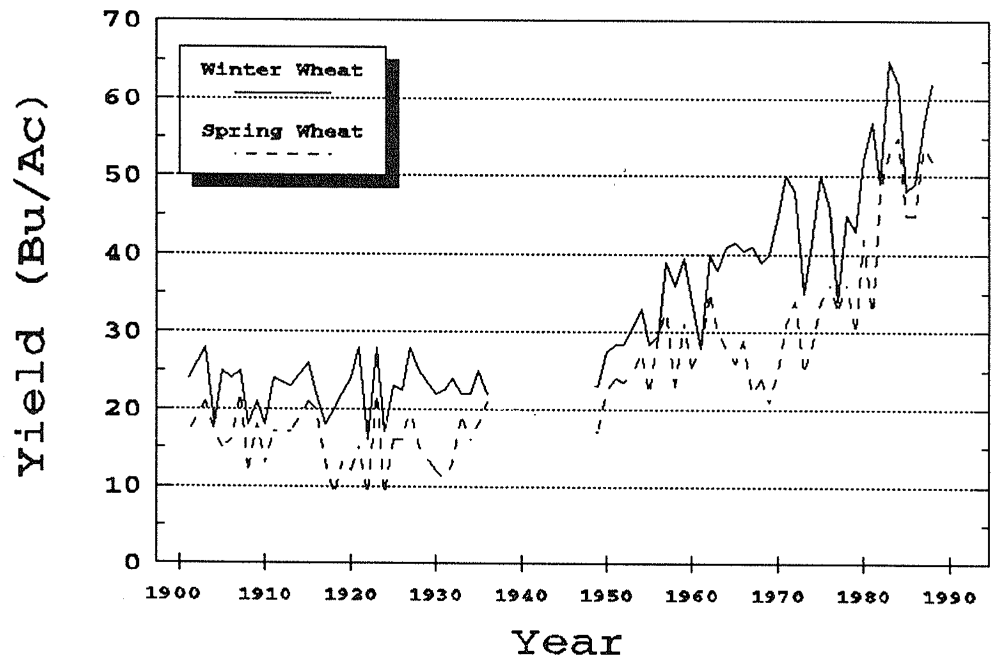
1990

Department of Agronomy and Soils

Washington State University

Field Day Research Report

"A CENTURY OF RESEARCH PROGRESS"



Dryland Research Unit, Lind
June 21, 1990

Palouse Conservation Station, Pullman
June 28, 1990

Spillman Farm, Pullman
July 12, 1990

TABLE OF CONTENTS

COOPERATIVE PERSONNEL AND AREA OF ACTIVITY

Samuel Smith........................President, Washington State University
L. E. Schrader...............Dean, College of Agriculture & Home Economics
Bonnie Johnson....................Interim Director of Resident Instruction
J. J. Zuiches.........Director of Research, College of Ag. & Home Economics
F. L. Poston............................Director of Cooperative Extension
D. G. Miller...............................Chairman of Agronomy and Soils

Cereal Breeding, Genetics and Physiology

R.E. Allen, J.A. Pritchett, L.M. Little, USDA................Wheat Genetics
E. Donaldson, M. Nagamitsu, B. Sauer, Dry Land Res. Unit, Lind ....Wheat
C.F. Konzak, M.A. Davis..........................Wheat Breeding & Genetics
S.E. Ullrich, C.E. Muir, D.A. Deerkop............Barley Breeding & Genetics
C.J. Peterson, D.F. Moser, K. Hinnekamp,
V.L. DeMacon...Wheat Breeding
R.L. Warner, A. Kleinhofs.....................Cereal Evaluation Laboratory
S.E. Brauen, Puyallup.................................Varietal Testing
B.C. Miller, P.E. Reisenauer.......................Cereal Cropping Systems
M.K. Walker-Simmons, J. Sesing-Lenz......................Cereal Physiology

U.S.D.A. Western Wheat Quality Laboratory

Craig Morris............................Research Cereal Chemist in Charge
H.C. Jeffers..Research Technologist
P.D. Anderson, A.D. Bettge, D. Engle...........Physical Science Technicians
G.E. King...Early Generation Testing

Cereal Diseases

S.D. Wyatt, T. Murray...........Cereal Viruses, Foot Rots & Other Diseases
R.J. Cook, D. Weller, Cooperative USDA..................Root Rot Diseases
R.F. Line, Cooperative USDA..............................Flag Smut Control

Breeding and Culture of Dry Peas and Lentils
F.J. Muehlbauer, J.L. Coker, R. Short, and S. Spaeth, USDA

Weed Control
A.G. Ogg, F.L. Young, and D.R. Gealy, USDA
E.P. Fuerst, Chris Boerboom

Fertility and Management
W.L. Pan, C.F. Engle
R.I. Papendick, D. McCool, K. Saxton, and J. Smith, USDA

Cereal Crop Seed Increase
Greg Vollmer

USDA Plant Material Center
Clarence Kelly, Manager

Spillman Farm Manager
Nels Anderson

Dry Land Research Unit Farm Manager
Dick Hoffman

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Cliff Wolf	Colton
Steve Wolf	Pomeroy
George Wood	Dayton

DEDICATIONS TO

Emmett T Field

Emmett headed west from Missouri in 1953 to pursue a career spanning 36 years of nonstop service to eastern Washington dryland agriculture. After two years as the manager of the first Shell ammonia dealership in Pullman he landed the job he most desired, that of working for Cooperative Extension and providing information and service to producers and agriculture in general.

Emmett has served as County Extension Agent in Lincoln and Whitman counties, but most of his career with Extension was served as an area Extension agent to conduct soil fertility demonstration trials with various crops in the dryland counties of eastern Washington. There aren't many county agricultural agents or producers in eastern Washington who haven't benefited from Emmett's trials and crop production knowledge.

Emmett is a 1950 graduate of the University of Missouri, Columbia. He also has a Master's degree in general agriculture received from the University of Idaho in 1968.

Being from the "Show Me" state of Missouri Emmett adapted that philosophy to his work and acceptance of others' work. It had to be thoroughly demonstrated beyond any doubt. Being modest, he is also reluctant to accept credit for accomplishments. He does speak with pride, though, about being the first to establish nitrogen use demonstration trials with small grains in Lincoln County and to having been the first to involve producers in eastern Washington on panels to establish production costs and returns of various enterprises. Together with many others, he takes pride in whatever small part he has had in the doubling of the wheat yield in eastern Washington that has occurred over his career.

Emmett has two daughters, two stepdaughters, and one grandson. In retirement he continues to live in Colfax, Washington.

It is very appropriate to dedicate a portion of this field day brochure to one who has devoted so much of his career to field trials and speaking at field day events throughout eastern Washington.

Ray Nelson

Ray Nelson retired September 1, 1989 after 30 years of service at Washington State University. Ray managed the Spillman Agronomy Farm for the past 8 years and previously worked for the Animal Science Department. Many improvements in the buildings and equipment at Spillman Farm were made because of Ray's efforts to improve the operation of the farm. A 100 foot addition was added to the main farm building and a second shop area was developed. New equipment was obtained and most of the old equipment was completely overhauled.

Ray was very diligent in his effort to make Spillman Farm the pride of Washington State University.

HISTORY OF THE DRY LAND RESEARCH UNIT

On April 1, 1915, Experiment Station Director I. D. Cardiff announced the establishment of the Adams Branch Experiment Station. It was "created for dissemination and conduction of demonstrations and experiments in the semi-arid portion of the state".

Adams County has played an important part in the history of the station. The county donated $6,000 to start the station and the land has been donated by the county. In the early '30s, during the depression, Adams County kept the station alive with a small appropriation until the College could fund the operation again. In 1965 Adams County deeded 318 acres to Washington State University; two acres were previously deeded, to make a total of 320 acres in the Dry Land Research Unit.

The first superintendent was the late Dr. M. A. McCall. 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." For 70 years this station has followed this policy of studying the problems associated with the 8 to 12 inch rainfall area.

In 1947 the station was named the Dry Land Experiment Station. This name was changed again in 1965 to the Dry Land Research Unit. In 1972 the administration of the station was moved into the Department of Agronomy and Soils. Although the administration was changed, the station is still devoted to dry land research. This experiment station has the lowest rainfall of any research station devoted to dry land research in the United States.

The present facilities include a small elevator which was constructed in 1937 for grain storage. A modern office and attached greenhouse were built in 1949 after the old office quarters were burned. In 1960, a 40' x 80' metal shop was constructed with WSU general building funds. In 1964, an addition to the greenhouse was built with a Washington Wheat Commission grant of $12,000 to facilitate breeding for stripe rust resistance. In 1966, a new deep well was drilled, testing over 430 gallons per minute. A pump and irrigation system were installed in 1967. The addition of a 12' by 60' trailer house, and improvements in 1966 and 1967 amounted to over $35,000, with more than $11,000 of this from Wheat Commission funds and the remainder from state funds. In 1983 a new seed processing and storage building was completed 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. The old machine storage, built shortly after the station was established, was removed in 1985. The major portion of the research has centered on wheat. Variety adaptation, wheat production management including weed and disease control, and wheat breeding are the major programs of research in recent years. Twenty acres of land can be irrigated for research trials. The primary purpose of irrigation on the Dry Land Research Unit is not to aid in the development of hard red winter wheats for higher rainfall and irrigated agriculture, but to speed up and aid in the development of better varieties for the dry land wheat summer fallow region. Although many varieties of wheat have been recommended from variety trials by the station, Wanser and McCall were the first varieties developed on the station by plant breeding.

Since 1916 an annual field day has been held to show farmers and interested businessmen the research on the station. This year marks the seventy-fourth field day. Visitors are welcome at any time and their suggestions are appreciated.

HISTORY OF SPILLMAN FARM

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

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 feet addition was added in 1981. In 1957 a well that produced 340 gallons per minute was developed. In 1968 the Washington Wheat Commission provided funds for a sheath 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, roadside seedings, and a conservation crop rotation including alfalfa and grass has been in use since the farm was purchased.

Nels Anderson was appointed farm manager in 1989.

CLIMATIC DATA

The climatic conditions in the low rainfall area of eastern Washington, commonly called the Big Bend Area, are unique when compared to Great Plains wheat producing areas. As shown in Table 1, about 90% of the rainfall occurs from September 15 to June 30. This rainfall pattern coincides with the normal winter wheat growing season. In most wheat production areas outside the Pacific Northwest a spring-summer rainfall pattern occurs. The efficiency of the moisture utilization is greater under our rainfall pattern with evaporation-transpiration rates during the months of maximum precipitation.

Table 1. Average temperature and precipitation at Dry Land Research Unit, Lind

Month	Temperature °F. Max.	Temperature °F. Min.	Precipitation 1989	Precipitation 1990	Precipitation 69 yrs. Av (in)
January	34	22	.38	1.17	1.00
February	42	24	.87	.32	.87
March	53	32	2.15	.30	.81
April	63	35	.90	1.36	.68
May	72	42	1.50		.79
June	83	45	.07		.82
July	90	52	.01		.25
August	90	50	.94		.34
September	79	45	.01		.56
October	65	38	.69		.84
November	47	29	1.08		1.23
December	37	26	.53		1.26
			9.13		9.45

Climatic measurements are made daily with standard U.S. Weather Bureau instruments. Data recorded are maximum and minimum temperature, daily precipitation, relative humidity, daily wind movement and daily evaporation. In addition, automatic instruments make a continuous record of soil and air temperatures and precipitation.

Table 2. Temperature and precipitation at Palouse Conservation Field Station, Pullman, 1989-90

Month	Monthly Avg. Temperature(F) Max.	Min.	Precipitation (in) 38-Yr Avg.*	Monthly	Total Accum.	Deviation from Avg. Monthly	Accum.
1989							
January	36.1	25.0	2.87	3.27	3.27	+ .40	+ .40
February	30.9	17.1	2.31	1.37	4.64	- .94	- .54
March	46.3	31.3	2.09	3.45	8.09	+1.36	+ .82
April	61.0	38.0	1.56	.77	8.86	- .79	+ .03
May	63.0	40.0	1.58	1.93	10.79	+ .35	+ .38
June	74.7	45.0	1.56	.86	11.65	- .70	- .32
July	82.9	48.5	.64	.13	11.78	- .51	- .83
August	77.2	49.0	.92	3.81	15.59	+2.89	+2.86
September	75.4	43.5	1.03	.48	16.07	- .55	+1.51
October	60.1	36.4	1.71	1.40	17.47	- .31	+1.20
November	47.0	34.3	2.79	2.10	19.57	- .69	+ .51
December	38.2	26.8	3.13	1.46	21.03	-1.67	-1.16
TOTAL	57.7	36.2	22.19		21.03		-1.16
1990			30-Yr Avg.**				
January	38.6	29.4	2.89	4.45	4.45	+1.56	+1.56
February	40.4	24.9	2.09	1.46	5.91	- .63	+ .93
March	52.9	31.3	1.96	.90	6.81	-1.06	- .13
April	59.1	36.6	1.58	2.81	9.62	+1.23	+1.10
TOTAL			8.52		9.62		+1.10
1989 CROP YEAR Sept. 1988 thru June 30, 1989			20.63		19.03		-1.60

* Thirty-eight year average for precipitation, 1948-1985
**Thirty year average for precipitation, 1951-1980.

PUBLIC CEREAL VARIETY DESCRIPTIONS

Baird Miller

WINTER WHEAT

Andrews

Andrews is a common-type, semi-dwarf, hard red winter wheat which originated from Washington State University in 1987. Andrews is an early variety with good snowmold and common bunt resistance, moderate resistance to dwarf bunt and stripe rust, and is susceptible to leaf rust, <xem rust and strawbOxaker (Cercosporella) foot rot. Yield performance out of the snowmold area has been fair. Emergence is typical of a semi-dwarf. Andrews is somewhat low in flour yield when milled. The bread baking properties of the flour are satisfactory.

Batum

Batum is a common-type, semi-dwarf, hard red winter wheat which originated from USDA-ARS and Washington State University in 1985. Batum is a shorter, more lodging resistant and less winterhardy than the other hard red winter wheats. It is resistant to common bunt, stripe rust, and susceptible to dwarf bunt, leaf rust, stem rust, strawbreaker (Cercosporella) foot rot and snow mold. It has acceptable milling and baking quality, but the test weight is slightly lower.

Buchanan

Buchanan (selection WA7523) is a new, common-type, mid-tall, hard red winter wheat which originated from Washington State University in 1989. Buchanan is designed for the dryland, summer fallow areas because it has excellent emergence ability, equal to or superior to Moro, under stress conditions. Buchanan is moderately resistant to snow mold, moderately susceptible to common bunt, dwarf bunt, stripe rust and leaf rust, and susceptible to strawbreaker (Cercosporella) foot rot and dryland foot rot. Buchanan is one inch taller and flowers one day later than Hatton. Buchanan has good winterhardiness similar to Hatton, but weak straw and test weight 2 lbs/Bu lighter than Hatton.

Crew

Crew is an awnless, white and brown chaffed, club-type, semi-dwarf, soft white winter wheat which originated from USDA-ARS and Washington State University in 1982. Crew, the first multiline wheat variety to be released in North America, was developed to lessen the genetic vulnerability of the region's club wheat crop to stripe rust. Crew is composed of 10 separate lines, each having seedling resistance and some have adult resistance to stripe rust. Crew is moderately resistant to common bunt, moderately susceptible to Cephalosporium stripe, and is susceptible to dwarf bunt, stem rust, flag smut and strawbreaker (Cercosporella) foot rot. Crew is a mid-season variety with very low winterhardiness.

Daws

Daws is a common-type, semi-dwarf, soft white winter wheat which originated from USDA-ARS and Washington State University in 1976. Daws is the most winterhardy soft white wheat available. Daws is resistant to common bunt, moderately resistant to stripe rust, moderately susceptible to leaf rust and Cephalosporium stripe, and susceptible to dwarf bunt, stem rust and strawbreaker (Cercosporella) foot rot. It is a stiff strawed, mid-season variety with only fair emergence characteristics and should not be planted where emergence from great depth is required. Daws has good milling property and the flour quality is satisfactory.

Dusty

Dusty is a common-type, semi-dwarf, soft white winter wheat which originated from USDA-ARS and Washington State University in 1985. Dusty is resistant to common bunt and stripe rust, moderately resistant to Cephalosporium stripe, moderately susceptible to leaf rust, and susceptible to dwarf bunt, stem rust and strawbreaker (Cercosporella) foot rot. It is a later, high tillering variety, with intermediate to low winterhardiness. The straw strength of Dusty is weaker than that of Daws and Stephens, and it may lodge under high production. Dusty has satisfactory milling and baking quality.

Hatton

Hatton is a common-type, mid-tall, hard red winter wheat variety which originated from Washington State University in 1979. Hatton is moderately resistant to common bunt, moderately susceptible to stripe rust and Cephalosporium stripe, and susceptible to dwarf bunt, leaf rust, stem rust, and strawbreaker (Cercosporella) foot rot. It is a mid-season with excellent winterhardiness, but is susceptible to lodging when grown under intensive management.

Hill 81

Hill 81 is a common-type, semi-dwarf, soft white winter wheat which originated from Oregon State University in 1982. Hill 81 is resistant to common bunt, moderately resistant to leaf and stripe rust, moderately susceptible to Cephalosporium stripe, and susceptible to dwarf bunt, stem rust strawbreaker (Cercosporella) foot rot. It is a mid-season variety with low winterhardiness, only slightly better than Stephens. It is taller than most semi-dwarfs and is susceptible to lodging when grown under intensive management.

Hyak

Hyak is a club-type, semi-dwarf, soft white winter wheat which originated from USDA-ARS and Washington State University in 1988. Hyak is resistant to strawbreaker (Cercosporella) foot rot, leaf rust, stripe rust and stem rust, moderately susceptible to common bunt and Cephalosporium stripe, and susceptible to dwarf bunt and flag smut. Hyak is a backcross progeny of Tyee and resembles Tyee in physical appearance, other agronomic traits, with early maturity and intermediate winterhardiness.

John

John is a common-type, semi-dwarf, soft white winter wheat which originated from Washington State University in 1986. John has snow mold resistance comparable to Sprague, moderately resistant to common bunt, moderately susceptible to CephalospoOxum stripe, and is susceptible to dwarf bunt, leaf rust, stripe rust, stem rust and strawbreaker (Cercosporella) foot rot. It is a mid-season variety with straw strength weaker than most other varieties, but better than Sprague.

Lewjain

Lewjain is a common head, semi-dwarf, soft white winter wheat which originated from USDA-ARS and Washington State University in 1982. Lewjain is resistant to dwarf bunt, common bunt, and stripe rust, moderately resistant to Cephalosporium stripe, moderately susceptible to leaf rust, tolerance to strawbreaker (Cercosporella) foot rot, and susceptible to stem rust and flag smut. It is a later season variety with winterhardiness only 10% less than Daws. Lewjain shatters slightly more than Daws, but it is easy to combine and thresh. Reel speed should be held to a minimum to avoid excessive loss from head snapping. Lewjain has excellent milling and good baking quality.

Madsen

Madsen is a common-type, semi-dwarf, soft white winter wheat which originated from USDA-ARS and Washington State University in 1988. Madsen is resistant to common bunt, leaf rust, stripe rust, stem rust and strawbreaker (Cercosporella) foot rot, and moderately susceptible to Cephalosporium stripe. Madsen is a backcross progeny of Hill 81, and is similar to Hill 81 in appearance and agronomic characteristics, with the additional resistance to strawbreaker foot rot. Madsen matures slightly earlier and has slightly better winterhardiness than Hill 81.

Malcolm

Malcolm is a common-type, semi-dwarf, soft white winter wheat which originated from Oregon State University in 1987. Malcolm appears to be best adapted to irrigated areas. Malcolm is susceptible to Cephalosporium stripe and has low to intermediate winterhardiness which is better than Hill 81.

Moro

Moro is an awnless, club-type, tall, soft white winter wheat which originated from OOxgon State University. Moro is resistant to common bunt, moderately resistant to dwarf bunt and flag smut, moderately susceptible to Cephalosporium stripe, and susceptible to leaf rust, stripe rust, stem rust and strawbreaker (Cercosporella) foot rot. Moro is a mid-season variety with excellent emergence characteristics, good winterhardiness equal to or better than to Lewjain, and poor straw strength.

Nugaines

Nugaines is a common-type, semi-dwarf, soft white winter wheat which originated from USDA-ARS and Washington State University in 1965. Nugaines is resistant to common bunt, moderately resistant to flag smut and Cephalosporium stripe, has intermediate resistance to stripe rust, and is susceptible to dwarf bunt, leaf rust, stem rust and strawbreaker (Cercosporella) foot rot. Nugaines is a mid-season variety with excellent straw strength and intermediate winterhardiness slightly less than Lewjain.

Oveson

Oveson is a common-type, medium-tall, semi-dwarf, soft white winter wheat which originated from Oregon State University in 1987. Winterhardiness is similar to that of Stephens, while resistance to Cephalosporium stripe is greater. Heading date is similar to or slightly later than Hill 81.

Sprague

Sprague is a common-type, white to grey chaffed, semi-dwarf, soft white winter wheat which originated from Washington State University in 1973. Sprague has good resistance to snow mold and common bunt, moderate susceptibility to leaf rust stripe rust, flag smut and Cephalosporium stripe, and susceptible to dwarf bunt, stem rust and strawbreaker (Cercosporella) foot rot. It is an early variety with excellent emergence, good winterhardiness, but has weak straw.

Stephens

Stephens is a common-type, semi-dwarf, soft white winter wheat which originated from Oregon State University in 1977. Stephens is resistant to common bunt Oxd stripe rust, moderately resistant to leaf rust, moderately susceptible to flag smut and strawbreaker (Cercosporella) foot rot, and susceptible to dwarf bunt, stem rust and very susceptible to Cephalosporium stripe. Stephens is a mid-season variety with good straw strength, fair emergence and very poor winterhardiness.

Tres

Tres is a club-type, semi-dwarf, soft white winter wheat which originated from USDA-ARS and Washington State University in 1984. Tres is one of the ten component lines found in Crew. Tres is intermediate in resistance to leaf rust, moderately susceptible to common bunt and Cephalosporium stripe, susceptible to dwarf bunt, stripe rust, stem rust, flag smut and strawbreaker (Cercosporella) foot rot. Tres is a mid-season variety with heavier test weight than other clubs, emerges slower than Moro and has intermediate winterhardiness. Tres has excellent milling and flour qualities typical of club wheats.

Weston

Weston is a common-type, brown-chaffed, tall, hard red winter wheat which originated from University of Idaho in 1978. The variety is taller and has weaker straw than Hatton or Wanser. Weston is susceptible to the races of stripe rust that attack Moro and most club wheats. It has some resistance to leaf rust and is resistant to local races of common and dwarf bunt. It has moderate snow mold resistance. Emergence is excellent. Flour protein tends to be slightly higher than Hatton or Wanser. Milling and baking properties are satisfactory.

NEW RELEASES

WA7529

WA7529 is a common-type, semi-dwarf, soft white winter wheat which originated from Washington State University in 1990. WA7529 is a replacement for Daws, with excellent winterhardiness equal to or greater than Daws and has outyielded Daws in the dryland areas. WA7529 is resistant to stripe rust, moderately resistant common bunt, dwarf bunt, strawbreaker (Cercosporella) foot rot and Cephalosporium stripe, and is susceptible to snow mold, leaf rust and stem rust. WA7529 is approximately 3 inches taller and matures 2 days later than Daws.

WA7431

WA7431 is a common-type, semi-dwarf, soft white winter wheat which originated from Washington State University in 1990. WA7431 is a snow mold resistant variety designed to replace Sprague. WA7431 has excellent winterhardiness equal to or greater than Daws. WA7431 has out-yielded Lewjain, Sprague, John and Andrews by 10.7, 17.6 20.5 and 28.7% in the snow mold area of Douglas county. WA7431 is resistant to snow mold, common bunt and dwarf bunt, moderately susceptible to stripe rust, and susceptible to leaf rust and stem rust. WA7431 is 1 inch taller than Daws, with straw strength better than Sprague and similar to Lewjain. WA7431 is similar in maturity to Lewjain.

SPRING WHEAT

Bliss

Bliss is a semi-dwarf, soft white spring wheat which originated from USDA-ARS and the University of Idaho in 1983. Bliss is resistant to stem rust, moderately resistant to stripe rust, susceptible to dryland foot rot and mildew, and very susceptible to leaf rust. Bliss is a late season variety with stiff straw, resistant to lodging, adapted to long season areas under irrigation.

Copper

Copper is a brown-chaffed, semi-dwarf, hard red spring wheat which originated from USDA-ARS and the University of Idaho in 1986. Copper is resistant to stem rust, moderately resistant to stripe rust, moderately susceptible to mildew and leaf rust. Copper is a mid-season variety with test weight and protein levels.

Dirkwin

Dirkwin is an awnless, semi-dwarf, soft white spring wheat which originated from USDA-ARS and the University of Idaho in 1978. Dirkwin is resistant to stripe rust and stem rust, susceptible to dryland foot rot and mildew, and very susceptible to leaf rust. Dirkwin is an early to mid-season variety, with lower test weight which is best adapted to the higher rainfall or irrigated areas.

