FIELD DAY

Dry Land Research Unit

Lind, Washington

June 26, 1969

INTRODUCTION

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 the land was deeded to Washington State University for as long as it is used for experimental purposes.

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 existency 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 inches 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. Although the name has changed, the station still is devoted to dry land research in the United States.

The present facilities include a residence, barn, and machine storage built shortly after the station was established. A small elevator was constructed in 1937 for grain storage. A modern office and attached greenhouse was built in 1949 after the old office quarters were burned. In 1960 a 40' x 80' metal shop was constructed with WSU general building funds. In 1964 an addition to the greenhouse was built with a Washington Wheat Commission grant of $12,000 to facilitate breeding for stripe rust resistance. In 1966 a new deep well was drilled testing over 430 gallons per minute. A pump and irrigation system were installed in 1967. 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 adaption, wheat production management including weed and disease control, and wheat breeding are the major programs of research in recent years. 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 53rd field day. Visitors are welcome at any time. Their suggestions are appreciated.

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 concides with the normal winter wheat growing season. In most wheat production areas outside the Pacific Northwest, a spring-summer rainfall pattern occurs. The efficiency of the moisture utilization is greater under our rainfall pattern with lower evaporation-transpiration rates during the months of maximum precipitation in both summer fallow and crop years.

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

Month	Temperature °F.		Precipitation		Precipitation
	Max.	Min.	1968	1969	48 yr. av. (in.)
January	34	22	.61	1.25	1.01
February	42	24	1.17	.68	.90
March	53	32	.31	.29	.72
April	63	35	.23	1.37	.62
May	72	42	.18	1.17	.76
June	83	45	.66		.96
July	90	52	.19		.22
August	90	50	1.32		.32
September	79	45	.43		.55
October	65	38	2.15		.90
November	47	29	1.81		1.21
December	37	26	1.20		1.25
					9.42

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.

RESEARCH ON CEREAL CROPS

The objective of the Dry Land Research Unit cereal breeding and testing program is to develop new varieties of cereals adapted to the Big Bend area, where annual rainfall is less than 13 inches. The program includes testing new varieties, and selections developed at other experiment stations throughout the Midwest and Pacific Northwest, foreign breeding programs, and breeding new varieties. Actual breeding and selection are done at the Station.

Final testing is at selected locations in the Big Bend. These sites are now located on the Bill Schmidtman farm, Waterville; Robert Kramer farm, Harrington; and Vollmer and Bayne farm, Horse Heaven Hills.

All experimental work at the outlying locations is conducted by the same methods as the work at the Station. About sixty varieties and new selections from breeding nurseries are tested at these locations. Farmers in these areas are urged to visit the plots on county tours or at any other time. The results of these trials and those at the Dry Land Research Unit will determine the value of any new selection for the Big Bend Area.

WHEAT BREEDING

Winter Wheat Breeding At The Dry Land Research Unit

W. L. Nelson, M. Nagamitsu

The major emphasis in wheat breeding at the Dry Land Research Unit is on hard red winter wheat. This program is planned to develop varieties adapted to the area which can produce hard red wheat and will include most of the area of below 10 inches of annual rainfall.

The program was started in 1951 with parent evaluation and crosses were made in 1952. Since 1952 crosses are made each year to continually add new sources for yield, quality, winter hardiness and disease resistance. Many of the crosses have been between high yielding white wheat varieties and the better yielding hard red varieties to improve the yield potential of the hard reds. Disease resistance is of major concern in the program and includes crosses for stripe rust, smut, foot rot and snow mold resistance. The stripe rust screening is made during the winter months in the greenhouse section built with Wheat Commission Funds. An average of 8,000 lines are screened each year in this program. As a result of this program, highly resistant lines are now in yield test stage with thousands more in the preliminary stages of testing.

Snow mold resistance has been included in the program since 1963, and selections in the seventh generation are now in the yield test stage with about 20 lines in rod row trials, in their third year of yield testing. About one third of these are red wheat, and the rest are white since most of the snow mold resistance sources are white wheat. Over a hundred crosses with 10 sources of snow mold resistance have been made, and the second generation crosses have been made on the most promising snow mold crosses.

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, winter hardiness, 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 in varieties that do well under our conditions. The breeding program, then, is a continuous program of attempting to get the desirable traits of the parents into adapted varieties of high quality and disease resistance for the low rainfall area.

The first two varieties to come out of this program were Wanser and McCall from the cross of Burt x Itana. These varieties have had an outstanding yield record. During the last five years these varieties were among the highest yielding in the regional tests. A summary of these yields are given in Table 2.

Wanser and McCall are widely adapted as shown by the regional tests in Table 2. The varieties yield well under both low and intermediate rainfall conditions. They are not recommended for rainfall areas of over 12" because the protein level is usually low. Table 3 gives the yields in the low and intermediate rainfall areas of Washington and Oregon.

Table 2. Yield of selected hard red winter varieties in the western regional hard red winter trials 1964-68.

Variety	1964 22 locations	1965 17 locations	1966 22 locations	1967 21 locations	1968 15 locations	5 yrs.	% Kharkof
Wanser	47.7	60.5	46.3	48.6	53.1	51.2	121
McCall	47.1	63.5	45.1	47.5	48.9	50.4	119
Cheyenne	43.0	56.7	42.3	43.4	46.0	46.3	109
Itana	40.7	52.7	40.6	39.0	46.0	43.8	103
Kharkof	38.6	52.7	37.5	40.8	42.5	42.4	100

Table 3. Yield of selected varieties in low and intermediate rainfall areas in Washington and Oregon, 1964-68.

Variety	Location and Rainfall				Average
	Lind 9.5"	Moro, Ore.* 11"	Pomeroy 14"	Pendleton 14"	
Gaines	43.7	36.1	67.2	68.7	53.9
Burt	40.1	33.9	52.6	58.9	46.4
Moro	43.6	35.9	58.3	58.1	49.0
Omar	38.0	32.9	54.0	53.9	44.7
McCall	40.2	34.5	56.3	61.7	48.2
Wanser	40.7	37.4	50.7	61.1	47.5
Cheyenne	38.6	34.2	55.2	52.8	45.2
Itana 65	37.9	33.1	53.7	51.7	44.1
Itana	34.9	33.8	49.7	49.5	42.0
Kharkof	36.6	28.6	50.5	48.9	41.2
Station Ave.	39.4	34.0	54.8	56.5	46.2

*Moro location 4 years - 1965 missing

Wanser and McCall have not been tested extensively under irrigation. In southern Idaho, both varieties have performed very well under both dry land and irrigation and are recommended for that area. Yields under irrigation at Twin Falls and Aberdeen are listed in Table 4. In Washington yields of 90 to 110 bushels per acre under irrigation for McCall and Wanser were obtained during initial seed increase. These are the first hard red varieties consistently yielding near 100 bushels per acre under irrigation. However, the yield potential of Nugaines and Gaines is greater under high rainfall or irrigation than Wanser and McCall.

