STATE COLLEGE OF WASHINGTON
INSTITUTE OF AGRICULTURAL SCIENCES
AGRICULTURAL EXPERIMENT STATIONS

34TH ANNUAL FIELD DAY

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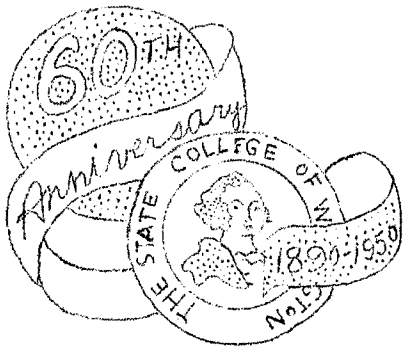

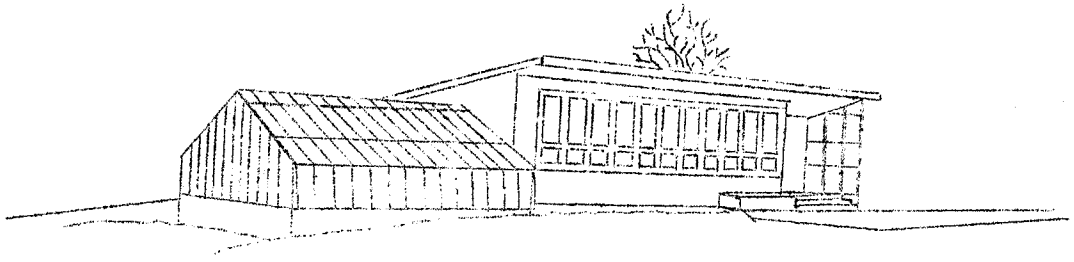

DRY LAND EXPERIMENT STATION
LIND, WASHINGTON

INTRODUCTION

The Dry Land Experiment Station, formerly the Adams Branch Experiment Station, first began in 1910 near Ritzville, when a ten-acre plat of land was leased and experiments with cereals, forage crops and certain phases of soils work commenced. Largely through the efforts of Spokane business men, the Milwaukee railroad, and Adams County a site was purchased approximately three miles northeast of Lind. Buildings were erected and the station moved to its present location in 1915. Originally, the station was operated with county, USDA and state funds. At present it is state supported, aside from a small labor fund contributed by federal agencies, the land being leased from Adams County. The farm consists of 320 acres of land, of which approximately 260 acres are devoted to crops production experiments, the remainder consists of grass and rough land. Early in 1949 the County of Adams deeded approximately 4 acres to the Board of Regents, Washington State College, and it is on this site that the new state financed office and greenhouse buildings were constructed. Under the leadership of the Washington Agricultural Experiment Station, the Dry Land Experiment Station has carried out a continuous program of research since its establishment.

Experiments are planned and conducted cooperatively with the different divisions of the Washington Agricultural Experiment Station at Pullman, Soil Conservation Service and Bureau of Plant Industry USDA, and with the U.S. Weather Bureau, Department of Commerce.

The field day is an annual affair held about June 15, for the purpose of acquainting farmers, ranchers and townspeople of Central Washington with the nature of the work being conducted and to furnish information collected from the many experiments in progress. The public is especially invited to attend these field days, although visitors are welcomed at all times.

Note: Data presented hereafter in this report are not for publication without consent of the Washington Agricultural Experiment Station and cooperating agencies.

Walter L Nelson

Walter L. Nelson, Superintendent

CLIMATIC STUDIES
Annual Rainfall Near Lind, Washington
1897-1950

Data Obtained by Dan Krehbiel		Data Obtained by O. W. Goodenough		Data Obtained by the Dry Land Experiment Station			
1897-98	6.34	1909-10	8.74	1916-17	7.60	1932-33	8.39
1898-99	8.76	1910-11	8.10	1917-18	6.64	1933-34	9.79
1899-00	12.00	1911-12	10.33	1918-19	8.10	1934-35	7.48
1900-01	15.34	1912-13	8.24	1919-20	6.56	1935-36	8.09
1901-02	12.33	1913-14	10.50	1920-21	7.01	1936-37	8.93
1902-03	13.67	1914-15	10.54	1921-22	6.99	1937-38	11.89
1903-04	15.03	1915-16	13.59	1922-23	10.92	1938-39	5.32
1904-05	11.34			1923-24	6.62	1939-40	13.01
1905-06	12.01			1924-25	8.32	1940-41	18.00
				1925-26	6.65	1941-42	12.29
				1926-27	12.65	1942-43	11.65
				1927-28	10.83	1943-44	8.60
				1928-29	5.77	1944-45	10.05
				1929-30	4.88	1945-46	11.80
				1930-31	6.91	1946-47	8.02
				1931-32	9.79	1947-48	23.07
						1948-49	7.00
Average	11.86		10.00				9.38

Average for 49 years: 9.93

Rainfall September 1, 1949 to June 14, 1950: 9.35

Approximately 55% of the rainfall received occurs during the winter months, 30% in summer and 15% in the fall.