Edwall

Edwall is semi-dwarf, soft white spring wheat which originated from Washington State University in 1984. Edwall is derived from the cross of an early CIMMYT wheat, Potam 70, and Fielder. Edwall is resistant to stem rust, moderately resistant to stripe rust and leaf rust, moderately susceptible to dryland foot rot, and susceptible to mildew. Edwall is a very widely adapted, mid-season variety.

McKay

McKay is a semi-dwarf, hard red spring wheat which originated from USDA-ARS and the University of Idaho in 1981. McKay is resistant to stripe rust, leaf rust, stem rust and mildew. McKay is a mid-season variety which tends to have lower protein levels.

Owens

Owens is a semi-dwarf, soft white spring wheat which originated from USDA-ARS and the University of Idaho in 1981. Owens is resistant to stem rust, and susceptible to stripe rust, dryland foot rot, leaf rust and mildew. Owens is a mid-season variety with good test weight.

Penewawa

Penewawa is a long awned, semi-dwarf, soft white spring wheat which originated from Washington State University in 1985. Penewawa is a sister line to Edwall and is similar in appearance, but is 1-2" taller and has a 1-2 lbs/Bu test weight advantage over Edwall. Penewawa is resistant to stem rust, moderately resistant to stripe rust and leaf rust, and susceptible to mildew. Penewawa is a mid-season variety with good lodging resistance and a wide area of adaptation.

Spillman

Spillman is a semi-dwarf, hard red spring wheat which originated from Washington State University in 1989. Spillman is resistant to stripe rust, leaf rust, stem rust and mildew. Spillman is a mid-season variety with a wide area of adaptation and good protein levels.

Treasure

Treasure is semi-dwarf, soft white spring wheat which originated from USDA-ARS and the University of Idaho in 1986. Treasure is resistant to stripe rust and stem rust, moderately resistant to leaf rust, and susceptible to mildew. Treasure is a mid-season variety with good test weight and yields well under irrigation and the low rainfall areas.

Wadual

Wadual is a semi-dwarf, dual purpose soft white spring wheat which originated from Washington State University in 1988. Wadual has a unique dual purpose flour quality characteristic. When protein is low the flour quality is good for pastries, and when the protein is high the flour has good bread making quality. Wadual is moderately resistant to stripe rust, leaf rust and stem rust, and is moderately susceptible to mildew. Wadual is a mid-season variety adapted to the intermediate to high rainfall and irrigated areas.

Wakanz

Wakanz is a semi-dwarf, soft white spring wheat which originated from Washington State University in 1988. Wakanz is the only soft white spring wheat resistant to hessian fly, which can be significant under conservation tillage production systems. Wakanz is also moderately resistant to stripe rust, leaf rust and stem rust, moderately susceptible to dryland foot rot and mildew. Wakanz is a mid-season variety, heading 2- 4 days later than Edwall, with good test weight, a wide area of adaptation, yielding well in the high rainfall areas and under irrigation.

Wampum

Wampum is a tan-chaffed, tall semi-dwarf, hard red spring wheat which originated from Washington State University in 1978. Wampum is resistant to stripe rust, moderately resistant to mildew, moderately susceptible to leaf rust, and susceptible to stem rust. Wampum is a later mid-season variety with relatively wide area of adaptation, but lower protein levels than currently available varieties.

Waverly

Waverly is a semi-dwarf, soft white spring wheat which originated from Washington State University in 1982. Waverly is moderately resistant to stripe rust, stem rust and leaf rust, and susceptible to dryland foot rot and mildew. Waverly is a mid-season variety with good lodging resistance.

TRITICALE

Flora

Flora is a winter triticale which originated from Oregon State University in 1986. Flora has excellent winterhardiness and is resistant or tolerant of most wheat diseases with the exception of Cephalosporium stripe. Flora has the yield potential equal to or greater than the top yielding soft white winter wheats in the higher rainfall areas. However, test weights are poor and kernels are shrunken.

Whitman

Whitman is a facultative, (can be grown in the winter or spring) triticale which originated from USDA-ARS and Washington State University in 1988. It has had adequate winterhardiness to survive winters at Pullman, Washington, if snow cover is present during coldest weather. Whitman has expressed some vernalization requirement and must be planted very early if planted in the spring. It is resistant to current races of stripe and leaf rust. Whitman is a tall triticale with good yield potential. Whitman heads out early, but is similar in harvest date to Daws or Nugaines. Test weights are only fair.

WINTER BARLEY

Boyer

Boyer is a mid-tall, 6-row winter feed barley which originated from Washington State University in 1975. Boyer does not have the severe "itching" characteristics of other winter varieties. Boyer's intermediate height and stiff straw results in excellent lodging resistance. Boyer's winterhardiness approaches that of Kamiak. Boyer has mid-season maturity, relatively good yield potential and a higher percentage of plump kernels.

Hesk

Hesk is a mid-short, 6-row winter feed barley which originated from Oregon State University in 1979. Hesk has mid-season maturity, with yields second only to the new Hundred winter barley. Boyer is 1-3" shorter than Boyer with good lodging resistance and winterhardiness approaching Kamiak.

Hundred

Hundred (selection 1574-77) is a new mid-short, club-type head, 6-row winter barley which originated from Washington State University in 1989. Hundred, named in honor of Washington State Universities centennial year, is a widely adapted variety, outyielding all other winter barleys throughout eastern Washington. Hundred has excellent winterhardiness, equal to or greater than Kamiak. Hundred's plant height is similar to Hesk, but has only intermediate lodging resistance.

Kamiak

Kamiak is a mid-tall, 6-row winter feed barley with light blue kernels which originated from Washington State University in 1971. Kamiak, an early variety, with good test weight and a high percentage of plump kernels. Kamiak does not have small glume hairs which cause "itching" during threshing. Kamiak's tall plant height results in poor lodging resistance. Kamiak has excellent winterhardiness, but generally lower yields than other winter barleys.

Showin

Showin is a semi-dwarf, 6-row winter feed barley which originated from Washington State University in 1985. Showin, named for its short winter habit, is 20 to 25% shorter than Kamiak which results in good lodging resistance. Showin will outyield Kamiak, but not Boyer. Showin is a later mid-season variety with a prostrate growth habit until the jointing stage. This prostrate growth habit could be an advantage in weed control and as an additional method for soil conservation. Showin tends to have slightly lower test weights and lower percentage of plump kernels. Showin is the least winterhardy of the public winter barleys.

SPRING BARLEY

Advance

Advance is a short, 6-row spring malting variety which originated from Washington State University in 1979. The variety has low or no cold tolerance and, therefore, is susceptible to winterkill which will reduce the problem of volunteer barley in subsequent crop rotations. This is especially important when wheat is grown after barley. Extreme earliness will permit Advance to mature under more favorable conditions. Advance is a short, stiff-strawed variety. Additionally, tests indicate that Advance has a higher feed value for livestock than Steptoe but it yields only 93 percent as much grain as Steptoe. Advance has some susceptibility to mildew, but in trials where this disease has been prevalent, yield losses were not detectable and malting quality was not impaired.

Andre

Andre is a mid-tall, 2-row spring malting barley which originated from Washington State University in 191982. Andre has a nodding head with medium-short stiff straw and good tillering capacity. Andre yields exceed Klages, approaching those of Steptoe. At Pullman, Andre is one day earlier than Klages and six days later than Steptoe. The variety has good lodging and shattering resistance. The kernels are slightly larger than those of Klages but smaller than the kernels of Steptoe. The test weight is higher than Steptoe. Feeding trials indicate that Andre is better than Steptoe in feed value. Malting barley tests indicated Andre has good 2-row malting barley quality.

Belford

Belford is a mid-tall, 6-row, hooded or awnless variety of spring barley which originated from Washington State University in 1943. Belford is mid-season in maturity with relatively weak straw. Belford is recommended only for hay and only in eastern Washington high rainfall areas and in central Washington under irrigation.

Cougbar

Cougbar is a mid-tall, 6-row spring barley which originated from Washington State University in 1985. Cougbar widely adapted with high yield potential and good lodging resistance. Its yield has equaled or exceeded Steptoe's at Pullman, and is about 96% of Steptoe averaged across eastern Washington. Cougbar has plump kernels, high test weight and less winterhardiness than Steptoe. Cougbar's yield, test weight and percent plump kernels have been greater than those of Advance. Cougbar has relatively good nutritional and malting quality. However, Cougbar is not as yet classified as a malting barley, as industry tests are incomplete.

Klages

Klages is a mid-tall, 2-row spring malting barley which originated from USDA-ARS and the University of Idaho in 1972. Klages is adapted to irrigated production and does not perform well in low rainfall areas. Klages is mid-season in maturity with stiff straw. Klages has excellent malting quality, but does not have as high yield record in Washington tests as other 2-row malting varieties.

Steptoe

Steptoe is a mid-tall, 6-row spring nonmalting barley which originated from Washington State University in 1973. Steptoe is a very widely adapted variety with excellent yield performance. The test weight is high for a 6-row. Steptoe heads later than most 6-row varieties. Steptoe has erect heads and stiff straw with good lodging resistance.

SPRING OATS

Appaloosa

Appaloosa is a yellow-grey kernel, mid-short, spring oat which originated from Washington State University in 1978. Appaloosa has moderate tolerance to yellow dwarf virus, slightly better tolerance than Cayuse. Appaloosa has up to 10 percent higher yield performance compared with Cayuse, but slightly lower average test weight. Appaloosa is an early season variety with straw 1 to 2 inches shorter than Cayuse. It has slightly better resistance to lodging than Cayuse.

Border

Border is a white kernel, mid-short, spring oat which originated from USDA-ARS and the University of Idaho. Border is a mid-season variety with moderate tolerance to yellow dwarf virus and good lodging resistance. Border tends to have lighter test weights with yields equal to or exceeding Cayuse.

Cayuse

Cayuse is a light yellow kernel, mid-short, spring oat which originated from Washington State University in 1966. Cayuse is an early variety with moderate tolerance to yellow dwarf virus. Cayuse is typically 1-3" taller than Border with good lodging resistance. Cayuse has relatively good test weight.

Monida

Monida is a white kernel, mid-tall, spring oat which originated from USDA-ARS and the University of Idaho in 1984. Monida is a mid-season variety with moderate tolerance to yellow dwarf virus. Monida has the potential to yield almost as well as Cayuse and Appaloosa and typically has higher test weights than Cayuse. Monida is taller than Cayuse with only intermediate lodging resistance.

Otana

Otana is a tall, ivory kernel, spring oat which originated from USDA-ARS and Montana State University in 1976. Monida is a mid-season variety with moderate susceptibility to yellow dwarf virus. Otana has good yield potential and excellent test weight. Otana's tall stature results in only intermediate lodging resistance.

Park

Park is a mid-tall, white kernel, spring oat which originated from the University of Idaho in 1960. Park is a mid-season variety which is susceptible to yellow dwarf virus. Park will not yield as well as Cayuse, but typically has higher test weight than Cayuse.

PACIFIC NORTHWEST HISTORICAL WHEAT NURSERY

Baird Miller, Clarence Peterson and Ken Kephart

The production of wheat in the Pacific Northwest started when the earliest settlers came to this region in the 1870's. In recognition of those early settlers who brought both their culture and wheat with them, Ken Kephart, former Extension Agronomist at the University of Idaho, identified and collected all the known wheat varieties grown within Washington, Idaho and Oregon over the last 100 years. To date more than 300 wheat varieties have been identified from the historical records as being produced in the Pacific Northwest.

Many varieties were introduced from other countries. A large number of wheat varieties came from Australia around the turn of the century and played an important role in the expanding PNW commercial wheat industry. Other varieties were developed in other states an eventually produced in this region. Many of the better adapted and higher yielding varieties resulted from the tremendous public investments made in the wheat breeding programs at the three land-grant institutions: Washington State University, University of Idaho and Oregon State University.

Seed form most of the post-World War II varieties was obtained from the regional wheat breeding programs in Pullman, WA; Moscow and Aberdeen, ID; Corvallis and Pendleton, OR; and Logan, UT. Most of the very old varieties were obtained from the USDA Repository in Beltsville, MD, which is currently located in Aberdeen, ID. The national repositories of Australia and Canada were also sources of seed of the early varieties which originated from these countries.

The variety breeding and production management research programs at Washington State Unvieristy and the other land-grant institutions in the PNW over the last 100 years have contributed tremendously to increase in Washington wheat yields (Figure 1). From 1900 through the 1930's, the

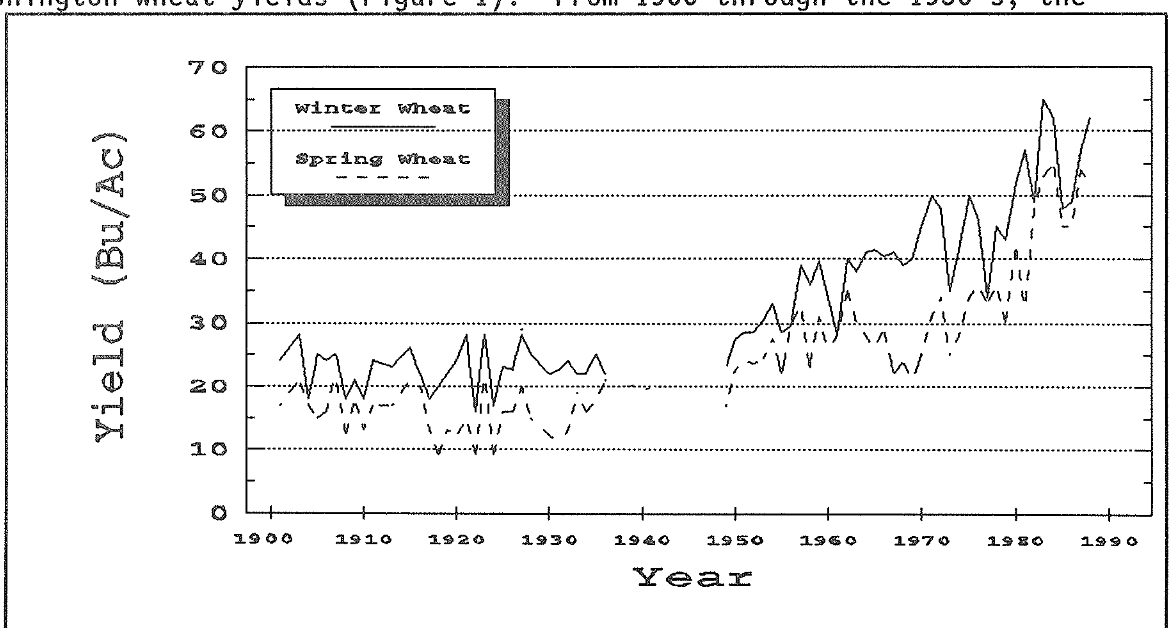
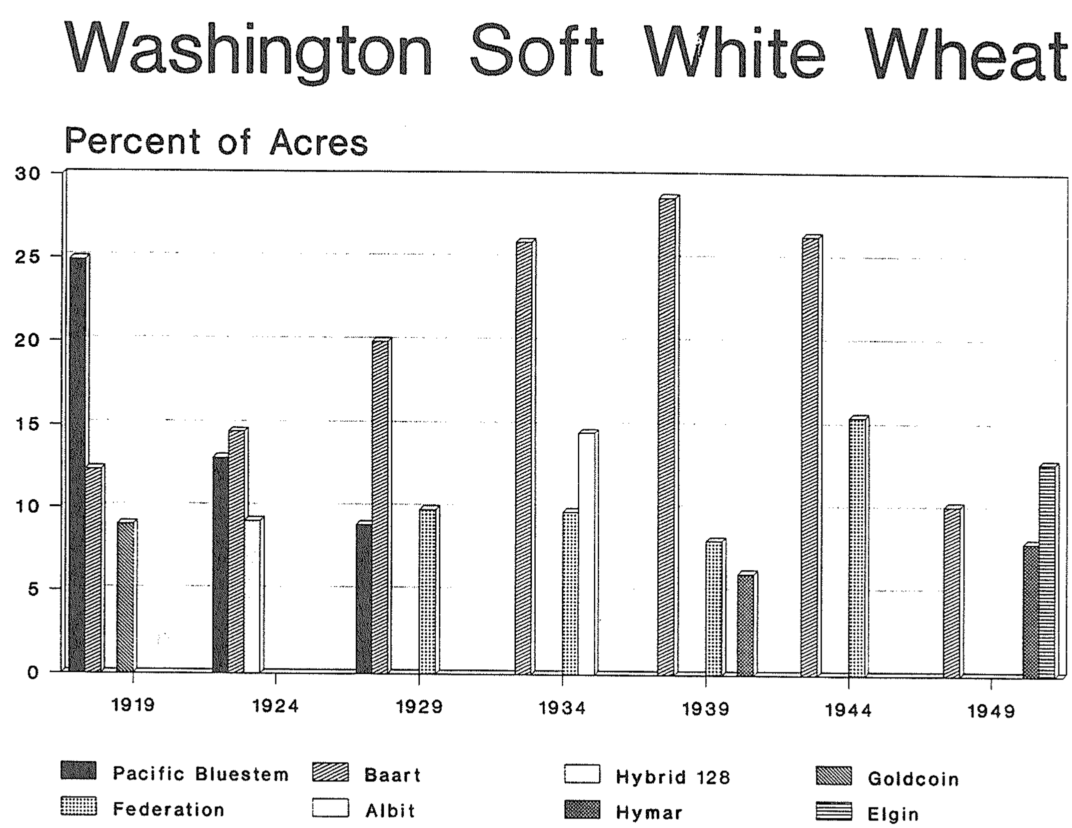


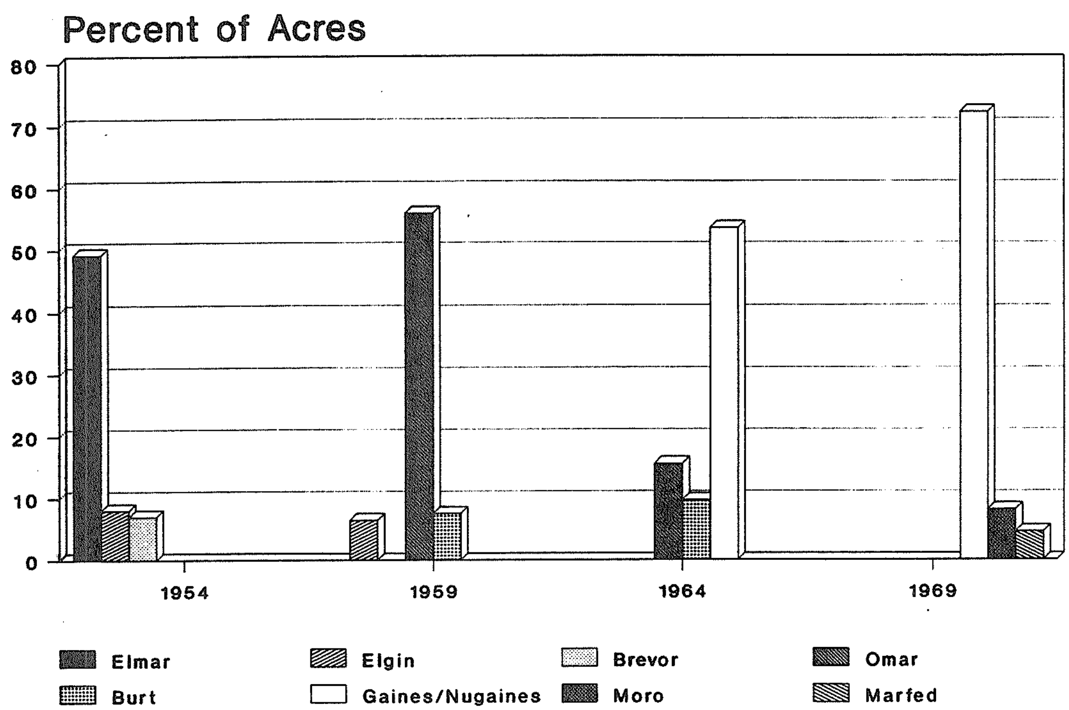
Figure 1. Progress in Washington wheat yields, 1900 - 1988.

Washington wheat yields remained relatively unchanged, with winter wheat averaging 22.8 Bu/Ac and spring wheat averaging 15.9 Bu/Ac statewide. These spring wheat yields were 30% less than the winter wheat yields during this time. From the 1940's to the late 1980's the average Washington winter wheat yields have increased to over 60 Bu/Ac and the average spring wheat yields have increase to over 50 Bu/Ac. Average winter wheat yields statewide now are only 23% higher than the average spring wheat yields. This improvement in wheat yields can be attributed to significantly improved production practices and varieties which are better adapted to Washington, more disease resistant, shorter and more lodging resistant.

The PNW Historical Wheat Nursery on display at Spillman Farm this year contains almost 300 wheat varieties which have been grown in this area over the last 100 years. Single rows of each variety of winter and spring varieties were planted. Take the opportunity to step back into the past and reminisce. Recall varieties such as Pacific Bluestem, Baart, Hydrid 128, Goldcoin, Federation, Elgin, Elmar, Brevor, Omar, Burt, Moro, Marfed, Gaines and Nugaines. Figure 2 shows the three most popular soft white wheats grown in Washington dating back to 1919. In addition, table 1 lists the varieties planted in the PNW Historical Wheat Nursery, their class, origin and date of release.

Figure 2. Three most popular soft white wheat varieties grown in Washington from 1919 to 1984.




Percent of Acres
80
70
60
50
40
30
20
10
0
1954
1959
1964
1969
Elmar
Elgin
Brevor
Omar
Burt
Gaines/Nugaines
Moro
Marfed

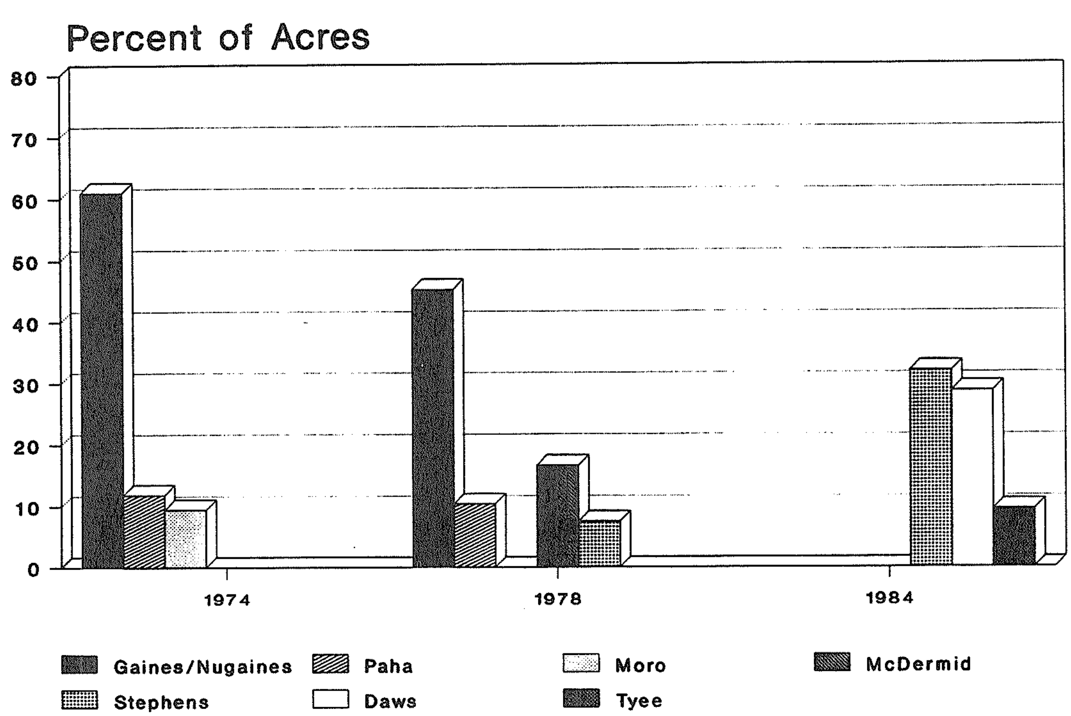

Percent of Acres
80
70
60
50
40
30
20
10
0
1974
1978
1984
Gaines/Nugaines
Paha
Moro
McDermid
Stephens
Daws
Tyee

Table 1. Varieties planted in the 1990 PNW Historical Wheat Nursery at Spillman Farm, Pullman, WA.

