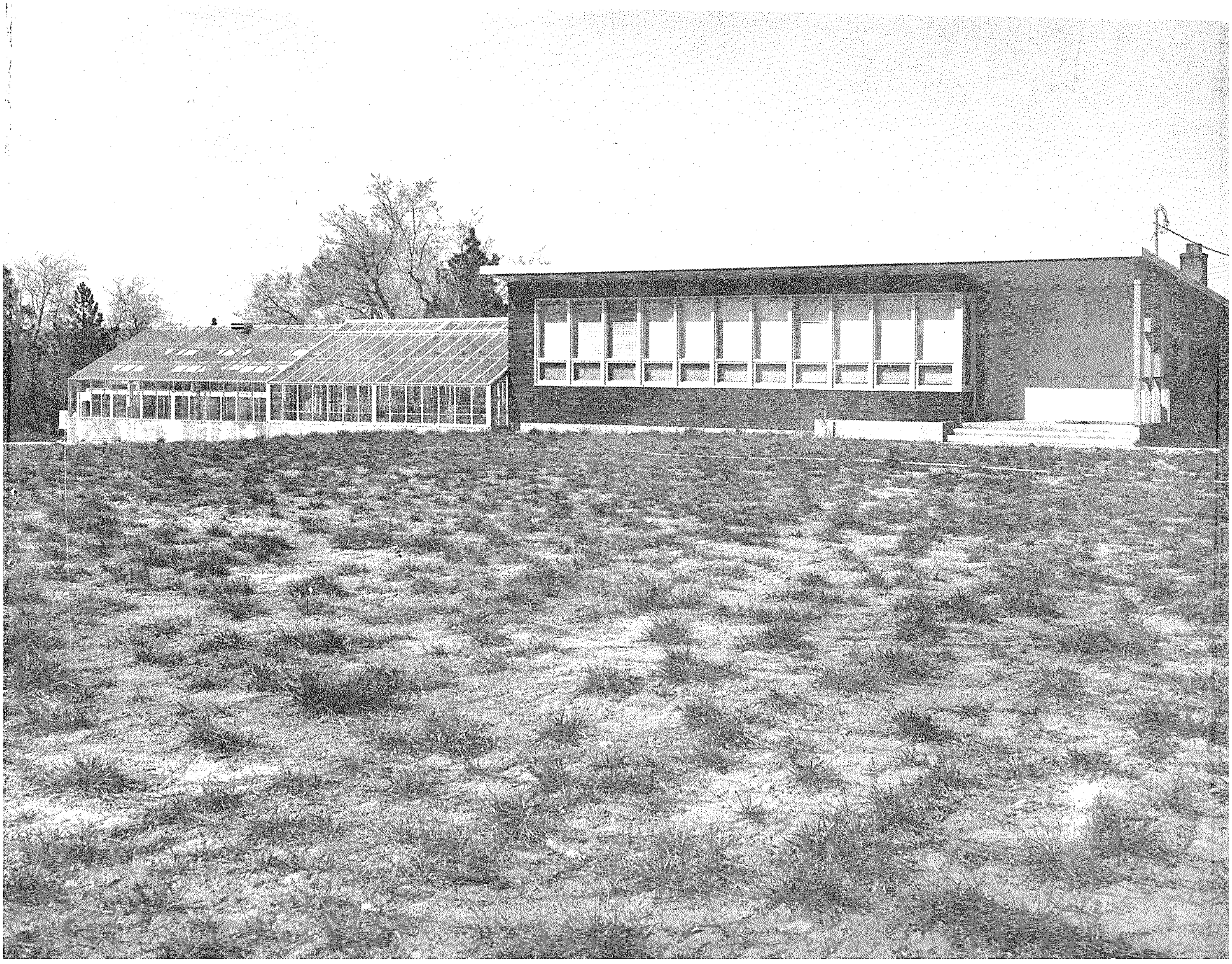
49th Field Day

DRY LAND EXPERIMENT STATION
LIND
FIELD DAY

1965

50th ANNIVERSARY



THE FIRST FIFTY YEARS AT THE DRY LAND EXPERIMENT STATION

Walter L. Nelson, Supt.

The Dry Land Experiment Station celebrates its Golden Anniversary this year.

As we look back over the last half century, we find some of the problems facing the farmers in 1915 are still unsolved, some problems have been completely solved, and others have been replaced by new ones.

The need for research appears as great today as it did to the embattled farmers of 1915 who pleaded for an experiment station to study the production needs of the dry land area of eastern Washington.

Interest in dry land research had been building up since about 1900. Experiment Station Director's reports of 1906 mentioned substations at Quincy, in the Horse Heaven Range and Ritzville. In 1907, tillage and moisture-conservation experiments were begun at Connell. This work was transferred to a tract of land near Ritzville in 1910.

During this period citizens of Spokane began to push for an experiment station in this area to protect their considerable investments in land and loans. The combined pleas of the farmers, business men, railroads and Experiment Station Director I. D. Cardiff finally bore fruit on April 1, 1915 when Adams Branch Experiment Station was established.