Climatic measurements are made daily, and consist of readings made with standard U.S. Weather Bureau instruments consisting of maximum and minimum thermometers, a manual precipitation gage, sling psychrometer, and evaporation instruments. In addition, a continuous record of soil and air temperatures, relative humidity and precipitation is taken by means of automatic recording instruments.

Temperatures: Temperatures at this station are usually not harsh, rarely dropping below zero or exceeding the hundred degree mark, although 116° F. and -33° F. extremes have been recorded. The average frost-free period is approximately 150 days, the last spring frost occurring about May 10 and the first fall one about October 8. In the winter months the soil usually remains frozen only part of the time, normally totalling 70 to 75 days during any winter. Previous to the winter of 1949-50 the soil had not remained frozen continuously for more than 40 days. However, from December 6, 1949 to February 25, 1950 the soil remained frozen--a total of 81 days.

Rainfall: The amount of rainfall received often is correlated very closely with the kind of crop harvested, particularly that portion

of moisture which is received during the winter months and stored up in the soil for crop use. Rains are measured in hundredth inches by means of a standard instrument consisting of a tube, funnel and rule. The intensity of the rain is measured by an automatic instrument which weighs the amount of moisture received and records it on a suitable chart. Since the chart is mounted on a revolving drum run by a clock, the record shows the length of time during which a given amount of rain falls. The precipitation record at this station is continuous since 1916, and is supplemented by records obtained during the period 1897-1906 by Dan Krehbiel at his farm 1½ miles north of the station, and by O.W. Goodenough from 1909-1916 at his farm south of Lind. Thus, over a period of 54 years, records for only three are missing.

The percent of possible sunshine is low in winter, but high in summer, being nearly double the number of hours in the latter season. Throughout the year, approximately 165 days are clear, 95 days partly cloudy, and on 105 days cloudy weather prevails.

Relative Humidity, Evaporation and Wind Movement: These three factors are of lesser importance than the preceding ones. However, the amount of wind movement in a given period has an important effect on evaporation, the amount of soil movement, and the physical condition of crops during certain seasons of the year. Wind movement is measured in miles of air movement past a given point in a twenty-four hour period, by means of a three-cup anemometer. Maximum and true velocities are not readily measured by the instruments available at the station. Relative humidity is measured by means of suitably mounted wet and dry bulb thermometers, which are collectively known as a sling psychrometer. Humidity is an important factor in the comfort of humans and indirectly affects plant growth. In semi-arid regions such as ours, the effect of low humidity and hot winds often results in failure of fruits and vegetables to bear because of damage from the hot, dry air. Evaporation is measured from a free-water surface in hundredths of inches, and is an important observation in relation to storage of water in open reservoirs, the amount of runoff expected in mountainous areas and the amount of rainfall stored in summerfallow. Until recently, evaporation from natural land surfaces has defied measurement and the evaporation tank has remained the common method of measuring this type of water loss.

CEREAL INVESTIGATIONS

Many winter and spring cereal varieties are tested each year at this station, some old and others new. The standard procedure has been to test a new variety in a rod row against standard varieties. If the new one shows promise, it is advanced to larger plots and further tested, usually for a five-year period. If the variety shows superiority in yield, disease resistance, stiffness of straw, quality and other factors it is considered for release as a new variety.

With new facilities now available, actual breeding as well as selection of new varieties for the Big Bend is now possible. New hybrids developed here and at other stations will be tested for agronomic characteristics and smut resistance in early generations. Promising

selections will be tested for milling and baking characteristics at the Wheat Quality laboratory at Pullman. Further testing in more comprehensive tests at Lind and outlying areas will be conducted on selections having suitable milling and baking characteristics. If a selection will show superiority in all these tests when compared to standard varieties, it will be considered for release. Major emphasis will be on winter wheat, although breeding work with spring wheat will be increased. Introduction of new varieties will be continued. These varieties will be studied for possible release in the near future, and for sources of parental material.

