WSU FIELD DAYS

June 25, 1981

Dry Land Research Unit, Lind

June 30, 1981

Palouse Conservation Station
Field Day, Pullman

July 9, 1981

Spillman Farm, Pullman

DEDICATION

We wish to use the 1981 Field Day Brochure to honor Mr. George F. Varner, who has served as the Spillman Farm Manager since March, 1974. George will retire this summer, and shortly after Spillman Field Day, he and Mrs. Varner will move to the Connell area.

George joined Washington State University in April, 1956, which makes him a member of the Quarter Century Club. Old hands in the department—and younger ones too—have learned that it doesn't take a lot of noise to get a job done. In his quiet way, George has managed the Spillman operation so effectively that the casual observer would not realize how much time and effort has been expended in getting the fields ready for research plot work, rotation for soil conservation, and clean-up each fall.

Spillman Farm has been a source of pride to the citizens of Washington for many years, and George Varner's stewardship has played a big role in maintaining the quality of operation that justifies that pride.

We take this opportunity to salute George Varner and wish him and Mrs. Varner a long and healthy retirement period. It is richly deserved.

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HISTORY OF 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 of information 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 $6000 to start the station and the land has been donated by the county. In the early 30's 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. Dr. 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 certain problems, which, because of special conditions such as climate, soil, etc., cannot be studied at a central station." For over fifty 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 has 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 machine storage built shortly after the station was established. The old barn was dismantled in April 1973 and the residence in 1979. A small elevator 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 Commissions 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. With the addition of a 12' x 60' trailer house residence 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. The major portion of the research has centered around 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. 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 64th field day. Visitors are welcome at any time. Their suggestions are appreciated.

IRRIGATION AT THE DRY LAND RESEARCH UNIT

Every year the question is raised as to why irrigation is used on an experiment station which is located in, and devoted to, research for the wheat-summerfallow area of Eastern Washington.

In the research conducted on the station, irrigation serves one or more of five purposes: 1. Insures the establishment of a good stand of wheat where the main purpose of the research would fail with an inadequate stand. Instances of this use are the dryland foot rot trial where plants must be stressed to fully express the disease, fertilizer trials, and disease nurseries. 2. Foliar diseases, leaf rust and stripe rust, are much more severe under irrigation, due to the heavier foilage and the fungi's requirement of free water on the plant leaves for infection. The foot rots, strawbreakers and take-all (a problem only under irrigation) are more severe and it is easier to obtain infection with the aid of water management. 3. Irrigation aids in stand establishment and in increasing the volume of seed harvested where a limited quantity of seed is available for testing and increase as in the case of seed from individual seeds or plants. 4. Certain agronomic traits, such as lodging resistance, shatter resistance, tillering capacity, potential yield capacity, and plant height are more readily determined from one or two seasons under irrigation than from many years of testing on dry land. 5. With an increase in irrigation and supplemented irrigation in the area, there is a need for research in these areas. One experiment on the station is concerned with annual cropping winter wheat under supplemental irrigation. The irrigated winter and spring wheat trials are designed to determine the agronomic trials which cannot be easily determined under dry land conditions as well as test the selections for yield and quality under irrigated culture.

The primary purpose of irrigation on the Dry Land Research Unit is not to aid in the development of wheats for higher rainfall and irrigated agriculture, but to speed up and aid in the development of better varieties for the dryland wheat summerfallow region.

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 1880's.

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.

George Varner was appointed farm manager in 1974.

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 moisure utilization is greater under our rainfall pattern with lower evaporation-transpiration rates during the months of maximum precipitation in both summerfallow and crop years.

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

Month	Temperature °F.		Precipitation		Precipitation
	Max.	Min.	1980	1981	60 yrs. av. (in)
January	34	22	1.44	.23	1.04
February	42	24	1.47	.79	.88
March	53	32	.68	1.23	.73
April	63	35	.64		.66
May	72	42	2.68		.78
June	83	45	.67		.86
July	90	52	.05		.24
August	90	50	.42		.35
September	79	45	1.12		.54
October	65	38	1.03		.86
November	47	29	1.09		1.20
December	37	26	2.30		1.27
			13.59		9.41

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 1. Temperature and Precipitation at Palouse Conservation Field Station, Pullman, 1980 and 1981

Month	Average Temperature °F		Precipitation				
	Max.	Min.	30-Yr. Avg.*	Monthly	Total Accum.	Deviation from Avg. Monthly	Deviation from Avg. Accum.
1980							
January	30.0	16.3	2.79	3.08	3.08	+0.29	+0.29
February	40.3	29.4	2.06	1.50	4.58	−0.56	−0.27
March	44.4	30.4	1.84	2.42	7.00	+0.58	+0.31
April	60.2	39.7	1.55	1.21	8.21	−0.34	−0.03
May	61.6	41.9	1.53	3.14	11.35	+1.61	+1.58
June	65.6	44.7	1.65	1.88	13.23	+0.23	+1.81
July	78.1	49.9	0.45	1.11	14.34	+0.66	+2.47
August	75.9	44.3	0.64	0.57	14.91	−0.07	+2.40
September	71.2	45.1	1.14	1.35	16.26	+0.21	+2.61
October	61.3	37.6	1.83	0.77	17.03	−1.06	+1.55
November	44.9	32.3	2.66	2.41	19.44	−0.25	+1.30
December	41.3	29.3	2.67	3.58	23.02	+0.91	+2.21
TOTAL	56.2	36.7	20.81	23.02	23.02	+2.21	+2.21
1981							
January	40.4	31.2	2.79	1.04	1.04	−1.75	−1.75
February	41.5	28.8	2.06	3.31	4.35	+1.25	−0.50
March	51.7	31.7	1.84	2.30	6.65	+0.46	−0.04
April	54.2	36.2	1.55	2.22	8.87	+0.67	+0.63
TOTAL	46.9	32.0	8.24	8.87	8.87	+0.63	+0.63
1981 CROP YEAR Sept. 1980-April, 1981			16.54		16.98		+0.44

*Thirty-year average for precipitation, 1941-1970

MT. ST. HELENS ASH: PAST AND PRESENT

Kenneth J. Morrison
Extension Agronomist

On May 18, 1980, shortly after 8:20 a.m., Mount St. Helens produced a massive volcanic eruption. By mid-afternoon most of the wheat producing area in eastern Washington was receiving a volcanic ash deposit. At the same time, total darkness descended upon the area. Volcanic ash continued to fall for almost 24 hours. By the time the ash had stopped falling on Monday, the deposition varied from almost 0 in the Walla Walla area and increased north through the wheat area beyond Spokane. The heaviest concentration occurred in Grant, Adams and Whitman counties with the Rosalia, Ritzville and Moses Lake areas receiving up to 3 inches of uncompacted ash.

Additional smaller eruptions occurred on May 25, June 12 and July 22. The fallout in the wheat producing area was minor compared to the May 18th eruption. The May 25 and June 12 eruptions deposited ash in southwest Washington and Northwest Oregon.

On Thursday, May 22nd, rains moved into eastern Washington, washing some ash off plants and reducing wind-blown ash.

Rain continued through May, June and July with the precipitation 1.68 inches above the average at Pullman for May, 1.34 inches above average for June and .72 inches above average for July. The temperatures were 3.6 °F below maximum for May, 5.6 °F for June and 4.4 °F for July. The mean maximum temperatures for May was 61 °F, 65 °F for June and July was 78 °F.

Growers were concerned with physical effect, as well as chemical effect, the ash might have on their crops. The rain washed the ash off of the grain, pea and lentil crops with very little damage occurring. Alfalfa that was ready for harvest or in the windrow was lost.

The following table gives the composition of the ash that fell in the Pullman area compared to a Palouse soil. Sulfur was the only fertilizer element of value in the ash. The salt concentration was considerably higher than the Palouse soil and some salt damage did occur.

COMPARISON OF ASH & SOIL AS RELATED TO BIOLOGY*

	ASH (May 18, 1980)	PALOUSE SOIL
pH	5.6 - 6.3	5.5 - 6.8
% Organic Matter	0	2.5 - 3.5
P (ppm)	1 - 3	1 -12
K (ppm)	90 - 160	75 - 300
Ca (meg/100g)	2.7 - 4.5	7 - 10
Mg (meg/100g)	0.4 - 0.7	1 - 3
Cu (ppm)	3.0 - 5.0	0.5 - 2.0
B (ppm)	0.85- 1.2	0.2 - 0.5
Mn (ppm)	10.0 -16.0	1.0 - 20.0
Zn (ppm)	0.5 - 0.8	0.15- 0.8
Fe (ppm)	14.0 -20.0	2 -50
Cd (ppm)	0.03- 0.05	0.05- 0.2
Cl (ppm)	200 - 500	Trace
SO_4 (ppm)	150 - 450	1 -10
Soluble salts (mmhos/cm)	4.5 - 5.5	0.3 - 0.8

*Soil Testing Laboratory, Washington State University

In the first days following the ash deposit, crop damage estimates were considerably higher than the actual losses that did result from the ash deposits. Alfalfa was damaged the most because it was harvested or ready for harvest and the ash caused excess lodging or covered the hay that was already cut. A few fields of wheat or part of the fields were lodged by the ash. Some of the heavily lodged areas were impossible to harvest because of the ash and the lodging.

Crop growth was slowed for about 10 days to 2 weeks following the ash deposit but the cool weather with the extra precipitation produced the largest wheat crop Washington ever produced and the barley yields were phenomenal, as were the pea yields. Some damage did occur on lentils but it was minimal considering the early estimates of damage.

The lighter colored ash caused increased light reflection from the soil surface resulting in lower peak soil temperatures and less water evaporation. The ash made harvest disagreeable and increased the wear on equipment. The engine wear was not excessive due to the filtering systems used but bearings, belts, pulleys, sheaves and non-lubricated wear points showed excessive wear due to the abrasive action of the volcanic ash.

Growers incorporated the ash in the summer fallow land. Ash on unincorporated surfaces slowed water penetration resulting in greater run-off. The ash does not appear to be a major factor in increased run-off and erosion in the future.

Because of the ash deposit on the Dryland Research Unit at Lind, the Field Day was cancelled. It had been scheduled for June 19 but the roads and plots were covered with about 2 to 2½ inches of uncompacted ash that created a dust cloud when disturbed, as was the Palouse Conservation Station Field Day north of Pullman. With the vehicle traffic on the roads and the foot traffic in the plot area, the decision was reached to cancel the Field Days.

RECOMMENDED VARIETIES—WHEAT, OATS, BARLEY

AREA	WINTER WHEAT	SPRING WHEAT	OATS	SPRING BARLEY	WINTER BARLEY
EASTERN WASHINGTON					
14 Inches or More Rainfall	Nugaines Luke Daws Barbee Stephens Faro Tyee	Urquie Dirkwin	Cayuse Park Appaloosa	Steptoe Advance Larker—malting barley Belford—for hay only Vanguard—malting barley Blazer—malting barley Kimberly	Kamiak Boyer
EASTERN WASHINGTON					
Less Than 14 Inches Rainfall	Wanser McCall Moro Nugaines Sprague Barbee Faro Hatton Tyee	Sawtell Wampum Wared Twin Urquie		Steptoe	
CENTRAL WASHINGTON					
Under Irrigation	Nugaines Daws Stephens Walladay Wandell (Durum)	Urquie Sawtell Wared Wampum	Cayuse Park Appaloosa	Klages Steptoe Belford—for hay only	Boyer
Snow Mold Areas	Sprague				

WHEAT, OATS, AND BARLEY

Kenneth J. Morrison
Washington State University

Winter Wheat

Nugaines

Nugaines is a soft white semidwarf winter wheat with excellent test weight, milling, and baking properties. The variety has a bearded, common-type head with white chaff.

Nugaines is not as winterhardy as Daws or the hard red winter wheats McCall or Wanser but is hardier than Luke and Paha.

Nugaines has good mature plant resistance to stripe rust but is susceptible to stripe rust in the seedling stage. It is also susceptible to leaf rust, dwarf bunt, snow mold, and *Cercosporella* foot rot.

Nugaines is resistant to most races of common bunt and has moderate resistance to flag smut and *Cephalosporium* stripe (fungus stripe). Nugaines was developed by SEA-USDA and Washington State University.

Luke

Luke is a late maturing soft white semidwarf winter wheat. Luke is resistant to most races of common and dwarf bunt and is well-adapted to areas where dwarf bunt is a problem. This variety is slightly better than most commercial varieties in resistance to *Cercosporella* foot rot, snow mold, and stripe rust. Luke is moderately susceptible to leaf rust, flag smut, and *Cephalosporium* stripe (fungus stripe). It emerges well for a semidwarf.

Luke is less winterhardy than Nugaines. The milling quality is unusually good for soft white wheat and the baking quality is similar to Nugaines. Its resistance to lodging and shattering are slightly less than that of Nugaines. Luke was developed by SEA-USDA and Washington State University.

Daws

Daws is a soft white common semidwarf winter wheat. The variety has about a 5-percent yield advantage over Nugaines. It is more winterhardy than Nugaines but is not as hardy as Wanser or McCall.

Daws has good milling property and the flour quality is satisfactory. The variety emerges slower than Nugaines. Daws has good stripe rust resistance but is susceptible to *Cercosporella* foot rot, snow mold, dwarf smut, and *Cephalosporium* stripe (fungus stripe). It is moderately susceptible to leaf rust. Daws was developed by SEA-USDA and Washington State University.

Stephens

Stephens is a soft white common wheat released at Oregon that is resistant to stripe rust and common smut. It is moderately resistant to *Cercosporella* foot rot. Stephens is susceptible to leaf rust, dwarf smut, flag smut, snow mold, and *Cephalosporium* stripe (fungus stripe). It is similar to

Nugaines in emergence. The grain yields of Stephens are slightly higher than Nugaines, McDermid, and Hyslop. Stephens has the same winterhardiness as Hyslop. The milling and flour qualities of Stephens are similar to that of Nugaines. Stephens was developed by Oregon State University.

McDermid

McDermid is a semidwarf soft white common winter wheat. It has weaker straw than Hyslop. McDermid has more winterhardiness than Hyslop but is not as hardy as Nugaines.

McDermid is similar to Nugaines in common smut reaction but is susceptible to most races of dwarf smut and *Cephalosporium* stripe (fungus stripe). The variety is moderately resistant to stripe rust and leaf rust. McDermid has shown a slightly lower yield than Nugaines in yield trials in Washington. The variety has performed the best in the northcentral areas of Oregon and southern areas of Washington. The milling and flour characteristics of McDermid are similar to Nugaines. McDermid was developed by Oregon State University.

Hyslop

Hyslop is a soft white semidwarf winter wheat that yields well in high rainfall areas or with irrigation. Hyslop has a slightly better yield record than Nugaines where winter injury is not a factor. Insufficient winterhardiness limits the use of Hyslop in eastern Washington. Coldhardiness tests have shown Hyslop to lack the winterhardiness of such varieties as Paha, Luke, McDermid, Nugaines, and Daws.

Hyslop is resistant to common bunt, stripe rust, and susceptible to dwarf smut, flag smut, leaf rust, and *Cephalosporium* stripe (fungus stripe).

Milling and baking qualities of Hyslop are similar to Nugaines. Hyslop was developed by Oregon State University.

Sprague

Sprague is a soft white common wheat developed for the snow mold areas. The chaff varies white to gray-brown; the heads are small and awned. It has high tillering capacity from early seedings but the straw is weak. The test weight of Sprague is below Nugaines but is has been above 60 pounds per bushel.

Sprague has good resistance to snow mold and common bunt but is susceptible to dwarf bunt, stripe and leaf rusts, and *Cercosporella* foot rot.

It has excellent emergence and good winterhardiness. Sprague was developed by SEA-USDA and Washington State University.

Barbee

Barbee is a semidwarf soft white club winter wheat with a bearded head. The variety has a slightly higher yield record than other club wheats. Barbee is not as good as other club wheats in emergence.

The variety has good stripe rust resistance and is resistant to flag smut and most races of dwarf smut, and moderate resistance to *Cephalosporium* stripe (fungus stripe). It produces an excellent flour but it mills more like a soft white common wheat variety than a club wheat variety.

Barbee is expected to replace Paha because of the higher yield record and better stripe rust resistance. Barbee was developed by SEA-USDA and Washington State University.

Tyee

Tyee is a soft white club winter wheat with compact heads and awnless white chaff. It is a semidwarf wheat that is medium in maturity. The variety has high resistance to stripe rust that is different from the resistance in Moro, Barbee, and Faro.

The emergence is about the same as Paha. Emergence would be slower than Moro. The variety is moderately susceptible to flag smut. It has about the same common bunt or common smut resistance as Nugaines. It is susceptible to dwarf bunt. Tyee has the same susceptibility to leaf rust as Barbee, Faro, and Moro. The variety is highly susceptible to mildew. Tyee has about the same tolerance to strawbreaker foot rot as Barbee. It is more tolerant than Paha or Nugaines. Data is not available on *Cephalosporium* stripe (fungus stripe).

Tyee has high yielding ability, exceeding Paha, Moro, and Barbee and often better than Faro. It has test weight comparable to Moro and Barbee. It is 1 to 2 inches taller than Faro, 1 to 5 inches taller than Nugaines, and 5 inches shorter than Moro. Tyee has more lodging resistance than Paha and considerably more resistance than Moro.

The variety has about the same winterhardiness as Nugaines and, under some conditions, may prove to be better than Nugaines.

The quality of Tyee is similar to Moro but somewhat lower in quality than Paha. It may be superior to Faro for low ash content and increased cookie diameter. The variety was developed by wheat breeding and production of USDA-SEA-AR and released jointly by the Washington, Oregon, and Idaho Agriculture Experiment Stations.

Paha

Paha is a short, standard height, white club wheat. It is susceptible to some races of stripe and leaf rusts, powdery mildew, and flag smut. It has moderate resistance to *Cercosporella* foot rot and *Cephalosporium* stripe (fungus stripe). The variety is resistant to lodging and shattering. Good germination and emergence characteristics of the selection are similar to other club wheats but not as good as Moro.

The variety is adapted to areas that produce the quality of club wheats desired by domestic and foreign markets. Paha was developed by SEA-USDA and Washington State University.