WINTER WHEAT

SOFT WHITE

CULTIVAR	SPIKE	ORIGIN	YEAR
WHITE WINTER	COMMON	ENGLAND	1855
DAWSON	COMMON	ONTARIO	1881
GOLDCOIN	COMMON	NEW YORK	1890
GENESEE GIANT	COMMON	NEW YORK	1893
EATON	COMMON	ENGLAND	1894
SATISFACTION	COMMON	NEW YORK	1895
HYBRID 128	CLUB	WASHINGTON	1907
FLORENCE	COMMON	AUSTRALIA	1914
WILHEMINIA (HOLLAND)	COMMON	NETHERLAND	1914
ALBIT	CLUB	WASHINGTON	1926
POWERCLUB	CLUB	IDAHO	1926
ARCO	COMMON	OREGON	1928
GENRO	CLUB	WASHINGTON	1928
WHITE ODESSA	COMMON	IDAHO	1928
HOOD	CLUB	OREGON	1929
GOLDEN	COMMON	OREGON	1930
ATHENA	COMMON	OREGON	1931
ALICEL	CLUB	OREGON	1932
REX	COMMON	OREGON	1933
HYMAR	CLUB	OREGON	1935
REQUA	COMMON	WASHINGTON	1935
REX M2	COMMON	WASHINGTON	1938
ELGIN	CLUB	OREGON	1943
ALBA	COMMON	BELGIUM	1948
BREVOR	COMMON	WASHINGTON	1949
DRUCHAMP	COMMON	FRANCE	1949
ELMAR	CLUB	WASHINGTON	1949
OMAR	CLUB	WASHINGTON	1955
GAINES	COMMON	WASHINGTON	1961
LUFT	COMMON	IDAHO	1963
MORO	CLUB	OREGON	1965
NUGAINES	COMMON	WASHINGTON	1965
YAMHILL	COMMON	OREGON	1969
HYSLOP	COMMON	OREGON	1970
LUKE	COMMON	WASHINGTON	1970
PAHA	CLUB	WASHINGTON	1970
SPRAGUE	COMMON	WASHINGTON	1972
McDERMID	COMMON	OREGON	1974
PECK	COMMON	IDAHO	1974
REW	COMMON	OREGON	1974
BARBEE	CLUB	WASHINGTON	1976
DAWS	COMMON	WASHINGTON	1976
FARO	CLUB	OREGON	1976
RAEDER	COMMON	WASHINGTON	1976
STEPHENS	COMMON	OREGON	1977
GREER	COMMON	IDAHO	1978
JACMAR	CLUB	WASHINGTON	1978
LENORE	COMMON	IDAHO	1978
TYEE	CLUB	WASHINGTON	1979
CREW	CLUB	WASHINGTON	1982
HILL81	COMMON	OREGON	1982
LEWJAIN	COMMON	WASHINGTON	1982
DUSTY	COMMON	WASHINGTON	1984
TRES	CLUB	WASHINGTON	1984
BASIN	COMMON	WASHINGTON	1985
CASHUP	COMMON	WASHINGTON	1985
JOHN	COMMON	WASHINGTON	1985
OVESON	COMMON	OREGON	1986
HYAK	CLUB	WASHINGTON	1987
MADSEN	COMMON	WASHINGTON	1987
MALCOLM	COMMON	OREGON	1987
SYRINGA	COMMON	IDAHO	1989

SOFT RED WINTER

CULTIVAR	SPIKE	ORIGIN	YEAR
MEDITERRANEAN	COMMON	S. EUROPE	1842
ODESSA	COMMON	RUSSIA	1865
FULTZ	COMMON	PENNYSLVANI	1871
GOLDEN CROSS	COMMON	NEW YORK	1888
JONES FIFE	COMMON	NEW YORK	1889
LOFTHOUSE	COMMON	UTAH	1890
RED RUSSIAN (1)	COMMON	ENGLAND	1890
PRIDE OF GENESEE	COMMON	NEW YORK	1893
HARVEST QUEEN	COMMON	KANSAS	1897
COPPEI	CLUB	WASHINGTON	1911
SUN (SOL)	COMMON	SWEDEN	1911
TRIPLET	COMMON	WASHINGTON	1918
RUDDY	COMMON	WASHINGTON	1919
THORNE	COMMON	OHIO	1937
NORIN 10/BREVOR 14	COMMON	WASHINGTON	1953
SPOKANE CHIEF	CLUB	WASHINGTON	1953
DUAL	COMMON	INDIANA	1955

HARD WHITE WINTER

CULTIVAR	SPIKE	ORIGIN	YEAR
BURT	COMMON	WASHINGTON	1956
COULEE	COMMON	WASHINGTON	1972

HARD RED WINTER

CULTIVAR	SPIKE	ORIGIN	YEAR
GOLD DROP	COMMON	NEW YORK	1843
TURKEY RED (KHARKOF)	COMMON	RUSSIA	1873
KHARKOF	COMMON	RUSSIA	1900
MONTANA 36	COMMON	MONTANA	1915
BLACKHULL	COMMON	KANSAS	1917
KANRED	COMMON	KANSAS	1917
RIDIT	COMMON	WASHINGTON	1923
MOSIDA	COMMON	IDAHO	1924
ORO	COMMON	OREGON	1927
EARLY BLACKHULL	COMMON	KANSAS	1928
SHERMAN	COMMON	OREGON	1928
RIO	COMMON	OREGON	1931
TENMARQ	COMMON	KANSAS	1932
YOGO	COMMON	MONTANA	1932
CHEYENNE	COMMON	NEBRASKA	1933
RELIEF	COMMON	UTAH	1934
CHIEFKAN	COMMON	KANSAS	1935
CACHE	COMMON	UTAH	1937
TRIUMPH	COMMON	OKLAHOMA	1940
PAWNEE	COMMON	NEBRASKA	1942
WASATCH	COMMON	UTAH	1944
BLUE JACKET	COMMON	KANSAS	1946
PI178383	COMMON	RUSSIA	1948
KIOWA	COMMON	KANSAS	1950
COLUMBIA	COMMON	OREGON	1955
BISON	COMMON	KANSAS	1956
ITANA	COMMON	OREGON	1956
WESTMONT	COMMON	MONTANA	1956
TENDOY	COMMON	IDAHO	1960
DELMAR	COMMON	UTAH	1961
ITANA 65	COMMON	IDAHO	1965
McCALL	COMMON	OREGON	1965
WANSER	COMMON	WASHINGTON	1965
CREST	COMMON	MONTANA	1967
ARK	COMMON	IDAHO	1972
FRANKLIN	COMMON	IDAHO	1972
RANGER	COMMON	IDAHO	1972
HANSEL	COMMON	UTAH	1974
HEGLAR	COMMON	IDAHO	1974
JEFF	COMMON	IDAHO	1974
ARBON	COMMON	IDAHO	1978
WESTON	COMMON	IDAHO	1978
HATTON	COMMON	WASHINGTON	1979
MANNING	COMMON	UTAH	1979
NEELEY	COMMON	IDAHO	1980
WINRIDGE	COMMON	MONTANA	1981
UTE	COMMON	UTAH	1983
NORWIN	COMMON	MONTANA	1984
BATUM	COMMON	WASHINGTON	1985
ANDREWS	COMMON	WASHINGTON	1987
BLIZZARD (ID0297)	COMMON	IDAHO	1988
SURVIVOR	COMMON	IDAHO	1988
BUCHANAN	COMMON	WASHINGTON	1989

SPRING WHEAT

SOFT WHITE SPRING

CULTIVAR	SPIKE	ORIGIN	YEAR
LITTLE CLUB	CLUB	CHILE	1700
SONORA	COMMON	MEXICO	1770
FOISY	COMMON	OREGON	1865
BIG CLUB	CLUB	CHILE	1870
TOUSE	COMMON	FRANCE	1870
DEFIANCE	COMMON	VERMONT	1878
SURPRISE	COMMON	VERMONT	187?
PACIFIC BLUESTEM	COMMON	AUSTRALIA	1882
WHITE FIFE	COMMON	CANADA	1888
WHITE MARQUIS	COMMON	MINNESOTA	1890
NEW ZEALAND	COMMON	FRANCE	1890
BLUECHAFF CLUB	CLUB	OREGON	1894
JENKIN CLUB	CLUB	WASHINGTON	1895
WILBUR	CLUB	WASHINGTON	1897
ALLEN	CLUB	WASHINGTON	1900
EARLY BAART	COMMON	AUSTRALIA	1900
GALGALOS	COMMON	RUSSIA	1903
MACKEY	COMMON	IDAHO	1906
HYBRID 63	CLUB	WASHINGTON	1907
HYBRID 143	CLUB	WASHINGTON	1907
RINK	COMMON	OREGON	1909
DICKLOW	COMMON	IDAHO	1912
GYPSUM	COMMON	COLORADO	1912
BUNYIP	COMMON	AUSTRALIA	1914
FEDERATION	COMMON	AUSTRALIA	1914
HARD FEDERATION	COMMON	AUSTRALIA	1915
CURRAWA	COMMON	AUSTRALIA	1916
MAJOR	COMMON	AUSTRALIA	1916
WHITE FEDERATION	COMMON	AUSTRALIA	1916
INDIAN	COMMON	UTAH	1917
PILCRAW	COMMON	CALIFORNIA	1917
ONAS	COMMON	AUSTRALIA	1918
OREGON ZIMMERMAN	COMMON	OREGON	1921
UNION	CLUB	OREGON	1923
HARD FEDERATION 31	COMMON	OREGON	1928
HYPER	COMMON	WASHINGTON	1929
RAMONA	COMMON	CALIFORNIA	1935
PACIFIC BLUESTEM 37	COMMON	CALIFORNIA	1937
IDAED	COMMON	CALIFORNIA/IDAHO	1938
ORFED	COMMON	WASHINGTON	1943
BIG CLUB 43	CLUB	CALIFORNIA	1944
MARFED	COMMON	WASHINGTON	1947
BAART 46	COMMON	CALIFORNIA	1948
AWNED ONAS	COMMON	CALIFORNIA	1950
LEMHI	COMMON	IDAHO	1953
LEMHI 53	COMMON	IDAHO	1953
ONAS 53	COMMON	CALIFORNIA	1953
KENHI	COMMON	ALBERTA	1958
IDAED 59	COMMON	IDAHO	1962
BEAVER	COMMON	OREGON	1965
FEDERATION 67	COMMON	IDAHO	1966
LEMHI 66	COMMON	IDAHO	1966
SPRINGFIELD	COMMON	IDAHO	1970
TWIN	COMMON	IDAHO	1971
FIELDER	COMMON	IDAHO	1974
URQUIE	COMMON	WASHINGTON	1975
FIELDWIN	COMMON	IDAHO	1976
DIRKWIN	COMMON	IDAHO	1978

SOFT WHITE SPRING CONTINUED

CULTIVAR	SPIKE	ORIGIN	YEAR
STERLING	COMMON	IDAHO	1980
OWENS	COMMON	IDAHO	1981
BLISS	COMMON	IDAHO	1982
WAVERLY	COMMON	WASHINGTON	1982
EDWALL	COMMON	WASHINGTON	1984
PENEWAWA	COMMON	WASHINGTON	1985
TREASURE	COMMON	IDAHO	1986
WADUAL	COMMON	WASHINGTON	1987
WAKANZ	COMMON	WASHINGTON	1987

SOFT RED SPRING

CULTIVAR	SPIKE	ORIGIN	YEAR
PURPLESTRAW	COMMON	AUSTRALIA	1820
RED FIFE	COMMON	GALICIA	1842
KINNEY	COMMON	FRANCE	1870
HUSTON	COMMON	BULGARIA	1876
DALE	COMMON	OREGON	1901
HYBRID 123	CLUB	WASHINGTON	1907
SCHLANSTEDT	COMMON	GERMANY	1909

HARD WHITE SPRING

CULTIVAR	SPIKE	ORIGIN	YEAR
CANADIAN RED	COMMON	CALIFORNIA	1919
UTAC	CLUB	UTAH	1928
FLOMAR	COMMON	WASHINGTON	1933
RAMONA 50	COMMON	CALIFORNIA	1951
ADAMS	COMMON	OREGON	1972
WORLD SEEDS 1	COMMON	CALIFORNIA	1974

HARD RED SPRING

CULTIVAR	SPIKE	ORIGIN	YEAR
LADOGA	COMMON	RUSSIA	1888
SEA ISLAND	COMMON	UNKNOWN	1890
PRESTON	COMMON	CANADA	1893
MARQUIS	COMMON	CANADA	1911
RUBY	COMMON	CANADA	1917
RED BOBS	COMMON	SASKATCHEWAN	1918
SUPREME	COMMON	CANADA	1922
CERES	COMMON	NORTH DAKOTA	1926
RELIANCE	COMMON	MONTANA/N. DAKOTA	1926
HOPE	COMMON	SOUTH DAKOTA	1927
REWARD	COMMON	CANADA	1928
KOMAR	COMMON	NORTH DAKOTA	1930
CANUS	COMMON	CANADA	1934
THATCHER	COMMON	MINNESOTA	1934
PREMIER	COMMON	NORTH DAKOTA	1938
PILOT	COMMON	NORTH DAKOTA	1939
REGENT	COMMON	MANITOBA	1939
RIVAL	COMMON	NORTH DAKOTA	1939
COMET	COMMON	MONTANA	1940
HENRY	COMMON	WISCONSIN	1944
MIDA	COMMON	NORTH DAKOTA	1944
SPINKOTA	COMMON	SOUTH DAKOTA	1944
CADET	COMMON	NORTH DAKOTA	1946
RESCUE	COMMON	CANADA	1946
REDMAN	COMMON	MANITOBA	1947
SAUNDERS	COMMON	ONTARIO	1948
RUSHMORE	COMMON	SOUTH DAKOTA	1949
LEE	COMMON	MINNESOTA	1951
CHINOOK	COMMON	CANADA	1952
SELKIRK	COMMON	MANITOBA	1953
CONLEY	COMMON	NORTH DAKOTA	1955
CENTANA	COMMON	MONTANA	1958
CANTHATCH	COMMON	MANITOBA	1959
JUSTIN	COMMON	NORTH DAKOTA	1962
PITIC 62	COMMON	CIMMYT	1962
MANITOU	COMMON	MANITOBA	1965
CHRIS	COMMON	MINNESOTA	1967
FORTUNA	COMMON	NORTH DAKOTA	1967
RED RIVER 68	COMMON	MEXICO (CIMMYT)	1968
NEEPAWA	COMMON	MANITOBA	1969
ERA	COMMON	MINNESOTA	1970
FREMONT	COMMON	UTAH	1970
ANZA	COMMON	CALIFORNIA	1971
BOUNTY 208	COMMON	MEXICO (CIMMYT)	1971
PEAK	COMMON	IDAHO	1971
BANNOCK	COMMON	IDAHO	1972
MORAN	COMMON	IDAHO	1972
PEAK 72	COMMON	IDAHO	1972
PRODAX	COMMON	CIMMYT	1972
WARED	COMMON	WASHINGTON	1972
NORANA	COMMON	MONTANA	1973
OLAF	COMMON	NORTH DAKOTA	1973
BORAH	COMMON	IDAHO	1974
BOUNTY 309	COMMON	MEXICO (CIMMYT)	1974
KITT	COMMON	MINNESOTA	1975
PROSPUR	COMMON	MINNESOTA	1975
PROTOR	COMMON	MINNESOTA	1975
YECORA ROJO	COMMON	CALIFORNIA	1975
NEWANA	COMMON	MONTANA	1976
SAWTELL	COMMON	IDAHO	1978
WAMPUM	COMMON	WASHINGTON	1978
PROBRAND 751	COMMON	CIMMYT	1979
AIM	COMMON	MONTANA	1979
PONDERA	COMMON	MONTANA	1980
MCKAY	COMMON	IDAHO	1981
WESTBRED 911	COMMON	MONTANA	1982
WESTBRED 906R	COMMON	MONTANA	1984

HARD RED SPRING CONTINUED

CULTIVAR	SPIKE	ORIGIN	YEAR
BRONZE CHEIF	COMMON	MONTANA	1985
KODIAK DWARF	COMMON	MONTANA	1985
COPPER	COMMON	IDAHO	1987
SPILLMAN	COMMON	WASHINGTON	1987

DURUM SPRING

CULTIVAR	SPIKE	ORIGIN	YEAR
KUBANKA	COMMON	RUSSIA	1900
KAHLA	COMMON	ALGERIA	1901
SENTRY	COMMON	NORTH DAKOTA	1954
LANGDON	COMMON	NORTH DAKOTA	1956
WELLS	COMMON	NORTH DAKOTA	1960
LEEDS	COMMON	NORTH DAKOTA	1967
WANDELL	COMMON	WASHINGTON	1972
WARD	COMMON	WASHINGTON	1973
PRODURA	COMMON	CIMMYT	1975
WAID	COMMON	WASHINGTON	1979
IRRIDUR	COMMON	IDAHO	1980
WHITE POLISH	COMMON	ENGLAND	1845

IMPROVEMENTS IN THE COOPERATIVE EXTENSION UNIFORM CEREAL VARIETY TESTING PROGRAM

Baird Miller

The goal of the Washington State University Cooperative Extension uniform cereal variety testing program is to provide growers with reliable and representative variety performance data to make their variety selections. This testing program also assists University plant breeders in making selections from their breeding programs.

In the last 2 years, several significant improvements in the management of the field trials have been implemented:

1. Funds provided by the Washington Wheat and Barley Commissions, Washington State Crop Improvement Association, Whitman County Crop Improvement Association, several other county Crop Improvement Associations and county Wheat Growers Associations were used to purchase a small plot grain drill and combine. The new drill allows us to plant on a 6" row spacing instead of 12". The drill row spacing can also be changed for conducting innovative planting design field studies. The new combine will improve the harvesting efficiency and allow us to double the harvested plot area. This will provide more representative and reliable variety performance information.
2. The seeding rate is now constant among the varieties. All varieties are planted at a uniform rate of seeds per square foot, rather than a constant seed weight. This approach is taken because the seed weight of a given variety can vary significantly among seed lots, and will also vary among varieties. If all varieties were planted at a constant seed weight, each variety would be established at a different plant population.
3. The spring cereal trials are now planted on recrop land, at all locations, following winter wheat.
4. As a result of the increased concern about high protein levels in soft white wheats, we are determining grain protein levels in all wheat varieties.

With a continued commitment to improve the uniform variety testing program, an industry advisory committee was formed to suggest future program enhancements. This advisory committee includes grower representatives, members of the Wheat and Barley Commissions, Washington State Crop Improvement Association, seed dealers, private seed companies, county agents, and University plant breeders.

Several priorities for enhancing the variety testing program were set forth by the advisory committee. These priorities included:

1. Evaluating additional public varieties from other Universities in the Pacific Northwest, which are nearing or have recently been released.
2. Evaluating private varieties.
3. Conducting a uniform testing program to provide unbiased variety performance data for the Washington State Crop Improvement Associations Certified Seed Buying Guide (WSCIA-CSBG). Currently the performance data used in the WSCIA-CSBG is provided directly by the private or public plant breeder.

Clearly, expanding the uniform variety testing program to implement these suggested changes would significantly increase the information currently provided. However, the increase in the number of plots was beyond our capabilities. A difficult compromise was made to increase the number of varieties evaluated, but reduce the number of trial locations. Prior to this year, there were 27 winter and spring cereal trials conducted by the Cooperative Extension cereal testing program. This number of locations has been reduced to 21.

Determining which sites to eliminate was based on several factors: 1) a statistical analysis of the similarity of the variety yield data among the original locations, 2) adequate geographical distribution of the trial sites, 3) adequate distribution of the trial sites among the different cropping zones, and 4) locations that were complementary to the WSU plant breeder's trial sites.

Based on the analysis described above, four winter cereal sites are being dropped: Clyde, Reardon, Goldendale and Uniontown. In addition: three spring cereal sites are being dropped: Asotin, Goldendale, and Uniontown. The spring cereal site at Mayview is being combined with the WSU plant breeder's evaluation site. On the positive side, both a winter and spring cereal site will be added in the irrigated cropping area at Moses Lake. Table 1 and 2 list the locations, categorized by their cropping zone, which are now included in the Cooperative Extension uniform variety testing program.

Statistical correlation analysis indicated which locations had similar yield performance results to those locations being dropped. Table 1 and 2 lists the locations with similar yield performance as those which are being dropped. The current testing site which had similar yield performance as the site being eliminated will not have identical yield levels. However, the relative performance between these two locations was very similar. For example, if the relative ranking of yield for Lewjain and Hill 81 was #1 and #2 at Pullman, then you can expect the same relative ranking at Uniontown.

Private breeding companies can enter their varieties into the uniform testing program on a 'fee for entry' basis. If the private company chooses not to enter their varieties, they will not be tested. After two years the data from this uniform testing program will be incorporated into the WSCIA-CSBG. Varieties which have not been entered in the uniform testing program will not have yield performance data listed in the WSCIA-CSBG.

There is concern among growers that testing sites are being lost in their locale. However, the improved quality of the results as a result of management changes and an increased number of varieties will more than compensate for this loss in the long run. With the support of the industry advisory committee, the Wheat and Barley Commissions, WSCIA, WSU College of Agriculture and Home Economics, and the numerous growers who are cooperators, this uniform variety testing program is undergoing numerous significant changes. These changes will tremendously improve the information provided to growers for making their variety selections.

We at WSU would like to express our sincere and deep appreciation to those farmers who have cooperated with WSU over the last several decades in the variety testing program, particularly those farmers who we won't have the opportunity to continue working with.

Table 1. Cropping zones and site characteristics of winter uniform cereal variety evaluation trials.

<u>Winter Crop - Pea/Lentil Annual Crop:</u>

Location:	Rainfall:
Farmington (E)*	24" - cool
Fairfield (E)	22" - cool
Pullman (B)**	20"

<u>Winter Crop - Fallow, on Deeper Soils:</u>

<u>Intermediate Rainfall</u>

Location:	Rainfall:
Walla Walla (B)	17-18"
Mayview (E)	18"
Coulee Height (E)	18" - cool
Dayton (E)	16-17"
St. John (E)	16-18"

<u>Low Rainfall</u>

Location:	Rainfall:
Wilbur (E)	15" - cool
Dusty (E)	15"
Lamont (E)	12-14"
Pomeroy (B)	15"
Ritzville (B)	14-15"
Harrington (B)	12-14"
Connell (B)	10-11"

<u>Winter Crop - Fallow, on Shallow Soils:</u>

Location:	Rainfall:
Asotin (E)	13-14"
Coulee City (B)	12-14" - snow mold area
Waterville (B)	12-14" - snow mold area
Bickleton (E)	10-12"
Lind (B)	9-10"

<u>Winter Crop Under Full Irrigation:</u>

<u>Location:</u>
Moses Lake (E)
Cunningham (B)

* (E) Extension uniform cereal testing trials, totalling to 12 sites.
** (B) Complementary WSU plant breeder's trials, totalling to 10 sites.

<u>Sites eliminated and sites which show similar relative variety performance:</u>

Sites Eliminated	Sites With Similar Performance
Reardon (16-17", Crop-Fallow) ----------	Wilbur/Creston
Uniontown (18", Annual Crop) -----------	Farmington or Pullman
Clyde (10-12", Crop-Fallow) ------------	Dayton
Goldendale -----------------------------	Bickleton

Table 2. Cropping zones and site characteristics of spring uniform cereal variety evaluation trials.

All Sites are Spring Recrop:

Annual Crop - High Rainfall:

Location:	Rainfall:
Farmington (E)*	24" - cool
Fairfield (E)	22" - cool
Pullman (B)**	20"

Flex-Cropping - Intermediate Rainfall:

Location:	Rainfall:
Walla Walla (B)	17-18"
Mayview (B)	18"
Coulee Height (E)	18" - cool
Dayton (E)	16-17"
St. John (E)	16-18"

Flex-Cropping - Low Rainfall:

Location:	Rainfall:
Dusty (E)	15"
Lamont (E)	12-14"
Harrington (B)	12-14"
Connell (B)	10-11"
Bickleton (E)	10-12"
Lind (B)	9-10"

Full Irrigation:

Location:
Moses Lake (E)
Royal Slope (B)

* (E) Extension uniform cereal testing trials, totalling to 9 sites.
** (B) Complementary WSU plant breeder's trials, totalling to 7 sites.

Sites eliminated and sites which show similar relative variety performance:

Sites Eliminated	Sites With Similar Performance
Uniontown ------------->	Farmington or Pullman
Asotin----------------->	Farmington
Mayview --------------->	Mayview Plant Breeders
Goldendale ------------>	Bickleton

SOFT WHITE WINTER WHEAT IMPROVEMENT

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The 1988/89 wheat crop was subjected to many adversities. The winter was very cold especially during the first part of February and approximately 50% of the winter wheat in Washington was killed. We lost winter wheat nurseries at Ralston, Cunningham and Ritzville. Dwarf bunt was prevalent in some regions and may have reduced yields. Cool weather and above normal precipitation in August caused severe sprouting of the grain in the spike.

We have received permission to release WA007431 and WA007529 however, foundation seed will not be available until the fall of 1991.

WA007431 is a semidwarf soft white winter wheat that is resistant to snow mold and common bunt. It is moderately resistant to dwarf bunt and stripe rust. WA007431 is susceptible to leaf and stem rust. It was one of the best lines in the 1988/89 nursery for resistance to winter damage. WA007431 has exceeded the grain production of Sprague and John in the Coulee City nursery over the past five years. WA007431 is later in maturity than Sprague and John.