Winter Cereals: In a great many years, soil moisture and rainfall conditions are unfavorable to establishing stands of winter-type small grains. It is estimated that in only one year out of five are moisture conditions adequate. Some control over fall seeding is accomplished by using the ordinary 7-inch drill when surface conditions are favorable and the deep furrow drill in adverse years. Generally speaking, if good stands can be obtained, fall sown grains out-yield those sown in the spring.

Average comparative data for certain selected varieties of winter wheat and rye - 1918-1946

Variety	Yield Per Acre		Wt. Per Bu.	No. Yrs. Grown
	Grain Bu.	Straw Lbs.		
Turkey	17.3	1606	59.4	20
Kharkof	17.0	1617	59.6	18
Rio	16.9	1563	56.6	9
Hymar	19.4	1682	56.6	10
Golden	16.6	1612	56.2	7
Elgin	17.7	1354	56.7	7
Requa	18.3	1682	58.7	4
Orfed	17.3	1749	60.5	6
Wasatch	16.9	1649	60.1	4
Rosen Rye	14.2	2306	51.4	27

Of the winter wheats, Hymar has shown the highest yield, but is not recommended for this area because of its unsatisfactory quality when grown under semi-arid conditions. Rio, a turkey type of winter wheat is recommended. Rio has equalled other turkey wheats in yield and test weight and has the advantage of superior smut and rust resistance. Orfed has shown some promise among the white wheats, but is primarily grown in those areas of eastern Washington where soft wheats are produced. Orfed can be sown either in the fall or the spring, but appears to be less hardy under our conditions than the turkey red sorts.

Requa has received limited testing at this station. This variety has shown some superiority over commonly grown Big Bend varieties in yield and is rapidly expanding in acreage particularly in Garfield County and the Horse Heaven area of Benton County. It rates only fair as a bread flour. Although classed as soft white, it frequently

grades hard white under limited rainfall conditions. Some of the objections to this variety are weak straw, tendency to shatter, susceptible to common and dwarf smut, all common rusts and to powdery mildew. It is not a recommended variety.

Spring Cereals: Although spring cereals yield somewhat less than winter ones when emergence stands are equal, they are in most years the predominate crops in Central Washington. This station has long placed major emphasis on the development of high yielding, high quality spring wheat varieties. Following is a table in which important spring wheat and other cereal varieties are listed.

Average data for certain spring Cereals
1918-1946

Variety	Yield Per Acre		Wt. Per Bu.	No. Yrs. Grown
	Grain Bu.	Straw Lbs.		
Baart	16.0	1176	58.9	30
Ceres	15.1	1299	58.7	21
Onas	16.2	1120	53.0	21
Federation	14.7	1069	55.0	28
Orfed	16.2	1288	59.4	5
Pacific Bluestem	14.7	1336	53.3	29
Marfed	16.9	1105	54.9	5
Awned Onas	18.8	1295	56.2	4
Reliance	14.8	1204	58.6	13
Marquis	13.8	1222	55.0	27
Common Sp.Rye	11.3	1464	50.5	25
Markton Oats	27.5	1132	34.2	25
Hannchen Barley	25.7	1056	47.2	4
Glacier Barley	19.0	862	42.8	2
Compana	25.7	1379	45.9	4

Over a 30-year period Baart has successfully maintained a primary position among spring wheats grown in the Big Bend. It will grade hard white under our conditions and is considered a high protein variety. The flour from Baart wheat is in demand among bakers, grading excellent for bread and good for crackers and cake. The hard red spring wheats have not been outstanding in our area. Among the newer varieties, Awned Onas, a bearded selection from Onas white wheat has shown considerable promise.

Many varieties of oats, barley and rye have been tested at this station. Among these, Markton oats and Hannchen Barley have been most satisfactory. Common spring rye is usually low in yield of grain, but produces a relatively heavy hay crop.

ANNUAL LEGUMES

Fall seedings of winter peas and vetch have been somewhat unsatisfactory because of winter annual weed growth. The more satisfactory spring sown peas, because of a cool temperature seedling

growth requirement, must be sown very early in the spring, and are best grown in 28-inch double rows to allow cultivation. According to records here, about 9.5 bushels of seed can be expected, on the average. No peas are in test at present. Peas are generally considered a high risk crop and their production under semi-arid conditions is not recommended.