Table 4. Average yield of selected hard red varieties grown under irrigation at Aberdeen, and Twin Falls, Idaho, 1964-68.

Variety	Aberdeen (5 years)	Twin Falls (4 years)	Average
McCall	91.8	90.0	91.0
Wanser	93.8	84.5	89.7
Itana	80.3	80.3	80.3
Itana 65	79.6	78.1	78.9
Cheyenne	76.3	70.8	73.8
Kharkof	69.2	63.2	66.5

McCall and Wanser are adapted to areas now growing hard red winter or in the Pacific Northwest. Due to price differential often paid hard red winter wheat, it may be more profitable to grow these varieties in some areas now producing white wheat.

Both varieties have good bread quality at protein levels of 11 percent or above, and are equal to any other hard red variety at lower protein content for blending with higher protein wheat.

In tables 5, 6, 7, and 8 the agronomic characteristics of recommended varieties, and the older varieties they replace, are given for four locations in eastern Washington. These data are from rod row nurseries. Table 9 gives the data from large scale field plots at Lind. Data from these trials and other large scale field plots in eastern Washington are used to make variety recommendations.

For early seeding in the 8 to 11 inch rainfall area, Wanser, McCall and Moro are recommended. Wanser is recommended for Adams, Franklin, and Benton, Grant, and Lincoln counties for those areas well adapted to hard red winter wheat. McCall is recommended for Douglas and Grant counties in the areas most likely to have snow mold. In these same general areas, Moro is recommended for farmers growing club wheat for early seeding. In years when summer fallow moisture is excellent for early seeding, Nugaines has the highest yield potential in the 10 to 11 in. rainfall area.

In areas of 11 to 13 inches in Adams, Grant, Lincoln and Douglas counties, Nugaines has the highest yield potential from either early or late seeding. When summer fallow moisture is good for early seeding, Nugaines is recommended for these areas. When summer fallow moisture is questionable or poor, Moro should be considered because of better emergency characteristics. Moro should be seeded one week to 10 days later than other varieties because of excessive fall growth.

Table 5. Summary of agronomic characteristics of winter wheat varieties grown near Harrington in rod row plots, 1952-68.

Variety	Plant ht.	Test wt.	1968* yield bu/a	Average yield bu/a	Yield % Kharkof	No. Years grown
Gaines	27	59.9	24.7	46.9	141	8
Nugaines	25	61.8	25.8	41.5	146	4
Burt	33	61.3	26.9	44.8	124	16
Moro	33	58.8	24.6	38.2	135	4
Omar	38	59.7	26.3	41.1	117	11
Wanser	32	61.6	27.8	33.4	150	2
McCall	30	62.6	29.1	35.2	158	2
Itana	37	61.8	24.9	39.7	111	13
Kharkof	38	61.4	18.5	36.2	100	16

*Non fertilized

Table 6. Summary of agronomic characteristics of winter wheat grown at Lind in rod row nurseries, 1952-68

Variety	Plant ht.	Test wt.	1968 yield bu/a	Average yield bu/a	Yield % Kharkof	No years grown
Gaines	26	60.6	44.3	44.7	129	9
Nugaines	26	62.4	43.3	43.6	121	4
Burt	30	61.1	44.0	36.9	119	14
Moro	29	59.4	38.6	43.6	119	5
Omar	30	56.7	39.2	36.2	109	11
Wanser	29	60.7	39.6	42.6	118	7
McCall	25	61.7	36.3	40.2	110	5
Cheyenne	30	61.0	37.8	37.3	113	11
Itana	30	61.3	34.8	33.2	107	14
Kharkof	30	60.3	36.0	31.0	100	14

Table 7. Summary of average agronomic characteristics of winter wheat varieties grown in the Horse Heaven Hill in rod row nurseries, 1951-68.

Variety	Plant ht.	Test wt.	1967* yield bu/a	Average yield bu/a	Yield % Kharkof	No. Years grown
Gaines	20	58.2	13.7	19.1	108	5
Burt	25	58.9	14.2	21.1	114	9
Moro	17	55.7	13.0	15.3	121	2
Omar	23	57.7	10.8	20.9	116	8
Wanser	23	59.4	14.3	17.8	117	3
McCall	23	59.3	13.8	17.1	113	3
Cheyenne	27	59.6	13.8	20.2	115	8
Itana	28	60.4	11.9	20.5	112	10
Kharkof	28	59.7	12.3	18.4	100	10

*1968 Nursery not harvested

Table 8. Summary of agronomic characteristics of winter wheat varieties grown near Waterville in rod row nurseries, 1952-68.

Variety	Plant ht.	Test wt.	1968 yield bu/a	Average yeild bu/a	Yield % Kharkof	No. years grown
Gaines	27	61.3	45.6	52.5	136	7
Nugaines	27	62.9	46.3	56.4	140	3
Burt	32	61.5	42.7	41.4	120	12
Moro	35	59.5	39.3	47.2	117	3
Omar	33	59.8	38.8	41.1	118	11
Wanser	36	62.7	45.4	49.2	126	4
McCall	34	62.7	42.0	48.5	121	3
Cheyenne	37	62.0	41.0	42.5	116	9
Itana	37	62.2	41.3	40.3	114	12
Kharkof	37	61.8	39.3	33.9	100	14

Table 9. Summary of agronomic data for winter wheat varieties grown at the Dry Land Research Unit in drill strip plots, 1954-68.

Variety	Date head	Plant ht.	Winter* hardiness	Stripe* Rust	1968 Av.	Av yield bu/a	Yield % Kharkof	Test wt.	No. years grown
Gaines	5/31	24	5	4	33.3	40.4	122	61.1	9
Nugaines	5/30	25	5	3	31.7	36.3	122	61.6	4
Burt	5/29	29	4	6	29.6	35.4	115	61.0	14
Moro	5/30	29	6	1	31.4	38.7	130	58.6	4
Omar	6/3	30	6	8	33.7	36.1	115	59.3	12
Wanser	5/28	29	2	3	28.7	37.0	117	62.0	6
McCall	5/29	28	3	5	33.4	36.6	120	62.3	5
Cheyenne	5/29	32	1	4	29.2	34.7	111	61.6	12
Itana	5/29	33	2	8	29.4	33.2	107	61.8	13
Kharkof	5/30	33	1	4	25.6	30.9	100	60.6	14

*Coded to 1 to 9 scale, with 1 mostly hardy or resistant and 9 least hardy or resistant.

In areas above 13 inches, Nugaines is recommended for either early or late seeding. Good summer fallow management in this rainfall area increases the probability of holding moisture adequate for early seeding. Use year old seed of Nugaines for early seeding whenever possible to avoid high temperature dormancy often found in Nugaines. New seed should be checked for high temperature dormancy when seeding into soils with temperatures in excess of 70°.

The only varieties that are recommended for eastern Washington are Nugaines, Moro, Wanser, and McCall. Gaines is recommended only if seed of Nugaines is not available. For early seeding, year old Gaines seed would be recommended over new Nugaines seed. If in doubt about the variety to seed in your immediate area and soil condition, see your County Agent.

