGE (DEPT STATISTICS, WSU)

## **Research Activities of Land Management and Water Conservation Research Unit, USDA-ARS**

D.R. HUGGINS, A.C. KENNEDY, D.K. MCCOOL, B.S. SHARRATT, J.L. SMITH & F.L. YOUNG

The optimization of nutrient use efficiency is critical to the performance and environmental impact of conservation cropping agroecosystems. We investigated key indicators for assessing nitrogen use efficiency (NUE) in cereal-based agroecosystems. Indicators were developed and applied to field-scale evaluations of NUE. NUE indicators can be used to evaluate crop suitability and N use across farm fields and help assess management performance.

The Revised Universal Soil Loss Equation (RUSLE) is a mainstay in the national, Congressionally-mandated conservation programs of the Natural Resources Conservation Service (NRCS). Our research has led to successful

adaptation of RUSLE to the freeze-thaw affected, dryland cropland of the Pacific Northwest. Little research has been done to improve performance of RUSLE for areas with colder temperatures and winter-long snow accumulation and spring melt. A snow accumulation and melt routine was used to estimate snow melt magnitude and timing for selected colder cropland areas of the western US, providing erosivity relationships for use in RUSLE2. The research will next be expanded to a broader area of application

We are developing management strategies for conservation cropping systems to improve long-term productivity and ensure farm profitability. Crop performance and stability of eight alternative crops in a no-till crop rotation were modeled for the dryland region of the Pacific Northwest. The modeling showed that several alternative crops are economically feasible for this region. Successful prediction of management zones and application of precision farming techniques could boost gross financial returns to growers by 50%.

A "blowing dust warning index" was created for the National Weather Service for predicting the occurrence and severity of blowing dust events across the Columbia Plateau. This predictive tool can be used to alert the public and transportation authorities such that appropriate safety precautions can be implemented in a timely manner to prevent health-related injuries, particularly to those individuals who suffer from asthma or other respiratory ailments, and vehicle accidents on dust-impacted highways.

Reducing tillage on agricultural land can have many benefits such as reduced water and wind erosion and improved stream water quality. We found that more C is retained in soil under reduced tillage and that this retention was similar for all crop rotations examined. We also found that more frequent addition of crop residue can stimulate carbon loss through microorganism metabolism and the loss may be greater than the loss from tillage. In developing cropping strategies for dryland conditions limiting the frequency, but not magnitude, of residue inputs may help build carbon in the soil.

## Composition of Straw from Cereal Cultivars in Dryland Systems

A.C. KENNEDY, USDA-ARS, T.L. STUBBS, WSU, J.C. HANSEN, USDA-ARS, P.E. REISENAUER, WSU, J.W. BURNS, WSU & K.G. CAMPBELL, USDA-ARS

Residue management is a concern of producers adopting minimum tillage systems to reduce soil erosion. Excessive residue levels can slow planting, and reduce soil warming, soil to seed contact, seed germination, and seedling emergence. Conversely, in the low rainfall zone (<300 mm precip.) too little residue may be present to prevent wind erosion. Spring barley, spring wheat and winter wheat plant residues produced at multiple locations in eastern Washington were analyzed for hemicellulose, cellulose, lignin, C, S, and N contents. The three crops varied in their composition. Structural component and nutrient content varied by location, precipitation zone, and cultivar. Over all locations, C:N ratios of the spring wheat cultivars separated by market class in the order soft white greater than hard white greater than hard red. Lignin content was highest in spring barley and least in winter wheat and hard white spring wheat. The lowest rainfall sites generally produced crops with the highest lignin. Information on decomposition of wheat and barley cultivars will aid growers in planning rotations for reduced tillage systems. The goal of this research is to quantify the management and environmental factors controlling residue decomposition of wheat and barley varieties currently planted by growers in the Pacific Northwest, and to relate this information to improvement in soil quality, build-up of organic matter and carbon storage.