METHODS OF SEEDING CEREALS

Best results have been obtained in seeding spring cereals by working the land early with a springtooth, or other suitable weeder, followed by seeding with a drill having press wheels. A moderately heavy pressure on the presswheels is desirable, although the depth should be relatively shallow. The usual rate of seeding has been 40 to 50 pounds per acre.

Best results have been obtained when winter wheat was sown between September 1 and October 20 at a rate of 60-70 pounds per acre. For spring wheat, early spring sowing has been most productive, although yields are not greatly reduced by deferring seeding until April 1.

FURROW SEEDING OF CEREALS

Semi-furrow seedings usually are superior to ordinary drills from the standpoint of yield. The deep furrow drill with 14-inch spacings has been tested for only one year, and the results appear satisfactory. Further testing with both hoe and disk type deep furrow drills is planned.

PURE SEED PRODUCTION

The modern combine, plus the bulk system of handling crops has greatly complicated the production of relatively pure seed on the farm. Mixtures between varieties as well as crops has been steadily increasing, more especially between wheat and rye. Winter wheat will usually be free from spring wheat mixtures due to winterkilling, but it is difficult to prevent winter wheat mixtures in spring wheat. Volunteer rye is almost impossible to eradicate owing to its early ripening habit, plus the fact that it readily shatters.

At this station a policy of constant watchfulness and frequent rogueing plus the use of clean seed has prevented the general establishment of rye in the fields.

The method of producing pure seed for distribution as practiced at this station is as follows: each winter a lot of from 200 to 300 pounds of choice seed of Baart or Rio is carefully fanned and hand sorted to eliminate all off-type kernels. Although this is a time-consuming process, it prevents the planting of many mixtures and variants which would later show up in the field. These lots of seed are planted at reduced rates in isolated areas for basic increase. By this means, enough seed is usually obtained to plant large station fields the following year to be used for distribution. During the growing season the fields are rogued several times to

remove any undesired plants, and again at maturity when plants showing off-color chaff and straw are most noticeable. In spite of these precautions, a few natural field crosses occur; rodents carry in seeds and whirlwinds deposit stray heads in the fields. At irregular intervals several thousand heads that are true to type are selected, threshed separately and grown in short rows for field inspection. From these rows which are again threshed separately and bulked after inspection a new stock of pure seed is obtained which is again increased until enough is secured to allow distribution. It is only in this manner that stocks of any variety can be maintained.

Pure seed stocks can be secured from this station by applying directly, or through your county agent. Seed to be used for production of certified seed must be obtained through the Washington State Crop Improvement Association.

FORAGE INVESTIGATIONS

Forage Adaptation Tests: Grasses and legumes for soil and moisture conservation are being tested at the Dry Land Experiment Station in cooperation with the Soil Conservation Service, Nursery Division.

The initial testing is done at Pullman, Lind is one of a system of outlying nurseries under different soil and climatic conditions to carry on secondary testing.

The following data supplements material presented at previous field days. Fall 1943, Dryland Grass Plots. Eighteen grasses were selected on the basis of past performance at Lind and seeded in the fall of 1943. The purpose of this planting was to compare conservation uses and hay yields for the 10 to 14-inch rainfall area. In dryland rotations grass roots add organic matter to the soil. This maintains fertility and improves the physical condition. The soil is more resistant to wind and water erosion when it is well supplied with fibrous grass roots and active organic matter. Hay yields along with root production, longevity, drought resistance, ground cover and availability of seed should be considered in selecting grasses for conservation seeding. The following grasses have been outstanding under dryland conditions at Lind:

Dryland bunchgrasses:	Crested wheatgrass
	Whitmar beardless wheatgrass
Sod-forming grasses:	Pubescent wheatgrass
Dryland bluegrasses:	Sherman big bluegrass
Fine-leaved fescues:	Sheep fescue P-274

From results obtained on this station and other dryland areas the following grasses can be recommended in the wheat-fallow area from 8 to 14 inches annual rainfall.

Range and Pasture

1. Crested wheatgrass - 6 lbs. & Bulbous bluegrass - 2 lbs.
2. Whitmar beardless wheatgrass - 8 lbs. & Bulbous bluegrass - 2 lbs.

Hay

1. Sherman big bluegrass - 4 lbs. & Ladak alfalfa - 2 lbs., Seeded in alternate rows
2. Sherman big bluegrass - 4 lbs.

Fall and Spring Seeding of Dryland Grasses and Legumes Alone and in Alternate Row Mixtures.