Faro

Faro is a semidwarf soft white club. It has a good yield record in the southern part of the wheat-producing area but does not have as good emergence as Moro. Faro is resistant to stripe rust and common bunt but is susceptible to flag smut, snow mold, and dwarf bunt. It is moderately resistant to dwarf bunt, foot rot, and *Cephalosporium* stripe (fungus stripe). Faro has equaled or exceeded the grain yields of Paha and it is similar to Paha in emergence and winterhardiness. Faro was developed by Oregon State University.

Moro

Moro is a soft white club winter wheat with brown chaff. Its chief advantages are resistance to stripe rust and excellent emergence. It is susceptible to leaf rust. When stripe rust is severe, Moro produces much better yields than stripe rust susceptible varieties. Moro is resistant to most races of dwarf bunt and common bunt. Moro is moderately resistant to *Cephalosporium* stripe (fungus stripe).

Moro is a good pastry flour; however, it has a higher flour viscosity than other club varieties. Moro is a medium-tall club variety with white kernels. Moro does not have the high yield potential of other club varieties in the higher rainfall areas. In the lower rainfall areas of Washington, where it is difficult to obtain stands with other varieties, Moro will germinate and emerge much better than other varieties from deep seedings in dry, dusty seedbeds. Moro was developed by Oregon State University.

Wanser and McCall

Wanser and McCall are hard red winter wheats developed for low rainfall areas of Washington. Both varieties yield well in areas that have less than 13 inches of annual rainfall. The two varieties can be distinguished by chaff color. Wanser has a brown-chaffed head and McCall has a white-chaffed head. Both have bearded, lax spikes.

Both varieties are resistant to common smut and most races of dwarf bunt. Wanser shows superiority over McCall in stripe rust tolerance and winterhardiness is important for maximum production.

McCall is well-adapted to the northern section of the Big Bend area, including Douglas, Grant, and Lincoln Counties. McCall is superior to Wanser in both snow mold tolerance and emergence from deep seedings—two qualities important to production in that area. McCall recovers rapidly in the spring which is another advantage for the northern area.

McCall has good winterhardiness, but less than Wanser. Both Wanser and McCall are more winterhardy than Nugaines, Daws, or the club wheats. Wanser and McCall are shatter resistant.

Wanser mills better than McCall. McCall has slightly better bread-baking qualities than Wanser. Neither is suitable for production of soft white wheat products. Wanser and McCall were developed by SEA-USDA and Washington State University.

Hatton

Hatton is a hard red winter wheat variety with a white-chaffed common type head. The variety is slightly taller and later maturing than Wanser. It has a higher yield record than Wanser. The variety has better stripe rust resistance than Wanser. It is susceptible to dwarf bunt, snow mold and Cercosporella foot rot.

Straw strength, shatter resistance and emergence are equal to Wanser. Winter hardiness is slightly better than Wanser. Milling and baking qualities are similar to Wanser and McCall for bread baking.

Hatton was developed by SEA-USDA and Washington State University.

Spring Wheat

Urquie

Urquie is a semidwarf, awned, white-chaffed, soft white spring wheat developed by Washington State University and SEA-USDA.

Urquie is lodging resistant. The test weight of Urquie is equal to that of Fielder and superior to that of Twin. Urquie is expected to yield competitively with Fielder and Twin, especially in the low rainfall areas of Washington. Urquie is resistant to many prevalent races of stripe rust but is susceptible to leaf rust and has moderate susceptibility to mildew.

Fielder

Fielder is a soft white spring wheat developed by SEA-USDA and the Idaho Branch Experiment Station at Aberdeen, Idaho. Fielder is a semidwarf, stiff-strawed, white-chaffed, awned variety with moderate resistance to common races of leaf rust but is susceptible to a new race present in the area. Fielder has moderate resistance to earlier races but is highly susceptible to a recently prevalent race of stripe rust, and is moderately susceptible to mildew. Fielder has established a higher yield record than Twin or Marfed in the higher rainfall areas of eastern Washington. Fielder yields about the same as Marfed in lower rainfall areas. Test weight of Fielder averages about 2 pounds per bushel more than Twin and about the same as Urquie.

Fieldwin

Fieldwin is a bearded, white-chaffed, semidwarf wheat released in 1977. Compared to Twin, grain test weight is nearly 2 pounds per bushel greater, maturity about two days earlier, and height about 1 inch taller. Fieldwin is moderately resistant to powdery mildew and leaf rust and moderately susceptible to stripe rust. Milling and baking qualities are good. Fieldwin was developed by SEA-USDA and the Idaho Experiment Station at Aberdeen, Idaho.

Dirkwin

Dirkwin is a beardless, white-chaffed, semidwarf wheat released in 1978. It is a very widely-adapted variety, yielding well under both droughty and high-producing conditions. Compared to Twin, Dirkwin is similar in plant height, test weight, and heading date. Dirkwin is resistant to powdery mildew and moderately resistant to leaf rust and stripe rust. The milling and baking qualities of Dirkwin are satisfactory. Dirkwin was also developed by SEA-USDA and the Idaho Experiment Station at Aberdeen, Idaho.

Wared

Wared is a hard red spring wheat evaluated and released by Washington State University and SEA-USDA. The original crosses and selections were made by Minnesota as part of the United States Department of Agriculture, Agricultural Research Service, and University of Minnesota wheat research programs. Wared has an awned, white-chaffed head with semidwarf plant-type growth. The variety is slightly earlier maturing than Marfed. Wared has a higher yield record than Peak 72 and has excellent milling and baking qualities when grown on dryland or with irrigation.

Wampum

Wampum is a new "tall" semidwarf hard red spring wheat developed by Washington State University and SEA-USDA. The straw is lodging resistant. Yields are higher than Wared and equal to Fielder under irrigation. It is resistant to leaf and stripe rusts. Wampum has excellent milling and bread baking qualities.

Sawtell

Sawtell is a semidwarf hard red spring wheat developed by SEA-USDA at the Aberdeen, Idaho, station. In Washington, Sawtell has sometimes shown higher yield potential under low rainfall conditions than other hard red spring wheats; however, it was inferior to Wampum in 1978. Under irrigation, its performance has not been exceptional but appears similar to other hard red spring wheats. Under some conditions, it has tended to produce grain of about 1 percent lower protein than other hard red spring varieties. Sawtell is moderately susceptible to stripe and leaf rusts and is moderately susceptible to mildew. In 1978, Sawtell was highly susceptible to both leaf and stripe rusts at Pullman.

Borah

Borah is a bearded, white-chaffed, semidwarf wheat released in 1974. Compared to Twin, grain test weight is about 3 pounds per bushel greater, maturity is five days earlier, and height is about 1 inch shorter. Borah is resistant to leaf and stripe rusts and has good milling and baking qualities.

Facultative Wheats

Walladay

Walladay is a soft white, semidwarf, facultative wheat developed by Washington State University and SEA-USDA. The variety has an awned common white-chaffed head. Kernels are white and mid-size. The variety is adapted to fall seedings in southeast Washington wheat-producing areas. The winterhardiness is not adequate to recommend growing Walladay in the other wheat-producing areas as a winter wheat.

From fall seedings in southeast Washington, yields of Walladay are competitive with Nugaines. From spring seedings, the variety is competitive with Fielder and Urquie.

Walladay is very susceptible to *Cercosporella* foot rot. The variety is moderately resistant to stripe rust, resistant to previous leaf rust, but susceptible to a new leaf race recently in the area. Walladay is slightly earlier than Luke but is a later maturing variety than Urquie or Fielder when spring seeded.

Spring Barley

Steptoe

Steptoe is a 6-row, rough-awned, spring nonmalting barley with a high yield record. The test weight is high. Steptoe heads later than most 6-row varieties. The variety has stiff straw with good lodging resistance. The straw is medium tall. The heads are erect with rough awns. The variety is not acceptable for malting. Steptoe was developed by Washington State University.

Advance

Advance is a 6-row spring variety with good potential as a malting variety. The variety has low or no cold tolerance and, therefore, it is very likely to winterkill which will reduce the problem of volunteer barley in subsequent crop rotations. This is especially important when wheat is grown after barley.

This extreme earliness will permit Advance to mature under more favorable conditions. Advance is a short, stiff-strawed variety. Additional 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.

Advance has a tendency to develop thin kernels under adverse conditions. The variety does produce more plump and less thin kernels than Blazer. Advance was developed by Washington State University.

Blazer

Blazer is a 6-row malting-type barley with rough awns. Blazer is expected to replace Traill and Larker, midwest malting barleys presently grown in Washington, Oregon, and Idaho. Blazer produces higher yields than Traill and Larker and has greater resistance to shattering and lodging.

Blazer yields in eastern Washington have averaged 500 to 700 pounds higher than Traill and Larker.

Test weight of Blazer is slightly lower than Traill or Larker but plump kernel percent is about the same as Traill. The variety was developed by Washington State University.

Karl

Karl is a mid-season, white-kerneled, midwest malting-type barley with rough awns. It averages about 8 percent higher than midwest types. Karl is usually 3 to 4 inches shorter and heads earlier than Traill. It has good test weight and kernel weight. It is slightly superior in shattering resistance.

Although Karl is generally equal to or superior to Traill in agronomic performance under irrigation, it is more susceptible to lodging and shattering than varieties such as Steptoe. It is not well-adapted to production on nonirrigated land in very low rainfall areas. The variety was developed by SEA-USDA and the University of Idaho.

Larker

Larker is a white-kerneled, semismooth-awned, 6-row malting barley. It has moderate resistance to lodging and is high in test weight. Larker yields have been low. It heads earlier than Traill. It is moderately susceptible to the smuts and powdery mildew and resistant to stem rust. It may have some tolerance to barley yellow dwarf virus.

Vanguard

Vanguard is a 2-row malting barley recommended for nonirrigated areas. It has good lodging resistance. Vanguard matures about the same and is the same height as other 2-row varieties. It is a 2-row, spring barley with rough awns. The seed size is slightly smaller than Piroline. The malting quality is slightly below Klages and Kimberly but the yield has been higher on nonirrigated tests.

Klages

Klages is a 2-row malting barley adapted to production with irrigation. The variety is not well-adapted to low-moisture dryland situations. Klages has been classified as acceptable for malting and brewing by the Malting Barley Improvement Association.

Klages has stiff straw and the beards are rough. It is mid-season in maturity.

The variety has excellent malting quality but does not have as high yield record in Washington tests as other 2-row malting varieties. Klages was developed by the University of Idaho.

Kimberly

Kimberly is a 2-row spring malting barley variety released by the SEA-USDA and the Idaho and Oregon Agricultural Experiment Stations. Kimberly has averaged higher yields than Klages and has been similar to Klages in test weight, plump kernel percent, height, and lodging in irrigated trials. It has performed similar to Klages in nonirrigated trials in yield. The variety is mid-season in maturity with long heads that have rough awns. The variety is similar to Klages in malting trials.

Belford

Belford is a 6-row, hooded or awnless variety of spring barley developed by Washington State University. It is mid-season in maturity and medium tall. The straw is relatively weak. Belford is recommended for hay and only in eastern Washington high rainfall areas and in central Washington under irrigation.

Winter Barley

Kamiak

Kamiak is a 6-row winter barley. It has produced high yields in tests. Kamiak has good winterhardiness with large kernels. It is more lodging resistant with short straw. The test weight of Kamiak is high. The variety matures in mid-season. Kamiak does not have small, glume hairs which cause "itching" during threshing.

Kamiak performs well in eastern Washington. Kamiak was developed by Washington State University.

Boyer

Boyer is a 6-row, white kerneled, winter barley variety with rough beards but it does not have the severe "itching" characteristics of other winter varieties.

The variety has relatively short, stiff-straw with a high yield record. Boyer is slightly more winterhardy than other varieties except Kamiak. Boyer has shorter straw than the other winter barleys with 15 percent less lodging.

The kernels of Boyer are larger and plumper than other winter barleys. Boyer was developed by Washington State University.

Oats

Cayuse

Cayuse is a high-yielding, moderately early spring oat recommended in Washington. Cayuse was developed by Washington State University from a selection made at Cornell University. It is a short, pale green variety with open and spreading heads. The straw is strong and resistant to lodging. The kernels are light yellow. Cayuse has yielded 10 to 20 percent more than Park in test plantings.

The main weakness of Cayuse is its low test weight compared with that of Park. The test weight of Cayuse has averaged about 35 pounds per bushel in all Washington locations, with 37 for Park.

Cayuse has fair tolerance to the most serious oat diseases in Washington—barley yellow dwarf virus disease, or "red leaf of oats." The yellow dwarf tolerance of Cayuse can be seen mainly in its high-yielding ability. Discoloration results after severe attack by aphids carrying the virus.

No other disease of consequence has attacked Cayuse at any Washington location since testing began in 1959. Cayuse is susceptible to node blackening and stem break in the eastern part of the United States, but the disease does not affect oat yields in Washington.

Appaloosa

Appaloosa is a new yellow spring oat developed by Washington State University with more yellow dwarf virus tolerance than Cayuse. Appaloosa has up to 10 percent higher yield performance compared with Cayuse, but slightly lower average test weight. Appaloosa is a mid-season spring oat with straw 1 to 2 inches shorter than Cayuse. It has slightly better resistance to lodging than Cayuse.

SOFT WHITE WINTER WHEAT IMPROVEMENT

Clarence Peterson, Steven Hayward, Mary Baldridge, and Leslie Little

Washington produced 160.2 million bushels of wheat in 1979-80 for a 51 bushel-per-acre average. Yields were reduced, however, in many areas by the cereal diseases *Cephalosporium* stripe, *Cercosporella* foot rot, stripe rust and leaf rust. *Cephalosporium* stripe was very severe in early sown fields, where a wheat fallow rotation had been followed. All of the commercial winter wheats are susceptible to leaf rust and the grain yields and test weights were reduced in the fields that were infected early. Plant vigor and stands were reduced by the severe winter but the long cool wet spring following the eruption of Mt. St. Helens aided in their recovery.

OBJECTIVE

The objective of the soft white winter wheat program is to develop wheats with the disease resistance and agronomic characteristics needed for production in the Pacific Northwest. The wheats must also have the quality characteristics that are needed for the domestic and export markets.

New Selections

WASHINGTON

WA 006363 (Luke/WA 5829) is a soft white common semidwarf winter wheat. It is resistant to stripe rust, common bunt, dwarf bunt, and moderately resistant to leaf rust. WA 006363 is susceptible to flag smut. It has some tolerance to *Cephalosporium* stripe, and *Cercosporella* foot rot. WA 006363 has slightly better straw strength than Luke. Grain yield of WA 006363 was 8 percent higher than that of Luke in 1979/80. The milling and flour qualities of WA 006363 are quite similar to those of Nugaines. WA 006363 is being increased and foundation seed should be available in 1982.

WA 006472 (Multiline Club) is a soft white semidwarf club winter wheat that has resistance to infection by stripe rust, common bunt, and leaf rust. This variety is a composite of ten different lines. WA 006472 is moderately resistant to *Cephalosporium* stripe, and *Cercosporella* foot rot. WA 006472 is susceptible to snow mold and dwarf bunt. It has generally exceeded the grain yields of Faro and Barbee and appears to be more widely adapted. Test weights of WA 006472 are heavier than that of Barbee and Faro. Milling and flour quality characteristic of WA 006472 are similar to those of Paha. WA 006472 is being increased and foundation seed should be available in 1982.

OREGON

OR 68007 (Yamhill/Hyslop) is a soft white common semidwarf that has common bunt resistance. It equals Luke and McDermid in winterhardiness. OR 68007 is moderately resistant to stripe rust. It has equaled or exceeded the grain yields of Daws and Stephens. OR 68007 is susceptible to *Cercosporella* foot rot and *Cephalosporium* stripe.

OR 7142 (SW 92/3*Omar//Moro) is a soft white club that is resistant to stripe rust and common bunt. It is susceptible to leaf rust. OR 7142 is shorter than Moro. OR 7142 doesn't have the emergence capabilities of Moro, but it is better than Faro, Barbee and Tyee. It has good milling and flour characteristics. OR 7142 has equaled or exceeded the other club varieties.

IDAHO

ID 745318 (WA 4765//Burt PI 178383) is a soft white semidwarf that has good stripe rust, common bunt, dwarf bunt, and *Cephalosporium* stripe resistance. It has some tolerance to *Cercosporella* foot rot. ID 745318 has generally equaled the grain production of Daws. The test weight of ID 745318 tends to be 1 to 2 lbs lower than that of Daws. Milling quality is generally below that of Nugaines.

RESULTS

Data was obtained on the winterhardiness again in 1978/80. Daws was the hardiest soft white winter wheat and Jacmar (developed by Harley Jacquot) proved to be the hardiest soft white club variety. Tyee was found to be as hardy as Nugaines. Many of the new selections were close to Daws in winterhardiness.

Some varieties, including Daws and Luke, that were shown to be tolerant to *Cephalosporium* stripe in the past were susceptible in 1980. A few lines (ID 745318, VH 068367, and VH 079245) were moderately resistant to both *Cephalosporium* stripe and *Cercosporella* foot rot.

The new varieties and selections show an improvement in yield over the older varieties (Table 1 and 2). The yield increase in most instances is the result of improved disease resistance. Grain yields from the Pullman early nursery are low because one half of the nursery is inoculated with the *Cercosporella* foot rot fungus.

Table 1. Grain Yield Data (Bu/A) for 6 Winter Wheats (Clubs) Grown at 5 Locations for 3 Years in Washington (1978-1980)

Varieties	Pullman Early	Pullman Late	Pomeroy	Walla Walla	Ritzville	AVG.
TYEE*	59	69	53	64	67	62
FARO	50	71	46	66	57	58
WA 6472	58	74	53	66	62	63
BARBEE	57	67	51	60	64	60
MORO	45	60	40	46	55	49
JACMAR*	66	67	62	61	69	65

*Two years 1979 and 1980.

Table 2. Grain Yield Data (Bu/A) for 8 Winter Wheats Grown at 5 Locations for 3 Years in Washington (1978-1980).