It was "created for dissemination of information and conduction of demonstrations and experiments in the semi-arid portion of the state." The county donated 320 acres of land and $6000 to get it started. Public spirited men in Spokane donated another $3,200. The Chicago, Milwaukee & St. Paul Railroad gave $1000. Additional funds came from USDA and the Main Station at Pullman. Today this same interest is exemplified at field day when 400 to 600 visitors swarm over the farm to look at the research.

The first Superintendent was the late Dr. M. A. McCall. Dr. McCall was a gifted research man given somewhat to philosophy in his early station reports. In his report of 1920, he outlined the fundamental reasons for outlying stations which are just as valid today. 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 on a central station." For fifty years this station has been guided by this philosophy of studying the problems associated with the semi-arid, 8 to 12-inch rainfall area.

During the station's first 12 years, average precipitation was 8.3 inches, about 2 inches less than the 50 year average. Turkey wheat averaged 15.4 bushels per acre when it was grown during this period. Only three times, 1923, 1927, and 1928, did the yield exceed 20 bushels per acre. Baart spring wheat averaged 13.4 bushels for this same period. By comparison in 1950-63, Turkey averaged 29.2 bushels per acre, and Burt 35.9 bushels. Baart averaged 20 bushels and Marfed 23.4 over the same period. Rainfall averaged 9.3 inches during this period. The yield difference reflects technological advances in farming of the area more than the slightly higher rainfall.

The period 1920 to 1935 was a difficult time for the farmers of the Big Bend. These were hard times for the Adams Branch Experiment Station, too. In the early 30's regular work was cut to what could be supported by a small appropriation from the Adams County Commissioners just to keep the station open. The drive to keep the station open was spearheaded by A. J. Urquhart, manager of the Union Elevator Company at Lind. With documented support, he met with President E. O. Holland and regents of what was then Washington State College, pleading to keep the station open. Representative Dave Phillips also pleaded the case. These farmer and industry pleas, with college support, resulted in Governor Clarence D. Martin's allocating funds from his Emergency Fund to keep the station open. The situation improved by 1937 and the legislature appropriated adequate funds to resume a full research program at the station.

The office facilities have had as hectic history as the station itself. First, office space was rented in downtown Lind. Later the office moved to that station in a remodeled bunk house. This was increased in size with the addition of a wing in 1937. A fire Feb. 17, 1949 destroyed this office and many of the records. The state legislature, then in session, appropriated $46, 000 to construct a new office with attached greenhouse section. A new greenhouse addition was built in 1965 financed by a $12, 000 grant from the Washington Wheat Commission. In 1960 the 40 x 80 metal shop building was constructed with WSU general building funds, greatly aiding the experimental program.

Besides Dr. McCall, station Superintendents have been H. M. Wanser, Harley D. Jacquot, J. J. Sturm and myself. The research staff has through the years remained at one or two scientists and a resident foreman and a farm laborer.

The nature of the experimental program conducted at the station has primarily been determined by the area needs and the research background of the personnel. Early research included the testing of many crops including all the cereals, corn, potatoes, and many of the known species of forages. Other crops in later years included safflower, sorghum, sunflowers, crambe, and peas. During World War II, extensive testing was done in horticultural crops for production of dry land gardens to aid the war effort. Extensive shelter belt studies initiated in 1945 added trees to the experimental program.

From the start, management problems of wheat production have received major emphasis. Some of the early work included studies in planting date, rates, harrowing of winter wheat, deep furrow seeding as compared to conventional seeding, use of press wheels for grain drills, row spacing and different methods of tillage. Smut was one of the early problems studied with different seed treatments. Soil conservation, and rotations with grass were emphasized in the thirties, as much of the land was going out of production.

It is interesting to note that some of these same problems need new answers today. As new varieties and new equipment came along, the old answers to these problems no longer apply. Advances in farm technology create new problems that require new answers to make the greatest use of our resources.

Soil conservation has always been included in the regular farming and research program at the station. The land has been stubble mulched since the thirties. Sweep or sub surface tillage has been used exclusively for the last 25 years. Extensive soil moisture studies by H. D. Jacquot helped develop the potential of annual cropping in the intermediate rainfall area.

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, the first varieties developed on the station by plant breeding are tentatively planned for release this fall. Two hard red winter selections from the cross of Burt x Itana are under seed increase this year.

It is hoped these varieties will be a tribute to the faith of the farmers of the Big Bend in this station. This station is dedicated to the improvement of farming practices, through improved methods, varieties, and pesticide controls to the betterment of the agricultural industry in the low rainfall area of Eastern Washington.

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 Sept. 15 to June 30. This rainfall pattern coincides with the normal winter wheat growing season. In most wheat production areas outside the Pacific Northwest, a spring-summer rainfall pattern occurs. The efficiency of the moisture utilization is greater under our rainfall pattern with lower evaporation-transpiration rates during the months of maximum precipitation in both summer fallow and crop years.

Table 1. 40 year average temperature and precipitation at Dry Land Experiment Station, Lind.