The preliminary trial was seeded in the fall of 1945 and the spring of 1946. The fall seeding was made late enough, November 16th, that no germination took place until the following spring. The spring seeding was made as early as possible, March 1st. This preliminary trial indicated that late fall seedings were better for both dryland grasses and legumes.

Another trial was set up to make a similar seeding in late fall and early spring for three consecutive years to check these results. The yields on these plantings have been very erratic due to variable stands and limited moisture. Under dryland conditions, thinly spaced plants will produce more per acre than thick stands. In general better stands of the grasses have been obtained in the fall seeding. With abundant moisture in the spring and summer of 1948, the spring seeding of grasses was equal to the fall. Early spring seeding is best for legumes, but the stands obtained have shown that fair to good legume-grass mixture can be established from late fall seedings. Whitmar beardless wheatgrass, Sherman big bluegrass, or standard crested wheatgrass can be recommended for alternate row seedings with alfalfa in dryland conservation plantings.

The second seeding of this project was made November 12, 1947 and March 15, 1948. The third seeding was completed in 1948-49.

Spring 1943, Dryland Legume Seeding: Six promising dryland legumes were seeded for adaptation tests and comparison with Ladak alfalfa. A table of annual and average yield from 1944 through 1947 of legumes seeded in the spring of 1943 at Lind, Washington follows:

Species	Yield lbs. per acre				Four-year Average
	1944	1945	1946	1947	
Sainfoin	1178	1341	966	303	921
Ladak alfalfa	1757	2290	1311	487	1461
Hybrid alfalfa	2032	2350	1344	458	1546
Siberian alfalfa	1905	3132	1594	345	1744
Cicer milk vetch	2658	2019	1197	183	1514
Sickle milk vetch	2252	2287	1785	426	1688
Perennial vetch	1301	1396	925	236	965

There is a need in the rotation for a legume that will produce and maintain a stand under dryland conditions. There is very little difference in the production of the top five legumes used here. Ladak alfalfa has maintained the best ground cover and stand. Cicer milk

vetch stays green longer than other legumes and would lengthen the grazing season in a pasture. The legume adds nitrogen, the grass builds soil.

Forage Crop Improvement: The forage crop program consists mainly of selecting strains that are most suitable for dry-land farming and range land plantings. The selections of grasses takes into account fall and spring recovery, amount of growth, quality of forage and desirable seed habit.

Each year, general observations are made in the grass nursery and field plantings to select certain plants that may have desirable characteristics. Some of these plants are taken up and cloned in small plots to study their behavior and habits under field conditions.

Methods of Planting Grasses: Among the several methods of planting grasses, the most satisfactory stands have been obtained by using a drill in a clean summerfallow. The drill can be adjusted to seed any desired rate and depth. If the stubble land is clean, grass can be successfully established by seeding the stubble in early fall. Since the grass grows very slowly during the seedling stage the seedbed should be free from weeds.

Broadcasting often is done with occasional success. This should be followed by light harrowing to cover the seed. A danger in broadcasting is the production of an uneven stand of grass, and an aggravated weed problem.

The rate of seeding grass most suitable for pasture purposes is 5 to 8 pounds per acre. This will establish a stand uniform enough to prevent invasion of weeds. The depth should not be over one inch, preferably it should be from one-quarter to one-half inch deep. Proper depth can be secured by using depth regulators on the furrow openers or having the hose fastened outside of the furrow openers. A drag chain may be used with the latter to cover the seed with about one-quarter inch of soil.

The best time to seed grass is in the fall of the year. If moisture conditions are suitable, it can be sown from as early as September 1 to as late as January 1, but the ideal time is from October 1 to 15. Spring seeding is not recommended unless it is sown early enough to become well established before the onset of hot weather.

Depending on the use to which the grass is to be put, row spacing may vary from seven inches to three feet. The wider the row spacing, the greater the forage and seed yield. Beyond the two-foot row spacing, additional care is required to control the weeds that may invade the stand between the rows. The 14-inch row spacing seems to be the most satisfactory. Much wider spacings than this makes the grass coarse and less desirable for pasture purposes, and if cultivated for seed, seems to promote erosion.