WA007529 is a high yielding semidwarf soft white winter wheat that is resistant to the local races of stripe rust, and common bunt. It is susceptible to leaf and stem rust. WA007529 has the same winter hardiness as Daws and will emerge better than Daws. When the grain production of WA007529 is averaged across all Washington nurseries it has exceeded the yields of Daws, Stephens, Lewjain, and Madsen. Bushel weight of WA007529 averaged 59.3 over 12 site/years of testing. Daws, Lewjain, Stephens, and Madsen had a bushel weight of 60.7, 60.5, 58.6, and 60.9 respectively over these same tests.

We received permission to increase breeders seed of WA007661 and WA007662, in 1990/91. They both have established excellent grain production records. WA007661 is a semidwarf club and WA007662 is a soft white common winter wheat.

Nurseries.

The WSU soft white winter wheat nurseries were grown at Pullman (early and late), Pomeroy, Walla Walla, and Coulee City in Washington, and at Cavendish, Idaho during 1988/89. Dusty (97.9 bu/a) was the best commercial cultivar when the grain yields were averaged across all locations (except Coulee City) and Daws (94.4 bu/a) was second. Tres (92.9 bu/a) was the best commercial club wheat.

The Pullman Early (table 1) nursery was sown September 6, 1988. One half of each plot was inoculated with Cercosporella foot rot fungus in the fall and the other half was sprayed with a fungicide early in the spring to control the disease. There was a very low incidence of Strawbreaker foot rot and grain yields were not reduced. Dusty (110 bu/a) was the highest yielding commercial cultivar in the inoculated plots and Syringa (122 bu/a) was the best in the control plots in 1988/89. Syringa is a private cultivar and it was developed and released by Plant breeders 1 in Moscow, Idaho. When the yields were averaged over both treatments for the past 6 years Madsen (78 bu/a) produced the most grain and Hyak (73 bu/a) was the best club. WA007529 averaged 82.5 bushels per acre over the last 6 years.

The Pullman Late nursery (table 2) was sown October 2, 1988. The entire nursery was fertilized before planting (60# nitrogen/a) and then one half of each plot received an additional 60# in the spring. Malcolm (116 bu/a) produced the most grain of the commercial cultivars under medium fertility and Syringa (118 bu/a) produced the most under high fertility. When the yields were averaged over both treatments for the past 6 years Madsen and Dusty (90 bu/a) produced the most grain. WA007529 averaged 91.2 bushels per acre over the last 6 years.

The Pomeroy nursery (table 3) was sown September 19, 1988. In 1988/89 Hill 81 (71 bu/a) was the highest yielding commercial cultivar and Tres (70.2) was the best club. When the yields were averaged over the past 6 years Lewjain and Crew (61 bu/a) were the highest yielding commercial cultivars. WA007529 averaged 67.7 bushels per acre over the last 6 years.

The Walla Walla nursery (table 4) was sown October 14, 1988. Malcolm (114 bu/a) was the highest yielding commercial cultivar in 1986/88 and Tres (101 bu/a) was the best club. When the yields were averaged over the past 6 years Dusty (92.3 bu/a) was the highest yielding commercial cultivar and Hyak (90.5 bu/a) was the best club wheat.

The Ritzville nursery (table 5) was not harvested in 1989. When the yields were averaged over the past 5 years (84-88) Lewjain (57.6 bu/a) was the highest yielding commercial cultivar and Tres (56.8 bu/a) was the best club wheat. WA007529 averaged 59.0 bushels per acre over the last 5 years.

The irrigated nursery at Cunningham (table 6) was not harvested in 1989. When the yields were averaged over the past 5 years (84-88) Malcolm (110.8 bu/a) was the highest yielding commercial cultivar and Tres (95.6 bu/a) was the best club wheat.

The Coulee City nursery (table 7) was sown August 28, 1988. Daws and Madsen (45 bu/a) were the highest yielding commercial cultivars in 1988/89 and Hyak (39 bu/a) was the best commercial club wheat. When the yields were averaged over the past 6 years Lewjain (43.8 bu/a) was the highest yielding commercial cultivar and Tres (43.2 bu/a) was the best commercial club wheat. WA007431 averaged 48.8 bushels per acre over the last 6 years.

The Cavendish, Idaho nursery (table 8) was sown October 18, 1988. Dusty (75 bu/a) was the highest yielding commercial cultivar in 1987/88 and Tres (72 bu/a) was the best club. When the yields were averaged over the past 6 years Tres (58.2 bu/a) was the highest yielding commercial cultivar.

Table 1. Yield data (bu/a) on soft white winter wheats grown at Pullman (early) for the past six years.

	83/84	84/85	85/86	86/87	87/88	88/89	Avg.
Stephens	22	51	75	64	55	99	61.0
Daws	52	69	91	43	75	109	73.2
Dusty	50	65	78	50	65	111	69.8
Lewjain	64	67	84	55	71	107	74.7
Hill81	56	67	84	56	75	105	73.8
Malcolm	21	56	75	55	54	89	58.3
Madsen	51	78	83	72	80	102	77.7
Crew	52	76	75	38	66	94	66.8
Tres	50	71	75	50	58	101	67.5
Hyak	50	76	88	70	83	88	73.4
WA007529	55	73	105	71	83	108	82.5
WA007431	72	71	82	45	64	107	73.5

Table 2. Yield data (bu/a) on soft white winter wheats grown at Pullman (Late) for the past six years.

	83/84	84/85	85/86	86/87	87/88	88/89	Avg.
Stephens	82	49	65	97	71	98	77.0
Daws	83	52	60	100	66	100	76.8
Dusty	93	60	85	103	84	112	89.5
Lewjain	78	54	88	98	81	108	84.5
Hill81	85	56	72	111	78	104	84.3
Malcolm	73	53	74	110	91	114	85.8
Madsen	95	66	85	98	84	109	89.5
Crew	89	52	76	86	61	100	77.3
Tres	84	59	71	96	81	102	82.2
Hyak	100	57	72	93	81	105	84.7
WA007529	87	60	94	104	90	112	91.2
WA007431	86	68	79	99	84	119	89.2

Table 3. Yield data (bu/a) on soft white winter wheats grown at Pomeroy for the past six years.

	83/84	84/85	85/86	86/87	87/88	88/89	Avg.
Stephens	38	36	69	69	52	61	54.2
Daws	67	40	73	61	51	66	59.7
Dusty	66	45	77	63	44	67	60.3
Lewjain	69	41	72	67	54	64	61.2
Hill81	73	38	64	67	49	71	60.3
Malcolm	65	46	65	68	54	66	60.7
Madsen	73	45	70	60	52	63	60.5
Crew	73	38	70	67	50	69	61.2
Tres	55	42	75	68	47	70	59.5
Hyak	76	43	60	63	47	66	59.2
WA007529	93	48	75	65	51	74	67.7
WA007431	80	48	61	50	57	68	59.2

Table 4. Yield data (bu/a) on soft white winter wheats grown at Walla Walla for the past six years.

	83/84	84/85	85/86	86/87	87/88	88/89	Avg.
Stephens	131	58	86	93	62	91	86.8
Daws	120	59	84	87	68	104	87.0
Dusty	137	76	92	89	64	96	92.3
Lewjain	123	68	85	87	65	86	85.7
Hill81	120	66	85	93	67	99	88.3
Malcolm	109	64	96	102	67	114	92.0
Madsen	128	65	90	86	69	100	89.7
Crew	113	59	92	89	61	89	83.8
Tres	118	64	94	84	63	101	87.3
Hyak	140	66	88	89	65	95	90.5
WA007529	132	70	88	95	66	98	91.5
WA007431	134	71	81	95	71	109	93.5

Table 5. Yield data (bu/a) on soft white winter wheats grown at Ritzville for the past five years.

	83/84	84/85	85/86	86/87	87/88	Avg.
Stephens	29	36	42	52	37	39.2
Daws	81	38	55	55	49	55.6
Dusty	60	47	49	58	48	52.4
Lewjain	78	46	54	57	53	57.6
Hill81	63	40	44	55	43	49.0
Malcolm	49	40	39	61	39	45.6
Madsen	68	41	51	55	51	53.2
Crew	74	43	51	57	48	54.6
Tres	71	49	54	66	44	56.8
Hyak	74	46	51	49	53	54.6
WA007529	77	51	59	55	53	59.0
WA007431	78	52	51	46	50	55.4

Table 6. Yield data (bu/a) on soft white winter wheats grown at Cunningham for the past five years.

	83/84	84/85	85/86	86/87	87/88	Avg.
Stephens	82	96	105	112	89	96.8
Daws	120	100	122	100	90	106.4
Dusty	85	120	110	80	100	99.0
Lewjain	121	116	113	59	100	101.8
Hill81	103	92	118	102	88	100.6
Malcolm	93	121	123	116	101	110.8
Madsen	109	111	95	93	93	100.2
Crew	89	106	122	67	89	94.6
Tres	82	112	121	68	92	95.0
Hyak	85	113	113	78	81	94.0
WA007529	106	119	117	58	89	97.8
WA007431	108	112	107	61	91	95.8

Table 7. Yield data (bu/a) on soft white winter wheats grown at Coulee City for the past six years.

	83/84	84/85	85/86	86/87	87/88	88/89	Avg.
Stephens	47	29	39	29	55	36	39.2
Daws	42	40	46	36	49	45	43.0
Dusty	57	35	39	39	52	38	43.3
Lewjain	67	31	41	32	48	44	43.8
Hill81	50	34	33	33	43	39	38.7
Malcolm	47	27	47	26	53	44	40.7
Madsen		29	37	32	40	45	36.6
Crew	64	34	35	32	53	34	42.0
Tres	60	40	42	35	45	37	43.2
Hyak		30	42	29	51	39	38.2
WA007529	59	44	42	39	61	44	48.2
WA007431	60	45	45	31	64	48	48.8
John	44	38	37	34	44	35	38.7
Sprague	36	38	44	40	50	37	40.8
Andrews	50	36	34	31	45	36	38.7
Weston	38	36	31	33	46	40	37.3

Table 8. Yield data (bu/a) on soft white winter wheats grown at Cavendish for the past six years.

	83/84	84/85	85/86	86/87	87/88	88/89	Avg.
Stephens	45	49	42	45	45	61	47.8
Daws	43	44	48	46	56	73	47.4
Dusty	46	64	50	44	57	75	56.0
Lewjain	43	55	50	55	64	71	56.3
Hill81	45	52	47	53	57	49	50.5
Malcolm	40	57	38	56	70	50	51.8
Madsen	46	57	40	44	61	70	53.0
Crew	51	56	47	43	37	58	48.7
Tres	43	66	46	54	68	72	58.2
Hyak	56	55	41	38	64	71	54.2
WA007529	50	59	35	53	67	84	58.0
WA007431	42	58	50	54	61	81	57.7

The above data does not take into consideration if the yields are actually different based on statistical significance.

PROGRESS IN WINTER WHEAT GENETICS

R.E. Allan, E. Haro, L.M. Little, J.A. Pritchett and D.E. Roberts

Development of Special Genetic Stocks and Germplasm Lines of Wheat.

The current primary mission of our USDA-ARS unit is to develop special genetic stocks and germplasm lines. Main objectives include the development of: a) Isogenic lines for important morpho-physiological traits. b) Varieties with diverse cytoplasms called alloplasmic lines. c) Lines and populations with unique and/or stable resistance to diseases. d) Stocks that facilitate improved breeding procedures.

Developing Isogenic Lines.

Our program aimed toward developing spring vs winter isolines for each of three *Vrn* genes in 12 historically important Pacific Northwest Wheat varieties has reached the third backcross stage. Seed was bulk harvested from both fall and spring sowings of the BC2-F_2 populations. The spring derived populations were sown in May. Selection of club wheats (Tres, Barbee, Tyee, and Omar) with spring growth habit will be accomplished during the 1990 summer.

Over 8000 F_3 head rows were classified for heading date in the program for transferring photoperiod response *(Ppd)* genes from Extra Early Blackhull, Suweon 185 and Chugoku 81 into six Pacific Northwest winter wheat varieties. Head selections were made among lines within each population to recover lines homozygous for the various photoperiod response genotypes. These head rows were sown last fall and will be used to make the final backcross. Along with genes which control plant stature *(Rht)* and vernalization *(Vrn)*, the *Ppd* genes facilitate adaptation of wheat to unique environments such as no-till, double-cropping and drought.

Intercrossing among the *Rht, Vrn, and Ppd* isolines continues. The goal is to combine these different genes in all combinations and generate isolines representing each of the possible genotypes. Genetic stocks of this type would greatly facilitate identifying the exact combinations of *Rht, Vrn, and Ppd* genes best suited for the various agricultural environments of Washington.

Transfer of Rht_8 and Rht_9 into several adapted northwestern USA wheats has reached the third backcross stage. These genes impart high yield potential but do not adversely affect emergence.

Developing Alloplasmic Lines.

Yield trials at Pullman and Walla Walla measured differences between reciprocal crosses involving alien cytoplasms derived from six species of *Aegilops, Haynaldia villosa, T. macha and T. turgidum.* Most of the sources appeared to have a neutral effect on yield. The cytoplasm of *H. villosa* and *T. macha* generally enhanced yield 1 to 9%. The cytoplasm of *Ae. uniaristata* and *Ae. cylindrica* enhanced yields in some wheat genetic backgrounds while reducing it in others.

The third backcross was made to several locally adapted wheats transferring their nuclear genetic material into *Aegilops ovata* cytoplasmic background. Japanese wheat scientists report that *Ae. ovata* cytoplasm imparts unique cold tolerance in combination with nuclear genes of hexaploid wheat. Preliminary 1989 results indicated lines with *Ae. ovata* cytoplasm had 93% mean stand compared to 65, 85, 95, and 42% for Stephens, Nugaines, Daws, and Marfed, respectively.

Developing Male Sterile Stocks.

The last backcross was made to complete the transfer of a single dominant male sterile gene to several of our SWW adapted wheat varieties. A final backcross will be made to transfer a recessive male sterile gene to the same varieties.

Enhanced Resistance to Sprouting.

Lines have been identified from a cross of Brevor to Clark's Cream that have superior grain dormancy to either of these white wheat sources of dormancy. These lines will be used as parents to transfer high sprouting resistance to adapted semidwarf SWW wheats.

Coldhardiness.

Presence or absence of the gene for vernalization requirement may have affected cold tolerance of near isogenic lines of SU185/4*Marfed. Isolines with the *vrn* allele for winter growth habit had 39% survival versus 24% survival for those with the *Vrn* allele for spring growth habit. No cold injury occurred in the Walla Walla test. In this test presence or absence of the gene for vernalization requirement did not affect heading date, plant height, nor grain yield.

Foliar Disease Resistance.

We tested 235 advanced lines to the stripe rust race that attacks the Tres and Moro genes and found that 42, 30 and 28% of the lines were resistant, segregating and susceptible as seedlings to this race. Varieties with seedling resistance included Stephens, Hill 81, Dusty, Madsen, Paha, Hyak, Tyee, Faro sib, and OR855. Those susceptible include Tres, Moro, Nugaines, Lewjain, Luke, Faro, and Barbee. Crew, WA7527, WA7526, and Daws are heterogeneous for resistance and susceptibility.

Three of six club wheat lines that appear to have adult plant stripe rust resistance derived from French wheat germplasm also proved to have high yield potential across three trials. These lines were used extensively as parents in 1989.

Sources of stripe rust resistance that we have yet to exploit in our club wheats include: *T. dicoccoides*, *T. spelta*, and *Agropyron elongatum*. Several lines deriving their resistance from these sources were placed in preliminary yield trials. A few of the BC3 alloplasmic lines involving Tyee, Nugaines and Luke expressed unexpectedly high resistance to stripe rust. These lines will be used as parents. They may be a form of cytoplasmic resistance.

Strawbreaker Foot Rot Resistance.

We have 83 advanced lines and 180 early generation lines in our 1990 strawbreaker foot rot field evaluation tests. The level of foot rot is such that we should get excellent data from these tests. To compliment our field tests, we have screened 133 of these lines for presence of the endopeptidase marker gene that is known to be tightly linked to the strawbreaker foot rot resistance gene derived from *Aegilops ventricosa*. We found that 44% of lines are homogeneous for its presence, 39% are homogeneous for its absence, and 17% are heterogeneous for the isozyme. This biochemical marker predicts which lines are most likely to have foot rot resistance. The field strawbreaker tests should tell us which lines give maximum expression of the gene for preventing yield losses caused by strawbreaker.

A genetic study of the cross between Cerco and VPM/Moisson 951 revealed that these two sources of resistance to strawbreaker foot rot are genetically different. A few of the lines of this cross showed higher resistance to the fungus than either parent and represent valuable parental material. The VPM type of resistance that is in Madsen and Hyak has sustained significant damage in 2 out of 9 trials. Hence a higher level of resistance should help prevent losses when strawbreaker is very severe.

Promising Advanced Lines.

WA7527 has been tentatively approved for release and breeders' seed is on increase at Othello. WA7527 is a semidwarf club multiline made up of 10 components. All of the components have Tres in their pedigree. Several of the components are susceptible to the Tres race in the seedling stage. Our results indicate that 40% of WA7527 seedlings express susceptibility to the Tres race. Whether to release WA7527 will depend on the degree of adult plant resistance that WA7527 expresses to the Tres race. Field plots of WA7527 and its components have been inoculated with the Tres race at Pullman.

WA7526 was approved for preliminary increase. It is a semidwarf club multiline bulk made up of 70 lines each of 7 populations. Similar to WA7527, Tres is a parent in each cross. WA7526 may be released instead of WA7527 if it proves to have better resistance to stripe rust. Our seedling tests suggest that WA7526 has a higher proportion of seedlings resistant to the Tres race than WA7527. We have both lines growing in paired plots at Spillman Farm so we should be able to determine whether they differ for their adult resistance to stripe rust.

WA7621 and WA7622 were high yielding club wheats in the 1988 and 1989 regional trials. Both lines have combined resistances to stripe rust, leaf rust, stem rust, and strawbreaker foot rot. WA7621 also has resistance to powdery mildew. Both appear to meet the exacting quality requirements of club wheat.

DEVELOPMENT OF HARD WHITE WINTER WHEATS FOR WASHINGTON

C.J. Peterson, Jr., R.E. Allan, E. Donaldson, C.F. Morris, B.C. Miller, D.F. Moser, and V. DeMacon.

Two hard white winter wheat nurseries were planted in 1988. They were sown at Ralston, and Pullman. The wheats in the Ralston nursery were killed by the cold weather during February. One nursery was sown in 1989 at Pullman. The milling and baking characteristics of the lines were evaluated by the Western Wheat Quality Laboratory. A few of the lines had fair to good quality. The grain production of the some of the potential hard white lines (Table 1) were quite competitive with the adapted cultivars. The lines originated from the programs of Dr. Allan (REA), Dr. Donaldson (N), Kansas (KS), and Dr. Peterson (VH).

Table 1. Yield and protein data on 11 wheats grown in the Hard White Winter Wheat Nursery at Pullman and Lind in 1987/88 and 1988/89.

ID. NO.	PULLMAN		LIND	Pullman	Lind	Quality
	Bu/a			% Protein		
	87/88	88/89	87/88	87/88	87/88	
STEPHENS	81.9	62.0		11.8		
N8705702	69.7	68.4	26.4	12.3	12.8	Good
N8708902	79.4	71.2	25.7	12.4	13.0	Poor
REA87446	72.4	66.6	24.8	11.6	11.9	Good
REA87792	70.1	45.0	29.5	11.6	14.5	Good
REA87802	58.7	48.0		11.5		Good
VH084463	72.0	70.9	21.7	10.8	13.2	Fair
KS84W196	42.3	40.4	14.8			Fair
BLADE **	60.7	19.4	14.9			Fair
SPEAR **	60.0	14.2	12.6			Good
DAGGER**	42.4	28.5	13.4			Good

** AUSTRALIA

Tissue Culture

Most of the time was spent by the technician in learning procedures. The first material tested consisted of eight F1's from Ed Donaldson's program (table 2). All eight F1's produced at least one green plantlet. Four different media/temperature treatments were tested with green plantlet production ranging from 0 to 10.7% depending on the genotype and treatment used. The resulting plants will be maturing in mid November and then increased in the greenhouse. Colhicine treatment of the plants was used to double the chromosomes and was not very effective.

Eleven F1's from our program and Lewjain, Madsen and WA007627 produced very few green plants. More effective media, and culture conditions now being used should result in the development of a higher percent of green plants.

used should result in the development of a higher percent of green plants. Five different media and higher incubation temperatures are currently being tested.

Future testing will include material from Dr. Allan's program that differs in cytoplasm and lines containing ID745318 which has been shown to give a high percent of green plants. Hard white F1's will be included in the anther culture program beginning in January. Three of our lines produced in Dr. Zemetra's anther culture program are currently being increased in the greenhouse.

Table 2. Development of homozygous plants from F1's through anther culture. F1's from the Lind program.

ID. No.	No. Green Plants	Average Green Plantlets Produced (%)*
ND89029	9	1.3
ND89030	1	0.15
ND89031	31	10.7
ND89032	41	3.1
ND89033	9	0.9
ND89034	26	1.6
ND89035	3	0.2
ND89036	10	1.0

$$\text{* Green Plantlet Yield} = \frac{\text{No. Green Plantlets}}{\text{No. Anthers cultured}} * 100$$

HARD RED WINTER WHEAT BREEDING AND TESTING

E. Donaldson, M. Nagamitsu and Bruce Sauer

The hard red winter wheat breeding and testing program in Washington is partially funded by the Washington Wheat Commission and is conducted from the Dry Land Research Unit at Lind. The primary objective is to provide Washington hard red winter wheat producers with good quality, consistently high yielding, disease resistant varieties through varietal development and testing of advanced selections and varieties developed elsewhere. The Great Plains yield nurseries, which include selections from Texas to Canada, from public and private breeders are grown at Lind. The western Regional Hard Red Winter Wheat nursery, which includes selections from the western region, including Oregon, Idaho, Utah, Montana, and Washington is grown at five locations in Washington. In varietal development, emphasis is placed on the agronomic characteristics of emergence, lodging resistance and yield performance. The most emphasis in disease resistance is currently being placed on strawbreaker foot rot, stripe rust, leaf rust, dwarf bunt, and snowmold. In breeding for bread baking quality, the challenge is to combine high protein with high flour yield and large loaf volume.

In the hard red winter wheat growing region of Washington the need for adequate straw to aid in the prevention of erosion varies from a demand for more straw than the present varieties to a desire to have less straw to reduce the need for extra tillage. Strong emerging varieties are a necessity throughout the area. In an attempt to provide shorter wheats with good emergence, two semidwarfing genes with long coleoptiles are being used in the breeding program. Selections containing the gene from an Omar mutant with exceptionally long coleoptiles and very good straw strength have failed to emerge better than the conventional semidwarf varieties. Crosses are now being made with selections with excellent emergence. The gene from Chinese wheats has not yet been tested in adapted backgrounds.

Of the advanced generation nurseries containing released varieties, only Waterville and the Hard Red Nursery at Harrington were harvested in 1989. The Waterville nursery had extensive grasshopper damage. The yields were below expectations, with the later selections sustaining the greatest damage. Yields were between 19 and 23 bu/a for the released varieties. Due to winterkill, only three replications of the nursery at Harrington were harvested. The yields were 39, 39, 44, 37, 33, and 19 bu/a for Hatton, Weston, Blizzard, Buchanan, Andrews, and Batum, respectively. Lewjain yielded 40 bu/a. Test weights were good and whole grain protein on an as-is moisture basis was 11% to 13%.

The seed zone moisture in the fall of 1988 was deep and varied from poor at Lind and Connell to fair at Harrington. Field variation in seed zone moisture was considerable at Lind and excessive at Connell. All plantings had about six inches of soil cover over the seed. Lind received 0.8 inches of rain between seeding and emergence. The resulting stands, along with the survival from the 1989 February storm, are given in Table 1.

Table 1. 1989 percent stand, percent survival, and percent final stand for six hard red winter wheat varieties and two hard white winter wheat cultivars.

	% Stand				% Survival				
	LD	CO	HA	Av	HA	CO	LI	Av	% Final Stand
Hard Red									
Buchanan	72	74	75	74	65	48	33	49	36
Blizzard	44	67	78	63	78	68	30	59	37
Weston	33	69	78	60	60	45	10	38	23
Hatton	23	78	73	58	65	80	33	59	34
Batum	14	6	53	24	33	1	6	13	3
Andrews	12	70	75	55	65	30	20	39	21
Hard White									
WA7650	43	74	80	66	75	47	15	46	30
WA7670	48	78	85	70	90	81	75	82	57

LD, CO, HA, LI are Lind Dry, Connell, Harrington, and Lind Irrigated, respectively.

Table 2 gives the yield, test weight and percent protein for the winter wheats that were planted on March 21 and March 31, 1989 at Lind. None of the winter wheats performed satisfactorily. In 1989 winter wheats should not have been used for reseeding into winterkilled fields since March 21 was as soon as spring planting could be done at Lind. That 1989 results are not necessarily typical is seen by comparison to the results for 1973, 1974 and 1975 as presented in Table 3. The cultivars tested were not the same.