Month	Temperature °F. Max	Min	Mean	Precipitation 40 yr. av. (in.)
January	34	22	28	1.07
February	42	24	33	.91
March	53	32	42	.72
April	63	35	49	.62
May	72	42	57	.77
June	83	45	64	1.00
July	90	52	71	.21
August	90	50	70	.30
September	79	45	62	.60
October	65	38	52	.96
November	47	29	38	1.12
December	37	26	31	1.23
				9.51

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.

The average frost free period (32^{o}) is 143 days, from 14 May to 4 October. Extremes of temperatures and rainfall recorded at this station are: maximum high, 113^{o}, minimum low -26^{o}, maximum annual rainfall 22.7", minimum annual rainfall 4.8". Average winter snowfall is about 12", but most of the winter precipitation is in the form of rain.

RESEARCH ON CEREAL CROPS

The objective of the Dry Land Experiment Station 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, 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. Fifty to 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 Station will determine the value of any new selection for the Big Bend Area.

Winter Wheat

The breeding program for winter wheat is concentrated on hard red winter varieties. Some work is also done on white winter varieties. Disease resistances being bred into these winter wheat lines include stripe rust, snow mold, foot rot and smut. Progress has been made in stripe rust, smut and snow mold; the foot rot program is just underway.

Tables 2, 3, 4, and 5 compare agronomic characteristics of selected winter wheat varieties at four locations. At three locations, Gaines is the highest yielding variety and has been outstanding in the Harrington area. Burt, Cheyenne, and Itana have been the best varieties for the Horse Heaven Hills. Itana is too susceptible to stripe rust and suffered severe damage in 1960-61. Omar has been the recommended club variety because of its smut resistance; however, Elgin has equal yield. Variety recommendations are Gaines and Omar in the Harrington area; Burt and Cheyenne in the Horse Heaven area; Burt, Gaines and Itana for the Waterville area; and Burt, Gaines and Omar in the Lind area.

Table 2. Summary of average agronomic characteristics of winter wheat varieties grown near Waterville in rod row nurseries 1951-63.

Variety	Plant ht.	Test wt.	Yield bu/a	Yield % Kharkof	No. years grown	Last year grown
Gaines	27	60.6	50.2	134.2	4	1963
Burt x Itana -34	34	62.8	44.1	126.0	1	1963
Omar	33	59.6	39.1	120.8	8	1963
Burt	32	61.3	35.5	120.1	9	1963
Brevor	31	60.9	37.9	120.0	10	1963
Cheyenne	37	61.7	39.8	115.0	6	1963
Tendoy	39	61.8	39.7	114.3	5	1963
Itana	37	61.9	38.5	114.3	9	1963
Columbia	33	62.0	36.7	113.5	10	1963
Rio	34	62.1	32.7	102.0	11	1963
Kharkof	37	61.8	33.2	100.0	9	1963

Table 3. Summary of average agronomic characteristics of winter wheat varieties grown in the Horse Heaven Hills in rod row nurseries, 1951-63.

Variety	Plant ht.	Test wt.	Yield bu/a	Yield % Kharkof	No. years grown	Last year grown
Burt x Itana -34	28	58.2	24.7	121.7	1	1963
Omar	26	58.2	23.6	118.0	6	1963
Cheyenne	30	59.6	22.8	117.5	6	1963
Burt	27	59.0	23.0	114.8	7	1963
Brevor	27	59.0	21.5	113.5	6	1961
Itana	29	60.3	22.1	111.9	8	1963
Columbia	26	61.0	21.1	106.8	8	1963
Gaines	22	57.5	21.6	106.2	3	1963
Burt x Itana -125	26	57.8	20.8	105.1	1	1963
Rio	28	60.4	20.0	101.0	8	1963
Tendoy	29	59.9	19.7	100.3	4	1963
Kharkof	30	60.1	19.8	100.0	8	1963

Table 4. Summary of average agronomic characteristics of winter wheat grown at Lind in rod row nurseries, 1950-64.

Variety	Plant ht.	Test wt.	Yield bu/a	Yield % Kharkof	No. years grown	Last year grown
Gaines	27	59.6	44.8	129.3	5	1964
Burt x Itana -34	33	60.7	44.9	119.0	3	1964
Burt x Itana -125	32	61.0	47.2	125.0	3	1964
Burt	30	60.7	35.9	121.4	10	1964
Cheyenne	33	61.0	37.6	117.2	7	1964
Elgin	27	59.3	32.5	115.5	14	1964
Itana	32	61.3	32.9	111.9	10	1964
Omar	31	59.0	35.9	111.2	7	1964
Brevor	28	60.0	31.2	110.3	13	1964
Tendoy	34	60.3	35.7	109.2	6	1964
Rio	31	61.8	28.2	100.4	14	1964
Kharkof	31	60.6	28.1	100.0	14	1964
Columbia	29	61.2	27.8	94.1	10	1964

Table 5. Summary of agronomic characteristics of winter wheat varieties grown near Harrington in rod row plots 1952-64.