Varieties	Pullman Early	Pullman Late	Pomeroy	Walla Walla	Ritzville	AVG.
ID 745318	77	86	55	67	69	71
STEPHENS	63	81	55	73	47	64
OR 68007	67	90	57	76	65	71
DAWS	65	81	52	71	67	67
WA 6363	76	83	55	75	70	72
NUGAINES	60	71	52	63	59	61
LUKE	63	81	48	71	64	65
VHO 76279	73	97	57	74	67	74

HARD RED WINTER WHEAT BREEDING AND TESTING

E. Donaldson, M. Nagamitsu and M. Dalos

The Hard Red Winter Wheat Breeding and Testing programs in Washington are partially funded by the Washington Wheat Commission and are conducted from the Dry Land Research Unit at Lind. Primary emphasis is placed on increasing yields of winter wheats for the 8 to 12 inch rainfall areas by combining the higher yield potential of soft white winter wheats with the better yielding hard red varieties and selections. Crosses are also made to incorporate the desired quality, disease resistance, rapid emergence, winterhardiness and agronomic traits into single lines. Every attempt is made to include a wide genetic background in the breeding program. Different types and sources of disease resistance are used to help prevent having only one source of resistance to any given disease. Many of the sources for disease resistance, winterhardiness, quality, or yield are not well adapted to the area and require one or two series of crosses (parent building) to get the desirable features into adapted varieties of high quality and disease resistance for the low rainfall area.

The 95 Tons/Acre of ash at Lind from the May 18, 1980 eruption of Mt. St. Helens caused problems with irrigation scheduling and run-off. No effects were noted in dry land wheat that could be associated directly and exclusively to the ash. The weather patterns following the eruption aided in causing the most severe rust infections ever noted at Lind. Stripe rust was severe on selections which in previous years showed only light and insignificant infections. Leaf rust normally is insignificant at Lind. Last year, however, the infections were severe and selection was possible.

An excellent *Cercosporella* infection was obtained in the 1980 trial. As research workers have found previously lodging *per se* was not indicative of yield. One selection (WA5840/Cerco), WA6817 was advanced to the regional nursery. WA6817 has a short coleoptile and poor emergence under problem conditions.

Three other selections, which showed overall superior yield and fair quality, were entered in the Regional Nursery. Each of these selections have deficiencies, which could prevent them from becoming varieties.

Lind nurseries this year were seeded into good moisture and good stands were obtained. The exceptionally mild winter did not reduce stands. Some leaf burning in the spring was noted in several varieties. Stripe rust and Leaf rust overwintered on susceptable selections and was quite severe early. The highest yield potential in several years was noted, as of the first of May.

Some agronomic characteristics of recommended varieties and the older varieties they replace are given for four locations in eastern Washington in Table 1, Harrington (Robert Kramer); Table 2, Lind; Table 3, Finley, (Richard Deffenbaugh); Table 4, Connell, (Dale Bauermeister); Table 5, Waterville, (Terry Ludeman). The nursery at Horse Heaven Hills was not harvested. These data are from rod row nurseries.

Table 1. Summary of agronomic characteristics of winter wheat varieties grown near Harrington in rod row nurseries, 1952-80.

Variety	Av. Test wt.	1980 Yield bu/a	Av. Yield bu/a	Yield % Kharkof	No. years grown
Nugaines	61.9	58.7	41.3	134	15
Luke	61.0	65.7	43.4	142	12
Sprague	61.3	66.7	46.3	142	10
Daws	60.6	57.7	44.5	133	7
Stephens	60.7	54.4	43.5	130	7
Moro	59.4	66.9	41.0	133	15
Tyee	59.0	69.8	50.3	151	5
Barbee	59.3	59.0	47.0	137	8
Faro	59.4	64.4	45.5	136	7
Wanser	62.3	56.1	39.9	131	14
Hatton	63.6	55.6	44.2	133	5
Kharkof	61.3	41.7	35.7	100	27

Table 2. Summary of agronomic characteristics of winter wheat varieties grown at Lind in rod row nurseries, 1952-80.

Variety	Av. Plant ht.	Av. Test wt.	1980 Yield bu/a	Av. Yield bu/a	Yield % Kharkof	No. years grown
Nugaines	26	61.3	43.4	37.5	129	16
Luke	25	59.7	43.4	33.6	126	12
Sprague	27	60.3	37.3	33.5	130	10
Daws	35	58.9	40.5	35.4	134	7
Stephens	29	57.8	36.4	31.3	123	8
Moro	30	58.6	45.8	36.4	123	17
Faro	28	57.3	44.6	37.5	122	7
Tyee	26	58.0	43.9	34.1	111	5
Barbee	26	58.1	44.4	41.3	137	8
Wanser	31	61.7	32.4	33.8	114	17
McCall	31	61.8	35.7	36.3	121	16
Hatton	31	62.4	35.5	32.3	138	5
Weston	37	61.2	35.5	31.9	137	3
Kharkof	33	60.5	28.9	29.2	100	26

Table 3. Summary of agronomic characteristics of winter wheat varieties grown at Finley in rod row nurseries, 1975-80.

Variety	Av. Test wt.	1980 Yield bu/a	Av. Yield bu/a	Yield % Kharkof	No. years grown
Nugaines	63.2	33.2	32.1	120	6
Daws	61.3	35.6	33.0	134	5
Stephens	59.9	33.2	30.3	123	5
Moro	59.8	39.9	36.8	138	6
Faro	60.3	40.2	34.6	140	5
Barbee	60.6	37.5	29.9	135	4
Wanser	63.1	33.7	30.1	113	6
McCall	63.5	35.3	31.3	117	6
Hatton	64.1	36.5	33.5	136	5
Weston	63.2	38.0	37.9	138	2
Kharkof	61.9	26.7	26.8	100	6

Table 4. Summary of agronomic characteristics of winter wheat varieties grown near Connell in rod row nurseries, 1975-80.

Variety	Av. Test wt.	1980 Yield bu/a	Av. Yield bu/a	Yield % Kharkof	No. years grown
Nugaines	62.3	33.9	33.3	109	5
Daws	60.6	38.8	33.9	119	4
Stephens	59.8	32.7	33.4	118	4
Moro	59.7	41.7	39.2	129	5
Faro	59.3	42.0	34.9	123	4
Barbee	60.4	41.8	29.4	119	3
Wanser	62.3	38.7	34.3	113	5
McCall	62.4	37.1	34.6	113	5
Hatton	63.0	41.9	34.1	120	4
Kharkof	61.3	32.2	30.5	100	5

Table 5. Summary of agronomic characteristics of winter wheat varieties grown at Waterville in rod row nurseries, 1952-80.

Variety	Av. Test wt.	1980 Yield bu/a	Av. Yield bu/a	Yield % Kharkof	No. years grown
Nugaines	61.9	30.1	44.6	125	11
Luke	60.6	36.7	47.5	143	8
Sprague	60.5	39.9	41.5	132	6
Moro	59.1	42.6	44.6	125	11
Wanser	61.9	30.8	40.4	114	12
McCall	62.0	33.3	41.8	117	11
Kharkof	61.1	24.0	34.1	100	21

SPRING WHEAT IMPROVEMENT*

C. F. Konzak, M. A. Davis, M. R. Wilson
Graduate Assistants: Patricia Franks, Tim Andersen,Tom Koehler, A. Jaradat

The spring wheat research in Washington is conducted using mainly the research facilities at Pullman (medium rainfall), Lind (low rainfall), and Royal Slope in the Columbia Basin (irrigated), with off-station regional research trials via grower cooperation near Connell, Dayton, Harrington, Pomeroy, Walla Walla and Waterville. Extension observation trials are conducted at these and a number of other locations in the wheat growing areas of Washington. Many new introduced varieties, lines, and plant selections are being tested in preliminary nurseries, with each entry being evaluated at all three main locations during the same year. By this method it is possible to more quickly estimate the probable adaptation and potential of varieties and lines and to select those that warrant further and wider testing in the off-station trials.

The general scope of WSU spring wheat research is indicated from the trials and numbers of selections under evaluation in 1980 and 1981 (Table 1). Among the nurseries grown at the three main station locations, several can be seen by those attending the field days, including the Regional Facultative Wheat Nursery and the Western Regional and Washington State SWS and HRS Wheat Nurseries. The USDA Uniform Regional Hard Spring Wheat Nursery and the International Spring Wheat Nursery (CIMMYT) are evaluated at Pullman. The main crossing blocks, parental lines and most early generation populations are grown at Pullman. F_3 populations are usually grown at Lind to subject them to some drought stress. All new crosses are made at Pullman because of the more favorable conditions and long period for crossing and regular adaptability of new parental sources. Many new foreign introductions and other new germ plasm sources are evaluated and some used in crossing each year. Inputs from several new sources, including new cooperative grant programs, NSF-Japan, BARD (U.S.—Israel), are included in 1981. The commercial variety trial is conducted with private breeder cooperation.

Objectives: Major emphasis in breeding and selection continues to be yield performance for both specific and general conditions, with crosses being made to incorporate the necessary quality, disease resistance, cold tolerance (facultative characteristics), and desirable agronomic traits into adapted lines. Research to improve the potential for higher protein content and nutritional value of hard red wheats is receiving increased attention as is research on a new dual purpose quality type in soft white wheats. Yield tests include some higher protein derivative hard spring wheat from crosses of local wheats with Argentine and other introductions. Included also in the 1981 tests are some high protein mutant lines from IAEA in Vienna. Several new high protein selections which showed competitive yield performance are in the 1981 Western Regional Spring Wheat Nursery, and in Washington State HRS Nurseries.

The 1981 Western Regional Tri State and Washington State Soft White and Hard Red Spring Wheat Nurseries include new entries from the Washington State cereal research program and from the states of Montana, California, Idaho and Utah. The Washington State Commercial Variety trial includes promising new entries from private breeders, as well as WSU's Western Regional entries and major cultivars.

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*Grower input of financial support via the Washington Wheat Commission for spring wheat improvement has made possible many of the advances in spring wheat breeding described herein.

Yields in 1980 on some lines exceeded 150 bu/a at Royal Slope, 139 bu/a at Pullman and 65 bu/a at Lind. Many durums yielded over 140 bu/a at Royal Slope. Volcanic ash from the St. Helens May 18 eruption caused physical damage to some lines at Royal Slope and Lind.

The situation with stripe and leaf rusts, already predicted from 1976 data, was more severe than expected in 1978, less than expected in 1979 but especially severe in 1980. May 1978 plantings of Fielder and Fieldwin types become 100% infected with the new stripe rust race at Pullman, and showed approximately 40% yield reduction. In 1980 losses due to stripe rust exceeded 60% on Fielder and Fieldwin. Urquie, Walladay and WS-1, as well as most WSU selections, showed good resistance to stripe rust in 1978 but the adult plant stripe rust resistance of these lines was inadequate in 1980. Of the soft white cultivars only WS-1 showed moderate resistance to leaf rust. Moreover, even in the Advanced Washington State and Western Regional trials only one of the soft white entries, WA6402, showed moderate resistance to both rusts. WA6402 has shown good yield performance in other years, and had sufficient testing to advance it toward release as a commercial variety. Its performance in 1979 and 1980 was generally good. Plants for breeder seed production were selected in 1980 and increased in Arizona over winter to permit a 1981 release. The name Waverly has been selected for WA6402.

The serious rust problem has resulted in some major adjustments in the WSU program. All new WSU-developed state and regional entries now carry resistance to both rusts. These entries were selected from among promising lines from single plot tests in 1978, evaluated for quality trials and increased over the 1978-79 winter season in New Zealand via the cooperation of a local plant breeder there. An increase of selected early generation materials also was made over the 1980-81 winter.

The new stripe and leaf rust races pose a serious threat to soft white spring wheat production in the area, since nearly all of the winter wheats and most soft white spring wheats grown are susceptible to stripe rust in the seedling and juvenile plant stages and are highly susceptible to leaf rust, providing abundant inoculum to infect the spring wheats. A crash program effort was initiated in 1976 and 1978 to identify new resistant sources. The 1981 plantings already reflect the results of that effort. The winter 1978-79 increase of over 1000 new selections made in New Zealand, resulted in many rust resistant good quality selections included in the 1979-81 regional trials, and in adaptation tests. The best of these lines are included in the 1981 regional and replicated advanced trials. Some of the new materials advanced by that increase outyielded the best cultivars by 20 to 30% in 1980.

One of the new disease resistant soft white lines (WA6753) advanced via the New Zealand winter increase showed promising agronomic performance in 1979 and 1980; it has satisfactory pastry quality. Plants will be selected in 1981 toward a potential breeder seed increase. Pre-breeder material was grown in Arizona over the 1980-81 winter.

New Quality Development. A totally new combination of quality traits appears to have been achieved in a number of WSU soft white spring and facultative wheat lines. This new quality type combines the processing characteristics (bread and pastry properties) of typical hard red wheats with those of the common soft white wheats. With wheats having this combination of traits, Washington growers could have access to a wider selection of market channels, and compete more effectively with Australia for Asian markets, as well as in U.S. specialty markets. These wheats also should offer advantages to the PNW market in their suitability and blendability at all protein contents. Small pilot scale tests of lines having the new quality type are in progress and larger scale tests are planned for 1981-82. Some of the new dual quality wheats show competitive yield performance with current soft white spring wheats, but have inadequate disease resistance. Newer lines have disease resistance, and

high yield performance, but have had less testing. Because they are still experimental, however, the lines are being tested only in Washington State research trials.
Washington State research trials.

Improving Protein Content and Nutritional Composition. Crosses made several years ago using germ plasm sources obtained from the Nebraska-USAID program and from several other sources have advanced to the stage where lines with potential for significantly increased protein content have been identified.

Generally, the high protein germ plasm sources have been poorly adapted for local conditions and have poor processing properties, hence many early crosses have had little potential. Thus, several breeding cycles may be necessary to exploit the full potential of these materials in developing competitive or higher yielding locally adapted varieties.

We now have identified selections with ability to produce a high content of protein and/or probably more nutritious protein in the flour, as well as a few that from preliminary processing tests show promise for mixing and potential baking properties. Yield data from 1979 and 1980 showed that several of the lines also yield competitively with current spring wheat varieties, thus they produced more protein per acre than the standard hard reds. Considering the increased costs of N fertilizers, and the potential for greater assurance that protein levels in harvested grain will meet market requirements, the progress made to date is encouraging. Three of these lines were entered in regional tests in 1981 and several others are undergoing evaluation in State trials. Promise is sufficient to permit a major shift in HRS research emphasis to high protein breeding.

Recent Variety Developments

Soft White Spring and Facultative Wheats:

WAVERLY—WA6402 was developed at Washington State University with the cooperation of USDA-SEA and is expected to be released in 1981. Waverly has good milling and pastry-making properties. Waverly has yielding capacity equal to other soft white spring wheats when rust is not a factor. Its main attributes are its adult plant resistance to stripe and leaf rust. Its adult plant resistance to stripe rust is superior to that of Urquie or Walladay. Waverly is a semidwarf soft white spring wheat resistant to moderately resistant to prevailing forms of stripe and leaf rust. Breeder seed stock was produced in Arizona by the Washington State Crop Improvement Association under an agreement with Washington State University to expedite the availability of this new soft white wheat to growers. Grants from the Grant and Lincoln County Crop Improvement Associations were instrumental in making the winter increase possible. Waverly produces grain with higher test weight than that from Twin or Dirkwin, but a slightly lower test weight than Fielder or Urquie in the absence of rusts. About 20 acres of Foundation class seed is in production in 1981.

URQUIE—Developed at Washington State University with cooperation of USDA-SEA and released by Washington and Idaho in 1978 as a replacement for Marfed. This new high milling and baking quality common soft white semidwarf spring wheat variety carries an effective adult plant type of resistance to stripe rust. Urquie is susceptible to leaf rust, however. Urquie also produces better test weight grain than Twin under all cultural conditions. Earlier tests indicated that Urquie was better adapted to the low rainfall areas than either Fielder or Twin. Tests indicate that Urquie will perform as well as Twin and Fielder in the higher rainfall areas and under irrigation, while retaining its superiority in the low rainfall area.

The greater cold tolerance of Urquie compared with Marfed, Twin and Fielder should permit earlier spring planting which is desirable for achieving highest yields. A good supply of registered and certified seed was available via WSCIA for 1981 planting.

WALLADAY—Increased in 1977 as WA6153. This semidwarf, facultative soft white common spring wheat was released in 1978. Walladay carries resistance to some races of leaf rust and is moderately resistant to stripe rust, including the races that severely attacked Fielder and Fieldwin in 1978. Its quality is similar to Fielder. Performance tests to date indicate that Walladay has equal to greater yield potential than Fielder. Its later maturity than Twin or Fielder may permit higher yield potential under irrigated culture, but may be a disadvantage in late spring plantings. However, it has done well in moderately early plantings in the dryland area. Walladay has greater cold tolerance than Urquie and may be suitable for late fall and midwinter and very early spring seedings in areas where this practice may be desirable or necessary due to severe freezing injury to winter wheats. Walladay has proved highly susceptible to *Cercosporella* foot rot. Also, the stripe rust resistance of Walladay may no longer be adequate for fall seeding in areas of heavy stripe rust attack, as in Western Washington, and a new race of leaf rust, which also attacks Urquie, Dirkwin and Twin, may be especially damaging on late spring plantings. The 1979-80 winter nearly killed out Urquie, and injured Walladay at Pullman, while Nugaines and standard winter wheats were comparatively little affected, indicating that a greater level of cold hardiness is needed for the Pullman area. Its survival was good at other Southeastern Washington locations. In 1980-81 there was virtually no winter kill at any of the test locations.

Hard Red Spring Wheats:

WAMPUM—Formerly WA6105, developed by Washington State University with USDA-SEA cooperation, is a 'tall' semidwarf stiff-strawed hard red spring wheat with good milling and baking properties. Wampum tends to be better adapted to higher rainfall and irrigated culture than other hard red spring wheats and may find its widest use in that area except when needed for overplanting injured hard red winter wheats. Wampum appears to carry different types of resistance to stripe and leaf rusts than other hard red spring varieties now in production. It is also resistant to powdery mildew. Foundation and registered seed were produced in 1978. Wampum carries high resistance to the new stripe rust races, adult plant resistance to local leaf rusts and may carry tolerance to barley yellow dwarf virus. Wampum achieved the overall highest yield record among wheats tested in Washington State trials in 1978. It generally was a high producer also in 1979 and 1980 and is expected to be the dominant HRS cultivar of the area in 1981. Management to achieve satisfactory protein levels is important to hard red spring wheat production.