## Crop Straw Utilization: Fiber for Paper Products and Carbon, Nutrients for Soil Amendments

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<sup>A</sup>WASHINGTON STATE UNIVERSITY; <sup>B</sup>UNIVERSITY OF WASHINGTON

The productive cereal and grass seed cropping systems of the Inland Northwest generate an abundance of crop straw that is a valuable resource to those systems in the way of recyclable carbon compounds and plant nutrients. Unfortunately, high straw loads can be impediments to maximum short term crop production in perennial grass seed production and in direct seed cereal systems, leading to field burning. Defining markets for straw can provide growers with need flexibility in managing these straw loads with judicious site-specific straw harvesting. With

rising costs of pulp and recycled fiber sources, the paper industry is rapidly becoming interested in crop straw as a supplemental fiber source for making paper and various paper products such as cardboard, molded packaging materials and containers, horticultural containers.

The question is, how much straw can we afford to remove from our cropping systems without depleting valuable soil organic matter? Carbon and nutrient poor soils would likely decline from repeated straw removal. One solution to this question is to design a system in which a good proportion of the removed carbon (>50%) during straw harvest is recycled to carbon poor soils as an organic rich soil amendment. Over the past several years, WSU has partnered with UW to define straw pulping processes that generate fiber and pulping black liquor products that are useful in papermaking and in amending soils. Much progress has been made in attracting commercial interest in straw fiber use in making various paper products mentioned above, and we have conducted numerous laboratory, growth chamber and field experiments to evaluate black liquor generated from straw pulping for its potential benefits as a fertilizer and soil amendment. This material is rich in lignin (a precursor to soil humus), carbohydrates and ash minerals. When added to soils, black liquor stimulates microbial activity, increases soil aggregation and improves nutrient availability. The next phase of research will endeavor to make this material a viable raw material for commercial fertilizer production.

## Potentials for Safflower Production

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R.C. JOHNSON, USDA-ARS, PLANT INTRODUCTION, PULLMAN WA

Safflower is mostly grown for edible oil in the US but has a number of other current and potential uses. These include bird seed, ornamental fresh and dried flowers, and livestock feed (especially meal but even hay). Potential uses include recent technology that uses safflower to produce proteins in seeds, including pharmaceuticals. Safflower oil could also be used for biodiesel production. Safflower is better adapted to dryer, hotter conditions than many other dicots. As a dicot, improved long term control of grass weeds should be possible in rotation systems with wheat. Despite being a minor crop, considerable breeding has been done on safflower and continues in California and Montana, where considerable acreage is grown. This means that high yielding, well adapted material, with varying oil characteristics, is available. Safflower is generally spring planted with blooming in early July; harvest is in late August or early September. Problems with growing safflower in Eastern WA include the lack of a local seed crushing facility and the rigors of the edible oil seed market. Safflower is vulnerable to weeds in the early rosette stage, has a large tap root that uses available water deep into the soil profile, and heads of commercial types are spiny. We have recently found unimproved germplasm with the potential for fall planting, which could increase yield and water-use efficiency. Safflower's multiple uses could lead to a niche in Eastern WA as market conditions, government policy, and farming needs change.

## GIS-Based Modeling of Wilderness Soils

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CRYSTAL BRIGGS, BRUCE E. FRAZIER, ALAN BUSACCA, DEPT. OF CROP AND SOIL SCIENCES, WSU