Spring Wheat

The spring wheat breeding program at the Dry Land Research Unit is designed to improve yield, protein content, quality, and disease resistance of adapted varieties. A comparison of Marfed, the highest yielding spring wheat, and Burt, a high yielding winter wheat, for the period of 1952-68 shows a 12 bushel yield advantage for Burt. Several years the difference exceeded 20 bushels in favor of the winter wheat. Higher yield is urgently needed for spring wheat varieties.

Spring wheat is seeded if winter wheat cannot be seeded because of lack of moisture, reseeded into winter killed wheat, and for rotation to control weeds. A higher yielding spring wheat would be very valuable in years when it is necessary to seed spring wheat. It could be used much more effectively in a rotation to clean up weed infested fields that have been continuously cropped to winter wheat. Since spring wheat is used more as an emergency crop, yield is even more important than in winter wheat.

Table 10 shows the agronomic characteristics of standard spring wheat varieties grown at Lind.

Table 11 shows the yield of spring wheat varieties at 3 locations in eastern Washington.

Marfed is the highest yielding variety at all locations.

Table 10. Summary of agronomic characteristics of spring wheat grown at Lind in rod row nurseries, 1950-68.

Variety	Date head	Plant ht.	1968 yield bu/a	Av yield bu/a	% Baart	Test wt.	No. years grown
Marfed	6/14	26	20.0	24.0	113	58.7	18
Idaed (Idaed 59)	6/9	25	16.5	21.1	100	59.0	18
Lemhi	6/13	27	19.3	22.2	104	57.8	18
Federation	6/12	25	19.4	22.2	104	58.4	18
Adams	6/12	28	20.3	24.2	110	58.9	6
Henry	6/11	27	*	20.0	94	59.1	16
Baart	6/11	28	17.6	21.2	100	60.2	18

* Not grown

Table 11. Yield in bushels per acre and percent of Baart for spring wheat varieties at three locations in rod row plots

Variety	Harrington			Waterville			Horse Heaven		
	No. years grown	T Baart	Yield bu/a	No. years grown	T Baart	Yield bu/a	No. years grown	% Baart	Yield bu/a
Marfed	18	117	30.6	17	116	30.7	15	109	19.9
Idaed (Idaed 59)	18	114	29.7	17	103	27.3	15	101	18.4
Lemhi	18	102	26.6	17	107	28.3	15	102	18.6
Federation	18	105	27.3	17	106	27.9	15	101	18.4
Adams	5	109	27.3	5	111	28.4	4	102	15.2
Henry	17	106	29.2	16	96	25.9	15	96	17.5
Baart	18	100	26.1	17	100	26.4	15	100	18.3

The spring wheat breeding program at the Dry Land Research Unit has some promising selections of both red and white spring wheat.

The hard red Spring Wheat selections do not have as good quality as desired, but acceptable. Three selections of Henry/Burt Sel. 65-2, Sel. 65-3, and Sel. 65-4 are among the highest yielding hard red spring wheats tested. They are susceptible to stripe rust with some tolerance to the disease. Yield data on these selections are shown in table 12.

Table 12. Yield in bushels per acre and percent of Marfed for three hard red spring wheat selections grown at Lind for 6 years.

Variety	Av. yield bu/a	%* Marfed
Marfed	24.1	100
Idaed	20.6	85
Henry x Burt S 65-2	22.7	96
Henry x Burt S 65-3	23.1	98
Henry x Burt S 65-4	23.3	98

*Based on individual comparisons in different nurseries for the same number of years grown

The white spring wheat selections are stripe rust resistant, good milling quality, and of pastry type. These are the first selections developed at the station which have consistently out-yielded Marfed. Yield data on these selections are shown in Table 13.

Table 13. Yield in bushels per acre and percent of Marfed for six white spring wheat selections grown at Lind for 4 years.

Variety	Av. yield bu/a	%* Marfed
Marfed	24.4	100
Idaed	21.5	88
Kenya 337/Awned Onas//Koelz 7941 S 66-6	27.1	106
Kenya 337/Awned Onas//Koelz 7941 S 66-8	26.0	111
Kenya 337/Awned Onas//Koelz 7941 S 66-9	26.2	105
Kenya 337/Awned Onas//Koelz 7941 S 66-12	25.2	107
Kenya 337/Awned Onas//Koelz 7941 S 66-20	26.8	111
Koelz 7941/Onas 52 S 66-9	25.8	109

*Based on individual comparisons in different nurseries for the same number of years grown.

WHEAT DISEASES

The most prevalent diseases in the low rainfall area are stripe rust, snow mold, and foot rot. Common and dwarf bunt, or stinking smut, are now controlled by good varietal resistance and seed treatment. Smut is always a threat and new sources of resistance are being added to new varieties. Active research on all of the diseases is conducted cooperatively with WSU plant pathologists. Major emphasis for control of these diseases is through breeding.

Stripe Rust

Since 1960 the potential for a serious stripe rust epidemic has been present most of the years. Stripe rust has been serious in certain small areas almost every year, however it caused serious damage in 1960, 61 and 67.

The Washington Wheat Commission financed a new section of the greenhouse for the station in 1964, especially equipped for stripe rust screening. During the past four years over 24,000 plant lines have been screened for stripe rust resistance. Several new sources of stripe rust have been added to the breeding program. Rust resistance is incorporated in all of the breeding programs for the low rainfall area.

To date, chemical control of stripe rust has not been particularly effective or economical. However, a new material, Plantvax, continues to show promise and may find acceptance for use under heavy rust conditions, if and when it is released for use.

The most effective control of stripe rust is through resistant varieties. Of the commercial varieties, Moro is highly resistant even as seedlings, to many of the prevailing races of the stripe rust fungus. It is susceptible however, to certain other races. The distribution and overall significance of the latter races is not yet established. Nugaines, Brevor, Gaines, Wanser, Cheyenne, and McCall are recommended varieties which have mature plant resistance. McCall has less resistance than the other varieties listed. These varieties will yield quite well under stripe rust infection.

Stripe rust research is under the leadership of Dr. J. W. Hendrix, WSU Plant Pathologist, and Dr. R. F. Line and R. A. Allan, ARS, USDA. The overall program includes epidemiology studies, biological race studies, evaluation for variety resistance breeding, and evaluation of chemicals for rust control.

Snow Mold
Dr. George W. Bruehl

Greatest emphasis in research aimed at practical control of snowmolds has been placed upon resistance. The breeding work started in earnest when the late Roderick Sprague began sreeening the world wheat collection. This work continued after his death through the cooperation of Orville Vogel and

Clarence Peterson who seeded the many lines during the screening stages, and this cooperation has continued ever since 1962. Walt Nelson and Dick Nagimitsu of the Lind Station made many crosses, and they continue making crosses, feeding new wheats into the program. The U.S.D.A. program also uses some of these wheats as parents. It is our hope that this extensive effort, supported generously by the Washington Wheat Commission, may finally begin to pay off.