Table 2. 1989 Spring Planted Winter Wheat

	March 21			March 31		
	Yield Bu/A	Test Wt	% Protein	Yield Bu/A	Test Wt	% Protein
Soft White						
Daws	7	51	19			
Stephens	4	48	21			
Madsen	1					
Crew	1					
Moro	2					
Tres	2					
Hyak	3					
Lewjain						
Hill 81						
Dusty						
Penawawa*	15	58	16	17	58	16
Hard Red						
Hatton	10	57	18	3		
Weston	13	57	18	6	56	18
Blizzard	11	55	19	2	57	19
Batum	--	--	--	--	--	--
Andrews	5	57	20			
Wanser	10	50	18	4		
Buchanan	--	--	--	--	--	--
Spillman*	20	58	18	16	57	18

*Spring wheat checks

Table 3. Yield in Bu/A For Winter Wheats Planted in the Spring.

	1973		1974		1975		
	Feb 27	Mar 16	Feb 27	Mar 18	Mar 11	Mar 27	Apr 8
Hard Red							
McCall	10	15	31	22	23	18	18
Wanser	10	14	25	23	22	20	18
Average	10	15	28	22	23	19	18
Spring Check							
Fortuna	9	11	16	14	12	8	13
Wared	9	11	21	16	23	24	24
Average	9	11	19	15	17	16	19
Soft White							
Moro	11	8	30	17	19	19	8
Paha	11	8	21	14	18	18	8
Nugaines	10	13	27	25	24	22	10
Luke	7	1			19	13	1
Average	10	7	26	19	20	18	7
Spring Check							
Marfed	10	14	28	29	28	29	26
Twin	12	15	38	21	28	26	27
Urquie	11	14	33	29	30	24	26
Average	11	14	33	27	29	26	26

SPRING WHEAT RESEARCH

C. F. Konzak, M. A. Davis, Mark Welter

General

WSU's spring wheat breeding activity is centered at Pullman to gain greater efficiency. Extensive evaluation and screening trials are conducted also in the low rainfall area at the Dry Land Research Unit near Lind, and under irrigation at the Royal Slope experimental farm near Othello. Smaller scale research test plots are conducted via grower cooperation on the Dale Bauermeister farm near Connell (dryland summer fallow), at the Kramer ranch near Harrington (dryland recrop), near Pullman at the Don Quist Ranch (dryland recrop), at the Bill Schwerin Farm near Walla Walla (dryland recrop), and at the Mehlke Farm near Davenport (recrop trial). Extension-related trials at numerous locations further supplement the research tests. In 1990, however, WSU's former commercial variety spring wheat trial has been adapted to conform to a reorganized WSU Cooperative Extension research Uniform Variety testing program with collaboration from Washington State Crop Improvement. The change has been initiated as a result of grower requests to be provided information on variety performance via comparative trials. The WSU spring wheat research program is cooperating in this study, providing data from up to eight test sites for the Uniform spring wheat tests. Because of the late development of this change a few varieties were not included in some early planted WSU tests (Connell), but were entered in all others. A more complete description of the Uniform tests is presented by Baird Miller earlier in this issue.

Uniform yield trials of hundreds of new lines are grown at the three main stations each year. The uniform yield trials include Washington State soft white and hard red spring wheat nurseries of up to 60 varieties each, which also are grown at many of the off-station sites, and a varying number of advanced and preliminary replicated trials of both wheat types. Since 1986 several off-station trials were placed on dryland recrop sites in order to evaluate the entries for drought tolerance and Fusarium root rot resistance. Nonreplicated seed increase plots, especially of soft white wheats, are usually grown at the Royal Slope farm, as are seed increase lots of advanced materials being prepared for entry into Western Regional trials. A number of special trials are grown only at Pullman. These include the Western Regional Spring Wheat Nursery and the Uniform Regional Hard Red Spring Wheat Nursery (Quist ranch). This group of nurseries, plus crossing blocks with many introduced accessions, supplement the base of germplasm available for cross-breeding.

New Varieties

Descriptions of Edwall, Penawawa, Wakanz and Wadual are presented elsewhere in this issue.

New Releases:

Spillman (WA7075) - Although released in 1989, only a small amount of foundation seed and breeder seed were produced in 1989. A modest amount of registered seed should be available for 1991 spring planting. Spillman has a yield record comparable to Wampum and McKay, but a slightly higher grain protein potential. Grain test weight tends to be about 1/2 lb/bu lower.

Each subline to be included in the subsequent breeder stock will have been tested for resistance. In the case of Wadual, lines included as part of the original release showed some differences for quality parameters. Consequently new evaluations are focused on a small number of lines, possibly even one which may prove superior. Use as an improved breeder stock or a separate release as Wadual 91 will be considered in early 1990.

New lines - HRS line WA7668 appears to show exceptional yield potential. Lines are being selected in hope of identifying one with equal yield potential but higher protein content. The line is being used also as a parent to produce higher protein lines from crosses with Butte 86 and WPB906R via anther culture.

WA7497 appears to be superior in quality and yield compared with WA7496. Reselections are in process for a possible breeder seed increase in 1991. WA7497 has good disease resistance, but is susceptible to the hessian fly.

Advances in Ongoing Research

Line evaluations: New adjustments have been made in the regional testing program in an effort to improve cost-efficiency relationships in line evaluations. Consequently, an effort has been made to place research test plots in more representative soil climatic areas and under typical production conditions.

Remote sensing of field plots: In an effort to improve the accuracy with which we can compare wheats for yield performance in field trials we have initiated new studies which we expect will lead to the development of new methods for adjusting observed yield data to account for soil related variability. The research initiated involves aerial photography of plots taken several times a season, and analysis of a greater number of soil samples, sampling at harvest across areas of noted variability, and computer analyses of remotely sensed data for comparison with collected yield data. We expect to be able to describe the composition of yield trials, obtain a better understanding of soil variability and its relation to measured yields, to determine if some part of the photographic data could be useful for improving the descriminating ability of the measured yield data, and especially see if any of the factors measured in photographs can provide better "ground truth" to the variety performance estimates. Because the research may have sufficient potential for wider-scale applications we have submitted proposals to NASA and to the Pioneer Foundation for separate funding of the research being conducted as part of the graduate study of Mr. Shane Ball. Plans now include photographic coverage of the WSU plot research areas at Pullman, Lind and Royal Slope, as well as of a number of test sites provided by growers. We anticipate that remotely sensed data taken a year earlier of potential grower contributed test sites could facilitate the placement of plots to improve the uniformity of the test area, thus reducing the potential for error.

The research has already stimulated two other WSU agronomy researchers to use aerial photography in their studies. The graduate study should result in a new technology able to improve the experience of variety evaluations, and may permit the earlier identification of high performers and improve the level of confidence with which researchers can eliminate likely lower performers. If similar research can be conducted for several years it should also be possible to identify the basis for the year and interaction components while reducing the influence of soil variability.

Because the year effect is so large it will be especially interesting if some parameters can be identified which are prime determinants in the differential yield response of varieties. Results of this research may also be applicable to grower situations as it may be applicable as a means to estimate crop yields prior to harvest. Soil variability identified by aerial photographs could be useful to growers for improving their management efforts to increase crop yields and reduce costs.

Russian wheat aphid resistance: Sources of resistance/tolerance to the russian wheat aphid were obtained and used in crosses with several WSU wheats. One of the best is a semi-winter hard white wheat. Because of progress made in the anther culture program hundreds of true breeding progeny have been produced from crosses with Spillman and WA7176. So many plants are being produced from these crosses that RWA screening tests will be done this summer. Seed harvested from resistant plants will be increased in Argentina through a cooperative arrangement being developed. The cross PI29494 and PI137739/WA7176 should result in progeny carrying resistance to the hessian fly as well as russian aphid tolerance or resistance along with other desired agronomic and quality traits, all of which will have to be evaluated. However, we are producing sufficient numbers of progeny that we expect at least some desirable lines to be identifiable. Moreover, we expect to cross RWA resistant plants back to varieties like Wakanz to increase the probability that all desired traits can be recombined into individual plants.

Anther culture research: Rapid and significant progress has been made over the past year with the new Washington Wheat Commission funding of this new technology. We have developed a practical system for producing doubled haploids and have now produced several hundred new doubled haploid lines now on increase at Spillman Farm. The new lines are mostly aimed at increased protein content grain in HRS wheats, although some new SWS lines also have been produced. As indicated above regarding RWA resistance, the production of new DH (doubled haploid) lines is becoming routine, and we hope to increase the rate at which new lines are produced during the next year, expanding into newly available greenhouse space. Research on culture media and on methods to further increase the production of DH lines continues, as will studies to grow DH plants from isolated microspores (pre pollen grains). We already have indications that certain plant growth hormone concentrations/combinations can markedly increase the proportion of doubled haploid to haploid progeny, and that certain carbohydrate sources may be more effective for numbers of calli/embryoids induced on the media. With the inputs of foreign trainee graduate students (USAID/Turkey, USAID/Pakistan, and China-IAEA) we are making steady progress on the identification of factors affecting the culture response, while producing useful DH lines for the practical program. We have demonstrated conclusively that genes present in both the nucleus and cytoplasm as well as their interactions can influence culturability. Moreover, culturability factors may show dominant inheritance and in some cases heterosis or hybrid vigor occurs for culturability including the proportion of green vs. albino (chlorophyll deficient) plants produced in culture. The RWA resistance crosses coming off now show exceptional heterosis for callus and green plant production. Neither of the parents involved is as good as the hybrids for culturability. Some good parent cultivars such as WPB906R may yield no calli at all, whereas the F_1 hybrid with parents like Spilling yield a modest frequency, allowing for the recombination of desired traits in DH progeny.

We have in process also studies to produce DH spring club wheats based on crosses yet to be made of good quality club winter wheats and spring club lines developed in California. Some of the latter materials will be on display at Spillman Farm this year, and DH progeny from crosses could be on display in 1991. A spring club wheat could prove useful for reseeding in winter injured stands of club wheat for which no comparable quality spring type is yet available. By the end of 1991 we expect to have preliminary yield and quality data to make a preliminary evaluation of the extent to which DH production can complement/supplement or displace some of the traditional methods applied in wheat breeding. However, considerable effort will need to be placed on the development of screening systems applicable t the DH production system. Experience will be gained soon with RWA and hessian fly screening systems, but systems need to be developed to exploit the DH method for producing disease resistant lines.

Because soft white wheats in general have given lower yields of calli on culture we have made selections to recycle certain parental lines through the culture system. Indications are that cultivars may contain genetic variation for culturability so that reselections can have improved culturability. In addition, crosses among culturable and nonculturable wheats are being made to improve the general base of culturability of wheats in the program. The same could be done for winter wheats as information becomes available on the culturability of parents, crosses and reselections.

Because of the genetic controls and gene/cytoplasm interactions involved in culturability, we must fully evaluate the range of progeny produced by the DH method and conventional means. The most rapid/efficient conventional means for progeny production is the single seed descent method. We hope to initiate some comparative studies. However, on the basis of tests made to date we believe the genetic controls of culturability may not affect the genetic ratios of progeny because their action is manifested in the sporophyte generation, i.e. the anther donor plant and not in the pollen cells able to generate calli. We expect that studies of progeny being produced will yield information relative to this question.

Soft White Spring Wheats

Progress continues in the conventional breeding program for SWS wheats, and because of grower interest testing was renewed for development of coldhardy spring (facultative) wheats. No winter killing occurred in the 1989-90 winter, but marked differences in *Cephalosporium* stripe reaction are present.

The second cycle of lines with hessian fly resistance will be evaluated as single plots in 1990. The break in sequence is due to our inability to continue the shuttle breeding program in New Zealand due to excessive costs and greater priority given to the anther culture program. SWS lines selected continue to have improved quality properties as adequate tests become available for assessing quality. Disease resistance screening has fallen behind in the past two to three years because of inadequate disease pressure in the field. As the doubled haploid (DH) program develops, it may be possible to eliminate susceptible DH by greenhouse screening rather than wait for progeny to be produced, thus saving time and funds.

Of the SWS cultivars in production, Penawawa has now largely displaced Edwall in acreage planted (see Tables 1, 3). However, Wakanz should increase as seed supplies become adequate, in part because Penawawa is showing more stripe rust infection than expected in Mt. Vernon trials, while the rust resistance of Wakanz and Wadual appears to be greater, offering growers more protection. Virtually all of the registered Wakanz seed was planted in the Lewiston, Idaho area because of the outbreak of hessian fly in the area. Hessian fly infestation seems to have expanded further in 1990. Wakanz is proving to have an excellent SWS quality record and is among the highest yielders. Idaho's Treasure is proving an excellent cultivar to compete with Penewawa, as will Idaho's new release of Centennial (ID312). Centennial may offer some earliness over other SWS wheats available to PNW growers. WSU's WA7497 is being evaluated as a possible future release because of its higher yield and superior quality.

Hard Red Spring Wheats

The major thrust in the HRS breeding program has been to complete the introduction of hessian fly resistance genes into the WHSE HRS germ plasm pool, and more recently to increase efforts to introduce high protein genes. Our studies have identified a number of high protein, good quality parental sources which are being incorporated via single 3- and 4-parent crosses. To speed up the effort, most of the new anther cultured DH progeny are from the high protein crosses, from which over 300 DH plant lines are being grown for evaluation. The DH progeny lines will be evaluated in the field and those selected will be screened via micro quality tests before being entered into single plot or replicated trials in 1991. DH plants producing seed too late for planting in the field at Pullman in 1990 will be increased in the southern hemisphere over our winter period, a cooperative project being developed so that single or replicated plots of promising DH lines can be grown in 1991 at Pullman. The discovery in 1988 that WPB906R carries hessian fly resistance increases its value as a parent for breeding. However, as of this date progeny of 906R crosses have not been impressive and it does not respond to anther culture. Fortunately, the F_1 hybrids involving WPB906R appear to be more culturable, with the result that many progeny are now available for single row field evaluations.

In the conventional breeding program about 500 or more crosses are being made each season, and a number of good quality lines have been advanced in yield trials. One line, WA7668, mentioned earlier shows exceptional yield potential, but low protein grains. It is being used intensively as a parent to recombine this potential with high protein sources, including new stocks obtained from the North Dakota and Volcain Institute (Israel) programs. The Volcain lines include also a new source of stripe rust resistance.

HRS wheat production in Washington appears to have declined somewhat, perhaps because of the grain protein problems. The dominant cultivar in 1989 was WPB906R, which the company is attempting to replace with the similar WPB926 (see Tables 2, 3). WPB926 seems to have about the same yield and grain protein content capacity as WPB906R, but in the 1988 trial at Connell did not have as much tolerance to dryland foot rot. Wampum and McKay are slightly better yielders where yield potential is high, but they fail on grain protein. Butte 86, an early, tall North Dakota cultivar, appears to have been useful to dryland area growers and may be produced in greater amounts in 1990. Butte 86 should also provide more residue while it is also early, two traits needed on HRS wheats useful for dryland production. The major obstacle we have had to advancing grain protein content in HRS wheats has been a frequent negative effect of increasing grain protein on flour mixing strength. It is hoped that in the next year will be able to prepare electrophoresis protein patterns on our parental stocks to better understand the cause of the problem. By knowing the protein patterns it may be possible to screen out potential poor quality types based on the _______in endosperms from a single one-half seed of a DH plant. Material is already available for such studies, but to date funds, time and/or personnel have not been adequate. However, the need for means to more rapidly screen out undesirable DH lines may increase the priority for this research. Fortunately, adequate equipment for the electrophoresis is available from an earlier study, but means to read and transfer the protein pattern data to a computer may be a limitation.

New Research Fund

In order to give greater impetus to and exploit the rapid advances being made in biotechnology-related wheat research at WSU we are initiating a new research fund, the Calvin F. Kodak Wheat Breeding Biotechnology Research Fund, through the WSU Foundation. We are fortunate to have a modest gift grant from a private company interested enough in the WSU anther culture research to provide funds to initiate the fund. It is hoped that growers and others interested in the new technology developments will contribute to the fund which is charged no indirect costs and involves less administration. The Wheat Breeding Biotechnology Fund may help to solidify efforts underway to develop a wheat biotechnology research collaborative team through greater coordination possible with increased funding. Increased support is essential if WSU wheat breeding is to remain competitive and to continue a leading role in biotechnology for which faculty are now available. The objectives of the new fund are to support:

1. Research in wheat breeding technology including tissue culture, anther culture, protoplast culture, genetic transformation, etc. for the development of superior cultivars.

2. Research to advance the genetic knowledge of wheat and of sources of genes potentially valuable for introduction into wheat; research on the induction evaluation and exploitation of new useful genetic variation in wheat, by any process or means available; research on the identification and transfer of useful genes from alien sources to common wheat; research on hybridization and recombination of cereals.

Growers and others interested in the research and its meaning to their future should plan to see displays at the Lind and Pullman field days.

Table 1. Spring Wheat Characteristics

SOFT WHITE SPRING WHEATS

Name	Origin (1)	Height (2)	Maturity (3)	Awns	Quality rating (4)	Drought tolerance (5)	Dryland foot rot (5)	Stripe rust Reaction (5)	Stripe rust Type (6)	Leaf rust (5)	Stem rust (5)	Mildew (5)	Hessian fly (5)	Irrig.	Adaptation High rain	Adaptation Low rain	Recrop
Bliss	USDA-ID	SD	L	Y	S	VS	S	MR	AD	VS	R	S	S	Y	N	N	N
Dirkwin	USDA-ID	SD	EM	N	S-	MS	S	R	SP	VS	R	S	S	Y	Y	Y/N	?
Edwall	WSU	SD	M	Y	S	MS-MR	MS	R-MR	AD+SP	R-MR	R	S	S	Y	Y	Y	Y
Landmark	FL-ML	SD	M	Y	E	?	?	R	AD+SP	R	R	R	S	Y	Y	Y	?
Owens	USDA-ID	SD	M	Y	E	S-MS	S-MS	S	SP	S	R	S	S	Y	Y	?	?
Penawawa	WSU	SD	M	Y	S	MS-MR	MS	MR	AD+SP	R-MR	R	S	S	Y	Y	Y	Y
Wakanz	WSU	SD	M+	Y	S	MS-MR	MS	MR	AD+	R-MR	MR	S	R	Y	Y	Y	Y
Centennial (new)	USDA-ID	SD	M	Y	S	?	?	R	AD+SP	R	S	R	S	Y	Y	Y	Y
WS1	WS	SD	M	Y	S-	S	?	MR	AD+	MR	S	?	S	Y	Y	N	N
Waverly	WSU	SD	M	Y	S	MS	S	MR	AD	MR	MR	S	S	Y	Y	Y	Y
Treasure	USDA-ID	SD	M	Y	S	?	?	R	SP?	MR?	R	S	S	Y	Y	?	?
Klasic*	NK	SD	E	Y	E	M	?	S	SP	?	?	?	S	Y	?	Y	Y
Sprite	USDA-ID	SD	M	Y	E	S-MS	S-MS	S	SP	S	S	S	S	Y	Y	?	?
Wadual	WSU	SD	M	Y	E	M	?	MR	AD+	MR	MR	MS	S	Y	Y	Y	Y

* Hard white
** Dual bread and pastry SWS

HARD RED SPRING WHEATS

Name	Origin (1)	Height (2)	Maturity (3)	Awns	Protein	Drought tolerance (5)	Dryland foot rot (5)	Stripe rust Reaction (5)	Stripe rust Type (6)	Leaf rust (5)	Stem rust (5)	Mildew (5)	Hessian fly (5)	Irrig.	Adaptation High rain	Adaptation Low rain	Recrop
Butte 86		T	E	Y	Y	?	?	R	AD+SP?	R	R	R	S	N	N	Y	Y
Stoa		TSD	EM	Y	Y	?	?	MR	AD?	R	R	R	S	N	N	Y	Y
Ceres	FL-ML	TSD	EM	Y	Y	?	?	MR	AD+SP?	R	R	R	S	Y	Y	Y	Y
Copper	USDA-ID	SD	M	Y	?	?	?	R	AD+SP?	MS	R	MS	S	Y	Y	Y	Y
McKay	USDA-ID	SD	M	Y	?	?	?	R	AD+SP	R	R	R	S	Y	Y	Y	Y
NK751	NK	SD	EM	Y	N	?	?	R	AD+SP	R	R	R	S	Y	Y	?	?
Spillman (new)	WSU	SD	M	Y	Y	?	?	R	AD+SP	R	R	R	S	Y	Y	Y	Y
Tammy	WS	SD	M	Y	?	?	?	R	AD+SP?	R	R	R	S	Y	Y	Y	Y
Telemark	Agripro	SD	EM	Y	Y	?	?	MR	AD	?	?	?	S	?	?	Y	Y
Wampum	WSU	TSD	LM	Y	N	?	?	R	AD+SP	MS	S	MR	S	Y	Y	Y	Y
WPB906R	WPB	SD	EM	Y	Y	?	R	R	AD+SP	R	R	R	R	Y	Y	Y	Y
Yecora Rojo	Cimmyt-CA	SSD	E	Y	Y	?	?	MS	?	MS	R	R	S	Y	N	N	N
WPB926	WPB	SD	E	Y	Y	?	S	R	AD+SP	R	R	R	R	Y			

Definitions:
(1) FL-ML = First Line Seeds, Moses Lake; NK = Northrup-King; WS = World Seeds; WSI = Wheat Specialties, Inc., Bozeman, MT.
(2) SSD = short semidwarf, SD = semidwarf, TSD = tall semidwarf;
(3) E = early, EM = early to mid, M = mid-season, L = late mid-season;
(4) S = satisfactory, E = excellent;
(5) VS = very susceptible, S = susceptible, MS = moderately susceptible, MR = moderately resistant, R = resistant;
(6) AD = late/adult plant, nonspecific, SP = race specific resistance.

1989 COMMERCIAL SPRING WHEAT TRIAL #46

	Yield Data Bushels per Acre			Test Weight Data Pounds per Bushel			Protein Data Average Protein %		
	Pullman	Lind	Royal Slope	Pullman	Lind	Royal Slope	Pullman	Lind	Royal Slope
VARIETY (WHITE)									
Fielder	73.8	34.3	104.9	60.2	60.0	62.0	11.0	12.7	10.6
Dirkwin	76.8	30.9	104.5	57.5	59.2	59.1	12.5	13.1	10.7
Waverly	79.0	33.5	107.0	59.6	59.2	60.7	12.8	12.8	11.1
Landmark	80.0	30.2	99.5	60.8	60.7	62.1	12.7	13.3	11.5
Lexus	74.6	31.2	105.9	60.8	59.7	62.5	12.3	12.1	11.5
First Line Seeds:									
#22	80.9	28.6	99.9	61.4	60.3	62.6	12.1	13.6	11.6
#23	75.2	28.4	102.0	61.7	60.0	63.2	12.3	13.9	11.7
#25	74.8	30.2	100.2	61.2	59.7	62.7	12.0	13.7	11.7
#46	72.9	29.8	102.1	60.7	59.9	63.6	13.5	13.5	11.2
Cowbird S.	86.4	32.9	116.0	61.9	59.5	62.9	11.2	12.8	11.5
Edwall	79.0	30.0	105.1	58.8	57.2	59.9	11.5	12.3	10.8
Treasure	83.9	32.0	119.8	60.6	60.1	61.7	12.3	12.9	10.6
Penawawa	80.9	32.8	116.3	59.1	57.9	60.7	12.2	13.2	11.1
Wakanz	91.3	33.0	113.3	60.8	58.9	61.7	12.1	12.8	10.3
Wadual	70.9	30.8	114.8	61.2	59.1	63.4	12.5	14.5	11.7
K74129-19	76.8	32.5	108.0	57.5	59.4	59.1	11.7	13.4	10.8
Sprite	81.7	36.4	111.0	59.4	59.4	63.0	12.1	13.3	10.3
Golden 86	80.2	30.9	98.2	62.3	61.5	63.2	13.6	13.9	12.4
Klasic	82.8	30.1	105.4	61.7	62.2	63.7	12.5	14.5	13.2
Yecora Rojo	84.2	31.6	100.1	61.0	61.3	62.6	13.0	14.7	12.9
Wampum	69.8	33.0	118.2	59.4	58.4	62.5	12.6	14.2	11.5
McKay	78.4	32.1	111.8	60.7	59.2	61.7	13.3	13.8	12.0
Czar	80.1	30.9	112.0	61.1	60.0	62.7	13.0	14.3	12.0
First Line Seeds:									
#306	64.7	25.9	88.8	60.9	60.0	62.0	13.5	14.0	11.1
Nomad	83.3	32.4	110.7	61.7	60.3	63.4	14.0	14.5	12.4
Nordic	80.5	33.7	109.7	62.3	61.9	63.3	12.3	13.6	10.9

	Yield Data Bushels per Acre			Test Weight Data Pounds per Bushel			Protein Data Average Protein %		
	Pullman	Lind	Royal Slope	Pullman	Lind	Royal Slope	Pullman	Lind	Royal Slope
Butte 86	71.8	34.7	102.0	61.3	61.0	64.1	15.4	14.6	14.0
Stoa	76.0	30.7	109.9	61.8	59.6	64.0	14.9	15.4	13.8
Copper	76.3	30.9	112.5	60.4	60.1	63.2	13.9	14.4	13.0
Butte	80.7	30.1	122.4	60.5	60.4	62.7	14.2	14.6	13.3
Spillman	76.9	32.9	107.4	59.7	58.5	61.5	13.7	14.5	13.4
K76130	73.3	33.2	105.5	60.3	59.2	62.1	12.8	14.1	12.7
NDM00004	85.2	34.2	102.0	60.7	59.0	62.2	12.6	13.7	12.2
NMD00004	80.5	32.8	106.3	60.6	58.8	62.6	12.7	13.6	12.8
UT881292	79.3	33.4	127.0	58.1	57.2	60.5	12.9	14.2	12.1
K80296	83.5	32.9	128.8	60.6	58.3	61.6	12.3	14.1	11.3
Western Pl									
Breeder 906R	75.0	29.8	99.5	60.3	60.4	62.3	13.8	15.2	13.4
Westbred 926	81.8	29.7	102.8	60.2	60.9	62.2	13.9	15.6	13.7
Wheat Spec 7070	73.4	24.4	101.6	60.6	61.1	62.6	14.0	15.8	12.9

TRITICALE

C.J. Peterson, D.F. Moser, K. Hinnenkamp, and V.L. De Macon

Early triticale had many undesirable characteristics such as: low yield, shriveled grain, poor seed set, and excessive plant height. Plant breeders have made considerable progress in improving triticale in the last 10 years. New cultivars are similar to wheat in grain production and the bushel weight although still low (approximately 50 pounds per bushel) has been improved. Seed dormancy and head shattering characteristics of triticale are similar to wheat. Therefore triticale does not present the same volunteer problem as rye.