Wilderness areas in the Western United States have been excluded from traditional soil surveys due to issues of inaccessibility and a lack of urgency in acquiring this data. Recently, it has become evident that soils information is an important addition to the resource inventories of wilderness areas and national parks, but access is always difficult and methods need to be developed to extrapolate from known points to cover vast areas. We collected over 100 soil pedon and site descriptions throughout Thunder Creek Watershed (TCW) in North Cascades National Park to understand the dominant pedogenic processes and recognize soil-landscape patterns. A knowledge-based classification model was then developed using a geographic information system (GIS) to create the soil distribution map suitable for printing at 1:63,360 scale. Information gathered through field and laboratory analysis was used to determine the combinations of various soil-forming factors and the threshold values for each that control soil formation. Climate, organisms, and relief act on parent material over time to form soils. We found that soil formation in TCW was primarily influenced by landscape stability, parent material, and vegetation. We used proxy indicators for the soil-forming factors that we determined control pedogenesis in the field. A landform map was used to proxy parent material and landform stability, and a vegetation layer created from remotely sensed data was used to proxy for vegetation and climate. Primary and secondary terrain attributes calculated from a digital

elevation model (DEM) were incorporated into the model to represent slope, aspect and soil wetness. Major soils found were Spodosols, Andisols, and Inceptisols.

## Part 5. Economics and Sustainability

### Protein Premiums can Motivate Nitrogen Fertilization of HRSW Beyond Maximum Yield

DOUGLAS YOUNG AND DUSTIN BAKER, SCHOOL OF ECONOMIC SCIENCES, WSU

**More on the Web** The price that a producer receives for hard red spring wheat (HRSW), unlike soft white wheat (SWW), is influenced by protein content (%). The producer receives a price premium on HRSW with greater than 14% grain protein and a discount with less than 14% grain protein. Since both yield and protein percentage directly effect profit, producers may desire to apply levels of Nitrogen (N) fertilizer to HRSW that maximize profits considering both yield and protein. This research extends earlier work to determine whether protein premiums may motivate growers to apply N beyond maximum total yield response, which economists refer to as “stage three” of production.

The objective of this research was to determine economically optimal nitrogen fertilization of HRSW for varying protein pricing structures and to discuss factors which motivate profitable fertilization beyond maximum total product or “stage three” of production. Quality based adjustments in competitive output prices are common in agriculture, but their influence on incentives for profitable production into stage three appears not to have been discussed in previous research. For the southeastern Washington HRSW data used in this study, profit was maximized in stage three whenever the premium/discount for protein relative to the 14% protein base price equaled or exceeded \$0.04/\$0.06 per bushel per 0.25% protein deviations. This premium/discount threshold held for all wheat and nitrogen price combinations examined. At the highest premium/discounts examined, up to 33 lb/ac additional nitrogen beyond maximum yield was applied to capture profitable protein quality premiums. At high premium/discount incentives, the combination of low wheat price and low input price pushed production furthest into stage three, because quality premiums accounted for a greater proportion of total returns. In general, as the proportion of net returns from quality adjustments increases, the incentive to produce into stage three increases.

### Economics of No-Till Annual Cropping Systems, Ritzville, WA

ELIZABETH NAIL, DOUGLAS YOUNG, AND WILLIAM SCHILLINGER, DEPT. OF AGRICULTURAL ECONOMICS, WSU, AND DEPT. OF CROP AND SOIL SCIENCES, WSU

**More on the Web** From 1997-2004, William Schillinger conducted a no-till annual spring cropping system experiment in Adams County, near Ritzville, WA. The objective of this study was to determine the long-run economic and agronomic feasibility of no-till cropping systems for low-precipitation areas of the inland Pacific Northwest. The last four years of the study had six rotations involving crops of soft white spring wheat (SWSW), hard white spring wheat (HWSW), spring barley (SB), yellow mustard (YM), and soft white winter wheat (SWWW). The six rotations were: four-year SWWW/SWWW/SWSW/SWSW, four-year SWWW/SB/YM/SWSW, two-year SWSW/SB, two-year HWSW/SB, continuous SWSW, and continuous HWSW. The two-year SWSW/SB rotation and the continuous SWSW rotation were the only two rotations maintained throughout the entire eight-year project period. Conventional tillage soft white winter wheat-summer fallow (SWWW-SF) was not included in the experiment. An economic comparison of this traditional system to the experiment's no-till annual cropping rotations was accomplished by conducting a multi-year yield survey among neighboring SWWW-SF farmers. Comparative yield results for SWWW-fallow on neighboring farms are reported in a separate paper in this section.