The winter of 1968-69 proved that some snowmold wheats are both winter hardy (Lind, no snow cover at the critical exposure) and snowmold resistant. Some of the wheats appear worthy of consideration as possible varieties.

The average percent of survival under snowmold attack in 1968-1969 season in Douglas County follows. Wanser and Burt, 4%; McCall and Nugaines, 5%; Itana, 13%; Omar, 17%; Moro, 58%; Selection 398, 78%; Sel. 399, 84%; Sel. 307, 88%; Sel. 317, 90%; Sel. 443, 94%; and Sel. 127, 95%. The selections are all white wheats. In the dry, windy harvest season of 1968 at Lind all of our hard red selections shattered seriously and they cannot be considered as varieties.

Variety responses to snowmold vary from year-to-year. Moro is the most resistant of present commercial wheats, but its rating this year was higher than normal. It is usually only slightly better than Omar. Itana is usually no better than other susceptible wheats.

Table 14. Yields of selection 398 in comparison with commercial varieties, bushels per acre, when no snowmold occurred.

Entry	Lind		Douglas Co., 1968			Average bu/a
			Beard	Wainscott		
	1967	1968	early seeding	early seeding	medium seeding	
Selection 398	60	44	51	38	42	47
Burt	--	40	--	--	--	--
Itana	37	41	44	32	--	--
McCall	52	42	48	48	52	48
Moro	65	42	38	36	49	46
Nugaines	61	48	55	32	51	49
Omar	--	--	44	40	39	--
Wanser	51	44	46	33	45	44

Increase of Sel. 398 and a few similar wheats will begin in the hope that at least one will warrant release to farmers.

Root and Foot Rot Diseases
Dr. R. James Cook

The root and foot rots continue to occur in damaging amounts in the low rainfall area. Cercosporella foot rot (strawbreaker) is most widespread. Fusarium root and foot rot is serious in isolated fields, especially in the drier years and in the early seeded fields. Take-all caused by Ophiobolus graminis is most severe where wheat is grown annually and under irrigation. Cercosporella foot rot is also increasing in importance where wheat is grown under supplemental irrigation. Dr. G. W. Bruehl, Department of Plant Pathology, Washington State University, and Dr. R. James Cook, USDA, Regional Cereal Disease Research Laboratory, Pullman, are project leaders in the study of these diseases with the Dry Land Research Unit cooperating.

The breeding program at the Dry Land Research Unit includes parental material that has tolerance to Cercosporella foot rot. In addition all advanced breeding material is tested at Pullman under heavy infestations of Cercosporella to evaluate their reaction to the disease.

Dr. Cook is attempting to establish Ophiobolus in a 1-1/2 acre plot of land on the station at Lind for the purpose of testing wheats for resistance to this fungus. This plot is now in the second year of continuous wheat under irrigation. In addition to screening wheats for resistance, Dr. Cook plans to test soil fungicides in the infested plot as well as look at the effect of different fertility and management practices on take-all.

Tests for resistance to Fusarium root and foot rot are made in naturally infested soils. These tests are on the Walt Jantz farm near Ritzville, and are conducted by Dr. O. A. Vogel and Dr. Cook. Unfortunately, winter kill in this nursery was severe this year hence no evaluations for resistance to Fusarium can be made. Last year, on the other hand, the nursery offered an exceptional opportunity to look for varietal resistance to Fusarium because the season was dry and the disease was severe.

Avoid early seeding in fields where root and foot rots occur. This recommendation applies regardless of whether the cause is Fusarium, Cercosporella or Ophiobolus. Where wheat is grown under supplemental irrigation, avoid recropping if possible. A Wheat-wheat-wheat rotation under irrigation favors both Ophiobolus and Cercosporella whereas wheat-fallow-wheat rotation lessens the effects of these two diseases. Fusarium, on the other hand, persists in fallow soil. The severe cold temperatures this past winter did not kill the Fusarium. Oats may cause acute build-ups of Fusarium and hence should be avoided as much as possible as a crop in the dryland area. Do not side dress fertilize, rotary hoe or skew tread in the spring in Cercosporella-infested fields as this will increase damage caused by this fungus.

WHEAT, OATS, BARLEY
Dr. Kenneth J. Morrison

Winter Wheat

Nugaines

Nugaines is a semidwarf white winter wheat released for use in Washington and other parts of the Pacific Northwest where Gaines, which it closely resembles, has proved to be well adapted. Outstanding superior characteristics of Nugaines are improved test weight per bushel and milling properties. The variety has a bearded, common-type head with white chaff. The kernels are classed as soft white. The head grows slightly more erect than Gaines.

Nugaines is not as winter-hardy as McCall or Wanser hard red winter wheats, but is slightly hardier than the club wheats. Nugaines is similar to Gaines in hardiness.

Nugaines has good mature plant resistance to stripe rust. It also has more stripe rust resistance than Gaines, but less than Moro. Nugaines, like Gaines, is susceptible to stripe rust in the seedling stage.

Nugaines is similar to Gaines in resistance to all known races of common smut and most races of dwarf smut. Nugaines has moderate resistance to flag smut and stinking smut.

Gaines

Gaines is a semidwarf soft white winter wheat. It has a common-type, bearded head with white chaff. In high rainfall areas, the straw is about 18 inches shorter than other varieties. In low rainfall areas, it is usually about 4 inches shorter. The straw is strong and stiff and resists lodging. Gaines is similar to Burt and Brevor in winter hardiness. It is not as winter hardy as Wanser or McCall. Gaines has fair mature plant resistance to stripe rust, but is susceptible in the seedling stage. It resists all known races of common smut and most races of dwarf smut. Gaines is higher yielding than any of the other currently recommended varieties except Nugaines. It is recommended in Eastern Washington areas with 11 or more inches of rainfall, on irrigated land in Central Washington, and in Western Washington.

Moro

Moro, a white club wheat with red chaff was released by Oregon and Washington experiment stations and the U. S. Department of Agriculture. It was developed at the Pendleton Branch Experiment Station, Pendleton, Oregon.

Its chief advantage over Omar is that it is resistant to stripe rust. Moro is more resistant to dwarf bunt and commont bunt also.

It emerges fast and yields the same as Omar when stripe rust is not a factor. When the disease is sever, Moro produces much better yields than stripe rust susceptible varieties.

Moro is a good pastry flour, however it has a higher flour viscosity than older club varieties that may make it less suitable for some uses.

Moro is a medium tall club variety, about two days earlier maturing than Omar. Its kernels are white and has brown chaff. Moro does not have the high yield potential of Gaines in the higher rainfall areas. The same fertilizer program is recommended for Moro as for Omar.

In the lower rainfall areas of Washington where it is difficult to obtain stands with Nugaines, Moro will germinate and emerge much better than Gaines from deep seedings in dry dusty seedbeds.

Brevor

Brevor is a soft white wheat variety. It has short, stiff straw and resists lodging. Brevor has a common, beardless, white-chaffed head and is moderately resistant to shattering. It has high smut resistance, but is somewhat less resistant than Nugaines or Gaines. Brevor has fair mature plant resistance to stripe rust, but is susceptible in the seedling stage. In areas with less than 14 inches of rainfall, Brevor yields less than Omar. Brevor is recommended in areas with 14 or more inches of rainfall in Eastern Washington.