Durum Wheat:

WAID—Formerly WA6292, was developed by Washington State University and released jointly in 1980 by Washington and Idaho experiment stations. Waid offers both a yield potential advantage over Wandell and distinctly better marketing quality, i.e. larger kernels and lower berry (higher % vitreous). Waid is expected to replace Wandell and offer irrigated wheat growers an economic alternative to soft white and hard red wheats. Waid is highly resistant to the rust diseases and moderately resistant to mildew. Fertilizer management to achieve high protein levels (over 12.5%) and vitreous grain is important to quality durum wheat production. Waid appears to be the only wheat in Washington with Hessian fly resistance.

Table 1. Research Trials and Number of Selections Under Test in WSU Research

Regional Nurseries	Coordinator	1979	1980	1981	1979	1980	1981
		Locations			Entries		
Western Regional Spring Wheat Nursery	USDA-WA	25(3)	25(3)	25(3)	36	36	38
Western Facultative Wheat Nursery	WSU	12(6)	12(6)	12(6)	12	12	10
Tri-State Spring Wheat Nursery (WA, ID, OR)	WSU	6(3)	7(3)		36	32	38
Uniform Regional HRS Nursery	USDA-MN		(1)	(1)	32	30	34
International Spring Wheat Yield Nursery	CIMMYT-Mex	60(0)	60(1)	60(1)	50	50	50
International Durum Yield Nursery	CIMMYT-Mex	27(1)	27(1)	27(1)	25	25	30
Western Durum Nursery	WSU	5(1)	5(1)	5(1)	36	30	30
International Durum Crossing Blocks	CIMMYT-Mex	12(1)	12(1)	(1)	150	200	356
International Spring Wheat Observation Nursery	CIMMYT-Mex	60(1)	60(1)	60(1)	300	300	431
International Winter/Spring Wheat Observation Nursery	CIMMYT-OSU	50(1)	50(1)	50(1)	250	250	250
Northwestern States Oat Nursery	USDA-ID	16(1)	16(1)	16(1)	28	28	20
N-C Hybrids Trial (Winter)	WSU			5(4)			8
N-C Hybrids Trial (Spring)	WSU			1(1)			11
WSU RESEARCH TRIALS—							
Commercial Bread Wheat Variety Nursery	WSU	(5)	(5)	(5)	32	32	43
Washington State Regional SWS Nursery	WSU	(9)	(9)	(8)	33	33	60
Washington State Regional HRS Nursery	WSU	(6)	(6)	(6)	27	27	60
Bread Wheat Advanced Trials SWS	WSU		(3)	(3)		100	158
Bread Wheat Advanced Trials Dual WS	WSU		(3)	(3)		30	36
Bread Wheat Advanced Trials HRS	WSU		(3)	(3)		150	100
Bread Wheat Preliminary Trials SWS	WSU		(3)	(3)		300	374
Bread Wheat Preliminary Trials HRS	WSU		(3)	(3)		400	220
Bread Wheat Preliminary Trials High Protein HRS	WSU			(3)			100
Bread Wheat Preliminary Trials Dual WS	WSU			(3)			33
Bread Wheat Preliminary Trials IAEA-High Protein, Hessian Fly	WSU			(1)			20
WSU Durum	WSU	(2)	(2)	(0)	100	60	0
Single Plots	WSU	(1)	(1)	(1)	4000	4000	2500
F_4-F_6 Single Row Evaluations	WSU	(1)	(1)	(1)	30000	30000	25000
F_2 Populations	WSU	(1)	(1)	(1)	350	350	450
Oat F_2, F_3	WSU			(1)			8
Durum F_2, F_3	WSU			(1)			21
Bread Wheat Hessian Fly Resistance F_3	WSU			(1)			30

TRI-STATE SPRING WHEAT NURSERY

C. F. Konzak

The plant breeders in the three Northwest states cooperating on variety releases interchange advanced lines of spring wheats for preliminary regional tests one season before the best performing lines become candidates for entry into the Western Regional Spring Wheat Nursery. The Tri-State Spring Wheat Nursery thus serves to provide wider scale tests on a larger number of promising lines than would otherwise be possible, and increases the possibility that those selections finally entered in the wider regional testing program will have variety potential for the Tri-State area. This nursery may be given increased emphasis for variety releases in the future.

COMMERCIAL VARIETY NURSERY

C. F. Konzak, M. A. Davis, and M. R. Wilson

Beginning in 1976, a new set of trials was established by WSU to evaluate promising new materials developed by private plant breeders which would likely be produced for sale in Washington State. We invited private breeders to send us their advanced lines and current varieties for inclusion in these tests.

In 1981 this nursery includes selections from five private breeding firms, North American Plant Breeders, Northrup King, Pioneer, Western Plant Breeders, and World Seeds. Current and obsolete local cultivars and Washington State University regional entries are also included for comparison. Growers attending Field Days or tours at any of the three main stations (Pullman, Lind and Royal Slope) and at Harrington, Cornell and Waterville will be able to observe and compare private as well as publicly developed wheats in this trial.

WESTERN REGIONAL AND WASHINGTON STATE SPRING WHEAT NURSERIES

C. F. Konzak, M. A. Davis, M. R. Wilson
K. J. Morrison, P. E. Reisenauer, E. Donaldson

This cooperative research test of the performance potential and adaptation of spring wheats usually includes 25 to 38 entries, some soft white, a few hard white and a high proportion of hard red spring wheats. The nursery is grown at about 25 locations throughout the West, ranging from Canada to Arizona including the Washington stations. Washington State University's 1981 entries include nine soft white and three hard red spring selections.

The Washington State Soft White Spring and State Hard Red Spring Wheat Regional Trials are grown at the three main stations. Either or both are also grown on sites provided by farmer cooperators. The standard commercial varieties and promising advanced 'near varieties' are included in all Washington State University Extension Service trials of spring wheats in the state.

WESTERN FACULTATIVE NURSERY

C. F. Konzak, M. A. Davis, M. R. Wilson
K. J. Morrison, P. E. Reisenauer

Facultative wheats are strictly spring wheats carrying a near-winter wheat level of winter tolerance, permitting them to be grown alternately from fall or spring seedings as may best meet growers needs. The first release, Walladay, has shown competitive performance with both winter and spring wheats, but due to changes in stripe and leaf rust populations and its susceptibility to *Cercosporella* foot rot, its future may be short-lived. However, Walladay's performance to this point has demonstrated a role for this type of wheat.

The Western Facultative Wheat Nursery was initiated in 1975, and it is coordinated at Washington State University. Inputs to the nursery have largely come from Washington State University research; recently materials from the OSU/CIMMYT Winter/Spring Screening Nursery have been included after they showed promise from Washington State University screening trials. The most cold-hardy new facultative spring wheat line appears to be WA6711. However, other new Washington entries appear to have a good combination of disease resistance, acceptable quality, and a near Walladay level of winter survival. The 1980-81 winter was too mild, however, to distinguish differences in cold tolerance.

DURUM WHEAT IMPROVEMENT

C. F. Konzak and M. A. Davis

There is potential for a modest, but significant acreage of durum wheat production especially in irrigated central Washington. WSU tests have consistently proved that grain of acceptable to high processing quality can be produced in Washington, and that yields can be competitive with soft white or hard red spring wheats. The variety Wandell, the first U.S. semidwarf durum, was developed by WSU in an effort to provide local irrigated growers access to the area markets for durum. While performing well agronomically, Wandell has a quality weakness in its tendency for producing grain high in yellow berry, a condition that reduces the market grade and thus income to the grower. Because durum must be handled as a separate, specialty or contract crop, this weakness has been serious. Central Washington growers of durum now have reasonably close access to the General Foods mill in Pendleton besides the Portland outlets, providing a ready market for this crop. Thus, a new variety is needed to permit irrigated growers an alternative to soft white wheat. WSU has carried on a small, but effective breeding and selection program for a number of years, and coordinates the Western Durum Nursery trials. Tests of CIMMYT's International Durum Nursery also are conducted at the Royal Slope farm. Based on results from five years' trials in the Western Durum Nursery, one WSU line, named WAID, has shown outstanding performance and advantages over Wandell in both Washington and Idaho tests. It not only has equal to or better yield than Wandell, but also has larger kernels and low yellow berry (a high tendency to produce vitreous grain) as desired by the industry. WAID is currently in Foundation and Registered seed production, and is being released cooperatively by the Washington and Idaho experiment stations. Recently, another selection, WA6521, has been named 'Cargidur' and registered for production in France by Cid. Cargill, under a contract with Washington State University Research Foundation, which is to receive 50% of the net royalties.

IRRIGATED HRS AND DURUM VARIETY X FERTILITY STUDY

C. F. Konzak and S. Roberts

A small new variety x N application trial was initiated in 1981 as the result of indicated need and cooperation of several commercial firms and an irrigated wheat grower. The trial includes two new durums and two to three new high yielding HRS wheats. Several fertility treatments are being investigated including heading period applications, and the N status of the plants is being monitored through the season. The objective is to obtain information that growers can use to plan for economic high protein HRS and durum production under sprinkler irrigation. Near infrared tissue analyses are being explored as a means for rapid analysis, permitting growers to test plant samples at a local feed mill, then apply the desired N the same day.

OATS IMPROVEMENT AND VARIETY EVALUATION

C. F. Konzak, M. A. Davis,
K. J. Morrison, P. E. Reisenauer

Oats remains an important crop for many growers in spite of the overall trend toward reduced acreage planted in the PNW and other parts of the U.S. The potential for high oat yields is exceptional in the PNW, and current varieties have good disease resistance and high yield potential. Varieties Cayuse and Appaloosa are now abundantly available. Their main weakness is low test weight. A recent Idaho release, Corbit, is almost as high yielding and has slightly higher test weight, but has greater tendency to shattering. Newer lines in various evaluation stages offer promise for equal or improved yield potential with higher grain weight. The hull-less variety Terra offers promise for special feed uses by growers able to feed their own production. Another notable cultivar is the variety Ogle from Illinois which has high-yield and good test weight.

BARLEY BREEDING AND TESTING PROGRAMS IN WASHINGTON

S.E. Ullrich, R.A. Nilan, C.E. Muir
K.J. Morrison and P.E. Reisenauer

The overall objective of the barley improvement program in the State of Washington is the development of high yielding, stiff-strawed agronomically acceptable varieties that are adapted to the different barley producing areas of Washington and that have superior malting and nutritional quality. When winter grown, they must have winterhardiness superior to the current winter barley varieties. This objective includes the development of "multipurpose" varieties that will be the highest yielding varieties available. Such varieties, whether 2-row, 6-row, spring or winter, will have quality that will meet malting industry standards and because of their malting quality they should be superior in feed quality. Thus, they will meet all market demands for barley grown in this state.

The program involves the development of winter and spring, 2-row and 6-row multi-purpose varieties at Pullman, selection and testing programs at Lind (dry land) and Davenport (winterhardiness), and major testing programs at Royal Slope (irrigated), Walla Walla, Dayton and other testing sites at Pomeroy, Vancouver, Puyallup, Mount Vernon, Dusty, Lamont, Cunningham, Deep Creek, Reardan, Bickleton, Mayview, Anatone, St. John, Uniontown, Fairfield, Farmington, and Wilbur.

The new varieties developed within WSU's barley breeding program are described in the front of the brochure under recommended barley varieties for the state of Washington. Representative results of the performance of these varieties in tests at Pullman are summarized in Table 1. This table also includes some advanced selections which will be discussed below.

6-row Spring

Advance, WSU's newest barley release (1979) was planted on over 11% of Washington's barley acreage in 1980 (1.3% in 1979) with a considerable increase anticipated in 1981. Its agronomic characteristics are described in the front of the brochure under recommended barley varieties for the state of Washington.

Advance was released without designation of its malting status. Industry plant scale testing for malting and brewing acceptability on 1978 and 1979 crop carlots has been completed and one is underway on the 1978 crop in much larger quantities. Results of the tests are very encouraging thus far, and its malt analytical properties are similar to Larker, the 6-row standard of quality.

Advance was tested for nutritional quality and was judged to be superior to Steptoe and equal to the best 2-rows in nutritional value.

2-row Spring

The next 2-row malting variety will probably be released within the next two years and will come from a selection involving a Klages cross. This selection, WA9691-75, (Table 1) has undergone initial plant scale malting and brewing tests. This selection is higher yielding than Vanguard, Klages, or Kimberly, yields 90-95% of Steptoe and has the quality of Klages. Release of this line will reestablish the Palouse area as a major 2-row malting producing area, a market unsurped by the superior qualities of Klages and Kimberly grown under irrigation in other areas.

Winter Barley

Winter survival data for this past winter at Pullman and Davenport is presented in Table 2. The long term average survival for Boyer, Kamiak and Luther is also present. The severe site at Davenport allowed for some determination of winterhardiness, but in other test sites survival was essentially 100% due to the extremely mild winter this year.

Most new winter 6-row and 2-row selections are of the "multipurpose" type, i.e., high yield, suitable malting and feed quality. No selections are as advanced as those of the spring types, chiefly because these selections must also be winter hardy. More progress has been made with the 2-row than with the 6-row. Several feed type 6-row lines distinguished themselves in 1980 with excellent yields.

Field Days

Visitors at Lind will see a number of the previously described varieties and selections (Table 1) in spring nurseries. Winter barley survival was excellent this year with very little differential winter kill.

Visitors at the Field Day at Pullman will have an opportunity to view in demonstration plots early and late seedings of 20 current varieties and new advanced selections of spring 6-row and 2-row and 18 current varieties and new advanced selection of 2-row and 6-row winter types.

Table 1. Comparative Yields of Barley Varieties and Lines
Pullman, 3 Year Average 1978-80 (lbs. per acre)

Spring		Winter	
6-Row			
Feed		Feed	
Steptoe WSU	5538	Boyer WSU	6502
Unitan	4395	Kamiak WSU	6046
		Luther WSU	5043
		WA2905-75	9225*
Malting		Malting	
Advance WSU	5075	Under Development	
Blazer WSU	4965	WA3435-77	6985*
Karl	4423		
Larker	3745		
2-Row			
Malting		Malting	
WA9691-75	5254	Under Development	
Piroline	5089	WA1623-75	6068*
Vanguard WSU	4864		
Klages	4867		
Kimberly	4749		

*1979-80 data only.

Table 2. Winter Survival (%)

Pullman			Davenport		1971-81
	79-80	80-81	79-80	80-81	Pullman
Boyer	85	100	40	100	93
Kamiak	100	100	40	100	94
Luther	100	100	65	100	94
WA3435-77	90	100	60	100	
WA1623-75	92	100	15	100	
2905-75	100	100	50	100	

TRITICALE

Clarence Peterson, Steven Hayward, Mary Baldridge, and Leslie Little

The new triticales that were tested for yield in 1981 showed that considerable progress has been made in the development of triticale. New lines from USDA (R. J. Metzger—Corvallis, OR), CYMMIT and Charles Jenkens were very competitive with the wheat checks.

Sixty-four triticales were included in both a winter and spring nursery at Pullman in 1979-80. Two nurseries from Alabama (winter and spring) and one from CYMMIT were also grown at Pullman. Most of the lines survive the winter at Pullman if we have snow cover during the cold weather. A few true winter lines were also included in the tests. Six lines in the winter nursery produced more than 100 bushels of grain per acre (based on a 60 pound test weight). They were M76-639 (117 Bu/a), M76-6292 (111 Bu/a), M76-6276 (109 Bu/a), M76-6923 (112 Bu/a), Bokalo (115 Bu/a), and AM004105 (103 Bu/a). Nugaines (winter wheat) produced 122 bushels per acre. Other lines that performed well in the spring and winter nurseries were MIA, DIRIA, Tcl Bulk 50-MA and T-5140.

Two cereal diseases, Cephalosporium stripe and Ergot, reduced grain production in 1980. Early fall-sown triticale lines were infected with Cephalosporium stripe. Most of the lines were very susceptible and grain production was reduced by 30-70 percent. It was difficult to determine if any of the lines were resistant because the disease was quite erratic. Ergot was very prevalent (winter and spring nurseries) in lines that were sterile or partially sterile. The triticale lines were quite resistant to the local races of stripe and leaf rust.

Test weight (pounds per bushel), plant height and head type of the triticales needs to be improved. The test weight of the triticale lines tested was about 10 pounds less than that of wheat. Progress has been very slow in increasing the test weight of triticale. Plant height of some of the new triticales has been reduced, but most of these lines are partially sterile. In spite of their height, the triticales have good straw strength and little lodging occurs. Brittle rachis and shattering is a problem with some triticale lines.

GENETICS OF DISEASE RESISTANCE

R. E. Allan, R. F. Line, C. J. Peterson, G. W. Bruehl, J. A. Pritchett, M. L. Baldridge, L. M. Little
USDA-SEA-AR-WARC

Strawbreaker Foot Rot: We have an excellent screening test this year for strawbreaker foot rot. We are now using a spore inoculation system that appears to eliminate the possibility of "escapes" which have thwarted our progress in the past when we used only the oat-kernel inoculation method. In the 1980 tests about 2% of 780 lines yielded 80 to 98 bu/ac and appeared to have resistance to both strawbreaker foot rot and Cephalosporium (fungus) stripe. Our major sources of resistance are wheats from northern Europe and include Cappelle, Viking, Svalof 814 and derivatives from a goat-grass (*Aegilops ventricosa*). Most of the lines identified in 1980 still have agronomic shortcomings. The main problems are shattering lodging, low test weight, smut susceptibility and many have red seed color. We reselected among our best material in 1980 and these lines are in the current 1981 tests. Hopefully some useful parents and perhaps potential cultivars will survive this severe screening.

Leaf Rust. The current major foliar disease vulnerability of our winter wheats in Washington is leaf rust. Last year afforded us with an excellent chance to classify our germplasm for reaction to this rust. Less than 1% of 14,000 early generation lines had useful resistance. Although few lines gave resistance, the sources of their resistance have been derived from a wide genetic base. These sources include Spelt wheat, goat grass, and 22 other introduced lines from Europe, China, Russia, Indiana, North Carolina, Oklahoma, and Kansas.