None of the rotations were able to generate sufficient market returns to cover total costs during the relatively dry 2001-2004 period. Five of the six rotations earned statistically equivalent returns over total costs. The HWSW/SB,

SWSW/SB, and SWSW rotations all had average annual losses of about \$58 per rotational acre. The HWSW/SB rotation was the most risky in terms of profit variability with a standard deviation of \$18.59/acre. Average returns of the surveyed SWWW-SF rotation considerably exceeded all of the experiment's no-till annual rotations at this site. Average returns over variable costs and total costs for the SWWW-SF rotation were \$40.09 and -\$9.99 per rotational acre, respectively, during 2001-2004. The S.D. of returns over total cost per rotational acre of SWWW-SF was \$9.58. The poor returns over total costs can largely be attributed to yields reduced by diminished precipitation in the last four years of the experiment.

Comparing the 2001-2004 results to previously reported 1997-2000 results showed that costs remained relatively constant over the entire eight-year period. However, net returns over total costs for continuous SWSW fell from \$17.92/acre for 1997-2000 to -\$58.79 in 2001-2004. The corresponding comparison for continuous SWSW/SB is \$8.12/acre versus -\$58.13. When returns over total costs are averaged over the eight-year experiment period, the continuous SWSW and the SWSW/SB rotations generated returns of -\$20.42/acre and -\$25.01/acre, respectively. SWWW-SF averaged net returns over total costs of \$2.35/acre over 1997-2004, roughly a \$25/acre/yr long term advantage over the two no-till SWSW rotations.

## Statistical Response of HRSW Yield and Protein to Nitrogen Fertilization: A Progress Report

RAPHAEL KARUAIHE, AND DOUGLAS YOUNG, SCHOOL OF ECONOMIC SCIENCES, WSU

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on  
the  
Web

Recommendations regarding profitable input applications are vulnerable to misspecification of both quality and yield response functions. Response functions most commonly fitted in empirical work are the quadratic (for yield) and linear (for protein). While the quadratic yield functions impose diminishing yield response after a maximum, they preclude a plateau at the maximum that is supported by some agronomic theory and data. An examination of scatters of some of our data for hard red spring wheat response to N also suggests a yield plateau (see Figures 1 and 2). Others hypothesize that increased levels of applied N beyond the onset of the yield maximum will result in higher grain protein while grain yield is constant. The existence and length of this yield maximum plateau depends on site-specific factors such as the level of residual nitrogen. An innovation our ongoing research is to represent eventually decreasing yield in response to excessive fertilizer.

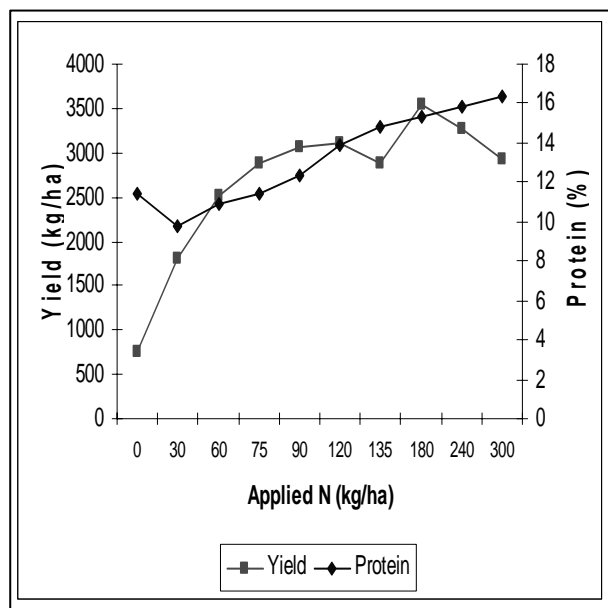


Fig. 1: Yield and protein responses to applied N, Bow Island, Alberta, 1998.