Burt

Burt is a hard white bread-type wheat. It has a common-type, bearded head with white chaff. Burt is highly resistant to all races of common smut and to most races of dwarf smut. It is slightly less resistant to stripe rust than Brevor and Gaines. It has short, stiff, lodge-resistant straw. Burt is recommended in the drier areas where the rainfall is 14 inches a year or less.

Wanser and McCall

Wanser and McCall are hard red winter wheats developed for low-rainfall areas of Washington. Both varieties yield as well as Gaines in areas that have less than 11 inches of annual rainfall.

The two varieties can be distinguished by chaff color. Wanser has a brown-chaffed head; McCall a white-chaffed head. Both have bearded, common-type heads and medium-height straw that resists lodging.

Wanser is recommended for the southern half of the Big Bend. Its superiority over McCall in stripe rust tolerance and winter hardiness 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 this area.

Wanser is as winter hardy as Itana. McCall has good winter hardiness, though less than Wanser. Both Wanser and McCall are more winter-hardy than Burt, Gaines, or the club wheats.

Wanser and McCall are more shatter resistant than Burt. They will shatter more than Itana, but are easier to combine and thresh clean.

Both varieties compare favorably with Itana in milling and baking characteristics. Wanser mills somewhat better than McCall. McCall has slightly better bread-baking quality than Wanser or Itana. Neither is suitable for production of soft white wheat products.

Wanser and McCall have higher yield potential than Itana, Columbia, or Cheyenne. Their potential is equal to that of Burt in the recommended areas.

Spring Wheat

Marfed

Marfed is an early to mid-season common soft white variety with medium tall, stiff, white straw. It has a beardless, white-chaffed head. Marfed is more resistant to common smut than Federation. It tillers more than Federation, but otherwise is quite similar. When spring seeded, there is no lodging difference between Marfed and Federation. However, when fall seeded, Marfed has lodged somewhat more than Federation. Marfed resists shattering. It has fair seedling resistance to stripe rust and some mature plant tolerance. Marfed is recommended in the areas of Eastern Washington with 10 or more inches of rainfall and for spring seeding in the irrigated areas of Central Washington.

Idaed-59

Idaed-59 is a common soft white wheat that is very similar in appearance and growth habits to Idaed. It matures early and has short, medium stiff straw. Idaed-59 has a beardless, white-chaffed head. It has fair field resistance to stripe rust and is resistant to the stem rust common in Eastern Washington. It resists shattering. In late seedings, Idaed-59 matures from 7 to 10 days earlier than other spring wheat varieties. In the higher rainfall areas, it is well suited to late seedings on heavy soils and early seedings on shallow soils. Like Idaed, some dry area seedings may not be uniform in height at harvest time, making harvest difficult. Idaed-59 is recommended for spring seeding in the 12-inch and higher rainfall areas and for late seedings on irrigated land in Central Washington.

Baart

Baart is a bearded white wheat with a slender open head. The kernels are rather long, large, yellowish, and soft to semi-hard. Baart is an early to mid-season variety. It has tall, weak straw and may lodge on heavier soils. Baart resists shattering, but is susceptible to all common wheat diseases, including smut. Baart is high yielding in the dryland areas of Eastern Washington. It is recommended in the 8-to-12 inch rainfall belt.

Henry

Henry is a hard red spring wheat. It is a mid-season variety with stiffer straw than Baart. It has a bearded head and is moderately resistant to shattering. It yields slightly less than Baart, but more than the other hard red spring wheat varieties commonly used for reseeding in the Eastern Washington dryland areas. Henry is recommended for reseeding in the hard red winter areas of Eastern Washington. Mixtures of Henry and hard red winter wheats may be graded down somewhat less than mixtures of white varieties and hard red winter wheats.

Spring Barley

Gem

Gem is a six-row, semi-rough-awned variety of spring barley. It is high yielding and has stiff straw that resists lodging. It has white kernels, but is not acceptable to the malting industry. Gem is recommended for nearly all areas of Eastern Washington and for irrigated areas in Central Washington. It is not recommended in the Goldendale area or in the glaciated valleys of Pend Oreille, Stevens, Okanogan, Chelan, and Ferry Counties.

Unitan

Unitan is a six-row barley with semi-smooth awns, white chaff, and white kernels. Kernel characteristics and test weight are similar to Gem. Unitan matures three to six days later than Gem. It is easier to thresh than Gem. Unitan is slightly taller than Gem and has about the same straw strength. In the lower rainfall areas, Unitan has yielded more than Gem. Unitan is recommended as a feed barley only in both the high and low rainfall areas of Eastern Washington.

Piroline

Piroline is a two-rowed malting barley that has a higher yield record than Hannchen or Hanna, the standard two-rowed barleys that have been grown for malting purposes.

Piroline is awned, with white kernels, and has a stiff straw that resists lodging. Piroline is about a week later than Gem and is recommended in the higher rainfall area of Eastern Washington.

Traill

Traill is a medium tall, six-row, spring malting barley. It matures a few days later than Gem. It has a rough, long beard and moderately stiff straw. The kernel size is small to medium. Traill may shatter if left standing after it is ripe. Traill is recommened for malting barley production in the high rainfall areas of Southeastern Washington.

Atlas -46

Atlas-46 is a six-row, rough-awned, spring variety with tall straw. It has blue kernels. Atlas-46 has good malting quality and is recommended primarily for the area represented by the Pomeroy trials.

Belford

Belford is a six-row, hooded or awnless variety of spring barley. It is midseason in maturity and medium tall. The straw is relatively weak. Belford is recommended for hay only in Eastern Washington high rainfall areas and in Central Washington under irrigation.

Winter Barley

White Winter

White Winter (Idaho Club) is a six-row winter barley. It is moderately winter hardy and resistant to mildew. White Winter has rough awns and compact head. In fall seedings, it matures early; in spring seedings, it is late maturing. When spring planted, its earlier growth is sprawling and at maturity it is medium tall. Its stiff straw makes it more resistant to lodging than other varieties. White Winter can be used for malting. Spring-sown White Winter has yielded somewhat less than other varieties. When fall sown, White Winter generally outyields spring varieties. White Winter is recommended for fall seeding in areas with 18 or more inches of rainfall in Eastern Washington.

It is not recommended for spring planting.

Luther

Luther is a mutant selection derived from treating seed of Alpine with diethyl sulfate. Luther has a higher yield record than Alpine or White Winter. It is more lodge-resistant than these two varieties because Luther is 5 to 7 inches shorter. Tests indicate that this short-strawed mutant responds to fertilizer in most locations and can be fertilized with a minimum of lodging. Luther is more winter hardy than Alpine and considerably more winter hardy than White Winter.

Luther is a feed barley and is not acceptable to the malting industry.