One club wheat line (WA 6698) with unique leaf rust, mildew and stripe rust resistance from Spelt wheat may soon be considered for release. In 1980 it averaged 70 bu/ac in 13 yield tests compared to yields of 66, 66, 65 and 63 bu/ac for the multiline club, Tyee, Faro and Jacmar, respectively. We know leaf rust can cause severe damage. In a 1980 management test on Spillman Farm that was severely infested with leaf rust, the leaf rust resistant to sib lines yielded 25 to 46% more grain than their leaf rust susceptible sib lines. Some leaf rust susceptible sib lines yielded as much as 40 bu/ac less than their leaf rust resistant sibs.

Stripe Rust. We should not underestimate the importance of continuing to breed for high stable resistance to stripe rust in our winter wheats. Currently most winter wheats have resistance but we still could be vulnerable to stripe rust damage. Four of five resistant club wheats carry the same gene for resistance. This is the Moro gene, and it also conditions resistance of Barbee, Faro, and Jacmar. If the Moro race once again becomes prevalent, all four of these cultivars would be severely damaged. The resistance of Tyee is unlike the resistance of all other winter wheats being grown in the PNW.

Recently, the release of WA 6472, a ten component club wheat multiline, was approved. This blend of ten stripe rust resistant lines has at least 9 different genes that condition resistance to the stripe rust fungus. In the event a new race does develop, it could probably only attack one of these lines and would therefore only injure about 10% of the plants. Use of multiline is a relatively new way to combat rust diseases but we think it will help us keep strip rust in check and limit losses if new races become established.

We have a split-block replicated test of 90 advanced lines representing several sources of resistance planted at Spillman Farm. One half of each plot has been sprayed with Bayleton to control stripe and leaf rust. The purpose of this test is to identify those sources of resistance that suffer the least loss to these two rusts. From previous tests we have learned that visual ratings of severity of stripe and leaf rust do not necessarily relate closely with the % of yield loss that different wheat lines have suffered. Tests like this one should help us identify the best sources of resistance to use in our breeding program.

Cephalosporium Stripe. Unlike 1980, the 1981 crop year will suffer very little loss due to Cephalosporium (fungus) stripe disease. Nevertheless, testing our germplasm for its inherent vulnerability to this disease remains a high priority. Commencing in 1981 we have initiated a disease garden for this disease. We sowed McDermid early in a low wet field and will recrop several years with it. Since this variety is highly susceptible, the disease should build up naturally. Once we achieve severe levels of this disease in the field, we will then plant our breeding material in the disease garden and rate the material for its level of resistance.

Last year gave us some information on resistance to fungus stripe disease. Of nearly 800 lines subjected to heavy disease infestation only about 4% appeared to have useful resistance. Germplasm was evaluated by using stability for yield, test weight and plant height in conjunction with high yield and test weight performance to identify lines exhibiting resistance. Most of the resistant lines had VPM/Moisson, VPM 1124, Viking, Cerco, Raeder, PI 178383, Thor or Barbee in their pedigree. About 2% of the lines had resistance to both strawbreaker foot rot and Cephalosporium stripe disease and yielded 80 to 98 bu/ac with test weights of 57 to 61 lb/bu. Cerco and Nugaines averaged 75 bu/ac with test weights between 54 and 56 lb/bu. The best of these lines were placed in 1981 tests. A field was infested with Cephalosporium strip by spreading about 1T/ac of wheat straw infested in the pathogen on the soil surface. As of 5 May only a few plants were exhibiting symptoms of the disease, however.

Dwarf Bunt or TCK. Breeding for resistance to TCK is much more difficult than breeding for resistance to common bunt. The dwarf bunt fungus spawns new races very rapidly and under ideal disease conditions the wheat plants' resistance often breaks down and allows for some smut to develop. The best breeding strategy would be to combine several resistant genes in one variety which should give more stable multiple resistance. Wheats with multiple resistance can usually resist attack by new races because they have other resistant genes that backup their protection. Yet in a self-fertilized crop such as wheat it is difficult to develop multiple resistance because wheat plants cannot be readily mated with one another in order to shift resistance genes into a single plant. To get around this problem, we have developed special parental stocks that can be completely cross pollinated because they are male sterile. These plants serve as females and are being grown among pollen producing male parents which as a group contain 10 different sources of TCK resistance. After several cycles of cross pollination, some of the seed produced on the females should constitute multiple gene resistance to TCK disease. By testing for common bunt and TCK disease reaction to several races, we should be able to tell which plants carry multiple or pyrimided resistance to smut. This short-cut breeding method has been used frequently to achieve stable multiple-gene disease resistance in crops such as corn and alfalfa but until cytoplasmic and genetic male sterile types were developed the system could not be exploited in wheat.

STRAWBREAKER FOOT ROT EXPERIMENTS

G. W. Bruehl, R. Machtmes, T. Murray

Breeding for resistance has been and is one of the major objectives in the wheat improvement scheme. Last year we had good results from inoculations with spores. The earlier the spores are applied, the greater the yield loss, and the greater the selection pressure within a testing program.

Selection 101, seeded at Lind on pre-irrigated land, was inoculated November 1, December 4, February 6, and March 3. The November inoculation reduced yield by 60%. The March 3 inoculation produced lesions on the stems but did not reduce the yield. We now recommend a single heavy inoculation in November with a spore suspension rather than relying on the oat-kernel inoculation technique of the past.

Last fall we gave Dr. Donaldson several hard wheats with resistance to foot rot for his use in his breeding program.

Two fungicides, Benlate and Mertect 340-F, were tested. Benlate was applied at 1 lb./acre and Mertect 340-F at 24 fluid ounces, both in 20 gallons of water by ground. Naturally infected Daws on the Leon Eggers Ranch near Albion and Stephens on the Jerry Sodorff Ranch near Pullman were sprayed. Foot rot was heavy in both fields, but Cephalosporium (fungus) stripe in spots ruined the yields, forcing us to rely on reading stem lesions to determine the extent of disease control. Samples were dug, the stems cleaned, and lesions rated, with 0 being healthy, 1 a light lesion, 2 a moderate lesion, 3 a moderately severe lesion, and 4 severe or dead. The average lesion rating gave us the disease rating. The lower the rating, the healthier the wheat (Table 1).

Table 1. The effect of Benlate and Mertect 340-F on foot rot near Pullman, 1979-1980 season

		Disease Rating	
Variety	Spray Date	Benlate	Mertect
Daws	Control	3.77	3.77
	November 7	3.74	3.88
	February 21	2.28	3.44
	March 19	1.75	3.53
	April 21	1.44	1.56
	May 14	2.50	2.95
Stephens	Control	2.49	2.49
	January 16	0.43	0.71
	February 21	0.53	0.66
	March 19	0.55	0.97
	April 21	1.32	1.87

Benlate was more effective than Mertect 340-F over a wider range of spray dates. Results from previous years with Nugaines at Pullman indicated that Benlate was effective when applied any time in February, March, or April. November or May sprays failed. Results with Daws in 1980 were quite similar, with March and April being the best months during which to spray. The results from Stephens differed markedly, with January, February, and March being the best times to spray. April was already somewhat late for this variety.

This is the first evidence we have that varieties may not respond the same to these fungicides. If these and similar fungicides are to play a prominent role ($3,000,000 spent applying Benlate in Washington in 1980), the tri-state area of Washington, Oregon, and Idaho should have a cereal pathologist who would specialize in the proper evaluation of fungicides.

T. Murray, a graduate student, is studying the relation of straw anatomy and composition to resistance to foot rot. The most resistant wheats have heavily thickened cell walls in mature stems. We do not know, however, whether characteristics of mature straw are related to resistance.

WINTER DISEASES OF WHEAT AND BARLEY

G. W. Bruehl, R. Machtmes, S. Ullrich, D. Jacobs, C. Peterson

The development of wheats and barleys resistant to low temperature fungi was hampered by the lack of persistent snow cover. On the bright side, moisture conditions enabled us to obtain meaningful yield data.

A soft white (Sel. 77-294, WA 6819) and a hard red (Sel. 77-99, WA 6820) wheat are under advanced testing as possible varieties for areas in which winter diseases are a problem. The soft white wheat has slightly stronger straw than Sprague, is slightly superior in quality, is equally hardy and equally resistant to snow mold. It is less resistant to rust and smut than Sprague. Our trials indicate a slightly higher yield potential under good conditions, but its grain has a slightly lower test weight.

The hard red (Sel. 77-99, WA 6820) is the first wheat of any type that we have developed with strong straw. It is less resistant to snow mold than Sprague or WA 6819, but it has more resistance to smut. It should be a useful parent because of its straw. In 1979, it outyielded McCall in all our nurseries. In 1980, Hattan outyielded it in all our nurseries. It is earlier than most wheats in the region and this probably reduced its competitive position last year when summer moisture was good. Yield data are presented in Table 1.

Table 1. Yields of WA 6819 (Sel. 77-294), a soft white selection, and of WA 6820 (77-99), a hard red selection.

			Selection	
Location	Year	WA 6819	WA 6820	Sprague
Almira	1979	38	41	45
Wilbur	1979	71	58	66
Harrington	1979	56	50	53
Pullman	1979	97	103	82
Mansfield	1980	88	69	88
Harrington	1980	83	63	70
Harrington	1980	65	59	67
Lind	1980	73	59	61
Ritzville	1980	74	63	74

The Pullman data reflect relative straw strength. The Mansfield yields are higher than normal because of reduced competition between plots. Lind, 1980, was pre-irrigated. The second set of yields from Harrington are courtesy of Dr. Donaldson. The seeding date was later than the first set of Harrington data. The Ritzville data are provided by Dr. C. Peterson.

Both wheats are in the regional nursery.

Data provided by Dr. Chuck Rhode from Pendleton, Oregon, give added information about these wheats.

Table 2. Performance of WA 6819 and 6820 at Pendleton, Oregon, from an October 31 seeding.

Selection	Heading	Tillers	Height	T.W.	Yield
Daws	June 5	595	37	61.5	79.5
Stephens	June 5	466	34	59.8	77.9
WA 6819	June 6	944	37	60.7	77.9
WA 6820	May 28	684	33	62.7	59.3
Hattan	June 7	627	43	65.0	56.5

Dr. Rhode's data illustrate the small heads and many tillers of WA 6819, like its Sprague parent. The earliness of WA 6820 did not reduce its yield at Pendleton relative to Hattan.

Dr. Peterson will test all our promising selections and we plan to accelerate this program in this way.

Two out of the past three years *Typhula incarnata* greatly reduced the survival of winter barley at Harrington. This year we attempted to evaluate the hardy selections of previous years for resistance to *Typhula incarnata*. The winter was inadequate and this effort will be repeated. The hardiness nursery of Dr. Ullrich and Carl Muir will serve this purpose.

We have begun a study of populations of sclerotia of the snow mold *Typhula* spp. in soil. We wish to learn how many are required to be a threat, what species are in what soils, how the soils affect their longevity, and what parasites might attack the sclerotia in soil. Part of this work is done by Darrel Jacobs, a graduate student.

CONTROL OF RUST AND MILDEW

Roland F. Line

Rust

The rusts (stripe rust, leaf rust, and stem rust) are diseases of wheat caused by fungi that parasitize the foliage. They are usually most severe in years when the weather is conducive to high yields. Rust can start from a few infections (pustules) in the spring, and increase to a level of severity where the plant is covered with pustules by the end of the growing season. The pustules break the surface of the plant and cause massive losses of water from the plant. Of the three rusts, stripe rust requires a low temperature, leaf rust an intermediate temperature, and stem rust a high temperature. Consequently, stripe rust begins to increase early in the spring, leaf rust increases later in the spring, and stem rust usually appears too late to cause significant damage.

Stripe rust appears as golden-yellow, sporulating stripes on the leaf surface, sheaths, and heads of the wheat plant; leaf rust appears as red pustules about the size of a pinhead on the leaves and sheaths of the plant and stem rust appears as larger red-brown pustules, primarily on the stems of the plant.

The stripe rust and leaf rust fungi infect the wheat plant in the fall, survive the winter inside the leaves, and increase by reinfecting leaves in the spring. In 1980, the mild winter and cool-wet spring favored the development of severe epidemics of both stripe rust and leaf rust, and damage from the diseases exceeded 20% (20-30 million bushels). Similar losses may occur this year (1981). Both rusts were unusually severe on fall planted wheat, especially in the early seeded fields. The winter of 1980-81 was one of the warmest in history. Consequently, the rusts not only survived, but also increased in severity during the winter. Spring weather may modify the severity of the diseases. Cool spring temperatures are especially favorable for stripe rust and reduce the effectiveness of adult plant resistance to the diseases. A wetter than normal period from mid-May to early July will provide favorable conditions for leaf rust.

The rusts only grow on a living host. Therefore, management practices influence the development of rust epidemics. Those practices that provide for a continuous, year-round host, such as early seeding, growing irrigated and dryland wheat in the same area, and planting spring and winter wheat in the same area, all contribute to a continuous source of inoculum for the subsequent crop. Moisture is especially important for development of leaf rust epidemics. Consequently, irrigation with overhead sprinklers increases the possibility of severe leaf rust.

The following is a list of Pacific Northwest wheats grouped according to their resistance to stripe rust and leaf rust.

Group I

Seedlings, adult plants and heads are resistant to stripe rust.
Plants are resistant or moderately resistant to leaf rust.

Winter Wheat	Spring Wheat
Greer	Wared
	Wampum
	Borah
	Wandell

Group 2

Seedlings, adult plants and heads are resistant to stripe rust.
Plants are susceptible to leaf rust.

Winter Wheat				Spring Wheat
Moro	Jacmar	Weston	Hansel	Twin
Faro	Raeder	Ranger	Mining	Springfield
Barbee	Lenore	Jeff	Hatton	Dirkwin

Group 3

Seedlings and heads are susceptible to stripe rust.
Adult plants are resistant to stripe rust.
Plants are susceptible to leaf rust.

Winter Wheat			Spring Wheat
Luke	Daws	Stephens	None

Group 4

Seedlings and heads are susceptible to stripe rust.
Adult plants are moderately resistant to stripe rust.
Plants are susceptible to leaf rust.

Winter Wheat				Spring Wheat
McCall	Gaines	Hyslop	Sprague	Marfed
Wanser	Nugaines	McDermid	Walladay*	Urquie
				Walladay*

*Walladay can be planted in the fall or spring.

Group 5

Seedlings, adult plants, and heads are susceptible to stripe rust.
Plants are susceptible or moderately susceptible to leaf rust.

Winter Wheat		Spring Wheat	
Peck	Yamhill	Sawtell	Fielder
Rew	Paha	Sterling	Fieldwin

Some varieties have had a high degree of resistance to stripe rust, but new races of the rust, which can attack the previously resistant wheat, have evolved. Most recently, new races have caused widespread damage to Fielder and Fieldwin spring wheat. The high-temperature, adult-plant resistance to stripe rust has not been circumvented by new races, but is less effective when spring temperatures are low, such as occurred in 1980. A few Pacific Northwest wheats were resistant to leaf rust, but new races that can attack those wheats have also evolved.

As part of the research program, we are testing fungicides to determine their effectiveness in controlling the rusts when applied at various rates and according to various schedules. One of the most outstanding fungicides has been Bayleton; however, it has not been registered for use in the United States. Because of the potential rust epidemic in 1981, an emerging exemption from the EPA for use of Bayleton for control of the two rusts was requested and granted in March. Information on the use of Bayleton has been provided to extension personnel and is available upon request. Use of the fungicide should depend upon the presence of the disease, stage of growth, weather and the type of resistance.

Powdery Mildew

Powdery mildew is prevalent throughout the region and is most prevalent in areas with higher rainfall or in irrigated fields. However, mildew is not as destructive as the rusts. Some of the new experimental fungicides, which control rust, also control powdery mildew. Powdery mildew has been reported to severely damage barley in Europe. Barley varieties developed for Washington vary in resistance to mildew. Presently, studies are being conducted to determine the damage caused by mildew.

QUALITY EVALUATION OF PACIFIC NORTHWEST SOFT WHITE WHEATS FOR SUITABILITY AS MIDDLE EASTERN AND NORTH AFRICAN BREADS

Hamed Faridi, Gordon L. Rubenthaler and Patrick L. Finney

Middle Eastern and North African countries are present and potential customers of U.S. soft white wheat grown in the Pacific Northwest of the United States. We are facing serious competition from other soft wheat producers such as Australia, New Zealand, France and West Germany.

In an effort to learn what wheat qualities are best suited for Middle Eastern and North African countries, who have been purchasing some rather large quantities of Western white wheat, we recently have conducted some studies evaluating several currently grown Western wheat varieties in a number of their flat breads. Little information has been available as to end-use qualities of our PNW soft white wheats in these markets. The information will be used in the variety development programs as a guide to improve future varieties that fulfill the requirements for the various flat breads.

One of their basic food habits is higher consumption of bread—especially flat bread. Breads popular in that part of the world are generally flat, made from very few ingredients (flour, water, salt and yeast most of the time), are chewier than the average Western loaf-type bread and made from higher extraction flours.

Sixteen Western wheat varieties representing hard red winter (McCall and Wanser), soft white winter (Nugaines, Sprague, Hyslop, Daws, McDermid, Stephens), durum (composite of experimental selections WA 6630 and WA 6631), white club (Paha, Moro, Jacmar), and three dual purpose selections [K76-514, K76-00514(L), K76-00514(H)], and a composite called western white (80% soft and 20%s club white) were studied. Each variety also represented a composite of three or four crops, all grown in the Pacific Northwest.

We are determining flour requirements of breads popular in Iran, Morocco, Tunsia, Egypt, Sudan, Saudi Arabia, Lebanon, Jordan, North Yemen, Lybia, India, Pakistan and many other countries in that part of the world. For this purpose a thorough search of existing research about different international flat breads was made. A series of questionnaires asking details of wheat, flour, and bread characteristics were sent to authorities in most of these countries. Micro-baking techniques for laboratory testing were developed and important factors for end product evaluation were established.