Uniform stands of grass can be established by seeding a cereal nurse crop in alternate rows with grass. The grain yield of the nurse

crops is approximately 90% of normal while at the same time satisfactory grass stands are established. The nurse crop can be cut for hay or left to mature for grain. The nurse crop utilizes the soil moisture which would otherwise be used up by the weeds, thereby providing a satisfactory weed control measure. The ordinary grain drill can be adjusted to seed the two crops in alternate rows by having removable partitions placed in the grain box. The rate of seeding for both the crops can be made at the same setting but for any desired variation, reducers made of heavy wire can be used very effectively. Recommended rate of grass and nurse crop seeding is eight pounds and forty pounds respectively. If rye is used as a nurse crop, the rate should be cut down to 20 pounds per acre. Spring tension should be lessened on the furrow openers of the drill sowing grass so that the seed will not be buried too deeply in the soil.

Care and Handling of Grass Stands: Almost as much importance should be given to the care and handling of a stand of grass as to the seedbed preparation and seeding. The grass in the seedling stage during dry seasons often does not develop brace roots without which it cannot stand any pulling or other mechanical disturbances. If moisture conditions are above normal, the brace roots are quite well developed during the first year's growth. At the end of the second year, the grass can be moderately pastured without serious damage to the plants. In the third year the grass will stand normal grazing. Sherman big bluegrass is the sole exception to this rule. This species pulls very readily when grazed at some seasons of the year. This grass is very desirable as a hay crop, however. The normal field carrying capacity for an established stand of grass ranges from five to twenty acres per animal unit depending on the soil moisture and the type of soil. During the time grass is in the seedling stage, weeds can be mowed at blossom time. Mustard can be harrowed down or cabled just after it heads out and before the stems become tough.

The age of maximum productivity of crested wheatgrass is three to five years after which it declines to a normal productive capacity resulting from the exhaustion of residual soil moisture and nitrates from the soil. This station has a 21-year old stand of crested wheatgrass which produces about the same now as it did ten years ago. In order to increase the productivity it may be desirable to use a cultivating implement both in late fall and in early spring to loosen the soil and thin out the thick stand. The cultivation increases the rate of nitrification so that the increased growth will be as much as 25% over the non-cultivated stand. Usually this is recommended for grasses that are over four years old.

The Use of Nitrogen in Seed Production of Grasses: In 1948, light applications of ammonium sulphate to both cultivated and uncultivated old stands of grass were begun. Ammonium nitrate also was used. Although no data are available, inspection of the plots indicates that a positive response was obtained, treated plots showing a darker color and more luxuriant growth. In 1949 the season was too dry to apply nitrogen to grass.

SOIL INVESTIGATIONS

Tillage Experiments: There are 16 different tillage treatments in the experiment to determine the effects of different types of implements, dates of tillage and amount of trashiness on crop yields and on erosion control. The present tillage series was started in 1938.

In past experiments, the best yields were obtained by wet fall or early spring plowing. There was a steady decrease in yield as the time of the initial tillage was delayed until about April 15 when the decrease became greater due to volunteer growth and weeds exhausting the soil moisture.

Deep tillage gave the best yield only when the annual rainfall was above normal, but for below normal rainfall, shallow tillage gave more satisfactory results.

Because the plow turns under the trash, this implement is not desirable for soil erosion control. Tillage by a lister type of implement leaves the surface soil layer extremely open and causes greater loss of moisture by evaporation. However, such tillage leaves the greatest amount of trash on the surface.

After-harvest tillage reduces the yield in relation to the amount of moisture lost in the fall by increased evaporation from the loose soil. If the depth of harvest tillage in the stubble is relatively shallow very little moisture is lost by excessive evaporation in the fall, and such tillage becomes extremely important in destroying Russian thistles before producing seed and in retaining the moisture that otherwise would be lost in maturing the weeds in the stubble. A blade machine, if properly adjusted, and other implements having suitable underground cutting devices are satisfactory for destroying weeds in the stubble. The stubble is then left standing to catch drifting snow in the winter and to control erosion. Weeding directly after harvest has given the highest average yield in tests with spring wheat.