Alpine

Alpine is a six-row, semi-club barley. The kernels are medium large and the beards are rough. Alpine has tall, stiff straw and is more lodge resistant than White Winter or Olympia. It has less head snapping than Olympia or White Winter. It appears to be slightly more winter hardy than White Winter. It can be seeded in the spring, but yields are lower than for the recommended spring varieties. Alpine has given good yields when fall seeded. It is a feed barley and is not acceptable for malting. Alpine is recommended for the high rainfall areas of Eastern Washington and on irrigated land in Central Washington

Oats

Cayuse

Cayuse is a high-yielding, moderately early spring oat recommended in Washington and Northern Idaho. 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 test weight, which is relatively lower than that of Park. The test weight of Cayuse has averaged about 35 pounds per bushel in all Washington locations - compared with 37 for Park.

Cayuse has some tolerance to the most serious oat disease in Washington - yellow dwarf 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 in any Washington locations since testing began in 1959.

Although Cayuse is susceptible to node blackening and stem break, these diseases do not affect oat yield in Washington.

Park

Park is an attractive, stiff-strawed, high yielding spring oat with plump plump, short, white kernels. It can be distinguished from most other oat varieities by its upright leaves, which are dark green in color. Park is a mid-season oat and is medium high. It rarely grows over 42 inches in height under irrigation. The heads are medium short and erect. Park has yielded about the same as Cody or Shasta. Park is recommended to replace Cody becuase it has more uniform straw height and kernel size. Park can be grown in Eastern Washington in areas with 14 or more inches of rainfall, on irrigated land in Central Washington, and in Western Washington.

RECOMMENDED VARIETIES - WHEAT, OATS, BARLEY

AREA	WINTER WHEAT	SPRING WHEAT	OATS	SPRING BARLEY	WINTER BARLEY
EASTERN WASHINGTON 14 inches or more rainfall	Moro Nugaines Brevor Gaines	Federation Marfed Idaed-59	Cayuse Park	Gem Unitan Atlas-46 - malting barley Traill - malting barley Belford - for hay only Piroline - malting barley	White Winter - 18 inches or more rainfall Luther
EASTERN WASHINGTON Less than 14 inches rainfall	Wanser McCall Moro Burt Nugaines Gaines - 11 inches or more rainfall	Baart 8-12 inches rainfall Henry-for reseeding in hard red winter Marfed-10 inches or more rainfall Idaed-59 12 inches or more rainfall		Gem Unitan	
CENTRAL WASHINGTON Under irrigation	Nugaines Gaines	Marfed Federation Idaed-59	Cayuse Park	Gem Belford - for hay only	Luther Alpine

TILLAGE PRACTICES

Tillage Practices For Dry Land Wheat Production

In the dry land wheat production areas of eastern Washington, water is generally the limiting factor for maximum wheat production. Since water is limited, the management of our soils during the fallow period becomes extremely important. Practices which allow maximum intake of precipitation and tend to limit evaporation or loss during the summer fallow year are essential. Date of seeding, proper fertilization, and use of adapted varieties are also important factors in reaching maximum yields with a limited water supply. The subject of this discussion will be primarily concerned with tillage practices related to moisture conservation.

Eastern Washington has a winter rainfall pattern. Approximately 70% of the precipitation occurs from October through April. During this period, temperatures are low and evaporation is at a minimum. Stubble fields should be in a condition to absorb all precipitation that occurs during this period.

Conservation of moisture should start as soon as the crop is harvested. The stubble should be worked immediately in areas where active weed growth occurs. These weeds are removing deep soil moisture that could be used by the next crop. In the low rainfall areas sweeping at a depth of 4 to 5 inches will usually kill these weeds, provided there is enough overlap in the sweeps. This leaves the soil somewhat pulverized, and a fall chiseling after rain will put the soil in a rough condition which will help increase moisture penetration.

In areas where the soils are frozen during some portion of the winter months, the soils should be chiseled. Depth of chiseling in the southern areas, where snow accumulation is low, should be 8 to 10 inches. In the northern areas where more snow is expected to accumulate and the soils freeze deeper, the soils should be chiseled to a depth of 10 - 15 inches. In areas of high snow accumulation, subsoiling to a depth of 24 inches will increase water penetration of the soil. These operations should follow the contour of the land to be most effective. Chiseling also helps prevent the formation of implement hard pans caused by the weight of implements operated at the same depth over a period of years. When implement hard pans have formed, crop root penetration is retarded and the rate of water downward movement is slowed down. Fall chiseling of stubble will probably be of less importance in areas that are relatively frost free, but all of the wheat production area is subject to frozen soils during some parts of the winter. Summer fallow fields that are being left over the winter for a spring crop, should be chiseled after the soils have frozen to a depth of 2 inches to leave the soil in a rough condition.

The initial spring tillage operation should be one to kill volunteer grain and weed growth and work up a mulch for weeding operations. As much stubble as possible should be left on the surface. The amount of straw that the drills can handle at seeding time should be left on the surface. Straw on the surface is very effective in reducing evaporation of water from the soil and will give good protection against wind erosion. The depth of spring tillage has not been adequately determined, and will vary with area and soil type. Temperature appears to be a very important factor in how deep the soils need to be worked. The initial spring tillage should be at least an inch deeper than the depth of dust mulch desired.

After the initial spring tillage with a sweep, offset disc, or similar implements, skew treading with the teeth in packing attitude will help firm up the soil, break up heavy straw, and kill small weed growth. Rotary hoes pulled backward or discs pulled with a small cutting angle are also effective in firming up the soil after initial tillage. Usually rod weedings after these operations is all that is necessary for weed control. Fields should be rod weeded as necessary for weed control. Fields should not be allowed to "green up" before weeding, because when weeds get that large, they are using moisture rapidly. Research data at Lind indicates that a 4 1/2 inch weeding depth is most effective in conserving soil moisture. In areas of cooler temperatures, a shallower depth may be as effective. In light sandy soils, skew treading may be too severe, and the rod weeder may be the only tool to use after initial tillage. If this is the case, weeding operations should take place as soon as possible after the initial spring tillage, to seal off the moisture below the weeding depth.

Fertilizer applications may have an effect on soil moisture. Unless fertilizer is applied immediately before seeding, the application should be made early in the summer fallow season before soil temperatures are high to prevent moisture loss. Applications should be timed just previous to a normal weeding operation. This will disturb the soil moisture less than if the fertilizer operation is not followed by a weeding.

Research at the Dry Land Research Unit at Lind show that early seeded wheat makes more effective use of moisture than late seeded wheat. The efficient use of moisture by early seeding is probably due, in part, to the increased growth made during cool temperatures. Late seeded wheat develops under higher temperatures especially during the stages of rapid growth of tillering, boot, and heading. In addition to rapid growth, the young cells of growing wheat require more water. Transpiration rates are higher in young cells than in maturing tissues. Early seeded wheat is in a more advanced stage when high temperatures occur. Early seeded wheat also develops a more extensive root system by spring, and is better able to supply nutrients moved down deep in the profile by winter moisture.