Other research associated with quality evaluation studies for international breads is to produce a new flat-type bread specifically for U.S. markets to promote domestic consumption of PNW soft white wheat. Our observations are that consumption and interest in flat bread is increasing in the U.S. and consumers are seeking ways to increase cereals in their diets. Internationally, flat-type (including "pocket-type") breads—made best from soft white flour—are more popular than Western-type loaf breads. There are innumerable types of flat breads which differ in taste, flavor, texture and appearance.

Hardly any flat-type breads (including "pocket-type") available in the supermarkets today are made and produced for American consumers. They are mostly produced by different ethnic groups. We are undertaking research into the production of U.S. type flat breads that would carry the characteristics of, be appealing to American consumer at large, have lower caloric value, have higher wheat fiber content, have improved nutritional value, have reasonable shelf-life, be produceable in large scale and do not contain any chemical preservatives.

SUMMARY OF RESEARCH ACTIVITIES OF USDA, WESTERN WHEAT QUALITY LABORATORY

G. L. Rubenthaler, P. L. Finney, J. S. Kitterman, H. C. Jeffers,
A. D. Bettge, P. D. Anderson, M. L. Baldridge and P. A. Allen

1. Milling and baking evaluations were determined on 1,608 preliminary and advanced experimental crosses developed by breeders in the Western States and grown during the 1979 crop year. Analysis and evaluations have been completed on about 1250 selections from the 1980 crop. Many of these were judged as having acceptable end-use quality fitting their market classes. Tests used to determine acceptability were flour yield, protein, ash and color; cookie diameter; loaf volume and crumb score; dough mixing requirements and water absorption; Japanese sponge cake volume and texture; Udon noodle yield, texture, color and score. Results were reported to the breeders in the Region.

2. In addition, we maintain a vigorous early generation testing program supported in part by grower funding. Four thousand two hundred fifty-five F_3-F_4 semi-micro (150 g) samples from the 1979 crop were evaluated for milling and baking quality by small scale tests. Of these, 1,651 (39%) were judged as having some overall promise in end-use quality. An additional 1000 single plant selections were screened for milling and protein by micro tests (5 g). Protein and lysine contents were determined on 1,100 hard red winter crosses made to high protein/lysine sources. This program increases the efficiency of breeding programs.

3. In cooperation with the USDA, FGIS and the Japanese Food Agency (JFA) a study was conducted to determine tolerance levels of sprout damaged wheat in Japanese products. Three samples were selected, which ranged from sound to 10.8% sprouted kernels. These were milled and blended to make 10 flours varying in sprout damage which were sub-sampled and sent to Japan for testing by JFA and the Flour Milling Association. Tests used were Falling Number, and Nephelometer (amylase analyzer), the traditional Amylograph, Japanese sponge cake, Udon noodle and pancake. Based on the data obtained on the samples, the following points were agreed to: 1) No significant difference could be found in samples which amyolgraph values were above 300 BU, while four of the samples with amylograph values below 300 showed deteriorated characteristics in Japanese style wet noodles. Noodles made at 3 mm thickness were most susceptible to enzyme deterioration. The deteriorated factors noted were: a) dull color, b) stickiness in the mouth when eaten. 2) The sponge cake test showed the same samples had dull crumb color and heavy texture characteristics which reduced cake score. 3) Compared to the noodle and sponge cake tests, less deteriorative effects were recognized in the pancake tests. However, the higher sprouted samples (amylographs below 300) did show some deteriorated characteristics. 4) In the case of white wheat, sponge cake is most sensitive to alpha-amylase followed by Udon noodle and hotcakes. Correlation coefficients of amylograph, Falling Number and Grain Amylase Analyzer (GAA) data between the JFA and WWQL data was .992, .878 and .989 respectively. Baking scores were similarly related. The work will contribute to establishing tolerance levels for sprout damage that is measured by methods mutually developed. The FGIS is pursuing implementation of a new method.

4. A variety mixture (4 SWS wheats sown together in a number of ratios) study which were planted at three different dates was evaluated for end-use quality. There was a general trend that second and third (late) plantings declined in test weight, flour yield, mill score and cookie diameter; while protein increased with the later plantings. Work was done in cooperation with Dr. Allan Ciha, USDA, Plant Physiologist.

5. In studies conducted in cooperation with Dr. Ciha to determine the influence of cultural practices of conventional tillage vs minimum and no-tillage, five soft white and two hard red spring varieties showed the following trends: Protein 12.6, 12.1, and 12.4; milling score 78.6, 76.6 and 76.4; cookie diameter 8.80, 8.73, and 8.67 cm; and loaf volume 1216, 1222, and 1227 cc respectively. Values are averages of the seven varieties across three planting dates. Results show a trend that minimum and no-till lower milling quality and cookie diameter, but favor bread baking characteristics.

6. Numerous fields of pivot irrigated wheat have been observed to lodge when the wheat is blooming to early filling stage. Usually these fields have been heavily fertilized with N and in a rotation with potatoes. Eight such fields in NE Oregon were selected for study by Dr. F. V. Pumphrey at the Pendleton Research Stations. The lodged areas showed a reduced yield of 25% (93.8 vs 69.7 bu/acre) and tested near 5 lbs lighter (59.5 vs 54.7 lb/bu). Grain taken from these fields of Hyslop and Stephens were evaluated for milling and baking performance. The lodged samples were consistently poorer in overall quality properties. They were lower in flour yield and milling score, higher in flour protein and smaller in cookie diameter.

7. A computer system is now operational which produces work forms, stores and calculates (transforms raw data), retrieves and prints the final transformed data in report form. Credit is due the USDA, SEA, CDSD for their cooperation over the past two years in programing. The system may serve as a model for other labs.

8. Some Pacific Northwest soft white wheat and other U.S. wheat varietal composites were evaluated for their breadmaking potential in a dozen international breads, principally flat-type, which varied greatly in formulation and procedure and which produced quite variable bread properties. Water hydration ranged from 40 to 85%, flour extraction from 70 to 100% and yeast from zero for a very short rest period to 2% with hours of sour dough fermentation. In addition to the significant differences in bread quality attributable to wheat class, color or hardness, we found wide ranges in bread quality even among varieties we have otherwise physically and chemically characterized as alike. The work will aid in better understanding of the wheat requirements of the Middle-Eastern markets and the development of wheat that will fill their needs.

9. Research experiments using various blends of Hard Red Winter (HRW), Dark Northern Spring (DNS), Western White (WW), and domestic Chilean (soft red winter) wheats were compared in baking quality for traditional Chilean "Marraqueta" bread. Flour consumption in Chile is about 300 g per capita/day, the greatest in the Western Hemisphere and among the top 10 countries in the world. Wheat, in some form, supplies over 40% of the calories in the Chilean diet. The primary product consumed is "Marraqueta" bread, a lean formula type product made in four 4 oz. pieces (110 g) and prepared 3 times a day. The product is similar to our hard rolls and has been traditionally made with their *soft wheat* and imported ordinary HRW. Domestic production of wheat is decreasing, therefore, imports are on the rise. Virtually all of Chile's wheat imports come from the U.S. In the 1979-80 export season, Chile imported approximately 614,000 metric tons of Hard Red Winter, 32,960 metric tons of Soft Red Winter, 72,970 metric tons of Western White and 64,000 metric tons of Durum wheat for a total of 784,530 metric tons. Tests demonstrated that WW wheat was very suited for their breadmaking and quite similar to their domestic wheat and could provide them a low cost wheat when the market situation favor WW. The work was done in cooperation with the U.S. Wheat Associates, Inc. in Santiago, Chile. Further research has been proposed to do more detailed study at the Western Wheat Quality Lab. to substantiate the potential for this Chilean market.

COMPETITIVE EFFECT OF WEEDS ON WHEAT PRODUCTION

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Weeds can cause yield losses ranging from 0 to nearly 100%. It is extremely rare when a competitive species does not cause some yield loss. In looking at the data, those rare occasions generally happen when there is a bumper crop or, in contrast, a near crop failure. However, keep in mind, weeds take their toll even on most bumper crops. A weed is probably least competitive when it emerges late in the crop year and the wheat out-competes the weed. In a year of near crop failure, the weed is probably not the only limiting production factor. One thing for sure, competition and numbers of weeds vary from year to year, as shown by the following information:

Weed species	Weeds/sq ft[a] Range	Weeds/sq ft[a] Average	Yield reduction Range	Yield reduction Average	Average loss per weed per sq ft
	(No.)		(%)		(%)
Downy brome	5-15	10	15-36	27	3
Wild oat	6-18	11	0-66	25	2
Jointed goatgrass	2-13	10	17-66	41	4
Fiddleneck	1- 3	2	0-30	18	9
Blue mustard	1-10	5	18-72	45	9
Mixed population[b]	2-12	6	0-17	12	2
Field bindweed[c]					
Wheat-summer fallow rotation	—	—	18-61	36	—
Annual cropping	—	—	0-45	31	—

[a]Weed populations were counted at the mature stage of growth.

[b]Field pennycress, mayweed, corn gromwell, henbit.

[c]Plant counts were not taken.

These data are from replicated field experiments conducted in five eastern Washington counties from 1968-1980. If the yield difference was not significant at the 5% level, a 0 is shown. Yields from weed infested plots were compared to yields from either a weed free check or the best herbicide treatment.

Wild oat was less competitive per plant than the other two grass weeds studied. Both downy brome and jointed goatgrass tend to mature earlier than wild oat and, perhaps because of this, always cause a yield reduction. It is also interesting to note that the average population of the grass weeds was two to three times that of the broadleaf annuals.

Blue mustard and fiddleneck were two to five times more competitive per weed than any other species we have studied. Blue mustard always caused a yield reduction regardless of year or location. These weeds have two things in common: they are both early maturing and are overstory (grow taller than the wheat crop) weeds. It is suspected that blue mustard and perhaps fiddleneck produce a toxin that inhibits other plant growth and germination of weed seeds. Casual field observations indicate that new blue mustard or fiddleneck seedlings do not appear until after the older weeds have been removed by winter kill, hoeing, or herbicides.

The mixed population of weeds in the higher rainfall areas were not as competitive. These later maturing weeds do not tend to overstory the wheat as much.

Field bindweed always caused a yield reduction in the wheat—summer fallow areas. In contrast, the crop sometimes was able to compete successfully against the bindweed in the annual cropping areas. However, long term studies show the average crop loss, due to bindweed competition, in the two types of farming was similar.

There is no way of knowing beforehand that the wheat might be able to out-compete the weeds. Even if there was a way to determine that the weeds would not cause a yield reduction, you would still want weed control to stop seed production. Thus, regardless of the crop condition and year, one should always control weeds, and for the annuals, control them early. For management and control of these weeds see your local county agricultural Extension agent.

INFLUENCE OF JOINTED GOATGRASS ON WINTER WHEAT

Duane Flom and Larry Morrow
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Jointed goatgrass (*Aegilops cylindrica* Host.) is a weed of increasing importance to winter wheat producers in the Pacific Northwest, especially areas in southeastern Washington. Similar growth habits and chemical susceptibilities between jointed goatgrass and winter wheat increase the difficulties in obtaining adequate weed control, especially under a continuous winter wheat cropping system. Current studies involve the evaluation of the competitive effects of jointed goatgrass on several heights of winter wheat. Isolines for three heights of the winter wheat variety, Brevor, plus several commercial varieties, are being grown in conjunction with several densities of jointed goatgrass. In 1980, winter wheat varieties were seeded in 12-in rows at 72 lb/A and the jointed goatgrass was broadcast seeded at 36, 72, and 144 lb/A. 1980 crop research data indicate that jointed goatgrass density has little effect on winter wheat height, but that tiller production and crop yield are decreased with increasing densities of jointed goatgrass (Table 1). Evaluated over all jointed goatgrass densities, the medium height wheat varieties were least affected and the tall varieties the most affected by the presence of jointed goatgrass (Table 2). Winter wheat varieties least affected by the presence of jointed goatgrass were the medium Brevor type and Daws, while the most affected variety was Hatton.

Table 1

	Percentage of Control Plots			
		Jointed Goatgrass Density (lb/A)		
Evaluation	Control	36	72	144
Height	100	101.5	98.8	97.0
Tillers (per meter row)	100	94.5	73.5	66.3
Yield	100	102.9	85.7	65.5

Table 2

Wheat Height Type*	Height	Tillers/Meter Row	Yield
Short (19 inches)	101	59	89
Brevor short			
Medium (30 inches)	99	87	93
Brevor medium			
Tyee			
Daws			
Tall (37 inches)	98	77	81
Brevor tall			
Hatton			

*Jointed goatgrass height was about 30 inches within each wheat type.

WILD OAT CONTROL IN SPRING WHEAT UNDER CONSERVATION TILLAGE PRACTICES

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Research was conducted in 1980 and is being repeated this year for wild oat control in spring wheat under conservation tillage practices. Fielder spring wheat was grown. Yields may have been decreased due to infections of leaf and stripe rusts.

Treatments in group I were unincorporated and applied on April 22, before wheat emergence in untilled soil. Granular triallate at 2.5 lb/a, unincorporated, either preplant or postplant, exhibited acceptable wild oat control and acceptable yields. Liquid triallate at 2.5 lb/a, unincorporated, exhibited reduced wild oat control and reduced yields. This may have been due to some volatilization of the chemical before the wild oat emerged. Metribuzin exhibited low wild oat control and low wheat yields.

Treatments in groups II and III involved less intensive conservation tillage practices. Treatments in group II were applied on April 22 on pretilled soil. All other treatments were planted directly into standing stubble. Treatments in group III were applied on April 22 and incorporated. Treatments in group IV were applied post-emergence on May 13, which allowed early competition by the wild oat plants.

Liquid triallate applied post-emergence at 1.25 lb/a, difenzoquat, diclofop, and triallate-difenzoquat, all exhibited acceptable yields and poor wild oat control. This may have been due to good wild oat control early in the growing season, with a second flush of wild oat germination sometime before June 19. The second flush may have been due to the cool, moist conditions experienced. This may indicate very early competition of wild oats is more detrimental to spring wheat yields than later wild oat competition.

The general decrease in control of wild oat between June 19 and August 6 may have been due to an extension of the second flush of wild oat germination past June 19, or an increase of tillers per wild oat plant.

Group	Treatment (lb/a)	Yield	% Wild Oat Control 6/19/80	8/6/81
I	Triallate, EC POPS, 2.5	20.3	35.2	0.0
	Triallate, 10g POPS, 2.5	30.3	89.3	88.2
	Triallate, 10g PRPS, 2.5	33.5	87.6	76.1
	Metribuzin, WP PRPS, 0.375	17.3	26.0	36.8
II	Triallate, EC POPS, 2.5 Till	32.5	79.0	50.0
	Triallate, 10g POPS, 2.5 Till	28.3	98.5	73.2
III	Triallate, EC POPI, 1.25	34.8	72.1	56.1
	Triallate, EC POPI, 2.5	37.2	100.0	92.9
	Triallate, 10g, POPI, 1.25	30.7	87.6	67.9
	Triallate, 10g, POPI, 2.5	28.3	87.6	81.1
	Triallate-Trifluralin 1.0 and 0.5	38.2	93.4	82.2
IV	Triallate, EC POST, 1.25	20.7	32.9	1.1
	Triallate, EC POST, 2.5	31.7	60.5	34.7
	Triallate, 10g, POST, 1.25	27.9	83.6	42.9
	Triallate, 10g, POST, 2.5	23.0	67.5	38.2
	Difenzoquat, EC POST, 1.25	36.0	11.6	22.5
	Diclofop, EC POST, 0.75	34.0	55.9	38.2
	Barban, EC POST, 2.5	23.2	80.7	46.5
	Triallate-Difenzoquat EC POST, 0.5, 0.5	31.5	62.6	47.5

SOIL FERTILITY MANAGEMENT FIELD TRIALS FOR WHEAT PRODUCTION

Fred Koehler, Marvin Fischer, Emmett Field, and Raymond Meyer

There are approximately 35 field experiments concerning soil fertility management for wheat production being conducted in 1981. These are distributed throughout the wheat producing area of eastern Washington from Asotin to Waterville (see map and lists of grower cooperators for locations).

A total of 11 no-till experiments are under way in 1981. In one study no-till is being compared with conventional tillage with both spring and winter wheat using various combinations of fertilizer materials and rates. Other studies involve only a no-till management system. At other locations variables include placement method, rate of nitrogen fertilizer, source of nitrogen, the use of nitrification inhibitor, and trace elements.

The use of spring top dressing with nitrogen for winter wheat is being studied. Treatments include rate and source of nitrogen as well as the use of sulfur in addition to nitrogen.

At Spillman Farm there is a long term study on the effect of soil acidity on wheat and pea production. Three levels of soil acidity have been established. Superimposed on these treatments are sources of nitrogen (ammonium N versus nitrate N) and the use of trace elements. To date there has been no effect on wheat yields.

Other experiments include further studies on nitrogen sources and rates for winter wheat, source and rate of phosphorus fertilizer, use of sulfur, rates and sources of nitrogen and sulfur with and without phosphorus and zinc for spring grain, and sources and methods of application of various kinds of fertilizers with a no-till system.

In 1978 there were several responses to spring top dressing of winter wheat. All nitrogen fertilizer materials gave similar yield responses. In the no-till experiments, where moisture was limiting, no-till resulted in higher yields than did conventional tillage. In other experiments where moisture supply did not limit yields, the highest yields were produced with conventional tillage. In the higher rainfall area, weed problems were more severe than in earlier years, presumably because of heavier than normal late spring and summer rainfall. Band placement of nitrogen and sulfur fertilizer for spring wheat with no-till was much more effective than was surface broadcasting these materials.

In 1979 and again in 1980 there was severe rodent damage to many of the no-till sites. At sites where there was both no-till and conventional tillage, the damage was more severe in the no-till plots. Where meaningful data could be obtained, yield responses were similar to those obtained in previous years.

In 1980 spring barley gave a yield response to shanked in phosphorus, in one of four locations, as a WSU soil test had predicted. There was no response to zinc at any location. All zinc soil test levels were at 0.5 parts per million or higher.

Because of the very dry fall of 1979, no-till recrop winter wheat had to be seeded before there was a chance for any weeds to germinate and be killed. As a result of the weed problems at several locations, plots had to be reseeded to spring wheat. There was a severe rust infection on spring wheat in 1980 and since the damage was greatest on adequately fertilized plots, yield responses did not correspond to growth responses. There was little difference between responses to broadcast and banded applications of N fertilizer for spring wheat in 1980. This was unlike previously observed responses and probably was the result of the unusually large amount of spring and summer rainfall.