Variety	Plant ht.	Test wt.	Yield bu/a	Yield % Kharkof	No. years grown	Last year grown
Gaines	29	58.8	56.1	146.0	4	1964
Sel. 4	33	58.6	53.1	134.0	2	1964
Burt	33	61.2	47.9	123.4	12	1964
Elgin	35	60.4	46.3	119.4	12	1964
Omar	39	59.4	46.2	118.9	7	1964
Brevor	33	61.3	44.7	115.2	12	1964
Itana	37	61.7	42.3	110.2	11	1962
Columbia	34	62.1	40.3	104.2	10	1961
Kharkof	39	61.4	38.8	100.0	12	1964
Golden	38	58.8	37.0	95.3	12	1964

Table 6. Summary of agronomic data for winter wheat varieties grown at the Dry Land Experiment Station in drill strip plots, 1950-64.

	+ or - Kharkof Date head.	Ht in.	Winter* hardi-ness	Stripe* Rust	Bu/a Yield	Yield % Kharkof	Test wt.	Years grown
Burt x Itana -125	-1	-5	3	5	40.5	120.9	63.4	1
Gaines	+3	-12	4	3	42.9	119.8	60.9	5
Burt x Itana -34	-2	-3	2	4	41.7	119.0	61.3	2
Omar	+5	-5	5	7	37.3	115.9	58.6	8
Burt	-1	-4	4	5	36.1	115.2	60.4	10
Tendoy	0	-1	1	3	36.2	110.4	60.7	6
Cheyenne	-1	-2	1	3	35.3	109.7	61.0	8
Itana	-1	-1	2	7	34.1	108.2	61.4	9
Brevor	+2	-4	5	3	31.8	107.7	60.1	13
Golden	+2	+1	5	3	26.4	104.6	58.6	5
Triplet	-2	-2	4	5	29.1	101.0	60.6	11
Kharkof	0	0	1	3	29.5	100.0	60.8	13
Rio	+1	-1	1	3	28.9	97.9	60.6	13
Columbia	-3	-4	1	8	29.7	94.7	61.2	10

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

Table 6 summarizes the agronomic data of winter wheat varieties grown at Lind in the drill strip field plots. These plots are planted and harvested with conventional equipment and compare more accurately with yields of farmers' fields. Gaines, Burt and Omar are the superior yielding varieties. The two new Burt x Itana selections look very good in the test the last two years.

BURT x ITANA SELECTIONS

The Dryland Experiment Station has two hard red winter selections under increase for possible release in 1965. About 12 acres of Burt x Itana -125 and 8 acres of Burt x Itana -34 are expected to meet foundation seed standards. Present prospects indicate about 700 bushels of both varieties might be available to turn over to Washington State Crop Improvement Association this fall for further seed increase. In addition, Idaho has a small acreage of each selection from the same breeders' seed furnished by this station.

Decision to release one or both selections will be made following the 1965 harvest. Present indications are that the performance of both selections warrant their release. The selections will be renamed before release to growers.

Burt x Itana -125

The overall yield record of this selection is slightly higher, about 0.5 bushel, than the sister selection -34. In 40 trials in regional and state nurseries, the average yield for the last 3 years has been 49.7 bushels. This compares to 42.6 bushels for Itana in 35 of these 40 nurseries. As shown in table 7, Selection 125 consistently outyielded Itana in the three areas summarized. Where enough data are available to compare with Burt, this selection was equal or better yielding.

This selection is white chaffed, about 2 inches taller than Burt, and 4 inches shorter than Itana. It is more lodging resistant than Itana but lodges slightly more than Burt. Under dryland conditions, lodging resistance should be adequate. Selection 125 is more subject to shattering than Itana but slightly better than Burt, and more resistant than Kharkof, Cheyenne or Tendoy. It is more winter hardy than Burt and less hardy than Itana. Spring recovery is rapid. Test weight is slightly better than Itana and superior to Burt, and the Turkey type wheat varieties. Kernel size is somewhat smaller than Itana and common Turkey types. Associated with the higher yield is a lower protein content; however, protein content appears to be about like Itana and superior to Burt.

Burt x Itana -125 has two outstanding characteristics which will be important in much of the area of projected production. It has outstanding emergence characteristics from deep seeding at high soil temperatures. It emerges 1 to 2 days before Itana or Omar and 3 to 4 days before Burt. It has been the best variety tested for this type of seeding at Lind. Tests in 1964 & 1965 in the snow mold area indicate that this selection is slightly more tolerant to snow mold than any commercial variety. This tolerance will be important in years of moderately heavy infection of snow mold, but will not protect against severe infections.

Burt x Itana -125 has fair stripe rust resistance. It is better than Burt, but has less resistance than Kharkof, Brevor and Gaines. In nurseries where readings were taken, it had a 2 to 3 type pustule with an average of about 25% infection. This compared to Kharkof with less than 5% infection and a type 1 and 2 pustule. Itana had about 70% infection with type 4 pustule. Smut reactions are similar to Burt, however it appears that Burt is slightly better. Dwarf bunt reactions indicate good resistance, except to the Kalispell race, to which it is susceptible. Selection 125 does not have resistance to foot rot, leaf rust, or stem rust. In these diseases it is similar to Burt or Itana.