The problem of early seeding is to have enough moisture in the seeding zone for seeding in late August or September. Equipment is available which will seed to depths of 6 to 7 inches and still not cover the seed more than 4 to 5 inches. Most of the deep furrow drills are on 14" row spacing. Research was conducted to determine if wider spacings would affect yield. Results from this study at Lind, and another trial at Dusty, show row spacings up to 20 inches will not decrease yields in the range of 30 to 80 bushels per acre. With wider row spacing, furrowing can be deeper, and the total depth of seed coverage can be less. Row spacings of 20 inches would allow seeding to a depth of 8 inches and still not cover more than 5 inches. Wheat will emerge in light soils readily from this depth.

In summary, tillage should be designed to allow free penetration of water during the winter following harvest. During the summer fallow year the tillage and fertilizing operation should hold the moisture close enough to seed early in the fall. A seeding date of approximately September 1, with a range of 15 days either way, would cover the optimum seeding date for most of the dry land area. The following program of stubble mulch tillage is recommended for the 8 to 12 inch rainfall area:

1. After harvest sweeping where weed infestation occurs.

2. Late fall chiseling to a depth of 8 to 12 inches on spacings of not more than 24". The deeper chiseling is recommended for areas of deep frost or heavy snowfall, and wider spacing can be used.

3. Initial spring tillage should be at least an inch deeper than the depth of dust mulch desired.

4. Follow soon after with skew treader, rotary hoe, light discing (disc almost straight), or rod weeder to firm up soil and establish mulch depth. The deeper mulches are recommended for areas of high summer temperatures.

5. Fertilizer should be applied in late spring or immediately before seeding.

6. Deep furrow seeding of recommended variety starting approximately August 25 in Douglas County, September 5, in areas similar to Lind, and September 15, in 11 to 12 inches rainfall areas of Lincoln County. It is better to have a stand of wheat seeded 10 days too early, than a poor stand of wheat seeded at the optimum time or seeded late.

7. Seeding rate for early seeding should not exceed 45 pounds per acre, and 25 pounds is enough for early seeding that germinates well.

Tillage Practices for Moisture Conservation

Dr. F. E. Koehler and Mike Lindstrom

In 1965 the Washington Wheat Commission began supporting a project to study the "Factors affecting water conservation for plant growth in the low rainfall areas of eastern Washington." The purpose of this project is to determine which soil structural and physical condition as influenced by tillage will provide the maximum moisture for the wheat crop with special emphasis on the moisture in the seed zone. This would increase the probability of getting a good stand of wheat from an early seeding. Previous research has shown that maximum efficiency of use of the limited moisture supply of this area can be obtained from an early seeding.

Fall tillage treatments studied have been: (1) Disc at 5-6 inches deep, (2) Chisel at 9-10 inches deep with chisel points on 12 inch centers, and (3) No fall tillage. Spring tillage treatments studied have been: (1) Disc at 5-6 inches deep, (2) Sweep at 5 inches deep with 18 inche shovels on 12 inche centers, and (3) Sweep at 8 inches deep. The three spring tillage treatments were applied to each fall treatment giving a total of nine different tillage treatments. All tillage treatments were then gone over with a skew treader to firm up the soil and then rod weeded. Plots have also been set out which received no tillage except for fall tillage treatments. Weeds were controlled in these plots by chemicals.

Fall tillage treatments, since this project was initiated has had little affect on the moisture intake, because there had not been any runoff from any of the plots, until this year. Moisture samples taken this spring show that plots that were chiseled last fall had slightly over 2 inches more water than plots that were not tilled. The disc plots had 1.5 inches of more water than the non-tilled plots. Total moisture in a 5 foot soil profile was 9.8 inches in the chiseled plots, 9.2 inches in the disc plots, and 7.7 inches in the non-tilled plots. Spring tillage treatments have appeared to have little affect on total moisture. No differences in total moisture content could be determined between the tilled plots and the non-tilled plots, but the non-tilled plots have had less moisture in the seeding zone.

Tillage treatments for the 1969 fallow year include the same treatments as above. Additional treatments have been included this year which were not skew treaded after the initial spring tillage. This should give a wider range of soil structural and physical conditions. Differential total moisture conditions were also set up this year by putting 5.5 inches of water on one complete set of tillage treatments with the irrigation system, to study the affect of total moisture content in the soil profile on the moisture content in the seeding zone. A study has been set up to study the affect of time of initial spring tillage on the total moisture content in the soil profile and on the moisture content in the seed zone. The times of spring tillage were: (1) As early as equipment could be used, (2) Regular time - determined by farmer activity, (3) Late spring - May 1, (4) Very late - June 1. Weeds and volunteer grain were controlled by chemicals. Soil moisture and temperature studies in cooperation with Dr. Papendick are also being conducted in this project. Information on this study will be reported separately in another section of this brochure.

Fallow Tillage Depth and Soil Water in the Seed Zone
Dr. R. I. Papendick

Maintaining adequate soil water in the seed zone for successful early stand establishment of fall-seeded wheat is a major problem in the low rainfall wheat-producing area. One important factor influencing seed zone water loss in such areas appears to be the depth of fallow tillage, particularly the depth of loose dry soil or dust mulch produced by rod weeding. The dust mulch apparently insulates the underlying moist soil which decreases its temperature and consequently reduces evaporative water loss. This is especially true during hot weather. The loose dry soil also conserves water by acting as a barrier to liquid water flow from the moist soil to the surface. Both the insulative and barrier effects depend in part on the tillage depth. Thus, in warmer areas the tillage depth may need to be increased to effectively conserve seed zone water compared to areas where summer temperatures are lower. However, the optimum tillage depth will also be influenced by the soil type, amount of straw mulch, and the physical condition (aggregation, density) of the loose dry soil.

Work was initiated in 1967 at Lind to determine the effect of dust mulch depth and surface residue on soil water in the seed zone at seeding time. The results of that study reported at last year's field day showed that soil temperatures in the seed zone during the summer averaged several Fahrenheit degrees cooler under a 4 1/2-inch dust mulch than under a 2 1/2-inch dust mulch. Seed zone water content at seeding time was highest under the deepest dust mulch. Surface straw residue increased seed zone water contend under the shallow dust mulch, but produced little or no effect under the deep dust mulch. Wheat emergence was most rapid and final stands were complete earlier on the deep dust mulch plots, which was a reflection of improved seed zone water conditions.

A similar study which included a spring irrigation to supplement overwinter water storage was established at Lind in 1968. However, the experiment yielded little useful information because August rains masked treatment effects.

Experiments were also established on the Roger Moore farm (approximately 10 miles east of Connell) and the Dick Deffenbaugh farm (15 miles south of Kennewick) where summer temperatures are higher and soils are coarser than at Lind. The following treatments established on wheat stubble were studied: (1) initial spring tillage 5-6 inches deep followed by rodweeding (a) 2-3 inches deep, and (b) 5-6 inches deep; and (2) initial spring tillage 8-10 inches deep followed by rodweeding (a) 2-3 inches deep, and (b) 5-6 inches deep. The Moore plots were seeded to Wanser wheat on September 4. Due to extremely dry conditions the Deffenbaugh plots were not seeded until after fall rains had occurred in late September.