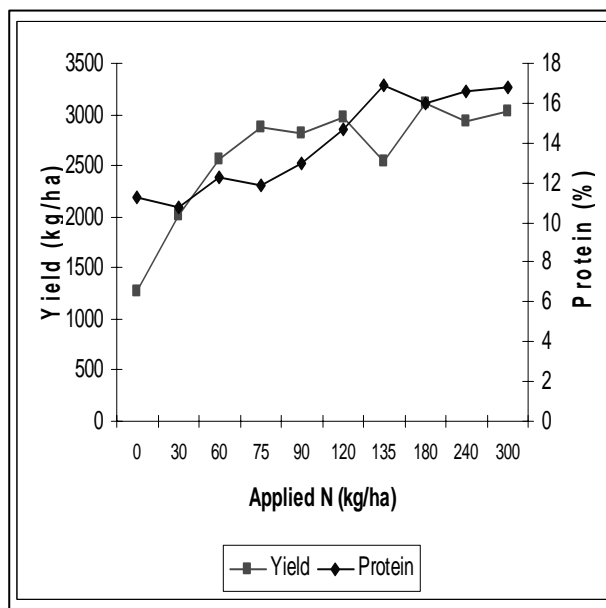


Fig. 2: Yield and protein responses to applied N, Bow Island, Alberta, 1999

In this research, a quadratic function with a stochastic plateau is considered. Using data from eastern Washington, USA and southern Alberta, Canada, optimal N levels and the expected plateau yield will be estimated statistically.

It is expected that, given the range of historical input and output prices, optimal N input recommendations and profits under the stochastic plateau model will differ from the conventional models.

## Winter Wheat after Fallow Yield Survey Results for Ritzville Growers, 2001-2004

ELIZABETH NAIL, DOUGLAS YOUNG, AND WILLIAM SCHILLINGER, DEPT. OF AGRICULTURAL ECONOMICS, WSU AND DEPT. OF CROP AND SOIL SCIENCE, WSU

### More on the Web

From 2001 to 2004, Washington State University conducted the second phase of an eight-year continuous no-till cropping system project on the Jirava farm near Ritzville, WA. One purpose of this project was to compare the profitability of no-till cropping systems with that of the conventional winter wheat/summer fallow system traditionally practiced in the area. In order to determine the profitability of the conventional system, yields of soft white winter wheat (SWWW) after fallow were surveyed on fields within a five-mile radius of the Jirava experiment site. The economic comparison of winter wheat/summer fallow and no-till annual cropping systems is presented in a separate paper in this section.

Ten farmers responded to the survey. Yield values varied over years and between farmers. The lowest annual yield average was 38 bu/ac in 2001 and the highest annual yield average was 52 bu/ac in 2003. These yield patterns correlate with precipitation over the four years. The average yield across farms and years was 45.9 bu/ac. Standard deviations of yields across years had a low value of 3.5 bu/ac in 2001 and a high value of 8.5 bu/ac in 2004. Standard deviations of yields across farmers had a greater range with a low of 3.9 bu/ac and a high of 12.4 bu/ac.

A similar survey was conducted in the same region for 1997-2000. During 1997-2000 annual precipitation at the Jirava farm average averaged 12.04 inches, compared to 8.88 inches in 2001-2004, a 26 percent drop. During 1997-2000 SWWW after fallow yields averaged 62.1 bu/a with a standard deviation of 10.2 bu/ac. These compare to the average 45.9 and standard deviation of 8.2 for 2001-2004. This reflects a 26 percent drop in average yields from the first to the second four-year period. The shortfall in precipitation in 2001-2004 probably explains a substantial share of the decline.