Cultivars

Both winter and spring triticale cultivars have been developed for production in the Pacific Northwest.

Winter Triticale

Flora, a winter triticale, was developed and released from the cooperative USDA/Agricultural Research Service - Oregon State University triticale program. Flora is a high yielding, semidwarf triticale that has a very low bushel weight (approximately 40 to 45 pounds per bushel). Plant height of Flora is similar to that of the semidwarf wheat cultivar Daws. Flora, like most triticale cultivars, is quite susceptible to Cephalosporium stripe.

Spring Triticale

Grace (also known as Palouse) is a spring triticale that was developed (selection identified by USDA/Agricultural Research Service - Washington State University program) by the Jenkins Foundation in California. Grace is a mid-tall (38-45 inches) triticale with good yield potential. It has some tolerance to freeze damage and has been grown at Pullman, Washington from both fall and spring seedings. The kernels of Grace are quite shriveled and therefore the bushels weights are about 10 pounds below that of wheat.

Whitman (VH080011) was developed and released from the cooperative USDA/ARS - Washington State University triticale breeding program. It is a spring triticale but will survive the winters at Pullman, Washington, if adequate snow cover occurs during the cold weather. Whitman must be seeded early in the spring because it has a short vernalization requirement and will not head properly from a late spring seeding. It is resistant to the local races of stripe rust and leaf rust. Whitman has a good grain yield potential from both winter and spring plantings. It is approximately 15 inches taller than Daws and has a 6 to 10 pound lower bushel weight. Whitman heads earlier than Daws but it matures about the same time. Protein of Whitman is 1 to 2 percentage points above that of the soft white winter wheat cultivars.

The spring triticale Juan (developed by CIMMYT and University of California at Davis) was released to the growers in California in 1984. Juan has performed quite well in the Pullman nurseries. Juan is a mid tall (38-45 inches) triticale and has a very good yield potential. Bushel weight and protein content of the grain is quite similar to that of Whitman. Unlike Grace or Whitman, Juan does not respond to photoperiod and it may head in the fall from an early seeding (August or 1st part of September).

There are a number of good private triticale cultivars available that we have not tested.

Tables 1 and 2 contain the grain yield data on triticales grown from a fall and spring seeding at Pullman for the past few years. Whitman has done as well from a fall seeding. Juan and Whitman have perform well from an early spring seeding. Juan can be seeded later in the spring than Whitman.

Table 1. Grain yield data (bu/a) for two winter wheats and three triticales grown for seven years at Pullman, WA.

Cultivar	1981	1982	1983	1984	1985	1986	1988	1989	Avg.
Daws	92	75	79	90	33	56	48	65	67
Stephens	116	88	83	75	32	34	53	70	69
Grace	102	37	81	67	40	39	80	59	63
Whitman	108	102	108	106	46	47	47	71	79
Juan	131	60	110	77		61	71	52	
Flora					51	56	57	89	

Table 2. Yield data (Bu/a) on two spring wheats and Three triticales grown in Pullman, Washington for five years.

Cultivar	1983	1984	1985	1986	1988	1989	avg.
Owens	40	57	43	49			
Waverly	46	56	43	32		53	
Grace	31	51	18	38	57	65	43
Whitman	46	60	39	34	46	63	48
Juan	47	69	43	39	66	86	58
Edwall					48	68	
Penawawa					51	59	

For further information on Triticale see the Pacific Northwest Bulletin Number 331.

USDA/ARS WESTERN WHEAT QUALITY LAB

Craig F. Morris

Gordon L. Rubenthaler retired as director last summer. I assumed full-time leadership January 1, 1990. The primary mission of the lab will remain the enhancement of wheat quality in the Western United States. This goal will be effected largely through the evaluation of breeders' selections. All of the public and many of the private breeders have been contacted and we have had extensive discussions on how the WWQL can better interface with their programs.

A second goal is to research the methodology and underlying basis of wheat quality. Varieties could be more efficiently developed if we could improve our evaluation methodology. To do this we often need greater insight as to the basic chemical and physical bases that control good and poor quality attributes.

The Washington Wheat Commission supports variety development activities in the WWQL by providing funding for a technician who works on quality assessment of early generation material. Cooperative projects this year included:

Pacific Northwest Grains Council harvest survey

Pacific Northwest Grains Council collaborative flour testing

U.S. Wheat Associates western white export cargo survey

Washington Wheat Commission comparative milling and baking of world wheats

BARLEY BREEDING AND TESTING IN WASHINGTON

S.E. Ullrich, C.E. Muir, R.A. Nilan, B.C. Miller, P.E. Reisenauer,
D.A. Keerkop, J.S. Cochran, and J.A. Clancy

Production

Barley is an important agricultural commodity in Washington State, with a usual value rank of 7th-10th among the 40 commodities produced and tallied. Barley is the third most important field crop behind wheat and hay. Washington ranked fifth among states in barley production in 1989. Barley production and acreage in Washington was 682,000 tons from 500,000 acres in 1989. The average statewide yield in 1989 was 2,800 lb/a. Steptoe was planted on 70% of the state's barley acreage in 1989, with malting types on about 15% of the acreage and winter types dropping to about 5% of the acreage due to the hard winter. The malting types grown included Advance, Andre, Clark, Cougbar, Harrington, Crystal, Klages, and Morex. The winter types grown were primarily Boyer, Kamiak, Showin, and Hesk. Other spring feed cultivars grown were primarily Bridger 82 and Camelot.

Objectives

The overall objective of the barley improvement program in the state of Washington is to develop high yielding, stiff-strawed agronomically acceptable spring and winter varieties that are adapted to the different barley producing areas of Washington and that have superior quality. Spring barley is emphasized in the program. The winter barley varieties need to be hardy enough to survive most winters with little or no damage. One major objective in both winter and spring varieties is to develop lines which meet high quality malting standards and also have superior feeding qualities. These multipurpose varieties would meet flexible market demands for Washington grown barley. Although malting quality screening has been ongoing for many years, feed quality screening has not. However, this past year a new technique utilizingcanulated pigs has been implemented to screen barley lines. Results from the first go-around are presented elsewhere in this brochure.

The program involves the development of winter and spring, 2-row and 6-row varieties at Pullman with selection and testing at the Lind Dryland Research Unit, the Mielke Farm near Harrington (winterhardiness), and the Royal Slope Research Unit (irrigated). Other major test sites are at Walla Walla, Pomeroy, Harrington, and Connell. Dusty, Dayton, Lamont, Creston, Deep Creek, Reardan, Bickleton, Goldendale, Mayview, Clyde, Anatone, St. John, Uniontown, Fairfield, and Farmington are additional extension test locations. The cooperation of B.C. Miller, C.F. Konzak, and many growers in the testing effort is gratefully acknowledged. A new project has been launched this year to improve variety testing to better predict on-farm production and performance within specific recommendation domains. Over 40 on-farm yield trials have been planted by farmers in 1990.

An additional objective is to measure variety response to various cultural practices. The effects of no-till and nitrogen levels have been or are being investigated at Pullman.

Results

The new varieties developed at WSU are described in front of the brochure under recommended barley varieties for the state of Washington. Yield results of released cultivars are summarized in the tables below along with newer high yielding selections.

Spring Barley

Spring barley performance is presented in Tables 1-6. Although Steptoe continues to perform well overall, the 6-row, Cougbar, has yielded well in the higher rainfall areas (Table 1). A 2-row selection, WA8771-78, which is a candidate for release, has done well compared to Steptoe over a wide range of growing conditions (Tables 1, 4). WA8771-78 has a plump kernel and produces a high test weight (Table 5). The malting industry has expressed interest in this line and it is currently being plant-scale tested.

A number of advanced lines, both 6-rows (Tables 2, 3) and 2-rows (Tables 4, 5) have performed well in comparison with Steptoe and other commercial cultures. Among the better 6-rows are WA12809-83, WA11136-83, WA9243-87, and WA11224-86 (Tables 2, 3, 6). Among the newer 2-rows WA9035-84, WA9029-84, WA10237-84, and WA16277-85 have done particularly well (Tables 4, 5, 6).

In general, over the years 2-row barley has tended to have broader adaptation than 6-row barley in eastern Washington. The 2-row cultivars and lines have tended to yield higher in the dryer areas, while 2-rows and 6-rows have yielded similarly in the moister areas. However 2-rows have also had consistently higher kernel quality than 6-rows. Steptoe continues to do well under almost all conditions.

Winter Barley

Winter survival was not a major issue this past winter as it was the winter before (1988-89). Most test locations had 90+% of survival of winter barley. However, there was uneven and spotty emergence at some test locations. Winter barley performance data are presented in Tables 7-11.

WSU released the new 6-row winter barley "Hundred", which had been tested as WA1574-77. Hundred's advantages over the currently grown cultivars in Washington are yield, lodging and disease resistance, and quality for feed and potentially malting. Hundred is a semidwarf (but not as short as Showin) with mid-maturity and a club-type head. Foundation seed production is currently underway.

Several newer winter lines that have done relatively well are WA2607-80, WA1727-84 and WA3035-84 (Table 10).

The WSU barley breeding program is also involved in developing specialty-type barleys for brewing, human food and livestock feed, including proanthocyanidin-free, hulless and/or waxy (high beta-glucan) and forage or hay-type barleys. The hulless and/or waxy types represent potentially new market opportunities for Washington producers.

Two tissue culture projects are underway in the barley program. One of these involves the culture of immature embryos to produce callus and regenerated plants to evaluate and exploit somaclonal variation for breeding purposes. Callus culture appears to induce genetic changes (mutations) which could contribute to positive genetic variability in barley.

The other tissue culture project involves evaluating and developing anther culture techniques to ultimately produce doubled haploid lines to accelerate the breeding program. Homozygous lines can be developed in one year or less after a cross is made, thereby circumventing the years and generations of segregation which normally occur after making a cross. We have been successful at culturing anthers, and made considerable improvements in culture efficiency and regeneration of green plants.

TABLE 1. SPRING BARLEY MULTIPLE YEAR YIELD AVERAGES.

VARIETY	ROW TYPE	YIELD [LB/A (%)] AVERAGE 47LOC-YR	PULLMAN 10 YR	POMEROY 10 YR	WALLA 10 YR	AVERAGE 30LOC-YR	OTHER E-WA 17LOC-YR
STEPTOE	6	<u>4010</u>(100)	<u>5010</u>(100)	<u>3480</u>(100)	3810(100)	<u>4100</u>(100)	<u>3860</u>(100)
8771-78	2	<u>3940</u>(98)	<u>4990</u>(100)	3460(99)	3800(100)	<u>4080</u>(100)	<u>3680</u>(95)
ANDRE	2	3820(97)	4620(92)	<u>3520</u>(101)	<u>3840</u>(101)	3990(97)	3500(91)
COUGBAR	6	3780(94)	<u>5050</u>(101)	3010(87)	<u>3830</u>(101)	3960(97)	3460(90)
CLARK	2	3730(93)	4680(93)	3080(89)	3640(96)	3800(93)	3600(93)
MOREX	6	---	3930(78)	2540(73)	3020(79)	3160(77)	---

TABLE 2. STATE SIX-ROW SPRING BARLEY NURSERY YIELDS IN 1989.

VARIETY	YIELD (LB/A) PULLMAN* 1	PULLMAN* 2	POMEROY	WALLA WALLA	CONNELL	LIND	ROYAL+ SLOPE	HARRINGTON	DAVENPORT
11163-86	<u>7120</u>	4500	<u>3550</u>	4680	2230	2220	5460	2260	2170
13352-85	<u>7090</u>	3910	3440	4780	1870	2035	5340	2380	2230
STEPTOE	6960	4270	<u>3610</u>	5030	<u>2410</u>	<u>2470</u>	<u>5750</u>	<u>2640</u>	<u>2920</u>
12809-83	6820	<u>4780</u>	3240	<u>5190</u>	2120	2020	5300	2190	2120
11104-84	6730	3960	2810	4810	2000	2040	5290	2000	2190
COUGBAR	6710	4490	3390	4820	2070	2050	5040	1820	2050
11224-86	6620	<u>4550</u>	3470	4720	<u>2290</u>	<u>2330</u>	<u>5980</u>	<u>2450</u>	<u>2650</u>
10217-83	6480	4170	2690	4630	2090	2190	4740	2380	2300
11136-83	6380	4460	2990	<u>5150</u>	2230	2230	4580	2410	2160
7929-84	6150	4110	3130	4700	2080	2130	4960	2430	2370
MOREX	5050	3820	3300	4590	2250	2140	4150	2450	2380

* PULLMAN - 1 - SPILLMAN FARM; - 2 - QUIST FARM WITH DELAYED HARVEST DUE TO RAIN

+ IRRIGATED

TABLE 3. STATE SIX-ROW SPRING BARLEY NURSERY AGRONOMIC AVERAGES, 9 LOCATIONS IN 1989.

VARIETY	YIELD LB/A	YIELD %	TEST WT LB/BU	PLUMP KERNELS %	PLANT HEIGHT IN	LODGING %
STEPTOE	4010	100	46	75	32	7
11224-86	3900	97	48	79	32	8
11163-86	3850	96	47	56	29	8
12809-83	3750	94	47	67	31	9
13352-85	3670	92	42	52	29	7
11136-83*	3620	90	48	70	28	5
COUGBAR	3610	90	47	53	29	4
7929-84	3560	89	46	66	27	7
11104-84	3540	88	45	57	31	9
10217-83*	3510	88	46	70	29	8
MOREX	3350	84	48	58	35	10

* GOOD FEED QUALITY BASED ON SWINE TRIALS.

TABLE 4. STATE TWO-ROW SPRING BARLEY NURSERY YIELDS IN 1989.

VARIETY	YIELD (LB/A) PULLMAN* 1	PULLMAN* 2	POMEROY	WALLA WALLA	CONNELL	LIND	ROYAL† SLOPE	HARRINGTON	DAVENPORT
9035-84	7060	4010	3520	5990	2390	2460	6560	2580	2620
9954-85	6870	3990	3480	5890	2210	2150	6190	2520	2470
16277-85	6690	4000	3470	5570	2510	2270	6910	2650	2270
9029-84	6680	4300	3380	5610	2260	2260	5090	2660	2700
9448-83	6670	4210	3400	5830	2220	2000	6520	2530	2650
STEPTOE	6630	4320	3880	5400	2390	2190	6730	2750	2390
8771-78	6480	3970	2910	5490	2280	2080	5700	2580	2500
CLARK	6470	3840	3140	5410	2320	2290	5810	2520	2800
HARRING-TON	6320	3920	3520	5310	2070	2130	5720	2530	2590
8805-83	6250	4000	3390	5640	2170	2210	6100	2510	2360
ANDRE	6220	3750	3100	5220	2070	2030	5380	2470	2150
KLAGES	6180	3880	2820	4940	2020	2110	5390	2280	2210

* PULLMAN - 1 - SPILLMAN FARM; - 2 - QUIST FARM WITH DELAYED HARVEST DUE TO RAIN

† IRRIGATED

TABLE 5. STATE TWO-ROW SPRING BARLEY NURSERY AGRONOMIC AVERAGES, 9 LOCATIONS IN 1989.

VARIETY	YIELD LB/A	YIELD %	TEST WT LB/BU	PLUMP KERNELS %	PLANT HEIGHT IN	LODGING %
9035-84**	4100	101	50	67	28	5
STEPTOE	4080	100	47	78	30	11
16277-85	4040	99	50	72	29	3
9448-83**	4000	98	49	64	27	5
9954-85	3970	97	50	62	23	7
9029-84***	3880	95	50	71	28	7
8805-83***	3850	94	50	67	29	2
CLARK	3850	94	50	67	29	8
HARRINGTON*	3790	93	51	59	27	6
8771-78	3780	93	50	65	30	10
ANDRE	3600	88	51	52	28	5
KLAGES	3550	87	49	52	30	7

***,**,* EXCELLENT, VERY GOOD AND GOOD FEED QUALITY, RESPECTIVELY, BASED ON SWINE TRIALS.

TABLE 6. FEED BARLEY NURSERY AVERAGES IN 1989.

VARIETY	ROW TYPE	YIELD (LB/A) AVERAGE 3LOC	%	PULLMAN	LIND	ROYAL┼ SLOPE	TEST WT LB/BU	PLUMP KERNELS %	PLANT HEIGHT IN	LODGING %
9243-87	6	4800	103	5340	1980	7080	47	76	26	3
STEPTOE	6	4650	100	5110	2160	6670	49	87	32	21
11858-87	6	4570	98	6170	2180	5360	49	78	32	29
COLUMBIA	6	4510	97	5310	1740	6480	47	80	27	15
13627-84	2	4510	97	5360	2070	6090	52	85	29	26
8598-87	6	4500	97	5340	1960	6210	49	68	30	7
10237-84***	2	4490	97	5800	1850	5800	51	81	31	21
AZ-25*	6	4390	94	5010	2170	6000	46	84	29	27
BOWMAN	2	4320	93	4870	2270	5830	54	92	31	17
11096-87**	2	4250	91	5150	1740	5670	60	42	28	21

┼ IRRIGATED
* WAXY COVERED MUTANT OF STEPTOE.
** HULLESS
*** GOOD FEED QUALITY BASED ON SWINE TRIALS.

TABLE 7. WINTER BARLEY YIELD PERFORMANCE 87 LOCATION-YEARS IN THE PACIFIC NORTHWEST.

VARIETY	LB/A	%
HUNDRED	4950	108
HESK	4840	106
BOYER	4570	100
SHOWIN	4410	96
KAMIAK	4190	92

TABLE 8. WINTER BARLEY MULTIPLE YEAR YIELD AVERAGES, LB/A (%).

VARIETY	PULLMAN 7 YR	POMEROY 5 YR	WALLA[2] 5 YR	DAYTON 3 YR	LIND IRR. 3 YR	EXTENSION 39 LOC-YR
HUNDRED	5620(113%)	4780(112%)	4520(101%)	5100(101%)	4460(118%)	4210(111%)
HESK	5520(111)	4600(108)	4420(99)	5280(104)	4310(114)	4070(107)
BOYER	4990(100)	4270(100)	4460(100)	5070(100)	3930(100)	3800(100)
SHOWIN	4660(93)	3900(91)	4120(92)	4740(93)	3770(96)	3720(98)
KAMIAK	4560(91)	3350(78)	4010(90)	3550(70)	2620(69)	3480(92)

TABLE 9. WINTER BARLEY EXTENSION NURSERY YIELD AVERAGES, LB/A.

VARIETY	AVERAGES 39LOC-YR	AVERAGES 1989(10LOC)	ASOTIN 4 YR	ASOTIN 1989	MAYVIEW 4 YR	MAYVIEW 1989	CLYDE 3 YR	CLYDE 1989
HUNDRED	4210	4270	3920	5530	4840	5430	2410	2780
HESK	4070	4040	3760	5230	4080	4130	2770	2410
BOYER	3800	4010	3700	5230	3860	3380	2590	2250
SHOWIN	3720	4000	3380	5060	3970	3440	2500	2410
KAMIAK	3480	3690	3440	4190	3750	3810	2240	2540

VARIETY	DUSTY 4YR	DUSTY 1989	ST. JOHN 4YR	ST. JOHN 1989	FARMINGTON 4YR	FARMINGTON 1989	FAIRFIELD 4YR	FAIRFIELD 1989	UNIONTOWN 1989
HUNDRED	3400	2210	6110	5620	4700	5100	4600	4800	3390
HESK	3310	2180	5970	6110	4240	4100	4390	4390	4580
BOYER	2840	1690	5820	6530	4090	4880	4240	4470	4470
SHOWIN	2690	1860	5670	6260	4020	4350	3870	3930	3830
KAMIAK	2500	1760	4390	3860	3680	4230	4280	5070	3910

VARIETY	BICKLETON 1989	GOLDENDALE 1989	LAMONT 3YR	REARDON 3YR	WILBUR 3YR
HUNDRED	2590	5270	3070	4020	4740
HESK	2360	4940	3730	3770	4400
BOYER	2790	4450	2980	3590	3620
SHOWIN	2570	5280	3190	2880	3690
KAMIAK	2410	5160	3010	2820	3980

TABLE 10. WINTER BARLEY YIELDS IN 1989.

VARIETY	YIELD (BU/A) AVERAGE	%	PULLMAN	POMEROY	DAYTON	WALLA WALLA
HUNDRED*	5860	119	7360	4520	6020	5550
HESK*	5470	111	7350	3750	6280	4490
SHOWIN	5170	105	5990	3750	5690	5260
BOYER	4940	100	6190	3770	5020	4780
KAMIAK	4360	88	5750	3300	3680	4690
2607-80	6190	125	7540	4010	6540	6680
1727-84	5910	120	7350	4520	6250	5530
3035-84*	5790	117	7130	4260	5830	5920
2554-81	5130	104	7100	3540	5020	4850

*RELATIVELY GOOD FEED QUALITY BASED ON SWINE TRIALS

TABLE 11. WINTER BARLEY AGRONOMIC PERFORMANCE, 7 YEAR AVERAGES ('83-'89), PULLMAN.

VARIETY	YIELD LB/A	TW LB/BU	SURV %	HT IN	LOD %	PLUMP %
HUNDRED	5620	49	100	34	1	66
HESK	5520	49	97	36	5	63
BOYER	4990	49	98	36	2	69
SHOWIN	4660	48	97	30	0	58
KAMIAK	4560	50	100	41	30	69

TABLE 12. HULLESS BARLEY PERFORMANCE AT PULLMAN IN 1989.

VARIETY	ROW TYPE	YIELD LB/A	YIELD %	TW LB/BU	PLUMP %
WA11090-87	2	5750	98	57	50
WA11089-87	2	5400	92	59	59
SCOUT	2	5130	87	58	81
TUPPER	6	4560	78	57	76
ODYSSEY	2	3800	65	60	85
ANDRE*	2	5870	100	54	95
CLARK*	2	5420	92	52	96

* COVERED CHECKS

BREEDING, DISEASES AND CULTURE OF DRY PEAS, LENTILS, CHICKPEAS, AND AUSTRIAN WINTER PEAS

F. J. Muehlbauer, S. C. Spaeth, J. L. Coker, and R. W. Short

Dry pea, lentil, chickpea and Austrian winter pea research is conducted in the Palouse region of eastern Washington and northern Idaho. New lines, cultivars and breeding populations are tested in these areas to identify plant types with multiple pest resistance, efficient water-use, stress resistance, yielding ability, and quality. The principal areas of research in each of these crops is as follows:

Dry Peas: The goals of the research program on dry peas include improved quality, mostly better color, and improved yields. Root diseases of peas caused by a complex of several organisms are a major reason poor yields have been common to the area. Most of our efforts have been in identifying resistant lines for use as parents, hybridizing the resistant lines with commercial cultivars, and screening the resulting populations for root rot-resistant segregants with good plant type, good color qualities, and adaptability. Quality tests for resistance to seed bleaching and for adaptability to reconstitution and canning are also conducted. Because pea enation mosaic virus and pea leaf roll virus have become extremely serious on peas and lentils in recent years, we have started screening for resistance in the field and greenhouse. Good resistance is available in peas, and we have recently identified resistance in lentils to pea enation mosaic virus. The goal is to incorporate resistance to these viruses into new cultivars.