Burt x Itana -34

Burt x Itana -34 differs from Selection 125 by brown chaff color. In height, it differs by being 2 inches taller. It is slightly less lodging resistant being intermediate between Selection 125 and Itana. It is as winter hardy as Itana, more winter hardy than Selection 125. It is more stripe rust resistant than 125, being about equal to Gaines. It is susceptible to snow mold, like Burt or Itana. Emergence is good, similar to Itana, but 1 to 2 days later than Selection 125. In other diseases the reaction is similar to Selection 125. Test weight and protein content appear similar to Selection 125.

Both selections have similar quality. Both mill satisfactorily with a good flour yield, very similar to the milling characteristics of Itana. Co-mingling of the two selections will be acceptable in milling.

The flour characteristics are also similar to Itana's. The flour is a strong gluten type with strong mixing characteristics. Absorption and loaf volume are good. Three years of testing at the Western Wheat Quality Laboratory, and one year of experimental milling by three commercial millers indicate that both selections have good quality.

Area of Recommendation

If released, Burt x Itana 125 will be recommended for the snow mold area of eastern Washington, which normally grows Burt, Itana, Columbia, Omar and some Gaines. This will be the lower rainfall regions in this area. This will be Douglas, Chelan, Okanogan, and parts of Grant and Lincoln Counties.

Burt x Itana -34 will be recommended for the low rainfall area of Washington, which is not normally infected with snow mold, and has a more serious stripe rust problem. This will be parts of Adams, Franklin, Benton, Lincoln, and Grant County.

In the absence of stripe rust and snow mold, either variety appears to be adapted to all of the low rainfall area. It is anticipated that if both are released, they can be grown in adjacent fields, depending upon individual farmer's preference.

Table 7. Yield of selected varieties at locations and years indicated comparing new Burt x Itana selections.

Variety	Lind 1962-64 5 Nurseries		Eastern*** Wn. 1963-64		Pacific Northwest 1964 - 22 locations	
	Bu/a	% Kharkof	Bu/a	& Kharkof	Bu/a	% Kharkof
Burt x Itana -125*	45.5	124.0	57.3	116.2	47.1	122.0
Burt x Itana -34	43.6	119.0	58.6	118.9	47.7	123.6
Gaines	44.5	121.3	66.6	135.2	---	---
Burt	41.7	113.8	56.1	113.8	---	---
Itana**	41.4	112.9	49.1	93.1	40.7	105.4
Kharkof	36.7	100.0	49.3	100.0	38.6	100.0

* 4 Nurseries at Lind

** 4 Nurseries in Eastern Washington

*** Eastern Washington 1963-64
4 Locations - 7 Trials

Spring Wheat

The Spring wheat breeding program at the Dry Land Experiment Station 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, the highest yielding winter wheat, for the period 1957-64 shows a 12 bushel yield advantage for Burt. In some years the difference was as much as 22 bushels in favor of the winter wheat. Higher yield is urgently needed in our spring wheat varieties. Higher yielding spring wheat would be important for rotation to control cheat grass, reseeding, and in years when winter wheat cannot be seeded.

Table 8 shows the yields of spring wheat varieties from nurseries at four locations. Marfed is highest yielding variety at all locations. It is recommended for the dry land area of eastern Washington.

Table 8. Yield in bushels per acre of six spring wheat varieties from rod row nurseries at four locations, 1950-64.

Variety	Lind	Horse Heaven	Waterville	Harrington	Av. all locations
Marfed	23.9	20.3	31.8	31.9	27.0
Lemhi	22.0	18.5	30.4	31.1	25.5
Federation	22.8	18.7	29.0	28.9	24.9
Idaed	21.2	19.1	27.4	30.8	24.6
Baart	21.4	18.6	27.3	27.9	23.8
Henry	19.8	17.9	23.6	29.0	22.6

Several spring wheat selections from the breeding program are in regional and state wide tests. Burt x Onas -52 selections show the most promise. These are hard white selections with good bread quality. Idaed x Burt selections from Pendleton are performing well. These are also hard white selections with bread quality. The hard red selections from Burt x Henry appear the most promising, but yield less than Marfed. Stripe rust resistance is being added to the spring wheat lines. About 150 different crosses are in various stages of the breeding program. If a new spring wheat variety is released in the next 2 years, it will be from Burt x Onas 52 or Idaed x Burt crosses.

WHEAT DISEASES

The important wheat diseases in this low rainfall area are stripe rust, foot rot, and snow mold. Adequate varietal resistance and chemical control have almost eliminated stinking smut. Active research is underway in all of these disease problems. The Dry Land Experiment Stations cooperate with WSU plant pathologists in control studies and breeding for resistance to these diseases.

Foot Rot Diseases

There has been a general increase in damage from foot rot (commonly known as straw-breaker disease) in the low rainfall areas. Contributing factors have been early seeding and favorable weather for foot rot development. Increased funds for the foot rot research from Liquid Fertilizer Dealers, Washington Wheat Commission and WSU have accelerated the research. Project leaders are Dr. G. W. Bruehl and Dr. F. E. Koehler, with the Dry Land Experiment Station cooperating.

In 1963, extensive foot rot trials at this station were conducted. A heavy infection of foot rot was established artificially in healthy wheat. Comparisons were made of fall and spring tillage, rates of fertilizer and date of application, date of seeding, variety reactions and sulfur treatments.