## Multi-Faceted Approach to Teaching Freshman about Sustainable Food Systems

CATHY PERILLO (WSU-CROP & SOIL SCIENCES), RICK PARKER (COLLEGE OF SOUTHERN IDAHO AND UNIVERSITY OF IDAHO), COLETTE DEPHELPS (RURAL ROOTS), CINDA WILLIAMS (UNIVERSITY OF IDAHO-PLANT, SOIL AND ENTOMOLOGICAL SCIENCES), AND DARCEL SWANSON (WSU-FOOD SCIENCE AND HUMAN NUTRITION)

There is a documented distancing of Americans from the source of their foods – both in geography and knowledge. A group of educators in Washington and Idaho recognized this, and developed a course for university freshman to increase the connection between students, their community, and regional food systems. Student exploration of the issues and concept of ‘sustainability’ was included to facilitate this connection. The course was piloted at WSU (cross-listed with neighboring UI) Fall 2002 as *Science, Society, and Sustainable Food Systems* (Soils 150) and is now in its third offering. This class fulfills a “science for non-science majors” general education requirement, which brings in largely non-agricultural students (a goal). The class introduces production, environment, and socioeconomic issues through 2 lecture/discussion hours and one 2-h hands-on session each week, is open to community members for continuing education credit, and fulfills the Sustainable Food Systems module of the *Cultivating Success* educational program and recently approved Certificate in Sustainable Small Acreage Farming and Ranching. Understanding and implementing the scientific method and the role of science are key components. In addition to agriculture and food-related experiments, we take field trips exploring the university’s food system including dining services, on-campus creamery, child-care center, and composting facility. The “lecture” component includes discussions, numerous guest speakers as well as traditional lectures on food system components such as soils, crop and animal production, and socioeconomic issues.

The web site for the class is at: <http://classes.css.wsu.edu/soils150/>.

## Spillman Agronomy Farm—Named after W.J. Spillman, WSU's First Wheat Breeder

William Jasper Spillman was a 30-year old science professor in Oregon when Enoch



Bryan, president of the new Washington Agricultural College and School of Science, invited him to take a research post in 1894. When Spillman arrived in Pullman to undertake his duties the region's agriculture was in a crisis since popular wheat strains adopted by early farmers simply did not have the toughness necessary to survive on the Palouse. After several years of unsuccessful efforts to introduce new wheat seed collected from other areas of the world, Spillman decided to try and create a special hybrid for the area that involved brushing the pollen from one parent wheat onto another to combine the characteristics of the two. A decade after his original experiments, Spillman's hybrids were being used all over the Northwest. They not only resisted cold weather, but produced 40-percent better yield.

Ultimately they formed the basis for the Northwest's wheat industry. He made such an impression that the U. S. Secretary of Agriculture offered him a job in Washington D.C. as founder and director of the Bureau of Farm Economics. He is also credited for being the first to suggest the county agent system. Spillman personally appointed the first 400 county agents. When he died in 1931 at the age of 68, Spillman's ashes were returned to Pullman and spread over the plot where he had grown his famous hybrid wheats.

## The Spillman Agronomy Farm Fund

"The importance of Spillman Farm will not diminish as time passes. Multimillion dollar structures on campus will not replace its (Spillman Agronomy Farm) vital role in crop improvement. I spoke at the Spillman Farm Field Day in July of 1996, the year I retired. I said then the farm was operating on a shoestring. Well, it is still being held together by the same shoestring. It is urgent after 50 years this facility receive the support it deserves." —*Bob Allan, retired USDA/ARS Wheat Geneticist*

The Spillman Agronomy Fund has been established to secure the future of cereal and pulse crop research and development by your tax deductible charitable gift. Please contact Patrick Kramer (509) 335-2243 [kramerp@wsu.edu](mailto:kramerp@wsu.edu) or Deb Marsh (509)335-2915 [marshdj@wsu.edu](mailto:marshdj@wsu.edu) for more information.