THE EFFECT OF SLOPE AND TILLAGE ON WATER STORAGE AND YIELD OF WINTER WHEAT

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Water storage and an optimum growing environment have always been a major consideration in nonirrigated wheat production. Reduced and no-tillage systems increase water storage, but have resulted in reduced wheat growth and yield on parts of fields and apparently increased yield on others. Therefore, a study was initiated to monitor water storage and various yield parameters with respect to tillage and slope position. The experiment consists of conventional, reduced, and no-tillage winter wheat cropping systems located at bottom, middle, and top positions of two south slopes located near Pullman and Colfax, Washington.

Overwinter water storage was unaffected by tillage at the bottom of the slopes, but was increased by both the reduced and no-tillage systems on the middle and top slope positions when compared with conventional tillage. The greatest differences were observed on the middle slope position where water storage was increased by 2 and 3.5 in for the reduced and no-tillage treatments, respectively. The reduced and no-tillage treatments at the top of the slope both stored 1 in more water than the conventional tillage. Tillering and head production per unit area decreased in both the conventional and reduced tillage systems with progression up the slope, but remained the same for the no-tillage system. Tillage did not affect yields at the bottom of the slope, but no-tillage significantly increased yields by 15 and 20% over conventional tillage at the middle and top of the slopes, respectively.

RESIDUE MANAGEMENT OF NO-TILL WINTER WHEAT

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Direct drilling of winter wheat through surface cereal residues reduces soil erosion, but frequently has resulted in stunted plants and lower yields than conventional planting methods. Phytotoxins produced during decomposition of surface crop residues have been implicated as the cause of these reduced yields. Field plots were established on spring and winter wheat stubble to compare plant stands, water storage, grain yields, and water-use efficiency between no-till or conventionally planted winter wheat. Residue management of the no-till treatments included: standing stubble, flailed stubble, complete residue removal, or moving the crop residue from the seed row. Water soluble phytotoxins from the crop residues were not found during the three-year study (phytotoxins appear to be produced only during cool-wet falls); consequently, grain yields were not reduced by surface crop residues. Because phytotoxins were not produced during this study, moving the crop residues from the seed row did not affect yields, but did alleviate the high crown node set which in turn reduced visual injury from soil-active herbicides. Surface crop residues significantly improved water storage during the 1978-79 season, which in turn increased grain yields. Water-use efficiencies were increased by surface crop residues in 1977 and 1979 when moisture limited yields, but had no effect in 1978 when precipitation was above normal. In 1979, the no-till treatments left an average of 2 inches more water in the profile than the tillage treatments, which is a 12 to 14 bu/acre loss in potential yield. The reason for the crop's inability to obtain this water has not been identified, but if no-till planting of winter wheat is to realize its full potential, the cause must be identified and corrected.

RUNOFF AND EROSION PREDICTION AND CONTROL

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Erosion Prediction (USLE)

Efforts continue to improve the adaptation to the region of the Universal Soil Loss Equation (USLE). Sufficient experience and data are now available to significantly improve the first generation adaptation which has which has been in use since 1974. Factors to receive attention are those for climatic influence, soil erodibility, topographic influence, crop management, and conservation practices. Since 1973, many farm owners and operators across Whitman and Latah Counties have allowed erosion measurements to be made on their property so the influence on erosion of climate and topography could be estimated more precisely. During the past winter, several cooperators across eastern Washington and northern Idaho have collected frost depth and air temperature data. This data will prove valuable in determining the extent and severity of soil freezing across the region and its influence on frozen soil runoff. We wish to thank our many cooperators for their help in these studies.

Effect of Crop Management on Runoff and Erosion

Runoff plot studies to compare the effect of land treatment on runoff, soil loss, and water quality have been installed on the Palouse Conservation Field Station (PCFS) in cooperation with the Agricultural Engineering and the Agronomy and Soils Departments of WSU. The studies include such treatments as conventionally seeded annually cropped winter wheat, a winter wheat/summer fallow rotation, no-till winter wheat seeding, no-till winter wheat seeding with vertical slotted mulch, and various rough tillages and standing stubble in preparation for spring crops. Slot mulch tillage is a new technique being tested to maintain water infiltration even under frozen ground conditions. Most of the studies were started in the fall of 1976. Since the 1976-77 runoff season, there has been only one severe runoff and erosion season at this location. That year, 1978-79, involved runoff on thawing soil. There was little difference in runoff from the various treatments (other than the slot-mulch). However, large differences were seen in soil loss. Winter wheat after summer fallow lost 11.6 tons per acre while conventionally seeded winter wheat after small grain lost only 2.4 tons per acre. In the less severe years since 1976-77, only the winter wheat after summer fallow has produced significant amounts of runoff and soil loss.

Evaluation of Latah County Five-Point Program

A current project of the Land Management and Water Conservation Research Unit in cooperation with the Agricultural Engineering Department of the University of Idaho is to evaluate the effect on soil erosion and water quality of the Five-Point Program of the Latah Soil Conservation District. The Five-Point Program consists of the following elements: (1) restricted summer fallow, (2) minimum tillage, (3) contour seeding, (4) divided slope farming, and (5) critical area treatment. The study was undertaken as part of the Section 208 area-wide waste treatment planning effort established by Public Law 92-500, Water Pollution Control Act Amendments of 1972. The study includes runoff plots to evaluate the effect on runoff and soil loss of such treatments as divided slope and minimum tillage, rill meter studies to evaluate more conventional treatments, and field outlet sampling to relate runoff water quality to crop treatment. The project was started in the fall of 1976 and is scheduled for completion in July 1981. Contact D. K. McCool, USDA-SEA-AR, Agricultural Engineering Department, Washington State University, Pullman, WA 99164, for the results of this study.

Soil Water Predictions

Several studies are underway to develop improved procedures for predicting soil water and its effects on crop yields. While this is a national effort, several sets of measurements are being made at the Palouse Conservation Field Station. Other data are being obtained in cooperation with the USDA-SCS in Whitman County and other locations throughout the U.S.

Slot Mulch Tillage

We continue to develop and evaluate this new tillage method. Recent results indicate a spacing of 15 to 18 feet may be workable in our climate. While we still believe it will have most application on direct-drilled wheat, we have made trials on bluegrass, alfalfa, pea stubble, summer fallow, and terrace channels. Infiltration analyses indicate that this configuration has good potential. We now must learn how to best fit it to farming practices and to develop appropriate machinery. This work is underway.

AGRICULTURAL ENGINEERING NO-TILL RESEARCH

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In order that new management practices be adopted to minimize soil erosion from farm land, methods and equipment are needed that will accomplish that task and at the same time maintain or improve production efficiency through improved yields, reduced production costs, or both.

Equipment that will plant through heavy surface residue, place fertilizer below the surface, and plant the seed in residue-free soil at a depth compatible with crop requirements is necessary for maximizing production efficiency with reduced-tillage cultural practices. These requirements were reasonably well defined during the past five years. Requirements yet to be defined include optimum row spacing for corresponding crop, residue, and climatic conditions, methods of applying the most energy efficient and economically efficient forms of fertilizers, defining the most desirable compaction patterns for seedling growth, and minimizing crop production energy needs under these cultural practices.

Objectives:

The objective of this project is to develop equipment and methods for reduced-tillage production of small grains that will minimize soil erosion, weed control, residue toxicity, and residue management problems while utilizing efficient fertilizer and energy balances, and maintaining or improving overall production efficiency.

Progress: 1979 Harvest

Statistical analysis of 1979 harvested yields (see also the 1980 Field Day report) show that, in pea residue under relatively dry fall planting conditions, no significant effect of location of main fertilizer (92 lb N and 20 lb S per acre) on wheat yield existed; while placing starter fertilizer (8 lb N, 40 lb P_2O_5 per acre) below the seed was significantly better than placing it with the seed. In general, if any of the fertilizer is placed below the seed, it is advantageous to place all of the fertilizer below the seed; and at the rates used, it should be placed two or more inches below the seed. A similar though insignificant trend existed in spring wheat plots.

With broadcast main fertilizer in wheat residue, winter wheat yields were less with the opener types that disturbed the soil below the seed. No such trend existed for plantings in pea residue.

1980 Harvest

Yield results may have been affected by volcanic ash fall and by leaf rust in spring wheat and cephalosporium stripe in winter wheat. Fall plantings were November 3 and 9, 1979, due to dry early-fall conditions. All plantings were made with sealer plate, modified HZ, or modified HZ opener-plus-double disk seed opener behind packer wheels. Each opener was tested with broadcast main fertilizer and starter with seed, and with main and starter fertilizers placed together below the seed level. Fertilizer rates were 100 lb N, 40 lb P_2O_5, and 20 lb S.

Results (Table 1) show a significant 8 bu/acre advantage for placed, compared to broadcast fertilizer in winter wheat at both the St. John and Pullman locations. Spring wheat showed a similar but insignificant trend. The sealer-plate opener overall gave slightly lower yields though nearly the same as the hoe-double disk combination, possibly because it provided only about 1 1/2 inches between seed and fertilizer placement while the other openers gave 2 to 2 1/2 inches. The modified HZ opener gave the best over-all results, even though it placed the seed in looser soil and disturbed the soil below the seed more than the hoe-double disk combination which placed the seed 2 inches above and 2 inches to the side of the fertilizer band. Previous crop at both locations was wheat.

Table 1

	Fall Seeding (Nov., Stephens)		Spring Seeding (Fielder)	
	St. John	Pullman	St. John	Pullman
Comparison 1:				
Placed Fertilizer	66a BU/A	69a	56a	42a BU/A
Broadcast Fertilizer	58b	61b	53a	40a
Unfertilized Check	37c	44c	47b	33b
Comparison 2:				
Sealer-Plate Opener	55b	67a	53b	41a
Modified HZ	62ab	68a	58a	42a
Hoe Fert., Dbl-disk Seed	66a	62b	52b	39a

Means within column and comparison with the same letter are not significantly different at the 5% level of comparison.

New Drill

A 3-point hitch-mounted no-till drill was designed, constructed, and used to seed plots in October 1980 and April 1981. It features liquid and anhydrous ammonia fertilizer application below the seed, variable row spacing, flexibility in component locations, improved maneuverability and transportability, and can place dry fertilizer with or below the seed.

Slot Mulching

Cooperative work is underway under another funding source to develop a machine for forming straw-mulched vertical slots on the contour to reduce water runoff from frozen ground and springtime water erosion. The machine will also be tested in conjunction with no-till plantings.

Publications:

Hyde, G. M., C. E. Johnson, J. B. Simpson, and D. M. Payton. 1979. Grain drill design concepts for Pacific Northwest conservation farming. ASAE Paper No. 79-1525, American Society of Agricultural Engineers, St. Joseph, MI 49085.

GENETIC AND ADAPTATION STUDIES OF WHEATS FOR CONSERVATION TILLAGE

R. E. Allan, A. J. Ciha, C. J. Peterson, J. A. Pritchett,
L. M. Little, and M. A. Patterson
USDA-SEA-AR

We have summarized 1979 and 1980 results of our split plot tests wherein the performance of 80 to 120 cultivars and special genetic lines were compared under conventional and conservation tillage systems. We measured eight criteria—which included yield, test weight, plant height, heading date, anthesis date, stand, harvest index and severity of fungus stripe disease. Tillage practice significantly affected these criteria in 55 of 100 comparisons. Plant height, test weight and heading date were most frequently affected by tillage. Tillage influenced yield in 25% of the comparisons and among these no-till increased yield 80% of the time. No till usually increased plant height but frequently delayed heading date. It reduced or increased test weight in about equal frequency. Limited comparisons suggest no-till increases harvest index and fungus stripe disease. Significant genotype × tillage practice interactions occur in only 12% of all comparisons. These interactions were detected for yield, test weight, plant height, heading date, stand and fungus stripe incidence. The occurrence of significant genotype × practice interactions clearly shows that wheat genotypes do respond differently to conservation tillage systems and confirms the need to test and select wheat lines under specific conservation tillage systems rather than under a single conventional tillage system.

A summary of our findings to date toward breeding wheats adapted to conservation tillage systems suggests:

1. An array of plant types can be used and there appear to be no serious breeding restrictions.
2. Earlier maturing types that have high stable test weight would be desirable.
3. Short, stiff-straw, medium height semidwarfs are needed.
4. The best yielding types under conventional tillage often yield best under conservation tillage but they may also lose more percentage yield under conservation tillage.
5. When weeds and volunteer are severe, we seldom see differences among wheats under conservation tillage.
6. So far there is no clear trend as to how conservation tillage affects wheat quality.
7. Foliar diseases favored by lateness can cause extensive loss in no-till some seasons.

ANNUAL CROPPING OF SPRING GRAINS

A. J. Ciha and Helen Murray
USDA-SEA-AR

Over the past several years spring grains have been grown continuously at Lind and Harrington, Washington. Several spring wheat and barley cultivars were examined using three tillage systems: (1) fall-chisel; (2) spring tillage only, and (3) no-tillage. The seeding rates were approximately 75 lbs/acre and were seeded at a 14 inch row spacing using hoe type openers and John Deere HZ split packer wheels.

In 1980, the yields were the highest of the past three years due to the cool conditions during June and early July. At Harrington, average spring wheat yields grown under fall tillage, spring tillage and no-tillage were 39, 30, and 28 bushels/acre, respectively; with Twin being the highest yielding variety at 41 bushels/acre averaged across the three tillage systems. At Lind, average spring wheat yields grown under fall tillage, spring tillage, and no-tillage were 29, 28, and 28 bushels/acre, respectively, with Twin being the highest yielding variety at 35 bushels/acre across the three tillage systems. Stripe rust infection severely reduced yields of several cultivars in 1980. The fall tillage resulted in higher yields at both Lind and Harrington and was also found to have the largest quantity of available soil moisture at seeding time when compared to the other tillage systems.

The use of annual cropping of spring grains in the low rainfall areas may help to reduce soil erosion and help control some of the weed problems associated with winter wheat production.

CULTURAL PRACTICES FOR TRITICALE PRODUCTION

A. J. Ciha and Helen Murray
USDA-SEA-AR

Fall and spring triticale lines varying in agronomic characteristics were grown using various rates and dates of seedings to examine their yield potential in relation to commonly grown winter and spring wheat and barley cultivars.

For the fall seeded triticale, winter survival was one of the most important factors in determining yield. Winter survival ranged from 29 to 79% with an average of 54% in 1979 and from 27 to 90% with an average of 74% in 1980. The best surviving triticale lines were equal in winter survival to the commonly grown soft white winter wheats and superior to the winter barley cultivars examined. Later plantings had a tendency to increase winter survival for the triticale. The highest yielding triticale lines were M76-6292 and M76-6764 which had yields equal to the winter wheats and greater than the winter barleys during both 1979 and 1980.

The spring seeding of the triticale lines resulted in a 10 to 20% yield reduction from that of the winter seeding. Later seedings (first week in May) usually resulted in yield reductions from that of early (end of March) and normal (mid April) dates of seeding. Increasing the seeding rate from 65 pounds/acre to 110 pounds/acre resulted in no yield advantage for the spring triticale seedings.

In general the triticale lines from both a spring and fall seeding were later in maturing than the wheats. Overall, the triticale lines examined showed a very wide range in yield potential, although there were a few lines equal in yield to the commonly grown winter and spring wheats.

IMPROVED STAND ESTABLISHMENT

R. E. Allan, J. A. Pritchett, M. L. Baldridge,
L. M. Little, and M. A. Patterson
USDA-SEA-AR

Retests among 74 lines developed by recurrent selection for improved emergence rate index (ERI) and final stand (FS) identified six semidwarfs superior for ERI and FS when compared to currently grown semidwarf varieties. One line AM 7974 appears to be particularly outstanding. During 4 years of tests this line has averaged 72 and 234 for FS and ERI compared to values of 65-68, and 117-134 for Nugaines and Daws, respectively. The 1980 yield tests involving AM 7974 were equally encouraging as shown below:

SITE/1980	AM 7974	DAWS	NUGAINES	LUKE	TYEE
Walla Walla	81	82	75	87	81
Ritzville	78	82	74	83	79
Pomeroy	76	74	70	65	66
Pullman Early	48	41	40	50	44
Pullman Late	74	53	49	62	59
	—	—	—	—	—
AVG. BU/AC	71	66	62	69	66

In addition to good emergence and yielding ability, AM 7974 has moderate resistance to leaf rust, a trait now lacking in most of our soft white winter wheats.

This year we have 120 club wheats in yield tests derived from crosses of our high yielding semidwarf clubs to Moro. Our objective is to develop club wheats which have high yielding ability with leaf and stripe rust resistance and which have improved stand establishment capability similar to Moro. We hope to select standard height as well as semidwarf types in this program.

Other tests dealing with stand establishment include (1) Measuring the relationship between flowering and emergence ability, (2) Screening wheat selections for genetic stability for emergence capability. Often a line has good stand establishment one year but behaves poorly the next year. We now have evidence that stability for emergence performance is partially under genetic control and can be bred into varieties. (3) Continue to exploit the bulk breeding method for improved emergence. We have placed several advanced lines in preliminary yield tests that were originally selected from superior emerging bulk populations. Their stand establishment potential will be tested again this summer.

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

F. J. Muehlbauer, J. L. Coker, and R. L. Short
USDA, Science and Education Administration, Agricultural Research

Dry pea, lentil, and chickpea research is conducted in the Palouse area of eastern Washington and northern Idaho, the nearby irrigated areas, and on the Camas Prairie. New lines, cultivars and breeding populations are tested in these areas to identify plant types with multiple pest resistance, stress resistance, yielding ability, and quality. The principal areas of research in each of these crops is as follows:

Peas: Root diseases of peas caused by a complex of several organisms are the major reason poor pea yields have been common to the area. Most of our efforts the past few years have been in identify ing 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 and adaptability. Two green pea varieties, 'Garfield' and 'Tracer,' were released in 1976. Yield tests showed that Garfield, a large-seeded selection, out-yields common 'Alaska' by over 15%.