Differences between commercial varieties were demonstrated. The following yield reduction in percent occurred at Lind between diseased and healthy plots: Gaines, 33; Omar, 36; Itana, 46; Rio, 48; and Burt, 50. These results were verified by yields of wheat in heavily infected plots at Pullman, where Gaines and Omar yielded 42 bushels and Burt 23 bushels.

The world collection of winter wheat varieties has been screened for resistance. Some tolerance or resistance is found in some of the European varieties. Some of these were included in greenhouse crosses in 1965. Evidence indicates that crosses between two susceptible parents may give lines with more resistance than the parents. Segregating populations of most crosses will be tested under disease conditions to select the most tolerant lines.

Nitrogen fertilizer was not a factor in the amount or intensity of foot rot infection in 1963 in the Lind tests. Foot rot heavily infected both fertilized and unfertilized innoculated plots. On Gaines wheat seeded Aug. 24, fall side dressed diseased wheat yielded 10 bushels more per acre than spring side-dressing at comparable rates of nitrogen. Spring skew-treading, and shanking with or without additional nitrogen increased the foot rot infection and decreased yields, some plots yielding as low as 7 bushels per acre.

Management trials in 1964 and 1965 did not develop heavy infections due to unseasonably dry spring weather. However, even with light infections, yields were reduced 10 to 20% in 1964, indicating damage from light infections may be more than was previously thought.

From the data now available these recommendations can be made for areas that have a history of foot rot: Gaines and Omar are the best commercial varieties to seed. Early seeding increases foot rot incidence and damage; however, infected early seeded wheat often yields more than late seeded wheat.

In the low rainfall area, nitrogen fertilizer should be applied pre plant or by fall side-dress, preferrably pre plant. Spring tillage with fertilizer shanks, rotary hoe, skew treader or harrow all increase foot rot infection.

Snow Mold

Snow mold is a serious problem on winter wheat in Douglas County and surrounding areas where snow cover over long periods during the winter is common. A project to study this disease is financed by the Washington Wheat Commission. Dr. G. W. Bruehl, WSU Plant Pathologist, is project leader. Most of the hybridization is done at the Dry Land Experiment Station. New cold chambers at Pullman will be used for artificial screening. The chambers will provide far more space than the cold chamber used in Wenatchee. The cold chamber work will be moved to Pullman.

Considerable progress has been made in this program. The world collection of winter wheat varieties was screened during the past 4 years. Three years gave good screening for resistance. Crosses have been made to varieties with tolerance or resistance to snow mold. Two series of crosses have been screened in the cold chamber and in the field. Back crosses have been made on the hybrid material that came through the cold chamber this year. Some of the crosses are ready to be tested in preliminary variety trials. Definite progress in the transfer of resistance to snow mold has been made in the breeding program.

A technique has been developed for testing for snow mold under artificial conditions. Basically, the test subjects hardened plants to snow mold in dark chambers at temperatures of 32 - 36°F until the disease develops to the desired degree. Plants are then returned to the greenhouse for comparison of injury and recovery ability. This test has been used for 4 years. Similar results were obtained in screening both hybrid and variety material in the artificial cold chamber and the field.

The use of an artificial technique for snow mold study is extremely important in breeding for resistance. Since the resistance that has been found to date is not a clear genetic immunity to the disease; transferring the available resistance is difficult. The scientist is selecting for degree of tolerance to a disease and must be able to detect this tolerance. By controlling the intensity of the disease through artificial means, he can select for the maximum resistance possible. Natural field infections are too variable for adequate screening where this type of resistance occurs. The effectiveness of field screening was improved with artificial innoculation in 1965, and will be part of future screening.

The snow mold project will intensify the work on hybridization to transfer resistance into adapted varieties. Testing of chemicals and the use of blackening agents has progressed to a point where very little new information will be gained until new chemicals are developed. The best approach is to transfer resistance as rapidly as possible into adapted varieties.

Stripe Rust

Stripe rust continues to be one of the most serious wheat diseases in the Pacific Northwest. During the past 3 years the low rainfall areas of eastern Washington have not been damaged by stripe rust. However, stripe rust was present each year in the fall on young wheat in amounts that could have triggered heavy epidemics had weather in the winter and spring been favorable for rust development. In 1963, the winter kill eliminated most of the spore bearing leaves except in eastern Oregon where snow cover prevented winter injury. This area suffered severe rust damage in 1963. In 1964 and 65, very dry springs prevented the stripe rust from reinfecting new leaves. As a result, no serious disease problem developed in the low rainfall area.

The Washington Wheat Commission financed a new section of greenhouse for the station in 1964. The greenhouse was equipped with an air conditioned innoculation bench. In 1964-65 over 5,000 plant lines were screened for stripe rust resistance in the greenhouse. Approximately 500 lines a week can be screened. All of the early generation hybrids at the station, snow mold parents, and foot rot resistant parents were screened for seedling resistance to stripe rust in 1965.