Crop Rotations: Because soil moisture is the major limiting factor for plant growth, very few crops can be successfully grown other than winter and spring cereals in most of the Big Bend Country. Therefore, a rotation system must take into account the limitation of suitable crops that can be grown and the value of such rotation in maintaining productivity and in erosion control. Although several crops have been included in a rotation system in the past experimental work at this station, the most satisfactory one has been wheat alternating with fallow. A new set of rotation plots was set up in 1938 using grass and wheat in a rotation system. The grass stand is left remaining for four years, followed by wheat alternating with summerfallow in the next eight years. This type of grass and wheat rotation was based on the probable effective maximum development of grass root density and on the number of years required for a complete decomposition of the grass roots in the wheat and fallow. Since crested wheatgrass reaches its maximum plant development at

the age of four years, it is assumed that the root density is also at its maximum and this should be an ideal time to break up the sod for wheat and fallow. The remaining eight years should be ample time for complete decomposition of the grass roots after which the land should be put back into grass to replenish the organic matter supplied by the grass roots. Although the organic matter depletion is retarded by this rotation, the greatest advantage is in the erosion control afforded by the protective mechanical action of the fibrous grass roots. Such a rotation system could be well adapted to the dry-land farming system in Central Washington.

During the past several years, this station broke out field areas of crested wheatgrass sod in strips of nine-rod widths. These are arranged to provide a rotation of wheat and fallow in alternate strips with a narrow strip of grass separating each rotation strip. The grass sod was broken when the stand reached the age of five years by means of a one-way disk in late fall or in the spring just after spring recovery was completed. The yield of the first crop of wheat produced on the sod land was about 75% of the normal field yield. The succeeding crops approached normal production quite rapidly.

AGRONOMIC DATA FOR WHEAT IN A ROTATION WITH GRASS

Crop	No. Crops After Grass	Average Bus. Per Acre	Lbs. Straw Per Acre	Wt. Per Bu.	Pl. Ht. In.	% Protein
1946						
Spring wheat	0	21.2	1244	60.8	26	
	1	21.4	1019	60.7	26	
Winter wheat	0	19.5	1226	59.2	26	
1947						
Spring wheat	0	13.9	653	60.1		13.9
	1	11.8	539	60.3	17	13.2
	2	15.4	718	60.0	19	13.9
Winter wheat	0	14.7	871	60.0	19	13.4

Application of Fertilizers to Maintain Soil Fertility: Except under extremely abnormal conditions, the application of fertilizers for maintaining soil fertility is not practical in dry-land farming. During years of abundant rainfall, the addition of a small amount of fertilizer will promote more normal development of plants in the early growing period. However, the increase in the grain yield has not been sufficient to cover the cost of applying the fertilizer.

This station started a series of permanent plots of eight variations of fertilizer applications in 1923. In 1941 the soil from these plots was analyzed for organic matter content to determine what

effect the application of fertilizers had on soil fertility. The analysis showed definite effects of fertilizers on the soil organic matter. Although the carbon content of the soil was increased for all applications, the nitrogen was increased in only two plots, namely, one having 3200 pounds of straw applied each crop year and the other having 3½ tons of manure applied. Since moisture is the limiting factor in crop production, the yield is naturally affected very little by the application of fertilizers.

Trees and Shrubs for Dry-Land Planting: Several species of trees and shrubs are included in the station forestry project for farm home landscaping and wind-break purposes. Some trees on the station are 25 years old while others are 17 years old. Trees are a valuable asset to any farm, both in improving rural living conditions and in increasing the value of the property.

Initial observational tests of woody 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 at 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 College.

A standard dryland windbreak planting consists of a minimum of five rows and when properly established, gives excellent protection from the wind.

Standard Species, Arrangement, and Spacing of trees and Shrubs for Windbreak Plantings in the 8-10 inch rainfall area.

Row No.	Species	Growth Habit	Spacing in row	Minimum distance from next row*
1	Caragana	Erect Shrub	3 ft.	18 ft.
2	Tamarix	Intermediate shrub	6 ft.	18 ft.
3&4	Black locust	Deciduous tree	12 ft.	18 ft.
5	Ponderosa pine	Evergreen tree	12 ft.	27 ft.

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

Results to date indicate that bladdersenna and southernwood are equal to caragana in the erect shrub group except that neither are quite as winter hardy. Since Russian olive contains an unidentified disease, tamarix appears to be the most promising intermediate shrub. American plum may replace the tamarix, but further testing is needed on this shrub. Black locust is still the most promising deciduous tree. Other deciduous trees being tested include green ash and Oregon white oak. Rocky Mountain juniper appears promising as a replacement for Ponderosa pine in the evergreen group. Both Douglas fir and Blue spruce also appear well adapted. Continuous clean cultivation is essential throughout the life of a dryland tree planting. Interplanting of crops utilizes moisture needed by the trees and shrubs and this practice is not recommended.