Rates of water uptake in germinating seeds may influence emergence rates and susceptibility to root rots. We have devised new ways to measure stresses in seeds. Lines are being tested for differences in water uptake rates and imbibitional stresses to determine whether these traits can be used in pea, lentil and chickpea improvement.

Variations in leaf morphology in peas are being studied to improve standing ability and reduce foliar disease infection. The semi-leafless type with increased tendrils appears to hold particular promise for reducing foliar disease and maintaining yields that are equal to normal plant types. Future germplasm improvement efforts are being directed toward developing virus resistant semi-leafless types. The afila or "semi-leafless" type has particular promise for a yellow pea type because the reduced foliage allows better light penetration to the pods and results in bright yellow peas. Also, the reduced leaf area hastens maturity. Development of shatter resistant peas is currently underway.

Varieties of peas developed are as follows:

'Alaska 81' was released to growers in 1984. The cultivar is early to flower (10th node), early to mature, and has excellent seed quality traits including dark green color and resistance to seed bleaching. Alaska 81 has resistance to *Fusarium* wilt race 1 and is tolerant to pea root rot. Alaska 81 is immune to pea seedborne mosaic virus.

'Garfield' is resistant to *Fusarium* wilt race 1, is larger seeded, and has a longer vine habit when compared with most Alaska strains.

Garfield flowers at the 14th node and has tolerance to pea root rot, two factors which delay maturity about one week when compared with most Alaska strains.

'Tracer' is a small-sieve Alaska type that is higher yielding than most other small-sieve types. Other major improvements of Tracer include greater plant height; a reduced susceptibility to seed bleaching; and resistance to Fusarium wilt race 1. The increased height of Tracer improves harvesting ease on the ridges where poor vine growth has been a problem. Tracer tends to set triple pods at one or more of the reproductive nodes.

'Umatilla'. When compared with Latah, Umatilla is about 7 inches shorter and 13% higher yielding. Umatilla sets double pods compared to the single podding habit for Latah. The seeds of Umatilla are larger and have averaged 18.7 grams per 100 seeds compared to 17.1 for Latah. Seeds of Umatilla are bright yellow and represent a significant improvement in seed quality when compared to Latah in which the seeds have an undesirable green cast.

Lentils: Current objectives in lentil breeding are toward developing an early maturing 'Laird' type. Laird is a large-seeded non-mottled variety developed for use in Canada; however, Laird is somewhat late maturing and, on the average, lower yielding than 'Brewer' when grown in the Palouse. An early maturing Laird type, 'Palouse', was recently released and is now available to growers. We are now developing a larger seeded type with green seedcoats to better compete with Laird in certain markets in South America and Spain.

Varieties of lentils developed are as follows:

'Brewer' consistently has been the highest yielding lentil variety in yield trials. The variety has averaged about 300 pounds per acre more than Chilean and is larger seeded. Brewer is earlier to flower and mature and matures more evenly.

'Redchief', a variety released in 1978, has shown a consistent yield advantage over Chilean. Redchief has red cotyledons and is now used to produce decorticated red lentils.

'Chilean 78' is a composite of selections made from common Chilean lentil seed stocks and, therefore, performance is identical to that expected for Chilean. The primary advantage of Chilean 78 is the absence of vetch-type rogues, particularly those rogues that have seeds similar in size, shape and color to lentils. Chilean 78 has largely been replaced by Brewer.

'Emerald', a bright green lentil with distinctively green cotyledons, has performed well in yield trials. Emerald is a specialty type lentil because of its distinctive green cotyledon color. The variety stays somewhat green at maturity and therefore must be closely followed in order to avoid excessive seed shattering.

'Palouse'. Released in 1988 is a large-seeded yellow cotyledon lentil that is similar in size to the Canadian Laird lentil. However, Palouse is earlier to mature and is comparable to Brewer for yield. Palouse also has seeds that are free of mottling.

'Crimson' is a small red lentil that was recently approved for release by the variety release committee. Crimson has small brown seeds with red cotyledons. The variety is a "persian" type typical of the lentils grown in the Middle East and northern Africa. The variety is well adapted to intermediate rainfall zones (15-18 inches annually) and therefore could become an alternative crop to wheat in those areas. Expected yields in those areas would be from 750-1000 pounds per acre. Marketing of small red lentils will depend upon availability of equipment for decortication and splitting.

Chickpeas: (Garbanzos) are grown throughout the world in similar environments to those where lentils are grown. The Palouse environment seems well suited to chickpeas and very favorable yields have been obtained. Varieties and breeding lines have been obtained from sources both national and international and have been evaluated for yield potential and seed quality. Cultural practices have included: (1) seeding rates-row spacing, (2) seed treatments, and (3) Rhizobium inoculation have been completed. There are basically two types of chickpeas: the "Kabulis", with large cream-colored seeds and the "Desis", with smaller seeds that are variously pigmented. Kabulis represent less than 20% of the world's production of chickpeas; the remainder are Desi types. The Desis are grown primarily on the Indian subcontinent and parts of Ethiopia; whereas, the Kabulis are grown primarily in the Mediterranean basin and North and South America.

Varieties of chickpeas developed are as follows:

'Tammany'. This variety has a unifoliate leaf structure which differs from the fern leaf structure that is typical of most chickpea cultivars currently in use. Tammany is earlier to mature and has larger seeds when compared to "UC-5"; the commonly grown cultivar in the region. Seeds of Tammany average 58 grams per 100 seeds compared to 52 grams from UC-5. The uniformly large light cream-colored seeds of Tammany are highly desired by domestic processors and by exporters.

'Garnet'. This variety originated as a plant introduction from Ethiopia that was mass selected for uniformity. Garnet has produced yields that were equal to or better than other Desi lines. Garnet matures in about 110 days from planting. The seeds are reddish-tan, uniform in size, and weigh 16.4 grams per 100 seeds.

'Sarah'. This variety orginated from India where it was selected as an Ascochyta blight resistant desi type and designated as C235. The variety is also produced extensively in Australia under the name 'Tyson'. Sarah has shown excellent resistance to Ascochyta blight in the Palouse region. Yields and quality are also very good. Foundation seed of Sarah should be available for the 1991 cropping season.

The current problem of Ascochyta blight on chickpeas in the Idaho-Washington area has prompted research on identification of resistant lines. Resistance to blight is available; however, the resistance is associated with late maturity and small-medium seed size. We currently have underway a program to incorporate the resistance into more acceptable types. The breeding material being tested this year is in the F_3.

Austrian Winter Peas: We recently took over the Austrian winter pea breeding program and have set a number of objectives including:
1) identification and incorporation of resistance to Aphanomyces root rot into winter hardy Austrian types, and 2) the development of types with

high biomass production and high yields that can be used for several purposes including green-manuring, and seed production

THE NORMAL CROP ACREAGE PROPOSAL AND SUSTAINABLE FARMING SYSTEMS: HOPE FOR THE FUTURE?

Douglas L. Young and Kathleen M. Painter

"The people who had lots of clovers and alfalfas, they came out on the little end of the horn every time as far as the base acreage and government programs went."

Palouse farmer, 1989

Several legislative proposals for the 1990 Farm Bill have promised to reduce policy barriers to planting flexibility and environmentally sound crop rotations. We briefly examine how one of these, the Bush Administration's Normal Crop Acreage (NCA) proposal, would affect the short and long run economics of two Palouse region green manure rotations. The NCA pools the grower's base acreage over all program crops and also permits green manures or other "conserving crops" planted on base acres to be counted as "considered planted" for future base acreage calculations (USDA). Furthermore, if the conserving crop is not harvested, it qualifies for deficiency payments on the base acreage for that year. Unharvested conserving crops like the green manure crops used in this analysis would also continue to satisfy ARP requirements.

The first sustainable system is known as PALS, an acronym for Perpetuating Alternative Legume System, and consists of an experimental three-year rotation of a green manure legume, winter wheat, and dry peas (see Goldstein and Young for further detail). The second system was used on the Don Lambert farm in southern Spokane county for thirty years. That rotation consisted of a three-year cycle of winter or spring wheat followed by dry peas, then an uncropped year consisting of one-half Austrian winter peas as a green manure crop and one-half summer fallow. In addition, a two-year grass planting was rotated over all of the acreage as an erosion control measure between 1977 and 1985 (see Painter for more detail). While the experimental PALS system shows considerable promise, more research is needed to substantiate its yield and cost figures on a whole-farm basis. Both sustainable systems would decrease soil erosion significantly, while eliminating the use of nitrogen fertilizer, wheat fungicides, and some herbicides.

The conventional cropping system used for this comparison consisted of a four-year rotation of winter wheat/spring barley/winter wheat/dry peas. It is representative of the more grain-intensive cropping systems in the annual cropping region of the Washington-Idaho Palouse. The conventional rotation devotes more than twice the acreage to program crops (wheat and barley) as the sustainable systems. Relatively high levels of fertilizer and pesticides are required to maintain grain yields and withstand pest and disease problems in the conventional system.

In this analysis, we assume <u>initial</u> bases for farms growing all three rotations equal to .50 of farm acreage for wheat and .25 for barley. This

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assumes that growers of sustainable rotations have converted from conventional cropping histories. (This is important because a farmer who has been following a green manure rotation for many years would be unable to take advantage of the flexibility offered by the NCA proposal, as he or she would lack excess base acreage for planting to conserving crops.) For both sustainable systems, annual history reflects planted wheat acreage of 0.33, plus the ARP acreage for that year, plus, under the NCA proposal, qualifying "conserving crop" acres. Base acreage is calculated as a rolling average of annual histories for the preceding five years.

We apply the NCA to the case studies retroactively, assuming that it had been law over 1986-90 instead of the FSA (Young and Painter). The last two lines in Table 1 show that the NCA would have been markedly more effective than the FSA in sheltering the base acreage of a farmer using the resource-conserving PALS and Lambert rotations. By 1991, total base under the FSA has shrunk to 41 percent of the farm for PALS and 39 percent for Lambert, but under the NCA it has stabilized at 67 percent for PALS and 54 percent for Lambert. Under the Administration's NCA proposal, acreage devoted to green manure crops or grass counts as "considered planted" every year for these rotations, either as wheat ARP or as a conserving crop on the "flexible" NCA base. The NCA annual history in Table 1 remains at 67 percent every year for PALS, comprised of 34 percent wheat and 33 percent green manure. Lambert's annual history under the NCA consists of 31 percent wheat, 15 percent green manure, and 8 percent in grass for a total of 54 percent base-qualifying acres.

In contrast, wheat base loss will seriously endanger the long term economic sustainability of the two low-input rotations under the base calculation rules of the 1985 FSA. As shown in Table 1, the barley base vanishes from both rotations by 1991, and wheat base falls from .50 in 1985 to .41 by 1991 for PALS and to .39 for Lambert. If large wheat stocks accumulate by 1991 (or later) and push ARP's up to 1986-88 levels, the PALS grower would need a wheat base of .43 to .46, which exceeds the .41 available, in order to maintain the one-third wheat, one-third peas, one-third green manure rotation. A similar base crunch would confront a grower of the Lambert rotation who would need a .44 base but would only possess .39. Under a continuation of current policy, the low-input grower would be faced with the choice of abandoning the fixed rotation or withdrawing from the profitable wheat program. These computations are consistent with findings of a recent survey where low-input Palouse farmers mentioned base loss more often than any other policy barrier to rotations using green manures or grasses (Beus et al.).

Table 2 reports estimated annual net returns over variable costs for the PALS, Lambert and conventional rotations for both the 1985 FSA and the Administration's proposed NCA. Lacking program-specific estimates, we used the market prices and annual deficiency payments paid under the FSA for both policies. A limitation of this approach is its failure to incorporate any differential price effects between the FSA and NCA, which could have altered deficiency payments. The conventional rotation's net returns remain unchanged under both policies as its acreage is allocated to wheat, barley, peas, and ARP exactly as before. The NCA increases net returns every year for the PALS and

Lambert rotations, by an average of 17 and 30 percent, respectively. The rotations receive weighted average wheat plus barley deficiency payments on non-ARP green manure acreage every year.

As shown in Table 2, the PALS rotation is substantially more profitably every year than the geographically comparable conventional rotation under the NCA. Under the FSA the PALS rotation lagged slightly behind the conventional rotation in three out of five years. The Lambert rotation is in a slightly lower rainfall region where the intensive conventional rotation is not feasible, thus an exact comparison is not relevant.

While the estimates in Table 2 support the ability of the NCA to increase the private competitiveness of green manure rotations, the absolute profitability estimates should not be overemphasized. If the NCA had actually been in effect during 1986-90, it is likely that wheat acreage would have been more promptly reduced, leading to a quicker recovery of market wheat prices. This would have produced a tighter wheat supply-demand balance earlier in this period, which would have reduced deficiency payments. Under this scenario, which is approximated by the 1989 NCA estimates, the PALS and conventional systems enjoy roughly similar profitability, although PALS holds a slim $3/acre edge.

Of course, this single region case study involving only two green manure rotations does not ensure that widespread adoption of similar rotations would occur with passage of the NCA or similar proposals. Such rotations may still fail to be competitive in some regions due to local physical and/or economic factors. Planting flexibility should also strengthen prices and thereby profitability of program crops as the constraints promoting excess production are reduced. Nonetheless, these proposals represent an important step toward making farm programs neutral as they relate to program and conserving crops.

REFERENCES

Beus, C. E., D. F. Bezdicek, J. E. Carlson, D. A. Dillman, D. Granatstein, B.C. Miller, D. Mulla, K. M. Painter, and D. L. Young, eds. 1989. Prospects for sustainable agriculture in the Palouse: farmer experiences and viewpoints. Review Draft, Dept. of Rural Sociology, Washington State Univ., Pullman, Wash.

Goldstein, W. A. and D. L. Young. 1987. An agronomic and economic comparison of a conventional and a low-input cropping system in the Palouse. Amer. J. of Alt. Ag. 2:51-56.

Painter, K. M. 1990. Does sustainable farming pay: a case study. Working paper, Dept. of Ag. Econ., Washington State University, Pullman, WA 99164.

U.S. Department of Agriculture. 1990. 1990 Farm Bill: Proposal of the Administration, Washington, D.C.

Young, D. L. and K. M. Painter. 1990. Farm program impacts on incentives for green manure rotations. Working paper, Dept. of Ag. Econ., Washington State University, Pullman, WA.

Table 1. Wheat and barley annual history[a] and base acreage as a proportion of total acreage for PALS and Lambert rotations, southeastern Washington state Palouse region, 1986-91, under two policy scenarios

Item	1986	1987	1988	1989	1990	1991
FSA 85						
Wheat in PALS rotation:						
Base	.50	.49	.48	.47	.44	.41
Annual History	.43	.46	.46	.37	.35	--
Wheat in Lambert rotation:						
Base	.50	.48	.47	.46	.42	.39
Annual History	.40	.44	.44	.34	.33	--
Barley (for both rotations):						
Base	.25	.20	.15	.10	.05	0
Annual History	0	0	0	0	0	--
Program crops base:						
PALS	.75	.69	.63	.57	.49	.41
Lambert	.75	.68	.62	.56	.47	.39
NCA Proposal						
Program crops plus permitted uses, PALS rotation:						
Base	.75	.73	.72	.70	.69	.67
Annual History	.67	.67	.67	.67	.67	--
Program crops plus permitted uses, Lambert rotation:						
Base	.75	.71	.66	.62	.58	.54
Annual History	.54	.54	.54	.54	.54	--

[a]Planted wheat and barley, acreage reduction program acres, and (under the NCA proposal) qualifying "conserving crops" in current year.

Table 2. Estimated farmer net returns ($/acre of rotation) for two green manure rotations and a conventional system under the 1985 Food Security Act (FSA) and the proposed Normal Crop Acreage (NCA) legislation, 1986-1990

		Rotation		
Year	Policy	PALS	LAMBERT	CONVENTIONAL
1986	FSA	133	96	144
	NCA	174	144	144
1987	FSA	119	84	119
	NCA	147	122	119
1988	FSA	120	84	112
	NCA	128	95	112
1989	FSA	96	64	99
	NCA	102	70	99
1990	FSA	96	63	97
	NCA	110	76	97
1986-1990 Average	FSA	113	78	114
	NCA	132	101	114

SOURCE: Derived from Painter, and Young and Painter.

CONTROL OF DOWNY BROME AND JOINTED GOATGRASS USING SOIL BACTERIA

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Downy brome and jointed goatgrass are problem weeds, infesting over 14 million acres of small grain lands in western United States. Each of these weed species reduces wheat yields 10 to 15%. Herbicide programs have been developed for the control of some of the major winter annual grass weeds, however for others no selective chemical control is available or costs are prohibitive. The search for alternative means of weed control is therefore warranted.

Research has shown that plant-suppressive rhizobacteria exert a subtle effect on plants but may greatly impact plant growth and development. They have the potential to be used in the biological control of weeds. We have isolated bacteria that specifically inhibit the grass weed downy brome or jointed goatgrass, but do not affect the crop. These bacteria, as biological control agents, colonize the root and deliver plant suppressive compounds during a critical point in the growth of the weed which allows the crop to be more competitive. Bacterial survival is critical to the success of this biological control but the influence of the environment on bacterial survival is not fully understood. Bacteria inhibitory to downy brome were most prevalent during cool temperatures. For us to better manage bacteria as biological control agents, we must better understand their distribution and survival in agricultural systems. The ultimate goal of this research is to develop low-cost, effective means to control weeds with minimal impact to the environment.

In a survey of 5000 naturally-occurring soil bacteria, more than half were inhibitory to downy brome or jointed goatgrass seedling growth in laboratory studies. Only 6 % inhibited downy brome and not winter wheat, while less than 4% inhibited jointed goatgrass and not the crop. Winter wheat was less susceptible than the weeds to the plant suppressive bacteria. The wheat was the source of fewer inhibitory bacteria for all plant species. The winter wheat inhibitory bacteria were highest in no-till while the bacteria inhibitory to downy brome and jointed goatgrass were greatest in conventional tillage. High N fertilization decreased the winter wheat inhibitory bacteria, but had no affect on numbers of bacteria inhibitory to jointed goatgrass or downy brome.

The effect of the soil environment and bacterial culture conditions on the interaction between the weed and the weed suppressive bacteria is being determined. In the greenhouse, bacteria colonized roots better and reduced downy brome growth more in moist soil (25% by weight) than in soil held at low moisture content (6%). The method of culturing bacteria was also important. Agar-cultured bacteria persisted on weed roots in fewer numbers than those of broth-cultured cells; however, reduction in weed growth was greater with cells grown on agar.

Commercialization of the biocontrol agent may require a tank mix application with conventional chemical herbicides or applications at close time intervals. Using commercial formulations in incubation trials, survival of the bacterium was dependent upon the herbicide and concentration. At tank mix concentrations, bacteria did not survive well in the presence of Hoelon or Far-go, while survival was better with Tycor or Finesse. The selection of bacteria for suppression of weeds must also include selection for tolerance to herbicides for tank mix use or alternative methods of application will have to be used.

Weed-inhibitory bacteria were applied to wheat fields in 1987-88 at four sites in eastern Washington. Plant populations and above-ground growth of downy brome were reduced 31 and 53%, respectively. Winter wheat yields were increased up to 35% with the application of the bacteria and subsequent suppression of downy brome growth.

In 1988-1989, downy brome populations in field plots at Lind and Pullman, WA were reduced up to 40 % by the application of the bacteria relative to the noninoculated check. Field trials at Pullman were in a no-till system and the bacteria were not as successful in suppressing the weed. Reduction in downy brome population was dependent upon the time of application and differed with location. At Lind the application of a single strain of inhibitory bacteria in concert with herbicides reduced downy brome population by an average of 13% beyond the control given by the herbicides. At Pullman in no-till wheat, the bacteria did not improve herbicidal control of downy brome. The bacteria did not reduce winter wheat or jointed goatgrass populations at either location. Influence of the bacteria on winter wheat yields was inconclusive due to winter injury and kill from cold temperatures.

Current biological control research includes isolation of additional strains of bacteria and field evaluations of these bacteria for the suppression of downy brome and goatgrass. We are currently examining influences of the soil environment and management practices in order to better manage the system so that the organism will be successful in controlling weeds. Field experiments are being continued at Pullman, Lind and LaCrosse, WA to evaluate the concentration and time of application of the inhibitory bacteria as prospective weed control methods. The field evaluation of applications of herbicides and bacteria is also continuing. Antibiotic resistant isolates of downy brome inhibitory bacteria were applied to field plots to evaluate the distribution and longevity of inoculated bacteria. Long term plots were established to follow the populations of bacteria over a 3 to 4 year period.

Thus far, field and laboratory studies have indicated that inhibitory bacteria can suppress the growth of weeds, resulting in increased winter wheat yields. More information is needed on the effect of environmental conditions on the survival and growth of the bacteria and on the optimum timing and application of these bacteria for successful control of grass weeds.

CROP ROTATION AND FALL N FERTILIZATION EFFECTS ON PRODUCTIVITY AND N USE EFFICIENCY OF NO-TILL HARD RED SPRING WHEAT

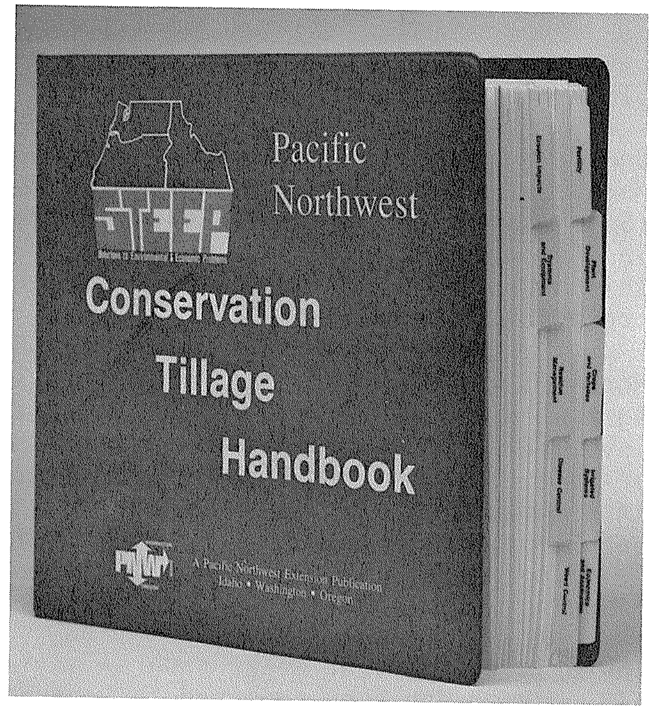
D.R. Huggins, W.L. Pan and J.L. Smith

Field experiments were conducted to evaluate N fertility strategies for improving N use efficiency of no-till hard red spring wheat. Fall and split fall-spring N applications increased grain protein concentration and N uptake efficiency, while yields were unaffected. Grain protein averaged 157, 156 and 142 g kg^{-1} respectively for the fall, split fall-spring and spring applications that ranged from 45 kg N ha^{-1} to 179 kg N ha^{-1}. Nitrogen uptake efficiency was 51% and 61% for the spring and fall N applications, respectively. These differences probably resulted from differences in positional availability of N. In a separate experiment yield, N uptake, and grain N of hard red spring wheat were improved when no-tilled into Austrian winter pea stubble (harvested for seed) when compared to wheat no-tilled into winter wheat stubble. In response to increased N levels from 0 to 168 kg N ha^{-1} of applied N, yields increased from 2755 to 3494 kg ha^{-1} following Austrian winter peas as compared to 2036 to 3347 kg ha^{-1} following winter wheat. Similarly, grain N ranged from 58 to 102 kg N ha^{-1} and from 45 to 94 kg N ha^{-1}, respectively.

PNW CONSERVATION TILLAGE HANDBOOK AND HANDBOOK SERIES

Roger Veseth
Extension Conservation Tillage Specialist WSU/UI

A new **Pacific Northwest Conservation Tillage Handbook** was published in November, 1989 as a PNW Extension handbook in Idaho, Oregon and Washington. The purpose of the **Handbook** is to help consolidate an extensive amount of new management technology for conservation tillage in the PNW into an organized resource guide to increase the accessibility of the information. The **Handbook** is in a large 3-ring binder to permit additions and revisions so it can be maintained as a current up-to-date reference.



The **Handbook** consists primarily of **PNW Conservation Tillage Handbook Series** publications, as well as some PNW Extension bulletins in the new "Crop Management Series on No-Till and Minimum Tillage Farming". All 103 of the publications have been printed since 1984. They are written from the perspective of how the new research developments can fit into a producer's management system.

Quarterly issues of the **STEEP Extension Conservation Farming Update** will now serve as a mechanism for keeping the **Handbook** current by including new **Handbook Series** publications in each issue. Everyone who receives the **Handbook** (<u>and returns the enclosed updating-card</u>) will be added to the **Update** mailing list. **Series** publications are three-hole punched and labeled, ready for insertion at the beginning of specified chapters of the **Handbook**. An updated Table of Contents will be provided periodically to include new additions to the **Handbook**.