The only effective method of combating stripe rust is through breeding of resistant varieties. All commercial varieties recommended in Washington have seedling susceptibility. However, Gaines, Brevor, Burt, Rio, Cheyenne, Tendoy and Turkey have various degrees of mature plant resistance. New varieties about ready for release that have fair stripe rust resistance are Burt x Itana 125, Burt x Itana 34, Itana 65 (an Idaho release), and a sister selection to Gaines (Selection 7). A new club wheat developed in Oregon (178383 x $Omar^2$ -Sel 172) is resistant to stripe rust in the seedling stage and has the best resistance of the new varieties being considered for release.

Stripe rust research is under the leadership of Dr. J. W. Hendrix, Experiment Station Plant Pathologist. Others working on stripe rust include Dr. L. H. Purdy, ARS, Plant Pathologist at WSU and Dr. R. A. Allan, WSU, ARS, Plant Breeder. The overall research program includes epidemiology studies, biological race studies, evaluation of varieties for resistance, and the breeding of new varieties for resistance.*

CHEATGRASS RESEARCH

Cheatgrass is the most serious weed problem of the low rainfall areas. In 1963, heavy infestation of cheatgrass cost the wheat growers an estimated $10 to $15, 000, 000 loss in extra tillage costs and yield reduction from competition with wheat.

Under a Washington Wheat Commission grant, cheatgrass research has been conducted for the last 6 years. Major emphasis of this work has been on chemical control of cheatgrass in the wheat crop. The research is conducted by Don Rydrych from the main station at Pullman. The grant was terminated July 1, 1965. Further research on cheatgrass will be limited to the work included in the station program.

Over the last 6 years, all the available chemicals that might have potential have been tested. None has been effective in controlling cheatgrass in post emergence applications. Atrazine appeared to have considerable promise early in the testing program but has now been dropped from extensive testing. Erratic control with this chemical and long soil residual life in low-organic soils are two major faults. The chemical has never been licensed by the manufacturer for use in growing wheat.

Two chemicals, Montsanto 45592, and UC 22463 are showing some promise as pre-emergence chemicals. Avadex is showing some activity as an incorporated chemical and it is worked into the soil before or right after seeding. Control at Lind in 1963 and 64 with SWEP has also looked promising. Additional research was conducted on these chemicals in 1965.

Control of cheatgrass by chemical summer fallow or winter fallow has promise. Combinations of three chemicals have given good control of cheatgrass in late fall or early winter applications on stubble. The chemicals and combinations effective in tests to date are: Amitrol-T 1 lb. and 2, 4-D Ester 2 lb.; Amitrol-T 1/2 lb. and Atrazine 1/2 lb.; Amitrol-T 1/2 lb., Atrazine 1/4 lb., 2, 4-D Ester 1/2 lb. These applications have given good control of cheatgrass, volunteer wheat, and broad leafed weeds until late spring or early summer. Tillage is recommended with these treatments, but can be delayed until late spring when new growth starts. Only 1 lb. Amitrol and 2 lb. 2, 4-D

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*Stations Circular 424, Stripe Rust, What It Is and What To Do About It, is available at your county extension office. This is an excellent review of the stripe rust problem written by Dr. Hendrix.

Ester have been approved for use in Washington for winter or chemical fallow. All of the chemical fallow combinations are most effective when applied post-emergence to the cheatgrass and volunteer wheat.

Production management is important in cheatgrass control. Management factors affecting cheatgrass control are discussed in EM 2335, available at your county agent's office.

WHEAT PRODUCTION MANAGEMENT

Wheat yields are very responsive to management in the low rainfall areas. Were annual rainfall is from 8 to 12 inches, management practices that conserve moisture are all important. Leggett (1) reported data over a wide range of moisture conditions of eastern Washington, and showed that every additional inch of moisture saved during either the fallow or crop year will increase yield of winter wheat by 6 bushels. Leggett and Nelson (2) reported that soil storage of rainfall in the fallow year varied from year to year with a range of 16 to 52% of the total rainfall. An average of about 35% of the rainfall was stored by the end of the fallow year. There is still a big potential in fallow management to improve the moisture storage.

The efficiency with which the moisture is used by the wheat crop is very important in production. As shown in table 9 there is a variety difference in efficiency of production. In general these data show that early seeding produced wheat more efficiently than late seeding. The one exception was in 1961 when a severe stripe rust epidemic reduced production. Other data also indicate less total moisture is used to produce more wheat when wheat is seeded early.

Table 9. Relative efficiency of available moisture for selected varieties of winter wheat at the Dry Land Experiment Station as compared to date of seeding.

			Inches of precipitation per bushel wheat				
Year	Date of seeding	2 year precip.	Kharkof	Itana	Burt	Elgin	Average
1959	11-5-58	20.81	.81	.68	.75	.71	.74
1961	9-10-60	21.48	.65	.84	.67	.69	.71
1957	10-27-56	19.23	.77	.64	.64	.64	.67
1958	10-9-57	17.63	.65	.56	.55	.54	.58
1954	10-23-53	15.69	.59	.53	.47	.44	.51
1960	9-24-59	19.94	.52	.55	.46	.45	.50
1962	9-13-61	20.58	.55	.48	.45	.47	.49
1964	9-4-63	17.58	.52	.47	.47	.42	.47
1955	9-28-54	15.38	.53		.44	.38	.45
1963	9-19-62	18.55	.51	.43	.43	.43	.45
			.61	.57	.53	.52	.56

Wheat is produced on from 1/2 to 1/4 as much moisture in eastern Washington as in the Great Plains areas of Kansas, Nebraska, and Montana. This is important in our management. It means small gains in total moisture are reflected in yield here more than in other wheat areas.