Some results were:

1. Soil water conditions 4-6 inches below the surface were improved where initial spring tillage was shallow compared to where tillage was deep. This indicated that good capillary continuity (deep tillage disrupts capillary continuity) with the deeper soil layers is important for replacing water loss from the upper fringes of moist soil when soil temperatures are high.

2. Possibly because of extremely dry conditions rodweeding depth produced less apparent effect on seed zone water content than did the depth of initial tillage. There was, however, some improvement in water conditions with deep rodweeding as compared to shallow weeding.

3. Wheat emergence on the Moore site was best in plots where initial tillage was deep even though water contents at 5-6 inches were lower there. This was because the loose soil in the deep tilled plots enabled the deep furrow drill to penetrate deeper and place seed in more moist soil compared to where initial tillage was shallow.

Studies are being continued this year (1969) at Lind and the Moore farm near Connell. An additional site has been established on the Buddrius farm near Almira. Treatment variables include shallow (5-6 inch) and deep (8-10 inch) initial spring tillage; and none, 2-3 inch, and 5-6 inch rodweeding depths. Chemicals will be used to eliminate weeds on plots not rod weeded.

MANAGEMENT PRACTICES FOR WHEAT PRODUCTION UNDER SUPPLEMENTAL IRRIGATION

Dr. Fred E. Koehler, Michael J. Lindstrom, Charles Boyd

This project, designed to find the best soil fertility and other cultural practices necessary for wheat production to utilize limited irrigation water most effectively, is being supported by the wheat industry through the Hay and Grain fund. Data was obtained from one experiment in 1968 at the Lind station.

Irrigation treatments for the 1968 experiment were (1) one irrigation in early April, (2) one irrigation in early May, (3) two irrigations (as in 1 and 2 above) and (4) three irrigations, as in 3 above plus one in early June. Each irrigation treatment received six nitrogen treatments, 0, 60, 120, 180, 240, and 300 lbs. N per acre.

The yields and protein concentration of grain are given in Table 15.

Table 15. Yield and protein concentration of Gaines wheat grown with different levels of N fertilization and supplemental water application. Lind, 1968.

Rate of N lb/a	April	May	April & May	April-May & June
		Bu/a		
0	35	33	31	35
60	46	46	58	59
120	51	48	68	71
180	48	43	65	68
240	49	45	64	72
300	44	46	63	76
		% protein		
0	6.4	6.9	6.6	6.9
60	8.8	8.0	7.3	7.8
120	10.8	11.4	8.3	9.3
180	12.3	12.4	10.8	10.6
240	12.5	13.6	11.8	11.6
300	13.4	13.0	12.9	12.1

Sixty pounds of N per acre gave near maximum yields where only one irrigation was used. With two or three irrigations, maximum yields occurred at about 120 lbs N per acre. Yields were not as high as expected, probably because of the damage done by the severe frost which occurred in late April. Protein content increased with increasing rates of nitrogen application, but did not reach objectionable levels until after maximum yield had been obtained.

The moisture applied, that used by the wheat, and the efficiency of use for the 120 lb. rate of nitrogen application are given in Table 16.

Table 16. Water application and use by Gaines wheat. Lind, 1968

Irrigation No. time	Water applied inches	Water used inches	Yield bu/A	Efficiency of use bu/in.	bu/(in. -4)
1 Apr.	7.4	12.3	51	4.1	6.1
1 May	6.1	11.5	48	4.2	6.4
2 Apr-May	13.5	16.4	68	4.1	5.5
3 Apr-May June	16.4	22.6	71	3.1	3.8

The wheat used water with approximately the same efficiency when one or two irrigations were applied. However, the June irrigation increased yields only slightly so this last application of water was essentially wasted as far as grain production was concerned.

TREES AND SHRUBS FOR DRY-LAND PLANTING

Many species of trees and shrubs are included in the Station forestry project for farm-home landscaping and windbreaks. The first plantings are over 40 years old. The present testing program at Lind was started in 1928 by the Dry Land Research Unit and the Department of Forestry and Range Management, Washington State University. Plantings have been made at intervals since then. This Station planting is one of the best in the West for studying trees and shrubs adapted to dry land conditions.

Initial observation tests of woody species are carried on at the Soil Conservation Plant Materials Center at Pullman. Secondary tests are carried on cooperatively at experiment stations at Prosser and Lind, Washington, and Moro, Oregon. Stations Circular 450, 1965, summarizes the results of these adaptation tests of trees and shrubs for the intermountain area of the Pacific Northwest.

A standard dry land windbreak planting consists of a minimum of three rows. When properly established, these give excellent protection from the winds. The windward row should be a tough, fast-growing shrub. Caragana is the best shrub for this purpose. Lilac is slower growing, but is hardy and makes a good dense hedge. Nanking cherry and blueleaf honeysuckle show good promise for the windward row. Where a taller shrub is desired, Russian-Olive appears to be the best adapted shrub, although a wild crabapple shows promise.

To give the windbreak height, black locust is still the best deciduous tree even though it did very poorly this past year in the test planting. Green ash may also be used. Austrian pine and ponderosa pine are the outstanding evergreen trees, both being superior to Scotch pine. Douglas fir and blue spruce can be grown, but require more care and grow much slower. Rocky Mountain juniper is more difficult to establish than other evergreens, but is extremely hardy and vigorous when once established.

The past year has been extremely hard on many trees and shrubs. The weather was very dry during last year's growing season. The hard winter just passed killed or severely injured many of the plants that were in a weakened condition. This was true of black locust and hawthorn for example. Some plants, such as caragana and green ash, went into a drouth dormancy during the dry summer, so were well hardened off for the cold winter. When these trees broke their dormancy, they were in good condition to take advantage of the high moisture conditions. As a result, some trees look the best they have for many years.

Damage from 2,4-D has been heavy. The late season and many spring seedings have resulted in later sprayings. This has damaged the spring growth on trees and shrubs more than usual.

A shelterbelt planting requires considerable work. To survive under dry land conditions, trees and shrubs require continuous clean cultivation. Space rows between trees so available machinery can be used. Transplant trees and shrubs as soon as you get them. All evergreens require special care when transplanting. Transplanted evergreen stock has survived better than seedling stock. Although transplanted stock is more expensive, the superior survival compensates for the extra cost.

Table 17. Standard species, arrangement, and spacing of trees and shrubs for windbreak plantings in the 8-10" rainfall area.

Row No.	Species	Growth Habit	Spacing in Row	minimum distance from next Row*
1	Caragana	Erect shrub	3 ft.	18 ft.
2	Russian olive	Intermediate shrub	6 ft.	18 ft.
3& 4	Black Locust	Deciduous tree	12 ft.	18 ft.
5	Austrain pine Scotch pine Ponderosa pine Rocky Mt. Juniper	Evergreen	12 ft.	27 ft.

*Rows can be spaced wider apart if cultivation equipment requires it.