Garfield is resistant to *Fusarium* wilt race 1, is larger seeded, and has a longer vine habit when compared with most Alaska strains. The increased plant height improves harvesting ease, especially on ridges where poor vine growth has been a problem. Garfield does not differ from Alaska in resistance to seed bleaching, powdery mildew, or mechanical damage resistance. 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 has yielded nearly 45% more than other small-sieve types. Other major improvements of Tracer over common, small-sieve Alaska strains include more uniform seed size, shape, and color; greater plant height; a lower 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. The need for a small-sieve variety resistant to *Fusarium* wilt race 1 was apparent in 1973 when it was shown that many small-sieve strains were susceptible. The release of Tracer should fill this need and also offer needed yield improvement.

WA610860 is a yellow pea selection that is earlier to bloom and mature than Latah and has comparable yield potential. This selection may be offered for release in 1982 pending results of 1981 yield tests.

Pea seedborne mosaic virus has caused problems in our breeding program and is a serious threat to both dry peas and lentils. Because of the obvious threat this virus poses to the industry, we incorporated resistance to the virus into eight pea varieties commonly grown in the region. These varieties include five dry peas and three freezer and canner peas. The lines were released as germplasm and four dry pea types are now in seed increase. The virus resistant derived varieties will be a means of preventing new outbreaks of the virus.

It has been known for some time that pea seedborne mosaic virus will also attack lentils and is seedborne in that crop. Immunity to the virus was identified in the Plant Introduction collection, and is inherited as a single gene recessive. Incorporation of the resistance into commercial lentils is underway.

Preliminary selections are screened for resistance to powdery mildew at Pullman. Natural infections obtained by planting late in May have reached epidemic proportions at about bloom. Lines showing resistance to mildew are increased and evaluated for agronomic characteristics, especially yield, and are used as parental material.

Lines with pea seed weevil-resistant parentage that showed resistance to *Fusarium* wilt race 1 are being evaluated in cooperation with the University of Idaho in 1981 for resistance to the insect. Hopefully, agronomically acceptable lines can be identified and used as a control measure for the insect or to effectively reduce the percentage of infestation.

Variations in leaf morphology in peas is 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.

Lentils: LC711981 was the highest yielding lentil selection in yield trials over the past three years. The selection averaged about 300 pounds per acre more than "Chilean" and was slightly larger seeded. The line was recently approved for release and is now under seed increase. Small quantities of this new variety should be available to growers in the spring of 1983.

Redchief, a selection released in 1978 has shown a consistent yield advantage over Chilean. Redchief has red cotyledons as opposed to yellow for the commonly grown Chilean.

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 roques, particularly those rogues that have seeds similar in size, shape and color to lentils.

Chickpeas: (Garbanzos) are grown throughout the world in similar environments to those where lentils are grown. The Palouse environment seems ideally suited to chickpeas and, based on 1980 results, very favorable yields and quality can be obtained. Research needs to determine suitable varieties and cultural practices for this crop. Varieties and breeding lines have been obtained from sources both national and international and are being evaluated for yield potential and seed quality. Cultural practices which include (1) seeding rates-row spacing, (2) seed treatments, and (c) *Rhizobium* inoculation are being studied. All indications are that chickpeas can be developed as a successful crop for the Palouse.

GRASS PLANTINGS AT THE LIND DRY LAND RESEARCH UNIT MADE BY THE PULLMAN PLANT MATERIALS CENTER

Clarence A. Kelley
Soil Conservation Service
Plant Materials Center Manager

The Pullman Plant Materials Center has (3) projects now existing at Lind. The purpose of these grass plantings is to compare techniques and methods of establishment and to test species for adaptation, drought tolerance, erosion control values and compatability in overstory-understory mixtures. Nordan crested wheatgrass, *Agropyron desertorum*, is the species used as a standard of comparison. The projects are:

1. Replicated row nurseries (19) species established by drilling seed 11/2/77 and transplanting greenhouse cone-tainerized plants 3/8/78.
2. A replicated randomized block planting made February 28-March 1, 1977, by drill seedings (12) overstory species on 12'' row spacing alone and in combination with (6) understory species seeded on 6'' row spacing.
3. Replicated and randomized block plantings of (5) grass species established fall and spring since 1977 through 1980 and seeded alone and in combinations.

Methods of establishment used both spring and fall.

a. Standard double disc drill with depth control bands.
b. Simulated drill row planter (Planet Junior).
c. Greenhouse transplants started in Ray Leach 'cone-tainers.'
d. Broadcasting.

Precipitation Records

Year	Annually	Jan.-Mar.	Oct.-Dec.
1976	5.73	2.38	.67
1977	8.57	1.18	3.28
1978	8.97	2.74	1.59
1979	9.89	2.60	3.71
1980	9.75	3.59	4.42

Three of the species being tested are now released, and if not presently, seed will soon be available commercially.

COVAR, *Festuca ovina*, was released in 1977. Covar is a dwarf, erect-growing, fine-stemmed, bluish-colored, short-leaved sheep fescue. Seedlings develop slowly, plants are tenacious, heavy root producing, good seed producers, long-lived and competitively crowd out many other species. It is disease-free and volunteers readily from shattered seed. Its principal use will be on roadsides, highway ditch banks, terraces, other critical areas and conservation seedings where a low-growing, low-lived, competitive grass is needed. It is a bunchgrass and is adapted to the 10-18 inch rainfall areas. It was developed from an introduction from Konya, Turkey.

CANBAR, *Poa canbyi*, was released in 1979. Canbar, canby bluegrass is a cool-season perennial bunchgrass. It is a selection from native stands at moderate elevations in the Blue Mountains area of Washington. Canbar is small with flat basal leaves. It produces vigorous early spring growth, sets seeds in mid-spring and plants become dormant in late spring. It is very drought tolerant. The principal use of Canbar will be as a component of seed mixtures for roadsides, ditch banks, burn areas, borrow pits and on rangelands as an understory competitor against cheatgrass.

SECAR, *Agropyron spicatum*, was released in 1980. It is a native bluebunch wheatgrass selection collected on the Lewiston grade in the Snake River Gorge near Lewiston, Idaho. Secar was selected for its superiority in drought tolerance, forage production in precipitation zones under 14 inches annually, spring recovery, the ability to establish and provide ground cover, root and crown production and seed yield potential.

Proposed uses include rangeland seeding on dryland sites (8-14 inch rainfall), critical area stabilization, reestablishment of native plant community, and mine spoil reclamation.

Other Outstanding Species

A thickspike wheatgrass selection, P-1822, *Agropyron dasystachyum*, is performing with excellence at Lind. It came from a native collection east of the Dalles, Oregon. It is vigorous, rapid spreading (rhizomerous) and productive. It grows well on light-textured soils. Its principal problem is the seed smut. A 1980 planting of 102 native collections from Oregon and Washington is now under evaluation at Pullman.

Critana is a released Montana variety of thickspike wheatgrass but it does not seem to be as good in forage production as P-1822. Critana is doing well in the Lind plantings, however.

Also performing well along with the standard of comparison, Nordan crested wheatgrass, *Agropyron desertorum* are:

Whitmar	*Agropyron spicatum f. inerme*
Sherman	*Poa ampla*
Sodar	*Agropyron riparium*
Luna	*Agropyron trichophorum*
Topar	*Agropyron trichophorum*

TREES AND SHRUBS FOR DRY LAND PLANTING

David M. Baumgartner and Rod Clausnitzer
WSU Cooperative Extension

For over 50 years, trees and shrubs have been tested at Lind for farm-home landscaping and windbreaks. Testing was started at Lind in 1928 by the Dry Land Research Unit and the Department of Forestry and Range Management at Washington State University. Plantings have been made periodically since then.

Many of the trees and shrubs currently growing at Lind were planted during the period 1946 through 1948. Concurrently, similar test plantings were made at Prosser and Pullman, Washington, and Morro, Oregon. Station Circular 450, "Adaptation Tests of Trees and Shrubs for the Intermountain Area of the Pacific Northwest," summarizes the results of these adaptation tests.

The planting at the Dry Land Experiment Station provides an excellent opportunity to observe the adaptability and growth of non-irrigated dry plantings over a long period of time.

Specific guidelines for windbreaks in the Pacific Northwest are available in the Extension Publication, "Trees Against the Wind" PNW Bulletin No. 5. "Windbreak, Forest and Christmas Trees: Where to Get Trees to Plant," Extension Bulletin 0790 provides information on sources of trees.

AUSTRIAN PINE TRIALS FOR EASTERN WASHINGTON WINDBREAKS

David M. Baumgartner and Rod Clausnitzer
WSU Cooperative Extension

The objective of the Austrian pine, *Pinus nigra* Arnold, planting at Lind is to evaluate sources from across the range of this species for adaptability and suitability for planting in low rainfall areas of eastern Washington. Austrian pine is a commonly planted windbreak and ornamental species in eastern Washington; however, survival and growth are often limited due to low moisture and high winds.

On May 4, 1976, 329 Austrian pine 1-2 (3 years old) were planted at the Lind Dry Land Experiment Station. These seedlings represented 40 different sources from the countries of Austria, France, Spain, Yugoslavia, Turkey, Greece and the USSR. Approximately ten seedlings were planted from each source, although individual sources ranged from two seedlings to fifteen seedlings.

At the end of the 1980 growing season when the seedlings were eight years old, the following results were observed:

Survival and Growth of Austrian Pine at Lind, Washington by Country of Origin, March 1981

Country of Origin	Number of Sources	Number Planted	% Survival	Average Height in Inches
Austria	3	29	90	45
France	3	21	43	36
Spain	3	28	50	29
Yugoslavia	2	17	76	48
Turkey	5	34	71	41
USSR	9	80	71	34
Greece	15	120	71	35
	40	329	69	37

There is considerable variation between and within sources. Trees now range from 74 inches in height to 9 inches. All seedlings from some sources died, while other sources showed 100% survival. It appears that the trees from Austria and Yugoslavia have shown the best overall survival and average height growth.

While it is difficult to draw conclusions with the relatively few number of trees planted and the few years of growth, it appears that further investigation into the genetic traits exhibited by different sources of Austrian pine could lead to improved adaptability and suitability for planting in eastern Washington.

The planting at Lind will be monitored as it continues to develop. It is possible that some sources will exhibit significantly better survival and growth. This may well be true when the trees reach and exceed ten to twelve years of age.

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1980-81
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Fertilizer and Amendments

Cenex
Chevron
Cominco American Inc.
McGregor Co.
Palouse Producers
Simplot
Western Farm Service, Inc.

Herbicides

Amchem
American Cyanamid Co.
American Hoechst Corp.
BASF Corp.
Chevron Chemical Co.
CIBA—Geigy Corp.
Diamond Shamrock Corp.
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Vita Grain, Inc.
Washington Wheat Commission
Western Plant Breeders
World Seeds

Farmer Cooperators

Variety and Disease Plots

James Anderson	Potlatch	Judel Farms	Basin City
Orin Anderson	Clyde	Koller Farms	Pomeroy
Dale Bauermeister	Connell	Robert Kramer	Harrington
Bayne Farms	Horse Heaven	Quetin Landreth	Espanola
Harold Beard	Mansfield	Lehn Brothers	Farmington
Bud Benedict	Asotin	Jack McCaw	Waitsberg
Meril and Bob Boyd	Pullman	Carl and Mac Mielke	Harrington
Ed Brewer	Spangle	Woodrow and Mac Mills	St. John
Elwood Brown	Bickleton	Lester Moos	Edwall
Lawrence Brown	Colbert	Stephen Naught	Bickleton
Clifford Burgeron	Reardan	Henry Niehenka	Colfax
Henry Carstensen, Jr.	Almira	Donald Ogle	Waterville
Clark Farms	Pullman	Kenneth Parks	Fairfield
Les Clemm	Troy, ID	O. E. Phillips Ranch	Lind
Harry Davis	Lamont	Marvin and Rick Repp	St. John
Richard Deffenbaugh	Kennewick	Craig Rettkowski	Wilbur
Diamond Spear Angus Ranch	Lamont	Luther Roecks	Fairfield
Don and Jim Druffel	Colton	Wayne Rock	Waterville
Leon Eggers	Pullman	Jack Rodrigues	Wilbur
Sanford Evans	Genesee, ID	Jerry Sheffels	Wilbur
Jim and Don Ferrel	Walla Walla	Jerry Sodorff	Pullman
Foundation Farm, Inc.—		Ernie Stueckle	Dusty
Jim DeWitt	Walla Walla	Ben and Harold Stueckle	Colfax
Heitstuman Farms	Uniontown	Warren Talbot	Pomeroy
Ed and Henry Hiller	Pomeroy	Elmo and Larry Tanneberg	Coulee City
Jim Hinze	Davenport	Mauris Ulhorn	Ferdinand, ID
Paul Hofer	Waitsburg	Tony Viebrock	Waterville
Ted Hornibrook	Goldendale	Darrel Walker	Moses Lake
Albert Jacobson	Waterville	Don and John Wellsandt	Ritzville
Dwelly Jones	Walla Walla	Earl and Paul Williams	Reardan

Fertility, Tillage and Management

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Vern Bidle	Albion	Maynard James	Wilson Creek
Harold Boyd	Pullman	Eddie Johnson	Wilbur
Arnold Clausen	Spangle	Norm Kagle	Ritzville
Dan Dorman	Lacrosse	Charles Keno	Fairfield
Dry Land Research Unit	Lind	Donald Lambert	Cheney
Elmer Easton	Harrington	Mark Martin	Creston
Fulfs Brothers	Pullman	McGregor Ranch	Hooper
Gordon Hamilton	St. John	Ted McMillan	Cheney
Bob Heitstuman	Pomeroy	Dan Moore	Dusty
Howard Hill	Moscow, ID	Merwin Neace	Dayton
Tom Hyslop	Espanola	Don Ogle	Waterville
Bill Iverson and Sons	Odessa	Kenneth Parks	Fairfield

Tom Petty	Asotin
Richard Quirk	Davenport
Glen and Chris Ramsey	Freeman
Ralph Reifenberger	Fairfield
Marvon and Rick Repp	St. John
Carroll Schulters	Colton
Harold Schulters	Colton
Leigh Schulters	Uniontown
Tom Schultz	Reardan
Spokane Tribal Farms	Wellpinit
Wilford Thorn and Sons	Dayton
Larry Vincent	Gifford, ID
Lewis and Dan Williams	Pomeroy

Weed Control Experiments

Asotin Co.	Clarkston
Bud Benedict	Asotin
Albert Bruce	Farmington
Harold Cochran	Walla Walla
Earl Crowe	Farmington
Henry Fisher	Oakesdale
Bob Frazier	Walla Walla
Garfield Co.	Ilia
Gary Gluck	Touchet
Earl Jefferies	Colfax
KCLK Radio Station	Clarkston
Bob Lux	Walla Walla
Kenneth Main	Palouse
Milt Nelson	Farmington
Elmer Paff	Garfield
Gene Rambo	Farmington
Jerry Sodorff	Pullman
State Highway Dept.	Washtucna
Ben Stueckle	Colfax
Jim Tetrick	Pomeroy
Turner Bros.	Dayton
Lyle West	Palouse
Dean Whitman	Benge

Dry Land Research Unit, Palouse Conservation Station
Spillman Farm Field Days Contributors

Adams Co. Wheat Growers
Agri-Service Inc.
Crites Moscow Seed Company
Lind Grange Supply
McGregor Co.
Nitagen Company
Palouse Conservation District
Palouse Producers
Palouse-Rock Lake Conservation District
Pine Creek Conservation District
Whitman Conservation District
Whitman Co. Wheat Growers
WilFac Inc.

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J. C. Engibous .... Chairman, Department of Agronomy and Soils
N. I. James .... Area Director OR-WA-ID Area AR-SEA

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E. Donaldson, M. Nagamitsu, Dry Land Research Unit, Lind .... Wheat Breeding
D. W. George, USDA, Pullman .... Winterhardiness
C. F. Konzak, M. A. Davis, M. R. Wilson, Pullman .... Wheat Breeding & Genetics
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A. J. Ciha, H. Murray, USDA, Pullman .... Wheat Mgmt. and Production
S. E. Brauen, Puyallup .... Varietal Testing
K. J. Morrison, P. E. Reisenauer, Pullman .... Varietal Testing
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S. J. Kitterman .... Research Chemist
P. L. Finney, H. C. Jeffers .... Research Technologists
P. D. Anderson, A. D. Bettge .... Physical Science Technician
M. Baldridge, G. E. King .... Early Generation Testing

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R. J. Cook, Cooperative USDA, Pullman .... Root Rot Diseases
J. W. Hendrix, Pullman .... Leaf Rust Wheat Septoria
R. F. Line, Cooperative USDA, Pullman .... Flag Smut Control

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Seed Testing

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R. Short, USDA, Pullman

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PUBLICATIONS ON WHEAT, BARLEY, OATS, PEAS AND LENTILS AVAILABLE FROM WASHINGTON STATE UNIVERSITY

Dry Pea Production, EB0582
Growing Lentils In Washington, EB0590
Garfield and Tracer Alaska Type Peas, EB0699
Tekoa Lentil Culture, EC0375
Pea Leaf Weevil: Biology and Control, EM3477
Peas Lentils for Eastern Washington, FG0025
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Seed Rates and Phosphorus Placement for Alaska Peas in the Palouse, XB0794
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Blazer Spring Malting Barley, EB0679
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Vanguard Barley, EC0385
Steptoe Barley, EC0392
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N Fertilizer/Irrigated Green Peas, XC0566
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Luke Wheat, EC0378

Paha Wheat, EC0379
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Wared Spring Wheat, EC0396
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Crop Residue Management in No-tillage Winter Wheat in Precip Over 18 In Year, EM4576
Dryland Wheat Recommendations For Eastern Washington, FG0019
Winter Wheat for Central Washington, FG0031
Farmer Use of Wheat Futures in the Pacific Northwest, WREP0001
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Wheat Yield/Moist and Nitrogen, XB0609
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N Levels Nugaines Rill Irrigation, XC0529
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Stripe Rust/Wheat Yield, XT0047
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Dryland Wheat Nitrogen Needs for Eastern Washington, FG0034
Livestock and Eastern Washington Wheat—Summer Fallow Farms, XT0054

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