Handbook Format

The **PNW Conservation Tillage Handbook** is organized into 10 chapters which best summarize the management technology available:

1) Soil Erosion Impacts on Productivity
2) Conservation Tillage Systems and Equipment
3) Residue Management Considerations
4) Plant Disease Management Strategies
5) Weed Control Strategies
6) Fertility Management and Fertilizer Application

7) Plant Development and Ground Cover Guides
8) Wheat Variety Development and Alternate Crops
9) Erosion Control on Irrigated Cropland
10) Economics and Application of New Technology

Technology Source

STEEP Research

One of the major sources of new conservation farming technology in the Northwest has been through a comprehensive research program entitled STEEP (Solutions to Environmental and Economic Problems). This program was initiated in 1975 to develop new crop management technology for improved protection of soil and water resources, as well as increased production efficiency and profitability.

More than 100 scientists from the land grant universities and the USDA Agricultural Research Service in Idaho, Oregon and Washington have been involved in over 60 research projects each year. Most projects are cooperative efforts between scientists from different disciplines, and many are interstate. The research has involved many disciplines including: plant pathology, weed science, soil fertility, agricultural engineering, plant breeding, soil physics, agricultural economics, soil microbiology, entomology, hydrology, meteorology and plant physiology.

The original 15-year STEEP program will terminate in 1990. A new 5-year "STEEP II" program has been proposed to Congress to focus, in part, on new challenges in conservation farming, as well as those which still remain unsolved. A major added emphasis is proposed on developing management practices for agricultural chemical use to protect surface and ground water quality under varied Northwest conditions. Development of methodology for viable on-farm research, and effective use of on-farm research and demonstrations for technology transfer are also proposed as new components.

STEEP Extension

Keeping up to date on research conducted through a program such as STEEP can be very difficult because of the magnitude and complexity of the research effort. A STEEP Extension program was initiated in 1982 to speed the transfer of new conservation farming technology from the researcher to Northwest producers, and the Ag-support industry and agencies. Funding has been provided primarily by Cooperative Extension and grants from Wheat Commissions in the three states. The program consists primarily of two Extension Specialists (Veseth and Don Wysocki, OSU Extension Soil Scientist at Pendleton) who concentrate on this technology transfer effort. Veseth and Wysocki are coauthors of the **STEEP Extension Conservation Farming Update** and **PNW Conservation Tillage Handbook**.

In addition to the **Update**, and **Handbook** and **Handbook Series** publications, a variety of technology transfer methods are utilized in the STEEP Extension effort. These include: farm magazine/newspaper articles; other PNW Extension publications; conferences and workshops; meeting presentations; field demonstrations and tours; audio-visuals; and decision aid software. The two Specialists are working in cooperation with the STEEP researchers, other Extension Specialists and Agents, Conservation Districts, the USDA-SCS, producer organizations, the Ag-service industry and other related groups to increase producer access to the new technology for conservation farming. The STEEP Extension program also provides an avenue of feedback of grower experiences to STEEP researchers in order to keep the STEEP research effort up-to-date, addressing the problems growers are facing in implementing conservation tillage systems.

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RUNOFF AND EROSION PREDICTION

D.K. McCool, K.E. Saxton, and R.I. Papendick
USDA - Agricultural Research Service

New relationships for nearly all factors of the Revised Universal Soil Loss Equation (RUSLE) were finalized during 1989. Regionalized relationships were incorporated to ensure that the model responds properly to the unique climatic, topographic, and management conditions of the Pacific Northwest. Two years of data as to the amount of surface residue incorporated by selected tillage implements were summarized and a report written. Residue cover/weight data were collected for selected varieties of winter wheat, winter and spring barley, and spring peas. The data indicate a large difference among varieties, as well as among crops. RUSLE and the relationships developed from the residue incorporation and residue cover/weight studies will improve erosion prediction and reduce uncertainties for both action agencies and producers in meeting compliance provisions of the 1985 farm bill.

The field study on the effect of soil freezing and thawing on surface soil strength was completed in 1989. Strength indices showed a wide range as frozen soil thawed, drained and reconsolidated. Data from this study will be used in the Water Erosion Prediction Project (WEPP), a model that will eventually replace the RUSLE.

A study on modeling the effect of conservation practices on surface and subsurface water quality was initiated in 1989. Field work was started in the fall of 1989. The purpose is to adapt a hydrology/water quality model for use in agricultural watersheds of the Palouse. When completed, this model can be used to help action agencies and producers develop and assess management systems that will protect water resources.

CONSERVATION TILLAGE FOR SOD SYSTEMS

Keith E. Saxton
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There are a number of farmland situations which involve grass sods that occasionally need to be revitalized or rotated into other crops. The usual course is to plow the sod followed by extensive tillage to develop a suitable seedbed. This often results in a condition conducive to large amounts of runoff and erosion plus the loss of one crop year. With the large amount of CRP land seeded to sod, this sequence may become highly common as this land is returned to crop production following the contract period. Research is actively being conducted to provide seeding and soil management tillage options for sod conditions.

Sod Seeding:

The Cross-Slot drill opener which originated at Massey University in New Zealand has been evaluated for conservation tillage seeding the past few years and more recently for capability of direct sod seeding. Crops of winter wheat, spring wheat, peas, lentils, and barley have all been tried with good seeding success following chemical killing the sod grasses. All yields have been essentially equal to those expected from conventional tillage except where poor chemical kills occurred. A range of sod conditions have been involved from 20+ year old poor grass stands to dense blue grass take-outs. Re-seeding grasses and legumes into sod for stand revitalization has also been successful with the Cross-Slot opener.

The new John Deere 752 drill was included in 1990 spring trials for both sod and residue-covered conditions. Stands of peas and barley have been comparable to slightly below those of the Cross-Slot opener. Evaluations are continuing.

Sod Tillage:

There are cases where sod fields become very compact and have restricted infiltration which causes considerable runoff. Most tillage in sod creates very rough conditions requiring excessive subsequent tillage. The slant-leg chisel of the ParaTill (Previously called ParaPlow) has been tested in sod conditions for deep loosening and surface cracking to enhance water management and restore better soil tilth. When properly adjusted and at proper soil moisture conditions, this implement shows good promise to accomplish the desired tillage without significant surface roughening. Further tests with new configurations of the chisel legs are being conducted.

CONTROL OF STRIPE RUST, LEAF RUST AND STEM RUST

Roland F. Line
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General Characteristics. Three rusts (stripe rust, leaf rust, and stem rust) occur on wheat in the Pacific Northwest. Stripe rust appears as golden-yellow, long, narrow stripes on the leaf surface and glumes; leaf rust appears as small, red pustules on the leaf surface and leaf sheath; and stem rust appears on the stems and as larger, red-brown, diamond-shaped pustules on the leaf surface. Stripe rust and stem rust can also occur on the heads. Stripe rust and leaf rust overwinter on wheat and rapidly increase during the spring. Stripe rust develops during the cool temperatures of early spring. Leaf rust develops at warmer temperatures later in the spring. Stem rust occurs on both wheat and barley. The stem rust pathogen does not usually survive on living wheat plants during the winter. It survives as dormant spores on straw and depends upon the common barberry for completion of its life cycle. In the spring, the dormant spores germinate and produce another type of spore that infects barberry leaves but not wheat. Spores produced on the barberry are the source of inoculum for the wheat in the spring. Therefore, elimination of the barberry would eliminate or reduce stem rust.

Historical Importance. In the late 1950's and early 1960's stripe rust caused losses in excess of 50 percent. Since then, destructive epidemics of stripe rust have occurred in fields of susceptible varieties in three out of four years. Stripe rust reduced yields in the Pacific Northwest by more than 20 percent in 1981 and more than 15 percent in 1983 and 1984. Without development of resistant varieties and emergency registration of a fungicide (Bayleton) for rust control, losses caused by stripe rust in Washington would have exceeded 50 percent in 1981 and 30 percent in 1983 and 1984.

As we develop varieties with better stripe rust resistance, leaf rust becomes more important because tissue not damaged by stripe rust is damaged by the later developing leaf rust. Consequently, leaf rust has become increasingly more important since 1962. Losses caused by leaf rust in susceptible varieties have exceeded 50 percent in some years. When not controlled, leaf rust has reduced yields by more than 15% in one out of two years since 1974. In irrigated fields, leaf rust can cause losses almost every year. Those losses have sometimes exceeded 60 percent in some fields. In 1980 to 1984, stem rust significantly damaged wheat and barley in eastern Washington and Oregon and northern Idaho, especially in late maturing fields.

Monitoring Rust. At least 42 races of _Puccinia striiformis_, the pathogen that causes stripe rust, have been identified. In 1989, races virulent on Fielder, Moro, Jacmar, Barbee, Faro, Weston, Tyee, Hatton, Tres, Owens, and seedlings of Stephens, Hill 81, and Daws were prevalent. New races that are virulent on several of the varieties have been detected. Most winter wheat varieties currently grown in the region are very susceptible to leaf rust. Since the current races can attack most varieties, there is no major selective pressure for new races of leaf rust. Consequently, no significant new races of _Puccinia recondita_, the pathogen causing leaf rust, were detected in 1989. We have more races of stem rust in the Pacific Northwest than in all of the other regions of the United States, and races of _Puccinia graminis_, the pathogen causing stem rust, are uniquely different from races in the other regions. The

Effect of Weather. The rusts are obligate parasites and must have a living host to grow on. The continual presence of living wheat plants throughout the year provides hosts for the rusts and adequate inoculum for initiation of new stripe rust and leaf rust epidemics. Also, many current varieties are susceptible to races of rust that occur in the region. Therefore, the factor that is most limiting for rust development is often the weather. When used in combination with monitoring data, a model for predicting stripe rust, based on winter and spring temperatures has proved to be reliable since 1979. When that information is used with precipitation data, it has enabled prediction of leaf rust and stem rust. In 1989, stripe rust, leaf rust, and stem rust developed late in the growing season because of unusually dry conditions in the fall and spring, and cold weather in February, which in some cases destroyed the wheat crop. Consequently, damage from the rusts only occurred in only a few fields. In general the fall, winter, and early spring weather for the 1989-90 season has been favorable for rust establishment and survival. Therefore, there is a potential for severe rust in fields of susceptible varieties.

Resistance. High-temperature, adult-plant resistance to stripe rust, which has now been incorporated into all major soft white winter wheats and most spring wheats (see Table 1), has continued to be durable against all races in the Pacific Northwest. In contrast, the high resistance expressed in both seedling and adult plant stages at all temperatures has been effective for three years or less. Information on the characteristics and inheritance of high-temperature, adult-plant resistance has been obtained, and that resistance has been or is being used in development of new resistant varieties. New information on the inheritance of race-specific resistance has been obtained, and that information and material should be useful in developing new disease control programs, identifying races, and understanding how resistance works.

We are currently evaluating the national germplasm collection for resistance to stripe rust in the field at Mt. Vernon and Pullman, WA and for specific resistance to the five most virulent stripe rust races in the greenhouse. The five races include all of the identified virulences in North America. As of this data, more than 30,000 germplasm entries have been evaluated in the field and half of those have been evaluated for resistance to the stripe rust races.

Studies of the inheritance of slow rusting resistance to leaf rust, have resulted in new information and germplasm for resistance to leaf rust. That germplasm should be useful in developing more durable leaf rust resistant wheats.

We are evaluating commercial varieties, advanced breeding lines from breeders in the Pacific Northwest, and differential cultivars for resistance to stripe rust and leaf rust. The information on resistance of germplasm and advanced lines should provide breeders with new sources of resistance, lead to a better understanding of how to use rust resistance, and improve the resistance of wheat varieties in the future.

Use of Fungicides. Resistance to all disease problems may be difficult or impossible to incorporate into a single variety, and new races of the pathogens are a frequent problem. Therefore, additional control measures are necessary. We have continued to study the use of fungicides for control of the diseases as part of an integrated disease control program. Foliar applications of Bayleton, Tilt, Folicur, Spotless, and ASC-66811 controlled stripe rust, leaf rust, stem rust, and powdery mildew, especially when applied at jointing to boot stages of growth, and effectively prevented wheat losses in the Pacific Northwest. Some of the chemicals also control leaf spotting fungus. Baytan and Folicur applied as seed treatments control early rust and mildew development, and if they are managed and prevent the delay in emergence, they provide significant yield improvement. Bayleton has been used since 1981 to control stripe rust and leaf rust when existing varieties become susceptible to new races and in combination with various types of resistance, and Tilt was registered for rust control in 1988. Baytan was registered as a seed treatment in 1989. Guidelines for the use of the chemical have been developed based on type of rust, type of resistance, intensity of rust, stage of growth, potential yield, and economic return.

Table 1. Seedling and adult plant resistance to stripe rust of cultivars grown in the Northwestern United States[a]

Cultivar	Stripe Rust Seedling	Stripe Rust Adult	Cultivar	Stripe Rust Seedling	Stripe Rust Adult
Soft White Winter Wheat			Hard Red Winter Wheat		
Madsen	R	R			
Stephens	S	R	Batum	S	R
Luke	S	R	Wanser	S	MR-MS
Lewjain	S	R	McCall	S	MS
Dusty	S	R	Centurk	S	MS-S
Daws	S	R-MR	Hatton	S	MS-S
Hill 81	S	R-MR	Weston	S	S
Malcolm	S	R-MR			
Hyslop	S	R-MR			
McDermid	S	MR-MS			
Nugaines	S	MR-MS	Soft White Spring Wheat		
Gaines	S	MR-MS			
Walladay	S	MS-S	Penewawa	S	R-MR
Yamhill	S	S	Edwall	S	R-MR
			Waverly	S	R-MR
Club Wheat			World Seeds 1	S	R-MR
Hyak	R	S	Urquie	S	MR-MS
Crew	R+S	R+S	Walladay	S	MS-S
Tres	S	MS-S	Fielder	S	MR-MS
Moro	S	S	Fieldwin	S	S
Jacmar	S	S	Twin	S	S
Barbee	S	S	Dirkwin	S	S
Paha	S	S	Owens	S	S
Tyee	S	S			

[a] R = resistant, MR = moderately resistant, MS = moderately susceptible, S = susceptible, and R+S = resistant plants and susceptible plants (multiline). High-temperature, adult-plant resistance is expressed as a range, except for highly resistant cultivars. Those cultivars currently susceptible in both the seedling and adult stage are resistant to older races in both the seedling and adult stage.

STRAWBREAKER FOOT ROT AND CEPHALOSPORIUM STRIPE

Timothy Murray, Cheryl Campbell Walter, and Larry Pritchett

Strawbreaker foot rot (eyespot) is one of the most important and chronic diseases of winter wheat in eastern Washington. Cephalosporium stripe (fungus stripe) is another important disease that can be devastating, but epidemics are more sporadic than foot rot. Both diseases are important on wheat seeded early on summer fallow, especially in areas with more than 16" annual rainfall, and where crop rotations are short (2 yrs or less). Early seeding is favorable to both diseases, but for different reasons. As plants become older and larger, they become more susceptible to infection by the fungus causing foot rot, *Pseudocercosporella herpotrichoides*, and they also provide larger targets for the spores of this fungus that are splashed around by rain. With cephalosporium stripe, root wounding is thought to be the primary mode of entry of the fungus, *Cephalosporium gramineum*, and the larger plants that result from early seeding have larger root systems and are more susceptible to winter root injury, and therefore infection. Yield losses of 50% can occur with strawbreaker and up to 100% when cephalosporium stripe is serious.

Cephalosporium stripe cannot be controlled with fungicides. The best controls for this disease are crop rotation and resistant varieties. A major problem in screening for resistance to cephalosporium stripe has been the lack of uniform disease development in plots and the low levels of resistance available to this pathogen. One of our primary goals has been to develop methods of inoculating plots for more uniform disease development to facilitate screening. One factor that we are investigating is the effect of increasing soil acidity (decreasing soil pH) on cephalosporium stripe. Tests are now being conducted in both the greenhouse and field to determine if soil acidity can be used to screen for resistance. Field experiments over the past three years have shown the potential for controlling cephalosporium stripe by liming. However, more work is needed to determine how liming affects disease development with different varieties and seeding dates. For example in our 1988 test, the percentage of stems with cephalosporium stripe was reduced by about 40% in both Daws and Stephens, but yield was increased significantly only in Stephens.

Currently, the most common control for strawbreaker foot rot is an application of a fungicide in the spring before jointing. Another goal of ours has been to insure the continued availability of effective fungicides. Last year we surveyed 70 eastern Washington and Oregon winter wheat fields and found 9 that had strains of the foot rot fungus that were resistant to Benlate, Mertect, and Topsin. It appears that there was reduced disease control and a significant yield loss in seven of those fields as a result of fungicide resistance. We are now recommending that all fields be carefully evaluated for foot rot before spraying a fungicide, which should be considered if 10% of the stems have foot rot lesions at spray time (before jointing). Fields sprayed five or more times since 1978 represent higher risks for development of fungicide resistance, than those sprayed less than five times. In these higher risk fields, a combination treatment of Tilt plus a half rate of Benlate, Mertect, or Topsin is the best choice for delaying or preventing development of resistance. Several new fungicides have been tested for use in combination with the current commercial fungicides (Table 1). When averaged over three sites with severe foot rot, both Tilt and Punch combinations have provided competitive disease control and yield responses (Table 2). This year we are testing several new experimental fungicides in trials with both fungicide-resistant and -susceptible strains of the fungus. We are again conducting an extensive survey of winter wheat for resistance in the pathogen to the currently-used fungicides. This information is vital for determining future fungicide use and the role of combination fungicide treatments.

Resistant varieties offer the best long-term solution for controlling strawbreaker foot rot, because they are the cheapest and most reliable. The recent release of the foot rot resistant varieties Hyak and Madsen, are milestones in research to control foot rot with genetic resistance and will be important tools for managing fungicide resistance. Incorporating resistance into commercial varieties has been difficult, partly because the mechanisms and genetics of resistance are not well-understood. We have been studying resistance to try and understand what makes a plant resistant and how resistance is controlled genetically. This year our emphasis is again on the genetics of resistance in adult plants in the field to back-up the results from the lab and greenhouse. We have about 200 progeny lines, selected from crosses between resistant and susceptible parents, planted in two-row plots. One-row of each plot is inoculated so we can evaluate disease resistance and yield loss. From this we hope to be able to estimate the levels of resistance necessary for economic control of foot rot.

Table 1. 1988-89 Strawbreaker Foot Rot Foliar Fungicide Efficacy Trial, Miller Farm, Garfield, WA

Treatment/Rate (a.i./ac)	DI[a] 0-100	DB[b] 0-4	Yield, bu/ac	Test Wt., lbs/bu
Benlate 80DF 1.0 lb	20.8[c]	1.3	84.2	60.4
Benlate 50DF 0.5 lb	31.0	1.5	84.5	59.9
Benlate 80DF 0.5 lb	31.2	1.7	89.8	60.1
Topsin 4.5F 9.2 oz	35.8	1.5	86.2	59.8
Tilt + Benlate 50DF 1.7 oz + 0.25 lb	44.0	1.6	86.2	59.6
Mertect DF 10.6 oz	46.4	1.7	79.7	59.7
SAN 709F 16.9 fl. oz product	52.4	1.7	86.2	59.6
EXP10064A 0.3 lb	54.8	1.7	82.1	59.1
DPX H6573 40EC 2.0 oz	61.3	1.8	74.6	58.8
Tilt + Mertect 89DF 1.7 oz + 5.3 oz	63.3	1.8	87.1	49.6
EXP10064A + Rovral 4F 0.3 lb + 0.4 lb	65.0	1.7	79.7	59.5
Rovral 4F 0.4 lb	65.1	1.9	80.0	58.9
Tilt 3.6E 1.7 oz	65.5	1.9	88.1	59.6
Tilt + CGA163935 250E 1.7 oz + 1.7 oz	70.9	1.8	84.5	59.5
DPX H6573 40EC 1.0 oz	70.9	2.0	82.3	59.0
Tilt + CGA163935 250E 1.7 oz + 1.0 oz	71.3	1.9	74.3	58.9
Untreated Control	73.8	2.1	80.6	58.8
LSD (P=0.05)=	13.1	0.3	NS	0.8

[a]-DI= Disease incidence; figures are the percentage of stems with symptoms evaluated 7/12-18/89.

[b]-Disease severity is based on a 0-4 scale where 0=a healthy stem, and 4=a dead stem.

[c]-Figures represent the mean of six replicates of Hill 81 wheat seeded 9/28/88.

Table 2. Performance of "standard" foot rot fungicide treatments and combination treatments in three years of field testing.

Treatment[a]	Disease Severity[b]	Yield, bu/ac
Benlate DF + Punch	0.9	103.1
Benlate DF	0.9	102.1
Punch	1.6	101.3
Benlate + Tilt	1.2	99.6
Tilt	1.8	88.6
Untreated Control	2.3	77.9

[a]-Treatment rates are the equivalent of 0.5 lb active ingredient/acre for Benlate alone, or 0.25 lb active ingredient/acre in combination. Rates for Tilt and Punch are 4 oz and 2.5 oz product/acre, respectively.

[b]-Disease severity is based on a 0-4 scale, where 0 is a healthy stem, and a 4 is a dead stem at heading stage.

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Luke Wheat	EC0378	.25
Sprague Wheat	EC0390	.25

2. Plant Diseases:

Take-All in Wheat: New Developments for Control	EB0988	.25
Barley Yellow Dwarf Virus in Winter Wheat	EB1002	.25
Foot Rot of Wheat	EB1378	.50

3. Insects:

None

4. Weeds:

Weed Control in Winter Wheat	EB0599	.50
Weed Control in Irrigated Wheat	EB0760	.25
Weed Control in Wheat, Western Washington	EB1079	.25

5. Soils and Fertilizer:

Fertilizer Guide: Winter Wheat and Barley for Western Washington	FG0017	.25
Fertilizer Guide: Spring Wheat, Barley and Oats for Western Washington	FG0048	.25
Fertilizer Guide for Winter Wheat, Eastern Washington Dryland Area	EB1390	.50
Fertilizer Guide, Winter Wheat (Soft White) Central Washington Irrigated	EB1487	.25
Nitrogen Fertilizer Use During Drought in Wheat Area of Eastern Washington	EM4264	.50
Holding Back Nitrification in the Dryland Wheat Area of Eastern Washington	EM4504	.25

Fertilizer Guide: Winter Wheat for Central Washington	FG0031	.25
Fertilizer Guide: Dryland Wheat Nitrogen Needs for Eastern Washington	FG0034	.25
Fertilizer Band Location for Cereal Root Access	PNW0283	.50
6. Conservation:		
Yields of Four Spring Wheat Varieties in Conv., Min., and No-Tillage Systems	EB1094	.25
Crop Residue Management in No-Tillage Winter Wheat in Precip. Over 18 In./Yr.	EM4576	.25
7. Irrigation:		
Irrigated Winter Wheat Production	EB0916	.25
Irrigated Spring Wheat in Washington	EB1111	.25
Wheat Irrigation	EM3048	.25
8. Miscellaneous:		
Wheat Seed Quality	EB1309	.25
Frost Damage on Wheat	EC0398	.25
Postharvest Dormancy of Wheat	EM3890	.25
Growing Winter Wheat in Western Washington	EM4618	.25

BARLEY

1. Varieties:		
Boyer Winter Barley	EB0678	.25
Blazer Spring Malting Barley	EB0679	.25
Advance Barley	EB0720	.25
Andre Spring Barley	EB1249	.25
Showin Winter Barley	EB1394	.25
Cougbar Spring Barley	EB1476	.25
Vanguard Barley	EC0385	.25
Steptoe Barley	EC0392	.25
2. Soils and Fertilizer:		
Fertilizer Guide: Winter Wheat and Barley for Western Washington	FG0017	.25
Fertilizer Guide: Spring Wheat, Barley and Oats for Western Washington	FG0048	.25
Spring Barley in Eastern Washington--Fertilizer Trial Results	EB1260	.25
Fertilizer Guide: Barley for Eastern Washington	FG0029	.25
3. Conservation:		
Yields of Four Spring Barley Varieties in Conv., Min., and No-Tillage Systems	EB1093	.25

TRITICALE

1. Varieties:		
Flora: A Winter Triticale	OR/EC1244	.50
Triticale	PNW331	.25

OATS

1. Varieties:		
Cayuse Oats	EC0358	.25
2. Soils and Fertilizer:		
Fertilizer Guide: Spring Wheat, Barley and Oats for Western Washington	FG0048	.25

PEAS, LENTILS AND CHICKPEAS:

1. Varieties:		
Garfield and Tracer Alaska Type Peas	EB0699	.25
Brewer Lentils	EB1408	.25
2. Insects:		
Pea Leaf Weevil: Its Biology and Control	EB0903	.50
Insects of Peas	PNW0150	.50
3. Soils and Fertilizers:		
Fertilizer Guide: Peas and Lentils for Eastern Washington	FG0025	.25
4. Miscellaneous:		
Description and Culture of Lentils	EB0957	.50
Description and Culture of Chickpeas	EB1112	.50
Dry Pea and Lentil Production in the Pacific Northwest	ID/B578	.25