The management program will be increased with a grant from the Washington Wheat Commission starting July 1, 1965. A full time senior Experimental Aide will be hired to assist in the program under the supervision of F. E. Koehler and others at Pullman and W. L. Nelson at the Station. The first phase of the program will study moisture retention and usage under different methods of tillage during both the summer fallow year and crop year.

Studies are designed to study the effectiveness of mulches on moisture retention, and the best methods to obtain effective mulches with equipment. The program is designed to study the best ways to save our limited moisture and then use it most efficiently.

Recommendations for winter wheat production management based on data available for the 8 to 11" rainfall area are:

1. Summer fallow program of late fall chiseling of stubble, and an initial spring tillage to depth of 6" with sweep or offset disk. This should be followed immediately with sub-surface packing by skew treader, or disk running with little angle, or rotary hoe, or rod weeder. Rod weed as necessary for weed control. When cheatgrass is a problem this method will have to be altered for additional cheatgrass tillage.

2. Fertilizer should be applied in summer fallow for winter wheat either in late spring or early summer or immediately before seeding. Nitrogen is the only fertilizer giving universal response. Sulphur and or phosphorus may be needed where nitrogen alone does not respond. Rates of 30 to 60 lbs. of nitrogen are recommended for this area.

3. Early deep seeding (Aug. 20 to Sept. 15) winter wheat of a recommended variety, is recommended. Use year-old seed whenever possible to eliminate high temperature dormancy of new seed. Seeding rates of 30 to 45 lbs. per acre are recommended for early seeding.

4. Seed late only if moisture is not adequate for early deep seeding. Late seeding is not a reliable weed control measure.

(1) Leggett, G. E. Relationships between Wheat Yield, Available Moisture and Available Nitrogen in Eastern Washington Dry Land Areas. Washington Agricultural Experiment Stations Bulletin 609, 1959.

(2) Leggett, G. E., and Nelson, W. L., Wheat Production as Influenced by Cropping Sequence and Nitrogen Fertilization in the 10- to 15-Inch Rainfall Area of Eastern Washington. Washington Experiment Stations Bulletin 608, 1959.

OIL CROPS

In cooperation with Dr. V. E. Youngman, WSU, the station has been testing oil crops during the last 10 years. Safflower and Crambe appear to have the most promise. Both crops are late maturing, and are poor competitors to Russian thistle. Both are better adapted to rainfall areas of more than 12 inches.

Safflower has a yield range of 400 to 800 lb. per acre in trials at the station. Weed competition reduced the yields by one third and made harvest very difficult. At prevailing prices it was not competitive with barley.

Crambe was grown in 1963. Yields were too low to compete with barley, and weed invasion made harvest very difficult. Crambe was seeded in 1964, but failed to emerge because of dry weather.

In 1965 good stands of both safflower and crambe were obtained. Temperatures of 23^{o} reduced the stands of crambe, but did not affect the safflower. Preplant treatment with Treflan at rates of 1/2 and 1 lb. per acre followed immediately with a skew treader effectively reduced Russian thistle emergence without any visible damage to safflower or crambe. The results this year warrant further testing of Treflan as a preemergence weed control for safflower and crambe.

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 35 years old. Plantings have been made at intervals since the original planting. The Station planting is one of the best in the West for studying trees and shrubs adapted to dry land conditions. Stations Circular 450, 1965, summarizes the adaptation tests of trees and shrubs for the intermountain area of the Pacific Northwest.

Initial observation tests of wood species are carried on at the Soil Conservation Nursery at Pullman. Secondary tests are carried on cooperatively at experiment stations at Prosser and Lind, Washington, and Moro, Oregon. The present testing program at Lind was started in 1928 by the Dry Land Experiment Station and the Department of Forestry and Range Management, Washington State University.

A standard dry land windbreak planting consists of minimum of three rows. When properly established, these give excellent protection from the winds. Results to date indicate the Caragana is still the best erect shrub. Blue leaf honeysuckle, Nanking Cherry, and Bladder Senna are showing considerable promise. Bladder Senna had considerable winter kill in 1965. Russian olive is the recommended species of intermediate shrub. Hawthorn and a strain of wild crab apple are showing promise.

Black locust is still the best deciduous tree. Green ash and Chinese elm may be used, but they are not as good as black locust. Austrian pine is the outstanding evergreen tree, being superior to both Scotch and Ponderosa pine. Douglas fir and Blue spruce can be grown but require more care and grow much slower. Rocky Mountain juniper is an outstanding medium height evergreen. Rocky Mountain juniper is more difficult to establish than other evergreens, but is extremely hardy and vigorous once established.

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

Table 10. 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	Austrian pine Scotch pine Ponderosa pine	Evergreen	12 ft.	27 ft.

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